VOLUME II

TECHNICAL EVALUATIONS

Final Environmental Impact Statement

SITING of WASTEWATER TREATMENT FACILITIES for BOSTON HARBOR

Prepared by:

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION I

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12/2/85

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Regional Administrator, U.S. EPA, Region I

This Final Environmental Impact Statement has been prepared by the U.S. Environmental Protection Agency (EPA) with assistance from the General Services Administration as a Cooperating Agency under the requirements of the National Environmental Policy Act. The FEIS identifies and evaluates the environmental impacts of various site options for wastewater treatment facilities for treating Greater Boston's wastewater in compliance with federal and state water pollution control laws.

FINAL ENVIRONMENTAL IMPACT STATEMENT

PROPOSED ACTION:	SITING OF WASTEWATER TREATMENT FACILITIES IN BOSTON HARBOR
LOCATION:	BOSTON, MASSACHUSETTS
DATE:	DECEMBER, 1985
SUMMARY OF ACTION:	This FEIS considers the environmental acceptability of alternative locations for the construction of new wastewater treatment facilities for Boston Harbor. The FEIS recommends the construction of a secondary wastewater treatment facility at Deer Island.
VOLUMES:	I. COMPREHENSIVE SUMMARY II. TECHNICAL EVALUATIONS III. PUBLIC PARTICIPATION and RESPONSE TO COMMENTS IV. PUBLIC and INTERAGENCY COMMENTS
LEAD AGENCY:	U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION I J.F.K. Federal Building, Boston, Massachusetts 02203
COOPERATING AGENCY:	GENERAL SERVICES ADMINISTRATION
TECHNICAL CONSULTANT:	THIBAULT/BUBLY ASSOCIATES 235 Promenade Street, Providence, Rhode Island 02908
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FINAL DATE BY WHICH COMMENTS MUST BE RECEIVED:	____________________

VOLUME II

Final Environmental Impact Statement

Technical Evaluations

I. Introduction

This document, Volume II of the Final Environmental Impact Statement (FEIS) on the Siting of Wastewater Treatment Facilities in Boston Harbor, is one of four volumes prepared to:

respond to comments raised on the Supplemental Draft Environmental Impact Statement published on December 31, 1985,

meet EPA's obligations under the National Environmental Policy Act (NEPA).

The other volumes of the FEIS are:

Volume I Comprehensive Summary

Volume III Public Participation and Response to Comments

Volume IV Public and Interagency Comments

Volume II of the FEIS contains technical reports on analyses conducted subsequent to the publication of the SDEIS. EPA received numerous comments on the analyses contained in the SDEIS on Siting of Wastewater Treatment Facilities in Boston Harbor. After a careful review of all comments received (written and oral) the Agency developed a list of issues which required further technical review and analysis. (See Volume III for a summary of all issues raised during the comment period on the SDEIS).

Each of the technical evaluations in Volume II begins with a summary of the issues requiring additional work by EPA or the MWRA for the FEIS or FEIR. Technical information contained in this volume is the result of joint efforts by EPA, the MWRA and their consultants.

VOLUME II

Technical Evaluations

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- Report on Alternative Technologies Potentially Applicable to Boston Harbor Wastewater Treatment Facilities to Reduce Facility Size (June 1985)

- Assessment of Volatile Organic Compound Emissions' Impact on the Siting of a New Boston Wastewater Secondary Treatment Facility -- Methodology Report (September 1985)

- Interim Systems for the Transportation of Sludge from Deer and Nut Islands, Exploration of Alternatives: Their Technical Feasibility and Costs (August 1985)

II-1

traffic and transportation

II-1 TRAFFIC AND TRANSPORTATION

A. Background

Comments on traffic and transportation centered on three areas:

1. Were the existing conditions of the roadways to each of the alternative sites fairly and accurately described in the SDEIS?

2. Were the proposed mitigating actions designed to reduce projected traffic volumes feasible?

3. Could over-the-road traffic be reduced even further than proposed in the SDEIS?

4. Were the forecasts of induced traffic remaining after implementation of the proposed mitigating actions reasonable estimates?

Review of traffic and transportation, since receipt of comments indicates that existing conditions, at least on the access roads to Deer Island through Winthrop, East Boston, and Revere, are more severe than previously estimated. However, the review also indicated that a greater percentage of the total traffic could access the construction sites by water than previously estimated, so that there could be even less traffic on the local streets. As a result, it was concluded that the proposed project would not add significantly to existing traffic problems.

B. Baseline Conditions

The questions on existing roadway conditions centered primarily on access to the Deer Island site and included: What routes would be used for access between the proposed sites and the regional expressway network? Are there truck restrictions? Are there safety problems? Congestion?

1. Deer Island

As shown on Fig. T-1, all traffic access to expressways from Deer Island must flow through the town of Winthrop using the town's network of residential and local commercial streets. It can leave the town by only two exit roads, one along Short Beach into Revere, and the other across the Belle Isle inlet into East Boston. By either route it is possible, by traversing residential areas in Revere and/or East Boston, to reach either the Northeast Expressway in Chelsea or the central artery in downtown Boston.

All automobile and small to medium truck traffic to the southern and western portions of the metropolitan area would leave Winthrop

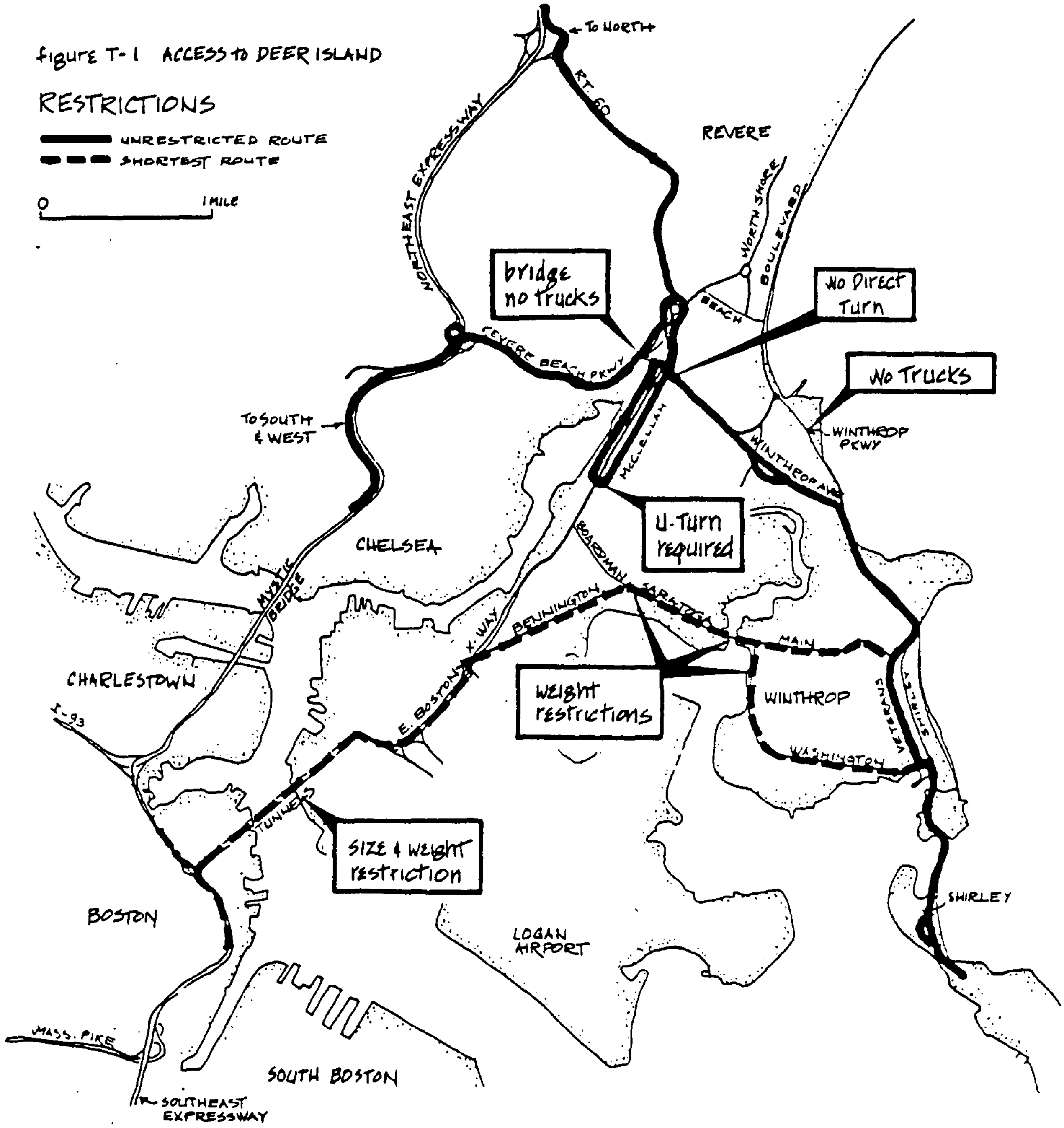


figure T-1 ACCESS to DEER ISLAND
RESTRICTIONS
UNRESTRICTED ROUTE
SHORTEST ROUTE
0
1 MILE
TO NORTH
RT. 60
REVERE
NORTHEAST EXPRESSWAY
NORTH SHORE
BOULEVARD
bridge no trucks
No Direct Turn
No Trucks
REVERE BEACH PKWY
BEACH
WINTHROP PKWY
TO SOUTH & WEST
McCLELLAN
WINTHROP AVE
U-Turn required
CHELSEA
BOARDMAN
MYSTIC BRIDGE
BENNINGTON
SARATOGA
MAIN
X-WAY
CHARLESTOWN
weight restrictions
WINTHROP
I-93
E. BOSTON
WASHINGTON
VETERANS
SHIRLEY
TUNNELS
SIZE & weight restriction
BOSTON
LOGAN AIRPORT
SHIRLEY
MASS. PIKE
SOUTH BOSTON
SOUTHEAST EXPRESSWAY

via Main Street to Saratoga and Bennington Streets in East Boston, the East Boston Expressway, the Sumner Tunnel, the Central Artery and, from there, either the Southeast Expressway to the south, or the Massachusetts Turnpike to the west. The heavy truck traffic would use Winthrop and Crescent Avenues through Beachmont to Revere, to the Revere Beach Parkway, the Northeast Expressway, the Mystic River Bridge, and the Central Artery.

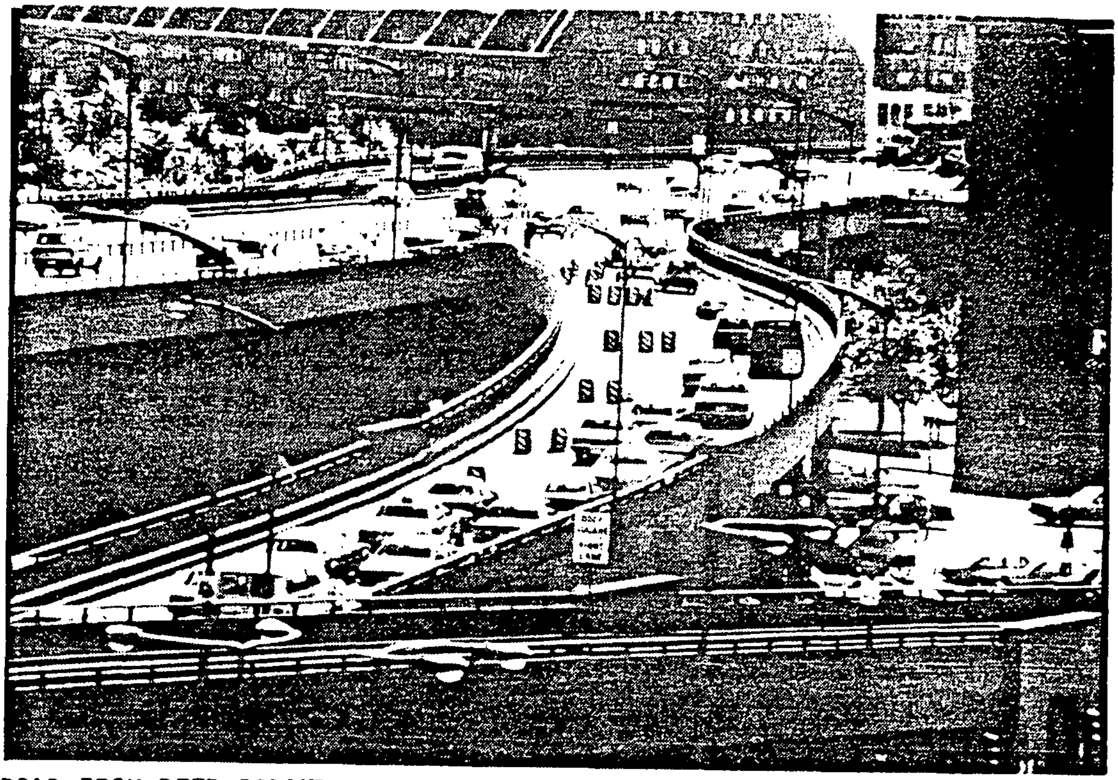
Light vehicle traffic to the northern metropolitan area from Winthrop would traverse Saratoga Street to Boardman Street, then follow Route 1A (McLellan Highway) through Mahoney (Bell) Circle to Route 60 and ultimately to Route 1 in Saugus. Alternate routes to the north include the Winthrop Parkway to the Revere Beach Boulevard to Lynn, or Winthrop Avenue to the Revere Beach Parkway and thence to Mahoney (Bell) Circle.

Most of the routes to Deer Island have some sort of truck restriction, including weight limits in the Sumner Tunnel and on most of the bridges, and a general truck and bus exclusion on Winthrop Parkway and the Revere Beach Boulevard in Revere. The only route that appears to be entirely without any specific restriction is fairly complicated, by way of Winthrop and Crescent Avenues in Revere, both medium to high density residential streets, to Route 1A, then south to a jug handle turn-around at the Revere/East Boston city line, then north back up Route 1A to Bell Circle, around the Circle and then back south again and finally west on the Revere Beach Parkway to the Northeast Expressway.

As shown on Fig. T-2, these routes include a number of safety deficiencies, especially in Winthrop and the Beachmont section of Revere. In a number of areas, the routes traverse narrow, lightly-used, residential streets. In such areas, it is difficult for small children (a new crop of four-year-olds every year) to recognize the hazard of running out into the streets and it is difficult, without congestion, to keep all non-residents from speeding through to and from their places of employment. Specific areas of this hazard potential include Point Shirley and Beachmont in particular.

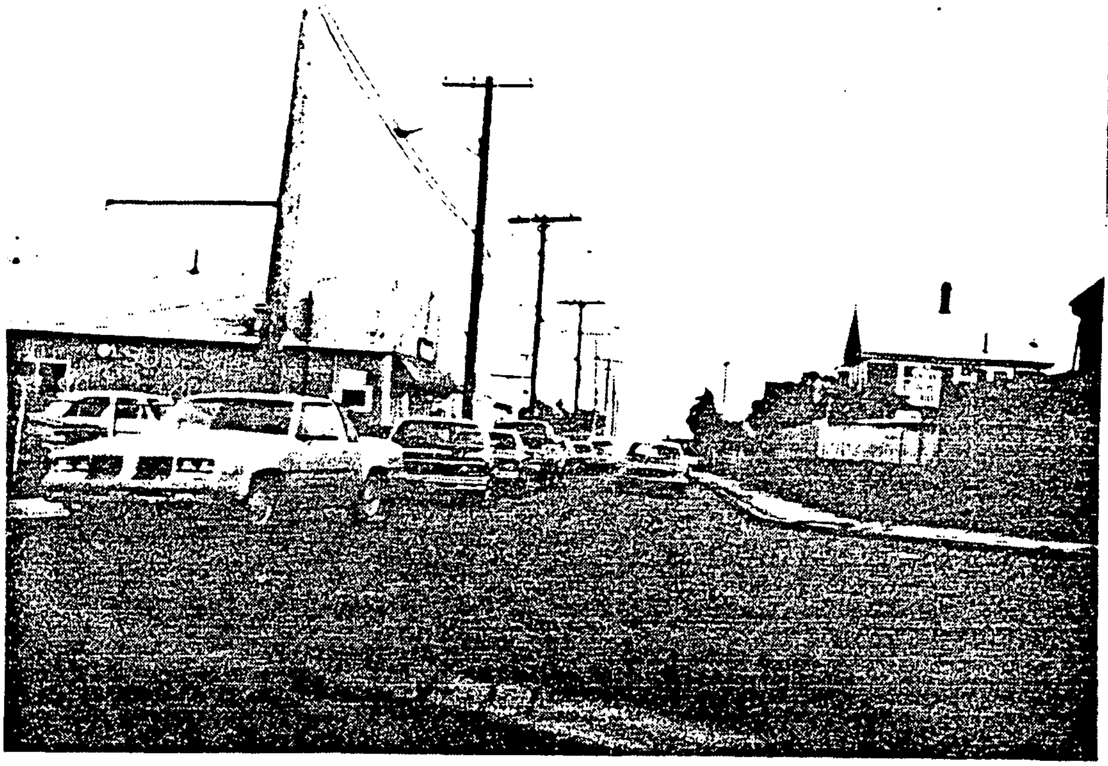
Other hazard areas that appear to be especially dangerous include Shirley Street between Washington Avenue and Yirrel Beach and the intersection of the East Boston Expressway ramp and Neptune Road in East Boston.

On Shirley Street the problem is extremely short sight distance, especially at the corner of Park Terrace opposite the Winthrop Yacht Club, complicated by a road curve so tight that vehicles have trouble staying in their own lanes, while at Neptune Road, traffic northbound to Winthrop, off the expressway must cross a stream of very fast moving vehicles exiting the airport around a blind corner.

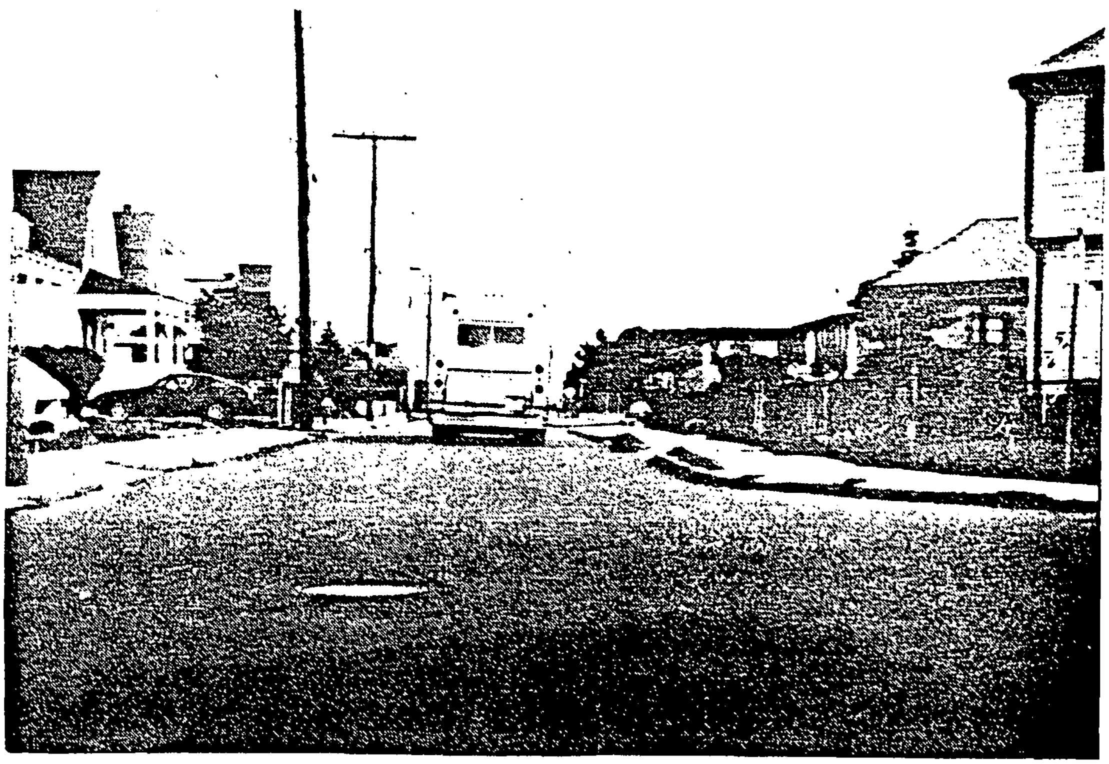


ROAD FROM DEER ISLAND
Single lane on ramp to Central Artery Southbound

ROAD TO DEER ISLAND
Taxi from Logan Airport cutting across expressway just before Neptune Road off ramp.



ROAD TO DEER ISLAND
One-way portion of Tafts Avenue at local business area



ROAD TO DEER ISLAND
Two-way portion of Tafts Avenue; No parking either side.

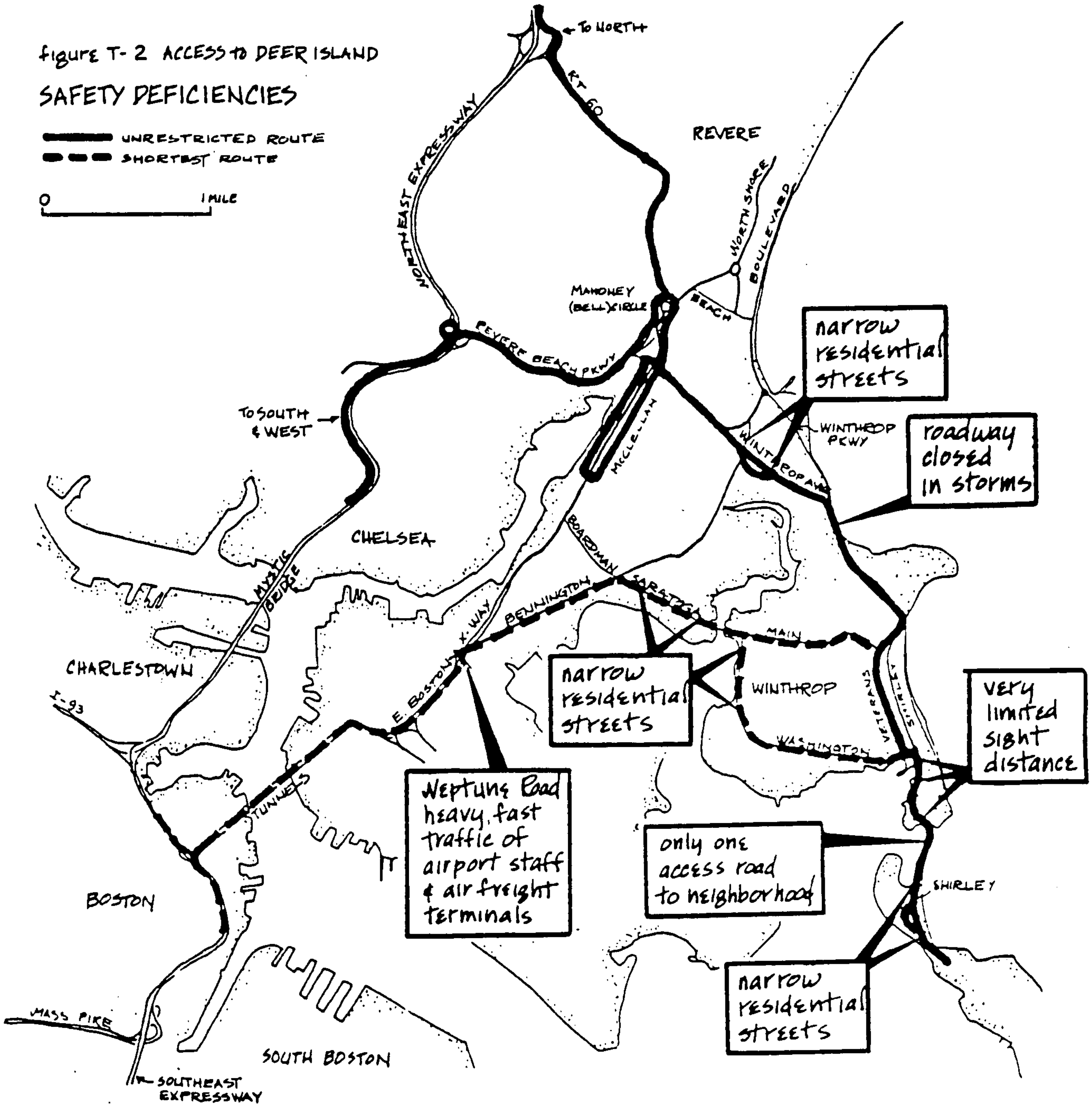
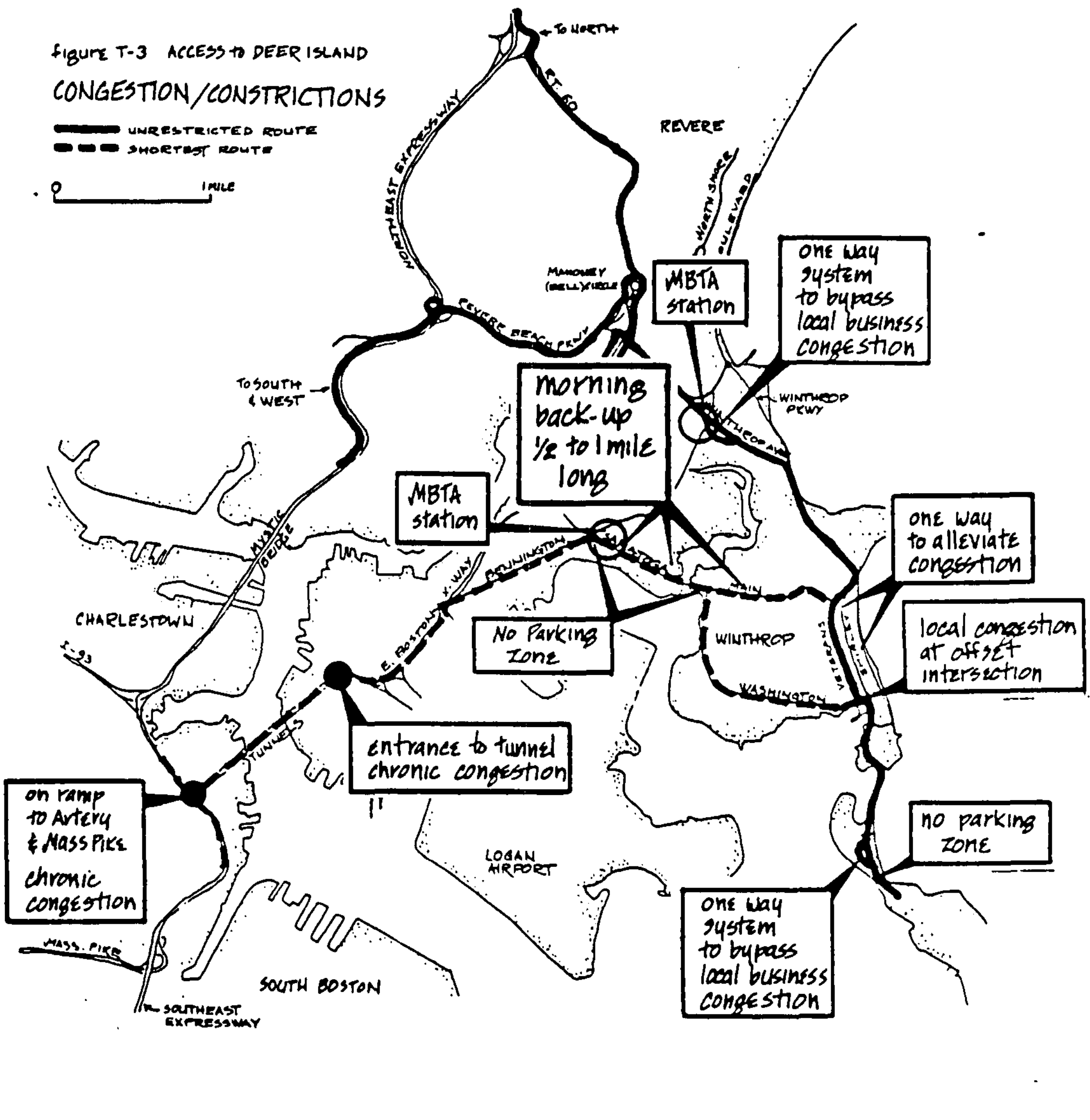
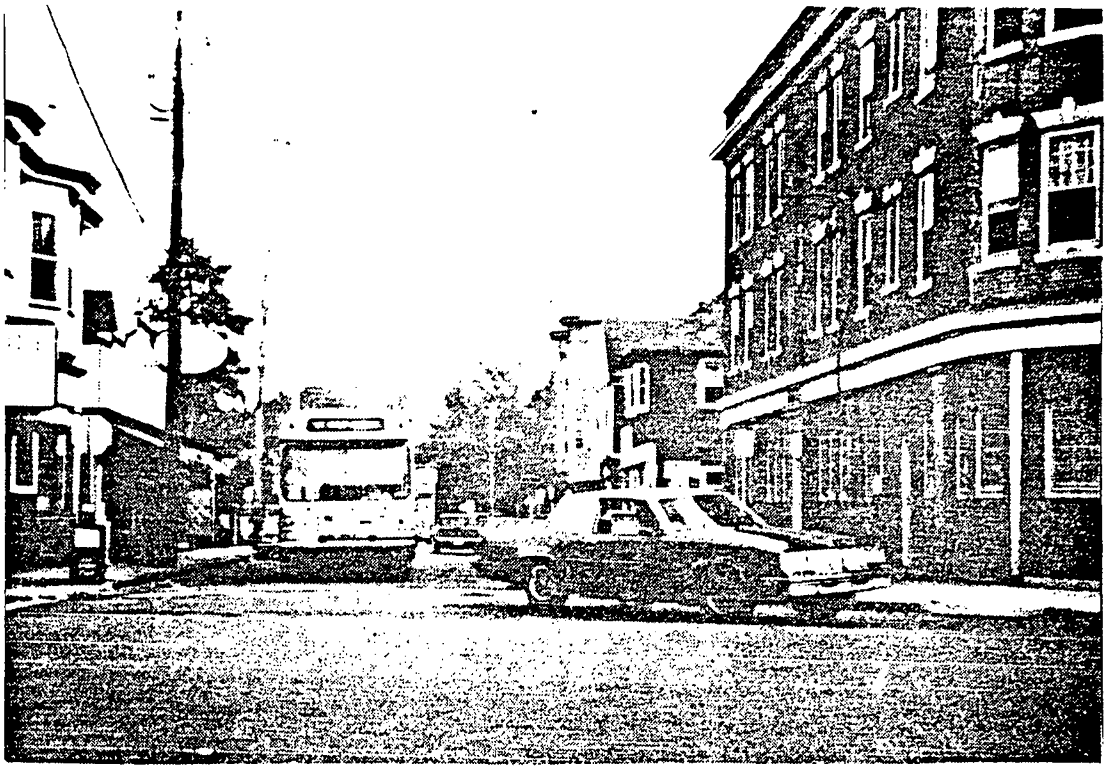


figure T-2 ACCESS to DEER ISLAND
SAFETY DEFICIENCIES
UNRESTRICTED ROUTE
SHORTEST ROUTE
0
1 MILE
To NORTH
RT 60
REVERE
NORTHEAST EXPRESSWAY
NORTH SHORE
BOULEVARD
MAHONEY (BELL) CIRCLE
BEACH
REVERE BEACH PKWY
To SOUTH & WEST
McCLELLAN
WINTHROP PKWY
WINTHROP AVE
CHELSEA
MYSTIC BRIDGE
BOARDMAN
BENNINGTON
SARATOGA
MAIN
CHARLESTOWN
I-93
E. BOSTON X-WAY
TUNNELS
WINTHROP
WASHINGTON
VETERANS
SHIRLEY
BOSTON
MASS PIKE
SOUTHEAST EXPRESSWAY
SOUTH BOSTON
narrow residential streets
roadway closed in storms
narrow residential streets
very limited sight distance
Neptune Road heavy, fast traffic of airport staff & air freight terminals
only one access road to neighborhood
narrow residential streets

In addition, it must be noted that the entire town of Winthrop is accessible by only two two-lane roadways (one of which is closed during severe storms) and that the Point Shirley neighborhood is accessible by only one roadway, conditions that could severely compromise the ability of emergency services to perform their functions (say if an airplane were to crash on Point Shirley) and the ability of those services to evacuate threatened areas in the case of toxic chemical spills.

And finally, fig. T-3 shows the most seriously congested and/or constricted areas along the access routes, routes travelled daily by the residents of Winthrop, East Boston and Revere.





ROAD TO DEER ISLAND
Shirley just south of Washington Avenue. Left turning automobile in wrong lane.

ROAD TO DEER ISLAND
Shirley Street

On a local level the existence of congestion and/or constrictions is attested to by the number of one way streets and the extensive prohibition of parking along the "major" roadways. Areas to be noted include:

a. Tafts Avenue in Point Shirley which is one way in one area to allow traffic to pass local business and "no parking" on both sides elsewhere to allow two vehicles to pass each other.

b. Shirley Street north of Washington Avenue, again local business and narrow street.

c. Winthrop Avenue in Beachmont, again local business and narrow streets.

On a somewhat larger scale of problem, special note must be made of the intersection of Shirley Street, Washington Avenue and Veterans Road, an offset intersection so narrow, with turning radius so small that when it is occupied by a single MBTA bus, the intersection is effectively full.

On a townwide basis, note should also be made of the problems on Saratoga Street in East Boston. This roadway is the most heavily used accessway to the town of Winthrop and it is essentially unavoidable in most of the comings and goings into and out of Winthrop. It is only two lanes wide, has parking on one side, businesses (with poorly parked delivery trucks) near its intersection with Bennington Street, and an MBTA train station that generates peak bus and peak commuter parking lot cross traffic at peak hours.

At morning rush hours, the traffic signal at St. Edwards Street (the entrance to the commuter parking lot) can back traffic up Saratoga Street, across the Belle Isle Bridge, through the intersection of Pleasant Street and well onto Main Street, in all, a full mile of stop and go congestion.

In the afternoon, no similar back ups were observed on reconnaissance trips but observation of the signal at St. Edwards Street indicated that its green time eastward was almost fully utilized.

And finally, moving closer to Boston, it should be noted that all traffic from Winthrop to the southern and western portions of the metropolitan area must traverse the Sumner Tunnel and the Central Artery. Access to both is chronically congested and beyond hope of correction without a direct harbor tunnel to the Massachusetts Turnpike.

2. Long Island

From Long Island, all automobile traffic can reach the Southeast Expressway near Neponset Circle by roads that, for the most part, are non-local and non-residential (see Figure T-4). These include the Long Island Bridge, Moon Island Causeway, Dorchester and East Squantum Streets in Squantum (housing on one side only, for only half their combined length), and Morrissey Boulevard, a heavily travelled, four-lanes-plus-paved-shoulders-plus-left-turn-storage-lanes commuter road. At Neponset Circle, there are direct ramps to and from the Southeast Expressway to the north and the Massachusetts Turnpike. Access to and from the south requires use of Gallivan Boulevard from Neponset Circle to Hallet and Hilltop Streets to Granite Avenue to the Expressway.

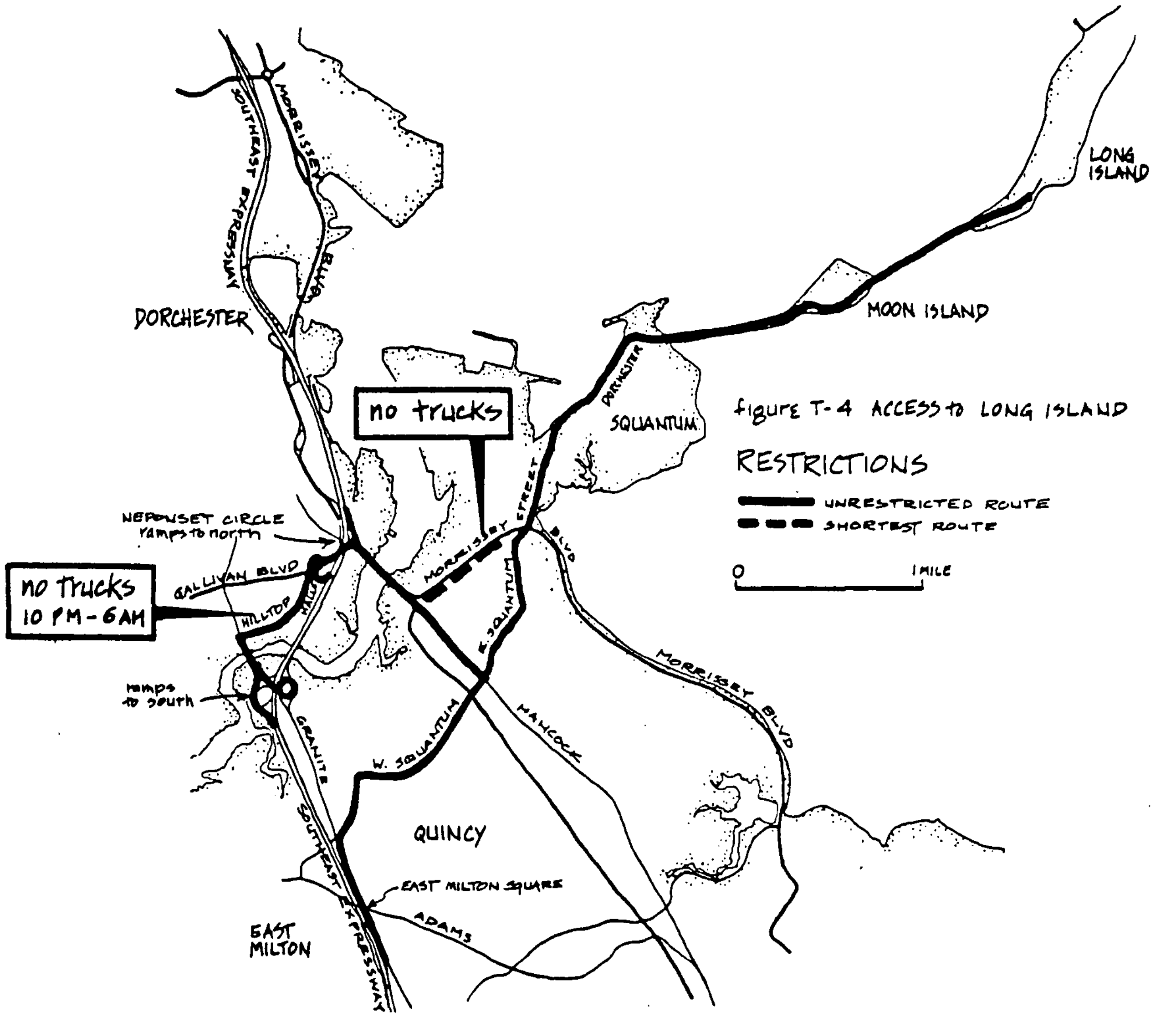
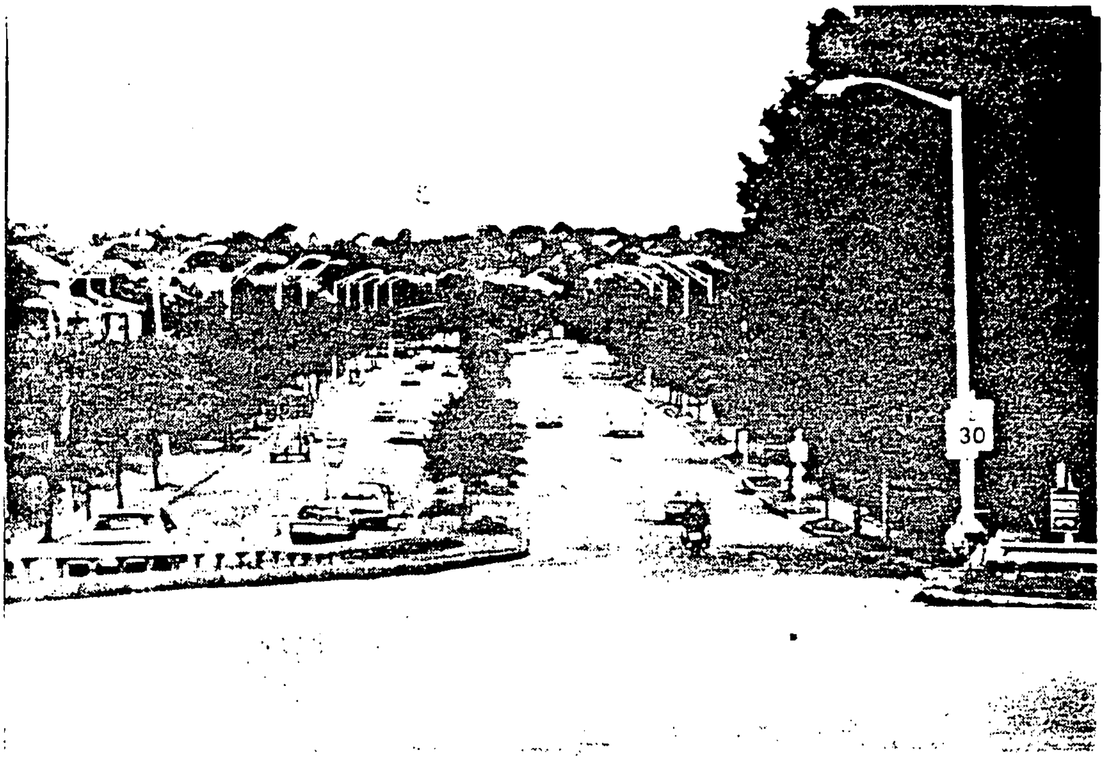


figure T-4 ACCESS to LONG ISLAND



ROAD TO LONG ISLAND
Morrissey Boulevard in Quincy 4-lanes plus shoulder. Trucks excluded.

ROAD TO LONG ISLAND
East Squantum Street, Quincy, looking from Morrissey Bou[illegible] toward Squantum
Former Naval Air Station (Marina Bay) on left

Trucks are prohibited on this route (by the MDC) on a portion of Morrissey Boulevard that has no structures and no constrictions. Alternative access to the Southeast Expressway for trucks, going northbound, requires the use of East Squantum Street, a narrow, winding, two-lane street, and Hancock Street, a wider, general purpose, "main" street, while Southbound access requires use of East and West Squantum Streets, both narrow, winding streets and Granite Street, a wider, general purpose, intertown roadway.

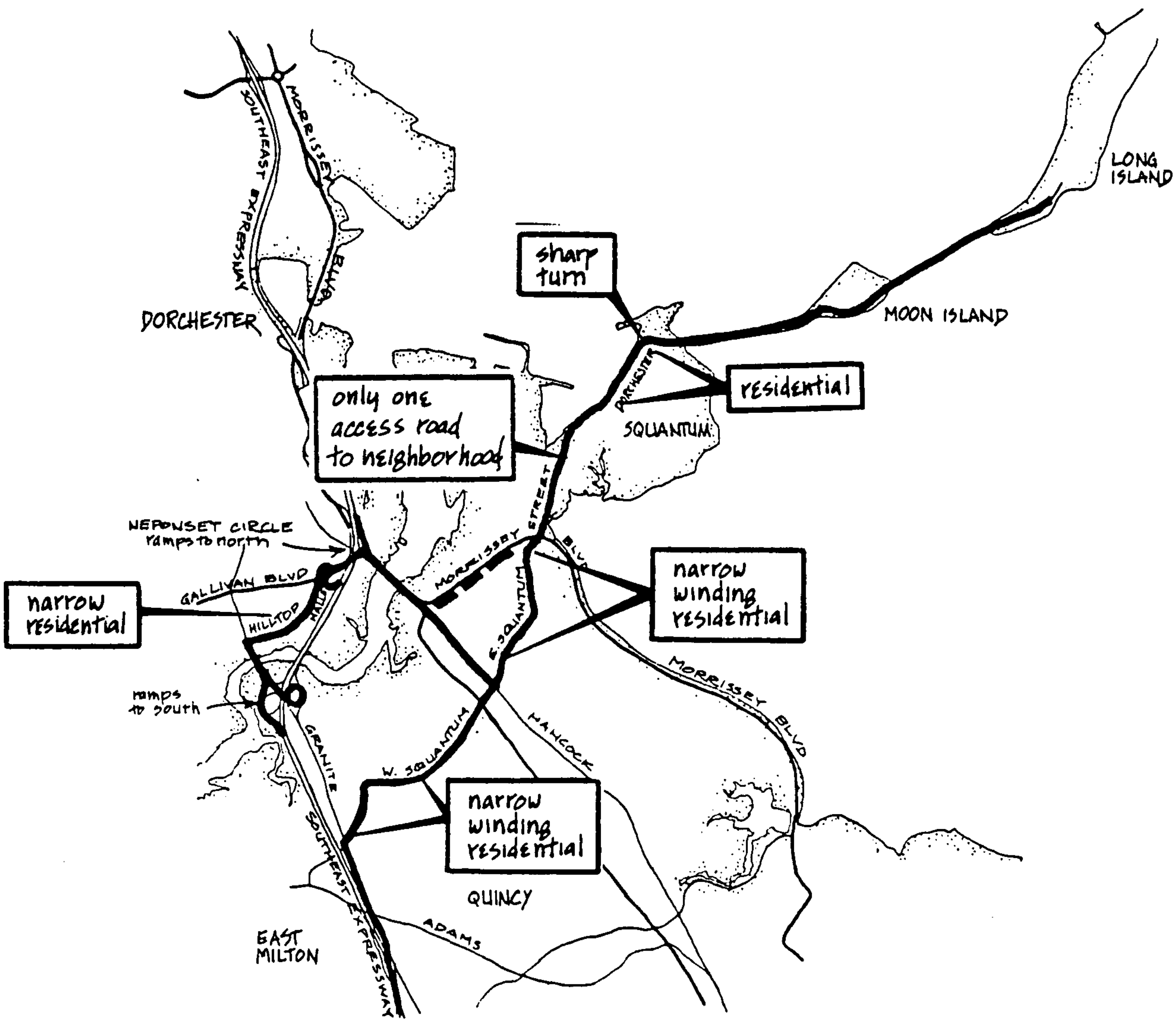


figure T-5 ACCESS to LONG ISLAND

SAFETY DEFICIENCIES

UNRESTRICTED ROUTE
SHORTEST ROUTE

0 1 MILE

As shown on figure T-5, these routes include a number of safety deficiencies where they traverse narrow residential street, creating the potential for lethal conflicts between playing children and through traffic. Specific areas of concern include Dorchester Street, East and West Squantum Streets and Hilltop Street in Dorchester. Note should also be made of the sharp turn on Dorchester Street in Squantum.

In addition, note should be made that the Squantum neighborhood is accessible by only one roadway, a condition that could severely compromise its emergency services.

And finally, figure T-6 shows the most seriously congested and/or constricted areas along the access routes. The most serious problem appears to be at Neponset Circle, a major access point to the Southeast Expressway, a regional facility now being rebuilt and widened to alleviate a long-standing regional problem. Other areas of local congestion include East Milton Square and the intersection of Squantum and Hancock Streets.

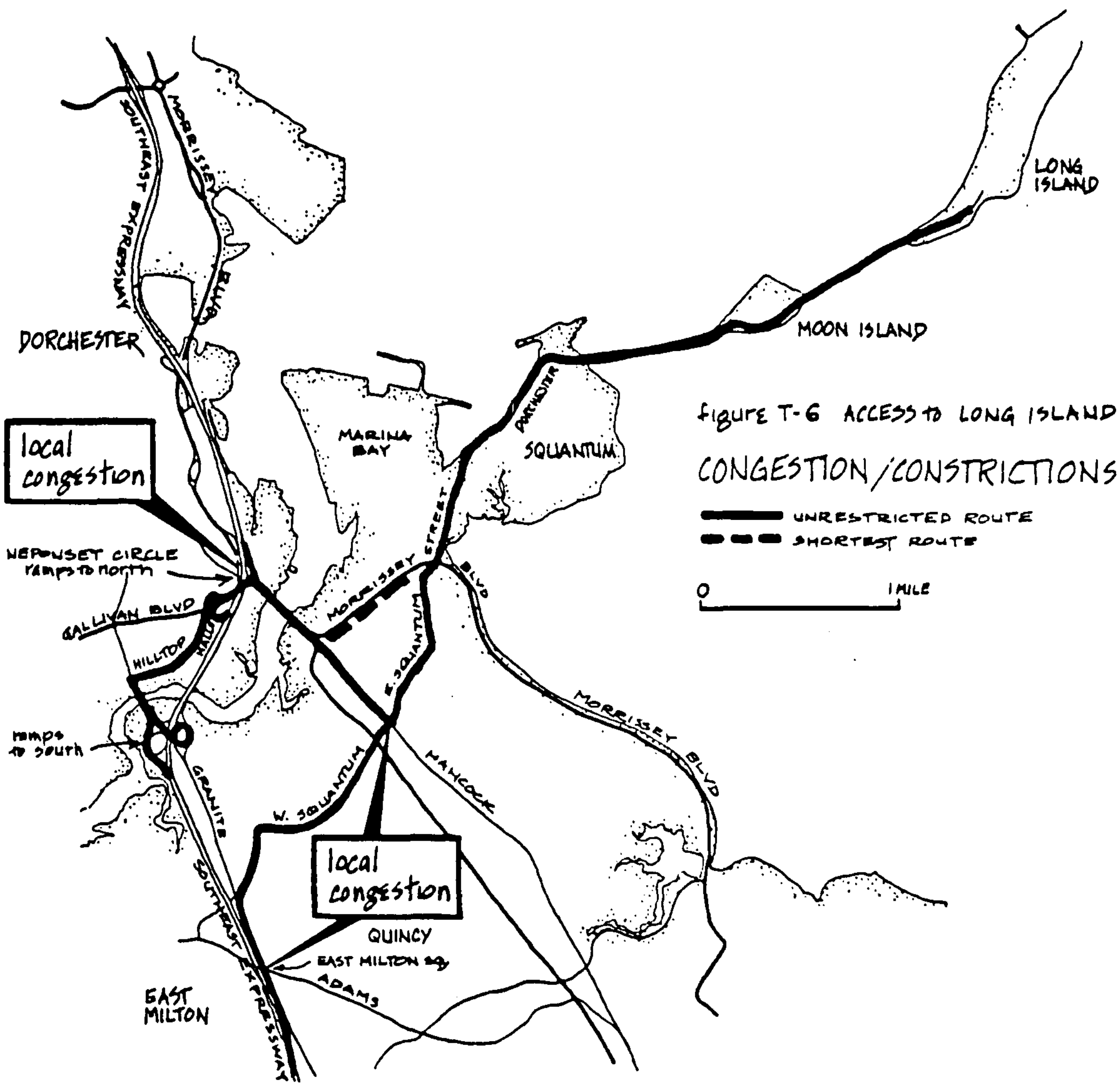
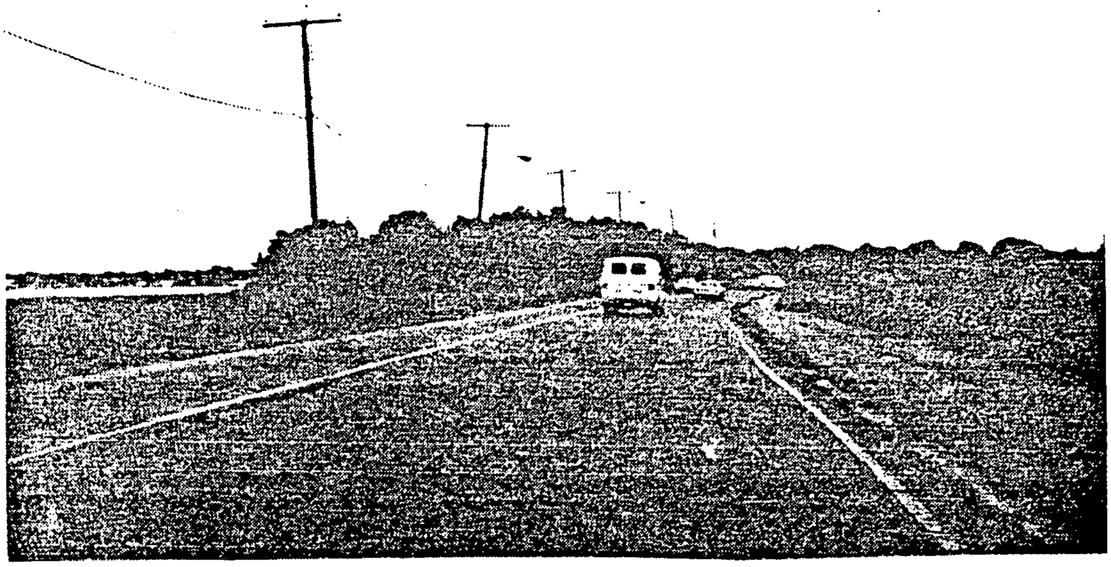
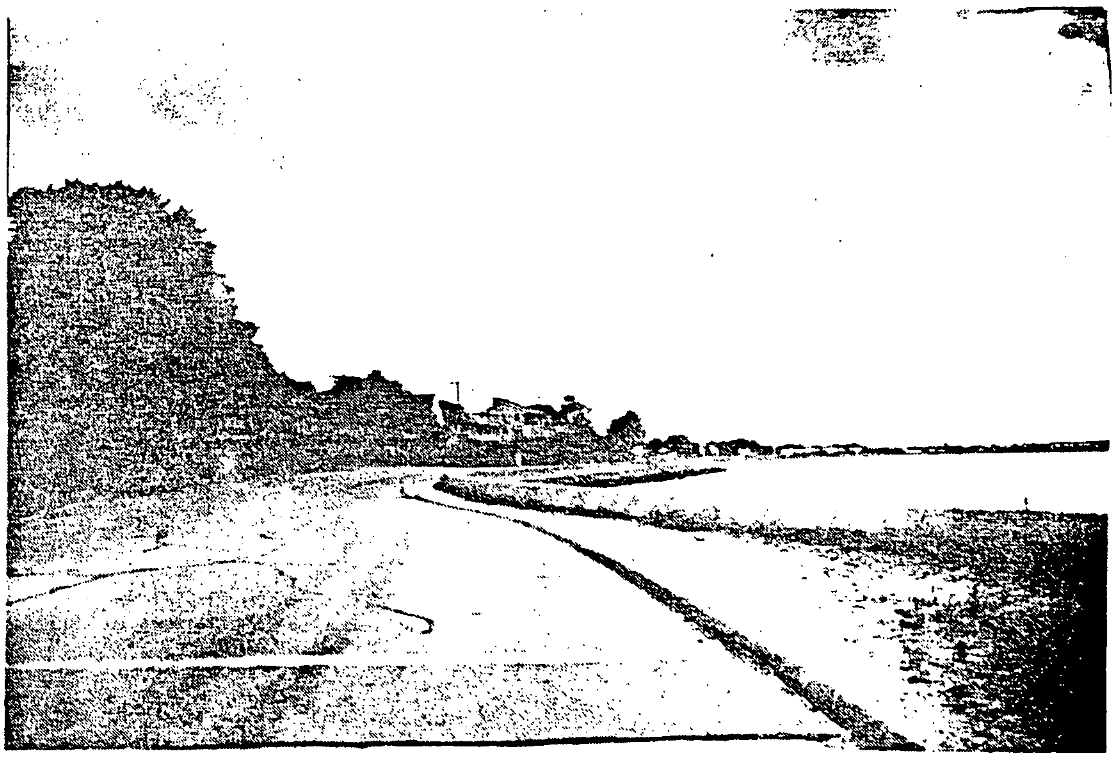


figure T-6 ACCESS to LONG ISLAND
CONGESTION/CONSTRICTIONS

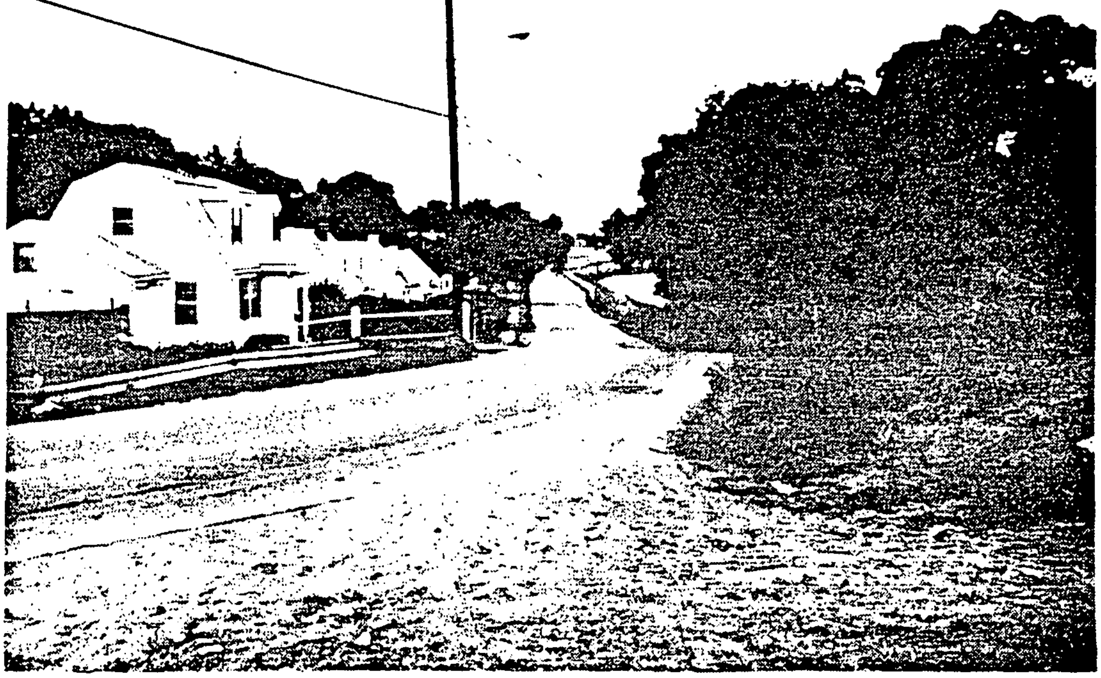


ROAD TO LONG ISLAND
East Squantum Street, looking toward Quincy from entrance to Marina Bay.

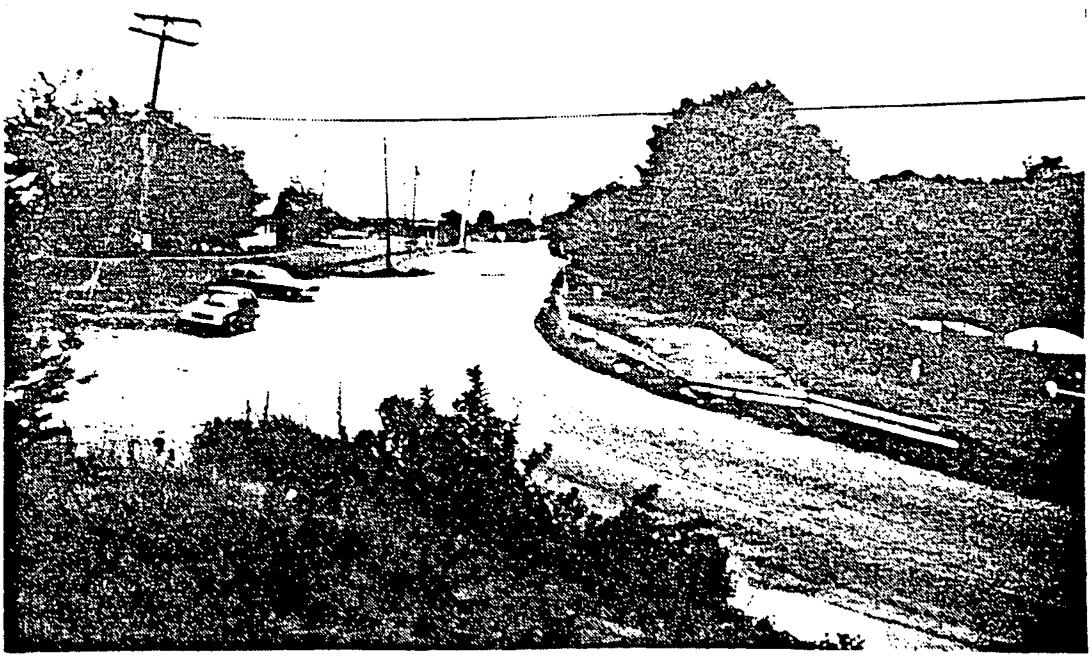


ROAD TO LONG ISLAND
[illegible] Street, looking toward [illegible] from [illegible]

Traf[illegible]



left
pic First house is below grade f street.



TO LONG ISLAND
oking in other direction. Same guard rail in right center of
width of on right (first house
link fence

3. Nut Island

From Nut Island, all traffic can easily reach the Southeast Expressway and Route 128 by following the route described in the SDEIS to the Southern Artery, then up Coddington Street to the new Burgin Parkway, a high-design-standard roadway that connects directly to the Southeast Expressway and Route 128. The Coddington Street portion of this route is a "main street"; it runs right through the center of the Quincy's downtown and is heavily travelled. The Burgin Parkway, in contrast, south of Coddington Street, is a four-lane divided semi-express road-way that is almost fully separated from adjoining land uses and intersecting streets. It connects to the regional expressway net at a point of exceptionally high traffic capacity.

The portion of this route closest to Nut Island is residential with streets on which children are accustomed to play. Use of these streets for through traffic could constitute a potential safety hazard. The portions of this route further away from Nut Island, however, are more heavily travelled, are not used as play areas and hence, pose less likelihood of construction traffic related accidents.

C. Mitigation

The feasibility of mitigating actions assumed in the SDEIS, i.e. barging of bulk materials and busing of construction workers, was questioned. The possibility of more extensive over-water transportation, such as the ferrying of workers and roll-on/roll-off transport, also was raised as an issue.

Review of the mitigating actions described in the SDEIS indicated that:

1. They are reasonable.

2. More extensive over-water transportation is possible.

Two major considerations determining the feasibility of barging bulk materials are the existence of suitable sites for pier construction at the wastewater treatment plant site, and available transfer stations to transport bulk materials. A study by Thibault/Bubly Associates regarding potential transfer stations, included as Appendix T-2, concluded that at a minimum, four potential transfer sites exist. A study by Lee Pare & Associations, Inc. (a civil engineering firm with considerable experience in waterfront facilities) concluded that pier construction is feasible at both Deer and Long Islands. Their report is appended hereto (Appendix T-3).

The use of barges for construction access to island sites is a well-established practice, and the existence of such large facilities asthe House of Correction, the Long Island Hospital, Fort Warren, and the lighthouses offshore demonstrate its feasibility. Similarly, the use of buses for transporting workers to sites with limited parking is quite possible and has become increasingly common in recent years.

The possibility of busing worker to either Deer or Long Island from either Wonderland or a site on the South Shore was reviewed by Crossman Engineering, Inc., traffic consultants. It was concluded that busing would be feasible; however, certain concerns were expressed:

1. During peak construction periods, traffic could be as much as 1,000 automobiles, potentially causing short-term traffic impacts. These impacts could be mitigated by using more than one parking lot, thus distributing the traffic. In addition, the Wonderland site is accessible by MBTA, which could be used by some of the commuting workers.

2. At least one intersection on the route to Deer Island provides a very tight passage for large vehicles such as buses. In order to alleviate this problem, it might be advisable to have a police car lead the buses through the community, clearing a pathway through intersections. A police escort would also ensure that buses proceeded at appropriate speeds through residential neighborhoods.

On the question of barging earth spoils from excavation and gravel for construction, the really significant part of the potential truck traffic, the assumptions in the SDEIS appear reasonable. Excavated earth that cannot be reused on the island would be likely to be glacial till from the island or broken rock from the inter-island tunnels. Neither material is likely to have a ready market at the quantities expected and so would have to be discarded. The assumption in the SDEIS, that it would be dumped in the ocean at the designated "foul area" off Marblehead appears reasonable since such dumping would be both environmentally acceptable and low in cost.

On the acquisition of gravel, the assumption that it would be shipped to Deer Island by barge likewise appears reasonable since gravel is expensive in the Boston area but inexpensive in Maine and New Hampshire, and since the scale of the project makes the construction of an unloading pier feasible.

Discussion of more extensive use of over-water transportation involves two issues: feasibility of roll-on/roll-off truck barging, and ferrying of workers. Analysis of available information shows both to be reasonable.

On the expansion of over-water transportation to include all heavy trucking, review indicates that it was not proposed in the SDEIS because there was no existing roll-on/roll-off terminal in Boston Harbor. Construction of such a facility, however, is feasible, requiring only a couple of acres of land, piled dolphins to secure a barge, and a roll-on/roll-off ramp that could be supported by either a float or a gantry crane. Potential sites for such a facility are available along the Chelsea and Mystic Rivers in Chelsea and Charlestown, and possibly on the Fore River in Quincy. With the provision of roll-on/roll-off terminals, virtually all medium and heavy trucking could be accomplished over water.

The feasibility of ferrying workers is dependent on a number of factors, including availability of suitable terminal sites, availability of ferries of appropriate size, time required for ferry trips, harbor regulations, existence of channels sufficiently deep to permit passage of ferries, and cost. Analysis of these factors indicates that operation of a worker ferry service would be possible. In addition, access to the terminals by workers must be considered. Terminal sites will require nearby parking for several hundred automobiles; access from public transportation would be desirable as well. Possible ferry terminal locations in the south shore area include Marina Bay in Squantum, the Neponset Drive-In in Quincy, and Hewitt's Cove in Hingham. The cost of ferrying all workers during an 8-year construction period would be approximately $30,000,000 (Table T-1). It should be noted that south shore waterfront sites are in demand for a variety of uses, and that the Authority should act to obtain the use of appropriate land if it wishes to implement future over-water transportation of workers.

Table T-1

Costs of Alternative Transportation of Construction Workers

	Average No. of Workers	Time Lost (Hrs.) Per Day	Time Lost (Hrs.) Per Yr.	Rate Per Hr.	Annual Cost	Annual Cost Bus/Boat	Total Cost 1 Year	Total Cost 8 Years
All bus	600	0.5	125	$17	$1,275,000	$ 500,000	$1,775,000	$14,200,000
All boat*	600	1	250	17	2,550,000	1,200,000	3,750,000	30,000,000
Mixed	600	0.5	125	17	2,550,000	850,000	2,125,000	17,000,000

Assumptions : See Appendix T-1

*300-passenger ferries were assumed. Use of a greater number of smaller vessels would increase costs, but not to a significant degree.

D. Forecasts

Assuming the mitigating actions described in Section C will be implemented, it was questioned whether the forecasts of traffic expected to be generated by the proposed project were reasonable.

The estimate of eight heavy and medium trucks, per day for 7 years, for materials not suitable for barging, assumed that roll-on/roll-off transport would not be implemented. This estimate is reasonable. With the addition of roll-on/roll-off barging, this number could be reduced further, theoretically to zero. It should be noted that even with maximum feasible over-water transportation, there would be additional traffic of smaller trucks carrying a variety of goods and services, but this traffic would be essentially indistinguishable in quality and quantity from the existing traffic to the prison and the existing treatment plant, and thus is not environmentally significant.

The estimate of 13 to 26 buses per day also is reasonable. The exact number would vary depending on the number of workers employed at a particular time, and the percentage of workers that could be ferried to the site.

Appendix T-1

Costs of Alternative Transportation of Construction Workers

Assumptions:

1. Ferry time would average 45 minutes each way (7 miles).
2. Bus time would average 15 minutes each way (5 miles).
3. All workers would get paid for time on bus.
4. If all workers are ferried, all would get paid for ferry time.
5. If only workers ferried are those who would be spared trip through downtown Boston, then all workers would be paid for 15 minutes of travel time each way (the bus trip time).
6. Average worker pay rate would be $17/hour.
7. Buses for all workers would average $500,000 per year.
8. Ferries for all workers would average $1,200,000 per year.

Appendix T-2

A. Introduction

A major consideration determining the feasibility of barging of bulk materials is the existence of transfer stations to transport bulk construction materials. The following pages are excerpted from the report Interim Systems for the Transportation of Sludge from Deer and Nut Islands (1985) prepared by Thibault/Bubly Associates for US EPA Region I. The report outlines transfer stations that might potentially be available to MWRA in order to implement barging of bulk materials which is a grant condition of this project. In order to adequately assess feasibility of barging, several factors need to be evaluated:

1. Navigational Restrictions

Width of channel, amount of existing traffic, and any special restrictions that might apply were considered. (For example, if the barges were to carry tractors as well as trailers, they would be classified as "ferries" and would be subject to Coast Guard inspection.)

