PROJECT NO. 12384

SUMMARY REPORT TO

HALIFAX REGIONAL MUNICIPALITY

ON

HALIFAX HARBOUR SOLUTIONS PROJECT

by

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1.0 PURPOSE OF THIS REPORT

This Summary Report on the Halifax Harbour Solutions Project has been prepared by the Halifax Harbour Solutions Project Team for the Halifax Regional Municipality Council (HRM Council) to summarize the more detailed technical report. The objective of both documents is to assist HRM Council with the development of a regional system to treat raw sewage currently entering Halifax Harbour. This summary report provides the key information and analyses that were considered in developing a Concept Plan for this regional system. The Concept Plan itself includes a discussion of the issues and objectives, an assessment of major alternatives, estimates of costs, and recommendations. The report also describes a means of implementing the project through phasing which will aid affordability while addressing Harbour water quality and use objectives.

1.1 Overview

The main highlights are presented below.

- The overall Concept Plan will accomplish the community's environmental and socio-economic objectives in the most efficient and affordable fashion for treating sewage.

- This Concept Plan meets the combined criteria and principles articulated by the Halifax Harbour Task Force (1990), Halifax Harbour Symposium (1996) and Halifax Harbour Solutions Advisory Committee (1998). It is also consistent with the directives and guidelines of HRM staff.

- In addition to the existing two sewage treatment plants (STPs), the objectives will be met by the operation of three to five advanced primary STPs, with at least one STP on Halifax Peninsula, in Dartmouth, and on Mainland South. The Plan also recommends changes to the sewage collection system as well as the consolidation and location of outfalls. Provision is allowed for potential future implementation of higher levels of treatment, separation of stormwater and sewage collection and further treatment of overflows. Areas for investigation and potential acquisition of sites for STPs are outlined. The ultimate number and location of plants will depend on the outcome of this site acquisition process, which is the next critical Project stage in the project definition process.

- Costs have been estimated for three Alternatives: 3, 4 or 5 STPs. The estimated capital cost of the Alternatives defined by the Concept Plan would be approximately $290-310 million plus applicable taxes. Operations and maintenance costs will average approximately $6 million per annum. Regardless of which Alternative within the Concept Plan is implemented, the total estimated life cycle cost is similar.

- The overall Concept Plan can be designed and constructed within 3 to 4 years.

- The cost of implementing the Concept Plan will necessarily result in increased user charges beyond those currently in place or approved. In the absence of a contribution to project costs from other levels of government or from the general tax base, these increased wastewater treatment charges will be approximately $160-$226 per year for the average household. The range within this estimate depends on the procurement option selected.

- Procurement options ranging from conventional design/bid/build to a variety of public private partnership options were modeled. Estimated annual capital and operating costs are $28 million to $37 million. A private sector design/build/own/operate model would be the most costly. A public/private partnership with a design/build/operate private sector component would be the least costly.

- If it is determined that the Concept Plan cannot be built in one phase, a two phase implementation scenario is presented. In this scenario, Phase I will accomplish a significant proportion of the overall project objectives with a cost of approximately $160-$210 million. The remainder of the project would then be constructed in a second phase. The construction would be completed over a total period of 10 years.

- At the conclusion of this report, a series of 'next step' recommendations is presented which will advance the refinement and definition of the Concept Plan, and will move towards project implementation.

2.0 HALIFAX HARBOUR - SEWAGE TREATMENT ISSUES

2.1 The Background

A new Halifax Harbour sewage treatment initiative must consider the substantial history, study and analysis that preceded it over the past decades. The Halifax Harbour Solutions Project Team was mandated to develop a plan which would satisfy the water use and quality guidelines outlined in the Halifax Harbour Task Force (HHTF 1990) and be consistent with the 12 principles developed at the Halifax Harbour Solutions Symposium (the Symposium) (HHSS 1996). The Project was also developed concurrently with the deliberations of the Halifax Harbour Solutions Advisory Committee (SAC) which addressed 11 unresolved Symposium issues. The Project Team participated in the SAC process by providing technical presentations, responding to requests for information, and issuing information reports that provided information and analysis in support of the SAC deliberations. The recommendations of the SAC have been accommodated within the overall long term Project scope. It is suggested that the March 1998 Report of the SAC be referred to in conjunction with this document to more completely understand the background information used to develop the Concept Plan.

In addition to the above mentioned sources, the Project Team reviewed a large number of previous technical studies related to sewage treatment in the metropolitan Halifax area. As well, pre-engineering and scientific work was conducted, although no new primary research was undertaken. A more complete discussion of this work is presented in the Technical Report which accompanies this Summary.

Since the scale and cost of the overall Concept Plan is significant, the Project Team recognized that HRM might not choose to or be able to undertake the entire Project at once. Therefore, although the team acknowledges the preference of SAC and many citizens to proceed with all Project components simultaneously, consideration was given to a phased approach. Options are presented in order to assist in defining a phased project which HRM could implement at a lower initial capital cost, while maximizing benefits to the community. Additional implementation phases would follow as further funding was available.

2.2 What are the Halifax Harbour Water Use Objectives?

There has been a high degree of support expressed by the citizens of the metropolitan Halifax area that the treatment of sewage flowing into Halifax Harbour should be an important community objective. At the same time, there are many views about which Harbour conditions are negatively impacted by sewage, the severity of these impacts that cause the Harbour to fall short of community standards, and objectives for Harbour use. There are also many views regarding the extent to which these conditions can be improved by varying types, levels, and costs of treatment.

Clear planning for sewage collection and treatment requires the consideration and application of objectives for Harbour water use. The HHTF classified the regions of the Harbour according to water use objectives:

- Outer Harbour: bathing and contact recreation, immediate shellfish consumption (SA);
- Middle Harbour, Bedford Basin: bathing and contact recreation, modified shellfish consumption (SB);
- Inner Harbour and Narrows, Northwest Arm: boating, industrial cooling, good aesthetics (SC).

The SAC has recommended a single change to this classification scheme: upgrade the Northwest Arm area to Class SB in recognition of its long standing use for bathing and contact recreation (Figure 2.1).

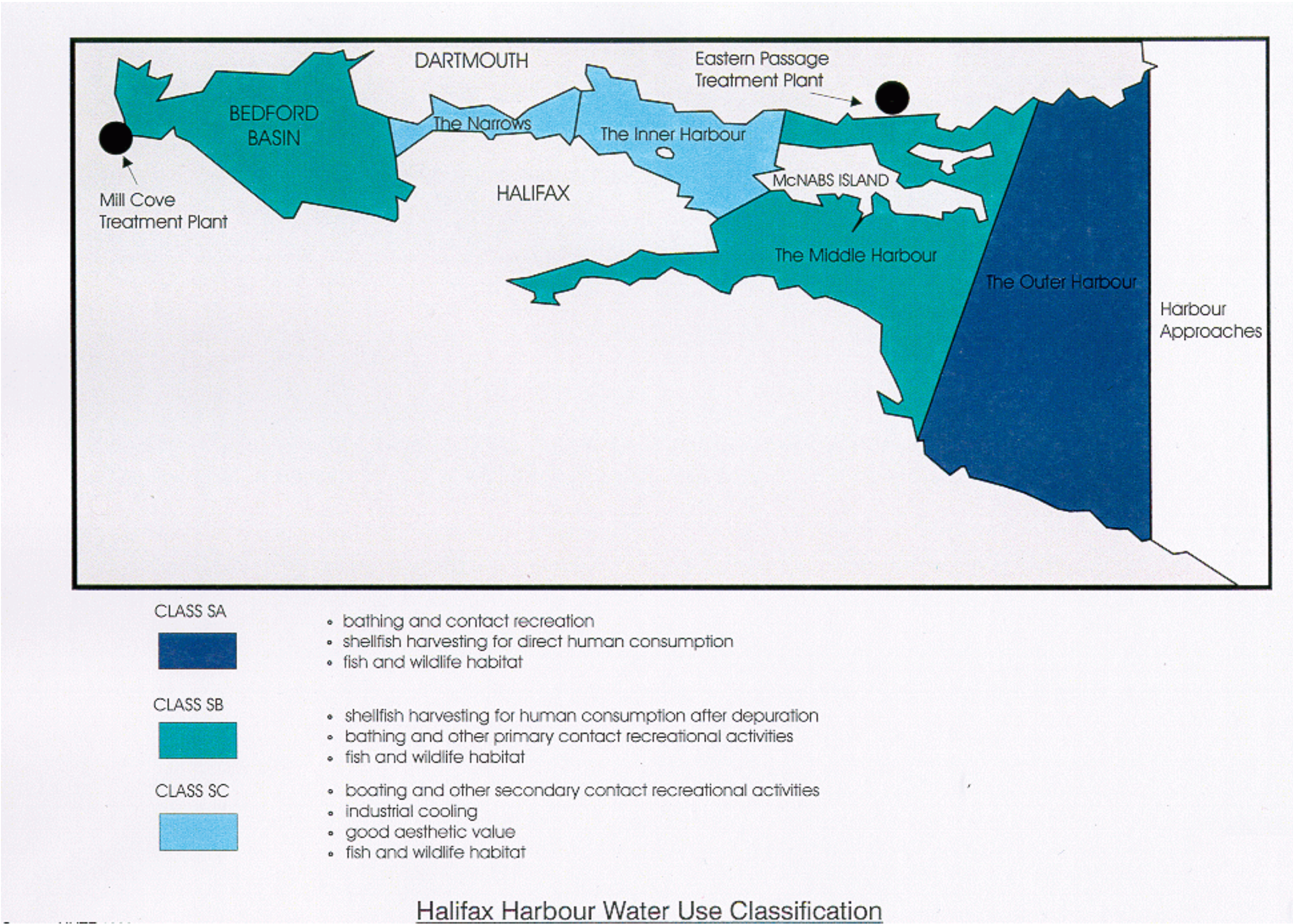

Figure 2.1 Halifax Harbour Water Use Classifications

2.3 What are the Water Quality Problems Related to Sewage Discharge?

Water quality is affected by sewage discharge in a number of ways:

- *Aesthetics*: Portions of the Harbour, particularly those areas of the Halifax and Dartmouth waterfronts frequented by citizens and tourists that are near major outfalls, are prone to exhibit noticeably grey, cloudy and/or sheen water with objectionable odours and unsightly floating objects.

- *Suspended Solids*: Untreated outfalls release sewage solids into the Harbour. Suspended material in Halifax Harbour is usually only evident in the vicinity of present outfalls except where it forms a cloudy appearance in certain weather conditions.

- *Deposited Sediments*: Sediment or sludge buildup has occurred near most of the sewage outfalls in Halifax Harbour. Sewage sludge banks form at the mouth of outfalls and smother the natural sediments and biota in these areas. Samples of these sediments have demonstrated high concentrations of metals which themselves result from a variety of sources throughout the collection system.

- *Pathogens*: Fecal Coliform is used as an indicator for the presence of pathogens (disease causing microorganisms). This presents a possibility of human infection through contact recreation such as swimming. Unacceptable levels of bacteria and other pathogens are found in sections of the Harbour where people may come directly in contact with the water, most particularly near beaches and sailing routes in the Inner Harbour, at the mouth and head of the Northwest Arm, at the mouth of the Sackville River, and at Herring Cove.

- *Biochemical Oxygen Demand (BOD)*: This is a measure of the oxygen requirement of sewage as it decomposes. BOD levels can be high adjacent to outfalls. Available oxygen within Harbour waters is generally sufficient to accommodate the BOD demand created by sewage discharges. Overall, BOD is not a problem in Halifax Harbour except in Bedford Basin, near some existing outfalls, in deep water, and possibly during algal blooms.

- *Nutrients*: Excessive nutrient loads combined with certain water movement patterns can cause harmful and potentially toxic algae blooms, especially in contained areas such as Bedford Basin. These blooms can cause diarrhetic shellfish poisoning and kills of fish and other marine life. At least one documented event resulting in these impacts has occurred in Bedford Basin. Sewage and precipitation run-off into the Harbour are significant sources of nutrient loads.

- *Metals*: Metals can be absorbed by marine life and can accumulate and contaminate a variety of marine organisms and people who eat marine food. Metals in the Harbour come from both households and institutions, commercial and industrial contaminants in wastewaters and are not significantly removed by primary treatment. Existing levels of suspended metals in Halifax Harbour water are very low, but metals have accumulated in the seabed sediments, particularly near existing outfalls.

2.4 Possible Sewage Treatment Strategies to Improve Water Quality

A plan to provide sewage treatment must improve water quality to a level consistent with intended Harbour water use objectives. A series of progressive steps can be taken to improve water quality through changes to the sewage systems. These steps are listed and briefly described below.

- *Collection and screening of outfalls* can reduce shoreline impacts by concentrating the discharge of untreated sewage to an area more removed from human activity or sight. In some cases this relocation can also deposit sewage where currents and water conditions provide more natural opportunity to assimilate nutrients or disperse and settle solids. If this consolidation is combined with the addition of basic screening technology, there can be a substantial reduction in offensive materials reaching the water column such as floatables and non-degradable objects.

- *Outfall extension* can involve extension or replacement of existing outfalls to create a discharge zone further from shore. The distance from shore alone may provide some aesthetic relief. It is often more important to put the outfall in greater depth or where water currents or other conditions cause greater dispersal of sewage.

- *Primary treatment* usually includes a combination of some or all of the following processes: screening of raw sewage; grit removal through controlled settling; additional tank settling of solids and separation of flotables; and disinfection. Approximate maximum removal efficiencies for conventional primary treatment is 65 percent for Suspended Solids (SS) and 35 percent for Biochemical Oxygen Demand (BOD). Sludge is created in primary treatment. This sludge undergoes further processing for land application. If they have the right properties, these materials may also be used in compost-making, which results in products that can be used for land applications and/or soil nutrient supplements. Primary sewage effluent is either processed further or disinfected and discharged to a receiving body of water.

- *Advanced primary treatment* can be employed to improve treatment efficiency. Advanced primary treatment adds flocculating agents which aid settling. The SS and BOD removal efficiencies are increased in advanced primary treatment to approximately 75 percent SS and 50 percent BOD.

- *Outfalls with diffusers* are used for the controlled discharge of effluent to receiving waters. Diffusers are structures located at the end of outfalls designed to release effluent (treated or untreated) by maximizing dispersion within the water column. They are typically sited in deeper water, where currents are strong, with diffused effluent directed towards areas where sedimentation is unlikely. They must be engineered and sited as part of an outfall design that safeguards against hazards such as marine traffic and anchor drag. A successful diffuser system can multiply the dilution capabilities of an outfall and substantially benefit the receiving water quality by reducing the concentration of contaminants adjacent to the outfall and improving water quality generally.

- *Treatment at Combined Sewer Overflows (CSOs), including disinfection* is used to minimize the impacts of stormwater discharges. In older sewer systems such as those in the metropolitan area, many sewers are combined with storm drainage systems. Periodic storm events can result in combined sewage and stormwater flows that exceed treatment or storage capacities. This can result in untreated overflows into receiving waters, generally near the shoreline. To the extent that CSOs can be fitted with additional preliminary treatment (such as screening) or separation technologies, they can mitigate some of the adverse effects of overflows.

- *Secondary Treatment* generally refers to a subsequent stage of treatment following advanced primary treatment. This may involve a form of biological treatment in a mixed reactor with a large population of cultured bacteria under suitable conditions of pH and salinity. An abundant supply of dissolved oxygen may be used or, in some cases, there may be the complete absence of oxygen. The bacteria break down the waste products. The combination of primary and secondary treatment can result in approximately 95 percent BOD and SS removal. Secondary treatment is a preparatory step for further removal of nutrients. The effluent is then disinfected and discharged or additionally treated.

- *Tertiary Treatment* is a supplementary process after secondary treatment. Typically it uses enhanced filtration for increased suspended solids removal. At the same time, it increases the removal of BOD and phosphorus. However, it can also be applied to a second set of aeration and settling tanks in series with the first set to increase removals of nitrogen (as well as SS, BOD and phosphorous). Tertiary treatment may also use natural processes involving plants and aquatic life forms to produce a high quality effluent. Those processes involving constructed wetlands or greenhouse systems generally require a minimum of advanced primary treatment as a preliminary stage.

As progressive treatment components are added, the resulting water quality of the effluent is improved, thereby enhancing the quality of marine waters in the receiving environment. At the same time, however, each of these components requires increased investment in technology and/or facilities. The cost effectiveness of this progression varies. In addition, there is usually an increased requirement for land area at treatment sites resulting in a need for larger sites. Engineering and siting of facilities, outfalls, and diffusers also may become more complex and expensive.

Many interested people agree that overall implementation of all stages of treatment (up to and including enhanced primary) should be incorporated into the Concept Plan. The outcome of future studies and monitoring may indicate requirements for more advanced treatment.

2.5 How Did Our Team Evaluate the Options for Halifax Harbour?

The measures recommended by the Project Team were selected to meet the objectives, principles and criteria recommended by the HHTF, Symposium and SAC and accepted by HRM staff. They include collection, screening and some treatment at CSOs; enhanced primary treatment at most treatment locations; and outfalls with diffusers in deep water in areas not subject to substantial sedimentation. A variety of technologies and approaches are being considered, provided these technologies have been demonstrated to meet necessary performance characteristics in analagous applications and under similar flow conditions.

The evaluation leading to the recommendation of the Concept Plan began with a close review and analysis of the baseline characteristics of the current and projected sewage flows in the year 2041. This was accompanied by a review of the current infrastructure of sewersheds, mains, and other aspects of the collection system with outfalls on Peninsula Halifax, Dartmouth, and Mainland South. The evaluation also involved review and analysis of data, information and study of Halifax Harbour conditions including oceanographic conditions, existing water quality, sedimentation characteristics, Harbour usage patterns, infrastructure, and existing Harbour wastewater management. The Project Team also reviewed the principles and criteria put forth by the Symposium and SAC and matched them against a variety of potential collection, treatment, and sludge management options.

