RETURN TO WALICK ROGAN SRA

# JACK LAKE
# Environmental Evaluation
# Final Report

960 acres
389 HA

Jack Lake Land Assembly
Bedford, Nova Scotia

Canada Mortgage and Housing Corporation
Nova Scotia Department of Housing

September 1986

DeLCan DE LEUW CATHER, CANADA LTD.
CONSULTING ENGINEERS AND PLANNERS

# JACK LAKE ENVIRONMENTAL EVALUATION

# FINAL REPORT

Prepared For

Canada Mortgage and Housing Corporation

and the

Nova Scotia Department of Housing

by

DeLCan, DeLeuw Cather, Canada Ltd.

September, 1986

04-1412-A-00

## ACKNOWLEDGEMENTS

The dedicated efforts of a number of people were required to prepare this report. We acknowledge all those who contributed, although they can not all be mentioned here. Special acknowledgement is made to **Trevor Gloyn**, of Canada Mortgage and Housing, Ottawa and **Wilson Fitt**, of Canada Mortgage and Housing, Halifax who toiled through the final report working hand in hand with us to complete the document. In spite of some setbacks along the way, they never lost their sense of direction or humor. Without their continued efforts, this document might not have been possible.

We would also like to acknowledge the efforts of **Laurel Russell**, from the Nova Scotia Department of Housing, who coordinated numerous individual efforts at the provincial level and expedited the necessary approvals needed in the processing of this document.

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August 26, 1986

Our Reference: 04-1412A-00

Canada Mortgage and Housing
Corporation
682 Montreal Road and
Eastern Parkway
Ottawa, Ontario
K1A 0P7

Attention: Mr. Trevor Gloyn

Dear Mr. Gloyn:

Re: Jack Lake Environmental Evaluation - Final Report

It is with pleasure that we submit the final study report for the Jack Lake Environmental Evaluation.

As you are aware the findings for the most part are positive and no serious impacts are anticipated that could not be dealt with through normal mitigation procedures.

We trust you will find the report satisfactory, and we wish you every success on the future steps in seeing the project become a reality.

Yours truly

W.E. Haigis, O.A.L.A., M.C.I.P.
Vice President of Planning

WEH:ap

Enclosure.

2315 RIVERSIDE DRIVE, BILLINGS BRIDGE PLAZA, P.O. BOX 8004, OTTAWA, ONTARIO K1G 3H6
(613) 733-4160 • CABLE DELCAN •

ST. JOHN'S, MONTREAL, OTTAWA, HAMILTON, NIAGARA FALLS, LONDON, THUNDER BAY, WINNIPEG, REGINA, SASKATOON, EDMONTON, CALGARY, VICTORIA, NEW WESTMINSTER, CHILLIWACK, NANAIMO, KAMLOOPS, CAMPBELL RIVER, PORT ALBERNI, PRINCE GEORGE, TERRACE, FORT ST. JOHN.

## EXECUTIVE SUMMARY

Canada Mortgage and Housing Corporation and the Nova Scotia Department of Housing in partnership own an undeveloped 389 ha. parcel of land within the Town of Bedford. The parcel was acquired in the 1970's as part of residential land assembly programs. In 1984, the Town asked the Partnership to conduct a comprehensive study of the environmental, socio-economic, housing, planning, engineering, and fiscal impacts which development of the site may have upon the Town, in order to assist in its decision making about the development. This is the report of the results of that study.

The study incorporated extensive field work and data collection and information from existing sources. Focussed presentations and consultations provided input from Bedford residents, interest groups, and public officials. Results of these study components were integrated into a new Concept Plan for the whole development, which in turn formed the starting point for the identification of potential impacts and appropriate mitigation measures. A customized computer program was developed to assess the impacts of development upon the Town's fiscal position.

The study report is in three parts: the Final Report summarizing all of the work and results; a detailed Appendix providing full background details of the environmental, planning and engineering analysis; and another detailed Appendix providing the background socio-economic, housing, and fiscal analysis.

The Concept Plan presents a mixed density residential community with a final population of about 9 000 people. The assessment of current market conditions indicates the development period would last for about 13 years. Approximately 40% of the site would remain as greenspace and parkland.

Soil conditions on the site require the use of erosion control measures during construction to avoid pollution of surrounding lakes and watercourses. Mitigation measures which have been successfully used to prevent negative impacts in similar developments are identified for use in this situation. The

bedrock in the area has a very low potential for acidic drainage. There are no rare or sensitive plant, fish, bird, or wildlife habitats which would be disturbed or lost. Impacts upon groundwater quality and other ongoing environmental impacts after development can be avoided through the use of appropriate stormwater management techniques, and control of the quantity and application of road salt.

The socio-economic analysis indicates that the demographic profile of residents of the Jack Lake development would not be significantly different from that which now prevails in Bedford. Development of Jack Lake would result in a higher rate of growth than would otherwise occur, but would not change the overall social pattern. No adverse impacts upon either the industrial or commercial development of Bedford are identified.