2. Docking Facilities Requirements

The two types of vessels considered for sludge transfer were:

1000 ton self-propelled tank barge, 170' x 37' x 8' draft
1000 ton self-propelled RO/RO barge, 170' x 37' x 6' draft

The tank barge would require a finger pier extending to water of suitable depth so that a barge could be docked in existing depth conditions without dredging and a row of dolphins to secure the barge. The pier would support a pipe and access catwalk.

The RO/RO barge would require a double row of dolphins to guide the vessel up to the loading ramp and to secure the vessel. The depth of water within the berth would have to be 6' minimum at low tide. The ramp would be extended to an existing 6' depth to avoid the need for dredging. The loading ramp would be supported by a gantry or other suitable means to allow the outboard end to be raised and lowered to meet the barge deck. Truck access to this ramp would allow quick safe backing of the tractors onto the barge for removing the full trailers and spotting the empty trailers. Good lighting for safe efficient operation at night would be necessary.

3. Ownership

The site should be in the possession of one owner who has clear title and who is ready and willing to sell or lease the site to the MDC for the planned transfer of sludge.

B. Potential Sites

Several alternative sites may be considered as transfer stations to transport materials to the site during the construction of the wastewater treatment facilities. These sites will require more detail investigation to determine their feasibility. They are:

1. Massport sites. Massport has sites with water access in South Boston and in Charlestown.

2. Quincy sites. The Quincy shipyard has excellent water access facilities. To date, the future use of this site has yet to be determined.

3. Texaco Facility, 99 Marginal Street, Chelsea

   Two Texaco Oil Terminal Facility properties are located between Marginal Street and the Chelsea River; a garage is located across Marginal Street. The total 5.5 acres are zoned for industrial and waterfront industrial use. Assessed at a value of $2,757,300, the property is being actively marketed by its real estate broker.

   The site is bordered to the north by Marginal Street and to the south by 550 feet of the Chelsea River. To the west is Quincy Oil, a small petroleum storage and transfer facility. To the east are old warehouses and docking facilities that are in disrepair. There are some residential buildings set back about 200 feet that are visible along the truck route to the west.

   Truck access, loading, and dispatch facilities at the site are adequate in design and in excellent condition for continued use as part of a sludge transfer facility. The property consists of five buildings, seven bulk storage tanks (10 million gallons total capacity), a loading rack, and a docking facility. The structures include two warehouse buildings (16,600 square feet), a garage (10,600 square feet), a small one-story brick foam house (336 square feet), and an electrical house (960 square feet). The loading rack is capable of filling four vehicles with liquid product. In addition, the facility is supported by all public utilities. For more detailed descriptions, see Figure VII-2.

   When the facility was operating, an average of 40 tank trucks a day passed through the facility. This is more than the 35 expected from operation of the sludge transfer facility. Although the Texaco Facility is not now used, a considerable amount of truck traffic is generated by six other petroleum transfer and storage facilities, warehouses, and other industries on Eastern Avenue and Marginal Street.

APPENDIX T-3

Feasibility Study

Pier Facilities for Water Transport of
Construction Labor and Materials to
Deer Island and Long Island
Boston Harbor, Massachusetts

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report examines the feasibility of building piers at Deer or Long Island in Boston Harbor to support vessels delivering men, materials and equipment to a wastewater treatment plant construction site. The proposed pier designs were to be capable of handling 1200 workers, 10,000 c.y. of bulk materials, and 100 roll on/roll off trailers per day. Seven variables affecting site selection and four variables affecting pier design were evaluated. As with any major civil engineering project, designing for peak demands, volumes, or 100 year storms can result in facilities oversized and overpriced for normal usage. To minimize overdesign, we have separated the pier project into three components based on the types of vessels to be serviced: commuter, bulk and roll on/roll off. The resulting design proposes three separate sites and facilities; each easily changeable to meet fluctuating demands. Since the need for most of the facilities is temporary, they are designed as such. Options for the future conversion of the permanent bulk materials pier into a sludge handling terminal are also provided.

In summary, construction of piers at either Deer Island or Long Island for the purpose of landing men, materials, and equipment is deemed feasible. Construction costs for Deer Island facilities are estimated at $5.2 million. The cost for similar facilities at Long Island could vary by 15-20% depending on siting and subsurface geological conditions.

A recommended course of action to follow after final selection of the island would include: additional subsurface investigation at the proposed sites; bathymetric surveys (soundings) and bottom sediment sampling; development of accurate estimates of quantities of men, materials and equipment to be handled per day.

With the above information, the second level of preliminary design could be accomplished.

1.0 PROPOSED SITES

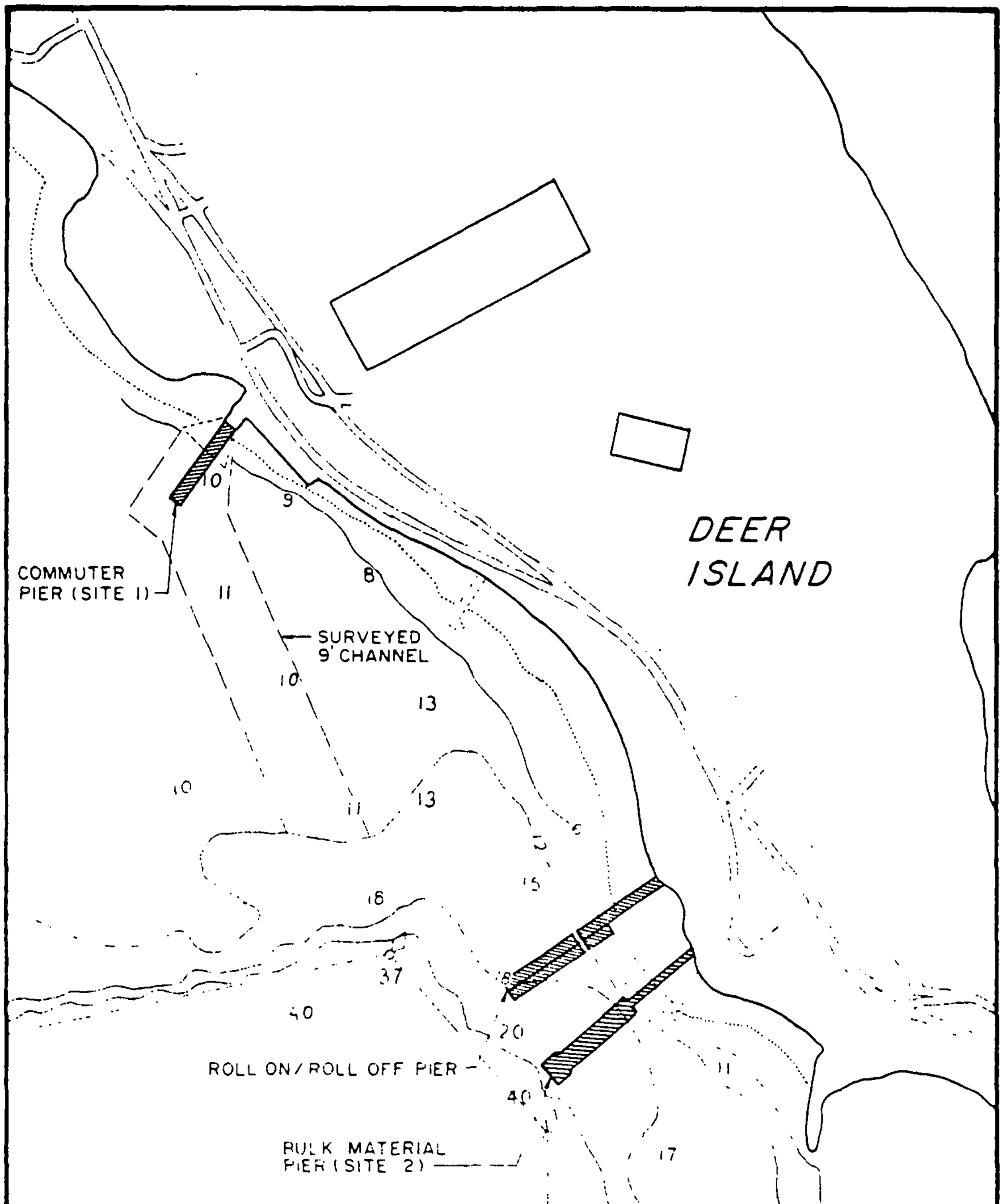
1.1 Deer Island Fig. 1

The proposed siting plan of pier facilities at Deer Island is composed of three separate piers, two temporary and one permanent. A temporary commuter pier would be situated about mid-island on the west shore, at an existing stone wharf (Site 1).

A permanent pier of concrete construction and a temporary ro/ro pier would be grouped together at a site on the west shore near the south end of the island at an existing riprapped section of shoreline. This site (Site 2) offers deeper water nearer to shore as well as better subsoil conditions.

1.2 Long Island Fig. 2

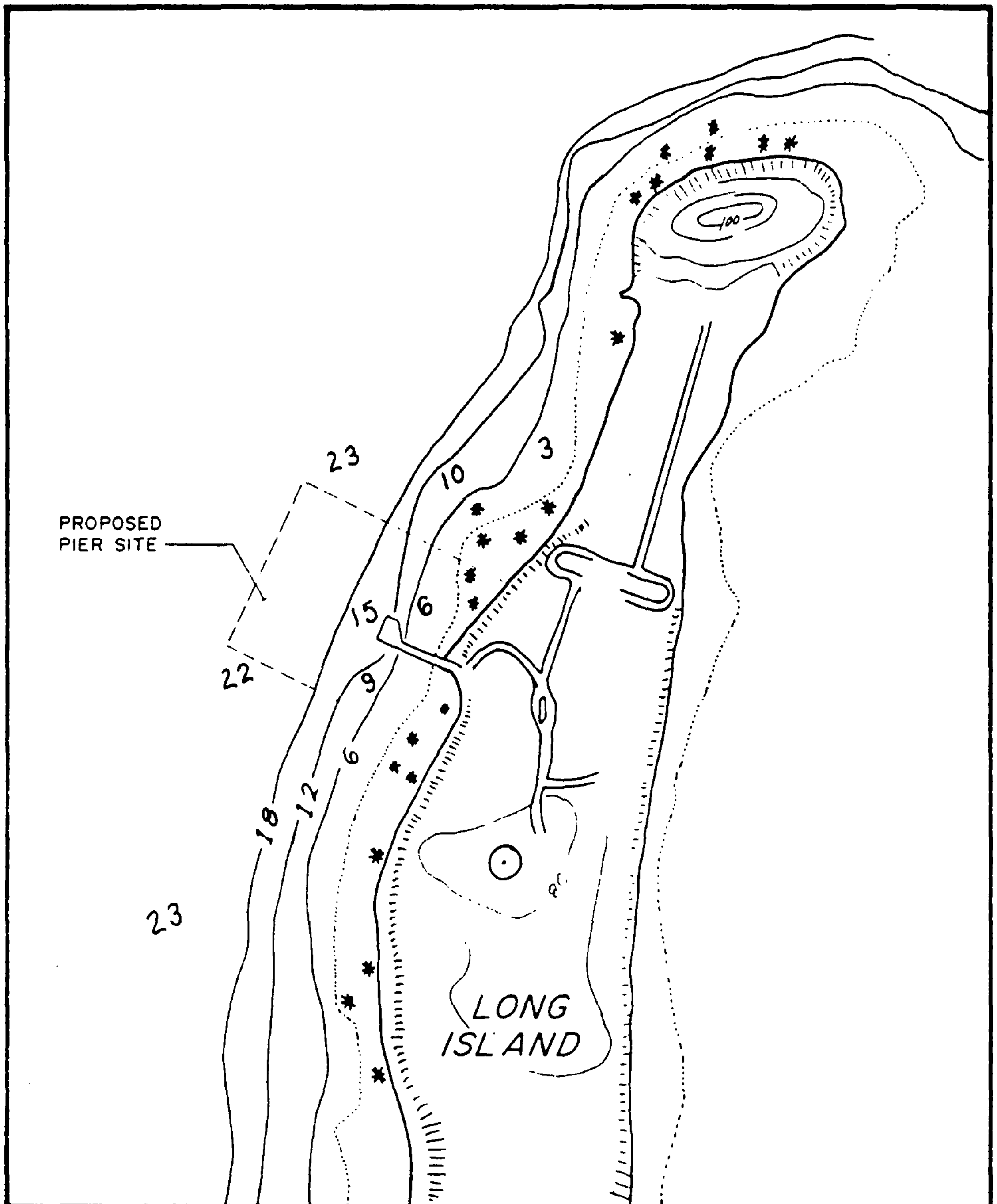
The proposed siting plan of pier facilities at Long Island comprises a 3-pier system as proposed for Deer Island. Siting would center around the existing pier located mid-island on the north shore. Due to a lack of soils information and a site survey, exact siting is not proposed for each of the three piers.



Lee Pare & Associates, Inc.

PROPOSED PIER SITES
DEER ISLAND

FIGURE 1



Lee Pare & Associates, Inc.

PROPOSED PIER SITE
LONG ISLAND

FIGURE 2

2.0 SITE SELECTION Figs. 1 & 2

2.1 Water Depths & Dredging

Existing nautical charts (NOAA #13272) were utilized to determine acceptable locations for the pier or piers. Previous work at Deer Island (GZA Soils Report) examined subsurface soil conditions at two sites: (Fig. 1): Site 1, located midway along the island's west shore at an existing granite block marginal wharf; and Site 2, also located on the western shore near the southern end, at an existing rip-rapped section of shoreline. These two sites and the shoreline between them constitutes the acceptable locations for the proposed marine facilities based on nautical chart examination.

Deer Island Site 1: Located in close proximity to the existing STP, this site is limited by 10' water depths. Although acceptable for shallow draft commuter vessels (4' - 10' draft), accomodating tugboats and bulk barges (draft 10 - 12') would require dredging approximately 80,000 c.y. of sediments. Utilization of this site for a commuter terminal only, would not require dredging.

Deer Island Site 2: Deeper water (12'±) approaches within 200' of the shoreline at this location. The construction of a pile supported or earth filled causeway across the shallows to reach a deep water pier is economically feasible. Depending on numerous factors regarding the physical and chemical makeup of the sediments, causeway construction may be competitive in cost with dredging, with much less impact on the environment.

Long Island Sites:

Since proposed sites at Long Island based on subsurface information have not been developed, we have proposed a general location, based on shoreline topography and water depths. Figure 2. The areas adjacent to the existing pier on the west side of the island offer suitable water depths (12') within reasonable distances (400' - 500') from shore.

2.2 Subsurface Geology

In general, suitable soils or rock to support pile foundations lie deep below the surface at Deer Island. Based on existing boring information, a layer of till lies at -50' to -75' (MLW) at Site 2 and at -65 to -85' (MLW) at Site 1.

The difference of 12.5' in the average pile length of approximately 400 piles represents a cost difference of $260,000, making Site 2 more attractive for a large pier structure. Without offshore soils information for Long Island, it is impossible to predict subsurface conditions. However, geologically, the two Islands are of similar origin and; therefore, soil profiles are assumed to be similar.

2.3 Proximity to Work Site:

Since all available sites on Deer or Long Island are within a mile of the construction work, proximity between the pier and the work is not critical for moving equipment and materials. It is critical, however, that workers be landed as close to the heart of the construction site as possible. Deer Island Site 2 would require an average 20 minute walk for workers, which based on 1200 workers would add $5,000 - $10,000 per day in added labor costs. If busing were to be provided, a minimum of 8 buses with drivers would be required, adding congestion to roads already heavily taxed by construction vehicles.

Site 1 therefore is the logical choice for locating a commuter vessel pier.

2.4 Adjacent Open Areas:

Due to the high volumes of materials & supplies which will be landed each day, large open areas for laying down cargo and storing trailers will be needed. In order to keep pace with the rapid offloading and loading schedules of the bulk barges, bulk material will have to be stockpiled on shore as close to the pier as possible. Empty trailers stored near the ro/ro pier for transport back to the mainland will facilitate the loadout operation.

Large open areas to the immediate north and south of Deer Island Site 2 make this site well suited for bulk material and ro/ro operations.

Deer Island Site 1 and the proposed Long Island site does not provide as much open area. Until definite volumes of materials and traffic are generated, it would be guesswork to estimate the adequacy of these sites.

2.5 Existing Shoreline Structures

Rehabilitating or otherwise utilizing existing shoreline structures can facilitate the work and possibly ease the permitting process since these areas have been previously disturbed and altered. Site 1 offers a well constructed stone wharf which could function as the link between shore and a pier, either temporary or permanent. Utilization of this structure saves approximately $250,000 in construction costs.

Site 2 offers 500 feet of bulkheaded and heavily rip-rapped shoreline. This shoreline feature can be incorporated into the proposed plans for a savings of approximately $50,000.

An existing pier structure at the Long Island site could be utilized as a commuter pier for an estimated project savings of $200,000.

2.6 Storm Exposure

Of the proposed sites, under normal annual storm conditions, the Long Island site can be considered most exposed and Site 1 is least exposed. During northeast storms, refraction of large ocean swells aroung the tip of Long Island may present problems for commuter vessels and the offloading of ro/ro barges at the proposed Long Island site.

Deer Island sites are well protected from northeasters and would confront only wind drive waves from southerly and westerly winds across the fetch of Boston Harbor. Under average conditions, these waves should not pose problems to bulk and ro/ro operations proposed for Site 2. Much of the energy in the larger waves will be dissipated in the shallow approach to Site 1; thereby offering a natural measure of protection to the proposed commuter pier.

In the event of a hurricane, all these sites would be equally jeopardized, with any natural protection lost to 360 wind directions and 10'± storm surges.

2.7 Cable Areas

A designated cable area occupies a portion of Site 2 at Deer Island. According to information provided by the Coast Guard and the Army Corps of Engineers, these areas do not present a problem to pier construction. During WW II, magnetic gaussing cables were laid across entrances to major harbors for detection of enemy submarines. Most of these abandoned cables have been removed, but still appear on the charts.

3.0 RECOMMENDED PIER DESIGNS & COST ESTIMATES

3.1 Bulk Material Pier Fig. 3

3.1.1 Description

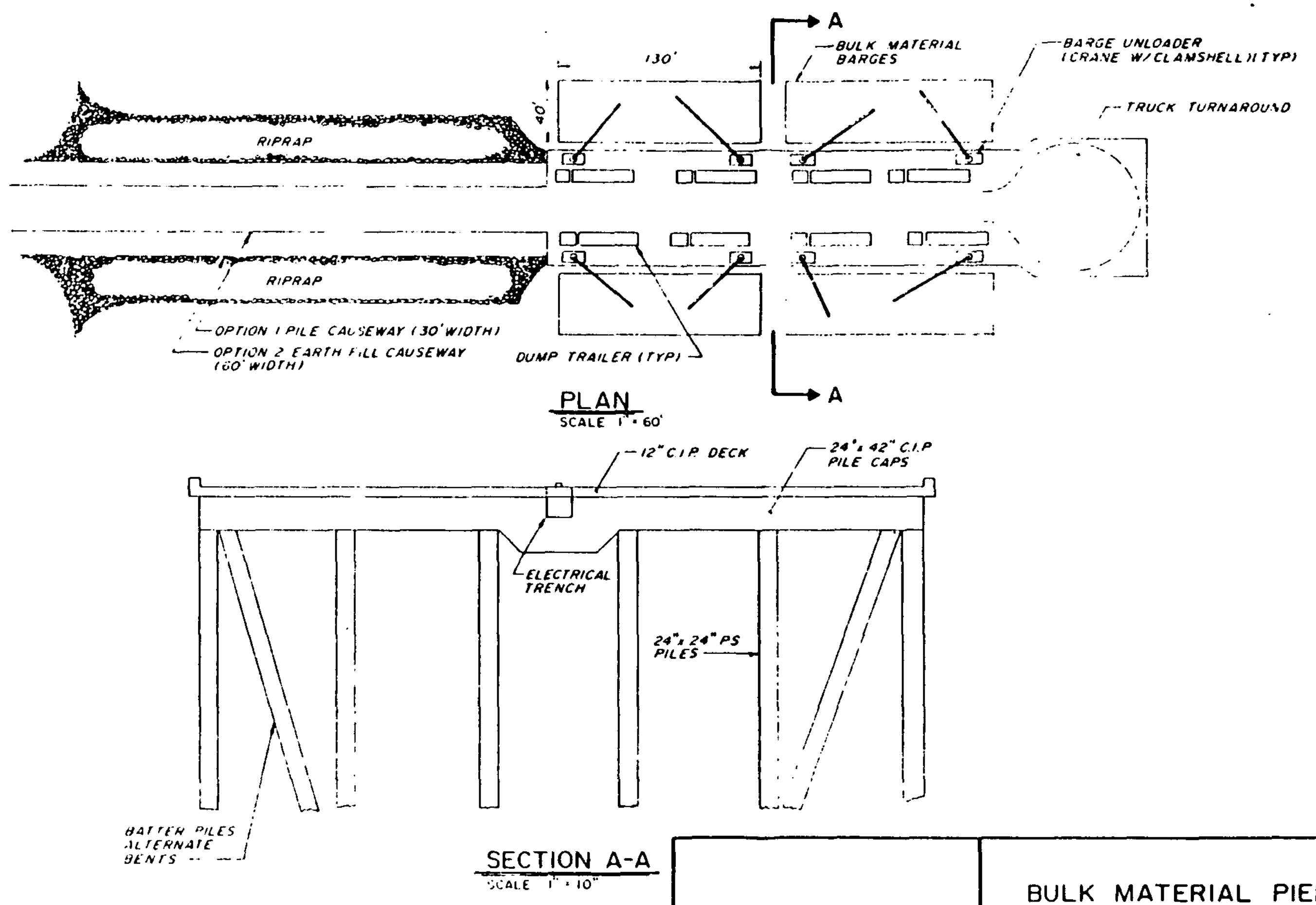
The proposed pier and causeway has a 12" concrete deck supported by 24" x 24" prestressed concrete piles. The causeway section (300' x 30') connects the shore and the main pier (300' x 75). A truck turn around area (80' x 90') is located at the end of the pier. The pier has the capacity to berth four bulk material barges simultaneously and unload as much as 10,000 cubic yds. of material per day.

3.2.2 Cost Estimate - Concrete Pier

ITEM	UNIT	QUANTITY	COST	TOTAL (1000'S)
Piles: 24" x 24" PS	LS	35,895	$ 52	$1,867
Pile Caps: 42" x 24" CIP	CY	1,015	320	325
Deck: 12" CIP	CY	1,435	320	459
Reinforcing Steel	TONS	318	1,320	420
Fender System	LF	850	265	225
Mooring Devices	EA	18	3,500	63
Utility Trench	LF	690	81	56
Lighting	LS			28
			Pier Sub Total	$3,443
			Engineering & Contingencies	690
			TOTAL	$4,133

3.1.2 Optional Earth Filled Causeway

A substantial cost savings may be realized by constructing an earth filled causeway rather than a pile supported causeway to connect the main pier to the land. The utilization of approximately 40,000 c.y. of excavated gravel material from the STP construction to create a 300' long berm (causeway) results in a potential savings of $468,500.



BULK MATERIAL PIER

FIGURE 3

3.1.3 Cost Estimate - Earth Causeway

ITEM	UNIT	QUANTITY	COST	TOTAL
Earth Fill	CY	40,600	3	$121,800
Road Pavement	SY	1,000	21	21,000
P.C. Curbing	LF	600	14	8,400
Shoulder Pavement	SY	1,000	4.50	4,500
Riprap	CY	4,133	27.50	113,700
Sheetpile Wall	LS			243,100
Engineering & Contingencies				102,000
		TOTAL		$614,500
Less Excavation Spoil Disposal Cost				-320,000
		TOTAL		$294,500
Cost of Pile-Supported Concrete Causeway				$763,000
		Potential Savings		$468,500

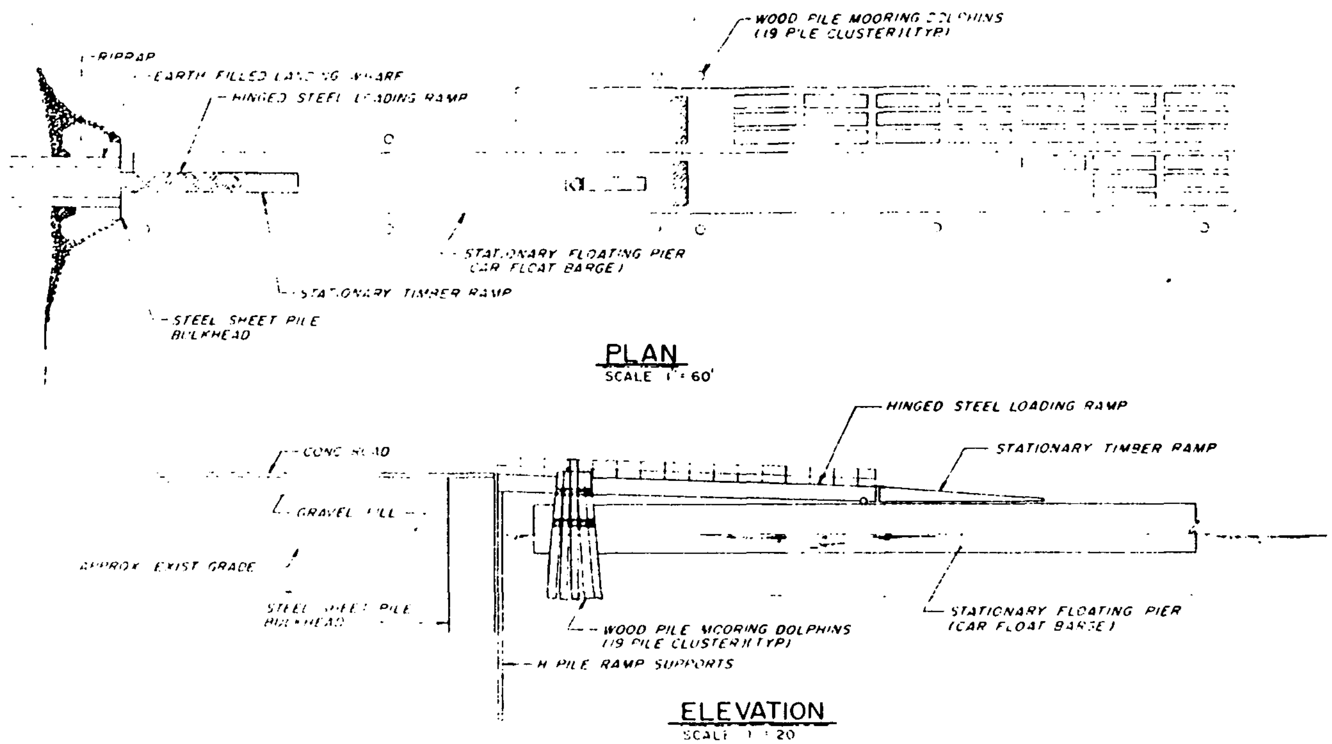
3.2 Roll On/Roll Off Pier Fig. 4

3.2.1. Description

The proposed pier consists of an earth-filled landing wharf built out from shore; a floating barge (car float) which acts as a causeway, and 10 mooring dolphins. Barges loaded with trailers are mated and moored to the stationary car float and unloaded with tractors. Ramps connect the barges to each other and to shore.

3.2.2 Cost Estimate

ITEM	UNIT	QUANTITY	COST	TOTAL
Earth filled landing Wharf	LS			$151,000
Ramp	LS			125,000
Barge Mating System	LS			51,000
Mooring dolphins	EA	10	28,500	285,000
Lease barge for 1 yr.	LS			50,000
Engineering & Contingencies				132,000
			TOTAL	$794,000



ROLL ON / ROLL OFF PIER

FIGURE 4

3.3 Commuter Pier Fig. 5

3.3.1 Description

The proposed commuter pier consists of a floating barge moored to an existing stone wharf. The existing wharf would be upgraded by the addition of gravel fill and pavement surfacing. Four mooring dolphins are required. A clear channel would be surveyed and designated with marker bouys leading in from deeper water to the floating pier.

3.3.2 Cost Estimates

ITEM	UNIT	QUANTITY	COST	TOTAL
Mooring Dolphins	EA	4	28,500	$114,000
Improvements to Exist Wharf	LS			14,000
Aluminum Boarding Ramps	EA	2	7,500	15,000
Survey Channel & Mark	LS			24,000
Barge Lease/per yr.				54,000
Engineering & Contingencies				44,000
			TOTAL	$265,000

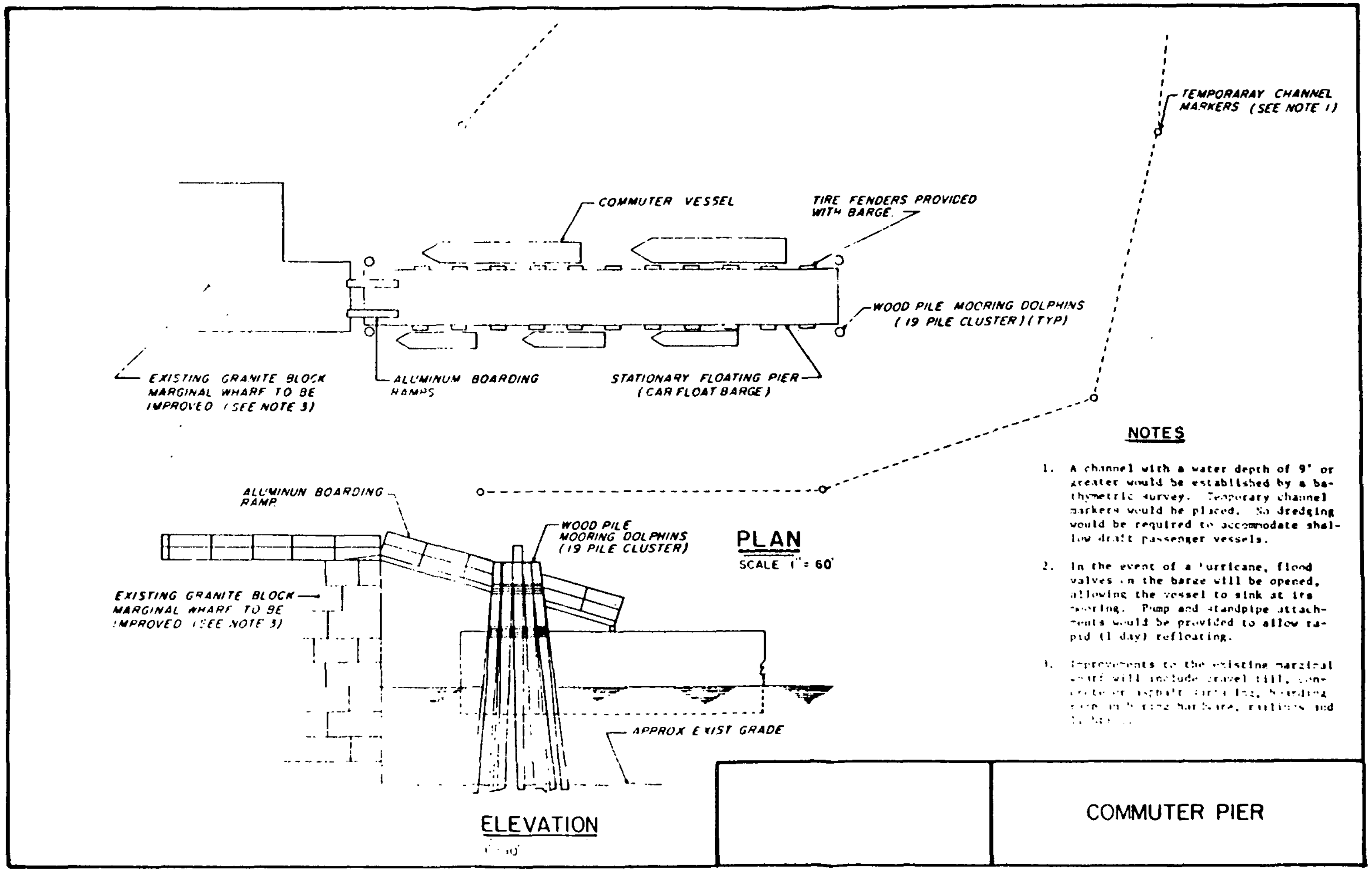

TEMPORARAY CHANNEL MARKERS (SEE NOTE 1)
COMMUTER VESSEL
TIRE FENDERS PROVIDED WITH BARGE
WOOD PILE MOORING DOLPHINS (19 PILE CLUSTER) (TYP)
EXISTING GRANITE BLOCK MARGINAL WHARF TO BE IMPROVED (SEE NOTE 3)
ALUMINUM BOARDING RAMPS
STATIONARY FLOATING PIER (CAR FLOAT BARGE)
NOTES
1. A channel with a water depth of 9' or greater would be established by a bathymetric survey. Temporary channel markers would be placed. No dredging would be required to accommodate shallow draft passenger vessels.
2. In the event of a hurricane, flood valves on the barge will be opened, allowing the vessel to sink at its mooring. Pump and standpipe attachments would be provided to allow rapid (1 day) refloating.
3. Improvements to the existing marginal
ALUMINUN BOARDING RAMP
WOOD PILE MOORING DOLPHINS (19 PILE CLUSTER)
PLAN
SCALE 1" = 60'
EXISTING GRANITE BLOCK MARGINAL WHARF TO BE IMPROVED (SEE NOTE 3)
APPROX EXIST GRADE
ELEVATION
COMMUTER PIER

FIGURE 5

4.0 PIER DESIGN CRITERIA

4.1 Volume Capacities

4.1.1 Bulk Pier

As designed, eight 900 c.y. bulk material barges could be unloaded per day for a total of 7,200 c.y. Four empty barges would be removed and replaced with four full barges during lunch hour to minimize lost time for operators standing by.

4.1.2 Ro/Ro Pier

Each ro/ro barge would consist of two car float barges (40' x 330') rafted together for a total carrying capacity of 42 trailers. (Trailer = 45' x 8.5' @ 40 tons). Assuming removal of a trailer every five minutes and delivery of a 2nd ro/ro barge during lunch, 84 trailers could be landed per eight hour day.

Empty trailers would be stockpiled in an adjacent staging area and then loaded out at night. Alternatively, a second ro/ro facility can be constructed to allow simultaneous unloading/loading operations.

4.1.3 Commuter Pier

The commuter pier consists of a single moored car float barge (40' x 330') providing 660' of berthing space. Eight, 77' high speed commuter vessels carrying 149 workers each can simultaneously dock at this facility.

4.2 Environmental Considerations

The negative impact of steel or concrete pile supported structures on the environment is negligible and occurs primarily during construction. During this time, noise, vibration and disruption of the sea bottom scares marine life from the area. However, piles quickly become fouled with marine organisms and provide a natural habitat for a variety of new species as well as the original inhabitants. Studies of pile supported oil rigs on the Gulf and West Coasts actually show positive impacts on the marine life ecosystem.

Fill projects rarely contribute positive impacts to the marine environment unless designed specifically to do so. To a certain degree, the negative impact is direclty related to the area filled; however, other factors such as runoff or disruption of tidal currents may have a more significant impact.

The proposed designs attempt to limit not only overall cost of the facilities but the impacts on the marine environment as well. The use of temporary floating piers greatly reduces the size of the permanent structures. The optional earth filled causeway is proposed primarily to reduce costs; however, judging by shoreline configuration and offshore contours, the impact is believed to be small; and material for its construction would be excavated gravel which when utilized as fill may cause lesser impact than would offshore disposal.

4.3 Storm Resistance

Facility design requirements include the necessity for structures to withstand a 100 year storm. Preliminary analysis of the proposed concrete pier based on assumed flood and wave conditions indicate that the pier can safely withstand hurricane conditions barring a major impact from a large ship.

The temporary floating piers for the ro/ro facility and the commuter facility will have the unique ability to be flooded and sunk at their berths. Waves and storm surge can, therefore, safely pass over the vessels. Minor modifications to the barges would provide flood valves and pump out connections. After passage of the storm, workers would connect pumps and refloat the barges. This method would provide the greatest assurance of safety to the barges. An alternative method would involve designing the mooring equipment (dolphins, chains, etc.) to withstand the estimated forces. Construction and material costs would be considerably higher for the overstrengthening thus required.

4.4 Future Uses of the Pier

Recreation:

Many fundamental design differences exist between recreational marine facilities and industrial marine facilities. However, it is not unreasonable to consider future conversion of the proposed bulk handling pier to a public recreational facility. Low cost modifications such as the addition of railings around the perimeter of the pier would suffice for use by fishermen, photographers, sightseers, etc.

A recreational marina could be economically created by attaching floating finger piers and ramp walkways to the pier. The viability of such a conversion largely depends upon the development of shoreside facilities and services.

Sludge Terminal:

The proposed permanent pier is sited and designed ideally for future utilization as either a roll on/roll off sludge tank truck facility, or as a deep draft sludge tanker terminal. Shallow draft sludge barges could be handled most economically of all.

Ro/Ro Facility:

Fig. 6, Option 1, shows a plan for conversion of the pier to a ro/ro facility suitable for handling tank trucks. The ro/ro ramp from the temporary facility can be moved and installed on the end of the pier. Two high strength breasting/mooring dolphins would be constructed to complete the facility. Estimated Total Cost: $250,000

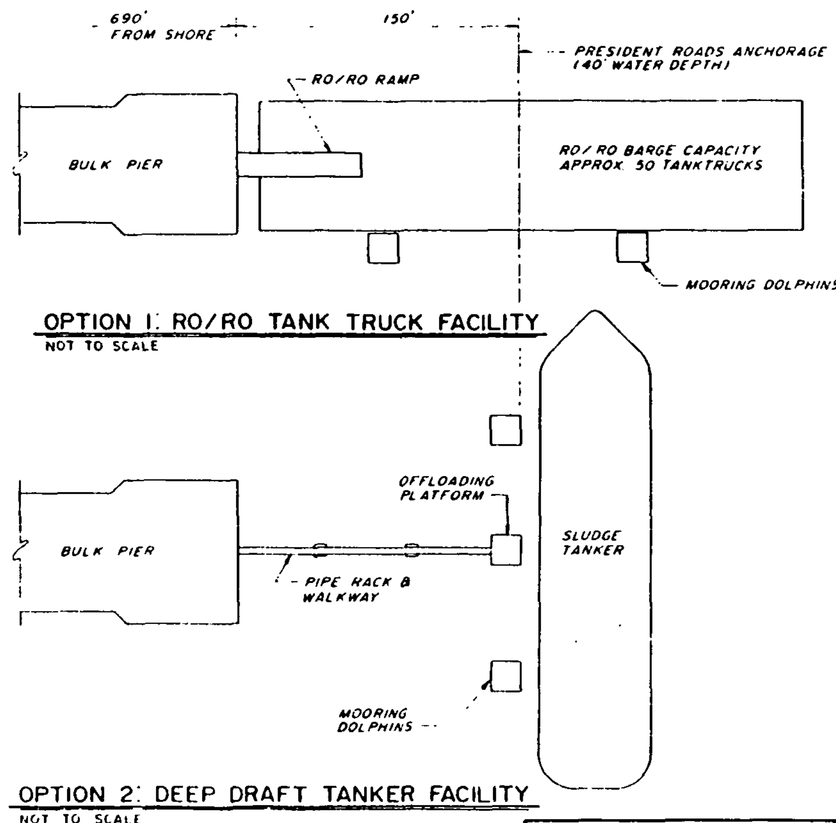
Depending on the type of vessel utilized as a "tanker", conversion costs vary dramatically. Since water depth at the end of the pier is estimated to be a minimum of 20', a shallow draft (12') fuel barge could be used for bulk sludge transport. Cost of conversion would be limited to the pipes, pumps, and hoses necessary for loading.

Fig. 6 Option 2, shows the addition of a pipe rack and walkway bridging the 150' distance from the pier to the President Roads Anchorage. With the construction of 3 breasting dolphins, the resulting 40' deep berth is capable of handling 600'+ tankers.

Estimated Cost: $850,000

Other Uses

A broad range of alternate future uses of the pier can be considered. Among them are: docking for tugs or pilot boats which service Boston Harbor; docking for Coast Guard or other government and rescue vessels; and fuel dock for commercial and/or recreational boats.



FUTURE SLUDGE TERMINAL OPTIONS

FIGURE 6

5.0 VESSELS FOR TRANSPORT DURING CONSTRUCTION

5.1.1 Commuter Vessels

High speed (over 20 knots) commuter vessels are commonly built in three classes based on passenger capacity: 49, 149 and 300 passengers.

Vessels in the 49 and 149 passenger class are available with totally enclosed, heated passenger compartments, suitable for all weather operation. The 300 passenger class vessels often accommodate up to 150 passengers on an open upper deck. These vessels would require modification to enclose the upper deck and then recertification by the Coast Guard. A greater number of smaller vessels capable of slightly higher cruising speeds and much lower docking times may prove most cost effective if workers are to be paid while enroute.

Assuming 1200 workers/day transported over water 20 - 30 miles round trip at an average speed of 22 miles per hour, preliminary cost estimates range from $8 - $14 per man per day. Varying factors include the number of vessels (vessel trips), contract duration in years, liabilities and penalties for down time, etc.

5.1.2 Roll On/Roll Off Vessels

Large barges 330' x 40' x 10' known as "car floats" are commonly used for transporting trucks, rail cars or other vehicles. Load capacity is approximately 2,000 tons. Deck space will accommodate 21-28 trailers. These barges lease for approximately $4,500/month from Hughes Bros., Inc. of New York among others.

The attractive feature of these vessels is the ability to simply lease more or less of them as the demand varies. Two barges can be rafted together and still managed by a single tug, effectively doubling the capacity.

5.1.3 Bulk Barges

Bulk barges are available in a variety of capacities and dimensions. Hughes Bros. offers a barge 130' x 40' x 11' with a capacity of about 900 c.y. for lease at approximately $3,500/month. Deck barges can effectively carry bulk materials such as steel rebar or palletized materials. Dump scows for offshore disposal are available with an 1,800 c.y. capacity for lease at approximately $15,000/month.

5.2 Dredging and Disposal

The facilities proposed herein do not require dredging for implementation. The use of shallow draft barges and the siting of the facilities eliminates the need for dredging.

It is possible that the sediment at Site 2 would qualify for offshore disposal, were dredging required. Sediment analysis was conducted by the Army Corps of Engineers in 1980 on samples from the President Roads Anchorage abutting Site 2. Contamination levels were found to be within Federal limits, and the dredged material was subsequently disposed of offshore.

Dredging at Site 2 would allow shortening of the causeway connecting the Bulk Pier to the Island. Shortening the causeway by 200' would result in a savings of $500,000 from pier construction, but would require the dredging of approximately 40,000 c.y. of material. An additional savings of approximately $160,000 would result from the shorter pile lengths required for the main pier structure, for a total savings of $660,000 on pier construction.

Dredging and disposal costs for 40,000 c.y. of material would approach $400,000. Engineering and the permitting process would add another $50,000 and require approximately six months. The net project savings from dredging would, therefore, only be approximately $200,000.

It must be noted that until the proposed dredged material is sampled and analyzed, it is somewhat uncertain if dredging would be permitted at all. It is possible that a six month design and permitting process could ultimately end in a denial of the permit and considerable loss of time and money.

6.0 CONCLUSIONS

The facilities recommended for Deer Island within this report are economically and practically feasible. Waterborne transport of labor and materials to Deer Island vs. land transport will not delay construction schedules and will not disrupt the lives of residents in the vicinity of Deer Island. The construction cost for waterborne transport may be higher than for land transport, but that cannot be determined with certainty within the scope of this study. Construction costs for the pier structures have been estimated herein.

Long Island has similar features and geology to Deer Island and is also deemed suitable for delivery of labor and materials via water. Cost estimates for construction of pier facilities at Long Island have not been developed because of a lack of subsurface information, but it is anticipated that costs would not vary greatly from those estimated for Deer Island. Long Island is slightly more exposed to storm conditions, which could result in additional lost time during delivery and handling of materials.

It has been determined that a separation of pier structures according to use is preferable to construction of one multi-use pier. This scheme has the added benefit that commuter and ro/ro piers can be temporary, and can be easily enlarged during construction and removed thereafter. The permanent bulk handling pier is adaptable to many uses after construction of the treatment plant is completed.

Dredging is not required for construction of the pier facilities recommended herein. Very little economic or logistic benefit could be derived from dredging; and the environmental risks and potential delays for permitting may prove to be very expensive in the long run.

II-2

odors

II-2 ODORS

A. Background

The issues raised pertaining to the odor impacts of the facility subsequent to the EIS draft, can be divided into three general areas:

1. What are the sources and what is the nature of sewage plant odors? How are odors measured and what are the effects on human health and well-being? Do other treatment plants experience odor problems?

2. How do odors disperse, and how can this be analyzed?

3. What specific mitigation methods can be applied, and what is the reliability and cost of each?

In order to answer these questions, a brief literature search and a computer modeling exercise were performed. The conclusion drawn from this study are:

1. Certain specific characteristics of the Boston sewage collection system have been shown to result in the formation of high levels of hydrogen sulfide, methyl mercaptan, and other odorous compounds.

2. The magnitude of wastewater to be treated will result in the release of substantial amounts of these compounds to the environment.

3. Computer air dispersion modeling predicts the odor impacts on nearby communities to be significant regardless of the siting option chosen.

4. In order to assure an effective and reasonable mitigation of odor, removal or destruction must be 99.9 to 99.99 percent complete.

5. Such mitigation is obtainable by careful application of reasonably available technology and by designing to achieve a high degree of efficiency.

B. Existing Conditions

1. Brief Literature Survey

Virtually all wastewater treatment facilities have the potential to emit offensive odors at some time. Surveys conducted both in the United states and other countries indicate that forty percent (40%) to sixty (60%) of the existing wastewater treatment facilities have received complaints about odor.

Odor can arise in treatment plants from any number of sources and a variety of causes, among them:

- septic wastewater
- toxic "slug" loads in the wastewater
- high concentration of volatile organics in wastewater
- incomplete treatment of wastewater
- raw or incompletely treated waste sidestreams
- organic overload due to return of highly concentrated recycle flows
- screenings, grit and skimmings with high concentrations of putrescible matter
- gas emissions from treatment processes, manholes, pump stations, outfalls, digesters, etc.
- chlorinated water containing phenols
- incomplete sludge stabilization
- incomplete oxidation of sulfur compounds

One of the most common sources of odor in sewage treatment plants is the formation of gases within the collection system itself. Inorganic gases resulting from biological activity within the collection system include hydrogen sulfide (H_2S) and ammonia (NH_3) as well as a number of odorless gases including carbon dioxide, nitrogen, oxygen, and methane. Organic odors, which may occur due to biological activity or from direct chemical addition from industrial sources, include mercaptans, indoles, and skatoles. These odors will occur due to the anaerobic decomposition of nitrogen and sulfur bearing compounds. Other odor sources include phenols, aldehydes, organic acids, and ketones.

Table 1 is a list of common odor-causing substances in municipal sewer systems (1). Hydrogen sulfide (H_2S) is the most commonly known malodorous gas emanating from domestic wastewater collection and treatment facilities. It is highly soluble (2 800 mg/l at 30°C to 5 650 mg/l at 5°C) in normal domestic wastewater (2). In addition to its rotten-egg odor, H_2S can cause highly corrosive conditions and is an extremely toxic substance.

The toxicity of H_2S is on the same order of magnitude as hydrogen cyanide (HCN), and death has been known to result when exposed to an H_2S concentration of 225 ppm by volume in air, such as can occur in confined areas such as sewer manholes. Such potentially lethal concentrations would not occur in open areas, however. The maximum permissible 8-hour concentration is about 20 ppm. Hydrogen sulfide can be dangerous because a person's ability to sense large concentrations is quickly lost. If the person ignores the first notice, the olfactory senses will become numbed and no longer give warning.

At a pH of approximately 9.0, hydrogen sulfide dissolved in water is over 99% in the form of the nonodorous hydrosulfide ion (HS), while at pH 5.0, only one percent (1%) is in the nonodorous form. As the pH of septic sewage is between 5 and 7.0, most of the sulfide generated is in the form of H_2S.

Hydrogen sulfide is produced by reduction of the sulfate ion (SO_4^{2-}) by anaerobic sulfate-reducing organisms. Sulfate may be present as inorganic sulfates either from industrial sources, or from seawater intrusion (seawater contains appreciable concentrations of sulfate). These bacteria thrive at low oxidation-reduction potentials (ORPs) of -0.20 to -0.30 V, pH's of approximately 6.0 to 9.0, and temperatures near 30 degrees Centigrade. The ORP of fresh wastewater is usually too high during the first one or two days in the collection system for significant production of H_2S. However, anaeorbic slime growths and sludge deposits that accumulate in sewer lines usually have lower ORPs than the wastewater, making them more conducive to H_2S production. Hydrogen sulfide may thus be produced even through the wastewater contains up to about 0.3 mg/l of oxygen (O_2) and the ORP of the wastewater is not sufficiently low to support sulfate-reducing organisms (3).

Waltrip (4) has reported levels of sulfide approaching 20 mg/l from a long collection system with a high seawater intrusion rate and making extensive use of force mains (as in Boston), and high levels of sulfide have been reported in a North Chicago system with long residence times and a high level of sulfate resulting from slaughterhouse operations discharging to the sewer (5).

For sulfate to be reduced to sulfide requires a medium completely devoid of free oxygen or other oxidizing agent. The stream of wastewater in a partly filled sewer is usually not anaerobic because it is exposed to the sewer atmospheres. Oxygen absorbed at the surface of the stream generally reacts with sulfides quite rapidly, and in large sewers the sulfide concentration in wastewater, therefore, is held to a very low level, particularly if the sewer is well ventilated.

Strictly anaerobic conditions can develop in the slime layer that forms on the submerged portion of the pipe wall. This layer is a matrix of filamentous microbes and gelatinous material (zoogleae) embedding various smaller bacteria. If oxygen is present in the stream, it diffuses into the slime layer, but only to a very short distance. Except where oxygen concentrations in wastewater are high, the aerobic zone is less than 0.25 mm (0.01 in.) thick. Beneath the aerobic zone the slime layer is anaerobic; it is there that sulfide generation generally occurs. The thickness of the sulfide-producing zone is generally of the order of 0.25 mm because of the lack of a nutrient supply. As long as the surface of the slime layer is aerobic, sulfide diffusing out of the anaerobic zone will be oxidized there and no sulfide will be found in the wastewater stream unless it is from some extraneous or upstream source.

However, if the oxygen concentration in the wastewater drops to a low level, generally a few tenths of a milligram per litre, not enough oxygen will enter the surface of the slime layer to oxidize all the sulfide that is produced and some can escape into the wastewater.

TABLE 1
ODOROUS SUBSTANCES

	Formula	Characteristic Odor	Odor Threshold (ppm)
Acetaldehyde	CH_3 * CHO	Pungent fruity	0.004
Allyl Mercaptan	CH_2 * CH * CH_2 * SH	Strong garlic, coffee	0.00005
Ammonia	NH_3	Sharp pungent	0.037
Amyl Mercaptan	CH_3 * $(CH_2)_3$ * CH_2 * SH	Unpleasant, putrid	0.0003
Butylamine	C_2H_5 * CH_2 * CH_2 * NH_2	Sour, ammonia-like	--
Chlorine	Cl_2	Pungent, suffocating	0.01
Chlorophenol	Cl C_6H_5O	Medicinal, phenolic	0.00018
Dibutylamine	$(C_4H_9)_2NH$	Fishy	0.016
Dimethylamine	$(CH_3)_2NH$	Putrid, fishy	0.047
Dimethyl Sulfide	$(CH_3)_2S$	Decayed vegetables	0.001
Diphenyl Sulfide	$(C_6H_5)_2S$	Unpleasant	0.000048
Ethylamine	C_2H_5 * NH_2	Ammoniacal	0.83
Ethyl Mercaptan	C_2H_5 * SH	Decayed cabbage	0.00019
Hydrogen Sulfide	H_2S	Rotten eggs	0.00047
Indole	C_8H_6NH	Fecal, nauseating	--
Methylamine	CH_3NH_2	Putrid, fishy	0.021
Methyl Mercaptan	CH_3SH	Decayed cabbage	0.0011
Propyl Mercaptan	CH_3 * CH_2 * CH_2 * SH	Unpleasant	0.000075
Pyridine	C_6H_5N	Disagreeable, irritating	0.0037
Skatole	C_9H_9N	Fecal, nauseating	0.0012
Sulfur Dioxide	SO_2	Pungent, irritating	0.009
Tert-Butyl Mercaptan	$(CH_3)_3C$ * SH	Skunk, unpleasant	0.00008
Thiophenol	C_6H_5SH	Putrid, garlic-like	0.000062
Triethylamine	$(C_2H_5)_3N$	Ammoniacal, fishy	0.08

In order to determine what type of odor control technology will be required it is necessary to evaluate the potential adverse impacts of odors emanating from possible alternative treatment plant sites. This involves identifying and quantifying the characteristics of odor that are the most important.

Unfortunately, odor evaluation is not a well-developed science, and there are no standard methods. What is known is that odors and their perception are very complex. They vary from compound to compound and from person to person. There are different thresholds of perception for each compound and significant variance in human reaction to increasing levels of specific odors among people.

It has been suggested that four independent factors are required for the complete characterization of an odor: intensity, character, hedonics, and detectability. To date, detectability is the only factor used in the development of statutory regulations for nuisance odors (6).

Odors can be measured by sensory methods, and specific odorant concentrations can be measured by instrumental methods. Under carefully controlled conditions, the sensory measurement of odors by the human olfactory system can provide meaningful and reliable information. Therefore, the sensory method is now used most often to measure odors emanating from wastewater treatment facilities.

In the sensory method, human subjects (often a panel of subjects) are exposed to odors that have been diluted with odor-free air, and the number of dilutions required to reduce an odor to its threshold of detection concentration are noted. The detectable odor concentration is reported as the dilutions to the odor threshold. Thus, if four volumes of diluted air must be added to one unit volume of sampled air to reduce the odorant to its threshold, the odor concentration would be reported as five dilutions to the threshold concentration.

In recent years, a number of regulatory agencies have established odor discharge standards on the basis of such dilutions. Fortunately, it appears that the composite odor of sewer gases correlates well with the hydrogen sulfide concentration. Thus the use of hydrogen sulfide appears to be satisfactory for defining the overall odor level in the air for the purpose of this modeling exercise.

Human perception of increases in odor is not linear, but relative or logarithmic (7). As for noise and light, it takes much more than a doubling of concentration to create a perception of twice as strong an odor; but unlike noise and light, the ability to perceive can diminish rapidly with time on any given exposure and constant exposure can lead to an inability to perceive. And finally, again like sound, between the threshold of perception and the point at which the stimulus can do physical harm, there is a broad grey area of increasing nuisance, increasing discomfort and increasing interference with normal and reasonable human activity.

2. Wastewater Characteristics and Collection System

The present municipal wastewater collection and treatment system serves 43 communities in the Boston regional area. The total flow and load estimates, taken from the 1982 site options study (8) are as follows:

Projected Average Flows (MGD)

Year	Sewered Pop.	Res. & Comm.	Ind.	Special Comm.	Until.	Infil. Inflow	Total Average Daily Flow
1980	1,900,700	134	44	25	4	253	460
1990	1,950,645	137	44	27	4	273	485
2010	2,034,400	142	43	31	4	280	500

The Infiltration/Inflow component is projected to be the majority contributor to the total wastewater load. Historically, there has been a significant flow increase during wet weather periods. Additionally there is evidence of saltwater intrusion into the collection system, which has the impact of damping the peak flows and also changing the characteristics of the influent wastewater, most notably by providing the higher sulfate levels necessary to bacterial sulfide production.

The industrial component is estimated at approximately nine percent (9%) of the total wastewater load. The impact of the industrial wastewater is primarily a function of its character, rather than its volume. Compliance with the ongoing wastewater pretreatment program is necessary to reduce the loading of toxics, organics, and shock loads of a wide assortment of industrial chemicals.

In addition to the wastewater component loads itemized above, the collection system accepts septage from numerous communities within the services area. In many cases, the septage is discharged into the system at relatively remote extensions of the collection system. This particularly common from communities which are partially sewered.

Due to the geographic expense of the collection system, a significant portion of the sewage has a much longer detention time within the collection system than might normally be expected. It has been estimated that some wastewater may be retained for two (2) days prior to discharge to the wastewater treatment facility. This tends to enhance the opportunity for formation of malodorous compounds.

The result of this is that both the influent to the existing Deer Island plant and the sewage in the High level Sewer have been reported to contain high H_2S levels, at times as high as 10 mg/l (8). Although this data base cannot be regarded as complete or definitive, the figure of 10 mg/l was used in the modeling for lack of better information. Any future work on odor impacts or mitigation should at the outset include sufficient influent sampling and analysis to completely define the extent of sulfide buildup.

While the exact level of sulfide may be subject to fluctuation based on any number of factors, a survey (admittedly not scientific) conducted by the Winthrop Concerned Citizens Committee contains many references to severe odor, lending support to the frequent presence of objectionable levels of sulfide and/or other odorous compounds. In addition, Deer Island House of Corrections personnel describe objectionable odors on numerous occasions.

It was for these reasons that a more formal appraisal of the odor impacts was conducted.

C. Projected Conditions

1. Model Assumptions

In order to predict the odor impact of the prosed action on surrounding areas, it was decided to model odor as a chemical species dispersing in the environment much the same as any other pollutant, using a Gaussian plume dispersion computer model. Precedent for the use of such a model for odor has been published by Hogstrom (9), who developed a Gaussian fluctuating-plume model to predict odor emission from a paper mill in Sweden, and Clarenburg (10), who refined a Gaussian plume model to predict odor complaints surrounding a chemical plant in Holland.

Gaussian dispersion models essentially use empirical formulas to predict dispersion coefficients as a function of downwind distance and prevailing meteorological conditions. These coefficients are then used to calculate concentrations at specific downwind receptors.

The major shortcoming of this approach is that, calculated on an averaging period of, say, one hour, the model predicts an <u>average</u> concentration resulting from dispersion but does not take into account the random wandering of a plume over short-term (ca. 30 seconds) averaging times. The net result of this shortcoming is that Gaussian plume models overpredict average concentrations, but would underpredict the number of occurrences of that concentration exceeding a particular value (i.e., odor threshold), since the concentration of odorous matter can exceed a value several times during a period when the hourly average concentration is below the value.

Another imperfection in this approach is that an odor threshold concentration must be specified for the compound of interest, and the threshold will naturally vary from individual to individual.

With these variabilities in mind, the analysis of odor impacts using Gaussian dispersion models should be regarded as giving only approximate (probably high), estimates of average concentrations and approximate (probably low) estimates of the number of perceived "odor events." Correlations with actual observations of odor events showed approximately twenty percent (20%) error (on the low side) for the models above. The ISC model and available data are sufficiently accurate for comparison of the relative odor impacts from a Deer Island or Long Island treatment plant, however.

The model chosen for this study is the Industrial Source Complex -- Short-Term (ISC-ST) model, an extended version of the single source CRSTER model developed by the Meteorology Laboratory of the United States Environmental Protection Agency (U.S.E.P.A.) in 1971 (11). It is one of the few computer dispersion models able to predict hourly concentrations from a number of area sources.

The ISC-ST model is designed to calculate concentration or desposition values for incremental time periods of one (1) to twenty-four (24) hours. With incorporation of a year of sequential hourly meteorological data, this model will calculate and point out annual, daily and hourly concentrations in a variety of formats.

The area source algorithm in the ISC-ST model is based upon equations for a continuous and finite crosswind line source. The general Briggs plume-rise equations are used to calculate plume-rise as a function of the downwind distance. These equations also can include momentum factors.

The source of meteorological data used was a tape of computerized hourly surface observations recorded at Boston Logan Airport, coupled with upper air (mixing height) data taken simultaneously at the Portland, Maine National Climatic Center Station.

The emission rates calculated were based upon a maximum 10 mg/l concentration by hydrogen sulfide in the influent reported in the Site Options Study and an influent flow rate of 500 MGD. If it is assumed as a worst case that one hundred percent (100%) of the influent sulfide is released in the plant, a total emission rate can be calculated. This was the emission rate modeled.

To select a specific compound to be used in this evaluation, the likely emission rates of hydrogen sulfide, ammonia and methyl mercaptan were estimated and compared with the thresholds of perception of each compound. Table 2 shows the estimated emission rates in grams per second, the threshold of perception stated in micrograms per cubic meter, and the ratio between the two. The compound with the highest ratio (H_2S) would be the most perceivable, and those with lower ratios would tend to be "masked" by the stronger one.

TABLE 2
COMPARISON OF ODOR POTENTIAL OF SELECTED COMPOUNDS

	Emission Rate* g/sec	Threshold** ug/m^3	Relative Ratio Emission/Threshold
H_2S	220	.6	366
NH_3	2400	26.0	92
MM	46	4.0	11.5

*Concentration in influent X flow per second.

**Converted from published volumetric threshold values in ppmv of .00047 for H_2S, .037 for NH_3, and 0.002 for MM.

Odor modeling was performed for four (4) sources in the proposed wastewater treatment facilities. This analysis assumed installation of the conventional activated sludge system as proposed in the Site Options Study, draft EIS and other documents. The process components studied included:

aerated grit chamber
primary clarifiers
secondary aeration tanks
sludge thickeners

In order to partition the overall emission rate among the four sources above, data reported by Ando (12) for concentrations of H_2S above typical unit operations was used; emissions were assumed to be proportional to relative concentrations on a unit area basis.

Areas for the four component operations were taken from Option 1 to the Site Options Study, "All Deer Island Secondary," and were calculated in accordance with ISC area source instructions to correspond to "presented areas" aligned with the north-south axis. These four area sources were then modeled as four co-located sources with their centers at the center of Deer and Long Islands, respectively.

The ISC-ST program was then run in a concentration mode with results given in micrograms per cubic meter. Discrete receptors were modeled to correspond to areas where odors are of concern. The eleven (11) discrete receptors are shown in Figure 1 and include:

RECEPTOR AND PLANT LOCATIONS FOR ODOR DISPERSION MODEL

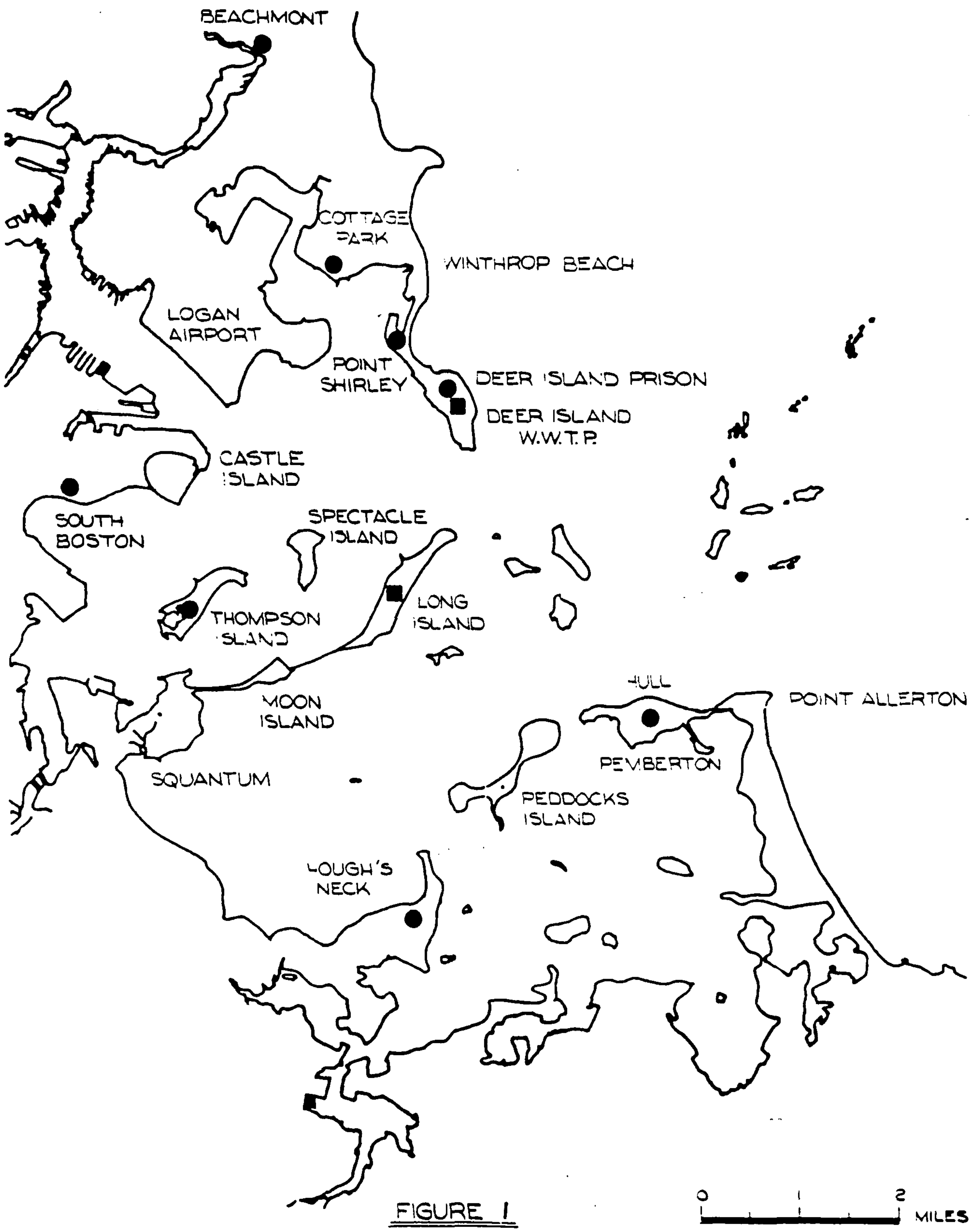


FIGURE 1

Deer Island House of Correction
Point Shirley (Winthrop)
Winthrop Beach
Winthrop Beach
Beachmont (Revere)
South Boston
Thompson Academy (Thompson Island)
Squantum
Houghs Neck (Quincy)
Peddocks Island
Hull

2. Results and Discussion

Introductory to remarks on the results of this study, it should be pointed out that this analysis predicts the impacts of an "uncontrolled" plant. EPA and the Commonwealth of Massachusetts are committed to odor control to the maximum feasible extent; this analysis is, therefore, used to predict the extent of control necessary, and not to illustrate the situation which will be in existence.

The resultant data were evaluated by comparing each concentration to the threshold value reported earlier. A concentration equal to, or exceeding the threshold value for a given receptor, was recorded as an odor event during which the receptor would find the odor objectionable. An "odor event" can then be defined as a concentration above the threshold of perception at a particular receptor, arising from the treatment plant, and carried to the receptor by the meteorological conditions recorded during that hour.

Table 3 is a tally by month of odor events occurring at each receptor for a facility located on Deer Island. Table 4 is a similar tally for a Long Island facility.

In terms of total odor events, no distinct advantage can be seen to locating the facility at a given location, as an odor would be detected at a populated receptor a substantial amount of time with the plant located at either site.

It is interesting to note that, in some circumstances, the effect of a Long Island treatment plant on Winthrop is as great or greater than the effect of a Deer Island plant. This is due to the southernly direction of the prevailing winds in summer and the fact that the two plants lie along a slightly different compass bearings.

In order to determine that this effect was real, three-hour concentration averages for June of three other years (1975-1977) were obtained, and approximately the same effect was noted.