This information was used to determine the appropriate optimal range of numbers and sizes of treatment plants and the varieties of treatment technologies that could both address the typical sewage and wastewater flows and achieve the necessary effluent water quality. The complex interplay of factors required considerable analysis and discussion within the Project Team, which approached the options identification and analysis in a multi-disciplinary process. All major analysis and decision-making sessions were organized in a workshop style with representation from all technical, scientific and engineering Project Team components. Water use and land use issues were considered to be interrelated. Water quality, infrastructure engineering, management, economic and social considerations were all considered in each of the alternatives.

The goal of the Concept Plan was to develop project concepts which could address the community's environmental and socio-economic objectives in the most efficient and affordable fashion.

It is recognized that any potential solution will involve a trade-off of costs and benefits and must balance a complex variety of issues and perspectives. At the same time, the Project Team recognized that the proposed Concept Plan should meet the SAC's recommendations in order to optimize the opportunity to move forward with consensus and maximum community support. Fortunately, the working relationship between SAC and the Project Team was excellent. The final recommendations of SAC are consistent with approaches that the Project Team believes can be supported. It is, however, less clear whether HRM and its residents can afford to implement all components of this plan simultaneously. SAC also recognized that a phased approach might be necessary. Some of the long term objectives, such as a separated sewer and stormwater system, will need to be addressed over many years following design and construction of the treatment system. Further, the difficulty in locating and negotiating suitable STP sites might lead to building components of the Project over a period of years, even if financing were immediately available for their construction. Therefore, the Project Team evaluated a phased approach.

It will be important to monitor and evaluate progress towards Harbour water quality objectives after system components are implemented. Some future components may only be deemed necessary subsequent to these evaluations.

3.0 THE OVERALL CONCEPT PLAN FOR SEWAGE TREATMENT

3.1 How did the Team select the Concept Plan with Alternatives?

The Concept Plan for the treatment of sewage entering Halifax Harbour was developed by the Project Team. Although the analysis of options was directed towards identification of an optimal project, it was decided that the Concept Plan should consider more than one Alternative. This was based upon the assessment that although it was clear that at least three additional treatment plants were required, there was more than one viable and cost effective solution. Further, given uncertainties at this stage regarding site availability, procurement options, and available financial resources, it was determined that the presentation of more than one Alternative within a single overall Concept Plan would maximize flexibility as the process unfolded.

Therefore, three Alternatives were developed by the Project Team, described as A (three STPs), B (four STPs) and C (five STPs).

The three Alternatives will provide water quality improvement that will comply with the recommendations of the HHTF, Symposium, and SAC.

A number of important guidelines and constraints were considered by the Harbour Solutions Project Team in order to arrive at these Alternatives, given the wide variety of possibilities. The main guidelines were provided by:

- the General Principles from the Harbour Solutions Symposium, including water use and quality guidelines developed by the HHTF;
- recommendations of the SAC;
- ongoing discussion with the HRM staff; and
- professional judgement and experience of the Harbour Solutions Project Team.

Guidance from these sources was used to propose potential site areas for treatment facilities, outfalls, and the number and size of plants.

The Project Team reviewed previous studies and conducted additional analyses to determine the appropriate numbers and sizes of treatment facilities to be considered in the Alternatives.

The Project Team concluded that three to five treatment facilities provided the lowest overall capital cost. However, operating costs increase somewhat as the number of plants increases. Multiple facilities provide the benefit of allowing an opportunity to phase in the overall system over a longer period of time.

The capital costs for a sewage treatment system are highest if a single treatment plant is selected, as this would require cross Harbour tunnels for the transmission of sewage. Consequently, it was recommended that there be at least one STP in the Halifax Peninsula, at least one STP on the Dartmouth side of the Harbour, and one STP in Mainland South. Further, it was agreed that an important objective is to locate new outfalls south of the Macdonald Bridge to alleviate the effects of outfall effluents in Bedford Basin.

3.2 Alternative A - Three STPs

Alternative A considers three treatment facilities located in broadly defined areas (Figure 3.1): on the Dartmouth side of the Harbour a facility would be located in the Dartmouth Cove/Sandy Cove area; in the South End Halifax Peninsula a facility would be located in the vicinity of the Ocean Terminals and the railyards; and in Mainland South there would be a single sewage treatment plant. No untreated sewage or effluent would pass in tunnels beneath the Northwest Arm or Harbour. Within all three Alternatives, two options have been identified for locating a single plant in Mainland South. The first option would be to locate a STP in the Herring Cove area and the second to locate a plant in the Roach's Pond (Princeton Avenue) area (See Figures 3.2 and 3.3). Alternative A includes three potential outfalls to service the candidate STP areas. Four candidate outfall areas are shown on Figure 3.1.

3.3 Alternative B - Four STPs

Alternative B considers four treatment facilities (Figure 3.4): in Dartmouth a facility would be located in the general Dartmouth Cove/Sandy Cove area; on the Central Halifax Peninsula a facility would be located south of the Macdonald Bridge between North and Cogswell Streets; and in the South End of the Halifax Peninsula the facility would be located in the vicinity of the Ocean Terminals and railyards. The two options for locating a facility in Mainland South are the same as discussed under Alternative A above. Alternative B includes four potential outfall locations to service the candidate STPs. Five candidate areas are illustrated on Figure 3.4 for these outfalls.

3.4 Alternative C - Five STPs

Alternative C considers five treatment facilities (Figure 3.5): in South Dartmouth a facility would be located in the Dartmouth Cove/Sandy Cove area; in Dartmouth North a treatment facility would be located in the vicinity of the Macdonald Bridge; on the Central Halifax Peninsula a facility would be located south of the Macdonald Bridge between North and Cogswell Streets; in South End Halifax the treatment facility would be located in the vicinity of the Ocean Terminals and railyards; and the two options for locating a facility in Mainland South are the same as discussed above under Alternative A. Alternative C includes five outfall locations to service the candidate STP areas. Six candidate areas for the siting of these outfalls are shown on Figure 3.5.

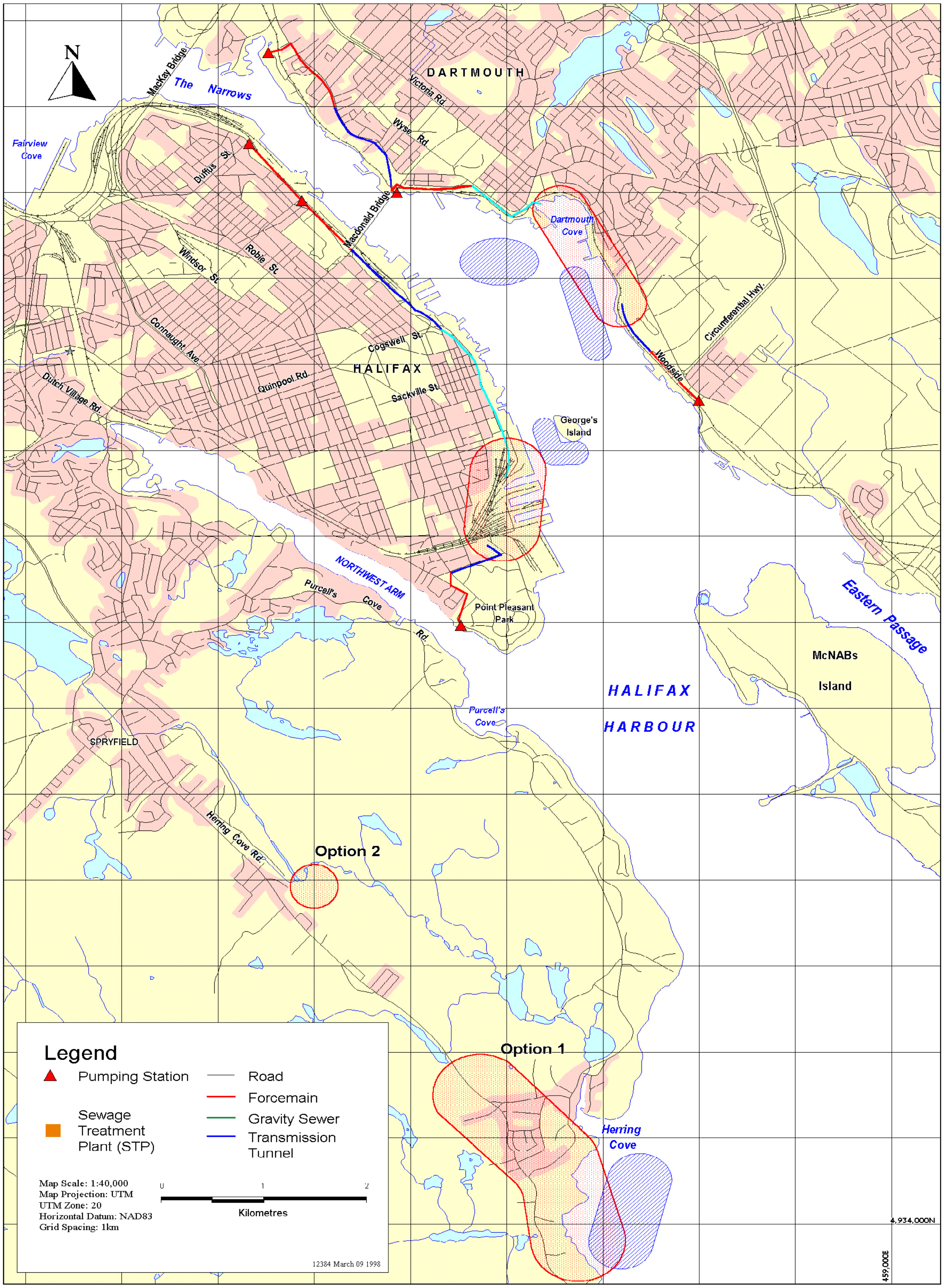

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Figure 3.1 Halifax Harbour Solutions - Alternative A
Three Sewage Treatment Plants