The development of Jack Lake is consistent with and will enhance current initiatives in developing a parkland and recreation network in the area. It will probably give rise to a change in the semi-rural character of the Hammonds Plains Road area, but will also bring to the area an extention and improvement of public services such as fire and police protection, schools, and recreation facilities. There will be very little visual intrusion upon nearby development.

Access to and from the site may cause some congestion on Hammonds Plains Road and short term disruption on or near Smith's Road. This is a sensitive issue, and the report recommends careful analysis of options, development of a secondary Hammonds Plains Road access, and construction of an interchange on the Bicentennial Highway as soon as possible in order to mitigate negative impacts.

The engineering analysis indicates that existing sewer treatment and trunk water services can accommodate the development.

The fiscal analysis indicates that the development would generate enough taxation revenue to provide full public services without any deficit to be financed by other residents of the Town. In addition, the agreement between the Province and CMHC relating to the project provides for the sharing of net

project revenues with the Town of Bedford for the purpose of making community facilities available on the site to all residents of Bedford. This would result in a net fiscal and social gain for the Town.

The study recommends a variety of ongoing monitoring and public information measures to be implemented during the development period to ensure that any unforeseen impacts are identified and addressed.

In summary, the analysis of impacts which can be anticipated from the development of the site in accordance with the Concept Plan indicate that no serious problems would arise which could not be avoided by close attention to project planning and design and the use of well accepted mitigation techniques. The analysis indicated that development must be done in a manner which is sensitive to environmental conditions on and surrounding the site, and socio-economic conditions in the community at large.

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# I INTRODUCTION

This environmental evaluation study of the Jack Lake Land Assembly (JLLA), was requested by the Town of Bedford, Nova Scotia, with concurrence of the Canada Mortgage and Housing Corporation (CMHC) and the Nova Scotia Department of Housing (NSDH). The CMHC and NSDH, in a federal-provincial partnership commissioned the study in 1984. The study was conducted during 1985 and the early part of 1986.

## A. Background

The Jack Lake site is one of several acquired by CMHC and NSDH in the 1970's as part of a comprehensive land assembly program. All of the major land assemblies have been or are being developed except Spryfield and Jack Lake. Development of the Jack Lake Land Assembly, which consists of 960 acres of land, is of significance at the regional level, and even more significant at the Town level. The importance of the development provided the rationale for this study.

## B. Purpose and Scope

The primary purpose of this environmental evaluation was to determine whether the impacts of developing the Jack Lake site would be positive or negative, in relation to the site itself, and in turn, the Town of Bedford. In addition, through the environmental evaluation process, a new scenario for the development of the Jack Lake Land Assembly as a residential community, was derived and addressed by the environmental evaluation study. Potential impacts were examined under environmental, socio-economic, engineering, and fiscal categories.

The original basis for assessing the impacts was a conceptual plan of the site prepared by CMHC a number of years ago. As a result of certain preliminary findings, this original plan was modified and subsequently a new concept plan was prepared during the study process. It should be understood then, that the impacts are based on an assessment of a **"proposed development concept"**, not actual development. This means that, based on similar projects, previous experience and ultimately professional judgements, the consultants attempted to predict what might happen, in the various categories mentioned, over a period of some 13 or 14 years (1988 - 2001) if Jack Lake is developed according to the Concept Plan developed as part of this Study. (See Section III.)

Since predictions were made from a proposal, extensive field testing or sampling was not carried out. Measurements were not made on the basis of actual impacts, but instead from sampling and examining existing conditions and through prediction, assessing what the impacts might be if any on those conditions. The reader should therefore approach the findings with some caution. While this suggestion is made to provide an indication of the procedures followed in this study, it should also be recognized that the underlying approach to this study, represents one of the most comprehensive pre-development, environmental evaluations ever undertaken in the Maritimes. The extensive appendix documents accompanying this final, overview report better indicate the breadth of the assessment completed.

Although certain new data were gathered through field observation and even more intensive efforts such as soil borings and sample collections, exhaustive field surveys and tests to obtain definitive data sets on the site were outside the scope of this study. Nor was it within the scope of this study to prepare detailed development plans for the site. Two appendix documents can also be consulted in addition to this Final Report, for a more comprehensive perspective of the study. The first covers the **Environmental, Engineering** and **Planning** components of the study and was produced by DeLCan, P. Lane and Associates Ltd. and Jacques Whitford and Associates Ltd. The second pertains

to **Socio-Economic** and **Fiscal** components of the assessment and was prepared by Cleland, Dunsmuir. Both documents can be obtained by contacting either CMHC or NSDH. The two appendix documents and this Final Report form the complete Environmental Evaluation Study.

## C. Assessment Goal and Objectives

The goal guiding the assessment was not in as much the end product or study report, but moreover, to determine the nature and extent of the environmental impacts of the Jack Lake development. The mitigation of adverse impacts determined was a primary consideration. This goal represented serious concerns for all those participating in the assessment, since the findings of the study could lead to abandoning the development altogether.