TABLE 3

DEER ISLAND WASTEWATER TREATMENT PLANT

NUMBER OF HOURS PER YEAR DURING WHICH ODOR WOULD BE DETECTED

	MONTH												
	1	2	3	4	5	6	7	8	9	10	11	12	Total	% of Year
Deer Island Prison	21	22	80	85	128	59	87	102	94	44	69	74	865	9.8
Cottage Park	11	13	44	45	76	31	46	64	53	21	42	25	471	5.4
Squantum	32	13	17	24	57	7	29	31	20	30	38	9	307	3.5
Hull	23	163	66	107	43	7	33	26	55	52	70	44	689	7.9
Point Shirley	16	17	51	54	90	33	58	75	61	17	47	31	550	6.3
Beachmont	10	6	35	23	43	26	20	32	31	7	24	41	298	3.4
Hough's Neck	66	40	35	16	18	11	30	49	46	31	87	19	448	5.1
Thompson Island	26	17	19	26	59	14	33	39	27	28	35	12	335	3.8
Winthrop Beach	18	7	45	27	52	34	22	32	42	11	26	39	355	4.1
South Boston	32	13	31	31	68	29	31	67	32	27	33	7	401	4.6
Peddock's Island	51	54	38	34	17	18	22	38	64	58	69	13	476	5.4
													5195	

TABLE 4

LONG ISLAND WASTEWATER TREATMENT PLANT

NUMBER OF HOURS PER YEAR DURING WHICH ODOR WOULD BE DETECTED

	MONTH													
	1	2	3	4	5	6	7	8	9	10	11	12	Total	% of Year
Deer Island Prison	26	7	53	27	61	104	59	37	54	41	28	30	527	6.0
Cottage Park	19	2	33	23	44	31	13	25	36	7	23	33	289	3.3
Squantum	34	18	23	32	72	27	30	57	27	28	34	9	391	4.5
Hull	125	212	157	150	77	109	64	64	42	79	18	207	1304	14.9
Point Shirley	26	7	42	22	51	41	24	15	51	11	27	31	348	4.0
Beachmont	21	3	38	23	46	29	15	15	37	4	23	29	283	3.2
Hough's Neck	57	62	45	39	22	19	24	40	70	61	81	9	529	6.0
Thompson Island	15	12	32	39	71	46	49	18	40	46	35	9	412	4.7
Winthrop Beach	25	8	45	20	47	54	33	23	53	17	26	28	379	4.3
South Boston	6	15	30	33	63	39	50	50	28	52	29	12	407	4.6
Peddock's Island	67	147	66	106	43	63	33	32	75	70	73	17	792	9.0
													5661	

In terms of the magnitude of odor generated from each operation, secondary treatment is responsible for only approximately five percent (5%) of the H_2S generated. Since a 500 MGD source was modeled, as opposed to the current 350 MGD at Deer Island, the predicted situation at Deer Island should be only slightly worse than the current situation. In fact, the history of odor complaints directed to the Deer Island facility would seem to support the need for an odor control program at the existing plant.

In addition to the number of odor events for each receptor, an analysis of the severity of these "odor events" must be made. In order to do this, two types of counts were done. Table 5 shows percentages of the predicted odor events for each receptor which are above 600 and 6000 ug/m^3, which might correspond to "probable strong complaint" and "severe interference with normal activity" levels (13). While only a few receptors show extreme concentration, almost all of the receptors suggest a significant amount of odor complaints, and some receptors (i.e., Deer Island plant to Deer Island House of Corrections) suggest a severe odor problem (with no controls in place as discussed above).

It should be recognized that not all of the sulfide will necessarily be released, due to the tendency for sulfide to oxidize in water containing dissolved oxygen. In experiments at Hampton Roads, Virginia, Waltrip reports a release of twenty-five percent (25%) of influent H_2S in an aerated prestripping process, the remainder being oxidized. Control of the prestripping was by maintaining 7 mg/l of dissolved oxygen in the tank; up to fifty percent (50%) release can be obtained if less oxygen is transferred.

Since the exchange coefficient of H_2S is reported to be seventy-two percent (72%) of the oxygen exchange coefficient (2), and oxygen was transferred in excess of the amount of sulfide oxidized in the above experiments, evidence would seem to indicate that, while direct calculations of sulfide release are impractical due to the uncertainties in design, a figure of twenty-five (25) to fifty (50) percent release is not impractical. In fact, the equilibrium value of H_2S in air in contact with a 10 mg/l solution of H_2S at pH 7.0 and twenty (20) degrees Centigrade is 2730 ppm (2), or twenty-seven percent (27%) volatilization into an equal volume of air.

Figures 2 and 3 show the percent of total hours at which a positive concentration was predicted, as a function of $\log_{10}$ H_2S concentration (in other words, every unit change to the right on the x-axis represents a multiplication of ten) for selected receptors for a Deer Island and Long Island facility, respectively.

TABLE 5

% OF TIME (ANNUALLY) THAT ODOR EVENTS WOULD EXCEED

TWO CONCENTRATIONS OF H_2S AT SELECTED RECEPTORS

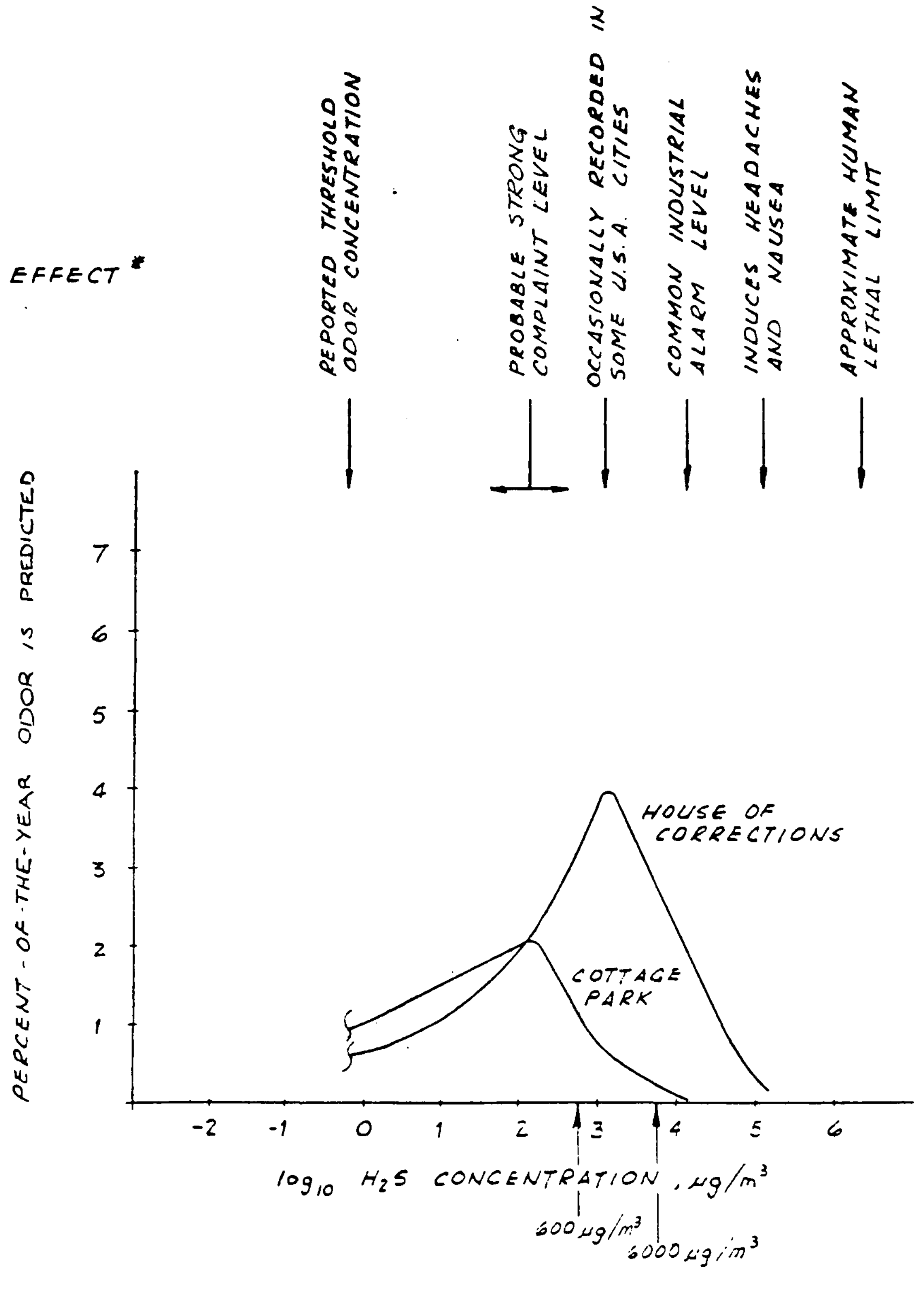
FROM ALTERNATIVE TREATMENT PLANT LOCATIONS

	Treatment Plant Location			
	Deer Island		Long Island	
	600* ug/m3	6000** ug/m3	600 ug/m3*	6000 ug/m3**
Deer Island Prison	8.1 %	4.3 %	1.2 %	--
Point Shirley	1.5	--	0.7	0.2 %
Winthrop Beach	1.0	--	1.0	0.2
Cottage Park	0.5	--	0.3	--
Beachmont	1.3	0.3	0.5	--
South Boston	0.4	--	--	--
Squantum	--	--	1.2	--
Hough's Neck	0.6	--	2.3	--
Peddock's Island	0.5	--	1.7	--
Hull	1.3	--	2.2	--
Thompson Island	0.3	--	1.6	1.0

* Probable strong complaint

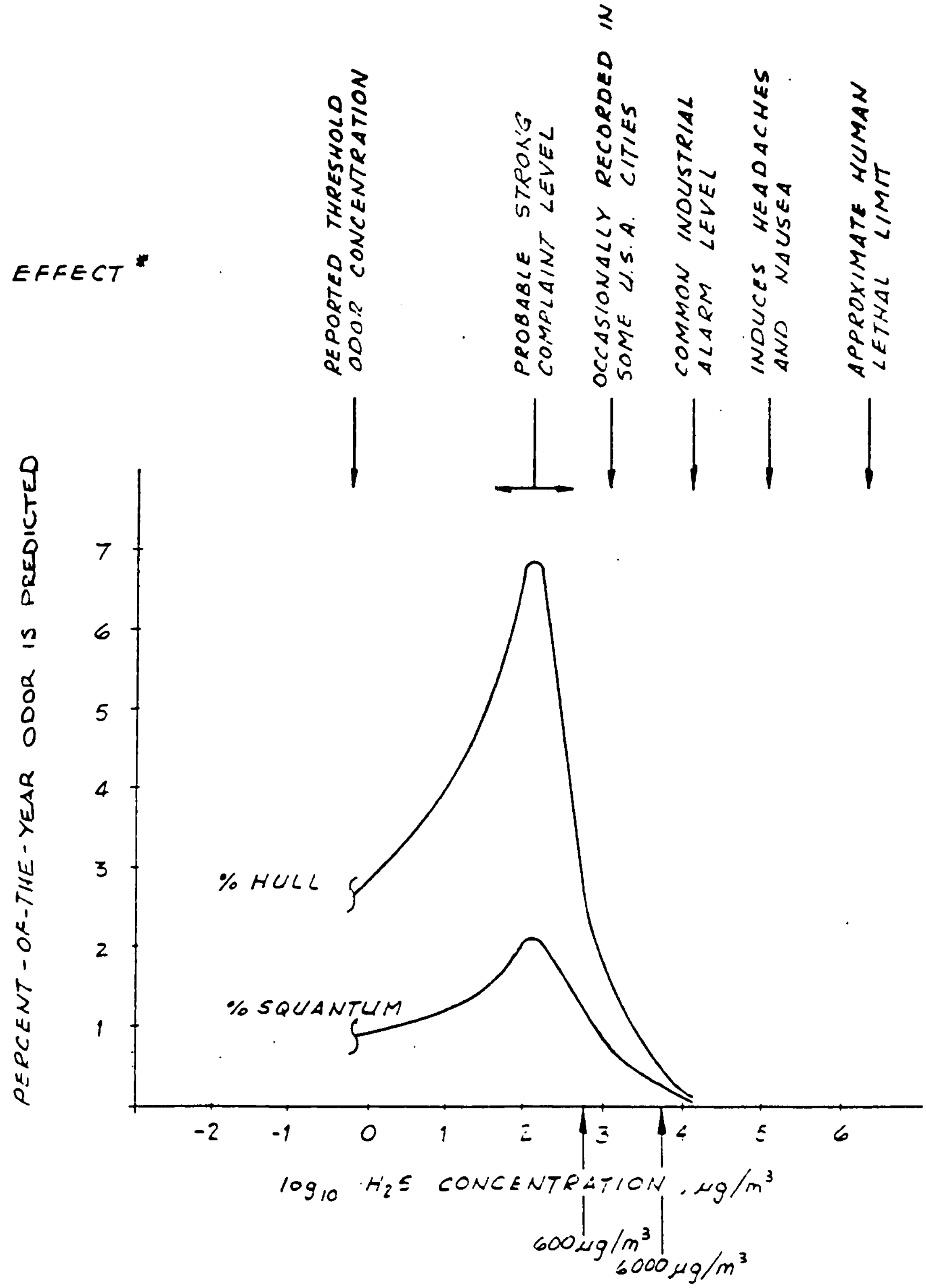
** Severe interference with normal activity

FIG. 2 - DISTRIBUTION OF CONCENTRATIONS OF ODOR EVENTS FROM DEER ISLAND PLANT FOR SELECTED REPRESENTATIVE RECEPTORS



* KOE, BRADY: "QUANTIFICATION OF SEWAGE ODORS", NTIS PB-84-116169

FIG. 3 - DISTRIBUTION OF CONCENTRATIONS OF ODOR EVENTS FROM LONG ISLAND PLANT FOR SELECTED REPRESENTATIVE RECEPTORS



* KOE, BRADY; "QUANTIFICATION OF SEWAGE ODORS", NTIS PB-84-116169

Figures 2 and 3 have been adjusted to reflect an emission rate of 25% of the incoming sulfide. The effect of this is shift the maximum of the curves about half a log unit to the left. The significance of this is that by adjusting the emission rate to reflect a more realistic release concentrations predicted for some receptors are still at best three orders of magnitude above commonly accepted threshold values.

For both situations, it can be seen that the majority of time during which H_2S could be detected, concentrations would be approximately three (3) to four (4) orders of magnitude over the reported threshold. For the situation at Deer Island facility's impact on the Deer Island House of Corrections, the data suggests that concentrations are often well above the range at which complaints would be expected, and approach the level at which some physiological reactions could be expected.

D. Mitigation

Effective mitigation of odor from a Boston Harbor treatment facility will be contingent upon the implementation of the following:

1. A further, complete monitoring of the odor characteristics of the influent to the current treatment works.

2. A committment to the maximum feasible degree of mitigation.

3. A thorough investigation of state-of-the-art odor control technologies undertaken as part of the facilities planning process.

By making every effort to apply reasonably available technology designed to achieve a high degree of efficiency, it is the opinion of the authors that a reasonable and effective mitigation of odors can be achieved. Due to the proximity of the Deer Island House of Corrections, it is possible that odor could reach levels at which complaints could arise; however, should the above mitigation strategy be applied, it is expected that these occurrences would be rare.

Literature available on the control of odors from municipal wastewater treatment facilities is limited, and often takes the form of statements such as "properly designed and operated sewage works employing good housekeeping practices should not pose an odor problem." While these are important factors in helping to control sewage plant odors, the preceding analysis demonstrates that the incoming wastewater carries with it the potential for serious odor problems independent of such factors and demands that a thorough investigation of specific mitigation actions be made.

Control of the impacts of odors can include designing the wastewater collection systems to minimize odor generation, or the application of effective odor control technologies and procedures.

The collection system in the greater Boston metropolitan area has been described earlier as contributing greatly to the magnitude of the odor problem. Since it is already in place, however, little can be accomplished in terms of mitigating design. Relocation of people and activity would be an expensive and inappropriate solution in Boston Harbor due to the large area affected.

It is therefore apparent that the application of specific technologies for odor control should be explored. These control strategies can take the form of (a) prevention of odor formation or chemical destruction of odor within the collection system itself, or (b) treatment of odor by a specific process for that purpose at the plant, either by collection and treatment of odorous gases or treatment of the bulk of the wastewater.

The preceding analysis has projected that the odor impacts of a combined wastewater treatment facility in Boston Harbor would be significant regardless of the siting option chosen. The concentrations of hydrogen sulfide predicted by the modeling range from 3 to 4 orders of magnitude above the reported odor threshold for significant amounts of time. The level of "removal" or "treatment" of odor is a difficult number to specify and depends to some degree on the legal and sociological ramifications of the odor problem (i.e., odor ordinances, etc.). No specific guidance on "acceptable" odor levels is available in Boston, but in order to meet a level of mitigation such as that required to produce a result as described above, a removal efficiency of 99.9 - 99.99 percent must be obtained, and the discussion which follows should be evaluated in that context.

Treatment or prevention within the sewer system takes the form of addition to the sewers of chemicals which act as oxidizers, chemicals that raise the oxidation-reduction potential (ORP), bactericides, or masking agents.

The most common additive is chlorine. Its effectiveness depends primarily on its bactericidal and oxidizing properties when added to sewers to control sulfide formation. By maintaining the ORP at positive (150-200 mv) levels, the inhibition of sulfate-reducing bacteria is accomplished, usually with less chlorine than that required to theoretically oxidize sulfide present.

Chlorine can be added as a gas or as hypochlorite solutions. Sodium hypochlorite, the usual solution, would be preferred as the handling of chlorine gas may present maintenance problems and safety risks if done in residential areas. Trade-offs in its use include higher cost and somewhat lower effectiveness than chlorine.

Reports on the use of chlorine for odor control in sewers are mixed. While several authors report it to be effective in smaller systems, particularly all gravity sewer systems, Waltrip noted a rapid regrowth of sulfide-reducing bacteria and concomitant increases in sulfide concentration within one or two miles of the addition point, in a sewer system described previously as being more similar to Boston's. Waltrip also evaluated the addition of chlorine directly to the incoming wastewater, and concluded that, while capable of reducing sulfide levels to zero, this method required large volumes of chlorine and is precluded by expense.

Determining an appropriate scheme for addition is largely a trial-and-error process for each individual collection system. The remote headworks in the Boston system have been reported as sources of odor, so any evaluation of chlorine addition should include addition directly to the headworks.

In terms of expense, an assumption of the addition of chlorine or hypochlorite directly to the headworks of the plant would most likely be the worst-case assumption. At a chlorine cost of $0.15/lb delivered in tank cars, and assuming 10 mg/l of hydrogen sulfide, chemical cost for this option would be on the order of 20 million dollars annually; addition of chlorine upline could be on the order of 25 to 50% of that figure. The cost of appropriate metering and delivery systems would add to that figure based on location(s) of addition.

The expense of hypochlorite use in place of chlorine would depend on where addition would take place. Upline addition could add approximately 25% to the chemical cost, while savings could be achieved at the plant by on-site generation of hypochlorite from seawater. Such an analysis is beyond the scope of this document.

In terms of other chemical additions upline, permanganate and hydrogen peroxide have been attempted. Waltrip reported that hydrogen peroxide addition was much more costly than chlorine (ca. 45%) due to a higher peroxide consumption than theoretically assumed, probably due to sulfide being oxidized primarily all the way to sulfate.

In summary, methods of treatment upline in the sewer system can be costly, and in terms of the removal necessary to eliminate off-site odors, could not be relied upon consistently as the only means of odor control. Such methods may be appropriate as supplemental control measures in the event of very high sulfide levels or as control methods at the remote headworks; however, treatment within the plant can take the form of precipitation of sulfide in the wastewater liquid or containment and treatment of odorous air.

Precipitation with Ferrous Sulfide was evaluated by Waltrip. Incomplete sulfide removal was obtained at costs equivalent to peroxide addition; the iron also contributed to clinker formation in subsequent sludge incineration.

Containment and treatment of odorous air can be accomplished either by covering all of the odorous operations at the plant and scrubbing the captured air, or by aerating the wastewater in a process specifically designed to strip volatile and odorous compounds. Both of these options would have as their limiting efficiency the efficiency of the scrubber proper. Differences in cost would primarily be the cost of extensive cover area for the first option traded against the expense of the separate covered aeration basin for the second. In either case, however, costs are likely to be similar to those for total chemical treatment as described above: costs for covering the plant and scrubbing with sodium hypochlorite are estimated at 18 million dollars as opposed to approximately 13 million for the preaeration process; these costs are only order-of-magnitude estimates of purchased equipment costs exclusive of engineering costs, minor pipework, etc., and contractors' fees and contingencies, and should be regarded as being plus or minus fifty percent.

Scrubber efficiencies depend on the chemical reaction chosen and the feed rate of that chemical; the Water Pollution Control Federation reports in its Manual of Practice No. 22 that typical hypochlorite scrubbing can be expected to remove 98% of hydrogen sulfide and 90% of mercaptans. If the option chosen is preaeration, then slightly more than two orders of magnitude of reduction could be expected, or 99.5% of the influent sulfide would be released, leaving 0.5% as a point source to the atmosphere. This reduction would not necessarily be sufficient to ensure that no odor would be detected offsite, as the distribution of odor events is skewed toward the high concentration (see Figures 2 and 3).

It is possible that some prechlorination followed by an air stripping process could reach effective removal rates. Moreover, the design of scrubbers to removal efficiencies well beyond those dictated by conventional economic trade-offs could also achieve three-order-of-magnitude removals, but likely at order-of-magnitude higher costs.

This assessment has not included any mention of control of volatile organic compounds. It is likely that any such compounds present would also be air-stripped along with the sulfide, but would not be effectively removed in a hypochlorite scrubber. Inclusion of an activated carbon system after the scrubber could control VOC's as well as function a a polishing column for the scrubber tail gas.

The authors feel reasonably confident that the installation of such a system (i.e., hypochlorite scrubbing followed by activated carbon polishing) can achieve the degree of mitigation necessary. Costs for such an integrated system are difficult to assess without a detailed analysis such as will be necessary during facilities planning, but should be no more than fifty percent (50%) higher than those estimated for scrubbing alone. As further investigation proceeds as part of the facilities planning process, other options and refinements will doubtless become available.

A detailed economic analysis of the cost and benefits of all of these systems is beyond the scope of this evaluation. The preceding discussion does, however, serve to illustrate that the odor impacts of such a facility in Boston Harbor are severe, and that conventional add-on technology may not be sufficient to mitigate these impacts.

The applicant should be required to complete a thorough examination of odor control technologies including appropriate pilot-scale work, if necessary, and subsequently present a detailed plan for odor mitigation.

APPENDIX O-1

Option 1: Covered Plant, Hypochlorite Scrubbers

1. Air Flows

   a. Preliminary Treatment

Grit chamber 400' long x 4.5 CFM/L.F. =	1,800
Assume from sewer gas	10,000
Grit & screen 50'x100'x20' - assume 6 air chgs/hr	10,000
	22,000

   b. Primary Treatment

Area = 385,000 ft.^{2}	
Assume: 3' freeboard	
1 air chg/hr	20,000

   c. Secondary Aeration

Air at 1500 ft^3/lb. BOD_5	
BOD_5 at 600,000 lb/day	
Assuming 145 mg/l	625,000
	667,000 cfm

2. Covers

Preliminary treatment area	10,000 ft^2
Primary treatment area	385,000
Secondary treatment area	495,000
	890,000 ft^2

Fiberglass sandwich panels \$14.75/ft^2 [1] = \$13,100,000

3. Scrubbers

   a. Glass-reinforced polyester
      50,000 cfm capacity = \$100,000[2]
      x 14 scrubbers = \$1,400,000

   b. Installation including inlet/outlet piping
      factor of 2.5 = 3,500,000

   c. Piping, duct work, fans, controls

10 x 60,000 cfm[3] =	300,000
assume 1000' x 30"[1] =	40,000
4000' x 10"[1] =	26,200
	366,200

4. Total Capital = $18,366,200

5. O&M

Chemicals[4]	$2,345,000
Power Est.	50,000
Labor Est.	30,000
Maint. Est.	30,000
	$2,455,000

References:

(1) Means Construction Cost Data, 1985.

(2) Odors from Stationary and Mobile Sources.

(3) Plant Design and Economics for Chemical Engineers.

Option 2: Preaeration, Scrubbing

1. Tankage

    45 min. detention time x 500 MGD = 15.6 million gallons
    4 x 4 M.G. = \$3,750,000(2)

2. Blowers, Diffusers

Blower fans, 10 x 12,500 cfm(3)	3,000,000
2.5 x for controls, installation	7,500,000
Diffusers est.	1,000,000
	\$11,500,000

3. Covers 20' x 312' x 10' depth

20' x 312' = 6250 ft^2 x \$14.75/ft^2 =	\$92,000

4. Scrubbers

    @ 250 cfm/MGD = 125,000 cfm

Assume 3 x 50,000 cfm capacity =	300,000
Installation 2.5 factor =	750,000
Piping, ductwork, controls (factored from Option 1)	80,000
	1,130,000

5. Total capital = \$12,720,000

6. O&M assumed similar to Option 1.

REFERENCES

1. R. Leffel, ed.; "Odor Control for Wastewater Facilities," Manual of Practice Number 22; Water Pollution Control Federation (1979).

2. "Process Design Manual for Sulfide Control in Sanitary Sewerage Systems," U.S. Environmental Protection Agency Technology Transfer (October 1974).

3. P. Cheremisinoff, R. Young; Industrial Odor Technology Assessment, Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan (1975).

4. G. Waltrip, E. Snyder; "Elimination of Odor at Six Major Wastewater Treatment Plants," presented at the 57th Annual Conference of the Water Pollution Control Federation, New Orleans, Louisiana (1984).

5. Personal communication, H.W. Byers, General Manager of the North Shore Sanitary District, Gurnee, Illinois (August 1985).

6. G. Leonardos; "A Critical Review of Regulations for the Control of Odors," JAPCA, Volume No. 5 (1974).

7. L.E. Bource, B.R. Ekstrand; Psychology, Its Principals and Meanings, Holt, Rinehart and Winston (1978).

8. "Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I - Site Options Study," Metcalf and Eddy (June 1982).

9. U. Hogstrom; "A Method for Predicting Odor Frequencies From a Point Source," Atmos.Environ. 6:103-121 (1972).

10. L.A. Clarenburg; "Penalization of the Environment Due to Stench. A Study of the Perception of Odorous Air Pollution by the Population," Atmos. Environ. 7:333-351 (1973).

11. User's Manual for Single Source (CRSTER) Model, EPA-450/2-77-013, U.S. Environmental Protection Agency (1977).

12. S. Ando; "Odor Control of Wastewater Treatment Plants," Journal WPCF, Vol. 52, No. 5 (1980).

13. C. Koe, D. Brady; "Quantification of Sewage Odors," NTIS PB-84-116169.

II-3

noise

II-3 NOISE

A. Background

Comments on noise can be divided into three categories:

1. Were baseline noise conditions in Winthrop measured properly?
2. Were the forecasts of noise done fairly and accurately?
3. Would noise mitigation be feasible during construction, and later during operation? By what means?

Review of the issues indicates that the Havens and Emerson measurements for Winthrop, as reproduced in the SDEIS, do portray existing conditions accurately, and that the forecasts of construction noise in the SDEIS appear to be somewhat understated.

B. Baseline

Comments on baseline conditions centered around the methods used to measure existing noise levels, as described in the SDEIS. Three specific aspects of the data were questioned:

1. Were ambient noise levels at Point Shirley overstated?

2. Was noise from the Deer Island Pump Station the cause of high early morning noise levels at Point Shirley?

3. Were noise levels within the prison high enough to negate the impact of construction noise?

a. Ambient Noise Levels at Point Shirley

To explore the first question, several sets of measurements were made including three 24-hour periods at Deer Island, Point Shirley, and Cottage Hill by Cavanaugh Tocci Associates, Acoustic Consultants on September 1985 and a series of fifteen readings were made in the Point Shirley area, i.e., by Thibault/Bubly Associates, on June 12, 1985, from 12:46 a.m. to about 2:00 a.m. The results are shown in Table N-1 and N-2. The Cavanaugh Tocci measurements show the quietest conditions observed during the stated time periods; the Thibault/Bubly measurements show the average of five minute observations at the stated time periods. Most of the readings were higher than those reported in the SDEIS (Havens and Emerson readings) and indicate that the SDEIS reports for Point Shirley did not overstate the ambient conditions.

Table N-1
LOWEST MEASURE L_{90} NOISE LEVELS AND APPLICABLE
LIMITS AT NOISE MONITORING LOCATIONS
(dBA)

Locations	Zoning	Lowest Measured L_{90}(1 hour)	City of Boston Limit[2]
		Daytime[1]	
1. Engineer's Res.	Residential/ Industrial	48 dBA	65 dBA
2. Tafts St.	Residential	49 dBA	60 dBA
3. Terrace Ave.	Residential	49 dBA	60 dBA
		Nighttime	
1. Engineer's Res.	Residential/ Industrial	44 dBA	55 dBA
2. Tafts St.	Residential	34 dBA	50 dBA
3. Terrace Ave.	Residential	39 dBA	50 dBA

[1] 7:00 a.m. to 6:00 p.m.
[2] Noise Code for the City of Boston (Chapter 11)

Source: Cavanaugh Tocci Associates, Inc.

Table N-2
Early Morning Outdoor Ambient Noise Levels
In the Vicinity of Point Shirley*
(dBa)

Site	12:46 am**	1:36 am**	1:58 am**
First House	46	47	47
End of Shirley Street	46	48	46
Seawall @ Yirrell Beach	54	51	36
Brewster Ave. @ Bayview	43	41	44
Mugford	40	38	39

*A-weighted Leq levels recorded by Thibault/Bubly Associates during Wednesday, June 12, 1984. All readings were taken between aircraft flights.

**Noise readings were begun at this time. After a five minute reading at 1 site was taken, Thibault/Bubly Associates proceeded to the next site.

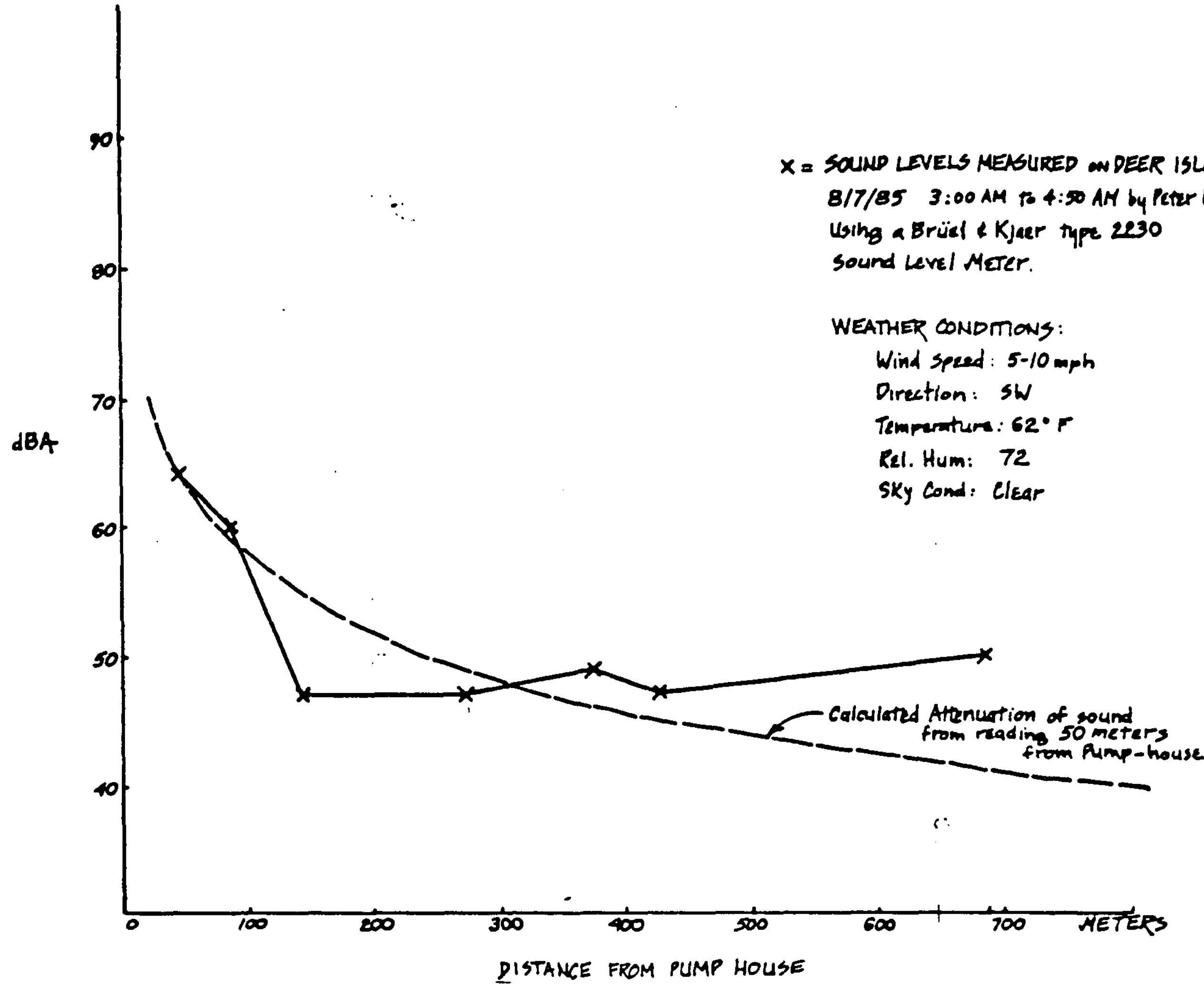
Source: Thibault/Bubly Associates

b. Noise Contribution of Pump Station

To explore the possibility that the Deer Island Pump Station contributed significantly to the ambient night-time noise at Point Shirley, noise levels were measured along the roadway from the pump house to the first house on August 7, 1985 between 3:00 A.M. and 4:50 A.M.

Figure N-1 shows the measured noise levels (solid line), and the maximum levels that could be attributed to the Pumping Station (dashed line). The maximum levels are based on the normal attenuation of a close-in reading with distance. The reading at the first house is approximately 9 decibels higher than the level that could be attributed to Pumping Station noise; therefore, the Pumping Station is not likely to be a major contributor to ambient nighttime noise at Point Shirley. Possible sources of the background noise suggested by the data collector included the lapping of waves on the nearby riprap shoreline and the general urban background noise across the harbor.

Figure N-1



Source: Thibault/Bubly Associates

c. Noise Levels in the Prison

Finally on the level of noise within the prison, a survey was made on August 24, 1985, between 9:30 a.m. and 11:45 a.m. Twenty-two measurements were made, (see Table N-3) scattered through the various buildings, on all floor levels and in a variety of room uses. The median indoor noise level was 55 dBA, with 50% of the measurements between 51 and 61 dBA. The quietest areas were unused spaces, the chapel and the infirmary. The noisiest were a dining hall, a kitchen, and an administrative office (typewriters and telephones).

These levels are below the 66 dBA that would impede communication (Beranak, Leo L., Noise and Vibration Control, 1971), and appear to be typical for institutional buildings.

C. Impacts

Three areas of forecasted noise were questioned:

1. The cumulative effect of multiple pieces of construction machinery.

2. The effect of increased traffic along truck routes.

3. Operational noise of a secondary plant.

a. Construction Noise

Analysis of noise of construction machinery indicates that the levels predicted in the SDEIS may be less than would probably occur.

The SDEIS based its estimate of average noise that would be generated during construction on an assumption of 10 pieces of heavy equipment, each generating 75 dBA (at 50 feet), working simultaneously and then compared the result with the requirements of the City of Boston Noise Control Regulation which permits up to 75 decibels 10% of the time.

Table N-3
NOISE LEVELS RECORDED AT DEER ISLAND HOUSE OF CORRECTION
MEDIUM SECURITY PRISON ON DEER ISLAND, WINTHROP, MASSACHUSETTS

Measurements taken 8/29/85 between 9:30 and 11:45 p.m.
by Peter Bates using a Brüel & Kjaer Type 2230
Precision Integrating Sound Level Meter,
Serial #1033258, tested 4/23/85.

Building	Room	Use	# of Windows	Open: Yes/No	Floor	Leq
Hill Prison	Bell Tower	Not used	4	Yes	5th	43.3
Hill Prison	Dorm #6, Lev. I	Not used	1	Yes	4th	52.8
Hill Prison	Dorm #6, Lev. II	Not used	2	Yes	3rd	59.6
Hill Prison	Dorm #6, Lev. II	Not used	2	No	3rd	51.6
Hill Prison	Infirmary	Treat sick inmates	4	Yes	2nd	49.8
Hill Prison, W Wing	1st Tier	Cell blocks	9	Yes	1st	62.6
Hill Prison, W Wing	2nd Tier	Cell blocks	10	Yes	2nd	58.8
Hill Prison, W Wing	3rd Tier	Cell blocks	10	Yes	3rd	56.7
Hill Prison, W Wing	4th Tier	Cell blocks	10	Yes	4th	53.8
Hill Prison, W Wing	5th Tier	Cell blocks	10	Yes	5th	55.8
Hill Prison, W Wing	Inmates' Dining Hall	Eating area	32	Yes	2nd	67.9
Dorm I		Inmates' Dormitory	16	Yes	1st	61.3
Dorm II		Inmates' Dormitory	20	Yes	1st	62.9
Admin. Building	SCORE Room	Inmates' classroom.	2	Yes	2nd	59.3
Admin. Building	Admin. and Records	Office	4	Yes	1st	69.2
Admin. Building	Superint.'s Office	Office	2	No	1st	60.5
Admin. Building	Maintenance Office	Office	1	Yes	1st	48.8
Admin. Building	Cutting Room	Making clothes	13	Yes	3rd	55.1
Admin. Building	Police Training	Classroom	8	Yes	2nd	50.9
Chapel		Services	3	No	1st	46.1
Officers' Kitchen		Eating Area	6	Yes	1st	63.3
Commissioner's House		Office	4	No	1st	45.6

Note 1: Weather was clear and sunny; temperature in the mid-70's; wind was out of the northwest.

Note 2: Due to the good weather, the inmates were outside the buildings. This caused the noise levels to be lower inside the buildings.

Source: Thibault/Bubly Associates

To test the validity of the conclusion, two independent evaluations were made. On one, an examination was made of both the number of pieces of heavy equipment likely to be used 10% of the time and of the noise that each piece of equipment would be likely to emit.

To determine the number of pieces of equipment, it was assumed that all or nearly all of the equipment on the site could be in use 10% of the time. A review was then made in R.S. Means, Building Construction Cost Data, 1985, of the ratio of construction equipment to construction workers for the kinds of construction activities likely to be on the site. Overall, this ratio appeared to be 1 to 7 or 8. Application of the ratio to the 600 workers (average) estimated for the project in the SDEIS yields about 80 pieces of equipment. (It should be noted that the exact number is not important since doubling the number would increase the perceivable noise by only 3 decibels and halving the number would reduce the perceivable noise by only 3 decibels.)

To verify the noise levels of individual pieces of equipment, telephone contacts were made with Caterpillar Tractor and John Deere Company, manufacturers of the kinds of equipment typically used in heavy construction. Caterpillar supplied noise levels expected to be emitted by a range of their current products. These levels were in the mid-80's range.

Table N-4
Noise Levels of Representative Pieces
of Heavy Construction Equipment, 1984-1985
(Sound Pressure Level @ 50')

Front Loader	1984-85 Models (dBA)	Earlier Models (dBA)
973	86	87
953	86	90
Dozers		
D7g	84	84
Graders		
14g	82	
12g	84	88
Scrapers		
631	84	89
621	85	90
633	86	86

Source: Catepillar Tractor Company

To calculate the effect of eighty pieces of equipment, each emitting, 85 dBA at 50 feet, a virtual peak was calculated for the center of the construction site using Weber-Fechner's Law of Perception and then attenuated off-site for distance, as a point source.

i. 85 dB = $10^{8.5}$ relative sound energy units (by definition of the decibel)

ii. $10^{8.5} \times 80 = 10^{10.4}$ relative sound energy units

iii. $10^{10.4}$ relative sound energy units = 104 dB

At the distance of the closer side of the prison this virtual peak would moderate to about 75 dBA; at the first house in Point Shirley to about 62 dBA; and to the northwesternmost house in Point Shirley to about 53 dBA, taking into account the shielding effects of the intervening houses.

In the second evaluation, sound power levels were calculated for 2 specific mixes of equipment expected to be used during construction. Table N-5 shows the mixes of equipment, while Table N-6 shows their anticipated noise impacts under various assumptions of equipment use and site conditions.

Table N-7 compares the two evaluations.

Table N-5
Construction Equipment Sound Power Levels for the
Most Significant Site Preparation and
Building Construction Phases

Equipment Items	Source[3] Lw in dBA re: 1pw (per item)	Usage-Percent	Construction Scenarios Phase I Site Preparation*	Phase II Building
30 yd. trucks	114	50	(15) 123	(10) 121
Misc. Matl. trucks	114	50	--	(12) 122
12 yd. conc. trucks	114	50	--	(6) 122
Headache Ball for Crane use for Demolition	--	--	--	[1]
Loaders	111	100	--	(2) 114
Track Drills (rock)	121	50	(4) 124	--
4 yd. shovel	111	50	(4) 114	--
Scraper	114	50	--	(4) (117)
D8-Dozer	114	100	(2) 117	3
(119)				
60 Ton Crane	111	100	--	4 (117)
600 HP Portable	102	50	4 (105)	--
Compressor Dewatering Equipment Including Emergency Portable Generator	107	100 (24 hrs.)	--	1 (107)
Portable 200 kw Generator	102	100 [2]	1 (100)	6 (110)
Dock Conveyance Facilities	100	100	--	--
Concrete Pump	111	50	--	--
1000 yd/day Concrete Batch Plant	110	110	--	(1) 110
Form yd. Sawmill Carpenter Shop	109	100	--	(1) 109
Total A-Weighted Sound Power Level in dBA Re: 1 picowatt			127 [4]	127 [4]

*Total Quantities of Equipment given in parenthesis.

Notes:

[1]Impact noise level not considered a problem

[2]Two generators running 24 hours.

[3]Noise levels for "Quiet Products, Level 1," from BBN Report 2887.

[4]If total quantities of equipment were operating the total sound level would be 3 dB higher.

Table N-6
Construction Equipment Sound Power Levels for the Most Significant Site Preparation and Building Construction Phases

Location	Lowest Measured L_{10} (1hr)[1]	Range of Estimated Const. Noise Levels - dBA	Total Noise Level[1]
Daytime			
Engineer's Residence (Deer Island)	58	44-54	58-59
Tafts Street (Pt. Shirley)	60	41-51	61
Terrace Ave. (Cottage Hill)	63	30-40	63
Prison	60 [3]	59-68	63-69

Source: Cavanaugh Tocci Associates.

Notes:

[1]Without aircraft noise.
[2]Applicable to noise at site.
[3]Estimated.

Table N-7
Expected Construction Noise
Deer Island & Vicinity

	TBA Evaluation	CTA Evaluation
Power Level (all equipment)	131 dBA	130 dBA
Equipment in use at least 10% of time (100% - deduct:	-0	
50% - deduct:		-3
Local, on-site shielding		
50% - deduct:	-3	
75% - deduct:		-6
Sound Pressure Level 50' from virtual center	104	94
Noise Level @ Point Shirley effects of distance (3200'±)	-42	-43
	59	51
Noise Level @ Prison Effects of distance (1,000'±)	-26	-26
	75 dBA	68 dBA

At the prison, with all heavy earthwork shielded by the drumlin, assuming that it is excavated from its southern side, construction noise out-of-doors would not exceed the Boston Noise Control Regulations for construction (75 dBA). Indoors, this increased noise would be about ten decibels above the median existing noise levels if the windows were open and not above it at all with windows closed.

At nearby and beachfront portions of Point Shirley, construction noise would not exceed the City of Boston construction noise standard, whatever set of assumptions is used, and therefore is considered acceptable to EPA.

At Nut Island, an adjustment of 10 dBA added to the non-pile-driver noise levels calculated in the SDEIS to account for the louder equipment likely to be used, would produce some 82 dBA in the adjoining residential neighborhood. This noise level is seven dBA above that allowed by the Boston Noise Code and is considered unacceptable by EPA for the five year construction period that would be required for the Split Deer Island/Nut Island alternative but acceptable for the shorter construction periods at Nut Island associated with demolition of existing structures for headworks options.

b. Noise Impacts of Construction Traffic

With all bulk materials required to be barged, the maximum normal traffic to be induced by construction is not likely to average more than 25 truck and bus round trips per day. With each vehicle perceivable above background noise levels for less than one minute per trip, the cumulative impact would not be significant.

Lighter vehicle traffic (automobiles, pick-up trucks, etc.) would be generally indistinguishable in character from existing traffic. Since it requires a doubling of such light traffic to increase background traffic noise by three decibels and since no such traffic increase will occur, there can be no perceptible change in background traffic noise.

c. Operational Noise

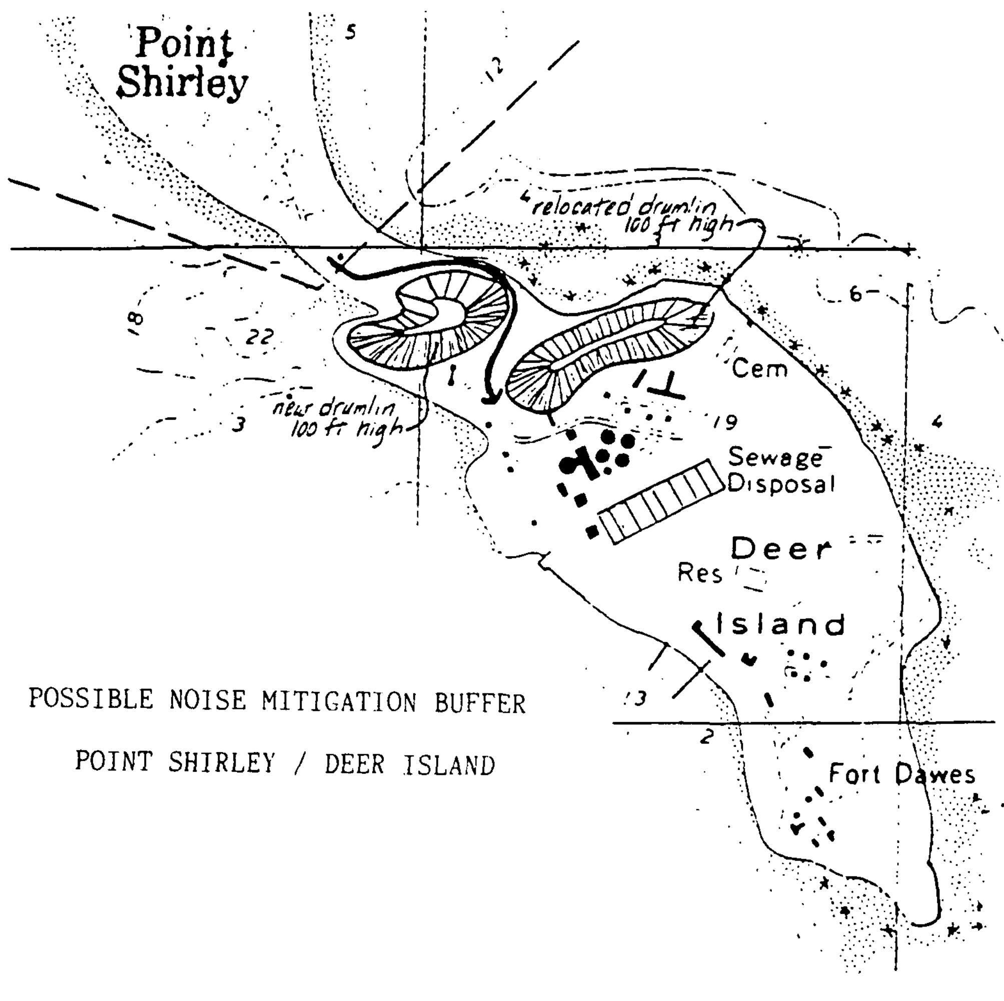
The noise generated by operation and maintenance of a secondary treatment can be significant. However, any plant that is built will have to conform to the City of Boston Noise Control Regulations, i.e. not over 50 dBA in residential areas at night and 55 dBA in institutional areas. It is feasible to design the plant with adequate noise control to meet those requirements, enclosing the stationary machinery that produces most of the sound, so that no adverse operational noise impacts are anticipated.

D. Mitigation

Opportunity for mitigation of the anticipated construction noise levels at Deer Island is severely limited by the geometry of the site. At the prison, shielding of outdoor ground level activities can be accomplished by a continuous wall immediately adjacent to the outdoor activity areas. Relatively quiet areas, out-of-doors, might be provided on the far sides of the larger buildings, extended into more effective barriers with new walls.

Similarly, for the houses at Point Shirley, some shielding does appear possible by the construction of earthen mounds, if sufficiently high and wide. A relatively short barrier to shield the closest group of houses built just below the former Shirley Gut, from shore to shore, would not shadow noise very far beyond those closest houses.

If the prison were to be partially or totally removed, or if the sea adjoining the neck could be filled (see attached figure), such a mound could be made both higher and longer, improving its effectiveness and reducing noise impacts over a larger area, and since it would be built of spoils that would otherwise have to be removed from the island at relatively great expense, the mound would have little (or even negative) cost. (It should be noted that the construction of any noise barrier will by itself create substantial but short lived noise in the areas to be protected.)



POSSIBLE NOISE MITIGATION BUFFER

POINT SHIRLEY / DEER ISLAND

II-4

recreation resource comparisons

II-4 RECREATION

A. Background

Comments on the SDEIS concerning recreation centered around one main issue:

- Was the inherent recreational potential of Long Island, independent of park plans, actually greater than that of Deer Island?

Evaluation of the opportunities for recreational development at Deer and Long Islands shows that the two islands are approximately equal in value as potential recreational resources. While the type of opportunity offered by each island differs, and different segments of the public would be interested in visiting them, the two islands have comparable overall recreational potential.

B. Comparison of Recreational Resources on Deer Island and Long Island

The SDEIS assumed that Long Island offers great recreational potential and that there is no similar potential on Deer Island. A question was raised as to the validity of this assumption. To test this assumption a systematic evaluation of the recreational potential of the two islands was undertaken.

DEM's letter of comment on the SDEIS presents a basis of a method for such systematic evaluation, i.e. that appropriate waterfront recreational activities or values could be identified and that each island could be scored for its suitability for each of these activities or values. Appropriate recreational activities/values for these two islands include regional use such as viewing the surrounding seascapes, access to shoreline fishing, historic displays, etc. as well as local use such as playfields where not incompatible with regional activities.

As a basis of such a systematic evaluation a brief series of maps were prepared and analyzed, including:

1. Site evaluation of Deer Island
2. Site evaluation of Long Island
3. Views from the bunker at the Southern end of Deer Island
4. Views from Long Island head.

Both islands are about the same size and both are located close to the harbor entrance, both have glacially deposited till uplands and both have lowlands that have been filled in by the sea. Both are accessible by a single roadway and both are about the same distance, by road or by boat from the congested central neighborhoods of Boston.

The shoreline of neither island is particularly well suited to swimming; neither island adjoins any water sufficiently sheltered for small boat mooring in bad weather, but both could be accessed by visitor boats off President Roads.

Both islands could be used for shoreline fishing, particularly if a deep water pier were constructed, and at least some parts of both islands would easily be developed into ballfields or similar usage.

Both islands, in their present state, contribute to the beauty of Boston Harbor, as viewed from other islands, the mainland and boats, but both are esthetically blighted by large buildings that are out-of-scale with the natural terrain (the drumlins) and with the general pattern of development found elsewhere in the harbor (the mosaic of small multicolored houses that hug the smooth oval forms of Cottage Hill, Allerton and Squantum). Deer Island's parklike, grassy drumlins and bunkers are overburdened by the monumentality of a large county prison and Long Island is home to an array of hospital buildings whose refuse cascades down the long ochre escarpments that are the hallmark of the island. Overall, Long Island presents a greater aura of remaining natural settings.

The differences between the islands, as recreational resources, for the most part, are matters of detail and of the various segments of the public that might visit them.

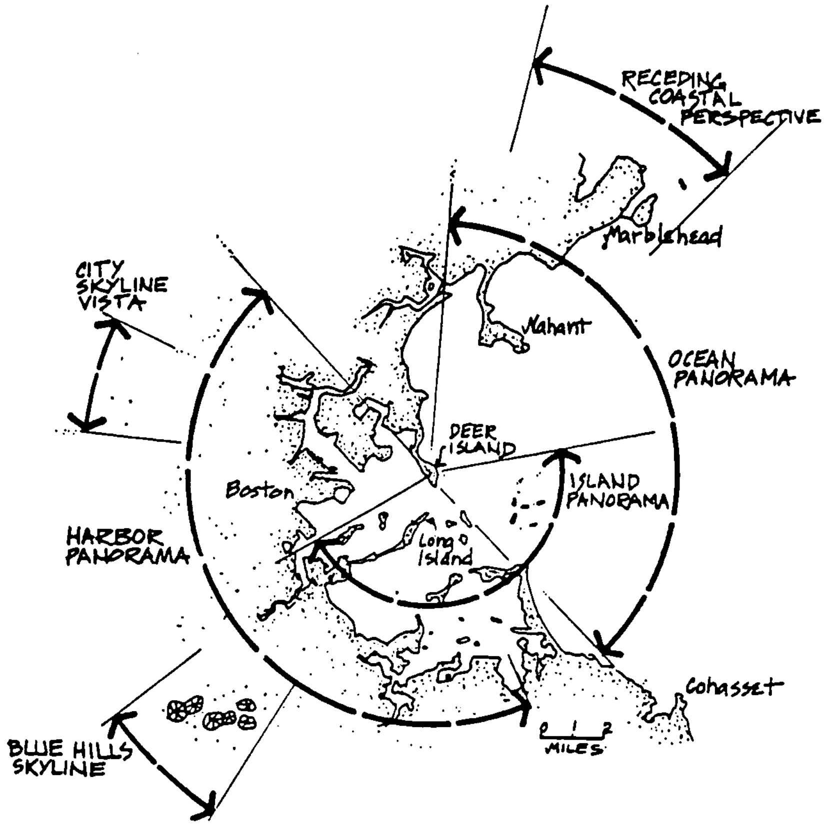
Long Island does contain some features not found on Deer Island including a late 19th century fortification on Long Island Head, totalling 12 acres; a wetland and barrier beach area totalling about 30 acres near the southwestern end of the island, and a very attractive CCC pine plantation totalling about 12 acres, at the southwestern tip. None of these by itself is unique; the adjoining George's Island contains larger late 19th century fortifications as well as some late to middle 19th century ones and the largest middle 19th century fort in North America, while the adjoining Thompson Island contains much more extensive and less disturbed wetlands, barrier beaches and sand spits. Taken together, however, with a connecting walk along the shoreline or the top of the bluffs, a picnic ground and a children's play area, the island could offer a most pleasant outing.

In a similar manner, Deer Island does offer some recreational opportunities not available on Long Island, centering mostly on its location at the only well defined entrance point to Boston Harbor. It offers a set of vistas of exceptional variety and interest. As the gatepost of the harbor, it offers back-to-back vistas of the open seas and the full extent of the harbor, both penetrated by a broad parade of islands that ranges from Castle Island to the Graves, with a skyline dominated to the southwest by the silhouette of the Blue Hills and to the west by downtown Boston. No similar view exists on Long Island, no similar platform to see the relationships between Boston, its harbor and the sea.

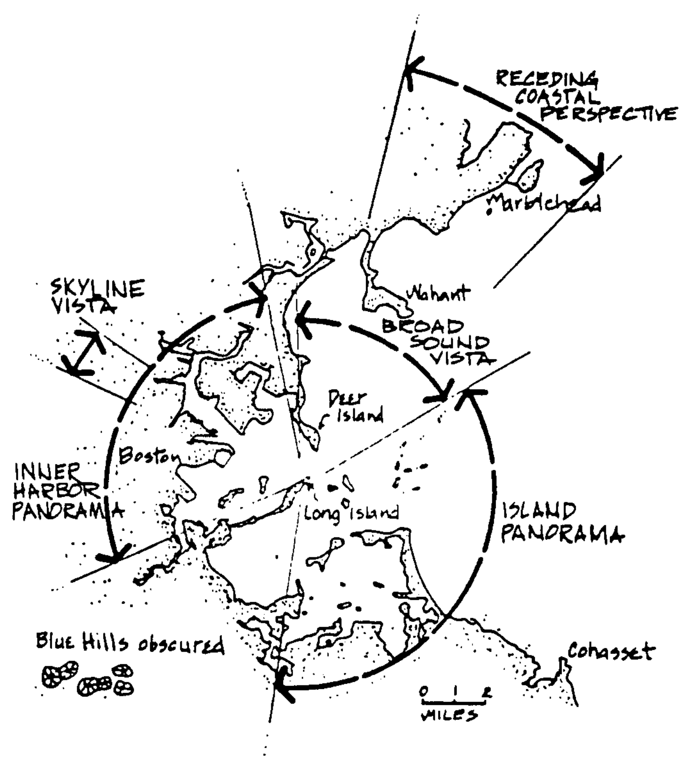
If the treatment plant were to be put on Deer Island and Long Island becomes a park, the most prominent view from the northern end of Long Island would be the sewage treatment plant on the leveled Deer Island, unless creative siting and design were carried through to retain a drumlinoid silhouette and buffer. Conversely, a treatment plant on a leveled Long Island would dominate the view southwesterly from Deer Island. In addition, such a plant on Long Island would be visible not only from the ship channel as would one on Deer Island, but also would intrude on the scene from Quincy Bay.

Looking at the islands from the point of view of their potential visitors, their local neighbors, the surrounding regional population, and visitors to Boston from afar, it can be seen that each of these groups has differing needs, and parkland would play a different role for each. In general, outside visitors want to see something unusual or that tells them something about the place they're visiting. Metropolitan residents are interested in a pleasant, but not necessarily unusual destination for a day-trip that provides an opportunity for a few recreational activities. Local residents are more likely to use nearby parkland frequently, in an informal manner. For local use, Deer Island would appear to be the greater resource. It is easily accessible for field sports, fishing, walking and sight-seeing, while there are no local residents within 1.5 miles of Long Island. For regional residents, either island would be a desirable destination with Long Island having a slight advantage because of its greater length of shoreline, more extensive natural landscapes, and the resulting opportunities for walking.

But for the visitor from afar, as well as for local students of history and geography, Deer Island would appear to be a potentially important resource. Its specialness as a platform for seeing Boston's relationship to the sea makes it also a special opportunity for explaining, to visitor and local student alike, how Boston came to be a great city; that it all started on a group of sheltered islands on which the original settlers could be safe from the depredations of the Indians on the mainland; that it grew to become the second city of the British Empire, inland beyond cannon range, protected by its island batteries from the French fleet just to the north at Louisbourg; that it was selected as the principal northern base for the infant United States Navy, over competing New York and Philadelphia because it was defended by its islands against the British Navy in an era when British squadrons could and did establish bases at Provincetown and Nantucket at will; that Boston was started and that it grew great because of its special place between the land and the sea.



Views from Deer Island



Views from Long Island

FINAL ENVIRONMENTAL IMPACT STATEMENT

PROPOSED ACTION:	SITING OF WASTEWATER TREATMENT FACILITIES IN BOSTON HARBOR
LOCATION:	BOSTON, MASSACHUSETTS
DATE:	DECEMBER, 1985
SUMMARY OF ACTION:	This FEIS considers the environmental acceptability of alternative locations for the construction of new wastewater treatment facilities for Boston Harbor. The FEIS recommends the construction of a secondary wastewater treatment facility at Deer Island.
VOLUMES:	I. COMPREHENSIVE SUMMARY II. TECHNICAL EVALUATIONS III. PUBLIC PARTICIPATION and RESPONSE TO COMMENTS IV. PUBLIC and INTERAGENCY COMMENTS
LEAD AGENCY:	U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION I J.F.K. Federal Building, Boston, Massachusetts 02203
COOPERATING AGENCY:	GENERAL SERVICES ADMINISTRATION
TECHNICAL CONSULTANT:	THIBAULT/BUBLY ASSOCIATES 235 Promenade Street, Providence, Rhode Island 02908
FOR FURTHER INFORMATION:	Mr. Ronald Manfredonia, Water Management Division, U.S. EPA, Region I, J.F.K. Federal Building, Boston, Massachusetts, 02203 (617-223-5610)

FINAL DATE BY WHICH
COMMENTS MUST BE RECEIVED: ______________________________

II-5

legal and institutional

II-5 LEGAL AND INSTITUTIONAL ISSUES

A. Background

Comments on the SDEIS raised questions about the possibility that the SDEIS, in characterizing the legal obstacles as "severe," exaggerated the legal difficulties of acquiring the Long Island site for a treatment plant. In response to these comments, EPA requested the Boston law firm of Warner and Stackpole to analyze the power of the Massachusetts Water Resources Authority to acquire necessary land and construct wastewater treatment facilities on both Long Island and Deer Island. What follows is the firm's memorandum of law addressing these issues.

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AN ANALYSIS OF THE MASSACHUSETTS WATER RESOURCES AUTHORITY ACT AND ITS APPLICATION TO THE ACQUISITION AND DEVELOPMENT OF THE LONG ISLAND AND DEER ISLAND ALTERNATIVES

July 15, 1985

prepared by

Warner & Stackpole

for

Thibault/Bubly Associates

I. <u>INTRODUCTION</u>

We have been requested to conduct research and analysis of Chapter 372 of the Acts of 1984, the Massachusetts Water Resources Authority Act (the "Act"), specifically with regard to the provisions of the Act concerning the acquisition of land and the development of wastewater treatment facilities by the Massachusetts Water Resources Authority (the "Authority"). The original memoranda regarding the Long Island alternative, dated August 28, 1984 and the Deer Island alternative, dated November 27, 1984, set forth a preliminary overview of the legal and institutional constraints affecting the acquisition and use of certain areas of Long Island and Deer Island as the site for a sewage treatment facility serving the Metropolitan Boston area. Because the Act, signed into law on December 19, 1984, had not been enacted at the time the original memoranda were submitted, it was not possible to discuss the specific legal issues which would confront the Authority in facility siting and implementation. Also, at the time of the original submission, certain issues involving the presence of barrier beaches on the islands were not clearly defined. This supplemental memorandum is intended to address these matters, and will serve to update the original memoranda.

II. <u>STATEMENT OF FACTS</u>

It is useful to reiterate certain facts regarding Long Island and Deer Island when considering the legal impacts of the Act and any other statutory constraints that may affect the transfer of ownership or future use of these properties. According to the Authority, all of Long Island with the exception of the light house is held in fee by the City of Boston, under the care, custody and control of the City of Boston Department of Public Health and Hospitals (Health and Hospitals). Long Island currently contains a functioning hospital for the chronically ill, and also contains historic and archaelogic artifacts including up to 2,000 unmarked graves which may be scattered across the island. A formal cemetery containing the remains of Civil War soldiers has also been identified on one section of the island. In the event that a siting decision is made that involves the sale of Long Island, the care and control of the island will revert from Health and Hospitals to the City of Boston Public Facilities Commission (Public Facilities) for disposition. Certain of the treatment plant siting options which have been considered for Long Island would require removal of the hospital and the Civil War cemetery.

Deer Island contains the Deer Island House of Correction, also known as the Suffolk County House of Correction, which is run by and is under jurisdiction and control of the City of Boston Penal Institutions Department. According to the Authority, certain parcels of land outside the perimeter of the correctional facility itself are also under the custody and control of the Boston Penal Institutions Department. Deer Island also contains a decommissioned military installation (Fort Dawes) which covers the southeastern quarter of the island, and which is currently owned by the United States Navy. The federal General Services Administration ("GSA") holds other federally-owned parcels on the island. Other parcels of property on Deer Island are owned by Metropolitan District Commission ("MDC"), and include the Deer Island Wastewater Treatment Plant presently in operation. Should facility siting on Deer Island involve land owned by the Navy, disposition will occur through the GSA. Under Section 4(c) of the Act, the Authority has full rights to use and improve real property owned by the MDC for sewer and waste treatment purposes.

III. DISCUSSION

This memorandum will first discuss the important elements of the Act, and then review the manner in which the Act enables the Authority to acquire the necessary land to develop a wastewater treatment facility in Boston Harbor. The Act provides new powers and limitations to the Authority which were not applicable to the MDC, including new provisions exempting the Authority from certain state laws, and subjecting the Authority to new legislative controls. These distinctions will be discussed as they may affect the ability of the Authority to undertake its mission to construct new facilities.

A. General Structure of the Authority

Under Sections 1 and 3 of the Act, the Authority is established within the Executive Office of Environmental Affairs (EOEA) to operate, regulate, finance and improve the delivery of water and sewage collection, disposal and treatment systems and services and to encourage water conservation. On July 1, 1985, under Section 4(a) of the Act, the Authority officially assumed control over the current MDC water and sewer system. The watershed division of the MDC, however, was not transferred to the new Authority and will operate independently.

The Authority is governed by an eleven-member Board of Directors, whose meetings are subject to the state open meeting law (M.G.L. c. 30A, §11 1/2), regulations for the preservation of public records (M.G.L. c. 30, §42), and the state Freedom of Information Act (M.G.L. c. 66, §10). The Board of Directors includes the Secretary of the Executive Office of Environmental Affairs as an ex officio member, and certain other specified individuals appointed by the Governor and the Authority's Advisory Board. The Advisory Board, under Section 23, is composed of representatives of the municipalities served by the Authority, whose votes are determined on a weighted basis according to the charges for services in each community. The powers of the Board of Directors and the Authority are set forth in Sections 5 and 6 of the Act, with the administration of the Authority provided by an Executive Director, as provided in Section 7. The Board of Directors has appointed a Transition Director to oversee the transition staff prior to the Authority's formal and complete organization.

The Authority is authorized under Sections 5(d) and 15 to issue up to $600 million of revenue bonds and, under Section 8(i), is deemed to be a "public entity" eligible to receive grants under the Massachusetts Clean Waters Act and any other federal and state statutes.

Under Section 10(a), the Authority must set its rates and charges to provide adequate revenue, pay its debts and expenses and to promote water conservation. Section 8(e) specifically terminates the prior practice of volume discounts.

B. Limitations on the Actions of the Authority

Because of the supremacy of federal law, the Authority, like all other state and local entities, must obtain all necessary federal permits and approvals to discharge emissions to air and water, and conduct activities in the waters of the United States. The earlier memoranda assumed the general applicability of state environmental law to the actions of the MDC in constructing and operating a facility on Deer or Long Island. Because the Authority was intended to be an independent public entity, however, the Authority is not constrained by the complete body of state law. With respect to state law, the Act provides, at Section 3(a), that:

> [the Authority] shall be an independent public authority not subject to the supervision or control of the executive office of environmental affairs or of any other executive office, department, commission, board, bureau, agency or political subdivision of the commonwealth except to the extent and in the manner provided in this act.

Certain transactions, however, such as acquisitions of property, are specifically made subject to other governing laws, by the provision of language stating that the transaction is to be conducted in accordance with the applicable laws and procedures. Section 4(c) of the Act, for example, provides that lands devoted to public use shall not be used or disposed of "except in all instances in accordance with the laws and Constitution of the Commonwealth."

The majority of the environmental laws and restrictions to which the Authority is subject are listed in Section 8 of the Act. Under Section 8(i), the Authority is subject to regulation under the Massachusetts Wetlands Protection Act, M.G.L. c. 131, §40; the Wetlands Restriction Act, M.G.L. c. 131, §40A; the Massachusetts Environmental Policy Act ("MEPA"), M.G.L. c. 30, §§61-62H; the Massachusetts Historic Preservation Act, M.G.L. c. 9, §§26C and 27C; the Ocean Sanctuaries Act, M.G.L., c. 132A, §§13-16 and 18; the Coastal Zone Management Act, M.G.L. c. 21A, §4A; the Water Resources Commission, M.G.L. c. 21A, §§8A-8F; the Hazardous Waste Facility Siting Act, M.G.L. c. 21D, §§3, 4, 7, 10, and 14; and regulations for waste treatment and disposal, M.G.L. c. 21C, M.G.L. c. 111, §§150A and 150B. It should be noted that Section 8(i) of the Act also contains certain general language stating that the foregoing statutes and regulations apply "without limitation on other public health or environmental regulations over the Authority exercisable pursuant to other law without conflict with the Authority's purpose of serving critical public needs on a broad geographic basis . . . ."