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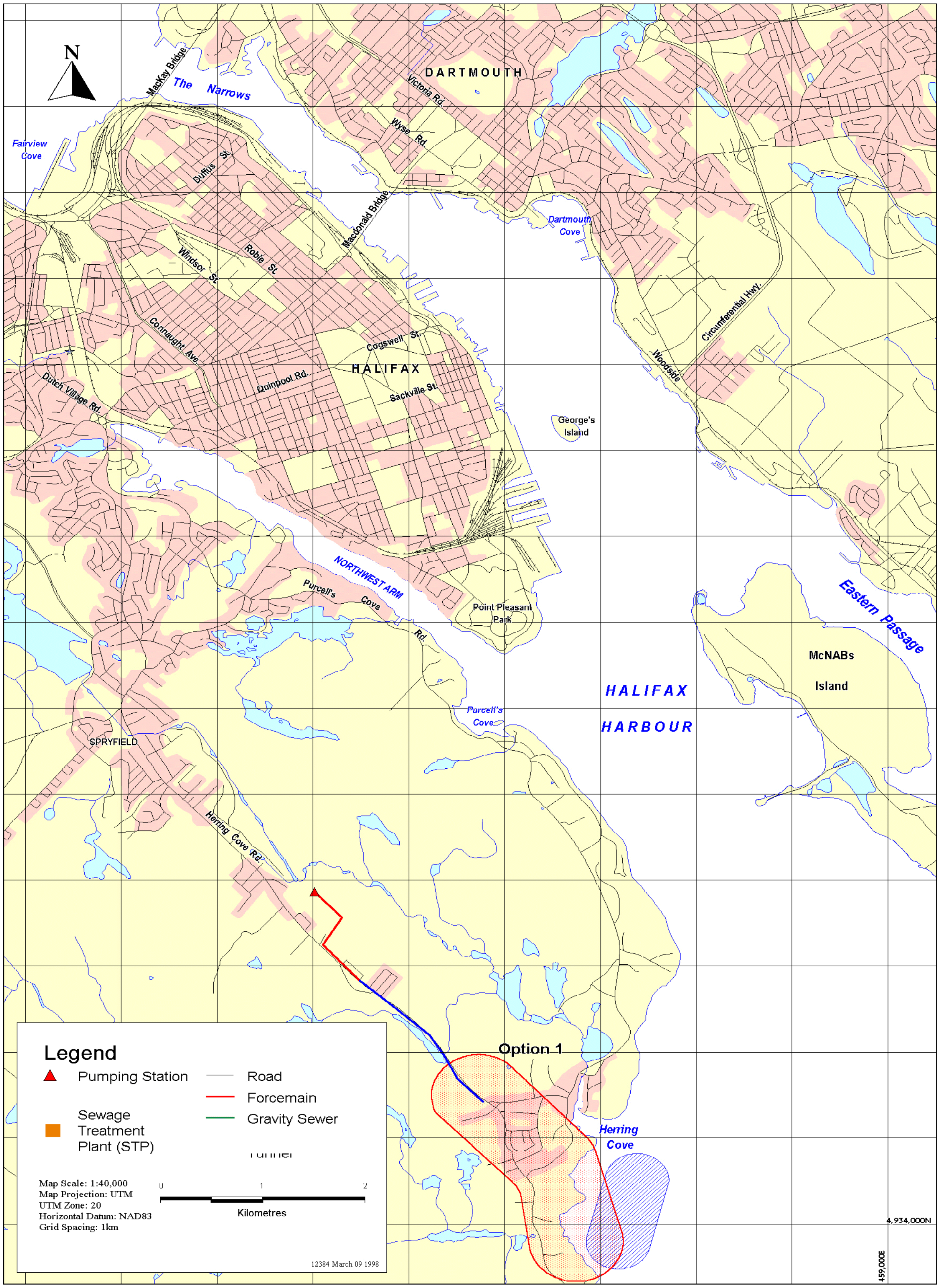

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Figure 3.2 Halifax Harbour Solutions - Mainland South
Option 1

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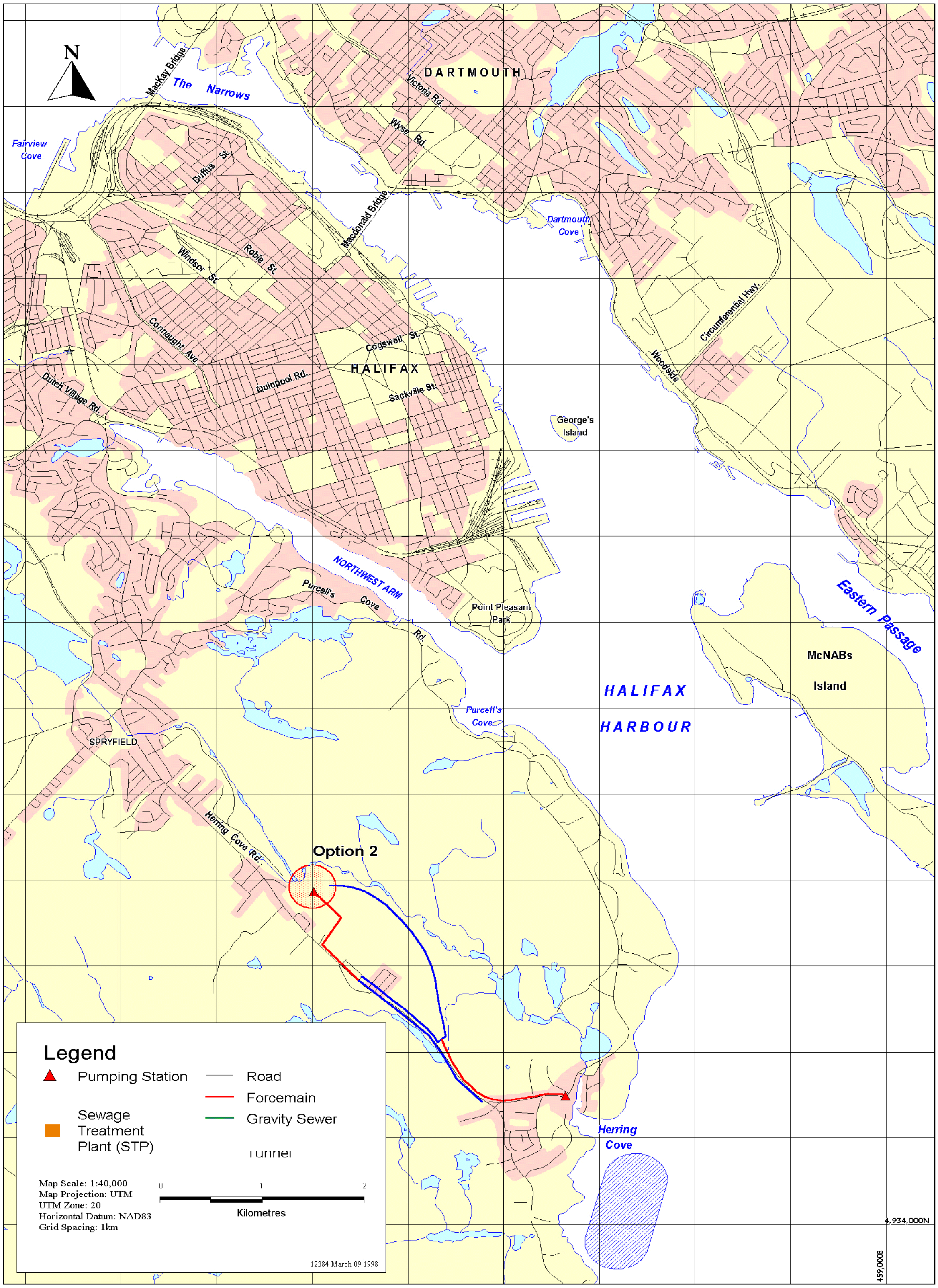