The Act, in Section 8(i), specifically identifies the programs administered by the Department of Environmental Quality Engineering (DEQE) to which the Authority shall be subject. These programs are:

Air Pollution

- M.G.L. c. 111, §2B (Air Pollution Emergency)
- M.G.L. c. 111, §§142A to 142E (Air Pollution Regulations)

Water Pollution

- M.G.L. c. 21,* §14 (Works of Improvement Regulated)
- M.G.L. c. 21,* §27 (Water Pollution Control)
- M.G.L. c. 21,* §§30A to 34C (Water Pollution and Wastewater Treatment)
- M.G.L. c. 21,* §37 (Reimbursement to MDC)
- M.G.L. c. 21,* §40 (Entry to Investigate Pollution)
- M.G.L. c. 21,* §§42 to 46A (Penalties and Permits for Discharges into Waters of the Commonwealth)
- M.G.L. c. 21A, §14 (Dredging Permits)
- M.G.L. c. 91 (Waterways Statute)
- M.G.L. c. 111, §2C (Enforcement of Statutes, Regulations, etc., relative to Pollution)
- M.G.L. c. 111, §5E (Application of Chemicals; Licenses, Regulations and Penalties)
- M.G.L. c. 111, §5G (Water Supply Treatment Facilities)
- M.G.L. c. 111, §17 (Advice as to Disposal of Sewage)

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* Section 8(i) of the Act, as passed by the Legislature and signed by Governor Dukakis, actually refers to §§14, 27, 30A to 34C, 37, 40, 42-46A of Massachusetts General Laws Chapter 21A, and not Chapter 21.

- M.G.L. c. 111, §31D (Provision of Facilities for Disposal of Contents of Privies, etc.)
- M.G.L. c. 111, §160 (Examination of Water Supply and Rules and Penalties)
- M.G.L. c. 111, §160A (Cross Connections between Public Water Supplies and other Water Supplies)
- M.G.L. c. 111, §160B (Violations of Water Quality Standards or Regulations)
- M.G.L. c. 111, §165 (Entry on Premises to Ascertain Water Pollution, etc.)

Hazardous Waste

- M.G.L. c. 21C, Hazardous Waste Management Act, §4 (Powers and Duties of DEQE Division Hazardous Waste)
- M.G.L. c. 21C, §6 (DEQE Regulatory Authority over Hazardous Waste)
- M.G.L. c. 21C, §7 (License Requirements and Facility Siting)
- M.G.L. c. 21C, §9 (Remedies for Violations of Hazardous Waste Regulations)
- M.G.L. c. 21D, Hazardous Waste Facilities Siting Act, §3 (Powers and Duties of DEM)
- M.G.L. c. 21D, §4 (Hazardous Waste Facilities Site Safety Council)
- M.G.L. c. 21D, §7 (Notice of Intent to Construct or Operate Hazardous Waste Facilities)
- M.G.L. c. 21D, §10 (Preliminary and Final Project Impact Reports)
- M.G.L. c. 21D, §14 (Compensation to Abutting Community paid by Developer)
- M.G.L. c. 21E, "Superfund Act," §4 (Response Action to Release or threatened Release of Oil or Hazardous Materials)
- M.G.L. c. 21E, §6 (Prevention or Control of Release of Hazardous Material)
- M.G.L. c. 21E, §7 (Notice Requirements)

- o M.G.L. c. 21E, §9 (Orders by Department, Containment and Removal Actions, Sampling, etc.)
- o M.G.L. c. 21E, §10 (Notice, Adjudicatory Hearings, and Persons Aggrieved by DEQE Determination)

The applicability of local bylaws and regulation is expressly limited by the above-cited provision of Section 3(a) referring to control by a political subdivision of the Commonwealth. The Act does not contain any reference to local law or regulation to which the Authority will be subject.

Under Section 4(f), the Act purports to exclude the Authority from all liability in tort or for water pollution arising prior to July 1, 1985. The Authority cannot enter into any consent decree according to Section 27 without the prior approval of the Governor and the Legislature. The Authority, under Section 24, shall be represented in legal matters by the Attorney General pursuant to M.G.L. c. 12. Section 24 also provides that enforcement actions by the Authority shall be filed in Superior Court, and that the Massachusetts Supreme Judicial Court has jurisdiction over any matter in which the Authority is a defendant and water pollution is an issue.

Finally, the last sections of the Act contain several references to specific special acts intended to apply to the Authority. For purposes of this discussion, it is interesting to note that neither Chapter 742 of the Acts of 1970, nor M.G.L. c. 114, sec. 17, the "burial grounds statute" are made specifically applicable. A discussion of these acts, and their applicability, follows in a later section.

C. Prior Public Use Doctrine

Under the state common law doctrine of Prior Public Use, public lands devoted to one public use cannot be diverted to another inconsistent public use without a majority vote of approval by the Legislature. Robbins v. Department of Public Works, 335 Mass. 328, 330 (1969). The Act contains several provisions applying the Prior Public Use doctrine to actions of the Authority.

The first mention of the Prior Public Use doctrine is made at Section 4(c)(ii) of the Act, which provides that:

> . . . no lands devoted to a public use shall be diverted to another inconsistent public use, except in all instances in accordance with the laws and the Constitution of the Commonwealth.

The doctrine is referred to again in Section 9, which, at Subsection 9(a), restricts the Authority's eminent domain power:

> . . . no property or rights already appropriated to public use shall be so taken without the prior approval of the governor and general court.

With respect to selling, leasing or disposing of Authority property, the Authority was also made explicitly subject to the Prior Public Use doctrine under Section 9(c).

The provisions of Section 9(a) are important because they modify the traditional requirements of the Prior Public Use doctrine to require gubernatorial approval, as well as legislative approval, of proposed changes in use. Theoretically, approvals of use changes governed by the Prior Public Use doctrine (as well as acquisition of lands protected by Article 97) could, with an adequate legislative vote, overcome a governor's veto of initial legislative approval. With respect to the Authority, however, gubernatorial approval, as well as legislative approval, is a prerequisite for such changes in use.

The fact that the Authority is made subject to the Prior Public Use doctrine also lends support to the argument that, notwithstanding the absence of explicit language in the Act regarding the applicability of M.G.L. c.114, §17, the Authority must comply with the provisions of that law if it acquires land containing burial grounds for its treatment facilities. M.G.L. c.114, §17 is considered to be a codification of the Prior Public Use doctrine as it applies to cemeteries (land devoted to cemetery use), and requires approval of the Legislature. By analogy, therefore, the Authority would require legislative and gubernatorial approval prior to appropriating publicly-owned burial grounds for Authority purposes. Further, M.G.L. c.114, §17 is one of the laws of the Commonwealth referred to in Section 4(c)(ii) of the Act as applicable to lands devoted to a public use.

The previous memoranda assumed the existence of a Civil War cemetery on Long Island, which would be affected by a new treatment facility. As public land committed to a prior public (cemetery) use, it appears that legislative and gubernatorial approval would be necessary to appropriate the cemetery. On Deer Island, however, the applicability of the Prior Public Use Doctrine is less clear with respect to cemeteries. It has been reported that there are hundreds of smallpox victims in unmarked graves located in the vicinity of the prison. Early maps of the island also indicated the presence of a cemetery near Fort Dawes. However, because the federal government has indicated that the cemetery near the fort was relocated off-island, and because the location of smallpox victim graves has not been confirmed during the archaeological research conducted during EIS preparation, it is unclear whether the Prior Public Use Doctrine provisions of the Act would apply to Deer Island because of cemetery use.

As stated in the previous memorandum regarding Long Island, the Long Island Hospital is subject to the protections afforded by the Prior Public Use Doctrine, and the hospital grounds could not be diverted to sewage treatment use without the approval of the Legislature and Governor. While the Deer Island House of Correction cannot be taken or acquired by the Authority to expand sewage treatment facilities without legislative and gubernatorial approval, it is not yet clear whether the Doctrine applies to land beyond the prison perimeter. The Authority staff has suggested that some parcels lying outside the prison fence were acquired specifically for prison purposes. However, some question remains with respect to whether the outside parcels are now "dedicated or devoted" to prison use. If further research confirms that these parcels are presently dedicated to prison use, the Doctrine may apply, as such, unless a wastewater treatment facility were considered "consistent" with that use, legislative and gubernatorial approval would have to be obtained by the Authority to acquire and use these parcels for treatment facility development.

D. Article 97 of the Massachusetts Constitution

Article 97 of the Massachusetts Constitution (amending Article 49 of the Constitution) provides that public land taken or acquired for conservation, scenic, historic or recreation purposes, may not be used for other purposes or otherwise disposed of without a two-thirds vote of the Legislature. Op. Att'y. Gen. April 12, 1976, 157. Article 97 is applicable only to those public uses specifically enumerated in the Article, and is therefore narrower in scope than the Doctrine of Prior Public Use.

Article 97 is first mentioned in the new Act in Section 4(c)(i), which states that "no lands or easements taken or acquired for the purpose authorized by Article 97 of the Amendment to the Constitution of the Commonwealth shall be used for other purposes or disposed of . . . except in accordance with the laws and the Constitution of the Commonwealth." The Legislature intended thereby to maintain the protections afforded Article 97 to certain public lands.

To date no information has been discovered which would suggest that any parcels on either Deer Island or Long Island were taken or acquired for Article 97 purposes. Accordingly, no further discussion of these provisions is warranted.

E. Applicability of Chapter 742 of the Acts of 1970

Section 8 of Chapter 742 of the Acts of 1970 provides that

> This act shall not be construed to limit the power or authority of any department, board or commission of the commonwealth or of any political subdivision thereof or of any public authority except where expressly provided otherwise herein; provided, however, that in, under or bordering Boston Harbor there shall be no acquisition

> of land by any such public agency or instrumentality other than [the Department of Environmental Management ("DEM")] without the approval of the [DEM], and no public land on or bordering said area may be sold, leased or used as a dump or refuse disposal area, and no sand, gravel or soil may be removed therefrom or deposited thereon, and no structure may be built thereon, without the approval of the [DEM].

On its face, this statute would appear to give broad power to the DEM to regulate the acquisition and use of the Harbor Islands, and require DEM's approval to acquire land and construct and operate a new facility on either Deer Island or Long Island. There was no question regarding the applicability of this statute to actions of the MDC, which formerly would be responsible for wastewater treatment facilities. However, there is some ambiguity regarding the applicability of Chapter 742 to the Authority.

Although the Act makes specific reference to a number of special acts as well as general laws to which the Authority is subject or exempt, the Act does not provide separate treatment of Chapter 742. Certain provisions of the Act, however, have some bearing on the potential applicability of Chapter 742. Section 3(a) of the Act states:

> . . . [The Authority shall not be] subject to the supervision or control of the executive office of environmental affairs or of any other executive office, department, commission, board, bureau, agency or political subdivision of the commonwealth except to the extent and in the manner provided in this act.

Because the DEM is a department within the Executive Office of Environmental Affairs, and because the Act does not specifically reference Chapter 742 as applicable, one might argue that the actions of the Authority may be beyond the control of DEM.

Further support for this interpretation may be found at Section 25 of the Act, which provides:

> The provisions of this act shall be deemed to provide an additional, alternative and complete method for accomplishing the purposes of this act, and shall be deemed and be construed to be supplemental and additional to, and not in derrogation of, powers conferred upon the Authority and others by law; provided, however, that insofar as the provisions of this act are inconsistent with the provisions of any general or special law, administrative order, or regulation, the provisions of this act shall be controlling.

By these terms, the Legislature may have intended that all other state law which may impede the purposes of the Authority are suspended with respect to the Authority.

However, it is possible to interpret the various provisions of the Act to require the application of Chapter 742 to the Authority. Because Chapter 742 grants to DEM authority over transactions involving land in Boston Harbor, the City of Boston, as grantor of Long Island or Deer Island, could be barred from transferring lands without DEM approval.

Further pursuasive support for applicability may be found in Section 4(c) of the Act, which requires that transactions involving the transfer of certain protected public lands be conducted in accordance with the laws and the constitution of the Commonwealth, which would include the provisions of Chapter 742. Read in this light, Section 25 would not preclude the application of Chapter 742, since the purposes of the Act include compliance with the laws of the Commonwealth in public land transfers.

F. <u>Power to Acquire Property by Eminent Domain</u>

To acquire the property on either Deer Island or Long Island necessary to construct a new treatment facility, it will be necessary to purchase or take by eminent domain land now owned by the City of Boston. Section 9(a) of the Act provides the Authority with the general power to take property by eminent domain in accordance with the provisions of M.G.L. c. 79 and 80A, subject to several limitations. In general, the taking of property by eminent domain requires the prior approval of the Legislature and the Governor, without regard to whether the property taken is held privately or by a public body. However, under Section 9(a), an exemption from the requirement of prior approval exists for takings related to certain sewers, pumping stations and combined sewer overflow works. Further, this section of the Act prohibits the taking of property, including water rights, that are part of the MDC watershed system. Section 9(a) reiterates the requirement that both the Governor and the Legislature must approve takings of property by the Prior Public Use doctrine.

Any taking by eminent domain under the Act requires prior certification by the Authority that it reasonably believes all regulatory approvals required for the proposed project and listed in Section 8(i) will be obtained in the ordinary course. However, there are no provisions in the Act which would prevent the Authority from taking any portions of city-owned land on either island by eminent domain.

G. Power to Acquire Land by Other Than Eminent Domain

Under Section 9(d) of the Act, after July 1, 1985, the Authority may acquire real and personal property or interests or rights therein, "if deemed essential for operation, improvement or enlargement of its sewer and water works systems." This section would allow the Authority to purchase or otherwise acquire property necessary for the proposed wastewater treatment facilities by means other than eminent domain. Section 26(b) provides that except with respect to real property acquired or held for purposes protected by Article 97, state and local agencies and other governmental entities are "authorized and empowered to lease, lend, give or convey to the Authority" any interest in real or personal property which may be necessary or convenient to effect the purposes of the Authority. That section further provides that any such conveyance would be "upon such terms and conditions as the conveying entity may deem appropriate and without the necessity of any action or formality other than the regular and formal action of said public bodies . . . ."

Under the provisions Sections 9(d) and 26(b), the Authority may purchase private property or property interests without the necessity of prior legislative or gubernatorial approval.

H. Power to Remove or Relocate Property

Under Section 9(b) of the Act, the Authority has the power to order the removal or relocation of certain property:

> The Authority may order the removal of any conduits, pipes, wires, poles or other property located in public ways or places or in or upon private land . . . subject to the ability of the proper authorities lawfully to grant or otherwise make provisions for new locations for any such structure so removed or relocated. Such orders, to the extent specified therein, shall be deemed a revocation of the right or license to maintain such conduits, pipes, wires, poles or other property in such public ways or places, and the private owner of any such structures in public ways or places shall comply with such orders.

It would appear that the intent of this provision is to enable the authority to remove and relocate all utility easements from its project areas, including both public utility and private easements. Read broadly, this vaguely worded section of the Act could be construed to allow the Authority to order removal or relocation of structures, including buildings ("property") located in a public place, subject to the ability of the proper authorities to provide for a new location of such property or structure. However, because Section 9(b) apparently limits the Authority to issue relocation orders to "private owners," the Authority may not use this provision to effectuate removal of public facilities such as the Long Island Hospital.

I. Relocation of Long Island Hospital

At present, the hospital on Long Island provides chronic and long-term care to approximately 150 patients and provides shelter for the homeless of the City of Boston. Depending upon the specific means used to appropriate hospital property and terminate hospital use, removal or relocation of the hospital may be subject to the provisions of M.G.L. c. 111, §§25B-G, the Commonwealth's "Determination of Need" law. The law requires that notice of a proposed change or termination of services be given to the Department of Public Health ("DPH") which must determine, in advance, that a need for such a change in services exists (M.G.L. c. 111, §25G; 105 CMR 100.001 et. seq.)

Pursuant to M.G.L. c. 111, §25(c), no person or government agency may make a substantial capital expenditure for construction of a health care facility or a substantial change in the services of any such facility unless the DPH has determined that there is need for such change. A substantial capital expenditure is defined in the Determination of Need ("DON") regulations to mean an expenditure of $600,000 or more which "under generally accepted accounting principles is not properly chargeable as a cost of operation . . ." The term "construction" is defined in the regulations to mean the construction of a new health care facility or the alteration of, expansion of, making of major repairs to, remodelling of, renovation of, or replacement of an existing health care facility. The term "substantial change in services" means, among other things, "any decrease in the level of service of a long-term care facility which involves a substantial capital expenditure; or any termination of a service when a capital expenditure is associated with such termination . . .; or any decrease by more than four beds of the bed capacity of a facility or of a service or unit thereof when a capital expenditure is associated with such decrease . . ."

The question of whether and how the Determination of Need law applies to the Long Island Hospital closing depends on how that closing is structured. If Health and Hospitals undertakes to raze the facility, arguably the project is subject to DON review as "construction" of a health care facility (i.e., "alteration" of such a facility at a cost of at least $600,000) or a substantial change of services (i.e., the termination or reduction of a service or beds which entails a capital expenditure). Moreover, the mere change of ownership of a health care facility is subject to DON review, although a change in ownership can be processed as a delegated or expedited review if the change does not involve a substantial change in services and if none of the statutory parties to the determination of need process objects to the application. (105 CMR 100.505(A)(f).) If DON review is required (particularly if it is not delegated review), the project can be the subject of a delay of eight months and perhaps much longer.

It is possible that, with proper structuring, a DON review may be avoided. If Health and Hospitals were to notify the DPH that Long Island Hospital plans to terminate its patient care services, and if the patients could be transferred out of the facility without a capital expenditure being incurred by the hospital, DON review would arguably be avoided, at least with respect to Long Island Hospital. Absent a capital expenditure in regard to the diminution of services offered by the Hospital, the diminution of services is not a "substantial change in service" subject to review. Moreover, once the hospital is no longer a health care facility, its alteration or destruction can no longer be termed "construction" of a health care facility. The subsequent acquisition of the building and the land upon which it sits by the Authority would no longer constitute a change in ownership of a "health care facility".

Avoidance of DON review for the transaction between Health and Hospitals and the Authority will, as noted above, depend, at least in part, on a finding that the transfer of the hospital's patients will not result in any capital costs. Since the hospital must inform DPH of the proposed closure for licensure reasons, the Department is likely to carefully scrutinize all closure and transfer of patient costs to ascertain the applicability of the DON provisions to the transfer. One additional caveat should be noted: any hospital that takes patients transferred out of the Long Island Hospital should assess its own exposure. If such hospitals already have chronic care services, and if they can accommodate the transferred patients without an increase in patient bed capacity, it would seem that there will be no DON implications for those hospitals unless the transfer itself involves a capital cost.

J. Massachusetts Department of Capital Planning and Operations Jurisdiction

The Deputy Commissioner of the Massachusetts State Division of Capital Planning and Operations (DCPO) has the discretionary power to approve or disapprove of acquisition of real property by state agencies. The Act, however, provides a partial exemption of the Authority from the jurisdiction of DCPO. Section 8(b) of the Act requires the Authority to file copies of any capital facilities programs with the DCPO pursuant to M.G.L. c. 7, §39c and, under Section 9(c) of the Act, the Authority must notify the DCPO of any sale, lease or disposition of interest which it has acquired in real property. The Act appears to exclude the DCPO from the process of approving the acquisition of land by the Authority, a control which the DCPO exerted with respect to the MDC.

K. Other Statutory and Regulatory Impediments to Facility Construction and Operation

The original memoranda discussed certain statutory and regulatory programs requiring state and federal permits and approvals to construct and operate a new facility. These laws included the Massachusetts Historic Preservation Act, Chapter 9, Sections 26 through 27D; the National Historic Preservation Act; the federal Coastal Zone Management Act and state coastal zone management program; and federal Executive Orders 11988 and 11990, concerning flood plain management and the protection of wetlands. All of these programs will apply with equal effect to the Authority, since the Act does not provide exemptions to these state statutes, nor could it provide exemption from federal law. The Authority staff has recently provided a more site-specific analysis of those permits and licenses required to construct and operate a facility on either island. These permits and licenses are required by programs from which the Authority is not exempt. These approvals include:

- state air pollution permits under 310 CMR 7.00 et seq.
- federal air pollution permits under 40 CFR parts 52 and 329
- state and federal NPDES permits
- federal dredge and fill permit (Section 404 permit)
- ocean dumping permit
- state and federal channel dredging and navigable waterways permits

- approval of activities within the coastal zone
- reconstruction of bridges and causeways

Without a detailed facilities plan, it is not possible at this time to identify very localized environmental conditions which may present obstacles to the issuance of these permits, or suggest the applicability of other state or federal permitting requirements.

One regulatory program which was not identified or discussed in the earlier memoranda is the federal Coastal Barrier Resources Act ("CBRA"), 16 U.S.C. 3501 et seq. Under this federal law, no new expenditures or federal assistance may be made available for any purpose within the Coastal Barrier Resources System as defined by the U.S. Department of Interior. Currently, there is one barrier beach on Long Island included in the Coastal Barrier Resources System, designated as C01C on the Interior Department's inventory, which is located at the southwesterly end of the island on land near West Head adjacent to the causeway from Moon Island. The Interior Department published a notice in the Federal Register on March 4, 1985 discussing proposed amendments to the CBRA and also proposing new additions to the inventory of designated barrier beaches. One of these proposed barrier beach areas, designated as MA-08, is located to the west of the causeway between Winthrop and Point Shirley just north of Deer Island. Another, designated as MA-11, is located to the east of West Head at the southeasterly end of Long Island and extends to the east to include Peddocks and Rainsford Islands. Any new additions to the barrier beach system as recommended by the Interior Department will require an Act of Congress. Precisely when any such legislation could be enacted is unclear, because at present the proposals are still in the public comment period, and have not yet been finalized for transmittal to Congress. In any event, neither the proposed barrier beach area on Deer Island nor the existing or proposed areas on Long Island appears to pose an impediment to construction of a new or expanded wastewater treatment facility on these islands. The CBRA may, however, influence the selection or location of the inter-island conveyance system.

IV. CONCLUSION

The foregoing discussion has identified several provisions of the Act, the Massachusetts Constitution and other general laws which must be satisfied by the Authority to acquire land on either Long Island or Deer Island for a new wastewater treatment facility. While the Authority may be exempt from some provisions of state law, it must still obtain legislative and gubernatorial approval for the taking of public lands protected by the Prior Public Use doctrine and land protected by M.G.L. c. 114, §17. It is clear that a special act of the Legislature will be needed to implement a plan to construct a secondary treatment facility on Long Island on the Long Island Hospital site. The need for a special act is less apparent with respect to Deer Island because of uncertainties associated with the application of the Prior Public Use Doctrine to land outside the prison grounds, and with the location of unmarked graves on the island. A final determination regarding the land ownership and use, and presence of an unmarked cemetery on the Island will establish whether legislative and gubernatorial approval is required.

II-6

air toxics

II-6. Air Toxics/Volatile Organic Compounds

A. Background

The comments on the SDEIS on Air Toxics and Volatile Organic Compounds which required additional evaluations by EPA centered on the following areas:

1. Will the proposed 500 MGD secondary wastewater treatment plant be a major source of air toxics?

2. If it is a major source will it impact the decision to site the wastewater treatment facility?

3. Will the proposed secondary treatment plant be a major source of volatile organic compounds (VOCs)?

4. What does the literature say about air toxics and VOCs from wastewater treatment facilities?

5. What type of control technologies exist that could reduce or eliminate air toxics and VOCs from a treatment plant should it be a problem?

In order to respond to these issues the EPA Region I Air Management Division and EPA's consultant, Thibault/Bubly Associates (T/B), conducted an evaluation resulting in the attached report. EPA's consultant has prepared a separate report on Documentation of Methods Used in Estimating Ground Level Concentrations of Volatile Organic Compounds (VOC). This report is part of the FEIS and is available from EPA under separate cover.

B. Executive Summary and Conclusions

Air Toxics

The air toxics issue is not a site determining issue, because it is predicted that the virtual safe dose will not be exceeded at any of the receptor populations (i.e., the prison, Point Shirley, Hull High School, etc.) if the secondary treatment plant is built on either Deer Island or Long Island.

Ozone

The secondary wastewater treatment plant will be a major source (over 100 tons per year) of volatile organic compounds (VOCs) and will have to be controlled to ensure reasonable further progress towards the attainment of the ozone standard. (VOCs, in the presence of sunlight, are precursors to the formation of ozone.) It is estimated, using the water concentrations found by the lab analysis of the May 1985 water samples, and assuming 85% volatilization at those concentrations, that without additional controls, such as pretreatment of covering of the plant, the emissions from the secondary wastewater treatment plant could be as much as 810 tons per year. EPA is presently requiring the State of Massachusetts to control emissions from all sources which emit greater than 100 tons per year of VOCs.

Methodology

Twenty-nine days of data were used to determine an average concentration for each volatile organic compound (VOC) found in the wastewater. The 29 data points are from the following sources:

1. Effluent data for the years, 1978, 79, 82, and 84 were taken from the 301 (h) waiver application and scaled back to influent concentrations by dividing the effluent concentration by the volatization rate for each compound.

2. Influent data for the year 1978 were taken from the 301 (h) waiver.

3. Water samples were taken at the inlet to the sedimentation chamber by T/B on May 20 and 22, 1985. EPA's lab analyzed the samples to identify compounds and their concentrations.

4. Water samples were taken at the inlet to the sedimentation chamber by EPA on June 11, 1985 and analyzed as described above.

Thirteen compounds were found in the influent and effluent and are represented in ug/m^3 concentrations (see Table III). These concentrations were converted to mass emission rates (gm/sec) for input into the Industrial Source Complex (ISC) area source model, and EPA approved model. Each compound's emission rate was derived by multiplying the percentage of the compound that could be expected to volatilize off a secondary wastewater treatment plant (taken from the literature) times the concentration found in the influent or the effluent.

Modeling for Predicted Concentrations

The ISC area source model was then used to predict annual concentrations at receptor points where there are residential populations, from 400 to 6000 meters away from the Deer Island and Long Island siting locations. The model predicted ground level air concentrations of VOCs, in ug/m^3, that were based on the estimated concentrations of the compounds that would volatilize off a secondary wastewater treatment plant and four years of meteorological data from the Logan International Airport.

Analysis

The predicted ambient air concentrations were compared to chemical specific "virtual safe doses" determined by an independent toxicologist. A virtual safe does (VSD) is defined as "the level of an agent which would be considered too small to be of concern and that would produce a risk relatively insignificant when compared to normal background occurrence of the toxic response (i.e., carcinogenicity) in the exposed population."[1,2]

The virtual safe doses for carcinogens used in this analysis were compared to predicted annually averaged concentrations which account for chronic exposure (70 years) to emissions from the facility. The level of risk used to determine VSDs for the carcinogens in this analysis was one additional cancer incident in 100,000. In other words, if a population of 100,000 is exposed to an ambient air concentration of a carcinogen equivalent to its VSD for 70 years, we would expect to see one or less than one additional cancer incident within the population due to that exposure. When analyzing the exposure of the inmates at the Deer Island House of Correction to the carcinogens, we considered a partial lifetime exposure since each inmate is exposed for less than 70 years.

The level of risk used in this analysis is conservative and it is used for comparative purposes only. EPA has not published an acceptable ambient air concentration nor an acceptable cancer incidence risk for any of the thirteen compounds in this analysis.

For the noncarcinogenic compounds, the VSDs were based upon Threshold Limit Values (TLVs) established by American Conference of Governmental Industrial Hygienists (ACGIH). Since TLVs are based upon different endpoints of concern (i.e, short term and/or long term health impacts), we compared the VSDs to modeled concentrations predicted for both annual and 24-hour time periods. (See Table III and Table IV.)

Conclusion

We compared all of the predicted concentrations to the appropriate virtual safe dose. The virtual safe doses are not exceeded at any of the receptors for any pollutant. Therefore, air toxics do not rule out any of the sites currently under consideration in the EIS study.

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[1]Stong, D. "Risk Assessment for Several Common Pollutants: Acceptable Ambient Concentrations," provided for T/B.

[2]Numerical values used as virtual safe doses are based upon information found in the following documents:

a. Health Assessment Document for Chlorinated Benzenes, EPA 600/8-84/015f, January, 1985.

b. TLVs -- Threshold Limit Values for Chemical Substances in the Work Environment, adopted by ACGIH for 1984-1985.

C. <u>Suggestions for Future Assessment</u>

This study is based on an estimate of 810 tons/yr. of VOC emissions. This estimate is based on samples taken and the use of existing effluent and influent data and represents the best estimate available. It should be noted that this estimate is much less than the 3,428 tons/yr. approximated using all the concentrations and other assumptions of the Indianapolis plant (scaled up to 500 MGD), that was studied by U.S. EPA Region V. (August 17, 1984 memo from Tim Henry and Pauline LeBlanc, EPA Region V, "Volatile Organic Carbon Emissions from an Indianapolis Wastewater Treatment Plant.") It is hypothesized that in the Boston case a significant amount of VOCs are being emitted in the collection system and at the headworks. Therefore, a monitoring and sampling program should be designed to determine the validity of this hypothesis and to identify and confirm or deny the existence of the potential sources.

The findings in this report are based on a limited number of data points. We are, therefore, recommending that the following three tasks be initiated as soon as possible.

First, samples should be taken at the influent to the existing Deer Island wastewater treatment plant to verify the emission rate used for this assessment and to identify the type of control equipment needed. The sampling study should be designed to identify peak influent and annual variations in influent concentrations.

Second, influent and effluent water sampling data should be collected at the existing headworks to determine the compounds and their concentrations and to evaluate the headworks as sources of VOC.

Third, air monitoring should be conducted at the headworks to determine the actual emissions of each VOC.

The Air Management and Environmental Services Divisions will provide guidance to properly design a sampling and monitoring program. We recommend that this sampling begin as soon as possible so that proper controls, if needed, can be designed for the plant.

D. <u>Raw Data</u>

The raw data for this study came from two sources:

1. The 301 (h) waiver application, and

2. Actual sampling at the inlet to the sedimentation tanks.

Thibault/Bubly Associates reviewed the 301 (h) waiver application and found four years of data which included 25 days of effluent sampling. In 1978 there were four dates of sampling data in July; 1979, four days in June and July; 1982, ten days in April; 1984, seven days in January. Additionally, Dorothy Allen of EPA found five days of influent sampling data from 1978 that were averaged into the 1978 effluent data. A total of 29 days of existing data were used.

Wastewater samples were taken from the inlet to the primary sedimentation tanks, the first place in the wastewater collections system, after the headworks, where the wastewater stream is exposed to the air and where there is turbulence and thus aeration. Eight samples were taken on May 20 and 22 and one additional sample was taken on June 11, 1985 (during the photovac air sampling). The volatilization rate of each compound was taken from a literature search to determine the amount of the compound that would be emitted from a new secondary aeration tank.

A more detailed description of the methodology is being provided by T/B as part of their contract report.

E. Air Monitoring

Air monitoring was conducted by Frank Lilley of EPA's Environmental Services Division (ESD) on June 11, 1985 at the Deer Island wastewater treatment plant. Frank calibrated a Photovac gas chromatograph for six compounds found in the water samples taken in May: 1,2 dichloroethane, benzene, trichloroethylene, toluene, tetrachloroethylene, M-xylene. He sampled over the inlet to the sedimentation chamber to determine the concentrations at a maximum concentration area and 50 yards downwind of the treatment plant to detect any dilution of the compounds. The photovac was calibrated for a 1-2 ppb detection limit in order to detect source and ambient concentrations. The meteorological conditions were good for measuring these compounds, hot ambient temperature and a slight wind.

A peak concentration of hydrocarbons was found over the inlet, (probably caused by a high concentration of acetone). The presence of unidentifiable organic compounds prevented the identification of any of the six compounds previously identified in waste samples. The concentrations for the six compounds were, therefore, estimated according to the percentage of each that would be expected to be found in the wastewater and 50 yards downwind of inlet to sedimentation chamber.

Table I
Air Monitored Concentrations

Compound	Air Monitored Concentrations (in ppb)	Air Monitored Concentrations 50 Yards Downwind (in ppb)
1,2 Dichloroethane	<1*	<1*
Benzene	<32	<6.5
Trichloroethylene	<13	<9.6
Toluene	<79	<35
Tetrachloroethylene	<41	<7.5*
M-Xylene	<15*	<15*

*Lower detection limit.

Note, these values cannot be compared to the water concentrations used in the Industrial Source Complex (ISC) model because the air concentrations in Table I above are reported in ppb, a volume/volume ration and the water concentrations used in the ISC model are in ug/L, a weight/weight ratio.

F. Virtual Safe Doses

For the five carcinogens studied (benzene, carbon tetrachloride, chloroform, tetrachloroethylene and trichloroethylene), Dr. David Stong, an independent toxicologist hired by T/B, used the linearized multi-stage model developed by Crump and Watson to describe a linear non-threshold dose-response relationship. This non-threshold model has been adopted by EPA's Carcinogenic Assessment Group (CAG) and is recommended in most cases for risk extrapolation of the dose-response relationship to low doses. The risk estimates made with such a model represent the most plausible, in this case, the 95% confidence limit, upper bound limit for the risk. That is, the true risk is 95% likely to be lower than the estimated risk, and therefore, may be regarded as a conservative estimate.

Chemical carcinogenic dose-response relationships are based primarily on animal oral toxicity studies although a few have been calculated using data from animal inhalation studies, human occupational exposure, or human drinking water exposure. The most accurate data set which estimates the highest lifetime cancer incidence is used to establish the dose-response relationship. This usually correlates with the most sensitive test species. For the six carcinogens as categorized by EPA (see Table III and Appendix A for EPA's classification), all but one contaminant's risk estimate, that for benzene, was calculated using data from animal oral studies. For benzene, the risk was estimated using human occupational exposure data.

Dr. Stong used an individual lifetime cancer risk estimate of 1×10^{-5} to determine virtual safe doses (VSDs) for the five carcinogens. That is, one person within a population of 100,000 breathing an ambient concentration of a contaminant equivalent to its VSD for 70 years would develop cancer as the result of that exposure. This value represents the excess, above the normal background, cancer rate and generally represents the number of cancer cases, not deaths, related to exposure to a specific pollutant. The use of a cancer incidence of 1×10^{-5} is consistent with past Center for Disease Control (DCD) and EPA's Carcinogen Assessment Group (CAG) risk assessment as to what may be considered as an acceptable maximum individual lifetime risk due to exposure to environmental contaminants.

The following calculation was used to estimate the VSDs. It follow guidelines used by CAG.

$P = q_1^* \times d$ Where:

- P = Risk
- q_1^* = Carcinogenic potency (slope from the dose-response curve)
- d = Dose, assuming the volumetric breathing rate of $10 m^3$/day for a 70kg person, breathing x $ub/1m^3$ of a chemical

(Note: This estimation is based on the assumption that dose per surface area is equivalent between humans and rats.)

For example, Benzene:

Where:

- P = 1×10^{-5}
- $q_1 8$ = 5.2×10^{-2} $(mg/kg/day)^{-1}$
- d = $(20 m^3$ day) x (1/70 kg) x (Y ug/m^3) x (10^{-3}mg/ug)
  [Virtual Safe Dose] [Conversion Factor]

Solving for Y:

$$Y = \frac{1 \times 10^{-5}}{(5.2 \times 10^{-2}\ (mg/kg/day)^{-1}) \times (20 m^3/day) \times (1/70 kg) \times (10^{-3} mg/ug)}$$

$Y = 0.67\ ug/m^3$

For noncarcinogens, or threshold toxicants, Dr. Stong has calculated a VSD equivalent to the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value-Time Weighted Average (TLV-TWA) for an eight-hour averaging time period, divided by a safety factor of 100. The safety factor of 100 considers (1) a safety factor of 10 for extrapolation from a subchronic exposure to a chronic exposure and (2) a safety factor of 10 for extrapolation from a healthy worker population to a sensitive population.

Table II (page 9) shows a comparison between the virtual safe doses established by Dr. Stong and ambient air levels set by two state **air** toxics programs. The virtual safe doses, according to Dr. Stong, protect the general public from chronic (i.e., long term) effects associated with the contaminants and, thus, should be compared to predicted annual average concentrations. Please note any differences in averaging times associated with the Michigan and New York values.

The State of Michigan conducts a risk assessment for known or suspected carcinogenic compounds. They follow the same basic risk assessment concepts as EPA's Carcinogen Assessment Group (CAG), setting an acceptable cancer incidence of 1×10^{-6} (one in a million). Michigan's ambient air concentrations associated with a cancer risk of 1×10^{-6} would be used as an annual average. Using an acceptable cancer incidence of 1×10^{-6} is more conservative than the 1×10^{-5} cancer incidence Dr. Stong used when setting VSDs. However, EPA has not published acceptable risk levels for carcinogens, and 1×10^{-5} is frequently used as an acceptable risk to environmental contaminants.

Of the six carcinogens classified by EPA, Michigan currently considers four of them as carcinogens. These compounds are appropriately marked in Table II. For noncarcinogens, Michigan uses 1% of the TLV (TLV/100) as an eight hour average. This is the same approach used by Dr. Stong to establish VSDs, however he recommends an annual averaging time.

The New York Air Guide I sets annual ambient air guidelines equal to the TLV/300 for high or moderate toxicity air contaminants and TLV/50 for low toxicity air contaminants. The following definitions are used when classifying contaminants:

High Toxicity:	Human carcinogens and other substances posing a significant risk to humans.
Moderate Toxicity:	Animal carcinogens, mutagens, teratogens, and other substances posing a significant risk to humans.
Low Toxicity	Those substances whose primary concern is an irritant. No confirmed carcinogenicity in animals.

Contaminant specific acceptable ambient levels (AALs) have been set for selected contaminants by the New York Department of Environmental Conservation (DEC) or the New York Department of Health. For the thirteen chemicals which Dr. Stong reviewed, the New York DEC's interim AALs were all derived from Threshold Limit Value-Time Weighted Averages (TLV-TWAs) set by the ACGIH. Dr. Stong's use of CAG's carcinogenic risk estimates to derive VSDs for the carcinogens provides a much more conservative acceptable ambient air level when compared to the New York approach.

Table II
Comparison of Virtual Safe Doses to State Air Toxics Guidelines
(ug/m^3)

Chemical (Classification)[a]	Virtual Safe Dose (Annual Avg.)	Michigan (8-hr. or (Annual Avg.)	New York DEC Air Guide I (Annual Avg.)
Carcinogens			
Benzene (Group A)	0.67[b]	0.14[ce]	100[f]
Carbon Tetrachloride (Group B2)	0.270[b]	0.04[ce]	100[f]
Chloroform (Group B2)	0.50[b]	0.02[ce]	167[g]
Dichloromethane (Methylene Chloride) (Group B2)	56	---[c]	1.17×10^3[g]
Tetrachloroethylene (Group C)	1.0[b]	3.35×10^3[d]	1.12×10^3[g]
Trichloroethylene (Group B2)	1.80[b]	2.7×10^3[d]	900
Noncarcinogens			
Acetone	1.8×10^4[d]	1.8×10^4[d]	3.56×10^4[h]
1,2-trans-Dichloroethylene	7.9×10^3	---	---
Ethyl Benzene	4.35×10^3	4.35×10^3[d]	1.45×10^3[g]
Monochlorobenzene	3.5×10^3	---	1.17×10^3[g]
Toluene	3.7×10^3	3.8×10^3[d]	7.5×10^3[h]
1,1,1 Trichloroethane (Methyl Chloroform)	1.9×10^4	1.9×10^4[d]	3.8×10^4[h]
Xylenes (m, p, o)	4.4×10^3	4.35×10^3[d]	1.45×10^3[g] (assigned to each isomer)

[a]See classification of carcinogenic evidence in Appendix A.
[b]Identified as a carcinogen by Dr. David Stong, cancer risk = 1×10^{-5}.
[c]Identified as a carcinogen by Michigan, cancer risk = 1×10^{-6}.
[d]Eight hour average.
[e]Annual average.
[f]High toxicity classification -- NY DEC.
[g]Moderate toxicity classification -- NY DEC.
[h]Low toxicity classification -- NY DEC.

G. Limitations

Wastewater Sampling

Very little influent data existed in the MDC computer system and time and resources did not permit extensive wastewater sampling. Therefore, T/B felt it was necessary to use the 301 (h) waiver application for effluent data in order to get the broadest view possible of the types of volatile organic compounds and their concentrations in the wastewater. In order to estimate the wastewater concentrations of the influent from the effluent data, T/B used data available in the literature to estimate the percent removal of each compound in a primary wastewater treatment plant and back calculated for the influent concentration. We believe this gave the best estimate possible for the influent concentrations for the ten compounds[1] studied except for chloroform[2].

However, since the concentrations of toxic pollutants in the MDC wastewater fluctuate depending on the time of day, wet or dry conditions, industrial dumps into the system, etc., we recommend that an influent sampling system be set up to monitor the toxic constituents so that appropriate controls can be designed if necessary. (See Suggestions for Future Assessments, page 4 .)

Volatilization Rates

For this analysis, volatilization was considered the only removal mechanism for VOC from the wastewater. All of the volatilization rates for a secondary wastewater treatment plant used in this analysis were estimated from the literature. Removal by biodegradation and adsorption to the solids were not considered because they have not been documented at the MDC system. IF a percentage of VOCs in the MDC system are removed from the wastewater by these mechanisms, it would mean the volatilization rates were used are inflated and thus are conservative. We used these conservative volatilization rates in order to maximize the potential risks from the thirteen pollutants studied.

Virtual Safe Dose

Under Section 112 of the Clean Air Act, EPA has the authority to establish national emission standards for hazardous air pollutants (NESHAPS). The term "hazardous air pollutant" refers to a contaminant "which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating, reversible ill-

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[1]Ten compounds for which influent concentrations were calculated from the 301 (h) waiver application are: carbon tetrachloride, benzene, chloroform, 1,1,1 trichloroethane, 1,2 trans dichloroethylene, ethyl benzene, tetrachloroethylene, toluene, trichloroethylene and methylene chloride.

[2]Explained in the Projected Annual Average Ground Level Concentrations Section.

ness."[3] Under this authority, chemical emission standards are set for specific source categories to control the emissions from both new and existing facilities. The process of establishing a NESHAP is extremely lengthy and includes a detailed review of all know toxicological and exposure data. To date, six NESHAPS have been promulgated by EPA and none of these would apply to the proposed secondary wastewater treatment facility. Additionally, EPA has not published an acceptable cancer incidence risk. However, in the interest of protection of public health, VSDs, established by an independent toxicologist, were used to assess the impacts of the thirteen compounds studied in this analysis.

The data reviewed in order to establish the virtual safe doses (VSDs) included unit cancer risk values established by the CAG as well as occupational threshold limit values (TLVs). These values do not constitute a risk assessment as proposed by EPA[4]. An EPA detailed risk assessment was beyond the scope of this study and could not have been done in the time frame or within the monies allocated. The virtual safe dose method was considered a reasonable approach for this study. However, there are limitations associated with this approach, and these are:

The exposed individuals are usually represented by a "reference man" having a standard weight, breathing rate, height, etc.; so reference is made to health, age, race, sex, nutritional status, etc.

The amount of information within specific toxicological databases varies from chemical to chemical. Also, a large portion of available information may be based on animal or in vitro studies. Extrapolation to human response is difficult. These are general limitations of toxicity reports.

The VSDs for the noncarcinogenic compounds are based upon varying toxicological studies and effects. Therefore, when establishing the VSDs for these compounds, the division of all TLVs by the same safety factors is not scientifically justified. Depending upon a specific chemical's effect, additional safety factors could be required.

Cancer was assumed to be the end point of concern for the six chemicals identified as carcinogens. These chemicals may also cause other adverse chronic health effects, as well as acute health effects. For this analysis, however, it was assumed that an ambient air concentration protecting the general public to a cancer incidence of 1 in 100,000 would also protect against other toxicological effects.

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[3]Section 112(a)(1) of the Clean Air Act as amended through July 1981.

[4]A detailed Carcinogen Risk Assessment as proposed in guidelines published on November 23, 1984 by EPA includes the following components: hazard identification, dose-response assessment, exposure assessment and risk characterizations (49 FR 46294).

We estimated the prisoners exposures to the secondary sewage treatment plant assuming they would never be exposed to the same chemical concentrations again. This may or may not be true depending upon where their post incarceration employment and living situations take them.

The general population is exposed to chemical mixtures. In general, a carcinogen when interacting with specific tissues may leave a "long-lasting imprint," however, the time from the initial tissue alteration to the production of a detectable tumor is usually measured in years and dependent on many factors (i.e., exposure regimen, nutritional status of exposed individual, etc.). This latency period also makes it difficult to identify a cause-effect relationship between a specific chemical and cancer since humans may be exposed to numerous chemicals during the interval between exposure and tumor production. Data are not available to demonstrate or deny the existence of additive (a summation of the effects of two or more chemicals), synergistic, (a greater than additive effect of two or more chemicals) or antagonistic (a less than additive effect of two or more chemicals) health effects related to chemical mixtures. Likewise, only limited information is available on the promotion or cocarcinogenic potential of most chemicals. A promotor is a chemical which enhances the effect of a carcinogen when exposure to the promotor occurs after exposure to a carcinogen. A cocarcinogen is a chemical which enhances the effect of a carcinogen when exposure occurs at the same time.

H. Projected Annual Average Ground Level Concentrations

Table III identifies the 13 volatile organic compounds found in the wastewater and classifies them as known, probable, or possible human carcinogens and noncarcinogens using EPA's Proposed Guidelines for Carcinogen Risk Assessment (see November 23, 1984 Federal Register, 49 FR 46294). The virtual safe dose (VSD); the VSD multiplied by 35 for carcinogens; the modeled, annual average, ground level concentrations in ug/m^3 for each of the 13 compounds at the closest receptors for Deer Island (400 to 4000 meters) and Long Island (300 to 4000 meters) are also listed.

A comparison of the modeled concentrations at the Deer Island receptors, except the prison receptor, show that all the modeled concentrations are below the virtual safe doses. For the prison population comparison, we took the virtual safe dose for each known, probable, or possible human carcinogen, and multiplied by 35 since the average incarceration at Deer Island is two years (nine months average stay with 40% repeat rate was estimated to be an average two year stay). Therefore, the multiplication factor of 35, (70 years divided by two) was used to calculate the partial life time exposure. In no case was the VSD, multiplied by 35, exceeded at the prison for any of the known, probable, or possible human carcinogens. This strategy was recommended by Steven Bayard, a statistician with the CAG. The partial life time exposure calculation for the prison population is not necessary for the noncarcinogens. The VSDs for the noncarcinogens are based on TLVs that are set for acute or noncarcinogenic chronic effects seen during an eight-hour averaging time exposure, not a 70 year life span. Therefore, Table III for noncarcinogens does not include any VSDs multiplied by 35.

A comparison of the modeled concentrations at the Long Island receptors, show that the modeled concentrations are below the VSD at each receptor. Due to the limitations of the data, the conservatism in the volatilization rates used in the model and the safety factors[1] and conservatism built into the virtual safe does, we considered values below or within the same order of magnitude of the virtual safe does to be an acceptable level of risk.

It should be kept in mind that the data presented in Table III represents the amount of each compound that will be emitted from the new primary and secondary aeration tanks at the plant under consideration. Thibault/Bubly Associates estimate that a portion of the measured concentrations are currently being emitted from the existing primary aeration tanks. These existing emissions were not subtracted from the concentrations used for the ISC model. Therefore, the concentrations presented are considered the potential maximum increase in emissions.

The chloroform concentrations in the effluent samples taken in 1978, 79, 82 and 84 were higher than the concentrations measured in the influent samples taken in 1985. This may be expected because the effluent samples were taken after chlorination, and chloroform is a product of chlorination. Therefore the average chloroform concentration used in this analysis is potentially skewed to a higher concentration than would actually be found in an influent sample and the predicted concentrations in Table III are also higher than will actually occur.

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[1]See the Discussion in Virtual Safe Dose Section.

Table III
Predicted Annual Average Ground Level Concentrations in ug/m^3
at Receptor Sites

Receptor/ Distance		Carcinogens: Benzene (Grp. A)[1]	Chloroform (Grp. B2)	Carbon Tetra-chloride (Grp. B2)	Methylene Chloride (Grp. B2)	Triethylene (Grp. B2)	Tetra-chloro-ethylene (Grp. C)
Annual Virtual Safe Dose							
(70 yr. exposure)		0.67	0.50	0.27	56	1.84	1.0
(2 yr. exposure)		23.5	17.5	9.5	1960	64.4	35
Deer Island Closest Receptors							
DI Prison E	400m	1.12	1.49	0.43	13.27	5.15	4.14
DI Prison W	400m	0.94	1.26	0.36	11.24	4.36	3.51
Pt. Shirley S	1000m	0.23	0.30	0.09	2.69	1.05	0.84
Pt. Shirley N	1500m	0.12	0.16	0.05	1.44	0.56	0.45
Cottage Hill	2000m	0.06	0.07	0.02	0.68	0.26	0.21
LI Hospital	3000m	0.06	0.07	0.02	0.66	0.26	0.21
Winthrop Wash. Ave.	4000m	0.04	0.05	0.01	0.46	0.18	0.14
Winthrop Main St.	4000m	0.02	0.03	0.01	0.23	0.09	0.07
Long Island Closest Receptors							
Thompson Is.	3000m	0.04	0.05	0.01	0.45	0.17	0.14
Pt. Shirley S	4000m	0.03	0.04	0.01	0.37	0.14	0.11
Hull HS	4000m	0.05	0.07	0.02	0.60	0.23	0.17
DI Prison	4000m	0.03	0.04	0.01	0.32	0.13	0.10
Pt. Shirley N	4500m	0.02	0.03	0.01	0.23	0.09	0.07
Cottage Hill	5000m	0.02	0.03	0.01	0.28	0.11	0.09
Squantum NE Shore	4000m	0.02	0.02	0.01	0.19	0.07	0.05

These values represent the potential maximum increase in emissions.

[1]See Appendix A for EPA's classification of carcinogens.

Table III (Continued)
Predicted Annual Average Ground Level Concentrations in ug/m^3
at Receptor Sites

Receptor/ Distance		Noncarcinogens: 1,1,1 Tri-chloro-ethane	Ethyl Benzene	Toluene	Acetone	Xylene	1,2 Trans Dichloro-ethylene	Chloro Benzene
Annual Virtual Safe Dose (ug/m^3)		1.9×10^4	4.35×10^3	3.7×10^3	1.8×10^4	4.4×10^3	7.9×10^3	3.5×10^3
Deer Island Closest Receptors								
DI Prison E	400m	7.72	5.15	11.67	23.72	2.18	1.43	1.75
DI Prison W	400m	6.11	4.36	9.89	20.10	1.84	1.21	1.48
Pt. Shirley S	1000m	1.47	1.05	2.37	4.62	0.44	0.29	0.36
Pt. Shirley N	1500m	0.78	0.56	1.27	2.57	0.24	0.16	0.19
Cottage Hill	2000m	0.37	0.26	0.60	1.22	0.11	0.07	0.09
LI Hospital	3000m	0.36	0.26	0.58	1.18	0.11	0.07	0.09
Winthrop Wash. Ave.	4000m	0.25	0.18	0.40	0.81	0.07	0.05	0.06
Winthrop Main St.	4000m	0.13	0.09	0.20	0.41	0.04	0.02	0.03
Long Island Closest Receptors								
Thompson Is.	3000m	0.24	0.17	0.39	0.80	0.07	0.05	0.06
Pt. Shirley S	4000	0.20	0.14	0.32	0.66	0.06	0.04	0.05
Hull High St.	4000m	0.33	0.23	0.52	1.08	0.10	0.07	0.08
DI Prison	4000m	0.18	0.13	0.28	0.58	0.05	0.03	0.04
Pt. Shirley N	4500m	0.13	0.09	0.21	0.42	0.04	0.03	0.03
Cottage Hill	5000m	0.15	0.11	0.25	0.51	0.05	0.04	0.04
Squantum NE Shore	4000m	0.10	0.07	0.16	0.33	0.03	0.02	0.0[illegible]

I. Assessment of the Annual Average Ground Level Concentrations

Thirteen compounds were found in the wastewater and put into an Industrial Source Complex (ISC) model. Of the 13 compounds, six are EPA listed carcinogens (see classification below and in Appendix A), and seven are noncarcinogens.

All modeled, annually averaged compound concentrations at the receptor points, (14 receptors for Deer Island, 15 for Long Island) were compared to a virtual safe dose (VSD), established by an independent toxicologist. Each VSD represents the annual average concentration of a compound that would be expected to cause one additional cancer incidence in 100,000 if exposed to that concentration for 70 years.

The following is an analysis of the EPA listed carcinogenic compounds studied. The projected annual concentrations represent the potential maximum increase in emissions.

Benzene -- Group A*

If located at Deer Island

Receptor	Distance in Meters	Concentration in ug/m^3	VSD in ug/m^3
Prison E	400	1.06	23.5**
Prison W	400	0.87	23.5**
Pt. Shirley S	1000	0.21	0.67

The VSD is for a 70 year life span, but those incarcerated at the Deer Island House of Correction serve an average of nine months and with an estimated 40% repeat rate, therefore, we used two years for the average exposure for the inmates. Therefore, we divided the 70 year life span by two and used 35 as a multiplication factor. Using 35 times the VSD, as an adjusted VSD, the predicted concentrations at the prison are below the adjusted VSD for benzene and the 12 other compounds. None of the Long Island receptor concentrations exceed the VSD.

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*See classification of carcinogenic evidence, Appendix A.

**Adjusted for partial lifetime exposure.

Chloroform -- Group B2*

If located at Deer Island

Receptor	Distance in Meters	Concentration in ug/m^3	VSD in ug/m^3
Prison E	400	2.39	17.5**
Prison W	400	1.98	17.5**
Pt. Shirley S	1000	0.48	0.5
Pt. Shirley N	1500	0.25	0.5

The prison concentrations do not exceed the adjusted VSD for the prisoners nor does the Pt. Shirley receptor concentrations exceed the VSD. None of the Long Island receptor concentrations exceed the VSD.

Carbon Tetrachloride -- Group B2*

If located at Deer Island

Receptor	Distance in Meters	Concentration in ug/m^3	VSD in ug/m^3
Prison E	400	0.23	9.5**
Prison W	400	0.19	9.5**
Pt. Shirley S	1000	0.05	0.27

The Prison concentrations do not exceed the adjusted VSD for the prisoners and none of the other Deer Island nor Long Island receptors exceed the VSD.

Methylene Chloride -- Group B2*

If located at Deer Island

Receptor	Distance in Meters	Concentration in ug/m^3	VSD in ug/m^3
Prison E	400	14.54	1960**
Prison W	400	12.01	1960**
Pt. Shirley S	1000	2.94	56

The prison concentrations do not exceed the adjusted VSD for the prisoners and none of the other Deer Island nor Long Island receptors are close to or exceed the VSD.

*See classification of carcinogenic evidence, Appendix A.

**Adjusted for partial lifetime exposure.

Trichloroethylene -- Group B2*

If located at Deer Island

Receptor	Distance in Meters	Concentration in ug/m^3	VSD in ug/m^3
Prison E	400	4.60	64.4**
Prison W	400	3.80	64.4**
Pt. Shirley S	1000	0.93	1.80

The prison concentrations do not exceed the adjusted VSD for the prisoners and none of the other Deer Island nor Long Island receptors exceed the VSD.

Tetrachloroethylene -- Group C*

If located at Deer Island

Receptor	Distance in Meters	Concentration in ug/m^3	VSD in ug/m^3
Prison E	400	3.31	35.0**
Prison W	400	2.74	35.0**
Pt. Shirley S	1000	0.67	1.0

The prison concentrations do not exceed the adjusted VSD for the prisoners and neither the Deer Island nor Long Island receptor concentrations exceed the VSD.

The receptor concentrations for the remaining seven noncarcinogens are all below 1 ug/m^3 and all of the VSDs for those compounds are three to four orders of magnitude above 1 ug/m^3. Therefore, none of these seven compounds exceed the VSDs at any receptor.

*See classification of carcinogenic evidence, Appendix A.

**Adjusted for partial lifetime exposure.

J. Risk Evaluation

The virtual safe doses (VSDs) for the thirteen organic contaminants are recommended by Dr. Stong to be used as acceptable levels to protect against chronic effects. Background concentrations of air pollutants were not considered. This evaluation addresses the increased risk, above background, to the general public from exposure to emissions from a secondary wastewater treatment facility only, not including the emissions from the existing primary treatment plant.

Additionally, we assumed a 100% absorption rate. That is, each individual absorbs 100% of the chemical that is within the inhaled air. This is a conservative estimate which does not consider a portion of the chemical that may be removed from the body prior to being absorbed (e.g., via exhaled air).

The VSDs for noncarcinogens are based upon acceptable occupational levels established by ACGIH. The scientific basis for each chemical's workplace standard varies. That is, some occupational standards are based upon chronic (i.e., long-term) effects while others may be based upon acute (i.e., short-term) effects. To account for the different endpoints used in ACGIH's analysis of the noncarcinogens, we compared the VSDs to the highest modeled ambient air concentrations within the annual (appropriate for long-term effects -- see Table III, page 14) and 24-hour (appropriate for most short-term effects -- see Table IV, page 21) averaging time periods. The VSDs do not take into consideration the difference between worker exposure (eight hours per day, five days per week) and environmental exposure (24 hours per day, seven days per week), that is,

$$\text{VSD} \times \frac{8 \text{ hours}}{24 \text{ hours}} \times \frac{5 \text{ days/week}}{7 \text{ days/week}} = 0.24.$$

Therefore, as a conservative measure the VSD's annual averages were also calculated with a time adjustment factor to account for this difference (see Table IV, page 20). In all cases, with and without the time adjustment factor, the modeled values were two to three orders of magnitude below the VSDs.

The VSDs recommended for the carcinogens or non-threshold toxicants, were closer to the modeled annual average values. Therefore, we looked at the potential chronic effects (i.e., cancer incidence) that might be associated with the modeled concentrations of these six contaminants at the nearest receptor points.

To consider the maximum individual lifetime risk, that is, the risk associated with an individual living nearest the source, exposed to the highest concentrations; the modeled ambient air concentrations were compared to the cancer incidence dose-response relationship. For each of the six individual carcinogens, the maximum lifetime risk is within a cancer incidence range of 10^{-6} to 10^{-7}. This is below the acceptable cancer incidence rate of 1×10^{-5} used in this analysis.

Methods to estimate the additive cancer incidence risk associated with the predicted ambient concentrations of the six carcinogens were discussed with Richard Hertzberg, EPA, Environmental Criteria and Assessment Office. Mr. Hertzberg has been involved with the development of EPA's risk assessment guidelines for assessing the risk from exposure to mixtures of pollutants. Little information is available on the additive, synergistic, or antagonistic properties of chemicals. Likewise, information on the cocarcinogenic or promotion potential of chemicals are limited.

Therefore, as a conservative estimate of the potential cancer incidence we assumed the tumor actions of each identified carcinogen to be independent and added the individual risks associated with their predicted ambient concentrations. Statistically this represents a 96-97% upper confidence limit. That is, the true risk would likely be 96-97% lower than the estimated risk. Estimates of the additive increase in the cancer incidence among the populations at the six closest receptor points exposed to the six modeled ambient air concentrations for the carcinogens are below or within the same order of magnitude as the VSD's.

In analyzing the exposure to the inmates at the Deer Island House of Correction, we considered a partial lifetime exposure to the carcinogens because each inmate is exposed for less than 70 years. The average term served by inmates is nine months with a 40% rate of repeat incarceration. Therefore, we estimated the average amount of time served to be as two years. Determining the virtual safe dose of each carcinogen for two years we divided the 70 year lifespan by two for a multiplication factor of 35. Therefore, modeled concentrations of the carcinogens at the prison were compared to 35 times the virtual safe dose. The adjusted VSDs were not exceeded at the prison for the six carcinogens.

Table IV
Predicted Highest 24-Hour Ground Level Concentrations in
ug/m^3 at Receptor Sites

	VSD	VSD x 0.24[a]	Highest 24 Hour DI[b]	LI[c]
Acetone	18,00	4,320	303.03	90.51
Chlorobenzene	3,500	840	22.37	6.68
1, 2-trans Dichloroethylene	7,900	1,900	1.43	0.05
Ethylbenzene	4,350	1,044	65.76	19.64
Toluene	3,700	888	149.14	44.55
1,1,1 Trichloroethane	19,000	4,560	92.19	27.54
Xylene	4,400	1,056	27.81	8.31

[a]Time adjustment factor for environmental vs. worker exposure. Environmental exposure being 24-hours per day and worker exposure 8-hours per day.

[b]Deer Island Prison, East; closest receptor if the secondary treatment plant is located at Deer Island.

[c]Long Island Head; closest receptor if the secondary treatment plant is located at Long Island.

K. Ozone

A rough estimate was made of the expected total volatile organic compounds (VOCs) that will be emitted from a secondary wastewater treatment plant. The following assumptions were used:

Assumptions:

1. The 13 compounds found in the analysis of the wastewater sample are the only VOCs in the wastewater.

2. Of the 13, one, 1,1,1 trichloroethane is considered photochemically nonreactive, so only 12 compounds will be added for total VOCs.

3. The concentrations in the water are those that would volatize into the air (i.e., assume 100% volatilization). A calculation is included below to correct this to the estimated average volatilization rate of 85%.

4. The flow rate at Deer Island is constant at 500 MGD every day.

VOC	Highest Measured Concentrations in ug/l
Methylene chloride	86
1,2 Dichloroethylene	6
Chloroform	12
Benzene	6
Tetrachloroethylene	40
Toluene	260
Ethyl Benzene	13
Acetone	710
Xylenes	100
Trichloroethylene	9
Chlorobenzenes	9
Total	1,251

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500 MGD at Deer Island = x l/day

500,000,000 gal/day x 10 l/2.64 gal = 1.8939×10^9 l/day

(1251 ug/l) (1.8939×10^9 l/day) = 2.3693×10^{12} ug/day
= 2369.3 kg/day

2369.3 kg/day x 365 days/year = 8.6479×10^5 kg/year

8.6479×10^5 kg/year x 2.2046 lbs/kg = 1.9065×10^6 lbs/year

1.9065×10^6 lbs/year x 1 ton/2,000 lbs = 953.3 tons/year

953.3 tons/year x 0.85 = 810 tons/year

Any VOC source that emits over 100 tons per year is considered a major source of VOC and must be controlled to ensure the attainment of the national Ambient Air Quality Standard for ozone. Since this will be a new source of VOC, the State would require control under their Regulation 310 CMR 7.02, New Source Review (NSR). The wastewater treatment plant would have to be controlled for attainment of the ozone standard regardless of its final siting location.

L. Controls

1. Under NSR the State could offset the increase of VOC emissions at the wastewater treatment plant by reducing emissions from another source. For instance, the State could require a more stringent cut point for the hydrocarbon standard in the automobile inspection and maintenance program to obtain the required offset. If the State does not use the offset rule, technological controls are available to reduce the emissions of VOSs.

2. The secondary aeration tanks could be covered and the emissions could be vented to a carbon adsorber, chemical scrubber or other add-on control device to control VOCs.

3. The industrial sources could be required to pretreat their VOC emissions or not allow them into the wastewater treatment collection system at all and dispose of them in another manor. This would also control possible emissions at the headworks and through the collection system.

An analysis of the existing controls available must be included in the design phase of this project.

Group A: Human Carcinogen

This category is used only when there is sufficient evidence from epidemiologic studies to support a causal association between exposure to the agent(s) and cancer.

Group B: Probable Human Carcinogen

This category includes agents for which the evidence of human carcinogenicity from epidemiologic studies ranges fro almost "sufficient" to "inadequate." To reflect this range, the category is divided into higher (Group B1) and lower (Group B2) degrees of evidence. Usually, category B1 is reserved for agents for which there is at least limited evidence of carcinogenicity to humans from epidemiologic studies. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard agents for which there is sufficient evidence of carcinogenicity in animals as if they presented a carcinogenic risk to humans. Therefore, agents for which there is inadequate evidence from human studies and sufficient evidence from animal studies would usually result in a classification of B2.

In some cases, the known chemical or physical properties of an agent and the results from short-term test allow its transfer from Group B2 to B1.

Group C: Possible Human Carcinogen

This category is used for agents with limited evidence of carcinogenicity in animals in the absence of human data. It includes a wide variety of evidence:

a. Definitive malignant tumor response in a single well-conducted experiment.

b. Marginal tumor response in studies having inadequate design or reporting.

c. Benign but not malignant tumors with an agent showing no response in a variety of short-term tests for mutagenicity; and

d. Marginal responses in a tissue known to have a high and variable background rate.

In some cases, the known physical or chemical properties of an agent and results from short-term tests allow a transfer from Group C to B2 or from Group D to C.

Group D: Not Classified

This category is used for agent(s) with inadequate animal evidence of carcinogenicity.

Group E: No Evidence of Carcinogenicity for Humans

This category is used for agent(s) that show no evidence for carcinogenicity in at least two adequate animal test in different species or in both epidemiologic and animal studies.

Source: Proposed Guidelines for Carcinogen Risk Assessment 49 FR 46294, November 23, 1984.

II-7

water quality outfall evaluation

II-7. WATER QUALITY OUTFALL EVALUATION

A. Background

EPA received comments on the water quality evaluations contained in Volume II of the SDEIS, Section 11.3. The comments centered on the following areas:

1. Was the SDEIS accurate in predicting the water quality impacts at the President Roads location?

2. What were the limitations of the MERGE modeling analysis?

3. Would ambient water quality conditions in the Harbor preclude any outfall from meeting water quality standards?

4. Were other outfall locations available that might be environmentally acceptable?

In order to respond to these questions EPA evaluated four potential outfall locations, two within Boston Harbor and two outside the Harbor. An EPA model DKHPLM as used to predict initial dilutions at these locations. The modeling results indicated that the potential for initial dilution of secondary effluent to meet EPA's saltwater aquatic life criteria exists at all discharge locations. The results also indicate that the President Roads and South Channel locations, both within the Harbor, have the potential for greater initial dilutions. The limiting factor for the acceptability of these two locations is the ambient water quality. Detailed monitoring at these potential locations is recommended in order to establish a comprehensive ambient water quality data base. Additional experimental and/or numerical modeling is also necessary for the two channel locations to assess the significance of the shadowing effect, the initial dilution reduction due to the orientation of diffusers in a direction parallel to the ambient current.

The construction and cost implications of the various discharge locations are also discussed.

Water quality issues were addressed in SDEIS through comparison of expected pollutant concentrations after initial mixing at the discharge location with established and proposed saltwater aquatic life criteria. The material presented in the SDEIS (Tables 11.3-10 through 11.3-12) suggests that the past and existing primary effluent concentrations of copper, cyanide, PCBs and heptachlor may result in the violations of saltwater aquatic life criteria. These violations were projected for periods of minimum current velocity, maximum ambient density stratification and above average pollutant loadings for a discharge in President Roads. All of these assumptions are environmentally conservative and in a modeling effort yield minimum initial dilutions.

Violation estimates were based on initial dilution modeling performed with the model MERGE. Modeling results should be interpreted with an appreciation for the limits of modeling methodology and scarcity of the existing input data. The model MERGE estimates dilutions of sewage plumes discharged through a multiport diffuser into a saltwatar ambient environment. The model accounts for effects of uniform ambient current, ambient density stratification, discharge depth and certain diffuser specifications. Besides being limited by the simplifying assumptions intrinsic to the model development, the modeling effort is dependent on the reliability of the input data. At the present time, ambient current and density data for the inner and outer harbor is not extensive and reliable enough to support sophisticated modeling efforts. Similarly, precise diffuser specifications and expected secondary effluent quality have not been established.

Although precise evaluation of water quality impacts is not possible at this time, a preliminary evaluation of alternative outfall locations was performed by EPA as part of the final EIS. This evaluation was performed to address the issue of water quality advantages and disadvantages of various outfall locations. The relationship of these outfall locations to siting of a secondary wastewater treatment plant at either Deer Island or Long Island was subsequently investigated. The evaluation was also performed in preparation for an assessment of future NPDES discharge permit requirements and compliance.

The SDEIS evaluated the discharge of secondary effluent at a location called the President Roads. Other possible discharge locations were studied by MDC as part of the Draft Deer Island Facilities Plan (Havens and Emerson for MDC, 1984). These locations were President Roads, South Channel, Broad Sound and Seven-Mile presented in Figure 1.