Figure 3.3 Halifax Harbour Solutions - Mainland South
Option 2

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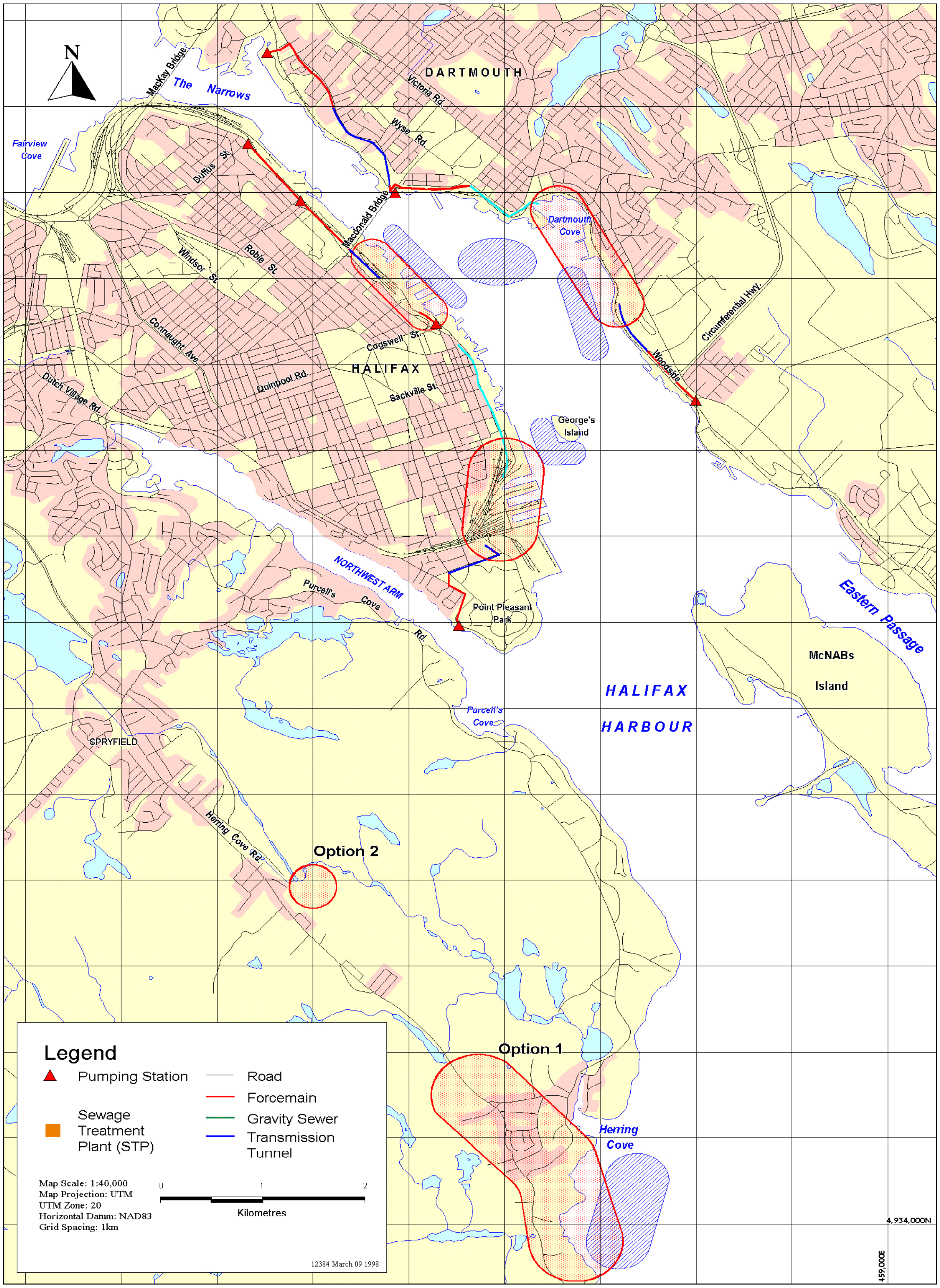

Figure 3.4 Halifax Harbour Solutions - Alternative B
Four Sewage Treatment Plants

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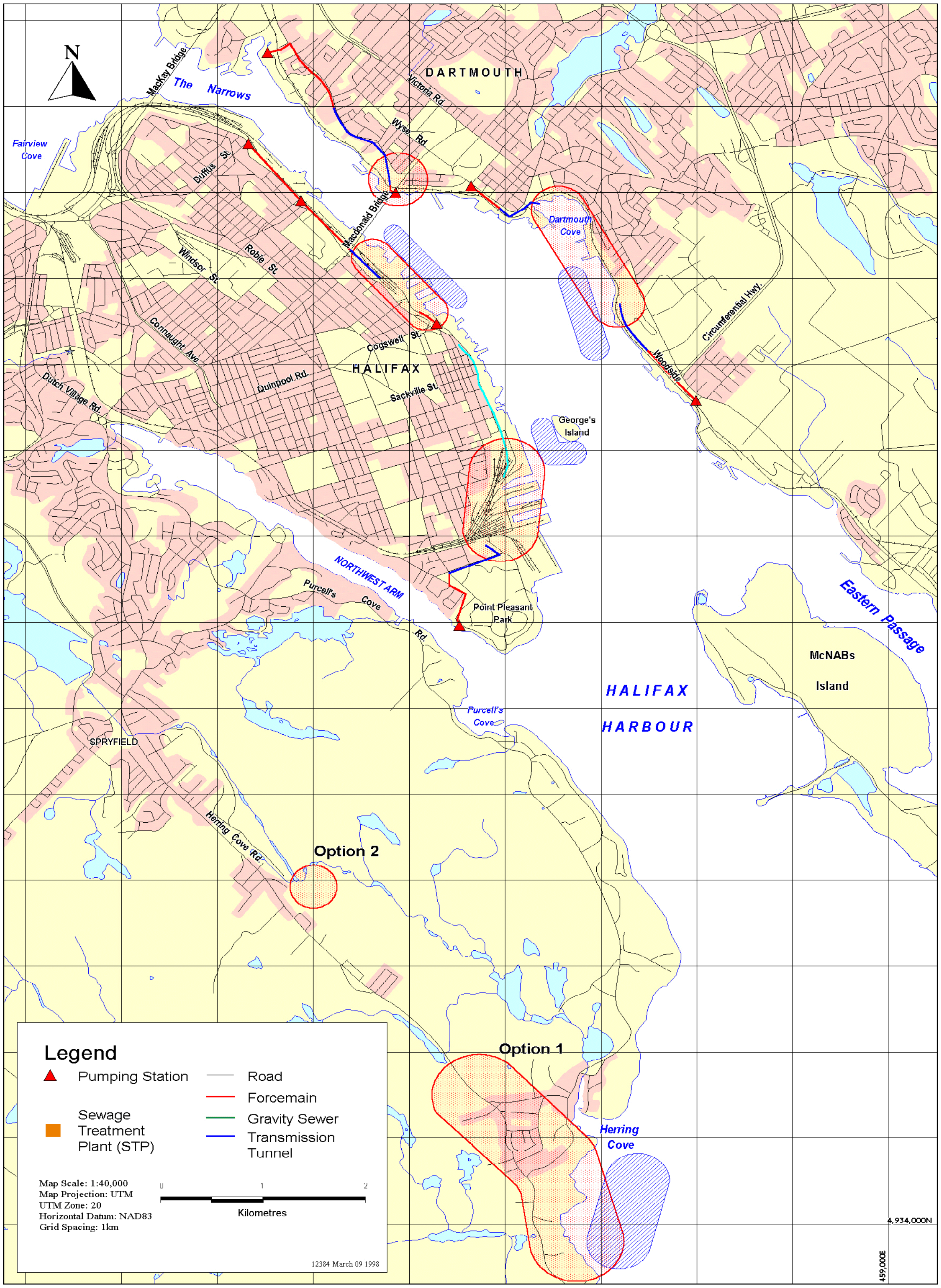

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Figure 3.5 Halifax Harbour Solutions - Alternative C
Five Sewage Treatment Plants

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4.0 WHAT ARE THE ESTIMATED COSTS FOR THESE ALTERNATIVES?

Conceptual level costing is normally used to provide general cost estimates for a preliminary design stage such as this. These cost estimates are considered to have an accuracy of +25% to - 10%.

Conceptual level estimated costs for the entire Concept Plan, including the Mainland South STP, were developed by the Harbour Solutions Project Team. The capital cost estimates are shown in Table 4.1 and 4.2.

Table 4.1
Capital Cost Estimates for System Components (exclusive of land, site development, engineering fees, environmental costs, siting, and taxes) ($millions)

Item/Component	Collection System ($ million)	Sewage Treatment Plants ($ million)	Outfalls ($ million)	Subtotal of Facilities Costs ($ million)
Dartmouth				
Single STP	24	39	12	75
Two (2) STPs	19	42	15	76
Halifax				
Single STP	31	74	15	120
Two (2) STPs	27	79	25	131
Mainland South				
Option 1, single STP	5	10	10	25
Option 2, single STP	7	10	10	27
Regional Alternatives				
Alternative A - 3 STPs	60	123	37	220
Alternative B - 4 STPs	56	128	47	231
Alternative C - 5 STPs	51	131	50	232

The costs in Table 4.1 can be input to a costing table which includes various contingencies. A specific item which is not included in Table 4.1 but which is recognized by the Project Team as important is the design and installation of treatment systems at CSOs. This activity has not been placed in the detailed entries in Table 4.1 because the selection of sites for CSOs, the design of treatment systems at them, and the requirements for upgrading of treatment at CSOs will become clarified as the Harbour Solutions Project proceeds. In light of this uncertainty, the Project Team has adopted an allowance for treatment systems at CSOs of $10 million.

Therefore the following are the costs of the three Alternatives, when the $10 million capital cost allowance for CSO treatment is added:

- Alternative A - subtotal of facilities costs = $230 million
- Alternative B - subtotal of facilities costs = $241 million
- Alternative C - subtotal of facilities costs = $242 million

Table 4.2
Capital Cost Estimates (millions of 1998 dollars) for Three System Alternatives

Item	Alternative A - 3 STPs ($ million)	Alternative B - 4 STPs ($ million)	Alternative C - 5 STPs ($ million)
Subtotal of Facilities	230	241	242
Land and Site Preparation	not estimated	not estimated	not estimated
Engineering and Contingency	35	36	36
Siting & Environmental Costs	2	2	2
Community Integration Costs	6	8	10
Taxes at net 6.45% (HST of 15% minus 57% rebate)	18	19	19
Total Estimated Costs (excluding land and site preparation)	291	306	309

As indicated in Table 4.2, the total estimated costs for the three System Alternatives are between $291 million and $309 million. The lower figure is estimated for Alternative A, while the highest figure applies to Alternative C. None of these estimates includes the costs associated with land acquisition and site preparation, as such costs cannot be realistically or reliably estimated without specific sites for evaluation.

In addition to the capital costs outlined above, the operating and maintenance (O&M) costs have also been estimated for the three Alternatives. It has been determined that the degree of variation in O&M costs among the Alternatives is relatively modest. Therefore, an estimated O&M cost has been adopted for economic modeling purposes which would accommodate Alternative C (five STPs). This cost, including pumping station electrical costs but excluding labour costs for collection system maintenance is approximately $6 million per year.

The capital costs for STPs relate to sewage flow volume capacities projected to approximately the year 2010. If flows increase as projected after 2010, some capital costs for upgrading equipment for increased volume will be required regardless of which procurement or implementation option is selected. In the Project Team's opinion, these "downstream" costs do not affect decision making required at this stage.

A 60-year lifecycle cost analysis was also prepared for the three regional alternatives. It was concluded that the capital and lifecycle costs for each of the alternatives are similar (within approximately 5%). Therefore the three Alternatives are similar from the perspective of costs, thus the land availability and acquisition aspects will substantially govern the selection of the Alternative to be implemented.

Estimated capital costs for the Concept Plan are $290 to $310 million, while estimated operating costs are approximately $6 million per year.

5.0 PROCUREMENT OPTIONS

5.1 What are Procurement Options and how did the Team Evaluate Them?

Various options for implementing the Harbour Solutions Project may be viable. These options can range from the traditional public sector tendering process, through a public-private partnership (PPP) model of Design/Build/Operate, to a PPP which encompasses a fully privatized Design/Build/Operate/Own/Finance. Governments at all levels in Canada have been interested in the benefits of implementing public infrastructure projects through PPP approaches. The Halifax Harbour Solutions Project has also been examined in this light. Our Project Team was also mandated to evaluate the lessons learned from PPPs for municipal wastewater projects elsewhere in Canada and to evaluate the applicability, costs, and benefits of various PPP approaches to this Project.

Our evaluation indicated that there are no significant impediments to implementing the project through a PPP. A review of Canadian experience illustrates that the majority of small municipal wastewater projects have been successfully implemented utilizing a PPP approach, although only a few large scale projects were available for review. Most large projects were delayed, primarily due to the municipality being unable to recover the substantial capital and operating costs from existing rate payers and uncertainty regarding the expected benefits. Other contributing factors to delaying these large projects included loss of control issues, complexity of the solution (including the PPP process itself) and the need for more self assessment and internal arrangements. There are, however, examples of successful large scale infrastructure projects that have produced substantial benefits to the public sector (Prince Edward Island Confederation Bridge and New Brunswick Fredericton to Moncton Highway project).

Experience in other jurisdictions illustrates that an open public process, in which local concerns and issues are incorporated in defining the project objectives, is critical to the successful implementation of a private sector participation option. If a PPP option is chosen, the public sector must demonstrate its commitment to this method of procurement.

Various options for implementing the Concept Plan may be viable. A partially privatized option such as Design/Build or Design/Build/Operate may provide significant savings to the Municipality and its residents compared to traditional public financing.

5.2 Will a PPP Approach Save Money for the Municipality and its Residents?

An economic analysis of the Project was conducted utilizing three models of public/private sector participation. The results of the analysis are summarized in Table 5.1.

Table 5.1
Annual Cost of Implementation Options (millions of $s)

Item/Description	**Design/Bid/ Build**	**Design/ Build**	**Design/Build/ Operate (DBO)**	**Design/Build/ Own/Operate/ Finance (DBOOF)**
Net capital financing cost per year	$26.0 million	$22.5 million	$22.5 million	$26.2 million
Net operating cost per year	$6.6 million	$6.6 million	$5.9 million	$5.7 million
HST paid by users under DBOOF model	0	0	0	$5.2 million
Total Annual Cost to HRM System Users	**$32.6 million**	**$29.1 million**	**$28.4 million**	**$36.7 million**
Percentage increase in wastewater management and environmental protection charge required to generate the annual revenue	189%	169%	165%	213%
Annual increase in wastewater management and environmental protection charge	$185	$165	$161	$208

As shown in Table 5.1, depending on the implementation option selected, the annual increase in charges to an average household would be $161 to $208 for implementing the Concept Plan.

6.0 IMPLEMENTATION OF A PHASED PROJECT

6.1 Could the Project be Financed in Full?

The financing and implementation of the Halifax Harbour Solutions Project is yet to be determined. Clearly, the selection of the method of implementation will require determining the charges and increases in charges that would be considered acceptable by taxpayers and users. This is an area where public input to the decision making process will be important.

HRM data indicate that the average residential user has a total water bill of $252 per year, of which $80 comprises the environmental protection (EP) and wastewater management fee portion (for HRM), and $172 is for water (which is for HRWC). Beyond April 1, 1998, this annual bill (without accounting for the potential of water conservation measures) will increase to $275 per year, of which $100 will comprise the EP and wastewater management fee portion.

As a "rule of thumb" for Canada, wastewater treatment charges to typical users are about 1.0 to 1.5 times their water bill. By contrast, the present HRM charge (after April 1, 1998) is about 58% of the typical residential water bill.

The economic analysis illustrates that this EP and wastewater management fee would have to increase by $161 to $208 per average household per year, depending upon which procurement option is utilized, in order for sufficient revenues to be generated to fund the annual financing and operating costs of the full Harbour Solutions Project. Table 6.1 indicates how a $160 increase in average household user fees could be implemented for either a four-year complete project as compared to a project phased over nine years.

It is possible that HRM and its residents may determine that such a cost increase cannot be absorbed at one time. Consequently, a phased project has been evaluated.

Table 6.1 Models of Cost and Funding		
Item	**Options**	
	Scenario 1	**Scenario 2**
Design and Construction	• begins in 98/99 • fully operational by 2003/2004	• Phase I: 98/99 - 2002/2003 • Phase II: 2004-2009 • fully operational in year 2009
Financing	• begins in 1999/2000 • incremental increase per household per year = $40 • $160 per year per household by 2003/2004	• begins in 1999/2000 • incremental increase per household per year = $20 • $160 per year per household by 2007

6.2 How could a Phased Project be Implemented?

The Harbour Solutions Team worked closely with the SAC and HRM staff to define an option for phasing which would avoid the "all or nothing" dilemma. A phased approach is consistent with the principles and recommendations arising from the Symposium and the SAC. In particular, the SAC recommended that "in order to achieve the Halifax Harbour Task Force water quality objectives, as modified by the Advisory Committee, a phased approach, affordable to ratepayers, should be implemented."