A comparative assessment of initial dilutions was performed by EPA with the use of model DKHPLM at the four locations. The DKHPLM model evaluates effluent discharge from a multiport diffuser and accounts for the effects of discharge depth, uniform current velocities, and linear salinity and temperature profiles. It does not assess the effects of shadowing, the reduction of actual initial dilution of downstream diffuser plumes cause by re-entrainment of effluent discharged from upstream diffuser plumes. This effect is minor when the current is perpendicular to the diffuser, but can be significant when current is parallel to a long diffuser, as would be the case in locations such as President Roads and South Channel. Although this model is different from the MERGE model employed in the SDEIS, it relies on similar input data. Therefore, the precision of the initial dilution values is subject to the limitations similar to those of the previous modeling effort. The results, however, may be used for the purpose of preliminary comparison of initial dilutions at different outfall locations.

The DKHPLM model input parameters include: diffuser specifications, such as, port spacing, port diameter, port velocity, port discharge angle, and the angle of ambient current with respect to horizontal discharge. The

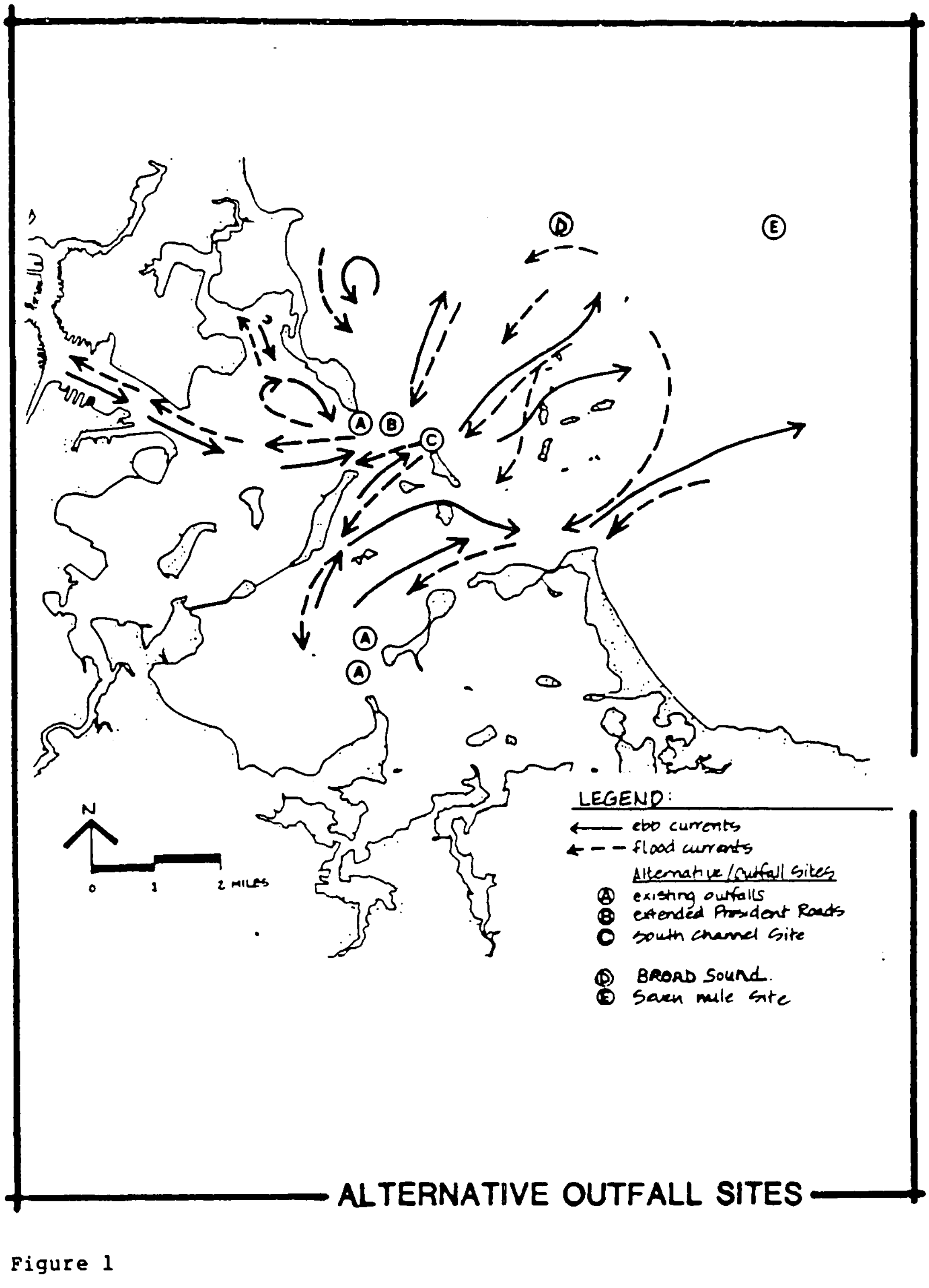
LEGEND:
ebb currents
flood currents
Alternative/Outfall Sites
A existing outfalls
B extended President Roads
C South Channel Site
D BROAD Sound.
E Seven mile Site
N
0
1
2 MILES
ALTERNATIVE OUTFALL SITES

Figure 1

input also includes ambient saltwater parameters, such as: ambient uniform current, ambient temperature stratification, ambient salinity stratification, and the discharge depth. The effluent characteristics of concern are salinity and temperature. The comprehensive summary of input data to the DKHPLM model is presented in Table 1. Each location was modeled with a single reasonable diffuser specification presented in Table 2 and developed in the SDEIS.

The results, summarized in Table 3, indicate that average initial dilutions, those that reflect approximately 50% current frequency, are comparable for the President Roads and South Channel discharge locations and are high for discharges which are in proximity to land. These high dilutions are due to high velocity tidal currents present in these harbor channels. The average initial dilutions for the Broad Sound and Seven-Mile locations, although modeled at greater depth, are lower and reflect the slower currents present in these locations. The effects of slower current velocities, those that represent approximately 10% frequency, at President Roads and South Channel were also investigated. The results indicate that these initial dilutions achieved at President Roads and South Channel are also higher than the average initial dilutions possible at the Broad Sound and the Seven-Mile locations.

Modeling results indicate that the potential for initial dilution of secondary effluent to meet saltwater aquatic life criteria exists at all discharge locations. The results also indicate that the locations with greater current velocities, President Roads and South Channel, have the potential for greater initial dilutions. These conclusions, however, are based on the assumption that sufficient supply of unpolluted ambient dilution water is available and comparable at the four locations, and that shadowing does not significantly reduce the initial dilutions at the President Roads and South Channel locations.

Presently, the harbor represents an ecologically stressed environment. Existing water quality surveys of the harbor indicate that water quality criteria are being exceeded for certain metals at various harbor locations (Metcalf & Eddy, Inc., MDC 301(h) Application, 1984, pp. II - B5.169-.178). Also, the studies of sediment contamination in the harbor (Metcalf & Eddy, Inc., MDC 301(h) Application, pp II - 5B.179-.295; Battelle, Organic Pollutant Biogeochemistry Studies Northeast U.S. Marine Environment, Part I and II, 1984) document the existing high levels of pollutants.

Due to the degraded condition of Boston Harbor, initial dilution calculation can only be used as guidelines for determining compliance with water quality standards. The draft National Pollutant Discharge Elimination System (NPDES) Permit includes chronic and acute effluent toxicity limitations, toxicity reduction evaluation requirements and bioaccumulation assessment requirements. The draft permit also indicates that EPA will evaluate the results of the toxicity tests in conjunction with the chemical analyses required by the permit to develop site-specific numerical effluent limitations for specific pollutants. EPA believes the

TABLE 2
EFFLUENT AND DIFFUSER SPECIFICATIONS

Specification	Value
Diffuser length[1] m	1,829
Jet velocity[1] m/sec	2.134
Port diameter[1] m	0.152
Port spacing[1] m	3.048
Discharge angle	vertical
Current angle w/respect to horizontal discharge	--
Jet temperature[2] °C	17.2
Jet salinity[2] °/°°	1.0

[1]Source: C.E. Maguire, SDEIS, 1985.

[2]Source: EPA Discharge Monitoring Reports, June 1985.

TABLE 3
INITIAL DILUTION AND HEIGHT OF RISE OF EFFLUENT PLUME

Outfall Location Current	Initial Dilution	Plume Height of Rise m
President Roads approximately 50% current	214	5.83
President Roads approximately 10% current	153	7.50
South Channel approximately 50% current	194	5.93
South Channel approximately 10% current	153	7.49
Broad Sound approximately 50% current	115	7.95
Seven-Mile approximately 50% current	73	8.59

TABLE 1
AMBIENT WATER PARAMETER INPUT TO DKHPLM MODEL

Ambient Parameter	President Roads	South Channel	Broad Sound	Seven-Mile
Discharge depth m	20.15	15.12	23.35	31.6
Approximately 50% current[2] m/sec	0.31	0.27	0.10	0.05
Approximately 10% current[2] m/sec	0.15	0.15	--	--
Bottom salinity[1] °/oo	31.85	31.85	31.85	31.85
Salinity gradient[1] °/oo/M	0.017	0.017	0.017	0.017
Bottom temperature °C	12.5[1]	13.0[3]	11.0[3]	6.7[1]
Temperature gradient °C/m	0.25[1]	0.25[3]	0.36[3]	0.46[1]

[1]Source: Metcalf & Eddy, Inc., MDC 301(h) Application, 1979.

[2]Source: NOAA, Boston Harbor Tidal Current Tables, 1985.

[3]Source: EG&G, prepared for Havens & Emerson, Data Summary and Documentation for Field Studies in Boston Harbor, 1984.

above mentioned approach and procedures in conjunction with other cleanup efforts (residuals management, CSO treatment) will eventually result in Boston Harbor achieving its designated water quality classification and use.

The environmental concerns, other than compliance with water quality criteria, should also be considered in evaluating various discharge locations. The Draft Deer Island Facilities Plan summarizes the results of a broad environmental assessment of the four sites. The assessment included the evaluations of: the potential of the effluent to be carried into the harbor, onto depositional areas, and toward beaches; the potential for exceeding water quality criteria for conventional as well as priority pollutants; the potential for affecting levels of metals and organics in sediment and biota; the potential of effects on lobster, winter flounder and fishing activities; and the potential for aesthetic impacts, and conflicts with other uses of harbor. The draft report concludes that Broad Sound and Seven-Mile locations are the most environmentally acceptable for a combination of Deer Island and Nut Island flows.

MWRA will be continuing outfall evaluations in the Facilities Plan for the proposed secondary treatment plant. The ultimate choice of outfall location will entail further study by MWRA in close coordination with EPA. Future studies should address the following issues to allow for an informed choice with respect to an outfall location. More comprehensive oceanographic data must be acquired to allow for accurate modeling of water quality impacts, such as; initial and far-field dilution of secondary effluent as well as sedimentation and transport of the secondary effluent particles. An experimental and/or numerical modeling effort should also be used to assess the significance of the shadowing effect, the reduction of initial dilution due to orientation of diffuser in a direction parallel to the ambient currents in President Roads and South Channel locations. Factors, such as, effects on recreational and fishing resources as well as aesthetic values of the estuary should also be incorporated into an evaluation of the secondary effluent discharge location. In addition, comprehensive ambient water and sediment quality data are necessary for the assessment of the future improvements and the recovery of the presently stressed environment.

Outfall construction feasibility for the four discharge locations were judged to be similar for Deer Island and the Long Island secondary treatment sites. EPA review of existing reports, including the Draft Deer Island Facilities Plan, determined that an outfall originating from either Deer Island or Long Island to any of the proposed locations is possible. No major difference in outfall construction or impact is expected for either island. Some of the discharge locations require crossing the main shipping channel for Deer Island and all may for Long Island. Both trenching and tunneling are open for consideration at this point in time and may be possible from either Deer Island or Long Island treatment plant sites.

Since more detailed work will be required of MWRA on location and cost of outfalls during facilities planning, EPA at this time did not do any further cost analyses. Preliminary construction and costs of outfall to the President Roads location are given in the SDEIS (Vol. II, Section 12-4) and for the Deer Island and Long Island options are $47.72 and $91.86 million, respectively (1984 dollars, ENR 4200). The SDEIS concluded that because Deer Island and Long Island are close to one another, there is relatively little difference in the cost of constructing an outfall from either island to the President Roads (4%-6% difference of total plant cost).

An additional outfall cost analysis for the Deer Island option, cited in the Draft Deer Island Facilities Plan (Havens & Emerson for MDC, 1984), is presented in Table 4, for the three other outfall locations. It should be noted that these costs are preliminary and are given in 1983 dollars. They are included to give the reader initial comparative cost information. Further detailed costing of alternative outfall sites will be prepared in the upcoming MWRA's Facilities Plan for the project.

TABLE 4
CONSTRUCTION COST COMPARISON FOR THE DEER ISLAND OPTION *

		Construction Costs 1983 Dollars (Millions)	
Site	Distance to Outfall (Feet)	Trench Construction	Tunnel Construction
Broad Sound	28,000	280	325
South Channel	10,500	105	142
Seven-Mile	35,000	410 **	430**

** Does not include power costs. (Includes pump stations, diffusers and shafts for tunnels.) Seven-Mile site costs were developed in MDC Site Options Study and updated by 10% to October 1983.

* Source: Havens & Emerson / Parsons Brinkerhoff, Draft Deer Island Facilities Plan, 1984. Prepared for the MDC.

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costs

II.8 Cost Estimates

A. Background

Comments on the construction cost estimates in the SDEIS included:

1. Whether the estimates significantly underestimated the probable costs of construction.

2. Whether the differences in estimated costs amongst the alternatives were significant.

These questions led to a series of meetings among the engineers who had at one time or another proffered cost estimates for the project, including Metcalf & Eddy, the original authors of the Nut Island Site Options Study; CE Maguire, the principal authors of the SDEIS; and Camp, Dresser & McKee, consultants to the MWRA. These meetings led to the conclusion that a broad range of costs for any given facility was possible, depending on the assumptions made by the cost estimator, including the size of the facility, the specific processes to be included, the "furnishings" to be included as "initial construction," the kind of construction, the assumed difficulty of the work, etc.

B. New Estimates

Since it was not clear just what differences did exist in assumptions for the various alternatives, and since new data on the site and on the proposed facility were being developed in the review of the proposed action by the MWRA subsequent to publication of the SDEIS, the MWRA asked its consultants to prepare new, up-to-date estimates. The major changes in assumptions made by Camp, Dresser & McKee included:

1. Increase in the unit costs of primary sedimentation tanks from $78/square foot to $151; of secondary sedimentation tanks from $112/square foot to $204; and of aeration basins from $164/square foot to $266.

2. Increase in sludge processing costs to reflect the modifications to the solids management including adding costs of $21 million for dissolved air flotation of secondary sludges, and $24 million for dewatering of all sludges.

3. Adjustments in the costs for removal of unsuitables -- essentially an estimate of costs associated with disposal of surplus excavated material. At Deer Island, the cost was estimated at $15 million to reflect the cost of removal of the drumlin. At Long Island, the cost was estimated at $45 million, which reflects the greater amount of excavation necessary to produce a suitable site at this location.

4. Adjustment of the estimated costs of pumping in two manners. The estimates of influent and effluent pumping at Deer Island were increased by $15 million and $60 million respectively, to reflect more recent costs, and, the estimates for pumping at Long Island were revised to reflect both the more recent costs and the need for an intermediate pump station in those alternative layouts in which both the treatment facility and the hospital would remain on the Island.

5. Inclusion of allowances for yard piping, site work, on-site electrical distribution and instrumentation (which includes the $30 million computer). These items added approximately $140 million to each alternative.

6. Inclusion of allowances for miscellaneous site conditions which are unique to each island. The costs for piers and erosion control at Long Island were estimated to be higher than at Deer while the cost for dikes to prevent wave run-up are expected to be greater at Deer Island.

7. Inclusion of allowances for additional costs if the facility is constructed on an island which is also occupied by an institution. An increment of about $40 million was made to account for the more complicated layouts which would be expected and for additional problems in scheduling and executing construction.

In addition, allowances were made for the mitigation of environmental impacts and for ancillary construction - particularly bridge repairs - which would be needed to allow construction to take place. Special cost allowances were also made for bussing and barging of personnel and materials to the construction site, control of construction noise, provisions for local recreational facilities, special treatment for visual enhancement, bridge rehabilitation/replacement and archaeological preservation. Table C-1 shows the costs of these items, by site option and the assumption of the presence or absence of the existing institutions on each island.

The differences in such costs amongst the alternatives were in the areas of bridge rehabilitation, visual enhancement, local recreation and the need for control of construction noise. The differences in the bridge costs reflect the estimated cost for replacement of the two smaller bridges on the approach to Deer Island, versus the cost for replacement of the large span bridge from Moon Island to Long Island. Costs allowances for visual enhancement on the Long Island site were higher because the island has more shoreline, and because it was expected that the plant construction would result in greater change to the landform. Local recreational opportunities were judged to be possible at Deer Island, but not at Long Island. And finally, allowances for some form of construction noise control were provided for both Islands with the institutions in place, but only at Deer Island if the institutions were removed.

TABLE C-1

POTENTIAL MITIGATION EXPENDITURES
($ MILLION)

	With Institutions		Without Institutions	
	Deer	Long	Deer	Long
Barging/Busing	45	45	45	45
Local Recreation	5	0	5	0
Visual Enhancement	5	10	5	10
Bridge Repair	4	15	4	15
Construction Noise Control	3	3	3	0
Archaeological	2	2	2	2
Odor/Air Emissions	23	23	23	23
TOTALS	87	98	87	95

Source: Camp, Dresser and McKee, Inc.; Thibault/Bubly Associates , 1985.

Changing the assumptions as to the status of the institutions also changes costs. Removing the prison from Deer Island would lower construction costs by about $20 million, as a result of $40 million in savings attributable to construction in an uncongested site and an offset of $20 million resulting from the loss of the existing clarifiers. Keeping the hospital on Long Island would raise costs by about $100 million, reflecting the changed pumping configuration, and an adjustment for construction in a confined site.

In addition, table C-2 summarizes the estimated cost for all the alternatives, all made using the same underlying assumptions. The primary treatment alternatives costs were based only upon primary treatment components, and an extended outfall with a total estimated cost of $479.5 million.

COMPARATIVE CONSTRUCTION COSTS OF OPTIONS (1985)

	All Deer	All Long	Primary: Nut & Deer Secondary: Deer	Primary Deer & Long Secondary: Long
PRIMARY	1,065-1,090	1,180-1,285	1,210-1,230	1,345-1,365
SECONDARY	1,115[1]-1,135[2]	1,180[3]-1,285[4]	1,275-1,295	1,355-1,375

[1]prison removed

[2]prison to remain

[3]hospital removed

[4]hospital to remain

Source: Camp, Dresser and McKee, Inc., FEIR On Siting of Wastewater Treatment Facilities for Boston Harbor, 1985

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facilities layouts

II-9 FACILITIES LAYOUT SCENARIOS

A. Background

Questions on the specific physical site layout characteristics of wastewater treatment facilities that might be designed at the alternative treatment facility siting options included:

1. What areas of land might be required for wastewater treatment at each alternative siting location?

2. What effects might such facilities designs have on the appearance, recreational potential, and documented archeological and cultural resources at the alternative sites?

To explore these questions, two teams of site planners were assembled and asked to explore the issues. One team was organized by EPA consultants and the other by the applicant, the Massachusetts Water Resources Authority. Each team included sanitary and civil engineers and landscape architects. Each team worked independently, with somewhat different assumptions as to the variables to be included. Both worked at a scale of 1"=200' and both considered profile views of the sites as well as topographic plans.

B. EPA Facilities Layout Studies

The EPA consulting team explored the following alternative assumptions:

1. For all facilities for primary and secondary treatment on Deer Island:
   a. removal of the prison off the island.
   b. relocation of the prison on the island.
   c. a treatment technology that would require less land than "activated sludge."
2. For all facilities on Long Island:
   a. removal of the hospital off the island and use of all uplands without documented archeological resources
   b. treatment technology that would require less land than "activated sludge."
3. For facilities to be divided between Deer Island and Long Island:
   a. division of facilities as proposed in SDEIS (primary for northern system on Deer Island, everything else on Long Island).
   b. alternative facilities, 40% on Deer Island, 60% on Long Island.

The specific alternatives, and the consultant's evaluations, included:

Alternative 1A: All Deer Island Secondary

Assumptions:

1. Existing prison to remain
2. Activated sludge process as per SDEIS

Effects:

The environmental impacts of this alternative are those described in the SDEIS and subsequent environmental reviews in the FEIS.

Alternative 1B: All Deer Island Secondary

Assumptions:

1. Existing prison to be relocated off-island
2. Activated sludge process as per SDEIS

Design Modifications:

1. Earth berm across northern end of island
2. Playfield on low land between berm and Winthrop
3. Parkway corridor along east shore
4. Small park at south end of island
5. Pedestrian/bicycle paths and promenades circling the shoreline and ascending embankments.

Effects:

1. Removal of existing prison buildings could improve view of island from Winthrop and elsewhere in harbor
2. Berm, if properly designed, could block view of plant from Winthrop and provide topographic variety from elsewhere in harbor
3. Harbor views from southern end of island, and access to them, could be preserved with proper design.
4. Facility emissions (whatever they might be) to prisoners would be eliminated.

Alternative 1C: All Deer Island Secondary

Assumptions:

1. Existing prison to be relocated over treatment plant
2. Activated sludge process as per SDEIS

Design Modifications:

1. Same as for alternative 1B
2. New prison on platform over treatment plant

Effects:

1. Similar to those of alternative 1B except that views of Deer Island would depend on quality of architecture.

Alternative 1D: All Deer Island Secondary

Assumptions:

1. Alternative treatment process (pure oxygen)
2. Relocate prison to southern end of island

Design Modifications:

1. Substitute process alternatives
2. Relocate prison south of drumlin
3. Construct earth berm across northern end of island
4. Playfield on low land north of berm
5. Small park at south end beyond prison
6. Retain drumlin

Effects:

1. Similar to those of alternative 1C
2. Smaller plant size makes air emission controls more practical and less costly.

Alternative 1E:

Assumptions:

1. Alternative treatment technologies
2. Prison to be removed from island

Design Modifications:

1. Substitute process alternatives
2. Remove prison from island
3. Construct earth berm across northern end of island
4. Playfield on low land north of berm
5. Small park at south end beyond prison
6. Retain drumlin

Effects:

1. Same as those for alternative 1D with greater Winthrop buffer and larger local and regional parks.

Alternative 2A: All Long Island Secondary

Assumptions:

1. Hospital to be relocated
2. Activated sludge process
3. Plant to be fitted into upland plateau

Effects:

1. Wetlands, pine plantation and documented archeological resources at southwestern end of island, escarpments, and Long Island Head could be preserved.
2. Roadway would be forced close to edge of escarpment.
3. Parade Ground would be required for treatment plant.
4. Cemeteries to be relocated.

Alternative 2B: All Long Island Secondary

Assumptions:

1. Hospital to be relocated.
2. Alternative treatment process, less space demanding.
3. Plant to be fitted to upland plateau, etc.

Effects:

1. Wetlands, pines, parade ground, Long Island Head, cemeteries, archeological sites, etc. could be preserved.
2. Depending on size reduction attained, plant could be well set back from escarpments allowing ample room for bicycle paths, roadway, walkways and landscape planting.
3. Smaller plant size makes emissions control less costly.

Alternative 3A: Split Deer Island/Long Island Secondary

Assumption:

1. Treatment plant to be divided between Deer Island and Long Islands as proposed in the SDEIS
2. Activated sludge process

Effects:

1. On Long Island, impacts similar to those of alternative 2A, somewhat less severe, cemeteries probably need not be relocated.
2. On Deer Island, impacts similar to those of alternatives employing less space demanding technologies.
3. Deer Island effects limited to primary effects only.

C. MWRA Facilities Layout Studies

The MWRA site planning team explored the following alternatives:

1. On Deer Island
   a. prison to remain
   b. prison to be removed
2. On Long Island
   a. hospital to remain
   b. hospital to be removed

For all these alternatives it was assumed that the total plant area would aggregate 140 acres, a "reasonable, conservative assumption" based on "technology that requires the maximum land area of reasonable alternative technologies," the alternative that "requires the most land of all the reasonable alternatives." It is a somewhat larger area than any plans shown in the SDEIS.

The MWRA consultant said of this exploration, "conceptual site layouts were developed that focus on the factors of noise, odor, visual impact, and operational reliability. The approach used to mitigate each of these factors is discussed separately in the following subsections. The purpose of this breakdown was to separately portray potential approaches to design that could be initiated as a form of mitigation. During both the facilities planning stages, and in final design these concepts will undergo further scrutinizing and revision."

"The suggestion has been brought forth that covering of the facilities would be beneficial. There is a perception that this plant could be buried, and that this would afford substantial benefits by way of odor and noise control, enhanced recreational opportunities, and visual relief. Commentors have pointed out that other wastewater facilities are covered, at least in part."

"An examination of other reported facilities found that the covering of facilities was commonly done for primary facilities only. These facilities were typically covered for odor control. Many of the covered plants have experienced high levels of maintenance and degradation of the structural integrity of the plant due to high moisture and hydrogen sulfide levels within the covered areas. While the covering of primary basins for odor control may be necessary such covers should -- based on experiences at other facilities -- be designed for protection against corrosion and should be easily removable for access to conduct maintenance."

"Other facilities cover aeration basins at installations with pure oxygen systems in order to capture and reuse (thereby decreasing operational costs) the available oxygen. At some locations, secondary clarifiers have been covered (typically domed structures on circular clarifiers). These plants are located in northern climates where adverse weather conditions may cause freezing."

"In summary, the covering of unit operations at a facility is done based upon the need to increase the operational reliability of the plant. However, the coverings are, however, an additional item that must be maintained and at times have caused maintenance problems in other areas. Such covers cannot be expected to result in either making the plant "disappear" or in providing additional area for recreational purposes. The alternative to covering the unit processes is to attempt, if possible, to locate facilities away from affected receptors. Both Island sites are sufficiently large, each with an axis of at least 6,000 feet in length, to allow for relocation of components on site to a more mitigated location."

"For each site, two layouts are presented, one with the institution and one without the institution. The existing conditions at the two sites have been defined in detail in the SDEIS. Some generalization about the topographical land forms should be noted."

"Deer Island and Long Island are both dominated by drumlin land forms that rise approximately 100 feet off the water. The drumlin at Deer Island occupies the central third of the island and is flanked to either side by rolling terrain. The drumlin at Long Island forms a broad high spine that runs the length of the island up to the neck of land that connects the main portion of the island to Long Island Head. The area occupied by the Deer Island drumlin is much less than the Long Island drumlin. Consequently, plant layouts at Long Island are envisioned as being at a higher overall elevation than at Deer where it is presumed that the drumlin would be substantially altered. Aside from elevation differences, the shape of Deer Island is boxier than Long Island which is longer and thinner. This results in the Long Island layouts being more linear, with appurtenant facilities located at either end of the Island. The facilities at Deer Island are more compact, with less distance between the outside edges of the plants."

"At each of the two Islands the drumlins present a contrast against the flat background of the ocean horizon. Removal of the drumlins will be a decrease in aesthetic quality."

"The need to remove, lower or alter the drumlins is governed by the hydraulic profiles of the proposed plants. At Deer Island the plant will be most likely constructed at or near the elevation of the existing primary basins which are located approximately 20 feet above sea level. Each of the next two unit processes will be constructed at a slightly lower elevation than the preceding unit process. This will allow the plant to flow by gravity, except for storm tide situations at which time the outfall pump station would be utilized. This results in a flat, sea level plant at the Deer Island site. With the prison this means that the drumlin material will have to be disposed of off site as there is insufficient land available to save the material on site. Also, the layout without the prison requires that the drumlin be cut down. However, a buffer strip can be maintained around the plant with a minimum width of 200 feet. It would be possible to move major portions of the drumlin material into this buffer area to create an esker-like mound varying in height from 40 to 60 feet to provide both visual screening and landscape qualities."

"At Long Island the fact that the bulk of the Island is a drumlin rising out of the Harbor makes it impractical, from an engineering cost perspective, to reduce the drumlin in its entirely in order to provide a sea level site. This means that the primary will require a greater amount of influent pumping than that required at Deer because they will be located at an elevated position above sea level. This is offset by the availability of sufficient hydraulic head to eliminate the need for an effluent pumping station under the secondary plant options. The drumlin at Long Island will have to be lowered or terraced to provide both a level site on which to construct the plant and to avoid the operational costs of pumping above the elevation necessary to ensure gravity flow through the outfall under all conditions. The amount of drumlin lowering will be between 20 to 50 feet. With the hospital on Long Island, the amount of drumlin lowering would require that a retaining wall be constructed to hold up the hospital grounds. Without the hospital, the drumlin lowering would likely be accompanied by a filling in and raising of the parade ground area. This would eliminate the need for off island disposal of surplus material. Because of the long thin shape of the island it is not possible to buffer and hide the facility. Visual mitigation would require the application of architectural detailing to the basins. One possibility would be to utilize the sloping characteristic in either direction to create a terrace effect. For the layout without the hospital, the plant components have been divided in half with the primaries located in the middle to create this terraced effect."

"At each site the height and scale of the buildings will require masking for visual acceptability. The routine practice of relying upon plantings will need to be supplemented by architectural considerations in the building facades themselves."

"If the institutions remain at either site, the possibility of providing meaningful recreational resources at either site will be minimal. At most, a limited shore line buffer zone would be preserved and even then portions of the shore line would require alteration with a breakwater or dike type structure to protect low lying portions of the facilities from storm damages."

"The possibility of limited recreational development exists without the institutions. At Deer Island without the prison, a walking path may be possible along the buffer mound. The vicinity of Shirley Gut area would be available to provide an extension to Yirrell Beach, offering enhanced local recreational opportunities. At Long Island without the hospital, the head end with its forts could be preserved intact. At the opposite end of the island the upland area between the barrier beaches and marshland could be preserved."

"The more land available the greater the flexibility in constructing a facility which responds to mitigation (i.e. of esthetic, recreational and cultural resource impacts). The constraints imposed upon either site by the inclusion of institutional facilities does not preclude the siting of a plant. However, the elimination of the institutional facilities from either site is preferable."

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historic/archeological

II-10 HISTORICAL AND ARCHAEOLOGICAL

A. Background

The comments on the SDEIS on historical and archeological issues which required further investigations center on the following question:

> Did the SDEIS overstate the historical and archeological value of Long Island and underestimate the historic and archeological resources of Deer Island?

In order to respond to this issue, it was important to review previous studies and investigations of historic and archeological resources for both islands. The scope of the SDEIS investigation was designed to build upon previous studies to ensure that the areas proposed for construction of wastewater treatment facilities had been adequately evaluated.

In June and June 1984, EPA's consultant Public Archeology Laboratory, Inc., conducted an intensive level archeological survey on sections of Deer and Long Islands. Two project areas ranging from 60 acres on Deer Island to between 20 and 115 acres on Long Island were stratified into zones of expected archeological sensitivity on the basis of a literature search and walkover survey.

Survey efforts on Long Island were coordinated with the University of Massachusetts, Boston field school in archeology. The University of Massachusetts field school had surveyed the Southern end of Long Island in summer of 1984. The combined efforts of the Phase I survey conducted by PAL, Inc., and the UMass Boston field school concluded that Long Island is considered to be a significant complex of prehistoric and historic period cultural resource much of which may be eligible for inclusion in the National Register.

On Deer Island, it was determined that the area covering the central drumlin had not been previously investigated. Earlier surveys of Deer Island were conducted by the Institute of Conservation Archeology and covered a small area on the southern tip of Deer Island and the site of the existing treatment plant. Other areas of the island exclusive of the prison site were judged to have been previously disturbed from construction activity and therefore did not warrant further investigations.

The conclusions of the Deer Island survey were that no potential significant prehistoric or historic period cultural resources were identified on Deer Island. However, the consultants did recommend further examination of the pump station/screening plant to determine its resent condition and structural integrity. Since the pump house is associated with the earlier operation of sewerage handling and disposal. For the Boston Metropolitan area, it could meet the criteria for eligibility to the National Register of Historic places.

The SDEIS analyses on historic and archeological inputs presented on a comparable level the information needed by the grantee and EPA in order to state a preference and selection of a siting alternative for the FEIS, on July 10, 1985, the MWRA in their vote to select Deer Island as the preferred alternative also voted to remove other institutions such as the prison or as a mitigation proposal. Earlier planning proposals assumed that adequate land area existed on Deer Island to construct a waste water treatment plant adjacent to the Deer Island House of Correction. As a result previous archeological investigation of Deer Island did not include Prison Property.

With the MWRA vote to relocate the prison off of Deer Island and utilize the site for the treatment plant, it was appropriate for additional investigations of the prison site and the pump house to be undertaken.

In September 1985, the MWRA commissioned Camp, Dresser, McKee, Inc., to conduct historical surveys and archaeological investigations the areas of Deer Island in and around the Deer Island House of Correction. The research and walkover inspection uncovered a small cemetery plot on the north west edge of the project area considered to be archaeologically sensitive. The exact horizontal limits of the cemetery are unknown and will require additional Phase II archeological investigations.

With regards to the Deer Island House of Correction and Pump Station building complex the survey concludes that both are probably eligible for listing on the National Register of Historic Places. Excerpts from those surveys and investigations follow this section., The full survey, report, including photos, appears as part of the FEIR.

The MWRA is continuing to collect additional information at the request of Massachusetts Historical Commission to determine support of the eligibility of the prison complex to the National Register of Historic Places. The MWRA will, during the facility planning phase, include evaluations on the preservation or reuse of the eligible sites. EPA will forward to the Keeper of the National Register nomination papers for these sites upon review and approval of the Massachusetts Historical Commission. A preliminary case report and memorandum of agreement will prepare for those sites where a determination of an adverse effect on a National REgister property is proposed.

The significance of a property being placed on the National Register of Historic Places is that it is offered protection by the National Historic Preservation Act, Section 106 of Act outlines the review process that federal agencies must adhere to before taking actions that might affect the property.

MANAGEMENT SUMMARY

An Archaeological Reconnaissance Survey of the Deer Island Corrections Facilities, Deer Island, Massachusetts

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Introduction

As part of a program to upgrade sewage treatment facilities and reduce pollution in Boston Harbor, the Massachusetts Water Resources Agency (MWRA) is currently planning for the relocation and construction of wastewater treatment facilities on Deer Island, in Boston Harbor.

Previously, two archaeological investigations had taken place on the island. In 1981, Harvard University's Institute for Conservation Archaeology tested the existing treatment plant area and the island's southern tip (Randall 1581). In 1984, the Public Archaeology Laboratory, Inc., conducted testing in the elevated central section which contained an earlier treatment plant and remnants of a former military installation. Fort Dawes (Ritchie and Gallagher 1984). While no prehistoric or historic archaeological deposits were identified by these studies, the former pump station and the screening plant on the island's southern shore were considered to be potentially significant standing structures because of their role in the early development of Boston's wastewater treatment facilities.

In September, 1985, the firm of Camp Dresser and McKee, Inc., contracted with the Public Archaeology Laboratory, Inc., to conduct an archaeological reconnaissance study in and around the area of the Deer Island Correctional Facility, in the island's northern sections. No archaeological investigations had been conducted in the northern island area prior to this study.

Research Goals and Strategies

The goal of an archaeological reconnaissance study is to identify areas of actual or potential archaeological sensitivity; that is to say to locate areas that may contain prehistoric or historic cultural deposits. To operationalize the objectives of such a study several lines of investigation are utilized, each with their own methodologies and results. This memo will summarize the activities which took place during investigations of the Deer Island correctional Facilities area and will conclude with recommendations based upon the results of those activities.

Walkover Reconnaissance

A walkover of the correctional facilities area was conducted in order to assess the degree to which modifications to the landscape had taken place. This aspect of the investigation included visual inspection of surfaces throughout the project area as well as subsurface probes to document soil profiles.

Across the facility transects were walked to facilitate mapping. Along these transects investigators paces a distance of approximately 20 meters to a "station." Here notes on disturbances or surface modifications were made and when possible a soil core was taken and the profiles recorded. Correctional officers Anthony Leggiero and Al Kane were interviewed. They provided information on recent modifications to the correctional facilities buildings and grounds.

Figure 1 represents the results of the walkover survey. Essentially, the project area can be subdivided into a three-layered hierarchy of archaeological potential. Areas I and II would include those areas that are comprised of fill and previously disturbed soils respectively. These two area types constitute low sensitivity sections where modifications would have severely impacted archaeological deposits. Areas in the third category, with intact soil horizons, represent those sections within the facility where archaeological deposits would have been less impacted by recent landscape modifications.

Within areas of intact soil horizons noted on Figure 1, no evidence of prehistoric or historic cultural deposits was encountered. Across the correctional facility we found evidence of a range of modifications resulting from landscaping impacts including building construction, water and utility line easements, filling, stripping, and resurfacing. Any cultural deposits which may have exited prior to these activities would have suffered impacts when they occurred.

The existence of a narrow, rectangular cemetery -- similar in configuration to a plot indicated on topographic maps of the island -- was verified during the walkover inspection. This cemetery plot has not been impacted by recent development and it is presumed that the burial area itself is intact. The remains of a wooden fence that originally defined this plot were also found during the walkover inspection. The open hillside immediately to the northwest of the cemetery has had the loam topsoil (A zone) removed, exposing the underlying subsoil. It is not clear when this soil stripping occurred, but it appears to have taken place within the last ten years. It is possible that this hillside could contain additional unmarked graves since documentation of former cemetery areas on Deer Island appears to be minimal. No obvious evidence of unmarked graves or a defined cemetery plot was found during the walkover inspection, however, this entire hillside should be considered to be an archaeologically sensitive area. At the base of the hill, approximately 50 meters south of the former piggery (now the K-9 Training Facility), is a small stone mausoleum inscribed with the date 1908. This also suggests that the open hillside it could have functioned as an unmarked cemetery area for prison inmates and transients. Limited soil auger probes taken in proximity to this cemetery area, illustrated in the northwest edge of the project area on Figure 1, indicate intact profiles.

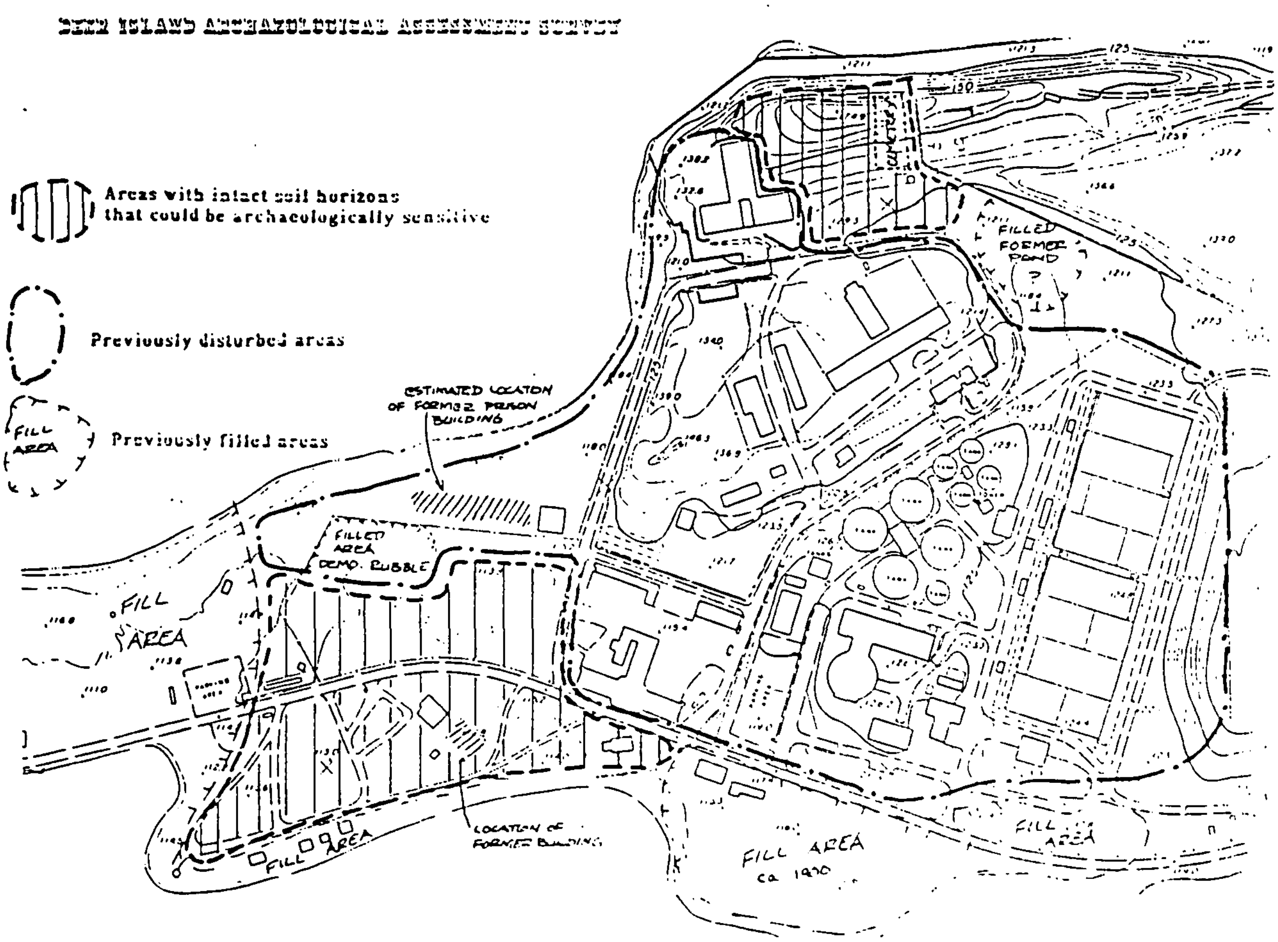

Figure 1

Historical Background

Deer Island was heavily forested with a large mobile deer population when the land was granted to Boston in 1634. Two years later, the island's forests were opened for wood cutting to residents of Boston. Within ten years, enough trees had been removed for the town council to restrict the cutting of wood to island residents in 1647 (Sweetser 1881: 194; Snow 1971: 199). By 1655, "only enough for a farm remained" (Drake 1856: 342). Besides providing wood for Boston, Deer Island served as a pound for stray goats and swine. John Ruggle built a pen to provide shelter for the strays in 1641 (Shurtleff 1871: 466).

From the mid 1640's, and for the next two hundred years, the Boston town fathers rented Deer Island lands to a series of individuals. Proceeds from these leases went to support Boston schools. During much of this period of the islands' history, Deer Island appears to have been used primarily as farmland, focussing on pasturage and grazing lands for cattle, sheep, and other livestock (Sweetser 1882: 1984; Snow 1971: 199-200).

During King Philip's War, Deer Island served first as a concentration camp for Christian or Praying Town Indians. The English settlers feared that these natives might take up arms along side Philip's hostiles, so they rounded them up from their towns and removed them to Deer Island. Some five hundred men, women and children were left on the island without adequate shelter, provisions, or boats during the winter of 1675. Many of them died. At the close of the hostilities the survivors were allowed to leave the island, only to be replaced by native prisoners of war who were then interned there. These captives were kept on the island until they could be sent away or sold into servitude (Sweetser 1881: 195).

A native claim was made to Deer Island in 1685 by Wampatuck, also known as Charles Josias. Citizens of Boston paid nineteen pounds to buy the island from Wampatuck (Snow 1971: 200-201).

As early as 1677 Deer Island was suggested as a quarantine station for the crews and passengers of ships infected with small pox (Snow 1971: 201). No more action was made on the idea until 1717 when the Boston town council voted to lease a small parcel on the island for the erection of a "Hospital or Rest House for the reception and entertainment of sick persons coming from beyond the Sea." This time the concept was carried out, but the pest house appears to have been built on Spectacle Island instead (Snow 1971: 202).

Deer Island was the site of two Revolutionary War incidents. In 1775 Major Greaton lead his Continental soldiers on a foray to the island where they took some 800 sheep and horses, and a barge to transport them off the island, from under the noses of the British (Sweetser 1881: 196). The following year two Continental privateers, the Franklin and the Lady Washington, were sneaking out of Boston harbor through Shirley Gut with the Lady Washington became grounded. The ships were attacked by the British, but were able to escape when the British retreated and the grounded vessel floated free with the tide (Sweetser 1881: 124). During the war, minor fortifications were constructed on Signal Hill overlooking the harbor and Shirley Gut.

A resort hotel was operated on Deer Island from the 1780's into the mid 1800's. William Tewksbury, the proprietor of the hotel, was locally known for his many rescues of seamen and passengers from sinking vessels in the harbor. The resort, which provided accommodations, a dance hall, lawn bowling, swings, and a beach was popular with families and outing groups from Boston (Snow 1971: 203).

In 1821, Deer Island was again considered as a location for a public institution. This time, the "Committee on the Subject of Pauperism and the Expediency of Erecting a House of Industry in the Town of Boston" concluded that the island "was not a proper site [sic] for the location of the proposed establishment" (Boston, Comm. on Pauperism 1821: 13).

It was not until 1847 that the first city institution was actually moved to the island. In that year, the "Committee on Alien Passengers" constructed a temporary Quarantine Station on Deer Island for the many Irish immigrants arriving with ship fever. More than 10,000 Irish landed in Boston between January and July of 1847, and by the end of the year hundreds had been buried in unmarked graves on the island (Sweetser 1882: 197). During the same year, a Boston "Committee on Public Buildings" reported "that the new House of Industry should be erected on Deer Island" (Boston, Comm. on Public Buildings 1847: 19).

In 1848, the first inmates from the crowded South Boston House of Industry were transferred to Deer Island. The following year saw the quarantine station made permanent. Plans for a new Almshouse were drawn up in 1848 and the structure was completed by 1852. That year the first of the city's paupers were removed to Deer Island (Snow 1971: 207).

The Deer Island Almshouse became the House of Industry in 1854 with the poor sent to Rainsford Island (Snow 1971: 207). Four years later Deer Island became the location of the House of Reformation and Almshouse School Housing some 160 boys under the management of the Boston Board of Directors for Public Institutions (Shurtleff 1871: 470). For the next forty one years the island housed a changing combination of paupers, neglected children, and boys in the reformatory. The institutions formed a self-sufficient community with some 1,200 to 1,500 men, women, and children working at the various trades necessary to provide the food, clothing, and supplies needed for the support of the institution (Sweetser 1882: 198).

The "House for the Employment and REformation of Juvenile Offenders" was removed to Rainsford's Island in 1895 (Snow 1971: 156) and the following year the Suffolk County House of Correction moved into the Deer Island facilities (Snow 1971: 208). By 1905, it had become the largest prison in Massachusetts.

The first sewerage facilities were built on the island in 1894. The Deer Island Pumping Station consisted of a single-story brick station, housing two Corliss-type steam engines and a third different engine, together with a house for the Superintendent. The facility was completely renovated and modernized in 1968 when the present sewerage treatment plant was built (Ritchie and Gallagher 1984: 40).

Recommendations

In summary, the results of background research and a walkover inspection indicate that the Deer Island project area (±200 acres) consists mostly of modified land surfaces that have been the site of numerous construction and demolition episodes (ca. 1850 -- present). Some areas on the northern end of the prison complex remained open, but have been altered by many sources of previous disturbance such as grading/landscaping, filling, and installation of utility lines and easements. Cultural resources may have survived in the area as small remnants, however, due to the extent of previous disturbances, it is not likely that they would have retained sufficient integrity to meet normal standards of significance.

The small cemetery plot on the northwest edge of the project area and the open hillside surrounding it are considered to be archaeologically sensitive. From current plans of the proposed treatment plant, it is clear that the cemetery area will be impacted by this development. The exact horizontal limits of the cemetery area are unknown at present and additional archaeological investigations will probably be necessary to verify the actual extent of this sensitive cultural resource.

REFERENCES

Boston, Committee on Pauperism
1821 Report on the Committee on the Subject of Pauperism and the Expediency of Erecting a House of Industry in the Town of Boston. Boston.

Boston, Committee on Public Buildings
1847 Report on the Removal of the House of Industry and Other Public Institutions at South Boston to Deer Island. J.H. Eastburn, Boston.

Drake, Samuel G.
1856 The History and Antiquities of Boston, From Its Settlement in 1630, to the Year 1770. Luther Stevens. Boston.

Randall, Debra
1981 Archaeological Survey of the Proposed MDC Sludge Management Plant. Deer Island. Massachusetts. The Institute for Conservation Archaeology, Harvard University. Submitted to MDC and Havens and Emerson, Inc. Boston.

Ritchie, Duncan and Joan Gallagher
1984 An Intensive Level Archaeological Survey on Deer and Long Islands, Boston Harbor, Massachusetts. The Public Archaeology Laboratory, Inc., Report No. 51-01. Submitted to CE Maguire, Inc., Providence.

Shurtleff, Nathaniel
1871 A Topographical and Historical Description of Boston. A Williams and Company, Boston.

Snow, Edgar R.
1971 The Islands of Boston Harbor, 1631-1971. Dodd, Mead and Company, New York.

Sweetser, M.F.
1882 King's Handbook of Boston Harbor. Moses King, Cambridge, Massachusetts.

MEMORANDUM

Historic Survey
of the Deer Island House of Correction
and the Deer Island Pumping Station
Deer Island, Massachusetts

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October 1, 1985
Revised October 23, 1985

MEMO ON DEER ISLAND HOUSE OF CORRECTION
AND PUMPING STATION BUILDING COMPLEXES

Summary of Significance

Based on the results of this study, we believe that both the House of Corrections complex and the Pumping Station are probably eligible for listing on the National REgister of Historic Places; the former based on its architectural and institutional history and the strong evidence it presents of the history of institutionalization throughout Boston's history, and the latter based on its architecture and relationship to the development of the Boston Metropolitan District Commission, one of the nation's earliest and most influential instances of regional planning for environmental management. We recommend that a Determination of Eligibility be sought in both instances.

Boston Affiliates, Inc., has conducted a historic study and analysis of the Deer Island House of Correction and Deer Island Pumping Station as part of the environmental study of the impact of the proposed sewage treatment plant on the island. The purpose of the study is to identify and document structures of historic interest and significance, and analyze the impacts of the proposed project.

Our approach in this study was to inspect and photograph the structures, and engage in documentary research on their history. We collected information from the following sources:

Boston Public Library
Winthrop Public Library
State Archives
State Library
Bostonian Society
Society for the Preservation of New England antiquities
Metropolitan District Commission
City of Boston Department of Public facilities
Northeastern University

This memo was prepared in a short span of time to meet a time line of the larger EIR/EIS project. All information sources have not been exhausted. A full report is being prepared to serve as an appendix to the Final EIR.

Deer Island House of Correction

History

Owned by the City of Boston since 1634, Deer Island in boston Harbor has proved a useful place for purposes that needed some site, but had to be set apart from a populated area. Its use has included the detention of Indians and the quarantine of contagious immigrants.

In 1850, the City sited a municipal Almshouse there, which became the first in a complex of institutions serving the poor, the criminal and the delinquent. The Almshouse was known as the House of Industry; other buildings, such as a reformatory, and schools for pauper boys and girls were added in the next three decades. In the 1890s the whole complex started being used for the detention of prisoners, and was called the House of Correction, the name still used today.

The Deer Island group of institutions for many years was self-sufficient, providing its own food from animals and farming. Dairy barns were built as late as the 1950s, but farming has now ceased. The Island was accessible by boat, and the Penal Institutions Department maintained its own steamboat to transport inmates between islands and the mainland. In 1940 the Island was connected to Shirley Point in winthrop by causeway.

Deer Island has not previously been surveyed for historical significance. Consequently, none of the buildings is listed in official inventories or has been identified as eligible.

The main points of historic interest are the following:

1. Administration Building (ca. 1850, 1929, 1949).

   This building incorporates major sections of the Deer Island Almshouse (also known as the House of Industry), designed by Gridley J.F. Bryant (1816-1899) with the assistance of Louis Dwight of the Prison Discipline Society. The original building of brick, in Italianate and vernacular style, is depicted in a lithograph shown as Figure 3.

   Fire damage in 1929 and 1949 led to the removal of the roof and portions of the building. Modern sections were added at the back. The building as it appears in 1985 is shown in Figure 5.

   Interior hallways and offices on the first floor have woodwork, matchboard paneling, and cast-iron columns which are apparently original. (Figure 16) The cell-block appears to date from the late nineteenth century, and is probably the addition designed by City Architect Edmund Wheelwright in 1892.

   The building is now used as administrative offices, reception and cells for new prisoners, training and schoolrooms, and workshops. The building appears structurally sound but worn and neglected.

2. Hill Prison (1902-04) (Figures 22-23)

   This building appears to be substantially unaltered. It was built as a women's prison, but is now the main prison in the complex, occupied solely by men.

   The architect was A. Warren Gould, active in the 1890s in Boston, where he designed a number of houses and buildings in Dorchester, including Whiton Hall for the Dorchester Women's Club. He moved to the Pacific Northwest and died in Seattle in 1922.

   The building is T-shaped. The two wings contain cell-blocks, the rear wing dining and recreational facilities.

   The building is of loadbearing brick, 24 ins. at first floor level; the foundations and entrance facade are granite. The floor construction is reinforced concrete, and brick vaults span the cell-block open areas. Interior supports are cast-iron columns and masonry. The pitched roofs are covered with slate.

   The style of the building is classical revival. The central section has a granite facade in the lower half, brick in the upper half. In the granite section, two projecting bays flank an arched entrance in Pal-

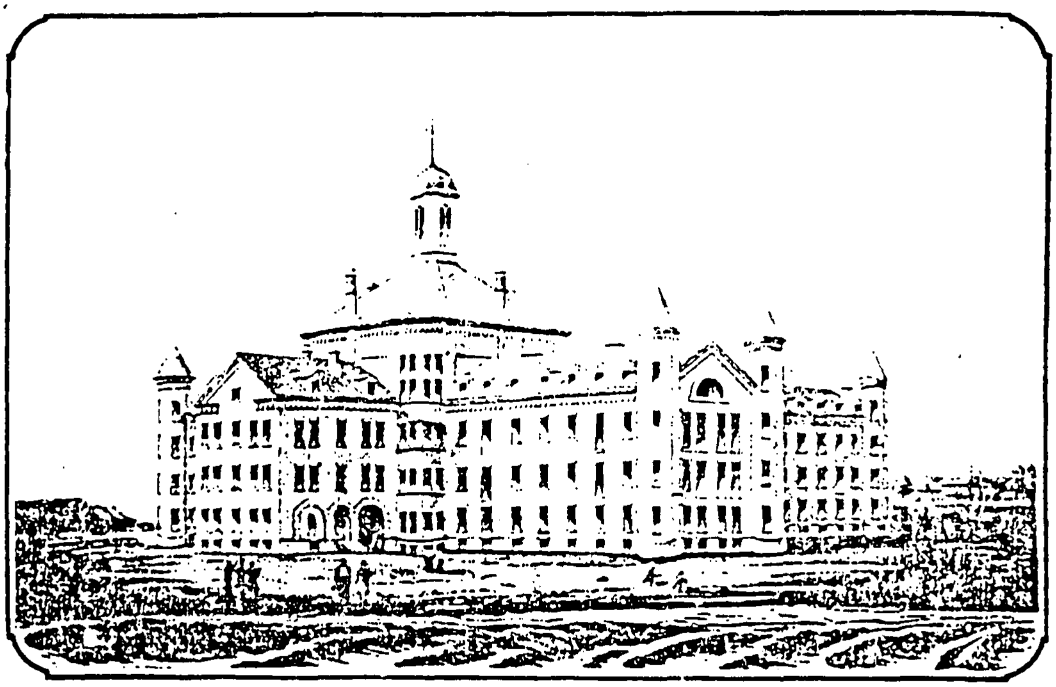

Figure 3: View of the New Alms House for the City of Boston on Deer Island, 1849
(Print Department, Boston Public Library)

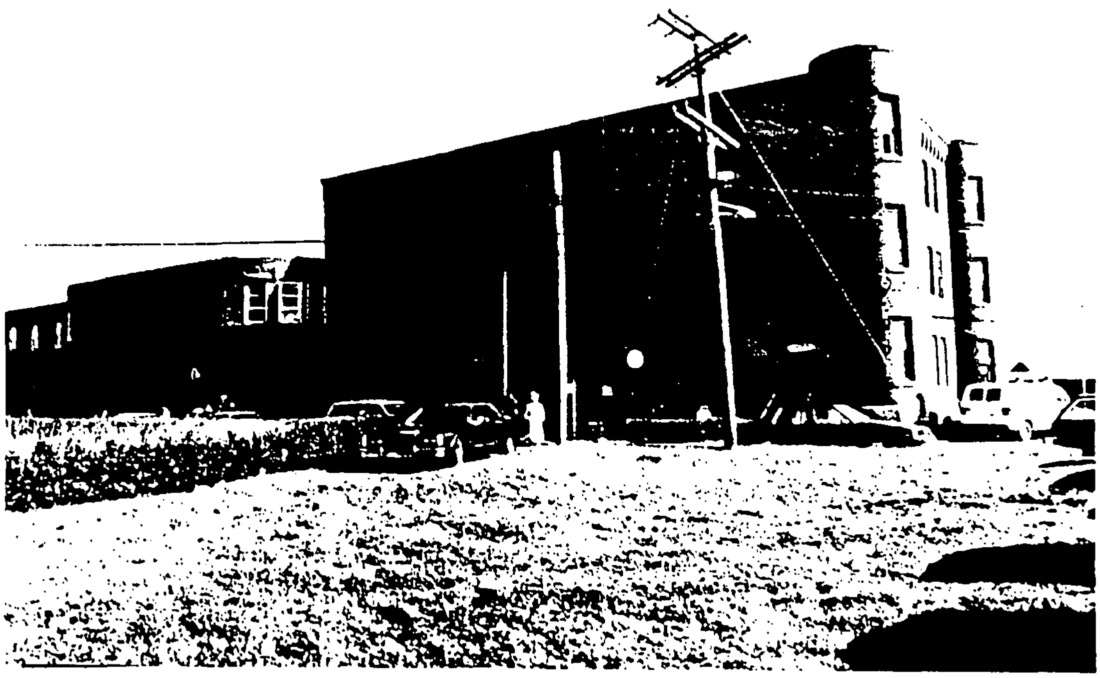

Figure 5: Administration Building, 1985

[illegible] H.H Prison, early twentieth century.

[illegible] H[illegible] 198[illegible]

ladian style, above which is a recessed balcony set in a semicircular arch. Above are a series of vertical brick pilasters between windows, topped by an entablature and surmounted by a hipped roof with clipped dormers and a prominent cupola.

The two wings contain a series of wide brick pilasters alternating with narrower barred windows arched at their tops. Since these windows give onto the open space of the cell-blocks, there are no floors behind them, and the windows are virtually continuous strips. Above is a broad entablature. The roof is pitched, and has ventilators at the ridge, which were once open roof viewing platforms. The end walls of the wings have the same pilaster and arched window motif of the front and rear elevations; the windows are bricked up.

The rear wing, also roofed with a pitched slate roof, has a series of brick semicircular arches, with windows at each floor level. In the uppermost floor -- the recreation hall -- the upper section of the window is blocked with plywood. The end wall of this wing is the stage wall, and is solid brickwork. The outer skin of this wall collapsed recently, and has been replaced.

Inside the building, most of the spaces are utilitarian. There is some architectural interest in the front entrance hall and in the recreation hall, which still retains original woodwork in the doorways, stage and proscenium arch, and balcony.

The building appears to be structurally sound. Inside all surfaces show signs of much wear, poor maintenance, makeshift repairs and careless painting.

3. Superintendant's Office (1910s?) (Figure 35)

This two-storey brick building, situated opposite the Administration Building, was once the Superintendant's residence.

The style is Georgian Revival with a central entrance topped by a segmental pediment. The windows are arranged in three bays on either side of the entrance with a window above it; those on the lower floor are nine over nine paned sash, and on the upper floor six over nine. The slate roof has five dormers and a chimney. The rear of the house, overlooking the harbor, has french doors leading onto a terrace. At the north of the house is a one-storey flat-roofed section in similar but plainer style. It may have been added later.

The house appears in sound structural condition though inadequately maintained.

No documentation for this building has been found.

Figure 35: Superintendant's Office, 1985

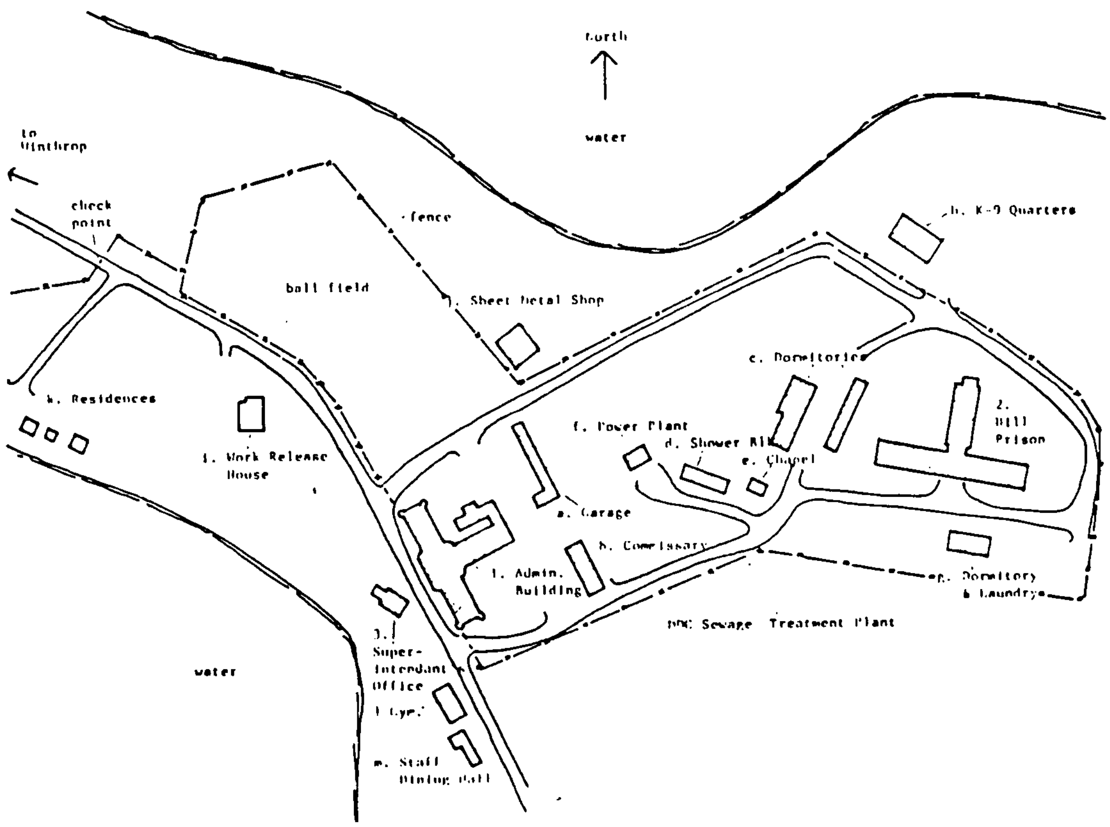

Figure 2: Site Plan, 1985

4. Ancillary Buildings

a. Garage -- 20th century.

b. Commissary -- 20th century. This building was previously three and a half stories, reduced to a one-storey building in 1946.

c. Dormitories (former Dairy Barns) -- 1957 and 1958. Architect, Joseph F. Page.

d. Shower Block -- date written on building is 1945.

e. Chapel -- 1950s (?)

f. Power Plant -- 1958. Engineers, J.M. McKusker Assoc.

g. Dormitory and Laundry (opposite Hill Prison) -- 1869. This building is a remnant of the Pauper Boys' School, roof and top floors removed.

h. K-9 Quarters -- 1980s. On site of former piggery.

i. Work Release House -- 1900s (?)

j. Sheet Metal Shop -- 20th century. Abandoned.

k. Residences -- 1900s (?). Three houses, previously occupied by prison officials. One is now the engineer's house, one the work release office, one vacant.

l. Gymnasium -- 1960s (?)

m. Staff Dining Hall -- 1941.

5. Site Layout (ca. 1850 to present) (Figure 2)

The Deer Island House of Correction consists of a grouping of major and ancillary buildings informally sited in an institutional yet rural setting.

The buildings form two clusters. Near the water's edge, the predominant building is the Administration Building, sited parallel to the main road. Opposite is the Superintendant's Office, Gymnasium and Staff Dining Hall. Nearby is the Work Release House, and further along the shore are three Residences. Behind the Administration Building and parallel to it are the Garage and Commissary.

Up on the hill the predominant structure is the Hill Prison, sited on a street sometimes referred to as Hill Prison Street. Across from the Hill Prison is the Dormitory and Laundry. Next to the Hill Prison are two Dormitories, a Chapel, the Shower Room, and the Power House. Below and across a road is the Sheet Metal Shop. Behind the Hill Prison are the K-9 Quarters.

The buildings are informally set on the site which has a character that is institutional, industrial and rural. There is a loop road that gives vehicular access to all buildings. It is paved, but without curbs in most places. The largest expanse of paved area is between the Administration Building and the Garage and Commissary. Stone retaining walls and foundation walls of demolished buildings occur on the site. Cyclone fencing and wooden telephone poles are in evidence. Trees, bushes and overgrowth of grass contribute to the rural character of the site.

Significance

The complex is historically significant because of its long history as an institutional complex accommodating a succession of uses related to social control. Various reform movements devoted to the treatment of the poor, delinquent, and criminal have found physical expression in the buildings on this site. The succession of buildings and alterations also speaks to the continual attempt to recategorize individuals (as poor, delinquent, unwed, truant, criminal, etc.) and to separate men from women, children from adults, and poor from deviant.

The site today, with its many support buildings clustered around the Hill Prison and the Administration Building, still reflects the self-sufficient character, with farming complementing the institutional use and officials living on the site, which was for more than a century an important part of its institutional philosophy. More research remains to be done on the relationship of this philosophy and its physical expression here to national trends, but Massachusetts was a nineteenth-century leader in these areas.

It would appear that the complex is eligible for listing on the National Register of Historic Places, under categories A and C, for its significance in social/humanitarian, political, legal and community planning, as well as architectural history.

The oldest building on the site, the Deer Island Almshouse (House of Industry) still contains large fragments of the original building and is on its original site. Its diminished integrity and altered interiors convey little of its original use, although the exterior clearly conveys its early origins. The cell-block, believed to date from the 1890s, is an intact interior eloquent of its past and current use.

The Hill Prison is virtually unchanged since it was built and has complete integrity in its exterior and interiors. It has been used continuously as a prison with minor alterations reflecting changes in penal practice.

Impact of Proposed Project

Although there are no firm designs for the proposed sewage treatment plant, Camp Dresser and McKee have developed alternative conceptual schemes.

One scheme retains the House of Correction, and locates the plant on the remainder of the island. This concept would subject the environment of the correctional site to noise and smell.

The second scheme gives the entire island to the treatment plant. In this alternative, the prison would be demolished entirely, and the historical evidence of institution practices on Deer Island lost.

Recommendations

If the House of Correction is altered or demolished, an intensive effort should be made to record and document the complex through photographing it, assembling original drawings and records, and preparing a thorough history. If the complex is retained, sections of historic interest should be identified so that further alterations and changes are carried out sensitively. If the complex is demolished, consideration should be given to saving artifacts, such as appurtenances of the cells and cell-block, for display.

Deer Island Pumping Station (Figures 54, 56)

History

In 1889, legislation, prompted by reports of the Massachusetts State Board of Heath on pollution of Boston Harbor, authorized the formation of the Boston Metropolitan Sewerage Commission. By 1900, the North Metropolitan Sewerage System, serving the 14 cities and towns of the Commission's northern region, was fully operational.

The North Metropolitan system's 74 miles of sewer lines connected nearly 1,000 miles of local lines and pumped to an outlet in Boston Harbor at Deer Island. The Pumping Station at Deer Island was the largest of three stations constructed to pump sewage through the North Metropolitan system. Constructed in phases in the period from 1894 to 1900, the Deer Island Pumping Station's development reflected the growing needs of the region's burgeoning population.