At the same time it was recognized that there is widespread interest in moving towards a comprehensive program as rapidly as possible. In a phased approach, segments of the project can be implemented and substantial improvement in water quality can be realized prior to the overall project completion. Therefore, Phase I should seek to accomplish a significant portion of the project objectives, while facilitating subsequent Phases. Consistent with this, the first strategic priority should be for HRM to investigate and acquire potential STP sites. Whether or not all system components are implemented simultaneously, this is a necessary first step before the Project can be defined in more detail.

The Project Team recognizes SAC's concern that interim stages be conducted within the framework of a clear long term plan and commitment. The Project Team recommends therefore that a Phase I project be considered as a part of the overall Concept Plan.

6.3 What are the Elements of a Phased Project?

The SAC, HRM staff and the Harbour Solutions Project Team all agree that the highest priority for immediate action is the downtown Halifax waterfront. The SAC also pointed to the sewage effluent from Duffus Street as a first priority. The Project Team recommends that either one or two treatment plants on the Halifax side of the Harbour be included in Phase I.

On the Dartmouth side of the Harbour, the Project Team recommends that the impacts of the Tuft's Cove outfall be mitigated as a first priority. A collector sewer routing this flow to an area near the Macdonald Bridge could be provided as an interim measure, with screening and possibly disinfection and an outfall in deeper water at the bridge area.

At major CSOs and outfalls, screening and disinfection would be provided, as appropriate, during Phase I.

Consequently, in point format Phase I is suggested as follows:

- One or two STPs in Halifax, depending on the results of land acquisition, with appropriate collection systems, and outfalls which are aimed at providing diffusers in deeper water and to the water quality and use objectives.

- Tuft's Cove outfall and other outfalls on the Dartmouth side north of the Macdonald Bridge would be collected together and routed to the general area of the Macdonald Bridge.

- An outfall would be constructed from the Macdonald Bridge area in Dartmouth, into deeper water.

- The existing consolidation system in Dartmouth Cove would have the recently installed outfall extended with a diffuser added. (This would improve aesthetics on the Dartmouth Downtown shoreline).

- Remaining major CSOs/outfalls would be fitted with screening, and disinfection if and where applicable.

Collectively, the conceptual level cost estimate for Phase I is $160 to $200 million. This is approximately 67% of the overall Concept Plan cost as presented in Table 4.1. An economic analysis was conducted on a $200 million Phase I project. It is estimated that the EP and wastewater management fee would have to increase by 105% to 138%, depending upon which procurement option is utilized, in order for sufficient revenues to be generated to fund the annual financing and operating costs of the Phase I Project. This would require an annual increase of $102 to $134 per average household per year. An increase of approximately $120 could be implemented over six years at $20 per year for the typical household, or over three years at $40 per year.

The Mainland South component can be implemented when community siting issues are resolved, at a capital cost of about $25-27 million, plus engineering, contingencies and land costs, taxes and associated costs.

A phased project can be implemented if it is determined that the overall Concept Plan cannot be afforded immediately. Phase I would require a commitment to the long term overall Concept with an immediate commitment to a project with a capital cost of $160 to $200 million. The capital and operating costs of this Phase I project could be funded by an increase in the wastewater management and EP charges of $102 to $134 per average household per year.

7.0 ACTIVITIES CRITICAL TO IMPLEMENTATION

Whether the Harbour Solutions Project is implemented in full or in a phased manner, there are many activities critical to implementation. These are presented below.

7.1 Project Definition for Financing Purposes

It is assumed that HRM Council will review the findings and recommendations of this report, as well as the related SAC and HRM staff reports, and then approve an overall Concept Plan. HRM Council may also decide to undertake the Project in more than one phase. Although it is not required at this point, HRM Council may also indicate its preferred financing approach for procurement. The alternatives to procurement have been discussed in Section 5. It is important to move forward towards a clear and precise project definition as soon as possible, whether or not a procurement decision is made now. Until the project evolves to such a definition, it will not be possible to complete a detailed economic analysis of procurement options. Even if the project is intended to occur in phases, an overall definition by phase will allow consideration of advantageous procurement arrangements for the entire program or individual phases. Whether the project is expected to proceed as a conventional design/bid/build project or any variety of public private partnership, a detailed project definition will be necessary to assess responses to Requests for Qualification or Proposal.

Obtaining sites for the STPs and gaining community acceptance will therefore be critical to moving forward. This, therefore must be a first priority.

7.2 Stakeholder and Public Consultation

It is recommended that HRM initiate a program of stakeholder and public consultation and information subsequent to the reports becoming public (i.e., during and following Council review). This program should be designed to exchange information with key project stakeholders, as well as provide accurate information to the media and general public. Public and community communication should become an ongoing aspect of the process in both the site acquisition and pre-construction periods. With a project as complex and potentially contentious as Harbour Solutions, a pattern of straightforward, responsive, and accurate information will be essential in gaining and keeping public support and credibility.

SAC recommended and endorsed an approach to siting known as 'WINBY' (Want It In My Neighborhood's Backyard). This approach emphasizes a pro-active and consultative process which seeks to work with communities in a constructive fashion towards acceptance of sites. The basis of this strategy is ongoing communication and consideration of community concerns and interests. This approach is essentially the opposite of the better-known, confrontational NIMBY reaction (Not in My Back Yard) which has been faced by countless municipalities in their efforts to site waste treatment facilities.

The WINBY approach relies on three important factors: technical expertise, public involvement, and community consultation. Technical expertise is critical in appropriately evaluating site information, design, costs, property information, and impact management. Public involvement is critical in identifying, for the local communities, the ways in which a proposed facility can benefit the neighborhood in some direct manner. Thirdly, community consultations require that the benign and acceptable nature of proposed facilities must be demonstrated before the potential neighbors can recognize the inherent opportunities in siting an STP in their neighborhood. It is imperative that citizens understand the capability of well designed and engineered treatment plants to be inoffensive neighbors. This is particularly important since in most areas, limitations on land availability are likely to require compact sites than can incorporate reduced buffer zones. It can also be useful in recognizing community objectives that can be reasonably incorporated into facility design. Amenities such as landscaping and traffic, parking or right of way adjustments are examples. To the extent that both the most closely affected neighborhoods and the HRM community at large can understand the issues, limitations and opportunities in a positive atmosphere, the siting and decision making processes can be facilitated.

7.3 Site Selection and Acquisition

HRM will need to begin the process of selecting specific sites for STPs within the candidate site areas. This will involve a more detailed review of the potential availability of specific properties, discussions with landowners, application of more refined site selection criteria (e.g., SAC criteria) and the beginning of the land acquisition process. It is unlikely that the project can proceed to the procurement phase until HRM has secured STP sites that have been subject to some level of public review.

The Solutions Project Team has identified four procurement alternatives for consideration by HRM. Each of these alternatives requires the identification, selection and acquisition of land for the purposes of

installation of STPs. To a certain degree the alternative which is adopted will depend on the ability of the HRM to successfully identify and acquire the necessary property within the desired areas.
In order to improve the probabilities of success in siting and land acquisition, the Project Team and the SAC have investigated new and successful approaches to siting of these types of facilities. As discussed above, it is recommended that HRM consider a siting process which conforms to the WINBY approach (Want it in My Neighborhood's Backyard).

7.4 Source Control Program

The Project Team recognizes the importance of Source Control as an integral component of the Halifax Harbour Solutions Project. However, Source Control was not included in the Terms of Reference for SAC or the present study. The basic reason is that Halifax Regional Municipality had already embarked on its Source Control Implementation Strategy in 1996. This strategy will result in important improvements in the levels of nutrients, metals, and toxins which currently make their way to the fresh and marine waters of the municipality. The strategy comprises seven key components:

- administration and technical organization
- public involvement and information
- Best Management Practices (BMPs)
- legislation and enforcement
- toxic and hazardous waste controls
- stormwater management
- water conservation

The Implementation Strategy having been developed, HRM staff are currently developing a work program for the next phase of the Source Control Program. The next phase is anticipated to include the following components:

- develop and adopt a pollution prevention vision
- define candidate IC&I (Industrial, Commercial and Institutional) sectors
- audit and assessment of candidate IC&I sectors
- implement baseline data collection and monitoring program
- develop pollution prevention information program
- implement enforcement initiatives
- develop GIS applications
- conduct program effectiveness review

HRM staff expect to see measurable reductions in pollutant loads entering the sewer system as a result of the components identified above. Simple changes to current habits can result in short-term improvements.

Aesthetics can be improved quickly and cheaply by encouraging residents to dispose of inorganic floatables such as solid waste in acceptable ways. In the longer term, our evaluation has highlighted the importance of controlling nitrogen (and secondarily, phosphorus) at source as one measure toward limiting algal blooms in the Harbour.

7.5 Regulatory Review and Approval

Regulatory review and approval is required from the federal and provincial governments before the Project can be implemented. Prospective private sector partners will require a clear understanding of the necessary approvals and approval processes for the Project before firm commitments are made. In particular, clarity will be required regarding regulatory processes, such as the environmental assessment process, which has often caused uncertainty for project proponents in the past. This uncertainty has been related to scope of assessment; cost implications of approval conditions; impacts on project schedule; and, even, ultimate approval of the project.