Site Plan

The Pumping Station at Deer Island lies on the southwesterly side of the island about midway down its length. Actually a complex of five attached buildings, the development of the station reflects the development of the North metropolitan Sewage System which it served. Completed in three phases between 1984 and 1899, the complex contains a Screen House, Coal House, Boiler Room and two Engine Rooms. The buildings give the appearance of a single structure, designed in a compatible manner by Arthur F. Gray, architect for the Stations at Charlestown and East Boston. Though operated in the periods between construction, it became fully operational in May of 1900. The Station was in operation until 1968 when the Deer Island Sewage Treatment Plant was completed. The building, still containing the old machinery, is now abandoned. To the southeast of the pumping station complex is a two-storey shingle structure of unknown origin or use but which will be referred to as the Farmhouse.

Facing the westerly elevation, the Pumping Station buildings are, from left to right:

Screen House (ca 1895)

A two-storey brick, granite and terra cotta structure 27' x 23'. Built in a simple vernacular industrial style with Queen Anne -- Romanesque elaborations and detailing, it has a hipped roof of slate with terra cotta tile coping and is surmounted by a cupola, now only partially extant.

The building covers the screen shaft of the pumping station system and contains machinery for hoisting and pressing. Sewage was screened with double rows of wrought iron bar cage screens before it was put through the pumping machinery. The Screen House and the adjacent Coal Pocket were constructed after the Boiler Room and the first Engine Room.

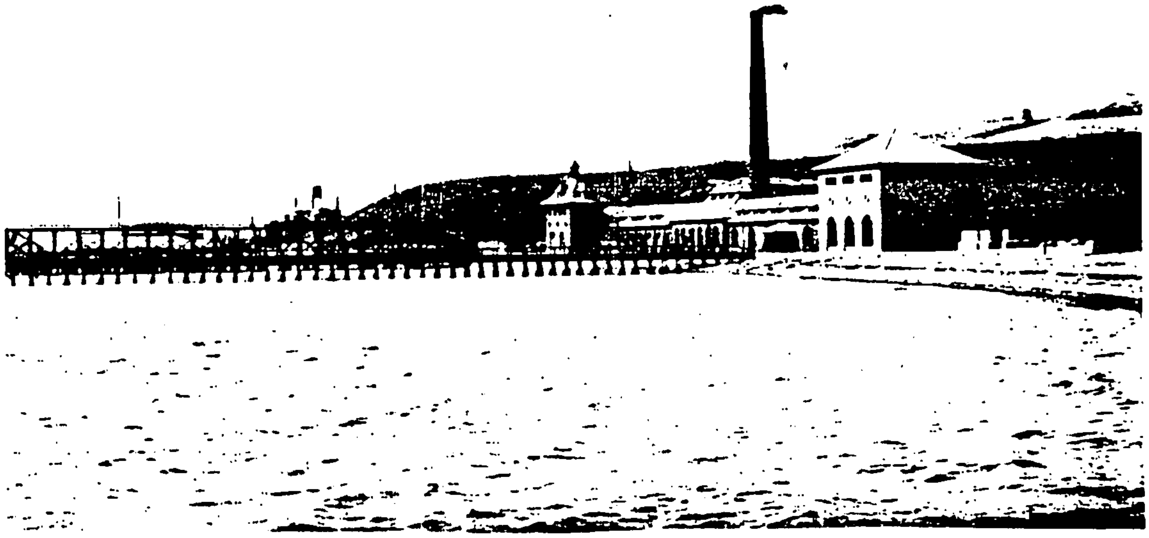

Figure 54: Pumping Station, ca. 1900

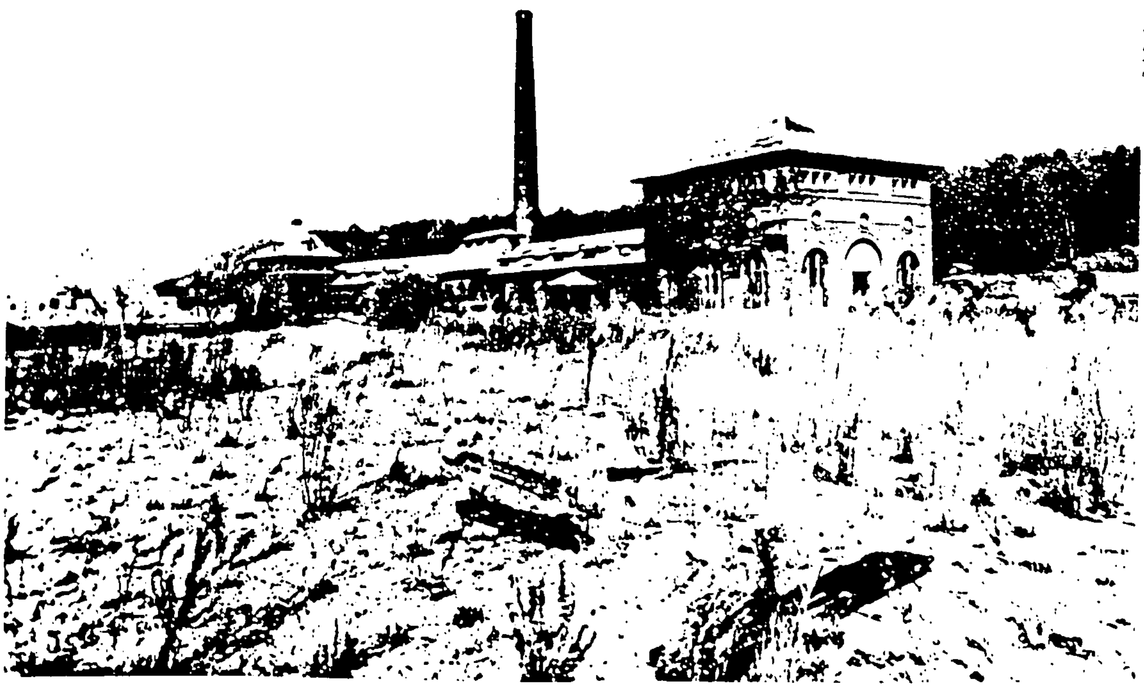

Figure 55: Pumping Station, [illegible]

Coal Pocket (ca 1895)

A one-storey brick, granite and terra cotta building 74' x 34' with a dynamo room attached. Styled similarly to the Screen House, it also has a slate pitched roof punctuated by dormer-type openings and terra cotta tile coping.

The engines for the pumping station were powered by coal burned in the boiler room until the facility was converted to diesel fuel in the 1950s. The Coal Pocket was designed to hold 600 tons of coal.

Boiler Room and Chimney (September 1894)

A one-storey brick, granite and terra cotta structure, 63' x 35' with a height of 17' to the roof trusses and an accompanying masonry chimney 125' in height. Styled in a vernacular Romanesque with Queen Anne details, slate pitched roof with terra cotta tile coping and topped with a ventilation structure (Figure 59). Converted from coal to diesel in the 1950s, the boilers still remain intact (Figure 60). The boiler room and the first engine room were the initial structures built for the pumping station, which shares its pattern of boiler room—engine room with the stations at East Boston and Charlestown.

Engine Room (first) (September 1894)

A one-storey brick, granite and terra cotta structure, 100' x 31 1/2', with a height of 15' to the roof trusses. Styled in a vernacular Romanesque with Queen Anne detailing, it also has a pitched slate roof punctuated by dormer-type openings and with terra cotta tile coping. Similar to the stations at East Boston and Charlestown, it was originally equipped with two triple-expansion Corliss type steam engines.

Engine Room (second) (ca. 1899)

A two-storey brick structure approximately 50' x 50' with a hipped slate roof. Built in a more formal style with Romanesque details of round-headed arches, brick patterns to create circles, and horizontal lines denoting function.

Because of a need for increased system capacity, an extra pump and engine were added to the Deer Island Pumping Station and housed in this structure. The machinery is still extant.

Farmhouse (ca. 1900)

Approximately 300 feet to the southeast of the Pumping Station stands a two-storey wood and shingle Queen Anne and Colonial Revival structure believed to have been a farmhouse. No information about its construction or design has been found to date. Little is known about its structural integrity.

Significance

The Deer Island Pumping Station and related structures (Farmhouse and now demolished Employee Dwelling) were constructed during the great institutional expansion which occurred in Boston at the turn of the century. The structures together form a complex which is expressive of the "Picturesque" movement in architecture. This movement, and the design of the pumping station complex, reveals "the deep new need of the time in an increasingly industrial and ugly age to dream romantically of a picturesque past." The complex is an expression not only of an architectural ideal, but of the perceived responsibility of a regional authority, the pride in the accomplishment of that authority and as a fine example of the contemporary technology and the changes in that technology at the turn of the century.

The significance of the Pumping Station complex can be outline in three areas:

Cultural/Historical

The complex is the largest pumping station of the area's first regional system. It was built in an era of strong individualism, and represents and important cooperation among many communities to address a problem which had been growing since the 1700s. The accumulation of structures is representative of the rapid suburban growth which characterized this period, and which the station served. Further, it represents a continuation of the use by the Boston region of Deer Island as a "dumping ground" for the region's various social and physical ills.

Architectural

The Deer Island Pumping Station and its related structures form a coherent grouping of institutional buildings representing the powerful influence of the picturesque on institutional architecture of its time. Usually found in the structures of contemporary park development, the complex at Deer Island is a sensitive blend of structures with a natural setting. This spirit contrasts with the trend to build monuments to the civic ego which soon followed. The complex is an intriguing example of vernacular adaptations of popular styles to express a certain whimsy in the design of a structure built to house a then particularly "offensive" operation. The workings of the station are directly represented in the differentiation of the parts of the structure. The careful additions to the original boiler-engine room station display the increasing demands placed upon the facility by the northern metropolitan region. Even the more monumental styling of the second engine house reflects the larger size of the added engine and pump. Additionally, the architecture of the station shares stylistic similarities with the suburban architecture in the communities directly served by the system.

Technological/Industrial

The Pumping Station is a nearly intact representation of the period technology, and one of the earliest and best designed sewer systems of its time. Aside from its quality as an industrial artifact, it expresses an incomplete attempt by contemporary technology to solve an increasingly dangerous problem -- the unsanitary handling of sewage in congested areas, closely linked to urban epidemics -- only to create another which endures to this day: the pollution of Boston Harbor.

Based on the above evaluation, it would appear that the Deer Island Pumping Station is eligible for listing on the National Register of Historic Places under category C, for its significance in community planning, engineering, politics/government and architecture.

Impact of Proposed Project

The development of a new sewage treatment plant on Deer Island will potentially affect the Pumping Station complex either by altering the setting or altering the structure. The largely natural setting of the pumping station is strongly related to the historical and architectural significance of the structures. The design of the structures and the use of the natural setting is heavily influenced by the "Picturesque" movement of the period. This relationship, a harmonious blend of site and structure remains largely intact despite 85 years of use. Changes to the setting will have an impact on the architectural and cultural/historical significance of a magnitude related directly to the degree of alteration. Alterations to the structures themselves will have an impact on significance corresponding to the extent of the alteration. The Pumping Station and Farmhouse have been untouched since their abandonment and machinery, boilers, pumping wells and pipes remain in the pumping station. The Farmhouse interior has not been examined.

Recommendations for Reuse

With any degree of alteration or demolition, the Pumping Station and Farmhouse should be thoroughly documented and photographed beforehand.

Reuse adaptations should take advantage of the characteristics of the site. Proximity to the new sewage treatment plant suggests the reuse of the structures for administrative of maintenance functions. The possibility of reuse as a facility for sewage treatment related functions will preserve much of their significance as industrial architecture.

II-11

disinfection

II-11. CHLORINE USE RISK EVALUATION

A. Background

Public comment on the SDEIS raised two questions on the continued use of chlorine as a wastewater disinfectant:

1. Does the continued storage and use of chlorine at Deer Island pose a risk to public health and safety, and if so, to what extent?

2. What are the implications of any risk from the use of chlorine for siting of the proposed wastewater treatment facility at Long Island as opposed to Deer Island, i.e., is one site inherently "safer" than the other?

   This report addresses the first question through a brief safety evaluation of chlorine use at sewage treatment plants, derived from a limited database on chemical spills, and through the results of a generalized hazard assessment based on a mathematical model of gas cloud dispersion. The second question is addressed through a comparison both of wind directions and of distances to residential areas at Deer Island and Long Island, and through a qualitative assessment of the implications of wind frequencies and gas cloud dilution for public safety.

B. Safety Evaluation

Chlorine is widely used as the wastewater disinfectant of choice at most sewage treatment plants. It is usually shipped and stored as a pressurized liquid, but if spilled it readily vaporizes at normal atmospheric pressures and temperatures. The resulting chlorine gas is toxic; it can irritate mucous membranes, the respiratory system, and skin at concentrations in the range of 5-15 ppm by volume, and can be lethal if inhaled for 30 to 60 minutes at concentrations as low as 40-60 ppm. Lethal concentrations for acute exposure (i.e., exposure times on the order of a minute or less) are roughly an order of magnitude greater, in the range of 800-1,000 ppm. (Underhill, 1920; NRC, 1976; Sconce, ____). At particular risk are individuals with a history of asthma, in whom chlorine gas has been observed to cause severe asthma attacks in concentrations of 4-6 ppm. (NRC, 1976).

Chlorine gas is more dense than air (density 2.5 relative to air) and can thus be expected, in the event of an accidental release, to persist in hazardous concentrations at or near ground level, where the potential for human exposure is high, for periods up to an hour or more under a worst-case scenario. The risk of an accidental spill during the transport of liquid chlorine by tank truck, or during its storage and handling at a sewage treatment plant, should therefore be considered a threat to the health and safety of treatment plant staff and local residents. Such accidents, while rare, have occurred.

EPA is currently compiling data for a planned database on chemical spills. This database is rather limited, having been compiled from data from only four states (Ohio, Texas, New Jersey, and California), several news wire services, and a national emergency hotline. Of some 3,100 events in the database, approximately 300 involved releases of chlorine during the period from 1981 to 1985, making it one of the most frequently spilled of the chemicals for which data are available. Of those 300 spills, nine have been identified which, judging solely from company names, may have occurred at sewage treatment facilities. Several of these were listed as resulting from "equipment failure," and one, a 150-pound chlorine gas release at the Monticello, Iowa, sewage treatment facility, was specifically listed as the result of a leaking chlorine cylinder in a storage area.

The nine possible sewage treatment plant releases ranged in size (where indicated) from 25 pounds to 1,500 pounds; five resulted in injuries. Of these five, the most harmful was a combined chlorine and methane release in Chippewa Township, Pennsylvania, in July of 1983, which resulted in nine injuries and caused a fire and explosion which destroyed the plant, releasing raw sewage to a nearby stream. A chlorine gas release in Knoxville, Tennessee, resulting from a chemical reaction between ferric chloride (a metal plating waste) and sodium hypochlorite in April of 1983, caused four injuries and necessitated the evacuation of 300 students.

Figures provided by the Transportation Systems Center in Cambridge, Massachusetts,[2] also indicate a need for concern over the safety of chlorine in transportation. During the period from January, 1983, to March, 1985, the number of chlorine releases per month in the transportation system (which includes intra-warehouse transfers as well as trucking) ranged from four to sixteen and averaged eight or nine; i.e., over the last two years there were an average of roughly 100 chlorine releases per year in the transportation system alone. On-site storage in tank trucks has also proven hazardous in at least one instance: in December of 1981, 20,000 pounds of chlorine leaked from a truck parked at a chemical plant in Fraser, Michigan. Although no one was injured, 6,000 local residents had to be evacuated.

C. Modeling and Analysis of Potential Chlorine Hazard

In light of these figures, and in light of questions raised by local public safety officials, it would be prudent to assess the severity of the expected hazard from a potential accidental chlorine release at either Deer Island or Long Island. It should be noted here that the following hazard assessment implicitly assumes a release of chlorine gas to the atmosphere. Safety procedures currently in effect at most sewage treatment plants, including the existing Deer Island facility are designed to prevent such a release. These safety procedures include off-loading and storage of chlorine in separate, fully enclosed buildings equipped with chlorine gas sensors. However, as the preceding safety evaluation indicates, such procedures have proven less than foolproof in the past. Mathematical modeling of the atmospheric dispersion of pollutants and gases is thus a useful tool in assessing the potential hazard associated with the continued use of chlorine. A search of recent scientific literature revealed that only a small fraction of the work in mathematical modeling of pollutant dispersal is applicable to the special case of dense gases such as chlorine. Furthermore, the few dense gas dispersion models which do exist represent attempts to describe the movement of specific clouds of known dimensions under carefully controlled and thoroughly documented experimental conditions (e.g., Picknett, 1981). Consequently, these models tend to be of rather limited applicability and require more detailed knowledge of site-specific meteorological conditions and case-specific cloud characteristics than are generally available for accidental hazardous gas releases. A more generalized model is needed to quickly and efficiently estimate downwind concentrations and assess public hazards at distances on the order of kilometers from the release point for a wide range of cloud sizes and meteorological conditions. One such model was developed by William B. Petersen at the EPA Environmental Sciences Research Laboratory (Petersen, 1982).

Petersen's model provides a set of equations for calculating peak concentrations and average concentrations up to 100 km. downwind from the release point for any amount of gas under various atmospheric stability conditions (which are functions of wind speed and the amount and intensity of sunlight, or insolation). The model assumes a Gaussian concentration distribution, but is applicable to negatively buoyant gases provided they are well mixed with the ambient air. For small to moderate quantities of chlorine gas dispersed over a range of 1-5 km., such as are of primary concern here, this is a reasonable assumption. Furthermore, for large gas clouds, the Gaussian concentration distribution assumes a degree of vertical dispersion characteristic of neutrally or positively buoyant gases and will thus tend to produce low estimates of the downwind ground-level concentration of a negatively buoyant gas.

A copy of the section of Petersen's model on which this study is based is appended to this report. The approach taken in applying the model was to calculate the size of chlorine releases which would result in a lethal chlorine gas concentration at various distances downwind of the release point for a range of atmospheric stability conditions. This approach permits a hazard assessment which minimizes assumptions on site characteristics, release conditions, and spill sizes. It should be noted, however, that the model implicitly assumes an instantaneous release of material, regardless of spill size; the validity of this assumption is dependent on the actual case-specific mechanism of release. Furthermore, for the purposes of this analysis it was assumed that the hypothetical chlorine spill volatilizes completely, i.e, that all of the chlorine released evaporates before any of it is cleaned up. The validity of this assumption is dependent, in part, on case-specific release mechanisms and spill sizes; nonetheless, this can be regarded as the functional equivalent of a worst-case assumption that the workers at the release point are forced to evacuate the site or are stricken by the gas cloud before initiating any emergency clean-up action.

For the purposes of this report, a peak chlorine concentration of 850 ppm. by volume in the atmosphere at ground level was assumed to be lethal. There is some disagreement within the scientific community regarding the minimum peak concentration which should be considered lethal in the case of instantaneous or acute exposures, reflecting the paucity of experimental data on human exposure to gaseous chlorine and the impracticality of obtaining such data. However, concentrations in the range of 800-1000 ppm. are repeatedly cited in the literature as lethal to most animals in a very short time; hence the assumption of 850 ppm. as a lethal concentration. To place this concentration level in perspective, it is worth noting that the Occupational Safety and Health Administration (OSHA) has set a workplace standard of 1 ppm. for exposure to chlorine gas. Any exposure above this level, regardless of duration, is considered a violation of OSHA safety regulations.

The results of our calculations are presented in Tables 1 and 2. Table 1 gives figures on the projected sizes of chlorine releases which will produce gas concentrations of 850 ppm. at various distances downwind for a range of atmospheric stability conditions at an ambient temperature of 20°C (68°F), corresponding to a hypothetical summertime release. Table 2 gives analogous figures for a hypothetical wintertime release at an ambient temperature of 3°C (37.4°F). Calculations for both tables incorporate an assumed constant atmospheric pressure of 980 mb. Included in the tables, for comparison, are figures on the amount of chlorine gas which, when released to the atmosphere, can be expected to result in concentrations of 250 ppm. at a distance of 250 meters downwind of the release point. These figures are intended merely to provide a rough estimate of the amount of chlorine gas that might reasonably be expected to pose a significant hazard to those in the immediate area who have a history of asthma or other chronic respiratory illnesses and are thus more susceptible to the toxic effects of chlorine gas.

A careful examination of Tables 1 and 2 shows:

1. that the amount of chlorine gas which will result in a lethal concentration at a given distance downwind is strongly dependent on atmospheric stability, decreasing markedly (by an order of magnitude) with a slight increase in stability.

2. that the projected hazard from a chlorine spill is only weakly dependent on temperature, with a seasonal decrease in temperature producing only a minor increase in the amount of chlorine resulting in lethal concentrations at a given distance downwind.

3. that under unfavorable meteorologic conditions (e.g., a moderately stable atmosphere), a very small chlorine spill (1.78 pounds) would produce lethal gas concentrations of 850 ppm. at a distance of 250 meters downwind, and a spill of approximately 67

pounds would be sufficient to produce lethal concentrations at a distance of 1 km. (the distance from the existing Deer Island treatment plant to the southern end of Point Shirley). To place these spill sizes in perspective, it should be noted that chlorine is presently stored at Deer Island in 16-ton (32,000-pound) tanks.

4. that even under comparatively favorable meteorologic conditions (a slightly to moderately unstable atmosphere), a spill of a few hundred pounds would result in lethal concentrations at a distance of 250 meters from the release point (the approximate distance from the existing Deer Island treatment plant to the Deer Island prison).

Table 3 presents a breakdown of the ranges of wind speeds and insolation conditions giving rise to the various conditions of atmospheric stability. As shown in the table, each atmospheric stability condition can result from two or three distinct combinations of factors. Note, in particular, that any given stability condition can reasonably be expected to occur in both summer (strong insolation) and winter (slight insolation). Thus the entire range of atmospheric conditions will occur throughout the year, and it is not possible to restrict the consideration of chlorine spills under unfavorable conditions to a particular season. Table 3 does show, however, that the most unfavorable atmospheric conditions are expected to occur on clear, calm nights.

It is concluded from this analysis that, even in the absence of figures on the probability of a chlorine spill, the risk of such a spill under adverse atmospheric conditions represents a potential public safety hazard, and that alternatives to the continued use of liquid chlorine as a wastewater disinfectant should therefore be explored.

D. Implications of Hazard Analysis for Siting of the Proposed Treatment Plant

Questions were raised on the implications, if any, of the possible continued use of chlorine for siting of the proposed treatment plant. Specifically, it was asked whether siting the plant on Long Island would be "safer" than placing it on Deer Island, and would pose less risk to public safety in the event of an accidental chlorine release. To answer this question, it was necessary to look at wind directions and frequencies in Boston Harbor, and at the distances from both Deer Island and Long Island to the nearest inhabited areas.

The closest residential areas to Deer Island are Point Shirley, 1 km. to the northwest, and Cottage Hill, 2 km. to the north-northwest. The closest inhabitants, however, are the inmates and staff of the Deer Island prison, some 250 meters north of the existing treatment plant. These areas would be at risk from any chlorine gas cloud blown on winds from the south, south-southeast, or southeast. A wind rose for Boston Harbor prepared by Metcalf and Eddy (1982) indicates that such winds are most common during the summer, when they occur approximately 20% of the time, and are fairly infrequent during the winter, when they occur approximately 8% of the time. Clearly, the population most particularly at risk from a possible chlorine spill at Deer Island are the inmates and staff of the Deer Island prison, who not only are exposed to a significant hazard in the event of even a small release under favorable atmospheric conditions, but are also constrained in their ability to evacuate the area if necessary. Relocating the prison can be expected to significantly reduce the level of risk to local inhabitants by increasing the distance to the nearest residents, and hence the size of spill which would result in lethal concentrations in areas where human exposure is likely. However, residents of Point Shirley will remain at risk from small- to moderate-sized spills under a range of atmospheric conditions which cannot be considered uncommon.

The inhabited areas which lie closest to Long Island, and would thus be exposed to the greatest hazard from a chlorine gas release, are Georges Island, lying 3 km. to the east, and the Pemberton-Stony Beach-Telegraph Hill section of Hull, lying approximately 5 km. to the east-southeast. These areas would be at risk from a chlorine gas cloud blown on winds from the west or northwest. The Boston Harbor wind rose prepared by Metcalf & Eddy indicates that such winds are prevalent during the winter, when they occur approximately 47% of the time, and are common during the summer, when they occur 23% of the time. From a purely qualitative standpoint, this indicates that the inhabited areas threatened by a hypothesized release of chlorine gas at Long Island would be at risk nearly three times as often as areas similarly threatened by a comparable release at Deer Island. This increased frequency of risk must be weighed against the fact that a gas cloud released at Long Island would, by virtue of traveling longer distances before reaching populated areas, undergo greater dilution prior to any public exposure than would a gas cloud released from Deer Island. A rigorous quantitative assessment of just how this frequency/dilution tradeoff will influence the expected level of risk in Hull, relative to that in Point Shirley, is beyond the scope of this report.

From this assessment, it is nonetheless concluded that siting the proposed plant at Long Island rather than at Deer Island would merely replace a comparatively high level of risk with a comparatively high frequency of risk, and would not substantially mitigate the existing public safety hazard from a possible accidental chlorine release.

E. Conclusions

In summary, it was found, from documentation of past accidental chlorine releases and from mathematical modeling of chlorine gas releases resulting in lethal concentrations downwind of the release point, that the continued use of liquid chlorine as a wastewater disinfectant in Boston Harbor constitutes a potential public safety hazard. The implications of this conclusion for siting of the proposed treatment plant are not clear-cut, as they involve a tradeoff between the level of risk to which the public is exposed and the frequency with which the public is exposed to that risk. Siting the plant at Long Island rather than Deer Island would place it farther from inhabited areas, insuring greater dilution of a gas cloud prior to public exposure (as well as more time for any evacuation that might be required), but would at the same time increase by roughly a factor of three the chances that the wind would be blowing toward a residential area in the event of an accidental (and hazardous) chlorine gas release. In short, moving the plant does not eliminate the hazard from a possible chlorine leak, and it is recommended that alternatives to the continued use of chlorine be examined. Various alternative disinfectants do exist (e.g., sodium hypochlorite, ozone), and it would be prudent, once an in-depth examination of the costs and feasibilities of these alternatives has been conducted, to discontinue the use of liquid chlorine as a wastewater disinfectant in Boston Harbor unless a clear and convincing need for its continued use can be demonstrated.

It should be noted, however, that in light of the figures on chlorine releases in the transportation system cited earlier in this report, and given the special problems posed by the difficulty of evacuating Deer Island and/or Point Shirley, the continued trucking of chlorine would appear to be a more important concern for the short-term than is the continued use of chlorine at the proposed plant. A tank truck accident involving a chlorine spill anywhere along the route to either Deer Island or Long Island would have the potential for exposing densely populated areas to very high concentrations of chlorine gas. It would therefore be advisable to adopt an alternative means of chlorine transport at the earliest possible opportunity.

NOTES

1. Mr. Fred Talcott, Office of Policy Planning, EPA Headquarters, Washington, DC; personal communication, October 23 and 25, 1985.

2. As cited by Mr. Fred Talcott in personal communication, October 23, 1985.

SOURCES REFERENCED

1. Metcalf and Eddy, 1982: Typical Wind Patterns in Boston Harbor, Summer and Winter; from "Climatology of the U.S., No. 82-19," U.S. Dept. of Commerce, National Climate Center.

2. National Research Council, 1976: Chlorine and Hydrogen Chloride; NTIS Publication PB-253196, April 1976.

3. Petersen, W.B., 1982: "Estimating Concentrations Downwind from an Instantaneous Puff Release"; Environmental Sciences Research Laboratory, USEPA, April, 1982.

4. Picknett, R.G., 1981: "Dispersion of Dense Gas Puffs Released in the Atmosphere at Ground Level"; in Atmospheric Environment, vol. 15, pp. 509-525.

5. Sconce, J.S., date unknown: "Chlorine: Its Manufacture, Properties, and Uses"; American Chemical Society Monograph Series; Reinhold Publishing Corp., New York.

6. Underhill, F.P., 1920: The Lethal War Gases: Physiology and Experimental Treatment; Yale Univ. Press, 1920.

ESTIMATING CONCENTRATIONS DOWNWIND FROM AN INSTANTANEOUS PUFF RELEASE

by

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CONCENTRATION ESTIMATES

INSTANTANEOUS PEAK CONCENTRATIONS

The peak ground level concentration from an instantaneous surface release is given by Equation 1.

$$\chi_p = \frac{2Q}{(2\pi)^{3/2} \sigma_x \sigma_y \sigma_z} \qquad (1)$$

Where: Q is the total emission (g),
σ_x is the downwind dispersion parameter (m),
σ_y is the crosswind dispersion parameter (m),
σ_z is the vertical dispersion parameter (m).

Typically it is assumed that $\sigma_x = \sigma_y$ for puff-type dispersion estimates. Nickola (1971) showed that, for ground level releases, σ_x is greater than σ_y in the first few hundred meters of travel, but the puffs become more symmetrical as travel distances approach 800 meters. For the purposes of this work σ_x and σ_y are assumed to be equal, and the dispersion in the xy plane will be indicated by σ_r. Equation 1 can then be expressed as:

$$\chi_p = \frac{2Q}{(2\pi)^{3/2} \sigma_r^2 \sigma_z} \qquad (2)$$

Figure 1 shows peak ground level concentrations normalized by emission strength, χ_p/Q, versus downwind distance for three stability regimes unstable, neutral, and very stable. The stability regimes can be determined from cloud cover, ceiling height and wind speed, using Turner's stability classification scheme (1970). In the absence of meteorological data at the site of release or from a nearby weather station, the stability regimes can be approximated as follows. On a clear, sunny day with light winds, use the unstable curves. During windy or cloudy conditions, use the neutral curves. On a clear night with calm or light winds, use the very stable curves. The dispersion coefficients for the three stability classes are those recommended by Slade (1968). Figure 1 was derived using Equation 2 with the dispersion coefficients mentioned above. Equation 2 is applicable only for surface releases. Solid lines on the curve represent distances of observed data. Dashed lines are extrapolations.

Example Problem 2-1

A 1000 kg instantaneous release of chlorine occurs during neutral stability conditions with a mean wind speed of 3 m/sec. What is the peak concentration 5 km downwind?

Step 1. Use Figure 1 to determine χ_p/Q at 5 km downwind on the neutral stability curve.

$\chi_p/Q = 9.5 \times 10^{-8}$ Note: χ_p/Q is independent of u.

Step 2. Compute $\chi_p = \chi_p/Q \times Q$

$\chi_p = (9.5 \times 10^{-8}) \times (1.0 \times 10^{6}) = 9.5 \times 10^{-2}\ g/m^3$

If the atmosphere was actually very stable rather than neutral, to what downwind distance would the peak concentration be greater than that computed in Step 2?

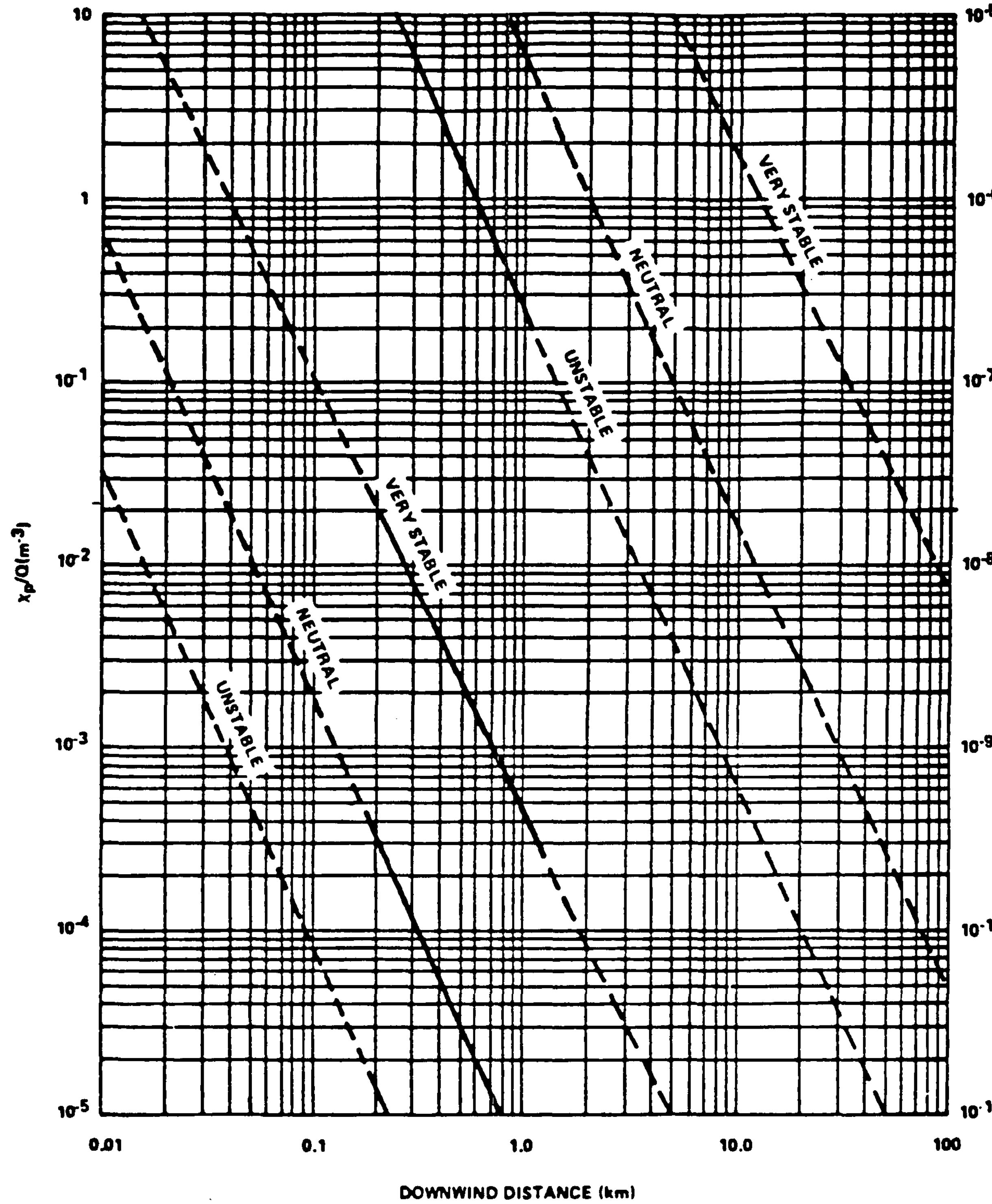


FIGURE 1. χ_p/Q VERSUS DOWNWIND DISTANCE. THE LEFT HAND SCALE IS FOR χ_p/Q VALUES OF 10^{-5} TO 10. THE RIGHT HAND SCALE IS FOR χ_p/Q VALUES OF 10^{-11} TO 10^{-6}.

Step 1. Find χ/Q (9.5×10^{-8}) on Figure 1, on the very stable curve.

Step 2. Read down to the distance scale.

$x = 32$ km.

CONVERSION OF CONCENTRATION UNITS

The equation of state can be used for conversion of concentrations from $\mu g/m^3$ to ppm.

$$\chi(ppm) = \frac{\chi(\mu g/m^3) \times T(K) \times R}{M \times P(mb)}$$

where: T is the absolute temperature (K),

M is the gram molecular weight (gm-mole),

P is the atmospheric pressure (mb),

R is the universal gas constant $8.31 \times 10^{-2} \; \frac{mb \; m^3}{gm\text{-}mole \; K}$.

The equation to convert ppm to ug/m^3 is given below.

$$\chi(\mu g/m^3) = \frac{\chi(ppm) \times M \times P(mb)}{T(K) \times 8.31 \times 10^{-2}}$$

In the example above the ambient temperature was 80°F and the atmospheric pressure was 980 mb. Find the concentration in ppm.

$$T(^{\circ}C) = 5/9(T(^{\circ}F)-32)$$

The absolute temperature is 299.7 (K). The molecular weight of chlorine (CL_2) is 70.91.

$$\chi_{(ppm)} = \frac{95000(\mu g/m^3) \times 299.7(K) \times 8.31 \times 10^{-2}}{70.91 \times 980(mb)} = 34 \text{ (ppm)}$$

The peak concentration 5 km downwind is 0.095 g/m^3 or 34 ppm.

AVERAGE CONCENTRATIONS

In the paragraphs that follow a methodology is described for computing ground level concentrations from an instantaneous surface release for a given stability class and sampling time. The average concentration over sampling time τ can be expressed as some fraction of the peak concentration.

$$\bar{\chi}_\tau = \chi_p \times F, \quad (3)$$

where: χ_τ is the average concentration for a given sampling time τ,
τ is the sampling time, i.e. 5 min., 1-hour etc.,(expressed in seconds)
χ_p is the instantaneous peak concentration,
F is the correction factor for sampling time, which always has a value less than or equal to one.

The correction factor F can be computed as follows:

$$F = \frac{(A-0.5)}{(N)\ 0.3989}, \quad (4)$$

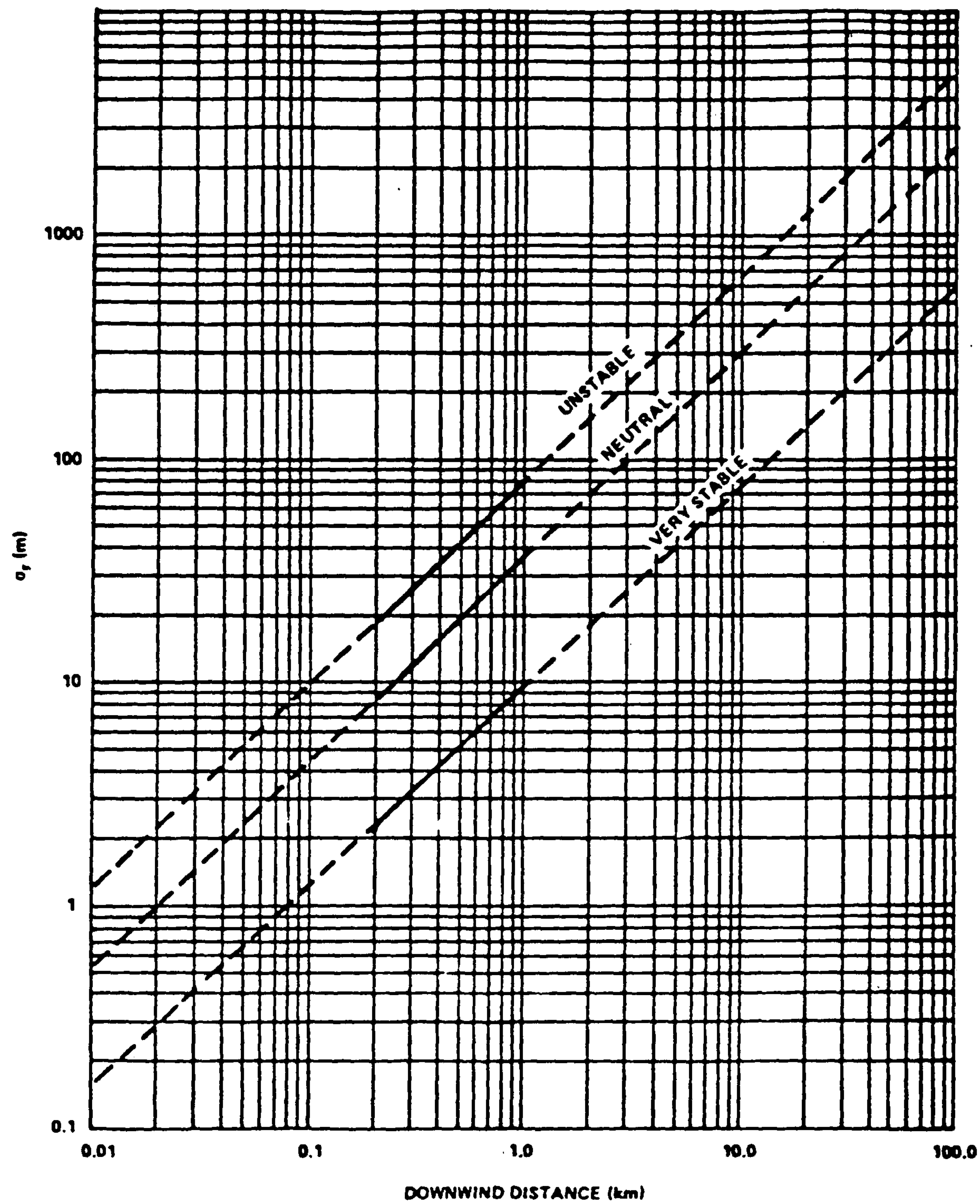


FIGURE 2. σ_r VERSUS DOWNWIND DISTANCE

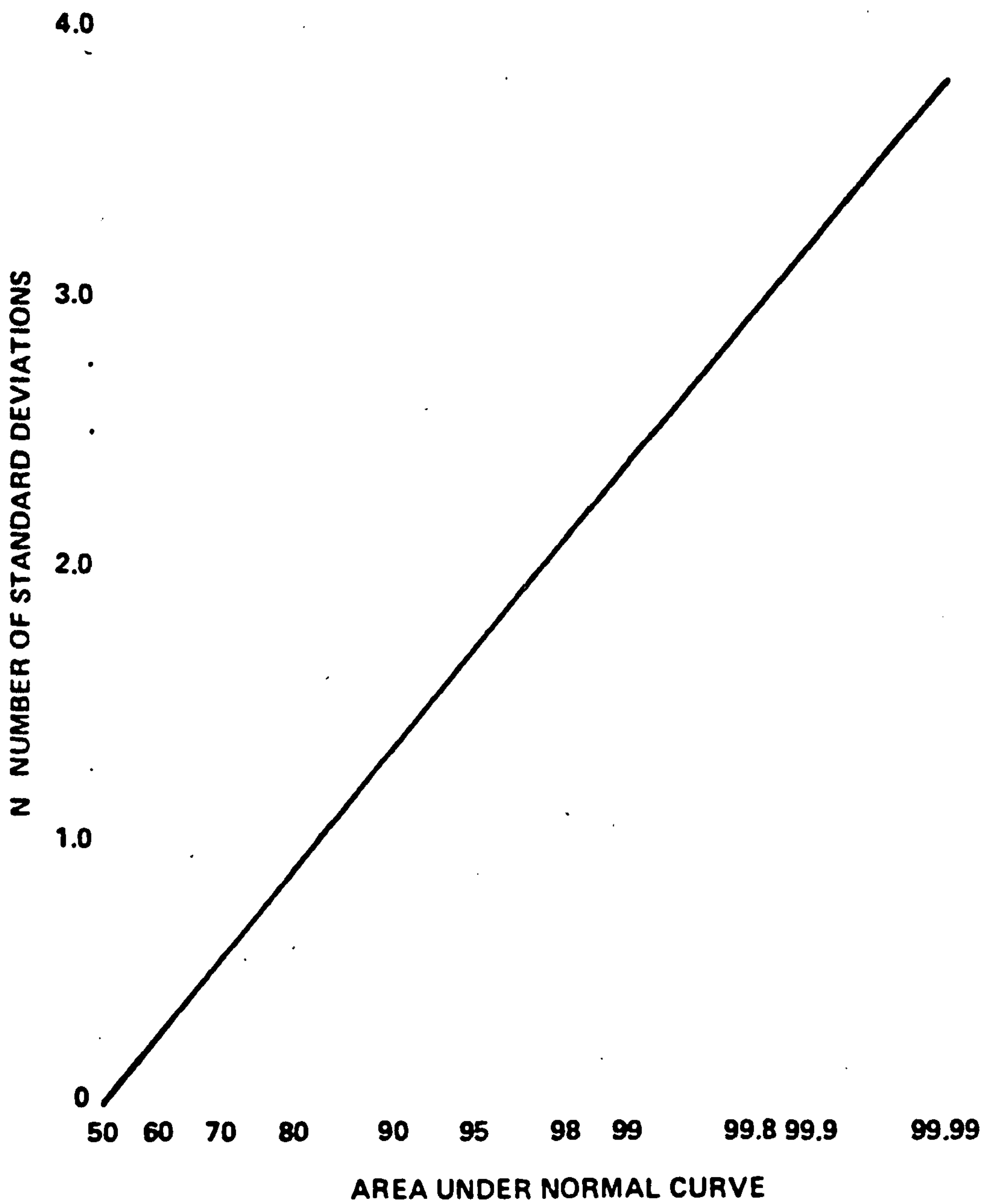


Figure 3. Percent area under normal curve for a given number of standard deviations.

where: A is the cumulative area under the normal curve (Figure 3),

N is the number of standard deviations out from the peak of the Gaussian distribution.

$N = \frac{\tau u}{2\sigma_r}$,

u is the mean wind speed,

σ_r is the horizontal dispersion coefficient (Figure 2).

The concentration at a given receptor location ranges from zero to a peak value as the puff moves towards the receptor. The peak instantaneoous concentration is always assumed to occur at time t when the center of the puff is at the receptor location. If the growth of the puff is small as the puff passes over the receptor, then the peak average concentration for sampling time τ at a particular location occurs during the time period $t - \tau/2$ to $t + \tau/2$.

Example Problem 2-2

For the conditions given in Example problem 2-1, find the peak 5 minute average concentration and the peak 1-hour average concentration at 5 km downwind.

Step 1. Compute the instantaneous peak concentration χ_p.

From problem 2-1, $\chi_p = 9.5 \times 10^{-2}$ g/m^3.

Step 2. Compute A.

(a) Determine the number of standard deviations.

$$N = \frac{\tau u}{2\sigma_r} = \frac{300(3)}{(2)(150)} = 3.0$$

σ_r is approximately 150 meters, determined from Figure 2 at 5 km downwind.

(b) Given a value of N = 3.0 determine A from Figure 3.

A = 0.998

Step 3. Compute χ_τ.

Substitute A into Equation 4.

$$F = \frac{(0.998-0.5)}{(3.0)\ 0.3989} = 0.42$$

Substitute F into Equation 3 to determine peak 5 minute average concentration.

$$\bar{\chi}_\tau = 0.42 \times 9.5\times10^{-2} = 4.0\times10^{-2}\ g/m^3.$$

In a manner analogous to the above, the peak 1-hour average concentration can be computed.

$$N = \frac{3600\ (3)}{2\ \sigma_r} = 36.$$

From Figure 3, A = 1,

$$F = \frac{(1.-0.5)}{(36)\ 0.3989} = 0.035$$

Substitute F into Equation 3 to find the peak 1-hour average concentration.

$$\bar{\chi}_\tau = 0.035 \times 9.5\times10^{-2} = 3.3\times10^{-3}\ g/m^3.$$

The total dosage, D, at a given downwind distance, stability class, and wind speed can be approximated using the following equation.

$$D \cong \chi_p \times \frac{2.5\, \sigma_r}{u} \text{ (matter-time/volume)} \qquad (5)$$

σ_r is determined for the given stability class and downwind distance.

II-12

sludge

II-12 Sludge Management Facilities

A. Background

In the Certificate of Adequacy on the Supplemental Draft Environmental Impact Statement/Report, issued by the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts, the issue of sludge management was discussed at length. The certificate indicates that segmentation of final sludge management is an appropriate course of action to take in the environ- mental review of the siting decision. However, it was noted that the SDEIS/R was inconsistent in describinq the sludge processing facilities that would be required. The Certificate directed the Final EIS/EIR to use common assumptions concerning sludge processing for all siting options.

Consultants for the MWRA reviewed the SDEIS/R and reassessed the sludge processing facilities that could be assumed to be necessary. The results of that assessment follow.

B. Information on Sludge Processing in the SDEIS/R

Information concerning sludge processing appeared in the SDEIS/R in several places. This information included conceptual site layouts, tables of numbers and sizes of sludge processing units, and tabular cost estimates.

A comparison of the information contained in the site layouts and the tables shows that there are inconsistencies between the data sources. Table I summarizes the information on sludge processing units that was presented in the SDEIS/R.

Table I shows that the SDEIS/R layouts and tables were consistent in their treatment of sludge processing at Nut Island. For Deer Island, the tables assume existing facilities would be used, but the layouts assume they will be abandoned; no compensatory sludge facilities are shown on the layouts to replace them. In addition, flotation thickeners are indicated on the Deer Island secondary layouts, but nowhere else in the document. For Long Island, only the split primary option shows any sludge processing at all.

As a result of these discrepancies, some confusion was created concerning the sludge processing units that might be used at the facilities. An inaccurate impression of the potential footprint of the plant also was conveyed. Specifically, layouts at Long Island underestimated the size of the plant because no sludge processing was shown.

Table I: Comparison of Numbers of Sludge Processing Units Shown in Tables and Layouts of the SDEIS/R

Secondary Options	Gravity Thickening Table	Gravity Thickening Layout	Anaerobic Digestion Table	Anaerobic Digestion Layout
All Deer	10	6	12	8
Deer/Nut				
- Deer	9	5	8	4
- Nut	2	2	4	4
All Long	8	0	12	0
Deer/Long				
- Deer	8	5	8	4
- Long	4	0	4	0
Primary Options				
All Deer	10	6	12	8
Deer/Nut				
- Deer	8	5	8	4
- Nut	2	2	4	4
All Long	8	2	12	4
Deer/Long				
- Deer	10	5	12	4
- Long	2	2	4	4

C. Sludge Processing Units

The specific processes for sludge management that will be used at the new wastewater treatment plant will not be known until the MWRA's comprehensive study on residuals management is completed. For the purposes of this report, conservative assumptions have been made concerning potential sludge processing unit operations, and used to develop layouts and cost estimates. These operations include:

1. Thickening. Thickening of sludges before further processing reduces their volume. The unit processes assumed here are gravity thickening for primary sludges and dissolved air flotation thickening for secondary sludges.

2. Anaerobic Digestion. Anaerobic digestion of sludges reduces the solids content and produces methane, which can be used for in-plant energy.

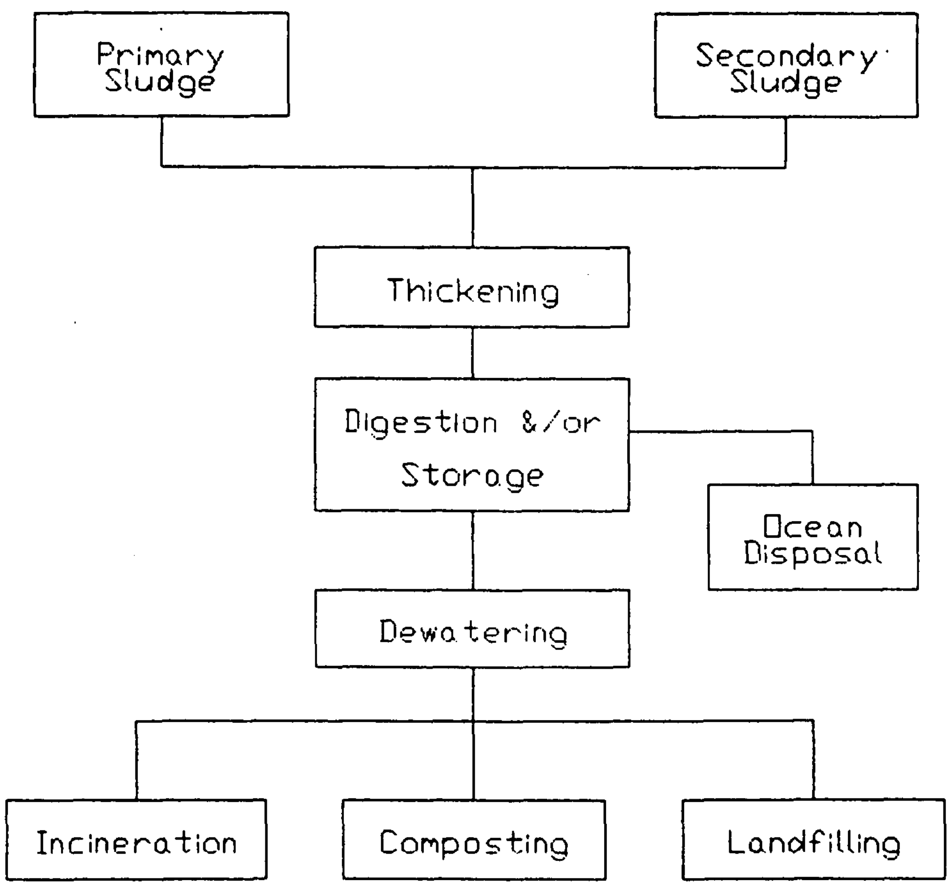
3. Dewatering. Dewatering of digested or undigested sludges reduces their water content, and thus, the volume of material.

A diagram of the process is shown in Figure I. This group of operations represents a conservative approach, and will result in the maximum land area needed for sludge processing. This ensures that plant area requirements and guidelines for developing mitigating actions will consider the 'worst case' for sludge processing. For development of site layouts, allowances have been made for either on-site incineration, or sludge storage for off-island transport.

For each sludge processing operation, numbers and sizes of tanks were estimated by taking data from previous reports on solids production. Figures of 265 dry tons per day of primary sludge and 150 dry tons per day of secondary sludge are used for the planning purposes of this final EIS/R.*

A summary of the resulting units and sizes for each alternative appears in Table II.

FIGURE I



Source:
*Camp, Dresser and McKee

Table II: Sludge Processing Unit Operations by Alternative and Sizes

Alternative Site	Gravity Thickening No. - Diameter X Depth	Flotation Thickening No. - Width X Length X Depth	Anaerobic Digestion No. Diameter X Depth	Belt Filter Presses No. - Width (meters)	Net Area Acres	Gross Area Acres
Secondary Treatment						
1. All Secondary, Deer Island (Option 1a.2)						
Deer Island (New)	8-80x12	28-20x75x12	24-110x30	20-2.2	15	18
2. Split Secondary, Deer Island, Nut Island (Option 1b.2)						
Deer Island (New)	6-80x12	28-20x75x12	20-110x30	20-2.2	14	17
Nut Island (Existing)	0	0	4-100x30	0	0	0
Nut Island (New)	2-80x12	0	1-110x30	0	1	1
Total					15	18
3. All Secondary Long Island (Option 2b.1)						
Long Island (New)	8-80x12	28-20x75x12	24-110x30	20-2.2	15	18
4. Split Secondary Deer Island and Long Island (Option 2b.3)						
Deer Island (New)	6-80x12	0	8-110x30	0	4	5
Long Island (New)	2-80x12	28-20x75x12	16-110x30	20-2.2	12	14
Total					16	19

Table II: Sludge Processing Unit Operations by Alternative and Sizes (continued)

Alternative Site	Gravity Thickening No. - Diameter X Depth	Flotation Thickening No. - Width X Length X Depth	Anaerobic Digestion No. Diameter X Depth	Belt Filter Presses No. - Width (meters)	Net Area Acres	Gross Area Acres
Primary Treatment						
1. All Primary, Deer Island (Option 4a.2)						
Deer Island (New)	8-80x12	0	11-110x30	13-2.2	9	11
2. Split Primary, Deer Island, Nut Island (Option 4b.2)						
Deer Island (New)	6-80x12	0	7-110x30	13-2.2	7	8
Nut Island (Existing)	0	0	4-100x30	0	0	0
Nut Island (New)	2-280x12	0	1-110x30	0	1	1
Total					8	9
3. Split Primary, Deer Island and Long Island (Option 5a.2)						
Deer Island (New)	6-80x12	0	7-110x30	13-2.2	7	8
Long Island (New)	2-80x12	0	4-110x30	0	2	3
Total					9	11
4. All Primary, Long Island (Option 5b.2)						
Long Island (New)	8-80x12	0	11-110x30	13-2.2	9	10

NOTES:

(1) Dimensions in feet except where otherwise indicated.

(2) Net Acreage includes 2.5 acres for incineration.

(3) Gross Acreage allows for piping space between components

(4) Costs do not include incineration.

II-13

disposal of properties on Deer Island by GSA

General Services Administration, Region 1
John W. McCormack Post Office and Courthouse
Boston, MA 02109

Date :November 18, 1985

Reply to
Attn of : IPEP

Subject: Disposal of Surplus Real Property
Deer Island, Boston, Massachusetts

To : Mr. Robert Mendoza
Water Management Division
Environmental Protection Agency
JFK Federal Building, Room 2100
Boston, Massachusetts 02203

Please find enclosed a copy of the revised section pertaining to the subject disposal action for your Final Supplemental EIS on Siting of Wastewater Treatment Facilities for Boston Harbor. This reflects discussion by our respective staffs on November 6, 1985. If you have any questions please call Mr. Fred Ryan, Chief, Planning Staff at FTS 223-2707.

L. M. PEARSON
Assistant Regional Administrator
Office of Public Buildings and Real Property

Enclosure

II-13 DISPOSAL OF PROPERTIES ON DEER ISLAND BY GSA

A. Background

This section describes the proposed administrative action by the General Services Administration (GSA) pursuant to the Federal Property and Administrative Services Act of 1949 as amended (FPAS) for the disposal of five parcels of land, formerly comprising Fort Dawes on Deer Island, Boston, Massachusetts.

Two parcels of 1.75 acres and 3.5 acres are currently under GSA control, pending disposal as surplus real property. These parcels were acquired on March 8, 1985 from the Metropolitan District Commission (MDC) by revestment of title. Three additional parcels of 32.74, 1.25 and 0.46 acres are controlled by the U.S. Navy which now is in the process of declaring them excess and reporting them to GSA for disposal. These parcels, totaling about 39.7 acres, are located at the southern end of Deer Island and are bounded by property owned by the MDC and City of Boston. (See Figure I-4.)

In May, 1985, GSA learned that these U.S. Government-controlled parcels may be required for construction of a wastewater treatment facility on Deer Island, as proposed in several alternatives described elsewhere in this document. On July 26, 1985, GSA met representatives of the Environmental Protection Agency (EPA) and Massachusetts Water Resources Authority (MWRA) to discuss GSA's disposal procedures and requirements. GSA and EPA have had subsequent meetings to coordinate their actions.

Since the siting decision and disposal action would be directly related because of their functional interdependence and geographical proximity, GSA has been designated as a cooperating agency in this environmental impact statement by the Environmental Protection Agency (EPA) which is the lead agency (4CCFR 1501.5 and 6).

B. Need for Action

GSA has statutory responsibility for the disposal of real property reported as excess by Federal agencies.

Council on Environmental Quality (CEQ) regulations require that all possible alternatives be identified and all "reasonable" alternatives be objectively and thoroughly evaluated. Two types of alternatives are considered: (1) the means of disposal by GSA and (2) the uses of the property after disposal.

C. Disposal Alternatives

After a property has been reported as excess by a Federal agency, GSA has a number of disposal alternatives which are summarized below:

1. Transfer to Another Federal Agency

GSA screens excess property for use by other Federal agencies as a first step. Two of the Government parcels on Deer Island have been screened with negative results. The remaining parcels are to be screened as soon as they are reported as excess. Normally, a request from another Federal agency would take precedence over other disposal options and GSA would transfer the property as requested. However, it is expected that screening will identify no federal need for these sites.

2. Disposal by Specific Public Benefit Program Transfer or Sale to Public Bodies

There are a number of programs by which surplus property may be conveyed to state or local governments or, in some cases, qualifying non-profit entities, at a discount of up to 100 percent. Specified public uses under these programs include education, health, park and recreation, historic monuments, public airports, highways, wildlife conservation and housing. In most cases, the land must be used for the specified use in perpetuity; otherwise title reverts to the Government.

Transfer of the subject Deer Island parcels is possible under one or another of these public benefit programs depending on the interest of eligible applicants.

3. Disposal by Negotiated Sale to Public Bodies

GSA may dispose of surplus Government-owned property to states, territories, possessions, and political subdivisions thereof, or tax-supported agencies therein by negotiated sale for unrestrictive use. Surplus property may be sold through negotiations at not less than fair market value obtaining such competition as is feasible for purposes that provide some public benefit. Value is based upon the property's highest and best use which is considered the most suitable use of the property from economic and environmental standpoints given the characteristics of the property and improvements to it.

Negotiated sale is a reasonable alternative for the subject Deer Island parcels.

4. Public Sale

Surplus properties not disposed of to public agencies or other eligible bodies are offered for sale to the public by GSA on a competitive bid basis. Scheduled sales are widely publicized through mailing lists, paid advertising and listing in the Commerce Business Daily. The sale may be by sealed bid or public auction. Considering the limited feasibility of private development of the subject parcels (discussed below) and the great likelihood that there will be public agency interest in the subject parcels, the public sale means of disposal is not considered a reasonable alternative.

5. No Action

The no action alternative would be inconsistent with GSA's legal mandate to ensure a timely disposition of surplus property. Hence, it is not considered to be a reasonable alternative.

6. Delay the Action

If, in its disposal activities, GSA finds that it cannot obtain fair market value, it may retain the property until market conditions improve.

D. Alternative Land Uses and Impacts

1. Wastewater Treatment Facility

Under several of the final alternatives for siting a Wastewater Treatment Facility for Boston harbor, the subject parcels on Deer Island will be required for construction and expansion. The impacts of this proposed land use are thoroughly considered in this environmental impact statement including comparison of environmental impacts compared with alternative sites in Boston harbor. This siting decision is the responsibility of EPA and the Massachusetts Water Resources Authority (MWRA).

2. Public Recreation

Due to the security needs of the Deer Island House of Correction, there has been no public access to Deer Island for many decades. In 1972, the Metropolitan Area Planning Council proposed to relocate the prison, expand the treatment plant in the northern portion of the island, and develop a park in the southern portion of the island. These plans were never implemented. In 1984, the Massachusetts Department of Environmental Management (DEM) proposed a new draft master plan for the harbor islands which proposed no recreational facilities on Deer Island. Though that plan has not been finalized pending completion of this siting decision, the Commissioner of DEM, who has authority to veto the placement of this treatment plant, has stated that as between Long Island and Deer Island, it is of great significance that Long Island be developed as the Harbor's major park, not Deer Island. A Deer Island park would be precluded by expansion of the treatment facility. However, alternative plans for the expansion of the treatment facility feature the possibility of also developing small scale recreation uses at Deer Island, such as public fishing piers or boat launching ramps SDEIS (Section 4.3.1). The subject parcels may be disposed of for recreational use by public benefit conveyance through the National Park Service (NPS) of the Department of the Interior or by GSA through negotiated sale.

The proposed plans (mentioned above) for recreational development of Deer Island indicate a minor level of impacts, compared to the treatment facility alternative. The existing topography would be maintained. The major impact will be visitor traffic based on projected peak daily visits of 1500.

3. Commercial/Residential Development

Reuse of the subject parcels by private developers in a manner consistent with local zoning might be feasible if the City of Boston and the State agreed to provide public access over their land. However, this scenario is considered unlikely since it would necessitate the relocation of either, and probably both, the prison and existing treatment facility. Proposals to relocate the Deer Island House of Correction would substantially reduce public access constraints resulting from security concerns. Nevertheless, accessibility and development potential would remain constrained by the existing treatment plant. There are no known public plans for residential or commercial reuse of Deer Island at this time. Also, this alternative would preclude the above mentioned recreation plans. Hence, this alternative is deemed to be not reasonable. Industrial land uses are likewise deleted from further consideration for these reasons as well as incompatibility with local zoning.

4. Conservation

Since no significant wildlife habitat or endangered species are identified on Deer Island, there are no reasons to consider reservation of the subject Government-owned parcels for conservation use.

E. Preferred Alternatives

In narrowing the range of alternatives for the disposal of surplus Government land on Deer Island, GSA has considered constraints imposed by existing land uses and site characteristics, as well as plans by other public agencies. Existing land uses (the prison and treatment plant), their associated operational restrictions on public access and negative impacts (security, noise, odors) are significant deterrents to residential or commercial development. There are no significant natural resources on the site which would warrant conservation use.

There are major public plans for the re-use of Deer Island for recreational and wastewater treatment facility use. If the Deer Island site is selected by the EPA and MWRA for the new Boston Harbor Wastewater Treatment Facility, GSA will consider that Facility to be the highest and best use for the surplus Government parcels because of the manifest public need for and benefits of such a project. Otherwise, GSA will re-evaluate disposal alternatives in consultation with other public agencies.

Given the preferred land use alternative, disposal would be by negotiated sale to a public body (i.e., the Massachusetts Water Resources Authority).

MEMORANDUM OF AGREEMENT

Between

THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I

and

THE GENERAL SERVICES ADMINISTRATION
REGION I

I. Introduction and Purpose

It is the purpose of this Memorandum of Agreement to formalize an existing lead agency-cooperating agency relationship between the Environmental Protection Agency, Region I (EPA) and the General Services Administration, Region I (GSA) in the preparation of the Final Environmental Impact Statement (FEIS) on the siting of secondary wastewater treatment facilities for Boston Harbor and the GSA disposal of surplus real property on Deer Island, Massachusetts.

The FEIS, which is now nearly complete, is expected to recommend as EPA's tentative preferred alternative the siting of the treatment facilities on Deer Island. In order to implement such a preferred alternative, it would be necessary to utilize five parcels on Deer Island which are owned by the federal government for construction of the facilities. Two of the five parcels are now available for disposal by GSA. In January, 1986, the U.S. Navy will be reporting three additional parcels for disposal by GSA. As a prerequisite to disposal of these parcels, GSA must conduct an environmental review pursuant to the National Environmental Policy Act of 1969 (NEPA). The FEIS which is being prepared by EPA pursuant to NEPA is a prerequisite to the grant of federal funds to the Massachusetts Water Resources Authority to construct the treatment facilities on Deer Island. Accordingly, applicable

applicable regulations require EPA and GSA to cooperate, to the extent practicable, to avoid duplication by adopting and combining environmental review procedures.

EPA and GSA have been observing a lead agency-cooperating agency relationship since it became reasonably clear that environmental analysis by GSA of disposal of the Deer Island parcels was appropriate. EPA and GSA have met several times since May, 1985 to ensure the participation of GSA in the review process, initiate the preparation of appropriate environmental analyses by GSA for use by EPA, and make the results of the EPA scoping process available to GSA so that GSA would be aware of and address the significant issues to be analyzed in the FEIS. GSA has heretofore prepared a draft environmental analysis and has submitted it to EPA.

II. General Provisions

In furtherance of the lead agency-cooperating agency relationship, EPA and GSA agree as follows:

1. EPA shall ensure compliance with NEPA as to EPA's administrative action. GSA shall ensure compliance with NEPA as to disposal of the five federal parcels. To the extent feasible, GSA shall incorporate technical information developed by EPA as part of the FEIS and earlier Supplemental Draft Environmental Impact Statement to complete GSA's environmental review for the disposal of surplus property.

2. EPA shall ensure the procedural and technical adequacy of the impact analysis of the FEIS on siting of the wastewater treatment

facility. GSA shall be responsible for the procedural and technical adequacy of the impact analysis for the disposal of the federal parcels.

3. GSA shall attend all public meetings and public hearings on the FEIS which are sponsored by EPA. GSA shall be prepared to respond to questions at these meetings concerning the GSA analyses contained in the FEIS. GSA shall respond in writing to comments received by EPA concerning the portions of FEIS for which GSA is responsible.

4. GSA shall complete its environmental review in a timely fashion to ensure availability of a camera-ready copy of the FEIS on or before December 4, 1985.

5. Robert E. Mendoza, EPA Water Management Division (223-0841) is designated by EPA as the point of contact for all correspondence, consultation and comments in connection with the FEIS and this agreement.

6. Richard Stewart, GSA Disposal Division (223-2651) is designated by GSA as the point of contact for all correspondence, consultation and comments in connection with the FEIS and this agreement.

Michael R. Deland
Regional Administrator
U.S. EPA, Region I
Boston, Massachusetts

Dated: 12/4/85

L.M. Pearson
Acting Regional Administrator
GSA, Region I
Boston, Massachusetts

Dated: 12/4/85

II-14

property values research evaluation

II-14 PROPERTY VALUES

A. Background

The SDEIS stated that property values in the vicinity of the proposed wastewater treatment facility could be expected to decline during construction, then rebound once the new facility began operation. Commentors, specifically the Town of Winthrop, disputed this view; town officials felt that a facility on Deer Island would have a permanent adverse effect on property values in Winthrop, thus affecting the town's tax base.

EPA, EPA's consultants, and the MWRA's consultants have investigated this issue in an effort to determine what is known generally about the effects of sewage treatment plants on adjacent property values, and, if possible, to determine the specific effects of a plant located on Deer or Long Island on property values in Point Shirley or Squantum, respectively.

It was discovered, as noted in the appended report, that no literature exists which specifically addresses the effect of proximity to sewage treatment plants on property values. Consequently, such information can only be inferred from existing data on the effects of other "negative" land uses. Whether such inferences are valid remains open to question. Furthermore, discussions with William Wheaton, Professor of Economics and Urban Planning at Massachusetts Institute of Technology, indicate that there are methodological problems associated with a specific prediction of the impact of the proposed treatment plant on property values. To make such a prediction, it would be necessary to collect real estate sales data from a number of areas, with and without treatment plants, which are otherwise similar in all respects to the area for which the prediction is to be made. Unless data were collected for a significant number (about a dozen) of such areas near treatment plants of the proposed type, it would be difficult to separate the effect of the proposed treatment plant from other influences such as airport noise or proximity to other negative land uses (e.g., a prison). The large number of variables affecting property values complicates statistical control of any systematic study to the extent that there would be only a 50 percent chance of producing a correct prediction.

The specific impacts (e.g., noise, odor, visual intrusion on the surrounding area) of an enlarged, operational treatment plant at Deer Island are unknown and cannot be definitively determined in the plant's absence. The problems of predicting the plant's effects on property values are compounded by the presence in Winthrop of waterfront and other amenities, as well as negative influences such as the airport and the prison. And finally, property values are strongly dependent on the subjective perceptions of neighborhood residents and of prospective buyers. Such perceptions are not quantifiable and are often as much emotional as rational. Consequently, it is impossible to predict with any certainty the effect of the proposed plant on property values, particularly in light of the fact that siting of the plant at Deer Island may well involve relocation of the prison.

Given these considerations, i.e., the lack of data on the specific effects of sewage treatment plants on property values, the methodological problems inherent in any effort to conduct a systematic study of those effects, the difficulty of separating the influence of the treatment plant from that of other facilities, and the ultimate dependence of property values on subjective perceptions, it appears extremely unlikely that any effort to monitor property values during construction would be cost-effective or would produce any meaningful result. It should also be stressed that information regarding property value trends during construction will have little or no bearing on the trends to be expected once construction activities cease and the plant becomes operational.

A literature review of the effects of sewage treatment plants on real estate values is appended.

The review was performed by Abt Associates, Inc. of Cambridge, Massachusetts, socio-economic consultants under the direction of David Berry, Ph.D. in Regional Sciences.

The Impact of Sewage Treatment Plants on Local Property Values: A Literature Review

I. Overview

Many essential public facilities generate "disamenities" such as noise, visual intrusions, smells, barriers to traffic, or possibly even health or safety risks. Among these are airports, railroads, electric power plants, sewage treatment plants, land fills, and prisons. The disamenities generated by these facilities are spatial in nature. That is, they spill over beyond the immediate boundaries of the facility into surrounding neighborhoods. One manifestation of the spatial extent of disamenities is a discounting of residential property values within the area of influence of the facility. Thus, for example, residential property values near an airport may be lower than the values of similar properties located away from the noise of the airport.

The capitalization of amenities and disamenities into property values is a widely observed phenomenon. It reflects people's willingness to pay to be near amenities and the market discount they must receive to be near disamenities. The dollar value of a property value discount attributable to a facility is an economic measure of the value of the disamenities generated by the Facility. (Likewise, the dollar value of property value increase attributable to amenities such as a beautiful view is an economic measure of the value of the amenity).

This report describes the type of residential property value impacts generated by noxious [The use of the negative term noxious throughout this report is intended to convey the public perception of a WWTF; however, properly designed and supported facilities are not expected to be noxious.] public facilities and the magnitude of those impacts. These impacts are taken from the literature on the relationship between disamenities generated by public facilities and the capitalization of those impacts into residential property values.

The general findings can be applied to the sewage treatment plants proposed for Deer Island or Long Island in Boston Harbor as part of the Massachusetts Water Resources Authority's program to improve sewage treatment in the Boston area. While it should be noted that the general relationships identified in the literature are just that, general, they can provide a broad view of what could happen to residential property values in the vicinity of a proposed sewage treatment plant.

The literature review was confined to empirical studies of the effect of noxious public facilities on residential property values. This literature is fairly small in comparison to the whole literature on the factors which contribute to urban residential property values and on the effects of environmental amenities (such as water access) or disamenities (such as air pollution) on property values. The principal source of literature was the set of journals devoted to urban and land economics issues.

In addition we investigated a couple of sewage treatment plants for the availability of site-specific reports. The first plant was in the town of Winthrop, Massachusetts that encompasses the Deer Island Sewage Treatment Plant. Unfortunately, there were no studies conducted assessing the impact of the plant on local land values. The second facility that was investigated was the Cedar Creek Sewage Treatment Plant managed by the Nassau County Department of Public Works in New York State. This plant was built on waterfront land filled marsh and integrated with a recreational park that includes facilities such as tennis courts and a golf course. While at the time of completion of construction of the Cedar Creek Plant there were no housing units in the neighborhood, wince then, some housing units have been built. However, again there have not been any studies assessing the plant's impact on property values.

II. Findings

The literature reviewed considered the impacts of various types of noxious public facilities on residential property values. However, no studies of property value impacts of sewage treatment plants were discovered. Nonetheless, this review is useful in that the general types and magnitudes of impacts of the disamenities generated by public facilities were identified: power plants, highways, railways, and airports. These studies were conducted in a variety of urban and suburban locations throughout the United States and Canada. For the most part the studies were conducted with data on property values in the 1970s. In general, the property value data were sales prices of residential property, but in some cases they were the average price of a house in each city block or census tract as estimated by the owner of the house in the 1970 Census.

Table 1 summarizes the property value impacts described in the literature reviewed. Several types of facilities were analyzed by the investigators:

TABLE 1: SUMMARY OF IMPACTS OF NOXIOUS FACILITIES ON RESIDENTIAL PROPERTY VALUES

Study	Noxious Facility	Locations	Years	Data
Gamble and Downing (1982)	Nuclear Power Plants	Plymouth, MA Waterford, CT Lacey TWP, NJ Rochester, NY Three Mile Island, PA	1975-1977 1977-1979 For Three Mile Island	Sales prices of residential property
Blomquist (1974)	Coal fired power plant	Winneta, IL	1970	1970 Census block statistics (average house price estimated by owner)
Poon	Railways	London, Ont.	1967-1972	Housing Sales Prices
Grether and Mieszkowski (1980)	Highway	Hamden, CT	1955-1970	Sales prices of single family homes
Nelson (1980 and 1982)	Airport noise, highway noise	Review of Literature on Impacts on Property Values	1960s&1970s	Housing sales prices or census tract or block data on property values.
Mieszkowski and Saper	Airport noise	Toronto, Ont.	1969-1973	Housing sales prices
Nelson (1979)	Airport noise	Six cities: San Francisco, St. Louis, Cleveland, New Orleans, San Diego, Buffalo	1970	1970 Census data for blocks (average house price estimated by owner
Emerson (1972)	Airport noise	Minneapolis-St. Paul	1967	Housing sales prices

TABLE 1: SUMMARY OF IMPACTS OF NOXIOUS FACILITIES ON RESIDENTIAL PROPERTY VALUES (Continued)

Study	Effect of Distance to Facility on Residential Property Values
Gamble and Downing (1982)	1. No observed effect of proximity to facility on property values. 2. Three Mile Island accident affected only volume of sales for a few weeks, but not property values.
Blomquist (1974)	1. Power plant affects value of property within 11,500 feet of plant. 2. Within 11,500 feet of plant, a ten percent increase in distance from the plant is associated with a 0.9% increase in property value for the average house.
Poon	1. Decline in housing values observed up to 800 to 900 feet from railway. 2. Sale price $2,161 higher 850 feet from railway as compared to 50 feet from railway, ceteris paribus (in 1972).
Grether and Mieszkowski (1980)	1. No statistically significant effect of proximity to highway on property values. 2. Similar studies conducted for distance to apartments, commercial zones, industrial zones, and public housing but these are not noxious public facilities.
Nelson (1980 and 1982)	1. For airports, noise discounts vary from 0.4% to 1.1% per decibel; thus a $40,000 house would sell for $31,000 to $37,000 in a noisy zone (20 decibels noisier than a quiet neighborhood).
Mieszkowski and Saper	1. 4% to 24% decline in housing values in noisy areas, although due to samples sizes, authors accept 15% decline as maximum impact.
Nelson (1979)	1. For all six cities averaged housing prices in very noisy neighborhoods were valued about $2,100 less than houses in neighborhoods subject to only ambient noise levels. 2. House values decline between 0.29% and 0.74% for each decibel increase in airport noise.
Emerson (1972)	1. Decline in property value of 9.8% at maximum noise level.

The basic form of the investigations is a regression analysis with sales price of residential property as the dependent variable and with attributes of the property, distance to the noxious facility, and year of sale as the independent or explanatory variables. That is,

$$Y = a_0 + a_1X + a_2D + a_3T + u$$

where Y is the sales price of the residential property; X is a vector of property attributes such as size, structural characteristics, access to major roads, and the like; D is a measure of distance to the noxious facility of interest or a measure of the intensity of the facility's spillovers at the property site (e.g., noise levels); T is a measure of time or year of sale to reflect appreciation and inflation of property values; and u is the error term. The regression coefficients are indicated by a_i. These models are often called "hedonic" models.

The form of the specification varies from case to case. In some cases a linear model is used, in others a logarithmic model is used. The form of D, distance to the noxious facility, is sometimes specified so that property values increase with increasing distance from the facility, but then level off, holding all other effects constant.

The major findings are:

- Not all noxious facilities have a detrimental effect on residential property values.

- When a noxious facility does have an effect on property values, that effect diminishes with distance and is no longer observed after a threshhold distance. The threshhold distance could be a few hundred feet to a few miles.

- The effect of a noxious facility on property values can be very small (e.g., less than one percent diminution) to very large (e.g., 15% diminution).

- The impact of noxious facilities on residential property values varies greatly from case to case and appears to depend on housing market characteristics, the specific characteristics of the facility, and local likes and dislikes concerning disamenities.

BIBLIOGRAPHY

Blomquist, Glenn, "The Effect of Electric Utility Power Plant Location on Area Property Value,": Land Economics vol 50 (1974) 97-100.

Emerson, Frank, "Valuation of Residential Amenities: An Econometric Approach,": Appraisal Journal, (April, 1972) 268-278.

Gamble, Hays, and Roger Downing, "Effects of Nuclear Power Plants on Residential Property Values,": Journal of Regional Science Vol. 22 (1982) 457-478.

Grether, David, and Peter Mieszkowski, "The Effects of Nonresidential Land Uses on the Prices of Adjacent Housing: Some Estimates of Proximity Effects," Journal of Urban Economics Vol 8 (1980) 1-15.

Mieszkowski, Peter and Arthur Saper, "An Estimate of the Effects of Airport Noise on Property Values," Journal of Urban Economics Vol 5 (1978) 425-440.

Nelson, Jon, "Airport Noise, Location Rent, and the Market for Residential Amenities,": Journal of Environmental Economics and Management Vol 6 (1979) 320-331.

Nelson, Jon, "Airports and Property Values," Journal of Transport Economics and Policy, (Jan. 1980) 37-52.

Nelson, Jon, "Highway Noise and Property Values," Journal of Transport Economics and Policy, (May, 1982) 117-138.

Poon, Larry C.L., "Railway Externalities and REsidential Property Prices," Land Economics Vol 54 (May, 1978) 218-227.

II-15

pathogen research evaluation

II-15. AIRBORNE TRANSPORT OF PATHOGENIC ORGANISMS

A. Background

EPA received comments on the SDEIS on the issue of impacts of airborne transport of pathogenic organisms.

The comments center on the following areas:

1. Why didn't the SDEIS include an evaluation of the impacts and health effects of aerosols from the wastewater treatment facility on nearby populations?

2. What does the literature say about pathogen transport and what is EPA official policy?

3. Does the issue of pathogen transport favor a site for the wastewater treatment facility?

In order to properly evaluate the above mentioned issues, Region I requested assistance from the EPA Health Effects Research Laboratory, Office of Research and Development, Cincinnatti, Ohio.

The Health Effects Research Laboratory has conducted a research literature review on the subject of potential health risk from wastewater aerosols. The FEIS contains a sampling of technical papers on this issue. The conclusions drawn from these studies indicate that the potential for airborne transport of wastewater aerosols does exist and has been documented to certain distances (up to 800 m.). However, according to the EPA Health Effects Laboratory, less than half of the wastewater aerosols are respirable and very few, probably about one percent are pathogenic. The results of the EPA research do not support any suggested increase in illness of residents living near secondary activated sludge treatment plants.

An examination of the research completed to date concludes there is no expected adverse impact on public health from treatment plants located near residential areas similar to the proposed Deer Island facility and its proximity to residents of Point Shirley.

B. Conclusions

Comprehensive investigations conducted on aerosol transport leave little doubt that living near a wastewater treatment plant does not present a significant microbiological hazard to people. There is presently no known information that would indicate a potential health problem at the plant or nearby residential neighborhood.

Although research has been completed at a number of plants around the country, there are few treatment plants the size proposed for Deer Island. In order to respond to the public concern regarding pathogens and their impact the MWRA might wish to conduct a pilot air monitoring program for pathogenic organisms at the perimeter of the wastewater treatment facility to verify that no potential problem exists.

The following references are attached for additional information which supports EPA's position on this issue:

Aerosols from Activated Sludge Plants: EPA TECHNIGRAM. Herbert R. Pahren, Walter Jakubowski, and Leland J. McCabe.

Study of Microbial Aerosols Emitted from a Water Reclamation Plant. Project Summary, EPA-600/81-83-013 by Kerby F. Fannin and Standley C. Vana. Sept. 1983.

Effect of an Activated Sludge Wastewater Treatment Plant on Ambient Air Densities of Aerosols Containing Bacteria and Virus. Kerby F. Fannin, Standley C. Vana and Walter Jakubowski. Feb. 27, 1985.

Health Risks of Human Exposure to Wastewater. Project Summary EPA 600-81-81-002. Mar. 1981.

Wastewater Aerosols and Disease. Proceedings of a Symposium. September 19-21, 1979. Edited by H. Pahren and W. Jakubowski: EPA. Office of Research and Development.

Aerosols from Activated Sludge Plants

Herbert R.Pahren, Walter Jakubowski, and Leland J. McCabe, Epidemiology Division, Health Effects Research Laboratory, USEPA, Cincinnati, OH 45268

Many wastewater treatment plants are constructed in urban areas in close proximity to residential housing. These systems generally contain aeration basins or trickling filters where there is an opportunity for small droplets of wastewater to be emitted. These droplets could contain a bacterium or virus and evaporate very rapidly to yield droplet nuclei in the size range of 0.5 to 30 microns in diameter. Such particles are known as aerosols.

Numerous persons have investigated the types of organisms emitted and the density in relation to distance from the treatment plant. An overview of the subject was published by Hickey and Reist.[4] There had also been discussions of the health significance of working at a sewage treatment plant, but there was a paucity of data upon which to base definitive conclusions regarding health effects.

The microorganisms from the treatment plant travel passively with the wind and their density decreases with time and distance as a result of atmospheric dispersion, loss of viability, and deposition. The potential for plant workers and nearby residents to inhale viable organisms certainly exists. However, there had never been a systematic investigation to confirm or negate the existence of a health hazard from these viable wastewater aerosols.

With this background, the Health Effects Research Laboratory of the U.S. Environmental Protection Agency arranged for several studies to gather information on health effects associated with aerosols from uncovered wastewater treatment plants. These studies were conducted by personnel from universities or research institutions and were presented at a symposium along with background information on exposure to microorganisms in aerosols.[2]

Epidemiology Studies

In one study, illness rates of students at an elementary school, located adjacent to a new advanced wastewater treatment plant, were measured by analyzing recorded absenteeism at this school before and after start-up of the new plant. Attendance at eight nearby schools was used for control rates. Microorganism densities from the plant were measured and a daily exposure index for the children was calculated. Detailed examination of school attendance patterns for the two year period prior to the operation of the sewage treatment plant and the two year period following operation revealed no differences for the school next to the treatment plant. Similar comparisons of attendance at this school and the eight other nearby schools showed no differences. The data provide no evidence of an adverse health response from the treatment plant.

Another study involved the evaluation of residents living near a new activated sludge plant for one year prior to start-up of the plant and one year following operation. Over 4,200 persons who lived between 0.4 and 5.0 kilometers from the plant answered questions regarding their illnesses and health status. Detailed statistical analyses were then conducted to determine if results could be related in any way to the operation of the plant. Another part of the study included taking clinical specimens from 282 persons near the plant. Environmental measurements were also made.

Although the plant was found to be a source of several microbiological indicators, the levels of the agents in the air, soil, and water samples in the neighboring residential areas were not distinguishable from background levels. Based on questionnaire results alone, the responses showed a slight increase in gastrointestinal symptoms after operation of the plant for persons living the nearest distance. Streptococci isolations in the throat swabs also increased. In contrast, tests for 31 viral antibodies and attempted isolations of many pathogenic bacteria, parasites, and viruses yielded no evidence of an adverse health effect from the wastewater treatment plant. On balance the overall conclusion was that the plant did not present a health hazard for nearby residents.

Still another evaluation was made near a very large plant that had been in operation since 1929. A health questionnaire survey was made of 2,378 persons over an eight month period. 318 persons gave paired blood samples at the beginning and end of the period, and stool and throat specimens were collected from children under age 12.

The plant was found to be a source of total viable particles which were still above background levels 800 meters downwind. Total coliforms were at background levels at this distance. However, there was no indication that the microorganisms resulted in increased illness rates, pathogen isolation rates or increased antibody to enteroviruses measured.

In an effort to check persons with the highest exposure to wastewater aerosols, and with the best probability of showing a response, studies were made of wastewater workers. It is recognized that such exposure could be due to direct contact with sewage or handling equipment contaminated by sewage as well as exposure by means of the aerosol route.

The primary study group consisted of about 100 newly employed activated sludge plant workers in three cities. In addition, various control groups were compared and included utility workers, sewer maintenance workers, highway maintenance workers, and persons who worked at a primary sewage treatment plant.

Detailed medical evaluations were made of the exposed and control workers as well as families of many participants. The only difference in illness rates among worker groups which was statistically significant was higher gastrointestinal illness between inexperienced workers and other groups. These gastrointestinal illnesses were mild and generally appeared within the first several months of employment. There was no relationship between the occurrence of illness and rise of antibody titer for any of the numerous agents checked. An increase in infection was not demonstrated by culture techniques but serologic tests suggested a slight increase with some viruses and bacteria in the wastewater exposed workers. In the study of families, there were no differences between the results of the two groups of families.

Assessment

The comprehensive investigations described leave little doubt that working at or living near a wastewater treatment plant does not present a significant microbiological hazard to the people. However, it should always be kept in mind that sewage contains potentially pathogenic agents and workers at sewage treatment plants should always maintain good personal hygiene and sanitation practices.

Several reasons may be offered why the study participants generally did not become infected or ill even though exposed to microbial aerosols. 1) Densities of specific pathogens were low, and were reduced rapidly with time and distance from the source. 2) A person would ordinarily inhale very few organisms unless constantly exposed for many hours. 3) The exposure levels were below the minimum infective dose. 4) Microorganisms in wastewater are primarily enteric organisms whereas the route of exposure was respiratory. 5) Phagocytic cells tended to respond to the foreign substance before antibody cells were formed. 6) Exposed persons were probably in good health and better able to combat infection than would sickly persons. 7) Infectious agents other than those checked may have caused an undetected infection.

Cost Impact

The most effective and probably only proven method to contain microbial aerosols would be to cover the aeration basins at an activated sludge plant. This would be costly as well as result in maintenance problems. As a result of local pressure and litigation, all of the treatment plant units, including six large retention basins, were covered at the Clavey Road Wastewater Treatment Plant in Highland Park, Illinois. It cost over $8.5 million to cover those units which was 24 percent of the total capital costs for expanding the plant from 4.5 to 18 mgd.[7] A similar proposal for a plant at Des Plaines, Illinois could have added 10 to 30 percent to the cost. If all sewage treatment plants in the United States would be handled similarly, the cost impact could be nearly $1 billion per year at recent rates of construction expenditure. The $3 million research expenditure over a five year period for the various health effects studies was a modest price to show that aeration basin covers are not necesary as a national policy to protect public health.

References

1. Hickey, J.L.S. and Reist, P.C. "Health Significance of Airborne Microorganisms from Wastewater Treatment Processes. Part I: Summary of Investigations." *Jour. Water Poll. Control Fed., 47, 2741 (1975).*
2. Pahren, H.R. and Jakubowski, W. [Eds.], "Wastewater Aerosols and Disease." EPA-600/9-80-028. U.S. EPA, Cincinnati, Ohio (1980).

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Health Effects Research Laboratory
Research Triangle Park, NC 27711

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Project Summary

Study of Microbial Aerosols Emitted from a Water Reclamation Plant

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The purpose of this investigation was to determine the occurrence of selected microorganisms in the air in the vicinity of the O'Hare Water Reclamation Plant (OWRP), Des Plaines, Illinois. The contribution of the OWRP to ambient microbial aerosols was determined by comparing baseline, or preoperational, observations during fall and spring/summer months to those made after operation was initiated. Three sampling sites were positioned < 150 m, 150 to 250 m, and > 250 m downwind, while one location was upwind of the center of the two-stage activated sludge aeration tanks. Depending upon the wind direction, the first downwind site was frequently positioned at < 5 m from the edge of the aeration tanks, with the other downwind sites proportionally nearer to this tank boundary.

Air sampling volumes were based upon predetermined sensitivity levels for each group of microorganisms. At each site, multistaged impactor and slit samplers were used to determine total aerobic bacteria-containing particle concentrations and particle size distributions. In addition, "large volume" air samplers, that included electrostatic precipitator and cyclone scrubber samplers, were used to detect aerosols of standard plate count organisms, total coliforms, fecal coliforms, fecal streptococci, *Salmonella* sp., other organisms within the total coliform group, coliphages of *Escherichia coli* C3000, and animal viruses detectable with Buffalo green monkey kidney (BGMK) and WI-38 cell cultures.

Low concentrations of several aerobic bacteria species and of certain coliphages were present in the air surrounding the newly constructed activated sludge plant before operation was initiated. After plant operations began at 21 to 67% of its design capacity of approximately 270,000 m^3/d [72 million gallons per day (MDG)], the frequency of detection of all microorganisms studied increased at the < 150 m downwind locations. The geometric mean total aerobic bacteria-containing particle (TABCP) concentrations, determined with slit samplers, increased from 59 to 218 colony forming units (cfu)/m^3 during the nighttime and from 34 to 57 cfu/m^3 during the daytime. The TABCP concentrations determined with Andersen samplers increased from 125 to 281 cfu/m^3 during the nighttime and from 87 to 234 cfu/m^3 during the daytime.

Using large volume scrubber (LVS) samplers at the first downwind location, standard plate count (SPC) organism geometric mean concentrations during the fall nighttime increased from 55 to 1325 cfu/m^3 and during the fall daytime from 49 to 220 cfu/m^3. Increases from 0.30 to 5.03 cfu/m^3 for total coliforms, 0.12 to 1.02 cfu/m^3 for fecal coliforms, 0.14 to 0.66 cfu/m^3 for fecal streptococcus organisms, and 0.004 to 0.095 most probable number plaque-forming units (mpnpfu)/ m^3 for coliphages were also observed at this first downwind site after operations started. At 150 to 250 m downwind from the center of the aeration tanks aerosol concentrations of total coliforms, fecal

coliforms, fecal streptococci, and coliphages were significantly higher during plant operations than before such operations started. When the aerosol concentrations of these organisms at the >250 m downwind site during plant operations were compared to preoperation concentrations, however, no significant ($p < 0.01$) differences could be detected from any group except for the coliphages.

Microbial aerosol concentrations were generally higher during the nighttime than during the daytime. The total coliform bacteria in aerosols during plant operations were predominantly *Enterobacter* sp., *Escherichia* sp., and *Klebsiella* sp., respectively. Animal viruses were detected at < 150 m downwind from the center of the aeration tanks in BGMK but not in WI-38 cells in two of twelve downwind air samples having total assay volumes of 385 to 428 m^3. Of the three virus isolates, two were identified as coxsackievirus B-1. The other virus was not identified by the antisera pools used.

The low-level concentrations of microbial aerosols observed before plant operations began did not increase beyond the perimeter of the plant on the east, south, and west sides during plant operations. Depending upon the meteorological and diurnal conditions, the concentration of certain microorganisms could occasionally increase beyond the north plant boundary. These concentrations, however, are very low (< 1 cfu or mpnpfu/m^3) and require very sensitive methods for detection.

This Project Summary was developed by EPA's Health Effects Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Population growth within large urban regions necessitates expansion of existing wastewater treatment systems for processing increased volumes of sewage prior to utilization or discharge. Locating new wastewater treatment facilities in densely populated regions, however, requires consideration of the potential environmental and health effects of their operation. Microbial aerosols are emitted by wastewater treatment processes into the surrounding air. Activated sludge treatment, for example, generates small bubbles by diffused air aeration that adsorb and concentrate suspended bacteria and viruses as they rise through the sewage depth in the aeration tank to the surface boundary. At this boundary, a surface film containing microorganisms is disrupted as these rising bubbles burst, releasing tiny aerosol droplets containing the bubble-adsorbed, as well as the surface film-associated microorganisms.

The nearly instantaneous evaporation which may occur as these droplets become suspended in air leaves dried residues referred to as droplet nuclei that are subject to downwind dispersion. The survival and dispersion of the organisms that may be associated with these droplet nuclei are affected by organism characteristics and environmental factors such as relative humidity, temperature, irradiation, wind velocity, atmospheric stability, and atmospheric pollutants.

While processes of wastewater treatment have shown to generate microbial-laden aerosols that can be carried downwind, the occurrence of potentially infectious microbial aerosols per se does not provide evidence of associated health risks. No conclusive evidence is yet available that demonstrates that persons residing in the vicinity of wastewater treatment facilities are subjected to greater health risks than those who do not dwell in such areas. Placing such facilities in regions of high population densities has, however, initiated concerns regarding the health implication of exposure to microorganism-containing wastewater aerosols.

One such facility, the O'Hare Water Reclamation Plant (OWRP), located in the City of Des Plaines, Illinois, was constructed to be operated as part of the regional Metropolitan Sanitary District of Greater Chicago (MSDGC) system. The proximity of this plant to a residential area has been the subject of concern over the past several years because of the potential for exposure to plant-emitted microbial aerosols. Because no data were available to determine the potential for community exposure to microbial aerosols that might be emitted from this plant, this study was initiated to determine the probability of such exposure over a wide range of environmental and meteorological conditions.

The probability of community exposure was evaluated by comparing the preoperational, or baseline, plant site microbial aerosol contribution to the surrounding environment to that observed after initiation of plant operations. This study was intended to provide data on whether or not significant increases in microbial aerosols could be attributed to facility operations during different seasons and atmospheric conditions.

Conclusions

1. When operating at 21 to 67% of its design capacity, the OWRP is a source of aerosols containing bacteria and viruses.
2. Significant aerosol concentration increases over the baseline at < 150 m downwind from the center (or, depending on the wind direction, to within 5 m from the edge) of the aeration tanks, were observed for total aerobic bacteria-containing particles, standard plate count organisms, total coliforms, fecal coliforms, fecal streptococci, and coliphages. The total coliform aerosols identified were predominantly *Enterobacter* sp., *Escherichia* sp., and *Klebsiella* sp. Animal viruses from assay volumes ranging from 385 to 428 m^3 in two cell culture lines were detected in two of twelve downwind air samples. Of three virus isolates, two were identified as coxsackievirus B-1 and the third was not identified with the antisera pool used.
3. At 150 to 250 m downwind from the center of the aeration tanks, no significant increases in microbial aerosol concentrations were observed during the daytime after the plant began operations. When considering both daytime and nighttime samples, however, significant increases were observed for total coliforms, fecal coliforms, fecal streptococci, and coliphages. The concentrations of these organisms at 150 to 250 m downwind sites decreased substantially from those observed at the < 150 m downwind locations during plant operations. These concentrations decreased by 85% (5.0 to 0.77 cfu/m^3) for total coliforms, by 76% (1.02 to 0.24 cfu/m^3) for fecal coliforms, by 33% (0.66 to 0.44 cfu/m^3) for fecal streptococci, and by 68% (0.004 to 0.002 mpnpfu) for coliphages.
4. Aerosol concentrations did not significantly increase after the plant began operations for any bacteria studied at sampling distances beyond 250 m downwind from the center of the aeration tanks. The frequency of detection did, however, increase from 38 to 79% for total coliforms, from 0 to 63% for fecal coliforms, and from 69 to 89% for fecal streptococci. Coliphage concentrations were, however, significantly higher and their frequency of detection increased from 22 to 86% after the plant began operations.

5. Bacteria aerosol concentrations were directly related to sewage flow rate within 150 m downwind of the center of the aeration tanks during the fall season of plant operations, but, at downwind locations greater than 150 m downwind, inverse correlations were observed at night.
6. During plant operations, bacteria aerosol concentration was directly related to wind velocity during the spring/summer season at locations ≤250 m downwind of the center of the aeration tanks. Before operations, negative correlations were found at upwind and 150 to 250 m downwind locations.
7. Bacteria aerosol concentrations were directly related to temperature at locations within 150 m downwind of the aeration tanks during plant operations. At nighttime, however, negative correlations were observed at locations > 250 m downwind and upwind.
8. Bacteria aerosol concentrations were generally inversely related to relative humidity.
9. Fecal streptococci and coliphages appear to be more stable in aerosols than the other indicator bacteria studied.
10. Low-level concentrations of bacteria and coliphages were present in the air in the vicinity of the OWRP before the plant began operations. These concentrations did not increase beyond the perimeter of the plant on the east, south, and west sides during plant operations. Depending upon the meteorological and diurnal conditions, the concentration of certain microorganisms could occasionally increase beyond the north plant boundary. These concentrations, however, are low (< 1 cfu or mpnpfu/m^3), and require very sensitive methods for detection.

Recommendations

1. Selected microbial aerosol parameters should be monitored at the OWRP boundary during the nighttime when the plant begins operation at full capacity. These data should then be compared to the baseline observations made in this study to determine whether significant concentration increases occur at higher sewage flow rates.
2. Coliphages and fecal streptococci appear to be stable as aerosols and are recommended as indicators of potential sewage-borne aerosol contaminations.

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The complete report, entitled "Study of Microbial Aerosols Emitted from a Water Reclamation Plant," (Order No. PB 83-234 906; Cost: $14.50, subject to change) will be available only from:
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Effect of an Activated Sludge Wastewater Treatment Plant on Ambient Air Densities of Aerosols Containing Bacteria and Viruses

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Bacteria- and virus-containing aerosols were studied during the late summer and fall seasons in a midwestern suburb of the United States before and during the start-up and operation of an unenclosed activated sludge wastewater treatment plant. The study showed that the air in this suburban area contained low-level densities of indicator microorganisms. After the plant began operating, the densities of total aerobic bacteria-containing particles, standard plate count bacteria, total coliforms, fecal coliforms, fecal streptococci, and coliphages increased significantly in the air within the perimeter of the plant. Before plant operations, bacteria were detected from five genera, *Klebsiella*, *Enterobacter*, *Serratia*, *Salmonella*, and *Aeromonas*. During plant operations, the number of genera identified increased to 11. In addition to those genera found before plant operations, *Escherichia*, *Providencia*, *Citrobacter*, *Acinetobacter*, *Pasteurella*, and *Proteus*, were also identified. Enteric viruses were detected in low densities from the air emissions of this plant. Only standard plate count bacteria remained at significantly higher than base-line densities beyond 250 m downwind from the center of the aeration tanks. Fecal streptococci and coliphages appeared to be more stable in aerosols than the other indicator microorganisms studied. In general, the densities of microorganism-containing aerosols were higher at night than during the day. The techniques used in this study may be employed to establish microorganism-containing aerosol exposure during epidemiological investigations.

Aerosols that contain microorganisms are generated through natural processes. Such microorganism-containing aerosols occur widely in nature and are generated in the oceans by wave action (5, 6) and on the land when wind suspends decaying vegetative debris through soil erosion (24). Microorganism-containing aerosols are reportedly capable of very long-range transport (6). Some of these aerosols can contain microorganisms pathogenic to humans as well as to agricultural livestock and crops.

Many other sources of microorganism-containing aerosols are, however, generated through human activities in both urban and rural areas (8, 9). Population growth in urban areas has increased the density of domestic wastes which must be disposed of in a safe and environmentally sound manner. Consequently, expansion of existing waste treatment or utilization facilities is necessary. Some of these facilities have, however, been shown to emit microorganism-containing aerosols under certain conditions. Sewage treatment plants (1, 20), sanitary landfills and resource recovery systems (17), and compost operations (18), for example, have all been considered as potential sources of airborne infectious microorganisms. Because of economic, environmental, or political constraints, some of these facilities are located in densely populated regions of urban or suburban communities. In these cases, a determination of the contribution of the facilities to the microorganism content of the ambient air may allow an evaluation of the potential for adverse health or environmental effects.

One such facility, the O'Hare Water Reclamation Plant, located near the O'Hare International Airport in the City of Des Plaines, Ill., a suburban area northwest of Chicago, was constructed to be operated as part of the regional Metropolitan Sanitary District of Greater Chicago system. The proximity of this plant to a residential area was the subject of concern for several years because of the potential for exposure of the surrounding population to microbial aerosols emitted from the plant. The purpose of this study was to determine the contribution of the newly constructed plant to the base-line microbial aerosol densities that already existed in the vicinity of that plant. The results reported here were part of a larger study of microorganism densities in air at the wastewater treatment plant site (13).

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MATERIALS AND METHODS

Field sampling approach. (i) Study site and sampling locations. The O'Hare Water Reclamation Plant was designed as a 272,000 m^3 (72 × 10^6 gallons per day (MGD) capacity two-stage municipal sewage plant. The dimensions of the two-stage aeration basins, including walkways, were ca. 160 by 200 m. The microbial aerosol densities reported in this paper were determined during the late summer and fall season in the vicinity of this plant before it was operated and again during a similar season after it began operating. The first sampling season was from 15 August to 7 November the year before the plant was started, and the second was from 26 August to 12 November during the first year of plant operations.

Aerosol sampling sites were located at various distances downwind (<150, 150 to 250, and >250 m) or upwind of the center of the aeration tanks. As shown in Fig. 1, this center was positioned ca. 80 m from the north and south aeration tank boundaries and ca. 100 m from the east and west boundaries of the first- and second-stage aeration tanks, respectively. This location was also ca. 120 m from the northwest and southwest corners of the second-stage aeration tanks and about the same distance from the northeast and southeast corners of the first-stage aeration tanks. The sampling sites in closest proximity to the aeration tanks were

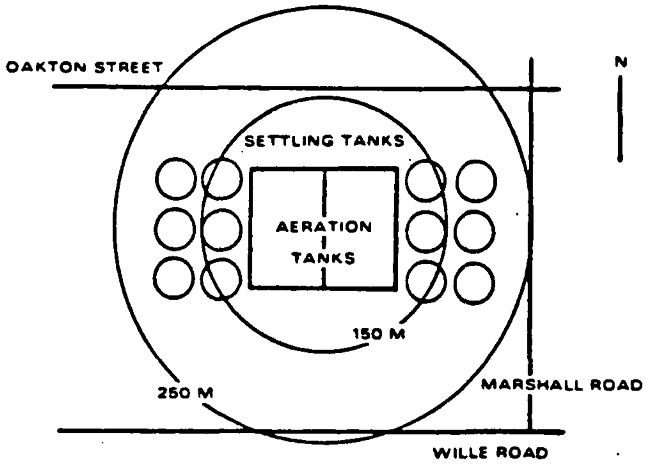

FIG. 1. O'Hare Water Reclamation Plant. Sampling distances with respect to center of aeration tanks.

located <150 m downwind from the center of the tanks. Since the exact location of these sites was determined by physical accessibility, many samples were taken near or at the aeration tank boundary.

(ii) Air sampling methods. Sampling instrumentation and procedures were selected with the goal of determining the density of microbial aerosols of potential public health significance. The organisms sampled, the sampling devices used, and the reporting units for the organisms studied are listed in Table 1. Air samples were taken during the day (0800 to 1959 h) and night (2000 to 0759 h) by using multistaged impactors (MSI) (3) and large-volume scrubbers (LVS) (12) at each of the four general locations with respect to the center of the aeration tanks.

Total aerobic bacteria-containing particle (TABCP) samples were taken at an air sampling rate of ca. 0.03 m^3/min by using MSI samplers (Andersen, Inc.). These samplers were swabbed with 70% ethanol and loaded with six glass plates containing 27 ml of Trypticase soy agar (BBL Microbiology Systems) with 0.01 to 0.02% cycloheximide and coated with 0.2% oxyethylene docosanol green), to reduce desiccation. Samples of standard plate count (SPC) organisms, total coliforms (TC), fecal coliforms (FC), fecal streptococci (FS), coliphages (CP), and enteric viruses (EV) were taken with LVS at air sampling rates of 0.6 to 0.9 m^3/min. These samplers were sterilized by conventional autoclaving before field use. The sampling fluids used were Trypticase soy broth (25%) for SPC organisms, TC, FC, and FS; dulcitol selenite broth (50%) for *Salmonella* sp.; phage assay broth (25%) for CP; and Hanks balanced salt solution with 25% nutrient broth for EV. Particle-laden sampling fluid was aseptically collected in serum-stoppered bottles. The fluid was recirculated during sampling for EV, and evaporation losses were replaced with sterile distilled water. Collected samples were maintained on wet ice during sampling and transport.

Assay and enumeration. When available, standard methods for assay and enumeration were those previously described (2). The standard membrane filter procedure was used for TC, FC, and FS assays, and the SPC procedure was used for SPC organism determinations. Selected TC colonies were identified by using API 20E strips (Analytab, Inc.) with the oxidase test.

Assays for *Salmonella* sp. and CP were performed in enrichment tubes and were enumerated by using the most-probable-number (MPN) method for estimating the density of small numbers of microorganisms in fluids. CP were assayed on *Escherichia coli* C3000 cells as previously described (11). *Salmonella* cells were enriched in dulcitol selenite broth at 40°C for 24 h and then streaked onto xylose lysine desoxycholate agar as previously described (16). Black colonies observed after 24 h of incubation at 37°C were identified with the API system.

Samples for EV assay were sonicated (model W-375; Heat Systems-Ultrasonics, Inc.), filtered through 0.2-μm heat-inactivated fetal calf serum-pretreated membrane filters and divided into two portions. The first portion was assayed for cytopathic effect. If this portion was negative, then the second portion was also assayed for cytopathic effect. Otherwise, the second portion was assayed by the plaque method.

EV assays were performed on Buffalo Green Monkey Kidney and WI-38 cell monolayers. Cell cultures were grown at 37°C in minimum essential medium with 10% fetal calf serum and antibiotics (gentamicin, 50 μg/ml; amphotericin B [Fungizone], 2.5 μg/ml). Cells were washed with Hanks balanced salt solution, inoculated with sample, and rewashed after a 2-h virus adsorption period. The inoculated cultures were then overlaid with either liquid- or agar-based minimal essential medium and assayed as previously described (10). Virus isolates were identified by serum neutralization by using pooled enterovirus antisera.

Quality assurance. Before use and periodically throughout the project, each sampler was calibrated to determine air flow rates by using a precalibrated mass flow meter or anemometer. These samplers were numbered, and collected samples were identified with a particular instrument. Field loading and unloading of MSI was monitored by using control agar plates. LVS and MSI were autoclaved at 121°C for 15 min.

During sample assay, two negative and two positive organism control assays were performed for each field trial. For the positive controls, suitable dilutions of *Enterobacter aerogenes*, *Escherichia coli*, *Streptococcus faecalis*, *Klebsiella pneumoniae*, *Salmonella enteritidis*, MS-2 phage, and poliovirus type 1 were used for TC, FC, FS, *Klebsiella* sp., *Salmonella* sp., CP, and EV tests, respectively. Periodic bacteria assays for SPC organisms with tryptone glucose extract by the spread plate procedure on Trypticase soy agar were used to confirm the SPC technique and the TABCP medium. Plates used for TABCP determinations were incubated at 35°C for 24 h before use and discarded upon evidence of colonial growth.

To minimize the possibility of cross-contamination, positive control assays were performed after sample assays. In

TABLE 1. Microorganism-containing aerosol sampling

Microorganisms	Sampling device	Air vol sampled (m^3)	Units
TABCP	MSI	0.8–1.7	CFU
SPC	LVS	0.8–1.7	CFU
TC	LVS	5–10	CFU
FC	LVS	10–20	CFU
FS	LVS	10–20	CFU
Salmonella sp.	LVS	30–60	MPN VU[a]
CP	LVS	30–60	MPN PFU
EV	LVS	400–600	CPU[b]

[a] VU, Viable units.
[b] CPU, Cytopathogenic units.

addition, positive EV control assays were always performed in a separate laminar flow hood from that used for sample assays. Virus isolates were stored at −70°C in a locked freezer containing no other virus stocks.

Data analyses. Data were analyzed to test the hypothesis that the densities of the microorganism-containing aerosols studied were not significantly different after the O'Hare Water Reclamation Plant began operations than were observed in the ambient air at the site of the future plant. The nonparametric Mann-Whitney U test was used for determining significance at the $P < 0.01$ level (22, 23). Geometric means were weighted by p/n, where p was the number of positive observations and n was the total number of observations. This weighting procedure was similar to that described by Snedecor and Cochran (23).

RESULTS

During the late summer and fall after the plant began operating the sewage flow rates ranged from 56,100 to 183,000 m^3/day (14.8 to 48.4 MGD) during aerosol sampling. The average flow rate was 106,000 m^3/day (27.9 MGD). A total of 738 assays were performed for TABCP, SPC, TC, FC, FS, and CP organisms among the four sampling locations during the fall seasons of this study. Of the 316 assays performed before plant start-up, 29, 28, 28, and 16% were from the upwind, <150-m-downwind, 150- to 250-m-downwind, and >250-m-downwind locations, respectively. Of the 422 assays performed after the plant was started, 30, 31, 24, and 15% were from those respective locations. Of the 30 EV assays, 12 were performed before and 18 were performed after the plant was started. One-half of these assays were performed from the <150-m-downwind and the upwind locations.

SPC. The geometric mean aerosol densities of SPC bacteria are shown in Table 2. The downwind densities increased significantly during the night at all downwind sampling locations after the plant began operating. At the <150-m sampling location the increase was from 55 to 1,325 CFU/m^3 ($P < 0.001$), at the 150- to 250-m location the increase was from 65 to 410 CFU/m^3 ($P < 0.01$), and at the >250-m location the increase was from 60 to 262 CFU/m^3 ($P < 0.01$) after the plant began operating. Significant increases were not observed during the daytime at any location.

TABCP. TABCP aerosol densities (Table 2) were generally lower than those observed for the SPC bacteria during plant operation, suggesting that aerosolized particles contained multiple organisms. After plant operations commenced, significant geometric mean density increases ($P < 0.001$) were observed during both the day (65 to 272 CFU/m^3) and night (102 to 373 CFU/m^3) at the <150-m-downwind location, but were not observed at further downwind locations. The upwind and most distant downwind locations were sometimes (depending on the prevailing wind direction) downwind from heavy road traffic, which contributed dust to the area and could have increased the density of TABCP aerosols at those sites, especially during daytime rush-hour periods.

TC. TC geometric mean densities (Table 3) increased significantly ($P < 0.01$) from 0.27 to 5.17 CFU/m^3 at the <150-m location during the night after the plant began operations. During the day, these densities increased from 0.24 to 6.81 CFU/m^3. These differences were substantial but were not accepted as significant ($P = 0.026$). The increases of from 0.18 to 0.57 CFU/m^3 during the night and from 0.28 to 0.86 CFU/m^3 during the day at the 150- to 250-m-downwind locations were not significant. The densities beyond 250 m downwind and at upwind locations did not increase significantly during either the day or night after plant operations started.

FC. No FC-containing aerosols were detected during either the day or night before the plant began operating. As shown in Table 3, the densities of these bacteria increased at all downwind locations after the plant began operating. During plant operations, the weighted FC aerosol densities were 0.01 CFU/m^3 upwind of the plant during both the day and night. At night the geometric mean densities were 2.09,

TABLE 2. Aerosol densities of SPC bacteria and TABCP

Microorganisms	Density (CFU/m³)							
	Upwind		Downwind (m)					
			<150		150–250		>250	
	Day	Night	Day	Night	Day	Night	Day	Night
SPC bacteria								
Preoperation	43	26	49	55	32	65	52	60
Postoperation	157	297	220	1,325	102	410	194	262
TABCP								
Preoperation	141	76	65	102	113	104	163	270
Postoperation	79	52	272	373	115	175	194	191

TABLE 3. Aerosol densities of TC, FC, and FS

Microorganisms	Density (CFU/m³)							
	Upwind		Downwind (m)					
			<150		150–250		>250	
	Day	Night	Day	Night	Day	Night	Day	Night
TC								
Preoperation	0.21	0.28	0.24	0.27	0.28	0.18	0.22	0.12
Postoperation	0.22	0.09	6.81	5.17	0.86	0.57	0.40	0.34
FC								
Preoperation	<0.04	<0.06	<0.03	<0.06	<0.04	<0.06	<0.03	<0.06
Postoperation	0.01	0.01	1.67	2.09	0.18	0.64	0.29	0.15
FS								
Preoperation	0.13	0.88	0.04	0.70	0.14	1.00	0.06	0.58
Postoperation	0.04	0.83	0.29	2.07	0.15	1.21	0.48	0.86

TABLE 4. Aerosol density of CP

CP	Density (MPN PFU/m³)			
	Upwind	Downwind (m)		
		<150	150–250	>250
Preoperation	$<2.5 \times 10^{-2}$	5.0×10^{-3}	$<2.6 \times 10^{-2}$	2.8×10^{-2}
Postoperation	1.2×10^{-2}	7.3×10^{-2}	4.9×10^{-2}	7.6×10^{-2}

0.64, and 0.15 CFU/m³ at the <150-, 150- to 250-, and >250-m-downwind locations, respectively. Daytime densities at the <150- and 150- to 250-m-downwind locations (1.67 and 0.18 CFU/m³, respectively) were lower than those observed at night. At the most distant downwind locations, the density was 0.29 and 0.15 CFU/m³ during the day and night, respectively.

FS. FS densities were consistently higher at night than during the day at all sampling locations both before and during plant operations. Night densities before the plant began operating were higher than those observed during the day during plant operations at all sampling locations. Background FS geometric mean densities (Table 3) ranged from 0.04 to 0.14 CFU/m³ during the day and from 0.58 to 1.00 CFU/m³ during the night at all downwind locations. After the plant began operations, night densities ranged from 0.86 to 2.07 CFU/m³ at the >250- and <150-m-downwind locations, respectively.

Members of the family *Enterobacteriaceae*. The diversity of bacterial isolates identified from TC aerosols increased after the plant began operations. Before plant operations, bacteria were detected from five genera: *Klebsiella*, *Enterobacter*, *Serratia*, *Salmonella*, and *Aeromonas*. During plant operations, the number of genera identified increased to 11. In addition to those genera found before plant operations, the genera *Escherichia*, *Providencia*, *Citrobacter*, *Acinetobacter*, *Pasteurella* and *Proteus* were also identified.

Before plant operations, the genus *Enterobacter* constituted 80% or more of the bacteria identified from each of the four sampling locations. *Enterobacter agglomerans* was the most frequently identified species at all locations. Other species were identified with extremely low frequency. For example, *Klebsiella pneumoniae*, *Klebsiella ozaenae*, and *Klebsiella oxytoca* were each detected with low frequency (on two or fewer occasions) before the plant began operations.

During plant operations, the most frequently isolated genera were *Escherichia* followed by *Enterobacter*, *Klebsiella*, and *Citrobacter*. Most of these isolates were found in aerosols <150 m downwind of the center of the aeration tanks. A total of 88% of the *Klebsiella*, 96% of the *Escherichia*, and 92% of the *Enterobacter* isolates were identified at downwind locations closer than 250 m. The most frequently isolated *Klebsiella* species was *K. pneumoniae*, followed by *K. oxytoca*.

***Salmonella* sp.** Before plant operations, one isolate, confirmed as *Salmonella cholerae* was detected within 150 m downwind of the center of the future aeration tanks. During plant operations, *Salmonella* sp.-containing aerosols were detected on one occasion at <150 m, and on another occasion *Salmonella paratyphi* was identified in samples at 150 to 250 m downwind of the center of the aeration tanks.

CP. The CP aerosol density increased at all sampling locations during plant operations. As shown in Table 4, the CP geometric mean density increased significantly ($P < 0.01$) from 5.0×10^{-3} MPN PFU/m³ to 7.3×10^{-2} MPN PFU/m³ at the <150-m-downwind location after the plant began operating. The CP density was also significantly higher at 150 to 250 m downwind after as compared with before starting plant operations. CP densities were highest at the >250-m-downwind locations both before and after starting plant operations at 2.8×10^{-2} and 7.6×10^{-2} MPN PFU/m³. The background density after plant operations began was increased by the high CP density that was observed in the single positive sample. Nevertheless, significant differences could not be accepted using the data analyses procedures employed in this study.

EV. No EV were detected before the initiation of plant operations in air sample volumes ranging up to 552 m³. After the initiation of plant operations, EV were detected on two of nine occasions. No viruses were detected during the daytime in air sample volumes of up to 428 m³. The two occasions on which EV were detected were during the night within 150 m of the operating aeration tanks. The general wind direction on both occasions was from the south at ca. 4 to 5 m/s. These viruses were detected in Buffalo Green Monkey Kidney but not in WI-38 cells from air sample volumes of 211 and 193 m³, respectively. When detected, the EV density ranged from 4.7×10^{-3} to 1.0×10^{-2} CPU/m³ of air. Although one virus isolate was not identified with the Lim-Benyesh Melnick antisera pool, the two remaining viruses were both identified as coxsackievirus B-1.

Aerosol particle size. The size of bacteria-containing aerosols was greater after the plant began operating compared to pre-operations. Although the aerodynamic count median diameter of TABCP was generally in the 3.3- to 4.7-µm range, the percentage of the particles counted that was below 3.3 µm decreased at all downwind sampling locations after the plant operations began. The cumulative percentage of these aerosols decreased from 38 to 24, 40 to 26, and 45 to 26 at downwind locations of <150, 150 to 250, and >250 m, respectively. The percentage of aerosols in this smaller size range remained relatively unchanged in the samples taken at the upwind locations.

DISCUSSION

The air near residential environments is not sterile but contains microorganisms, some of potential enteric origin, which have unknown significance to human health and welfare. The air of the suburban environment of a major U.S. midwestern metropolitan area, for example, contained microorganisms of potential enteric origin before initiation of operations at a major wastewater treatment plant site. Densities of these microorganisms in the air were generally highest during the night. Of the indicator bacteria studied during the late summer and early fall season before plant operations, FS observed in the night had the highest densities, with geometric means ranging from 0.58 to 1.00 CFU/m³. TC ranged from 0.12 to 0.28 CFU/m³, but no FC were detected in air sampling volumes of 10 to 20 m³. Enteric bacteria from five genera, *Klebsiella*, *Enterobacter*, *Serratia*, *Salmonella*, and *Aeromonas*, were identified. The geometric mean densities of TABCP ranged from 65 to 163 CFU/m³ during the day and from 76 to 270 CFU/m³ during the night over four different sampling locations. SPC bacteria densities were lower, ranging from 32 to 51 CFU/m³ during the day and 29 to 65 CFU/m³ at night. The densities of the TABCP aerosols were within the same order of magnitude as those observed in the suburbs of an eastern metropolitan area, which had a geometric mean of 79 CFU/m³ (15).

The sources of microorganism-containing aerosols are multiple and may include natural processes as well as those produced by human activities. One such activity, that of wastewater treatment, increases the aerosol density of certain microorganisms above those observed in the absence of such a plant. After starting the operation of a wastewater treatment plant, the greatest increases in the densities of SPC, TABCP, TC, FC, FS, CP, and EV were observed at downwind locations closest (<150 m) to center of the aeration tanks. Many of these samples were within a few meters of the edge of the tanks. The densities of all of the microorganisms studied decreased at 150- to 250-m-downwind sampling locations. Although these densities remained above the pre-plant-operation levels, significant ($P < 0.01$) increases at locations beyond 250 m downwind were only observed for the SPC bacteria.

The occurrence of potentially infectious microbial aerosols per se does not provide evidence of associated health risks. Several studies on the health of populations living near wastewater treatment processes did not demonstrate significant adverse health effects due to exposure to wastewater-generated microorganism-containing aerosols (20). These studies, however, all had major limitations that made it difficult to attach significance to either the positive or negative findings. There were low numbers of persons subject to exposure to high doses of microbial aerosols, and the rate of this exposure throughout the population could not be adequately and quantitatively determined (14). Furthermore, the epidemiology of exposure to microbial aerosols in heterogeneous and mobile communities is largely affected by the secondary exposure rate and by the susceptibility of the population.

The possibility of exposure to higher densities of microbial aerosols in a suburban environment are greater during the night than during the day. These higher densities observed during the night indicate either increased microorganism survival rates or greater atmospheric stability, or both. The data clearly demonstrate that daytime sampling of the environment for microorganism-containing aerosols will result in underestimation of the densities to which a population may be exposed at night. Since the highest ambient airborne microorganism densities occur at night, any efforts to determine maximum exposure rates or to limit or control exposure will be most effective when employed during that time period.

Higher densities of SPC bacteria than of TABCP at downwind locations during plant operations demonstrate the differences of assaying bacteria and bacteria-containing particles. If the particles contain multiple bacteria, enumeration for SPC bacteria will promote disassociation of these organisms. The data suggest that more bacteria were associated with airborne particles during plant operations than before such operations began.

This study documents the first reported isolations of enterovirus-containing aerosols from outdoor secondary wastewater treatment processes. EV were, however, only detected at the <150-m-downwind sampling locations and only at night. Other investigators have reported low-level enterovirus densities around spray irrigation facilities (19, 25) and in enclosed secondary treatment processes (21). Earlier studies demonstrated that the aerosol density of EV around wastewater treatment processes is very low compared with indicator bacteria and CP and that detection requires sampling methods with high sensitivities (10, 12).

Both CP (10) and FS (7) have been suggested as possible indicators of the potential for microbial aerosol contamination from wastewater treatment processes. CP, which increased at all downwind locations after plant start-up, have been shown to be more stable than coliform bacteria at distant locations from the source (10). The CP, f2, was also demonstrated to be more stable than bacteria during treatment with chlorination and were detectable at distances up to 137 m downwind (4). These CP have also been demonstrated to be more stable in wastewater aerosols than are polioviruses (K. F. Fannin, S. C. Vana, and R. Ehrlich, Abstr. Annu. Meet. Am. Soc. Microbiol. 1981, Q115, p. 219), suggesting that they may survive in aerosols to travel to greater distances than certain EV.

The data from the present study indicate that CP are stable in aerosols, with the highest densities observed at distances of >250 m downwind from an operating wastewater treatment plant. The FS also demonstrated greater stability than the other indicator bacteria at these downwind locations, but showed marked differences in densities between day and night. Although these data support the conclusions that certain FS and CP organisms could be used as indicators of domestic wastewater treatment plant aerosols, the relatively high background densities of FS, especially at night, increase the difficulty in determining the originating source of these bacteria. Whereas the sensitive detection of appropriate indicator organisms do not indicate densities of pathogens, it can measure the potential for airborne contamination and could serve as a measure of exposure for epidemiological studies.

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LITERATURE CITED

1. Adams, A. P., and J. C. Spendlove. 1970. Coliform aerosols emitted by sewage treatment plants. Science 169:1218–1220.
2. American Public Health Association. 1975. Standard methods for the examination of water and wastewater, 14th ed. American Public Health Association, Washington, D.C.
3. Andersen, A. A. 1958. New sampler for the collection, sizing, and enumeration of viable airborne particles. J. Bacteriol. 76:471–484.
4. Bausum, H. T., S. A. Schaub, K. F. Kenyon, and M. J. Small. 1982. Comparison of coliphage and bacterial aerosols at a wastewater spray irrigation site. Appl. Environ. Microbiol. 43:28–38.
5. Baylor, E. R., V. Peters, and M. B. Baylor. 1977. Water-to-air transfer of virus. Science 197:763–764.
6. Bovallius, A., B. Bucht, R. Roffey, and P. Ånäs. 1978. Long-range air transmission of bacteria. Appl. Environ. Microbiol. 35:1231–1232.
7. Crawford, G. V., and P. H. Jones. 1979. Sampling and differentiation techniques for airborne organisms emitted from wastewater. Water Res. 13:393–399.
8. Cronholm, D. S. 1980. Potential health hazards from microbial aerosols in densely populated urban regions. Appl. Environ. Microbiol. 39:6–12.
9. Dutkiewicz, J. 1978. Exposure to dust-borne bacteria in agriculture. I. Environmental studies. Arch. Environ. Health

33:250–259.
10. **Fannin, K. F., J. J. Gannon, K. C. Cochran, and J. C. Spendlove.** 1977. Field studies on coliphages and coliforms as indicators of airborne animal viral contamination from wastewater treatment facilities. Water Res. 11:181–188.
11. **Fannin, K. F., J. C. Spendlove, K. W. Cochran, and J. J. Gannon.** 1976. Airborne coliphages from wastewater treatment facilities. Appl. Environ. Microbiol. 31:705–710.
12. **Fannin, K. F., and S. C. Vana.** 1982. Development and evaluation of an ambient viable microbial air sampler. EPA-600/1-81-069. U.S. Environmental Protection Agency, Cincinnati, Ohio.
13. **Fannin, K. F., and S. C. Vana.** 1983. Study of microbial aerosols emitted from a water reclamation plant. EPA-600/1-83-013. U.S. Environmental Protection Agency, Cincinnati, Ohio.
14. **Jakubowski, W.** 1983. Wastewater aerosol health effects studies and the need for disinfection, p. 68–82. *In* A. D. Venosa and E. W. Akin (ed.), Municipal wastewater disinfection: proceedings of the second national symposium. EPA-600/9-83-009. U.S. Environmental Protection Agency, Cincinnati, Ohio.
15. **Jones, B. L., and J. T. Cookson.** 1983. Natural atmospheric microbial conditions in a typical suburban area. Appl. Environ. Microbiol. 45:919–934.
16. **Kenner, B. A., and H. P. Clark.** 1974. Detection and enumeration of *Salmonella* and *Pseudomonas aeruginosa*. J. Water Pollut. Control Fed. 46:2163–2171.
17. **Lembke, L. L., and R. N. Kniseley.** 1980. Coliforms in aerosols generated by a municipal solid waste recovery system. Appl. Environ. Microbiol. 40:888–891.
18. **Millner, P. D., D. Bassett, and P. B. Marsh.** 1980. Dispersal of *Aspergillus fumigatus* from sewage sludge compost piles subjected to mechanical agitation in open air. Appl. Environ. Microbiol. 39:1000–1009.
19. **Moore, B. E., B. P. Sagik, and C. A. Sorber.** 1979. Procedure for the recovery of airborne human enteric viruses during spray irrigation of treated wastewater. Appl. Environ. Microbiol. 38:688–693.
20. **Pahren, H., and W. Jakubowski (ed.).** 1980. Wastewater aerosols and disease. EPA-600/9-80-028. U.S. Environmental Protection Agency, Cincinnati, Ohio.
21. **Sekla, L., D. Gemmill, J. Manfeda, M. Lysyk, W. Stackiw, C. Kay, C. Hopper, L. Van Buckenhout, and G. Eibisch.** 1980. Sewage treatment plant workers and their environment: a health study, p. 281–294. *In* H. Pahren, and W. Jakubowski (ed.), Wastewater aerosols and disease. EPA-600/9-80-028. U.S. Environmental Protection Agency, Cincinnati, Ohio.
22. **Siegel, S.** 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Co., New York.
23. **Snedecor, G. W., and W. G. Cochran.** 1967. Statistical methods. The Iowa State University Press, Ames.
24. **Spendlove, J. C.** 1974. Developments in industrial microbiology, p. 20 to 27. American Institute of Biological Sciences, Washington, D.C.
25. **Teltsch, B., S. Kedmi, L. Bonnet, Y. Borenzstajn-Rotem, and E. Katzenelson.** 1980. Isolation and identification of pathogenic microorganisms at wastewater-irrigated fields: ratios in air and wastewater. Appl. Environ. Microbiol. 39:1183–1190.

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Project Summary

Health Risks of Human Exposure to Wastewater

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The primary objective of this research was to determine the health effects associated with occupational exposure to biological agents present in municipal wastewater. An additional objective was to determine the sensitivity of the methodology for detecting potential health impacts of other wastewater exposures, such as recreational contact with surface water receiving wastewater effluents. The procedure was a prospective seroepidemiologic study applied to municipal wastewater workers and controls in three metropolitan areas: Cincinnati, Ohio; Chicago, Illinois; and Memphis, Tennessee. The primary study group consisted of more than 100 workers recruited at the time they began work at activated sludge plants and who remained in the study for a minimum of 12 months. In addition, a Chicago group of 30 experienced sewage treatment plant workers were included and, in Cincinnati, two other wastewater-exposed groups were recruited consisting of about 50 sewer maintenance workers and 50 primary wastewater treatment plant workers. The latter group was recruited into the study just before start-up of plant improvements that included activated sludge facilities. The purpose of including this group was to differentiate between aerosol exposure and exposure to wastewater and sludge through those operations associated with primary wastewater treatment.

The protocol involved quarterly collection of blood, throat, and rectal swabs; yearly medical examinations; collection of illness information; work observations; and environmental monitoring. Initial recruitment of workers began April 1975 in Cincinnati; July 1976 in Chicago; and July 1977 in Memphis. Final specimens in all cities were collected in the fall of 1978. The serological survey included testing for antibodies to a large group of viruses and bacteria and determination of immunoglobulin levels. Work observations were used to evaluate the level of the workers' contact with wastewater and, in conjunction with the biological air monitoring, to assess the extent of contact with aerosols. The environmental monitoring included viral and bacterial analyses of wastewater and the use of six-stage Andersen samplers to determine the respirable concentrations of bacteria in the work areas of the plant.

A total of over 500 volunteers participated in the study including both subjects and controls.

This Project Summary was developed by EPA's Health Effects Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Objectives

The purpose of this study was to determine the health effects, if any, of the occupational exposure to the viruses, bacteria, and parasites present in municipal wastewater. The central feature was an extensive surveillance of the health of 100 newly-hired activated sludge treatment plant workers during a minimum of 12 months of occupational exposure to wastewater. Specific objectives of the project were:

1. To determine whether wastewater workers develop clinical illness or specific bacterial, viral, and parasitic infections due to occupational exposure to sewage.

2. To determine the immunologic response among workers presumed to be exposed to a high level of antigenic simulation, i.e., through wastewaters.

3. To determine whether wastewater workers serve as a reservoir of certain infections and, if so, whether members of the workers' families are affected.

4. To determine the effect of exposure to aerosols generated by the activated sludge treatment process.

5. To determine the concentration of bacterial aerosols at wastewater treatment plants, and to compare them to levels at other public works facilities.

An underlying objective of the study was the determination of the sensitivity of various elements of the epidemiological-serological approach for the detection of wastewater-related health effects. Such a determination would permit an assessment of the potential application of this methodology to the study of health risks associated with other population exposures to wastewaters. The latter would include persons working with or living near wastewater land-disposal facilities, persons living in the vicinity of wastewater treatment plants, and persons engaged in recreational use of bodies of water receiving waste effluents.

Background

Information regarding the human health risks associated with contact with wastewater and related materials brought about by occupational and other exposures is limited. However, assumptions concerning these risks are providing motivation for the promulgation of state and federal standards designed to protect populations from various wastewater exposures. The growing emphasis on the land application of wastewater and sludges as a viable method of wastes utilization increases the need for reliable and up-to-date information on the health risks, if any, involved. Wastewater also contains a wide variety of harmful chemicals which may under some conditions compromise the health of wastewater workers. However, chemical hazards were not considered in this study.

Table 1. *List of Viruses, Bacteria, and Immunoglobulins for Which Workers' Sera Were Tested for Antibodies.*

Viruses

1. *Polio 1, 2, and 3*
2. *Coxsackie A-7, A-9, A-16, A-21, and B-1 to B-6*
3. *Echo 1, 3, 4, 5, 6, 8, 9, 11, 13, 14, 19, 24, 30*
4. *Reovirus*
5. *Adenovirus*
6. *Cytomegalovirus*
7. *Herpes simplex*
8. *Hepatitis A antibody and Hepatitis B antibody and antigen*
   Test Methods: Microneutralization for Polio, Coxsackie and all Echo viruses; Radioimmunoassay for Hepatitis A and B; and Complement Fixation for the others.

Bacteria

1. Salmonella: *Group A, B, C, D, and E*
   Test Methods: Rapid slide agglutination (1975-1976)
   Microagglutination (1978)
2. Leptospira
   Test Method: Microagglutination
3. Legionella pneumophila
   Test Method: Indirect immunofluorescence

Immunologic Factors

1. *IgA*
2. *IgG*
3. *IgM*
4. *Rheumatoid Factor*
   Test Methods: Radial immunodiffusion for immunoglobulins, latex reaction for rheumatoid factor

Methods

The study consisted of an intensive serologic survey correlated with epidemiological, clinical, and environmental data on the study populations. The central feature of the design was an evaluation of the effects of occupational exposure to wastewater over at least a 12-month period based on the measurement of specific viral and bacterial antibodies and immunoglobulin in sera collected over that time period. In order to help separate the effect of the occupational exposure from that associated with other possible disease pathways, appropriate control groups were utilized. In addition, many of the wastewater workers were recruited into the study at the time of their initial employment in the wastewater treatment industry

Each quarter blood samples, throat swabs, and fecal samples were collected from participants in the study. Blood specimens were used for the serologic surveys and the throat swabs and fecal specimens were used for analysis for bacteria, viruses and parasites. (Parasitic examinations were performed only during the early period of the study in Cincinnati.) The serologic survey involved the determination of antibodies to a group of viruses and bacteria and measurement of immunoglobulin levels (Table 1). Of concern in the serologic survey was whether the prevalence and level of antibodies were different in the wastewater exposed and control groups, and whether the number of infections as indicated by increases in antibody concentration was different among the various study groups.

Illness information was obtained by monthly health diaries maintained by the workers supplemented by telephone and on-the-job contact. Illness symptom information from all sources was combined in a manner designed to avoid double counting and was categorized as "respiratory," "gastrointestinal," and "other." The data processing procedures provided for coding various possible combinations of these. The definition of these illness categories was based on the symptoms indicated on the health diary, as follows:

Respiratory	- Cold symptoms, sore throat, cough or other lower respiratory symptoms.
Gastrointestinal	- Nausea, vomiting, diarrhea, or intestinal upset.
Other	- Fever, persistent headache, eye inflammation or other eye trouble, earache or other ear trouble, skin infection, rash, boils, or open sores.

From time to time job locations of participants were visited to determine types and levels of exposure and other work conditions. Work site air was monitored periodically for bacterial concentrations, and concurrent wastewater samples at the wastewater treatment plants were analyzed for bacterial and viral concentrations. Six-stage Andersen samplers were used to collect the airborne bacteria. In order to process the air samples as soon as possible, preparation and analyses of the plates for bacterial sampling were performed in Chicago by the Metropolitan Sanitary District of Greater Chicago (MSDGC), in Memphis by the Memphis State University, and by the bacteriologist on the study staff in Cincinnati. All wastewater samples for virus assay were processed by the aluminum hydroxide continuous flow centrifuge technique and assayed by a plaque assay procedure.

On a yearly basis, study volunteers were offered a medical evaluation that included hematology, urinalysis, pulmonary function testing, blood chemistry (including tests of liver and kidney function), and examination by a physician.

A number of comparisons and correlations were made from the epidemiological, environmental, clinical, and serological aspects of the study.

As initially conceived, the study goals were limited to the first three specific objectives listed above. The population groups planned for the study were sewer and highway maintenance workers in Cincinnati. The research design initially called for recruitment of an equal number of men beginning their respective jobs as those recruited who had two or more years experience, for both exposed and control groups. Soon after the study was initiated economic conditions in the municipal government forced a moratorium on hiring new employees in the Cincinnati Public Works Department which eliminated prospects for establishing a newly employed highway maintenance study group.