Nova Scotia Department of the Environment requires sewage treatment facility proponents to obtain an approval under the *Nova Scotia Environmental Act* according to the *Activities Designation Regulations*. The general conditions for provincial approval are described in the Nova Scotia Guidelines Manual for the Collection, Treatment and Disposal of Sanitary Sewage (NSDOE 1992). It is assumed that these Guidelines will be followed by the Project proponent in close consultation with NSDOE to ensure an efficient approval process.

A provincial environmental assessment is not automatically required for sewage treatment facilities under the *Environmental Assessment Regulations.* However, the provincial Minister of the Environment can require an assessment if, for example, there is a high degree of public concern regarding potential adverse environmental effects (including socio-economic effects) from the Project. Preliminary discussions with NSDOE officials indicate, however, that they view the proposed Project as environmentally beneficial, and it is unlikely that a provincial environmental assessment will be required. This is particularly true if HRM demonstrates an effort to identify and address stakeholder and public concerns.

Federal approval will be required under the *Navigable Waters Protection Act (NWPA)*. In particular, early consultation with the Canadian Coast Guard is required to approve the potential outfall and diffuser locations. Approval may be required under the *Fisheries Act* if fish habitat will be altered through infilling or other activities. Some level of federal environmental assessment under the *Canadian Environmental Assessment Act* will be triggered if federal permits are required (e.g., under the *NWPA*); federal lands or waterlots are used; or if federal cost shared is eventually provided.

On the basis that the full Project described is intended to meet the basic water quality criteria already established for the Harbour, it is anticipated that the appropriate environmental approvals could also be obtained for a phased Project. This assumes that HRM undertakes the recommended scoping exercise and consultations with the federal and provincial regulators.

7.6 Monitoring Program

The Harbour Solutions Project Team anticipates that the full development of the regional sewage treatment system as described in this report will achieve the basic water quality objectives. A phased Project will achieve these objectives in stages. It is important that progress toward these objectives be quantified and confirmed through a monitoring program. In addition to confirmation of overall objectives, monitoring can help identify specific issues, thereby allowing an opportunity to modify the Project if necessary during a phased implementation and/or during Project operation. A monitoring program therefore should be developed by HRM as a required part of the overall Project.

It is recommended that HRM develop a scope for a monitoring program in consultation with the appropriate regulatory authorities (e.g., NSDOE, Environment Canada, DFO). Some potential applications of monitoring data could be used to determine if additional levels of treatment are required beyond those currently recommended, such as secondary treatment; nutrient removal; or additional treatment at CSOs. Monitoring information could be particularly useful during implementation of a phased project to identify the incremental benefits from the addition of the various components. Thus, limited resources may be directed to achieve the best project value.

A monitoring program could include a review of existing baseline information supplemented with additional data gathering and modeling at specific outfall locations. In particular, additional oceanographic studies are likely required to determine the effluent plume and settling patterns at specific outfalls and for different diffuser designs. Some studies may be required regarding potentially affected communities of biota and fishing activities (e.g., lobster). Monitoring will also be required to determine whether known or suspected contaminated sediments are being disturbed. Archaeological monitoring will be required in the waters and on land areas to be disturbed by the Project, which are known or have a high potential to contain archaeological or heritage resources.

Activities critical to implementation of the Harbour Solutions Project include project definition, public consultation, site selection, source control, regulatory approval, and initiation of long term monitoring programs.

8.0 RECOMMENDATIONS

The Halifax community has repeatedly indicated its desire to move forward towards a sewage treatment solution for Halifax Harbour. The Harbour Solutions Project Team is confident that significant progress can be made within the bounds of fiscal prudence and economic acceptability to community residents. Based upon the outcomes of the Halifax Harbour Symposium and now, the Halifax Harbour Solutions Advisory Committee, the Project Team believes that there is a unique opportunity to act, based upon broad consensus among many key stakeholders. We believe that it is particularly noteworthy that the three Reports currently being tabled before Halifax Regional Council, from SAC, HRM Staff and the Harbour Solutions Team are all in substantial concordance on the parameters and approaches that should be accepted. The Mayor and Council have mandated and encouraged the steps during the past eighteen months that have led to this opportunity.

The decisions that Council can take at this time can put in motion the next series of steps leading to a Halifax Harbour Solution. Based upon the findings summarized in this report, The Harbour Solutions Project Team recommends the following actions:

- That HRM Council accept and endorse the Report of the Halifax Harbour Solutions Advisory Committee as recommended by the HRM Staff Report. Those items identified in the Staff Report for further evaluation or consideration should be advanced as rapidly as feasible.

- That HRM Council approve the overall Concept Plan for a Harbour Solution, as described earlier in this document. As described, this Concept Plan offers three Alternatives with between three and five new advanced primary sewage treatment plants. It is recommended that HRM Council not single out only one Alternative for implementation until site acquisition opportunities are defined. All three Alternatives can be implemented within a similar range of capital, operating and maintenance, and life cycle costs.

- That no decision on procurement options is required until a more complete and detailed project definition is developed and approved, which in turn will depend on which sites are acquired.

- That HRM Council should decide on the scale of project which can be afforded at this time, and in light of overall project costs and the length of time over which the complete project should be undertaken. A schedule of measures to fund the project should be generally determined. This schedule should include increased user charges, consider funding contributions from general revenues, and opportunities for cost sharing or contributions from other levels of government. Incremental increases in wastewater management and EP surcharges could be phased in over time to assist in social acceptability and affordability to residents and users. Initial stages of this funding program should be implemented immediately and should continue during the pre-operational period in order to accelerate growth of the reserve fund and to advance the implementation of higher user charges.

- If the complete project is deemed to be too costly to embark on at once, it is recommended that a two phase project be approved with a first phase costing about $160 - 200 million in initial costs. This Phase I can be defined to accomplish a significant proportion of the overall project objectives. In the event that a Phase I project is initiated, the commitment should be clear to proceed with a second phase to complete the overall Concept Plan.

  - Within a phased approach, priority should be given to treating sewage which presently discharges into the Harbour in the area of Downtown Halifax between the Dockyard and Terminal Road. This is an area where water quality aesthetics have a severe and large scale adverse impact on both quality of life and economic opportunity as it is frequented by tens of thousands of citizens and visitors each year.

  - Other areas for priority inclusion in the Phase I project are the two major outfalls discharging to the Narrows at Duffus Street and Tufts Cove and impacting Bedford Basin. The Duffus Street discharge should be included in the Halifax collection and STP installation program. The sewage flows into the Tufts Cove outfall should be relocated to an appropriate site south of the Macdonald Bridge and consistent with eventual treatment plant construction.

  - Given the water use objectives recommended for the Northwest Arm, the sewage flow currently discharging to a location near Chain Rock in Halifax should also be routed to a Halifax treatment facility. The Dartmouth Cove outfall should be extended and upgraded.

  - Mainland South sewage treatment can be considered for incorporation into the project as soon as the community considerations highlighted by SAC are addressed

- That HRM staff be authorized to proceed with initial land identification and acquisition processes for the proposed STPs. The results of this initiative will in large measure determine the number and size of plants which can be constructed on each side of the Harbour. This decision will influence subsequent detailed project definition.

- That the process of evaluating site suitability and project options in light of progress on land acquisition continue and accelerate. This can be undertaken by the multi-disciplinary team of HRM planning, engineering and finance staff supported by engineering, scientific, economic and planning expertise of the Solutions Team. Towards coordinating and expediting this effort, HRM should consider appointment of a staff Project Manager supported by resources appropriate to the level of effort required. Candidate STP sites should be evaluated in consideration of the siting criteria outlined by SAC. To this end, focused site evaluation and examinations should be undertaken as soon as possible to evaluate the preliminary geotechnical, environmental, and economic suitability of sites so as to qualify or eliminate them from further consideration.

- That HRM should simultaneously undertake other activities critical to Project implementation and acceptance.

  - A stakeholder and public involvement and communications program, closely linked to the site acquisition and evaluation process should be initiated. The SAC Report suggests an approach that seeks community acceptance by communicating design capabilities to integrate treatment plants into the community without unacceptable impacts and with potential for local enhancements.

  - The regulatory review and approvals process should be advanced with both Federal and Provincial agencies.

  - The Source Control Program should be assertively continued.

  - A Request for Interest (RFI) from private sector contractors, operators, and engineering groups should be prepared. The resulting responses should be evaluated in order to assess the capabilities and level and type of private sector interest, regardless of the ultimate decision on the scope of the project or on procurement options. This Request For Interest would require a modest effort for preparation and evaluation of submissions. This step will greatly assist in the follow-up Request for Proposal (RFP) process.

9.0 REFERENCES

9.1 Literature Cited

Halifax Harbour Task Force. 1990. Halifax Harbour Task Force Final Report. Halifax, Nova Scotia.

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