About one year after this research began, its goals were expanded to include a determination of the health effects associated with the dispersion of aerosols generated by the activated sludge wastewater treatment process (Specific Objectives 4 and 5). At this time the study design was expanded to include two additional exposed population groups: 50 men at the Cincinnati Mill Creek Sewage Treatment Plant which was in the process of being expanded from primary wastewater treatment to include the activated sludge process; and a total of 100 men newly employed at activated sludge treatment plants. Since only one-third of the 100 inexperienced activated sludge plant workers were expected to be available in Cincinnati, the study was expanded to include workers at the plants in Chicago and Memphis. These cities were chosen because at least 50 new employees would be hired within the next year, the plants contained the activated process in open basins with porous plate-type diffusers, they were reasonably accesible to Cincinnati, and the plant administrators were agreeable to the study. MSDGC hired a significant number of new workers because of normal work force turnover by virtue of its size. In addition, its long experience in wastewater treatment and the technical support for monitoring available from its Research and Development Department made it very suitable for study. Memphis was in the final stages of construction of its second activated sludge treatment plant, the North Treatment Plant, an entirely new facility. In addition, its first plant, the Maxson Wastewater Treatment Plant had plans to hire more workers.

Comparison groups in Cincinnati, Chicago and Memphis were highway maintenance water treatment plant workers and gas and electric utility workers, respectively.

Conclusions

1. Gastrointestinal illness rates were higher in the inexperienced wastewater exposed workers than in the experienced workers and controls. Wastewater workers were not found to be subject to any detectable risks due to parasites present in wastewater. There was only slight evidence, if any, to suggest that there were risks due to viruses and bacteria in wastewater.

2. Immunoglobulin levels were not found to be consistently higher in wastewater-exposed workers than in controls in any of the cities studied.

3. Wastewater workers were not found to serve as a source of viral infections for their family members.

4. In a few instances levels of antibody to certain viruses appeared to be related to level of exposure to wastewater aerosols.

5. Bacterial aerosol levels in buildings where wastewater sludge was being processed were generally higher than levels adjacent to outdoor aeration tanks at the same treatment plants.

6. Since the seroepidemiologic approach did not detect any significant health effects of occupational exposure to wastewater, it is unlikely that this approach would detect potential health impacts in populations with lower levels of exposure to wastewater.

Recommendations

Since the basic design of this study was to compare antibody levels between two quarters in each year of the study, all sera collected over the entire study period have not been tested. It is possible that changes in antibody levels were not detected by semiannual testing. Selected viruses of high prevalence should be studied by testing all sera for each individual.

Because the predominance of seroconversions to Hepatitis B were in the sewage-exposed groups (seven of 123 sewage-exposed workers compared to one of 52 control workers), additional testing should be done on workers not yet evaluated to determine whether this trend persists.

Additional testing of sera of workers occupationally exposed to soil, such as some sewer and highway maintenance workers, would be useful in attempting to verify previous suggestions that soil exposure increases the risk of infection to *Legionella pneumophila*.

Because of the limited testing of sera for antibody to Hepatitis A, the initial sera of a number of workers has not been tested. It would be useful to test these sera to determine whether any of these people acquired the antibody during the course of the study.

Serologic testing for rotavirus or parvovirus agent was not performed during the study. Since these viruses are now recognized as a major cause of gastrointestinal illness, the sera collected during the study should be analyzed for antibody to them.

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Walter Jakubowski is the EPA Project Officer (see below).

The complete report, entitled "Health Risks of Human Exposure to Wastewater," (Order No. PB 81-143 406; Cost: $15.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
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U.S. Environmental Protection Agency
Cincinnati, OH 45268

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Wastewater Aerosols and Disease

Proceedings of a Symposium

September 19-21, 1979

Sponsored by the
Health Effects Research Laboratory

Edited by
H. Pahren and W. Jakubowski

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our national environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The primary mission of the Health Effects Research Laboratory in Cincinnati (HERL) is to provide a sound health effects data base in support of the regulatory activities of the EPA. To this end, HERL conducts a research program to identify, characterize, and quantify harmful effects of pollutants that may result from exposure to chemical, physical, or biological agents found in the environment. In addition to the valuable health information generated by these activities, new research techniques and methods are being developed that contribute to a better understanding of human biochemical and physiological functions and how these functions are altered by low-level insults.

These proceedings represent an attempt to publish current knowledge on the human health aspects of exposure to microbial aerosols from wastewater treatment plants. With a better understanding of these health effects, design engineers, municipal officials, and persons involved with regulatory decisions can make more informed judgments on the siting and operation of such plants.

R. J. Garner
Director
Health Effects Research Laboratory

PREFACE

Many wastewater treatment plants are constructed in urban areas close to residential areas. These systems generally contain aeration basins or trickling filters where there is an opportunity for small droplets of wastewater to be emitted. These droplets, which could contain a bacterium or virus, evaporate very rapidly to yield small droplet nuclei known as aerosols.

A number of persons have investigated the types of organisms emitted and their concentration in the air as a function of distance from the treatment plant. These microorganisms travel passively with the wind, and their concentration decreases with time and distance as a result of atmospheric dispersion, die-off, and deposition. The potential for plant workers and nearby residents to inhale viable organisms certainly exists. However, there has never been a systematic investigation to confirm or negate the existence of a health hazard from these viable wastewater aerosols.

With this background, the Health Effects Research Laboratory of the U.S. Environmental Protection Agency arranged for several epidemiological studies to gather information on health effects associated with aerosols from uncovered wastewater treatment plants. These studies were conducted by personnel from universities or research institutions.

The purpose of this symposium was to present and discuss the results of the epidemiological studies, as well as related health topics which could aid in understanding the findings. The symposium brought together interested persons from several countries, who contributed freely and provided an opportunity to summarize the current knowledge in a single publication.

The proceedings are organized according to the format of the symposium into six main sections addressing the topics of contaminants, health fundamentals, population studies, occupational studies, and aerosol suppression and providing an assessment. In many cases, the proceedings papers are more comprehensive than the symposium presentations to provide a more thorough coverage of a given topic. Edited discussions are included with the papers, and an attempt was made to identify each questioner. A list of registrants is presented to allow the reader to contact any participant for further information.

HERBERT R. PAHREN
WALTER JAKUBOWSKI
Editors

ABSTRACT

The Health Effects Research Laboratory of the U.S. Environmental Protection Agency sponsored a Symposium on Wastewater Aerosols and Disease on September 19-21, 1979, in Cincinnati, Ohio.

This symposium brought together scientists, engineers, physicians, and public health officials from all over the world to present and discuss current state-of-knowledge on human health aspects of exposure to microbiological agents emitted as aerosols from wastewater treatment plants. Sessions on the nature of the contaminants, health aspects, epidemiological studies, and aerosol suppression and a panel discussion assessing the information were held. The proceedings consist of 22 invited papers and associated discussions.

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301 (h) evaluation summary

TECHNICAL SUMMARY
Revised Application for Section 301(h) Modification
Metropolitan District Commission, Boston, Massachusetts

The Clean Water Act (the "Act") of 1972 required all publicly owned treatment works (POTWs) to provide the equivalent of secondary treatment. Secondary treatment, as defined by the Environmental Protection Agency (EPA) regulations, requires 85% removal of the biochemical oxygen demand (BOD) and 85% removal of the suspended solids (SS) in the waste material. In 1977, Congress amended the Act to allow POTWs which discharge to marine waters to seek a waiver under section 301(h) of the Act from the secondary treatment requirement.

The EPA may grant such a waiver provided the following conditions are met:

(1) there is an applicable water quality standard specific to to the pollutant for which the modification is requested, which has been identified under section 304(a)(6) of the Act;

(2) such modified requirements will not interfere with the attainment or maintenance of that water quality which assures protection of public water supplies and the protection and propagation of a balanced, idigenous population of shellfish, fish and wildlife, and allows recreational use of the water;

(3) the applicant has established a system for monitoring the impact of such discharge on a representative sample of marine biota, to the extent practicable;

(4) such modified requirements will not result in additional requirements on other point or nonpoint sources;

(5) all applicable pretreatment requirements for dischargers to the treatment works will be enforced;

(6) to the extent practicable, the applicant has established a schedule of activities to eliminate the entrance of toxic pollutants from nonindustrial sources into such treatment works;

(7) there will be no new or substantial increase in the effluent volume specified in the permit.

On September 31, 1979, the Metropolitan District Commission, Boston, Massachusetts, submitted to the EPA an application seeking a 301(h) waiver. EPA, after extensive review, denied the waiver application on June 30, 1983. In accordance with EPA regulations, the MDC submitted a second and final revised application for a waiver on June 30, 1984. The revised application proposed a further extension of the treatment system outfall into Massachusetts Bay. The MDC proposed the following effluent characteristics in the revised application:

BOD	437,000	lbs/day
SS	263,000	lbs/day
pH	6-9	
Flow	485	million gallons/day

It should be noted that the proposed effluent characteristics are for the year 1990. Substantially higher levels are expected for the year 2010.

Of particular importance in the review of a 301(h) waiver application is the determination of the expected solids deposition resulting from the proposed discharge. Solids deposited on the seabed can have a significant impact on shellfish, fish, and bottom dwelling organisms. Further, the deposited solids, if resuspended during the critical summer months, could lower the dissolved oxygen level of the receiving water to undesirable levels.

As a part of the review process, EPA Task Force scientists, in consultation with Tetra Tech, Inc., an EPA contractor, and a scientist at the Massachusetts Institute of Technology, have determined that the expected solids deposition rate would be nearly 100 times greater than the solids deposition rate estimated by the MDC in the 301(h) application. Using the significantly higher deposition rate, EPA has concluded that:

(1) The Commonwealth's dissolved oxygen standard would be violated during resuspension events; and

(2) The benthic (sea floor) community would be adversely modified over an area of at least 8.5 km^2. This area is nearly 50 times greater than the zone of initial dilution (ZID). The ZID, specifically defined by the 301(h) guidance documents, is the region of initial mixing surrounding the discharge diffuser.

The EPA Task Force also has conducted an extensive review of studies depicting existing physical, chemical, and biological conditions of Boston Harbor and Massachusetts Bay. The EPA Task Force concluded that (1) significant deterioration of benthic biological communities is presently occurring in Boston Harbor; (2) ambient receiving water and sediments of Boston Harbor are contaminated by toxic pollutants; (3) existing waste discharges including effluents from Deer and Nut Island treatment facilities contribute large amounts of solids contaminated with toxic pollutants to Boston Harbor; and (4) present discharges from Deer Island are likely contributing to the incidence of fish disease in Boston Harbor.

The EPA Task Force has concluded that similar biological degradation due to deposition of sewage solids and associated toxic pollutants will occur at the proposed site.

The tentative decision document outlines in detail the various technical determinations which resulted in denial of the MDC's revised application for a section 301(h) modification.

FACT SHEET
Tentative Decision Document
Revised Application for Section 301(h) Modification
Metropolitan District Commission, Boston, Massachusetts

- Task Force recommends denial of section 301(h) modification

- Natural conditions

  - Circulation pattern is characterized by variable current direction and slow net drift
  - Important recreational and commercial fisheries are sustained by the waters in Boston Harbor and Massachusetts Bay
  - The proposed discharge area presently shows signs of environmental degradation

- Existing facilities consist of two primary treatment plants, Deer and Nut Island, which in 1984 treated average annual flows of 304 and 117 mgd, respectively

- Proposed modifications include relocating the outfall from Boston Harbor to Massachusetts Bay as well as upgrading the treatment facilities and improving operation

- Discharge characteristics (Proposed)

  - Effluent discharge approximately 9.2 mi from Deer Island at a depth of 118 ft
  - Design flow for 1990 is 485 mgd which is 9.1% industrial (44.1 mgd) in origin
  - Critical initial dilution (90:1)
  - Proposed treatment removal efficiencies: 28% BOD and 61% SS

- Projected impacts

  - The discharge will result in sedimentation rates of sewage particles approximately two orders of magnitude greater than those predicted by the Applicant
  - Major reductions in total density and diversity of pollution sensitive benthic species resulting from deposition of sewage particles (357 $g/m^2/yr$ over 8.5 km^2) and associated toxic materials
  - State water quality standard for dissolved oxygen adopted to protect marine life will be violated during summer resuspension events
  - Important commercial and recreational fisheries will be adversely affected near the proposed discharge
  - Bioaccumulation of priority pollutants will occur in benthic and pelagic species
  - PCBs and copper will exceed EPA water quality criteria
  - Sedimenting sewage particles may cause combined adverse impacts on recreation and biota in North Shore areas

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EPA draft permit for secondary treatment

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

FACT SHEET

DRAFT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT TO DISCHARGE TO WATERS OF THE UNITED STATES AND DENIAL OF A SECTION 301(h) VARIANCE REQUEST.

NPDES PERMIT NO.: MA0102351

NAME AND ADDRESS OF APPLICANT:

Massachusetts Water Resources Authority (MWRA)
7th Floor
One Center Plaza
Boston, MA 02108

NAME AND ADDRESS OF FACILITY WHERE DISCHARGE OCCURS:

MWRA Publicly Owned Treatment Works (POTW) to Boston Harbor, Combined Sewer Overflow (CSO) Treatment Facilities to the Charles River, Inner Harbor, and Mystic River, and CSO Outfalls to the Charles River.
c/o MWRA
7th Floor
One Center Plaza
Boston, MA 02108

RECEIVING WATERS: Boston Harbor, Charles River, Inner Harbor and Mystic River.

CLASSIFICATION: As designated by the Massachusetts State Water Quality Standards, 314 CMR 4.00.

I. Proposed Action, Type of Facilities, Discharge Locations

The above named applicant has applied to the U.S. Environmental Protection Agency (EPA) for reissuance of a NPDES permit to discharge into the designated receiving waters. The EPA has prepared Draft NPDES Permit No. MA0102351 for public notice and comment. The draft permit is for discharges from publicly owned treatment works (POTW), combined sewer overflow (CSO) facilities and CSO outfalls, as specified in the draft permit. The facilities are engaged in the collection and treatment of municipal wastewater.

The Massachusetts Water Resources Authority (MWRA) is a public corporation established pursuant to the Massachusetts Water Resources Authority

Act of 1984. It came into existence on January 1, 1985. On July 1, 1985, responsibility for the management and operation of the sewerage system operated by the Metropolitan District Commission (MDC) passed to the MWRA pursuant to the enabling legislation. Also on July 1, 1985, responsibility, coverage, and liability under NPDES Permit No. MA0102351 issued August 12, 1976, to the MDC transferred to the MWRA pursuant to 40 CFR 122.61(b). The 1976 permit expired May 1, 1981, but continues in force pursuant to 40 CFR 122.6 because the MDC submitted a timely application for a new permit. The MDC and MWRA have agreed that the application for a new permit and for a section 301(h) variance filed by the MDC shall be treated as an application by the MWRA and that the new permit shall be issued to the MWRA.

II. Denial of Section 301(h) Variance Request

On September 13, 1979, the MDC pursuant to section 301(h) of the Clean Water Act (CWA or the "Act") applied for a variance from the secondary treatment requirements contained in section 301(b)(1)(B) of the Act. The MDC submitted three addendums to the application in 1982. The Administrator of EPA denied the application in June 1983. In July 1984, the MDC submitted a revised and final section 301(h) waiver application, which was supplemented in October 1984. On March 29, 1985, the Regional Administrator of EPA tentatively denied the revised application for a modification of the secondary treatment requirements of the CWA pursuant to section 301(h) and 40 CFR Part 125, Subpart G.

An eighty-five page analysis of the revised section 301(h) application was prepared by Region I EPA and was issued concurrently with the Regional Administrator's tentative denial. As stated in that decision document, EPA made the following findings with regard to compliance with the section 301(h) statutory and regulatory criteria based upon its review of the data, references, and empirical evidence furnished in the application, the applicant's responses to EPA's requests for additional information, and the technical review report prepared by EPA's outside contractor:

- The proposed discharge is expected to violate the Commonwealth of Massachusetts' water quality standard for dissolved oxygen during summer resuspension events, but is not expected to violate the Commonwealth's standard for suspended solids.

- The proposed discharge is expected to interfere with the protection and propagation of a balanced, indigenous population of marine life and may not allow for recreational activities. The proposed discharge will not adversely impact public water supplies.

- The applicant has established a system for monitoring the impact of its discharge. This program contains deficiencies as discussed in the technical review report.

- The proposed discharge may impact other point and non-point sources to the north and west.

- The applicant has developed a program to enforce all applicable pretreatment requirements. This program has been submitted to the EPA Regional Office and approved under the pretreatment regulations, 40 CFR part 403. A recent EPA audit shows that the program has not been adequately administered.

- The applicant has proposed a schedule of activities intended to limit the entrance of toxic pollutants from non-industrial sources into the treatment works. This schedule of activities contains deficiencies as discussed in the technical review report.

- There may be new or substantially increased discharge of pollutants in the effluent from the proposed discharge above that specified in the permit.

The Region concluded that the applicant's proposed discharge would adversely impact the ecosystem and beneficial uses of the receiving waters and would not comply with the requirements of section 301(h) and 40 CFR Part 125, Subpart G, and recommended denial of the variance request. Accordingly, the Regional Administrator authorized the Region to prepare a draft permit with effluent limitations based upon secondary treatment in accordance with his tentative decision to deny a section 301(h) modified permit.

This action will implement the Regional Administrator's decision, by requiring secondary treatment, in accordance with the procedures for decisionmaking at 40 CFR Part 124.

III. Description of Discharges

A quantitative description of the POTW discharges, in terms of significant effluent parameters, based on discharge monitoring reports from January 1984 to June 1985 is presented in Attachment 1.

IV. Limitations and Conditions

The effluent limitations and monitoring requirements are set forth in the attached Draft NPDES Permit No. MA0102351 which consists of 28 pages in Part I and 19 pages in Part II.

V. Permit Basis and Explanation of Effluent Limitation Derivation

A. POTW Discharges: Conventional Pollutants

Under section 301(b)(1)(B) of the CWA, POTW must achieve effluent limitations based upon secondary treatment by July 1, 1977. The secondary treatment requirements are set forth at 40 CFR Part 133. The regulations describe the secondary treatment requirements for biochemical oxygen demand (BOD), suspended solids (TSS), and pH. The "Average Monthly" and "Average Weekly" BOD and TSS limitations are based on the requirements of 40 CFR 133.102. Numerical "Maximum Daily" limitations, where applicable, and the numerical limitations for settleable solids, pH, and fecal coliform are based on the Commonwealth's state certification requirements under section 401(a)(1) of the CWA, as defined in 40 CFR 124.53. Total residual chlorine permit conditions and numerical limits for oil and grease of petroleum origin are based on the Massachusetts Surface Water Quality Standards.

In accordance with the provisions of 40 CFR 133.103(a), EPA has determined that the 85 percent removal requirement established under 40 CFR 133.102 is not attainable. The determination is based upon the fact that the existing MWRA POTW are served by a combined sewerage system resulting in wastewater influent with less than 200 mg/l of BOD or TSS. Should circumstances change as to future MWRA POTW, EPA will reevaluate this determination.

B. POTW Discharges: Toxic Pollutants

Under section 301(b)(1)(c) of the CWA, discharges are subject to effluent limitations based on water quality standards as well as on secondary treatment. The Massachusetts Surface Water Quality Standards include a narrative statement that prohibits the discharge of any pollutant or combination of pollutants in quantities that would be toxic or injurious to human health or aquatic life. 314 CMR 4.03(4). The Commonwealth does not have numerical criteria for specific toxic pollutants or toxicity criteria. According to 314 CMR 4.03(2), EPA water quality criteria are to be used to interpret the narrative standard in 314 CMR 4.03(4).

Information and data from the permittee's Industrial Pretreatment Program and the 301(h) application demonstrate that toxic pollutants are being discharged from the MWRA POTW. Evaluation of this information and data shows that the POTW discharges may contain toxic pollutants in concentrations that after dilution exceed EPA water quality criteria (see, EPA Water Quality Criteria Documents, 45 Fed. Reg. 79318, Nov. 28, 1980). EPA's analysis of the section 301(h) application concluded that there is a likelihood of toxic effects to biota in the receiving water from the permittee's discharges.

Therefore, in accordance with EPA policy, the draft permit includes chronic and acute effluent toxicity limitations, toxicity reduction evaluation requirements, and bioaccumulation assessment requirements. (See, e.g., "Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants", 49 Fed. Reg. 9,016 (Mar. 9, 1984); see also, EPA's Technical Support Document for Water Quality-Based Toxics Control). The principal advantages of biological techniques are: (1) that the effects of complex discharges of many known and unknown constituents can be measured only by biological analyses; (2) bioavailability of pollutants after discharge is best measured by toxicity testing; and (3) pollutants for which there are inadequate chemical analytical methods or criteria can be addressed.

The No Observed Effect Concentration (NOEC) limitation in the draft permit prohibits chronic adverse effects (e.g., on survivial, growth, and reproduction) when marine organisms are exposed to the POTW discharges at the calculated available dilution of 10:1 or less. The No Observed Acute Effect Levels (NOAEL) limitation prohibits acute effects (lethality) when marine organisms are exposed to the POTW discharges at half of the calculated available dilution of 10:1 or less. Because of the immediacy of acute toxicity (lethality), a margin of safety is applied to the NOAEL limitation. Should the dilution available for future POTW discharges differ from the 10:1 calculated available dilution for the existing POTW discharges, the NOEC and NOAEL permit limits will be modified accordingly.

The draft permit requires the permittee to conduct a toxicity reduction evaluation if there are two or more violations of the NOEC or the NOAEL limitations within a six month period. A toxicity reduction evaluation is an investigation of the sewerage system to isolate the sources of effluent toxicity and specific causative pollutants and to determine the effectiveness of pollution control options in reducing the toxicity.

EPA also will evaluate and may use the results of the aquatic toxicity tests and bioaccumulation assessment (which addresses potential human health hazards) in conjunction with the chemical analyses required by the permit and any other relevant information or data to develop site-specific numerical effluent limitations for specific pollutants. The permit may then be modified to incorporate such limitations, particularly if specific chemicals in the POTW discharge are identified as bioaccumulative or the cause of effluent toxicity.

C. Combined Sewer Overflow: Conditions for Discharge

The draft permit prohibits discharges from the permittee's combined sewer overflow (CSO) outfalls and CSO treatment facility outfalls during dry weather. Dry weather discharges must be monitored as specified in sections 4.a and 5.b of the draft permit and reported in accordance with General Requirement 1 on pages 5 and 6 of Part II.

During wet weather, discharges from the permittee's CSO treatment facility outfalls and CSO outfalls are permitted providing the discharges receive the level of treatment described in section D below. In addition, wet weather discharges shall not violate water quality standards.

Wet weather discharges from the CSO treatment facilities outfalls must be monitored as follows: (1) conventional and nonconventional pollutants for each discharge; (2) several toxic pollutants during one storm related discharge per month; and (3) 48 hour acute toxicity tests and chemical analyses once every two months. When wet weather discharges occur from the permittee's CSO outfalls, the following information must be submitted for each outfall: (1) the period of discharge; (2) the estimated volume of discharge; and (3) precipitation data from the National Weather Service for the area.

D. Combined Sewer Overflows: Required Treatment

Section 301(b)(1)(A) of the CWA requires by July 1, 1977, the achievement of effluent limitations for combined sewer overflows which are based on application of the best practicable control technology currently available (BPT). (See Montgomery Environmental Coalition v. Costle, 11 E.L.R. 20,211 (D.C. Cir. 1980) and Decision of the EPA General Counsel No. 49, June 30, 1976). As of July 1, 1984, CSOs also must receive treatment at a level providing Best Conventional Pollutant Control Technology (BCT) to control and abate conventional pollutants and Best Available Technology economically achievable (BAT) purusant to section 301(b)(2) of the CWA.

On September 29, 1978, EPA submitted a report to Congress on the "Control of Combined Sewer Overflow in the United States" as required by section 516(c) of the CWA. The report concluded that there is no single best CSO control alternative which can be applied in all cases. Consequently, EPA has not issued national BPT, BCT, or BAT effluent guidelines for CSOs. In the absence of national standards, CSO limitations must be established on a case by case basis using best professional judgement (BPJ) pursuant to section 402(a)(1) of the CWA.

The permittee's current permit, which was issued in 1976 and continues in force pursuant to 40 CFR 122.6, requires that the nineteen specified CSOs owned and operated by the MDC receive treatment based on BPT by July 1, 1977. (Special Condition A(2)(a) of 1976 permit). Prior to the issuance of the permit in 1976, CSO construction projects were organized into five planning areas as a mechanism to provide treatment based on BPT for the 108 or more CSOs which discharge into Boston Harbor and its tributaries, including the 19 or more CSOs owned and operated by the MDC. (See, MDC's 1976 Eastern Massachusetts Metropolitan Area Wastewater Engineering and Management Study). The MDC, as the overall operator of the region's sewage system, was required by the 1976 permit to complete by July 1, 1977, the following construction projects for the following five areas: (1) Neponset River combined sewers; (2) Charles River combined sewers; (3) Dorchester Bay combined sewers; (4) Inner Harbor combined sewers; and (5) Charles River Marginal combined sewers. (Special Condition B.5 of the 1976 permit).

In an Enforcement Compliance Schedule Letter (ECSL) issued to and signed by the MDC on August 11, 1976, EPA defined the level of treatment to be attained upon completion of the five CSO projects, in order to meet BPT, as follows:

> All Combined Sewer Overflow Projects shall be designed and constructed such that untreated discharges of combined sewage shall not occur at rainfalls less than a storm of 1 year severity and 6 hour duration.
>
> After completion of the Combined Sewer Overflow Projects, all flows shall receive, as a minimum, screening, chlorination and detention prior to discharge. All flows discharged shall contain a minimum chlorine residual of 1.0 mg/l at all times.

To date, the following construction projects for the following four areas have not been completed as required by the 1976 permit: (1) Neponset River combined sewers; (2) Charles River combined sewers; (3) Dorchester Bay combined sewers; and (4) Inner Harbor combined sewers. In 1982, the MDC completed facilities plans for the four project areas. As summarized in the MDC's 1982 CSO Project Report, in order to complete the four remaining area-wide CSO projects, the completion of thirty-eight combined sewer overflow sub-projects by the MWRA is required. (MDC Combined Sewer Overflow Project Summary Report, pp.7-10, April, 1982).

The draft permit continues the requirements of the 1976 permit for CSO treatment. The statutory scheme established for effluent limitations requires that BAT be at least as stringent as BPT. Accordingly, EPA has made a BPJ determination pursuant to section 402(a)(1) of the CWA that BAT and BCT for the CSOs in the five project areas requires, as a minimum, the level of treatment provided through the completion of the CSO sub-projects recommended in the MDC CSO facilities plans and any amendments thereto approved by EPA.

The draft permit requires that the completed CSO projects provide, as a minimum and unless otherwise approved in writing by EPA, screening, chlorination, and detention of all flows at rainfalls less than a storm of one year severity and six hour duration. EPA no longer supports the concept that a minimum chlorine residual is required for all municipal discharges because chlorine residual concentrations have the potential to cause toxicity to the aquatic environment.

Because section 301(B)(2) of the CWA requires that CSOs acheive BCT and BAT by July 1, 1984, the draft permit requires the permittee to have completed by the effective date of the permit the thirty-eight CSO sub-projects recommended in the MDC CSO facilities plans and any revisions thereto approved by EPA. EPA is aware that, in some instances, circumstances have changed since the completion of the CSO facilities plans in 1982 so that portions of the plans must be amended accordingly and the draft permit provides for this. EPA also is aware that in some instances the facilities plans do not provide for detention and do not utilize the one year, six hour design storm. The draft permit also provides that the level of treatment may vary from this standard, if approved in writing by EPA.

EPA will review the level of treatment provided by the required CSO projects and any approved revisions thereto, the results of the CSO monitoring required by the draft permit, and available water quality data to determine what (if any) additional CSO controls are necessary to ensure that the water quality standards of the receiving waters will be maintained or attained. EPA believes that the level of CSO treatment cannot be completely finalized until, among other things, required pretreatment standards are achieved by the industrial sources discharging to the sewerage system, secondary treatment is achieved by the MWRA POTW, and dry weather discharges are eliminated.

E. Monitoring Requirements

The effluent monitoring requirements have been specified in accordance with 40 CFR 122.41(j), 122.44(i) and 122.48 to yield data representative of the discharge.

F. Sludge

The discharge of sewage sludge into marine waters is prohibited by section 301 of the CWA and implementing regulations. The 1976 permit required the termination of all sludge discharges from the Deer Island and Nut Island wastewater treatment facilities by July 1, 1977.

The draft permit continues the prohibition of sludge discharges. It states that "the permittee shall not discharge sewage sludge." In addition, General Condition p (Removed Substances) of Part II of the draft permit requires that solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner consistent with applicable federal and state laws and regulations.

G. Bypasses

The draft permit prohibits bypasses unless all of the following conditions occur: (1) bypass was unavoidable to prevent loss of life, severe injury, or severe property damage; (2) there were no feasible alternatives to the bypass (e.g., adequate backup equipment, auxiliary treatment facilities, maintenance, etc.); and (3) the permittee submitted notice of the need for an anticipated bypass at least 10 days prior to the bypass date or the permittee submitted notice of an unanticipated bypass within 24 hours from the time the permittee became aware of the discharges to be followed by a written submission within 5 days of discovery.

The draft permit makes it clear that even wet weather bypasses can be unlawful: Discharges from any point source, regardless of ownership (e.g., discharges from the Boston Water and Sewer Commission's Moon Island facility), which result from past, present, or future failure to properly design, operate, or maintain the permittee's POTW, or appurtenant facilities, or to adequately control or limit incoming flows to the permittee's POTW will be considered unauthorized discharges by the MWRA. Thus bypasses will be considered unlawful if, for example, they could be avoided through upgrading and expansion of treatment facilities.

Pursuant to 40 CFR 122.41(e), the draft permit also requires the permittee in cooperation with its member communities to operate and improve its POTW and total sewer system to minimize the discharge of pollutants from bypasses or CSOs.

H. Infiltration/Inflow

The draft permit requires that the MWRA minimize Infiltration/Inflow.

I. Pretreatment

The MWRA must implement and enforce the Industrial Pretreatment Program required under section 307 of the CWA and implemented by 40 CFR Part 403. The permittee's Industrial Pretreatment Program was approved by EPA on July 20, 1982. The annual reporting requirements and other pretreatment program conditions of the draft permit will assist EPA in determining the permittee's compliance with the requirements of 40 CFR Part 403.

Based on the potential for toxicity as a result of industrial discharges to the POTW, the draft permit includes effluent toxicity limitations and requires the performance of effluent toxicity tests and bioaccumulation tests. These tests will assist in assessing the effectiveness of the permittee's pretreatment program and also may be used as a basis for development of specific numerical pretreatment limits.

J. General Conditions

The general conditions of the permit are based on 40 CFR Parts 122, Subparts A and D and 40 CFR 124, Subparts A, D, E, and F and consist primarily of management requirements common to all permits.

VI. Interim Limits and Compliance Schedules

The EPA may develop interim discharge limits and compliance schedules for the existing discharges in enforcement actions subsequent to issuance of this Permit. On January 31, 1985, EPA filed a complaint in the U. S. District Court for the District of Massachusetts against the MDC, Commonwealth and MWRA to enforce the requirements of the CWA.

VII. State Certification Requirements

The staff of the Massachusetts Division of Water Pollution Control has reviewed the draft permit. EPA has requested permit certification by the State pursuant to 40 CFR 124.53 and expects that the draft permit will be certified.

VIII. Public Comment Period, Public Hearing, and Procedures for Final Decision

All persons, including the applicant, who believe any condition of the draft permit is inappropriate must raise all issues and submit all available arguments and all supporting material for their arguments in full by the close of the public comment period on September 17, 1985. (See 40 CFR 124.13). Comments should be directed to:

U.S. Environmental Protection Agency
Compliance Branch
John F. Kennedy Federal Building, Room 2109
Boston, Massachusetts 02203
Attn: Veronica Hamilton

A public hearing will be held on September 17, 1985, at Gardner Auditorium located at the State House from 7:00pm to 10:00pm. In reaching a final decision on the draft permit the Regional Administrator will respond to all significant comments and make these responses available to the public at EPA's Boston office.

Following the close of the public comment period, the Regional Administrator will issue a final permit decision and forward a copy of the final decision to the applicant and each person who has submitted written comments or requested notice. Within 30 days following the notice of the final permit decision any interested person may submit a request for a formal hearing to reconsider or contest the final decision. Requests for formal hearings must satisfy the requirements of 40 CFR 124.74.

IX. EPA Contact

Additional information concerning the draft permit may be obtained between the hours of 9:00 a.m. and 5:00 p.m., Monday through Friday, excluding holidays from:

Gerald C. Potamis, P.E.
Massachusetts State Coordinator
U.S. Environmental Protection Agency
John F. Kennedy Federal Building
Boston, Massachusetts 02203
Telephone: (617)223-3949

August 16, 1985
Date

David A. Fierra, Director
Water Management Division
U.S. Environmental Protection Agency

Attachment 1
MWRA Fact Sheet
MA0102351

Period January 1984 to June 85

Pollutant	Monthly Average	Maximum Daily
Deer Island		
BOD_5 (mg/l)	107	155
TSS (mg/l)	90	146
Settleable Solids (ml/l)	1.8	4.1
Nut Island		
BOD_5 (mg/l)	85	127
TSS (mg/l)	68	123
Settleable Solids (ml/l)	1.1	1.4

[OW-FRL-2533-1]

Development of Water Quality-Based Permit Limitations for Toxic Pollutants; National Policy

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: EPA has issued a national policy statement entitled "Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants." This policy addresses the technical approach for assessing and controlling the discharge of toxic substances to the Nation's waters through the National Pollutant Discharge Elimination System (NPDES) permit program.

FOR FURTHER INFORMATION CONTACT: Bruce Newton or Rick Brandes, Permits Division (EN-336), Office of Water Enforcement and Permits, U.S. Environmental Protection Agency, Washington, D.C. 20460, 426-7010.

SUPPLEMENTARY INFORMATION: As the water pollution control effort in the United States progresses and the "traditional" pollutants (oxygen demanding and eutrophying materials) become sufficiently treated to protect water quality, attention is shifting towards pollutants that impact water quality through toxic effects. Compared with the traditional pollutants, regulation of toxic pollutants is considerably more difficult. The difficulties include (1) the great number of toxic chemicals that may potentially be discharged to receiving waters and the difficulties in their analysis; (2) the changes in the toxic effects of a chemical resulting from reactions with the matrix of constituents in which it exists; and (3) the inability to predict the effects of exposure to combinations of chemicals.

To overcome some of these problems, EPA and the States have begun to use aquatic toxicity tests and various human health assessment techniques to complement chemical analyses of effluents and receiving water samples. Because these techniques or their application to effluent testing are new, EPA and the States have been cautious in their use. Based on EPA's evaluation of these techniques and the experiences of several States, EPA is now recommeding the use of biological techniques as a complement to chemical-specific analyses to assess effluent discharges and express permit limitations. EPA has issued these recommendations through a statement of policy and is developing a technical guidance document to help implement the policy.

The complete test of the national policy statement follows:

Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants

Statement of policy

To control pollutants beyond Best Available Technology Economically Achievable (BAT), secondary treatment, and other Clean Water Act technology-based requirements in order to meet water quality standards, the Environmental Protection Agency (EPA) will use an integrated strategy consisting of both biological and chemical methods to address toxic and nonconventional pollutants from industrial and municipal sources. Where State standards contain numerical criteria for toxic pollutants, National Pollutant Discharge Elimination System (NPDES) permits will contain limits as necessary to assure compliance with these standards. In addition to enforcing specific numerical criteria, EPA and the States will use biological techniques and available data on chemical effects to assess toxicity impacts and human health hazards based on the general standard of "no toxic materials in toxic amounts."

EPA, in its oversight role, will work with States to ensure that these techniques are used wherever appropriate. Under section 308 and section 402 of the Clean Water Act (the Act), EPA or the State may require NPDES permit applicants to provide chemical, toxicity, and instream biological data necessary to assure compliance with standards. Data requirements may be determined on a case-by-case basis in consultation with the State and the discharger.

Where violations of water quality standards are identified or projected, the State will be expected to develop water quality-based effluent limits for inclusion in any issued permit. Where necessary, EPA will develop these limits in consultation with the State. Where there is a significant likelihood of toxic effects to biota in the receiving water, EPA and the States may impose permit limits on effluent toxicity and may require an NPDES permittee to conduct a toxicity reduction evaluation. Where toxic effects are present but there is a significant likelihood that compliance with technology-based requirements will sufficiently mitigate the effects, EPA and the States may require chemical and toxicity testing after installation of treatment and may reopen the permit to incorporate additional limitations if needed to meet water quality standards. (Toxicity data, which are considered "new information" in accordance with 40 CFR 122.62(a)(2), could constitute cause for permit modification where necessary.)

To carry out this policy, EPA Regional Administrators will assure that each Region has the capability to conduct water quality assessments using both biological and chemical methods and provide technical assistance to the States.

Background

The Clean Water Act establishes two principal bases for effluent limitations. First, existing dischargers are required to meet technology-based effluent limitations that reflect the best controls available considering economic impacts. New source dischargers must meet the best demonstrated technology-based controls. Second, where necessary, additional requirements are imposed to assure attainment and maintenance of water quality standards established by the States and approved by EPA. In establishing or reviewing NPDES permit limits, EPA must ensure that the limits will result in the attainment of water quality standards and protect designated water uses, including an adequate margin of safety.

For toxic and nonconventional pollutants it may be difficult in some situations to determine attainment or nonattainment of water quality standards and set appropriate limits because of complex chemical interactions which affect the fate and ultimate impact of toxic substances in the receiving water. In many cases, all potentially toxic pollutants cannot be identified by chemical methods. In such situations, it is more feasible to examine the whole effluent toxicity and instream impacts using biological methods rather than attempt to identify all toxic pollutants, determine the effects of each pollutant individually, and then attempt to assess their collective effect.

The scientific basis for using biological techniques has advanced significantly in recent years. There is now a general consensus that an evaluation of effluent toxicity, when adequately related to instream conditions, can provide a valid indication of receiving system impacts. This information can be useful in developing regulatory requirements to protect aquatic life, especially when data from toxicity testing are analyzed in conjunction with chemical and ecological data. Generic human health effects methods, such as the Ames mutagenicity test, and structure-activity relationship techniques are showing promise and should be used to identify potential hazards. However, pollutant-specific techniques are the best way to evaluate and control human health hazards at this time.

Biological testing of effluents is an important aspect of the water quality-based approach for controlling toxic pollutants. Effluent toxicity data in conjunction with other data can be used to establish control priorities, assess compliance with State water quality standards, and set permit limitations to achieve those standards. All States have water quality standards which include narrative statements prohibiting the discharge of toxic materials in toxic amounts. A few State standards have criteria more specific than narrative criteria (for example, numerical criteria for specific toxic pollutants or a toxicity criterion to achieve designated uses). In States where numerical criteria are not specified, a judgment by the regulatory authority is required to set quantitative water quality-based limits on chemicals and effluent toxicity to assure compliance with water quality standards.

Note.—Section 308 of the Act and corresponding State statutes authorize EPA and the States to require of the owner/operator any information reasonably required to determine permit limits and to determine compliance with standards or permit limits. Biological methods are specifically mentioned. Toxicity permit limits are authorized under Section 301 and 402 and supported by Section 101.

Application

This policy applies to EPA and the States. The policy addresses the use of chemical and biological methods for assuring that effluent discharges are regulated in accordance with Federal and State requirements. This policy was prepared, in part, in response to concerns raised by litigants to the Consolidated Permit Regulations (see FR 52079, November 18, 1982). Use of these methods for developing water quality standards and trend monitoring are discussed elsewhere (see 48 FR 51400, November 8, 1983 and *Basic Water Monitoring Program* EPA-440/9-76-025). This policy is part of EPA's water quality-based control program and does not supersede other regulations, policy, and guidance regarding use attainability, site-specific criteria modification, wasteload allocation, and water quality management.

Implementation

State Role

The control of toxic substances to protect water quality must be done in the context of the Federal-State partnership. EPA will work cooperatively with the States in identifying potential water quality standards violations, assembling relevant data, developing appropriate testing requirements, determining whether standards are being violated, and defining appropriate permit limits.

Note.—Under sections 303 and 401 of the Act, States are given primary responsibility for developing water quality standards and limits to meet those standards. EPA's role is to review the State standards and limits and develop revised or additional standards or limits as needed to meet the requirements of the Act.

Integration of Approaches

The type of testing that is most appropriate for assessing water quality impacts depends on the type of effluent and discharge situation. EPA recommends that an integrated approach, including both biological and chemical techniques, be used to assess and control water quality. The principal advantages of chemical-specific techniques are that (1) chemical analyses are usually less expensive than biological measurements in simple cases; (2) treatment systems are more easily designed to meet chemical requirements than toxicity requirements; and (3) human health hazards and bioaccumulative pollutants can best be addressed at this time by chemical-specific analysis. The principal advantages of biological techniques are that (1) the effects of complex discharges of many known and unknown constituents can be measured only by biological analyses; (2) bioavailability of pollutants after discharge is best measured by toxicity testing; and (3) pollutants for which there are inadequate chemical analytical methods or criteria can be addressed.

Pollutant-specific chemical analysis techniques should be used where discharges contain few, well-quantified pollutants and the interactions and effects of the pollutants are known. In addition, pollutant-specific techniques should be used where health hazards are a concern or bioaccumulation is suspected. Biological techniques should be used where effluents are complex or where the combined effects of multiple discharges are of concern. EPA recognizes that in many cases both types of analysis must be used.

Testing Requirements

Requirements for dischargers to collect information to assess attainment or nonattainment of State water quality standards will be imposed only in selected cases where the potential for nonattainment of water quality standards exists. Where water quality problems are suspected but there is a strong indication that complying with BCT/BAT will sufficiently mitigate the impacts, EPA recommends that applicable permits include testing requirements effective after BCT/BAT compliance and reopener clauses allowing reevaluation of the discharge.

The chemical, physical, and biological testing to be conducted by individual dischargers should be determined on a case-by-case basis. In making this determination, many factors must be considered, including the degree of impact, the complexity and variability of the discharge, the water body type and hydrology, the potential for human health impact, the amount of existing data, the level of certainty desired in the water quality assessment, other sources of pollutants, and the ecology of the receiving water. The specific data needed to measure the effect that a discharger has on the receiving water will vary according to these and other factors.

An assessment of water quality should, to the extent practicable, include other point and nonpoint sources of pollutants if the sources may be contributing to the impacts. Special attention should be focused on Publicly Owned Treatment Works (POTW's) with a significant contribution of industrial waste-water. Recent studies have indicated that such POTW's are often significant sources of toxic materials. When developing monitoring requirements, interpreting data, and determining limitations, permit engineers should work closely with water quality staff at both the State and Federal levels.

A discharger may be required to provide data upon request under section 308 of the Act, or such a requirement may be included in its NPDES permit. The development of a final assessment may require several iterations of data collection. Where potential problems are identified, EPA or the State may require monitoring to determine whether more information is needed concerning water quality effects.

Use of Data

Chemical, physical, and biological data will be used to determine whether, after compliance with BCT/BAT requirements, there will be violations of State water quality standards resulting from the discharge(s). The narrative prohibition of toxic materials in toxic amounts contained in all State standards is the basis for this determination taking into account the designated use for the receiving water. For example, discharges to waters classified for propagation of cold water fish should be evaluated in relation to acute and chronic effects on cold water organisms, potential spawning areas, and effluent dispersion.

Setting Permit Limitations

Where violations of water quality standards exist or are projected, the State and EPA will determine pollution control requirements that will attain the receiving water designated use. Where effluent toxicity is an appropriate control parameter, permit limits on effluent toxicity should be developed. In such cases, EPA may also require a permittee to conduct a toxicity reduction evaluation. A toxicity reduction evaluation is an investigation conducted within a plant or municipal system to isolate the sources of effluent toxicity, specific causative pollutants if possible, and determine the effectiveness of pollution control options in reducing the effluent toxicity. If specific chemicals are identified as the cause of the water quality standards violation, these individual pollutants should be limited. If a toxicity reduction evaluation demonstrates that limiting an indicator parameter will ensure attainment of the water quality-based effluent toxicity requirement, limits on the indicator parameter should be considered in lieu of limits on effluent toxicity. Such indicator limits are not limits on causative pollutants but limits demonstrated to result in a specific toxicity reduction.

Monitoring

Where pollution control requirements are expressed in terms of a chemical or toxicological parameter, compliance monitoring must include monitoring for that parameter. If an indicator parameter is used based on the results of a toxicity reduction evaluation, periodic toxicity testing may be required to confirm the adequacy of the indicator. Where biological data were used to develop a water quality assessment or where the potential for water quality standards violations exist, biological monitoring (including instream monitoring) may be required to ensure continuing compliance with water quality standards.

EPA believes that the intelligent application of an integrated strategy using both biological and chemical techniques for water quality assessment will facilitate the development of appropriate controls and the attainment of water quality standards. EPA looks forward to working with the States in a spirit of cooperation to further refine these techniques.

Policy signed February 3, 1984 by Jack E. Ravan, Assistant administrator for Water.

Dated: February 16, 1984.

Jack E. Ravan,

Assistant Administrator for Water.

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bibliography

Aerial Data Reduction Associates, Inc., 1981. "Topographic Survey of Long Island, Boston Harbor, MA," April, 1981.

Anderson-Nichols & Co., Inc., and Hazen and Sawyer, 1982. Facilities Planning Relief of the Framingham Extension Sewer -- Volume I -- Engineering Report.

Bank of Boston, February 8, 1984. Protecting Water Resources: A Financial Analysis. Prepared for Massachusetts Executive Office of Environmental Affairs.

Barber, Russell, 1983. Archaeological Survey and Testing on Thompson Island, Boston Harbor: The 1982 Field Season. Unpublished ms. on file at Thompson Island Education Center.

Blomquist, Glenn, "The Effect of Electric Utility Power Plant Location on Area Property Value,": Land Economics Vol. 50 (1974) 97-100.

Board of Prison Commissioners, 1904. Public Document Number 41, 4th Annual Report of the Board of Prison Commissioners of Massachusetts for the year ending September 30, 1904. Wright and Potter Printing Company, Boston.

Boston Board of Health, City of, 1885. 14th Annual Report.

Boston City Document, No. 112, 1892. Final Report of the Special Committee Appointed by the Mayor to Inspect the Public Institutions of Boston.

Boston City Document, No. 144, 1898. Report on the Boston Municipal Camp for Boys on Long Island; Initial Season ending September 3, 1898.

Boston City Document, Numbers 15 and 29, 1928. Annual Report of Institutions Department, 1928.

Boston Landmarks Commission, 1984. Boston's Archaeological Legacy: The City's Planning and Policy Document. Draft Report.

Boston, Committee on Pauperism, 1821. Report on the Committee on the Subject of Pauperism and the Expediency of Erecting a House of Industry in the Town of Boston. Boston.

Boston, Committee on Public Buildings, 1847. Report on the Removal of the House of Industry and Other Public Institutions at South Boston to Deer Island. J.H. Eastburn, Boston.

Bower, Beth, John Cheney and Joan Gallagher, 1984. Intensive Survey of St. Mary's Housing for the Elderly Project Area, Charlestown, Massachusetts. Submitted to the Archdiocese of Boston, Office of Planning. Prepared by The Public Archaeology Laboratory, Inc., Providence and the Museum of Afro-American History, Roxbury.

Braun, David P., 1974. Explanatory Models for the Evolution of Coastal Adaptation in Prehistoric Eastern New England. American Antiquity 39:582-596.

Brenninkmeyer, Benno M., 1976. Dynamics of Sedimentation and Coastal Geology from Boston to Plymouth. In Geology of Southeastern New England, edited by Barry Cameron, pp. 205-223. 68th Annual Meeting New England Intercollegiate Geological Conference. Science Press, Princeton.

CE Maguire, Inc., 1983. Final Report on Sludge Sampling Analysis of the MDC Wastewater Treatment Facilities in Boston Harbor, prepared for: U.S. Environmental Protection Agency, Region I.

Cambridge Systematics, Inc., 1983. Boston Harbor Islands State Park Master Plan Update, Draft Transportation Plan.

Camp Dresser & McKee Inc., 1984. Draft Report to the Metropolitan District Commission Sewerage Division on Discharges from Moon Island. Prepared for the Metropolitan District Commission, Commonwealth of Massachusetts.

Camp Dresser & McKee Inc., 1981. Report on Combined Sewer Overflows in the Dorchester Bay Area, Vol. I and II, prepared for: Metropolitan District Commission, Commonwealth of Massachusetts.

Camp Dresser & McKee, Inc., undated. Preliminary Draft Infiltration/Inflow Report. Submitted to Massachusetts DEQE - DWPC.

Cheney, John and Stephen Mrozowski, 1983. Archaeological Investigations for the Town Hill Condominium Project. The Public Archaeology Laboratory, Inc., Report. Submitted to Paramount Development Association, Framingham.

City of Boston, 1984. Boston in Transition, A Program and Policy Analysis.

Committee on Public Buildings, 1847. Report on the Removal of the Houses of Industry and Other Public Institutions at South Boston to Deer Island. Boston Committee on Public Buildings, J.H. Eastburn, Boston.

Connelly, Patrick J., 1932. Islands of Boston Harbor, 1630-1932. Chapple Publishing Company, Dorchester.

Cote, W.C., 1958. Observations and Conclusions Regarding the Archaeology of the Cochato River Valley Area. Bulletin of the Massachusetts Archaeological Society 19(2):22-26.

Cox, Deborah C. and Peter F. Thorbahn, 1982. Archaeological Investigations in Narragansett, Rhode Island, the Campbell and Sprague I Sites. Department of Anthropology, Brown University Report. Submitted to Lee, Pare and Associates, Inc., Pawtucket, Rhode Island.

Cox, Deborah C., Peter Thorbahn and Alan Leveillee, 1983. An Archaeological Assessment of the Pettaquamscutt River Basin. The Public Archaeology Laboratory, Inc., Report #12-1. Submitted to Rhode Island Historical Preservation Commission.

Cox, Deborah, Ann Davin and Alan Leveillee, 1984. Final Report on the Archaeological Data Recovery Program at the Jamestown Bridge Site (RI-711). The Public Archaeology Laboratory, Inc., Report. Submitted to R.A. Cataldo and Associates, Inc., Pawtucket.

Dincauze, Dena F., 1974. An Introduction to Archaeology in the Greater Boston Area. Archaeology of Eastern North America 2(1):39-67.

Dincauze, Dena F., 1972. The Atlantic Phase: A Late Archaic Culture in Massachusetts. Man in the Northeast 4:40-61.

Dincauze, Dena F., 1973. Prehistoric Occupation of the Charles River Estuary: A Paleographic Study. Archaeological Society of Connecticut Bulletin 38:25-39.

Drake, Samuel G., 1856. The History and Antiquities of Boston, From Its Settlement in 1630, to the Year 1770. Luther Stevens. Boston.

EG&G, 1984. Oceanographic Study of Various Outfall Siting Options for the Deer Island Treatment Plant. Prepared for Havens & Emerson/Parsons Brinkerhoff as part of the 1984 Deer Island Facilities Plan.

EPA 600/8-84/015f, January 1985. Health Assessment Document for Chlorinated Benzenes.

EPA, (-625/5-76-012). Environmental Pollution Control Alternatives: Municipal Wastewater.

EPA, 1976, USEPA Direct Environmental Factors at Municipal Wastewater Treatment Works (EPA -- 430/9-76-003, January, 1976).

EPA, 1976. Quality Criteria for Water

EPA, 1977 (-430/9-76-017c). Federal Guidelines, State and Local Pretreatment Programs.

EPA, 1977 (EPA-600/2-77-087). Microorganisms in Urban Stormwater.

EPA, 1982 (-440/1-82/303). Fate of Priority Pollutants in Publicly Owned Treatment Works.

EPA, 1982 (-600/6-82-004b). Water Quality Asessment: A Screening Procedure for Toxic and Conventional Pollutants.

EPA, March 1981. Health Risks of Human Exposure to Wastewater. Project Summary 600-81-81-002.

ERT, Inc., 1979. Water Quality Goals, Objectives, and Alternatives in the Boston Metropolitan Area -- A Case Study. Prepared for the NSF, EPA, OMB, and CEQ.

Emerson, Frank, 1972. "Valuation of Residential Amenities: An Econometric Approach," Appraisal Journal, (April, 1972) 268-278.

Environmental Assessment Council, Inc., 1977. Environmental Inventory -- Boston, EIS.

Environmental Research & Technology, Inc., 1979. Sludge Management Planning in the Boston Metropolitan Area -- A Case Study. Prepared for National Science Foundation, EPA, Office of Management & Budget, Council on Environmental Quality.

Fay, Spofford and Thorndyke, Inc. Report Upon Infiltration/Inflow Analysis for Nut Island Service Area. Prepared for the Metropolitan District Commission.

Federal Water Pollution Control Administration (FWPCA), 1969. A Practical Guide to Water Quality Studies of Streams.

Gamble, Hays, and Roger Downing, 1982. "Effects of Nuclear Power Plants on Residential Property Values,": Journal of Regional Science Vol. 22 (1982) 457-478.

Grace, R.A., 1978. Marine Outfall Systems, Planning, Design and Construction. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Greeley and Hansen, 1978. Environmental Impact Statement on the Upgrading of the Boston Metropolitan Area Sewerage System Volumes One and Two, prepared for U.S. Environmental Protection Agency Region I, Boston Massachusetts.

Grether, David, and Peter Mieszkowski, 1980. "The Effects of Nonresidential Land Uses on the Prices of Adjacent Housing: Some Estimates of Proximity Effects," Journal of Urban Economics Vol. 8 (1980) 1-15.

Griffiths et al., 1980, I.D. Grifiths, F.J. Langdon, and M.A. Swan, "Subjective Effects of Traffic Noise Exposure: Reliability and Seasonal Effects," Sound and Vibration, Vol. 71(2), 1980, p. 351-386.

Havens & Emerson/Parons Brinkerhoff, 1984. Deer Island Facilities Plan, prepared for: Metropolitan District Commission Sewerage Division.

Havens & Emerson/Parsons Brinkerhoff, 1984. Draft Deer Island Facilities Plan. Unpublished draft prepared for the Metropolitan District Commission.

Havens and Emerson, 1980. Combined Sewer Overflow Facilities Plan Neponset River Estuary. Vol. 1 and 2, prepared for: Metropolitan District Commission, Commonwealth of Massachusetts.

Havens and Emerson, Inc., 1982. Wastewater Sludge Management Update, Summary Report. Prepared for the Metropolitan District Commission.

Herbert R. Pahren, Walter Jakubowski, and Leland J. McCabe. Aerosols from Activated Sludge Plants: EPA TECHNIGRAM.

Huntington, Frederick, 1979. Archaeological Investigations at the W.K. Webb State Park, Weymouth, Massachusetts. Institute for Conservation Archaeology, Peabody Museum, Harvard University.

Jonah et al., 1981, Brian A. Jonah, J.S. Bradley, and N.E. Dawson, "Predicting Individual Subjective Response to Traffic Noise," Journal of Applied Psychology, Vol. 66(4), 1981, p. 490-501.

Johnson, Frederick (editor), 1942. The Boylston Street Fish Weir. Papers of the R.S. Peabody Foundation for Archaeology 2. Andover, MA.

Kales, Emily and David, 1976. All About the Boston Harbor Islands. Harman Publishing Co., Inc., Boston.

Kaplan, Lawrence, 1975. Paleoethnobotany. In Final Report on the Archaeological and Paleobotanical Resources of 12 Islands in Boston Harbor, pp. 112-127. Report submitted by Barbara Kaye, Clifford A., 1976a. Outline of the Pleistocene Geology of the Boston Basin. In Geology of Southeastern New England, edited by Barry Cameron, pp. 46-63. 68th Annual Meeting New England Intercollegiate Geological Conference. Science Press, Princeton.

Kaye, Clifford A., 1976b. The Surficial Geology of the Boston Basin. In Geology of Southeastern New England, edited by Barry Cameron, pp. 158-159. 68th Annual Meeting New England Intercollegiate Geological Conference. Science Press, Princeton.

Kaye, Clifford A., 1977. "Boston Area Surficial," U.S. Geological Survey, November 1977.

Kaye, Clifford A., 1967. Erosion of a Sea Cliff, Boston Harbor, Massachusetts. In Economic Geology in Massachusetts, edited by O.C. Farquhar. University of Massachusetts, Amherst.

Kerby F. Fannin and Standley C. Vana, Sept. 1983. Study of Microbial Aerosols Emitted from a Water Reclamation Plant. Project Summary, EPA-600/81-83-013.

Kerby F. Fannin, Standley C. Vana and Walter Jakubowski, Feb. 27, 1985. Effect of an Activated Sludge Wastewater Treatment Plant on Ambient Air Densities of Aerosols Containing Bacteria and Virus.

Kolb, M. Dept. of Environmental Quality Engineering, Updated June 1983. Boston Harbor: An Overview and History.

LaForge, L., 1932. Geology of the Boston Area, Massachusetts. USGS Bulletin 839, 105 p.

LaForge, Laurence, 1932. "Geology of the Boston Area, Massachusetts," U.S. Geological Survey, 1932.

Langdon, 1976, F.J. Langdon, "Noise Nuisance Caused by Road Traffic Noise in Residential Areas: Part III," Journal of Sound and Vibration, Vol. 49(2), 1976, p. 241-256.

Lipman, S.G. DEQE. c. 1983-84. Boston Harbor Cleanup Effort: An Overview.

Lochner, H.W., Inc., 1984. Bridge Inspection Report For Viaduct Between Moon Island and Long Island. Prepared for City of Boston Public Facilities Department.

Luedtke, Barbara, 1980. The Calf Island Site and the Late Prehistoric Period in Boston Harbor. Man in the Northeast 20:25-76.

Luedtke to Massachusetts Department of Natural Resources.

MaKinnon, 1983. Testimony submitted under Commonwealth of Massachusetts Superior Court Civil Action No. 138477, City of Quincy, Plaintiff v. Metropolitan District Commission, et al., Defendants.

Massachusetts DEQE, DWPC, 1983. Boston Harbor 1983 Water Quality and Wastewater Discharge Data.

Massachusetts Department of Environmental Management, September 1983. Boston Harbor Islands State Park. Newsletter, September 1983.

Massachusetts Executive Office of Environmental Affairs, 1983. Preliminary Report on I/I Removal. Submitted to Prof. Charles M. Harr, Court Appointed Master for Commonwealth of Massachusetts Superior Court Civil Action No. 138477, City of Quincy, Plaintiff v. Metropolitan District Commission, et al., Defendants.

Massachusetts Historical Commission, 1982. Historic and Archaeological Resources of the Boston Area. The Massachusetts Historical Commission, Boston.

Massachusetts Historical Commission, 1984. Historic and Archaeological Resources of the Connecticut Valley. The Massachusetts Historical Commission, Boston.

Massachusetts State Archives, 1676-1763. Manuscript on file at the State House, Boston.

Massport 1984, Generic Environmental Impact Report, Operation of Logan International Airport, Massachusetts Port Authority, Boston, M.A., October 1984.

Metcalf & Eddy, Inc., 1979. The Commonwealth of Massachusetts Metropolitan District Commission. Application for Modification of Secondary Treatment Requirements for Deer Island and Nut Island Effluent Discharges into Marine Waters, Vol. 1-5.

Metcalf & Eddy, Inc., 1982. The Commonwealth of Massachusetts Metropolitan District Commission Application for Modification of Secondary Treatment Requirements for Its Deer Island and Nut Island Effluent Discharges into Marine Waters, Addenda 1-3.

Metcalf & Eddy, Inc., 1984. The Commonwealth of Massachusetts Metropolitan District Commission Application for Modification of Secondary Treatment Requirements for Its Deer Island and Nut Island Effluent Discharges into Marine Waters. (1984 301(h) Waiver Application).

Metcalf & Eddy, Inc., 1979. Wastewater Engineering Treatment, Disposal, Reuse. McGraw Hill Book Company, Boston.

Metcalf & Eddy, Inc., 1982. Nut Island Wastewater Treatment Plant Immediate Upgrading. Prepared for the Metropolitan District Commission.

Metcalf & Eddy, Inc., 1980. Combined Sewer Overflows Charles River Basin Facilities Planning Area (Draft Report) Vol. I and II, prepared for : Metropolitan District Commission.

Metcalf & Eddy, Inc., June 1982. The Commonwealth of Massachusetts, Metropolitan District Commission. Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study, Volumes I and II.

Metcalf & Eddy, Inc., March 1976. Wastewater Engineering and Management Plan for Boston Harbor -- Eastern Massachusetts Metropolitan Area (EMMMA) Study. 23 Volumes. Prepared for the Metropolitan District Commission.

Metcalf and Eddy, 1982. Typical Wind Patterns in Boston Harbor, Summer and Winter; from "Climatology of the U.S., No. 82-19," U.S. Dept. of Commerce, National Climate Center.

Metropolitan Area Planning Council (MAPC), 1982. Regional Decline or Revival: An Interim Population Forecast for the Boston Metropolitan Area 1980-2010.

Metropolitan Area Planning Council (MAPC), 1972. Boston Harbor Islands Comprehensive Plan. Prepared for Massachusetts Department of Natural Resources.

Metropolitan Area Planning Council, 1972. Boston Harbor Islands Comprehensive Plan. On File at Massachusetts Department of Natural Resources.

Metropolitan District Commission, 1984. Metropolitan Sewer District, Member Municipalities -- I/I Status.

Metropolitan District Commission, 1982. Transcript of Public Hearing on Nut Island Facilities Planning Project Phase I Site Options Study.

Metropolitan District Commission, July 1982. Recreational Facilities.

Mieszkowski, Peter and Arthur Saper, 1978. "An Estimate of the Effects of Airport Noise on Property Values," Journal of Urban Economics, Vol. 5 (1978) 425-440.

Mikal, Alan, 1973. Exploring Boston Harbor. Christopher Publishing House, North Quincy.

National Oceanic and Atmospheric Administration (NOAA), 1982. Navigational Chart of Boston Harbor No. 13270, 47th edition, November 20, 1982.

National Oceanic and Atmospheric Administration (NOAA), 1979. Boston Harbor Tidal Current Charts. Fourth Edition 1974.

National Research Council, 1976. Chlorine and Hydrogen Chloride; NTIS Publication PB-253196, April 1976.

Nelson, Jon, 1979. "Airport Noise, Location Rent, and the Market for Residential Amenities,": Journal of Environmental Economics and Management Vol. 6 (1979) 320-331.

Nelson, Jon, 1980. "Airports and Property Values," Journal of Transport Economics and Policy, (Jan. 1980) 37-52.

Nelson, Jon, 1982. "Highway Noise and Property Values," Journal of Transport Economics and Policy, (May, 1982) 117-138.

O'Brien and Gere, 1981. Combined Sewer Overflow Project Inner Harbor Area Facilities Plan, Vol. I and II, prepared for: Commonwealth of Massachusetts Metropolitan District Commission.

Pahren, H. and W. Jakubowski, editors, September 19-21, 1979. Wastewater Aerosols and Disease. Proceedings of a Symposium. EPA, Office of Research and Development.

Parello, Thomas, R., P.E., Report on Inspection and Rating -- Saratoga Street over Belle Island Inlet, May 1980. Prepared for the City of Boston, Massachusetts.

Patterson, J.W., and P.S. Kodukula, 1984. Metals Distributions in Activated Sludge Systems. JWPCF, Vol. 56, No. 5, p. 432-441.

Pendery, Steven; Claire Dempsey; Edward Gordon; John Cheney; and Russell Barber, 1982. Phase II Archaeological Site Examination of the Project Area for the Central Artery, North Area, Charlestown, Massachusetts. Institute for Conservation Archaeology, Peabody Museum, Harvard University, Cambridge, Massachusetts.

Petersen, W.B., 1982. "Estimating Concentrations Downwind from an Instantaneous Puff Release"; Environmental Sciences Research Laboratory, USEPA, April, 1982.

Petrasek, A.C., Jr., et al., 1983 a. Removal and Partitioning of Volatile Organic Priority Pollutants in Wastewater Treatment. Presented at the Ninth U.S. - Japan Conference on Sewage Treatment Technology, Tokyo, Japan, September 13-29, 1983. EPA MERL Cincinnati Contribution No. 50.

Petrasek, A.C., Jr., and I.J. Kugelman, 1983. Metals Removals and Partitioning in Conventional Wastewater Treatment Plants. JWPCF, Vol. 55, No. 9, p. 1183-1190.

Petrasek, A.C., Jr., et al., 1983 b. Fate of Toxic Organic Compounds in Wastewater Treatment Plants. JWPCF, Vol. 55, No. 10, p. 1286-1296.

Picknett, R.G., 1981. "Dispersion of Dense Gas Puffs Released in the Atmosphere at Ground Level"; in Atmospheric Environment, Vol. 15, pp. 509-525.

Poon, Larry C.L., 1978. "Railway Externalities and Residential Property Prices," Land Economics Vol. 54 (May, 1978) 218-227.

Proposed Guidelines for Carcinogen Risk Assessment. 49 FR 46294, November 23, 1984.

Randall, Debra, 1981. Archaeological Survey of the Proposed MDC Sludge Management Plant, Deer Island, Massachusetts. The Institute for Conservation Archaeology, Harvard University. Submitted to MDC and Havens and Emerson, Inc., Boston.

Ritchie, Duncan and Geoffrey Moran, 1976. Phase I Archaeological Investigations of Fort Independence, South Boston, Massachusetts. Department of Anthropology, Brown University Report. Submitted to Metropolitan District Commission, Boston.

Ritchie, Duncan and Joan Gallagher, 1984. An Intensive Level Archaeological Survey on Deer and Long Islands, Boston Harbor, Massachusetts. The Public Archaeology Laboratory, Inc., Report No. 51-01. Submitted to CE Maguire, Inc., Providence.

Rosenbluth and Associates, 1948. Finance Commission of the City of Boston, Administrative Survey of the Government of the City of Boston. Report No. 36, Parts 1 and 2.

SEA Consultants Inc., 1982. Wellesley Extension Sewer.-- Draft Facilities Plan and Environmental Document for the Metropolitan District Commission.
Wallace, Floyd, Associates, Inc., et al., October 1984. Boston Harbor Islands State Park, 1984 Roster Plan Preliminary Report. Prepared for the Massachusetts Department of Environmental Management.

Sconce, J.S., date unknown. "Chlorine: Its Manufacture, Properties, and Uses"; American Chemical Society Monograph Series; Reinhold Publishing Corp., New York.

Shurtleff, Nathaniel, 1871. A Topographical and Historical Description of Boston. A Williams and Company, Boston.

Snow, Edgar R., 1971. The Islands of Boston Harbor, 1630-1971. Dodd, Mead and Company, New York.

Snow, Leslie C., 1984. Archaeological Survey and Testing on Thompson Island, Boston Harbor: The 1983 Field Season. Unpublished report on file at Thompson Island Education Center, Boston.

Stokinger, William, 1978. A Final Report of Archaeological Investigations of Fort Independence: 1976-1997. Department of Anthropology, Brown University Report. Submitted to Metropolitan District Commission.

Sweetser, M.F., 1882. King's Handbook of Boston Harbor. Moses King, Cambridge.

TLVs -- Threshold Limit Values for Chemical Substances in the Work Environment, adopted by ACGIH for 1984-1985.

Task Forces to Mayor Flynn, January 1984. Boston in Transition, A Program and Policy Analysis, Office of the Mayor.

Taylor & Hall, 1978, S.M. Taylor and F.L. Hall, "Regulatory Implications of Individual Reactions to Road Traffic Noise," Transportation Research Record 686, 1978, p. 27-33.

Tennta, Lisa, 1983. Long Island Research Project. Unpublished ms. on file at University of Massachusetts, Boston, Department of Anthropology.

Underhill, F.P., 1920. The Lethal War Gases: Physiology and Experimental Treatment; Yale Univ. Press, 1920.

Wallace, Floyd, Associates, Inc., et al., 1984. Boston Harbor Islands State Park, 1984 Master Plan Preliminary Report. Prepared for the Massachusetts Department of Environmental Management.

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