To achieve this goal, certain objectives were set out for the assessment and the study process:

1. To report to the Partnership very serious negative impacts as discovered rather than waiting for a final report.

2. To prepare a study that attempts to set out the significance of potential impacts and to recommend what mitigating measures if any are appropriate in dealing with such impacts.

3. To prepare a study document that when reviewed now or in the future would be consistent with the formating and procedures expected in such a document. In this regard, the environmental evaluation process under the Federal Environment Assessment Guidelines has been followed.

4. To recommend the necessary steps and procedures to monitor the actual development.

5. Other objectives for the study included:

- the suggestion of development types to minimize the negative impacts for the environment;

- the suggestions or recommendations regarding the planning of development to better address any impacts on the Town of Bedford;

- to indicate the procedures followed during the course of the study, so that others could verify the findings by following the same procedures.

## D. Study Report Format

The study was broken down into the following major component parts:

- o Site Description
- o The Concept Plan and Housing Market;
- o The Natural Environment;
- o The Socio-Economic Environment;
- o The Engineering Evaluation;
- o The Fiscal Evaluation, and;
- o Recommendations.

Under each component, there is a consistency of format including sub-sections on **Approach, Existing Conditions, Impact** and **Mitigation Measures.**

Where potential impacts of the JLLA development were identified under each of the environmental and socio-economic components of the study, every effort was made to be as objective as possible in assessing the nature and extent of these impacts. Readily apparent, negative or adverse impacts that were assessed, are followed in this report with recommendations on mitigation measures.

## II SITE DESCRIPTION

The JLLA is a 390 ha (960 acres) site located within the Town of Bedford, Nova Scotia, northwest of the Bicentennial Highway, between Hammonds Plains Road and Highway 101. The site is covered with second growth forest ranging from upland hardwoods to lowland bog shrubs. The only visible intrusion by man is the abandoned quarry, the various roads and trails meandering through the site, and the transmission line corridor along the eastern border of the property (Figure 2-1). Here the Jack Lake site is described from the environmental and socio-economic perspectives.

### A. Environmental Conditions

#### 1. Physiography:

In the vicinity of Jack Lake, the area is characterized by a rolling topography with broad, smooth ridges and hollows generally following the northeast strike of the underlying bedrock. The intervening depressions are often filled with poorly drained galcial deposits covered with well-developed peat bogs. An excellent example of this "ridge and swale" topography is observed at Jack Lake. The JLLA is situated on a local topographic high ranging between 38 m at the east and west boundaries to 99 m on the top of some of the drumlin hills.

#### 2. Climate:

The climate in the Bedford area is described as a modified continental type with mild periods in winter and cool periods in summer because of the influence of moist Atlantic air masses.

Available climatological records (AES, 1980) for Shearwater show an average annual percipitation of 1361.4 mm. These values compare with the 1954-1966 data from Bedford which reports 1439.3 mm annual precipitation. For the Bedford area, minimum monthly precipitation

generally occurs in June and maximum precipitation usually occurs in November.

The mean annual temperature is in the order of 6.3° C, with a minimum value of -30°C occurring in February and maximum values of 33°C occurring in late summer. The mean frost free period is 173 days. Wind direction (Halifax Airport) is generally from the northwest in the winter months, shifting toward and away from the south during summer months. Available wind data indicate the prevailing wind direction is from north-west-south (76% of the time) at an average velocity of 12 to 15 knots. The strongest gales tend to be from west to east, 80% of which occur in the winter.

3. Water Bodies:

The almost totally vegetated JLLA site contains two water bodies; Jack Lake and Marsh Lake. As development impacts could extend beyond the immediate site, the following lakes and rivers were included in this study, even though they are outside the JLLA boundary.

- Sandy Lake
- Paper Mill Lake
- Sackville River

4. Vegetation:

The entire JLLA site has been "cut over" several times within the last 150 years resulting in a forest cover at varying regeneration stages. Remnants of the human activity are evident as old logging roads, aggregate extraction areas, and a well developed trail system.

## B. The Socio-Economic Setting

This section describes the socio-economic context in which the Jack Lake environmental evaluation was undertaken.

## 1. The Site in the Regional Context:

The site is one of a number acquired by CMHC and the Nova Scotia Housing Commission (now Department of Housing) in the 1970's as part of a comprehensive residential land assembly program. The Regional Plan contemplated a strong development focus for the region at the head of Bedford Basin. Looked at in this light and in the context of the existing development in Bedford and Sackville, the Jack Lake development is essentially large scale infill and is consistent with a long established regional strategy.

For a community like Bedford, however, a development like Jack Lake does not appear as infill. It involves both a population increase and reorientation of development patterns in the Town.

## 2. Bedford in the Regional Context:

Bedford is in part a suburban commuter town and in that sense, can be compared with other suburban communities in the region. Bedford, however, differs from all of these communities not only in being a town in its own right, but in being a long established community with a developed economic base. None of the other suburban communities in the region has a comparable industrial base. In summary, Bedford is by no means a passive recipient of growth, but rather an emerging growth generator in its own right. In the same sense, it is reasonably well placed to benefit in fiscal terms from further growth.

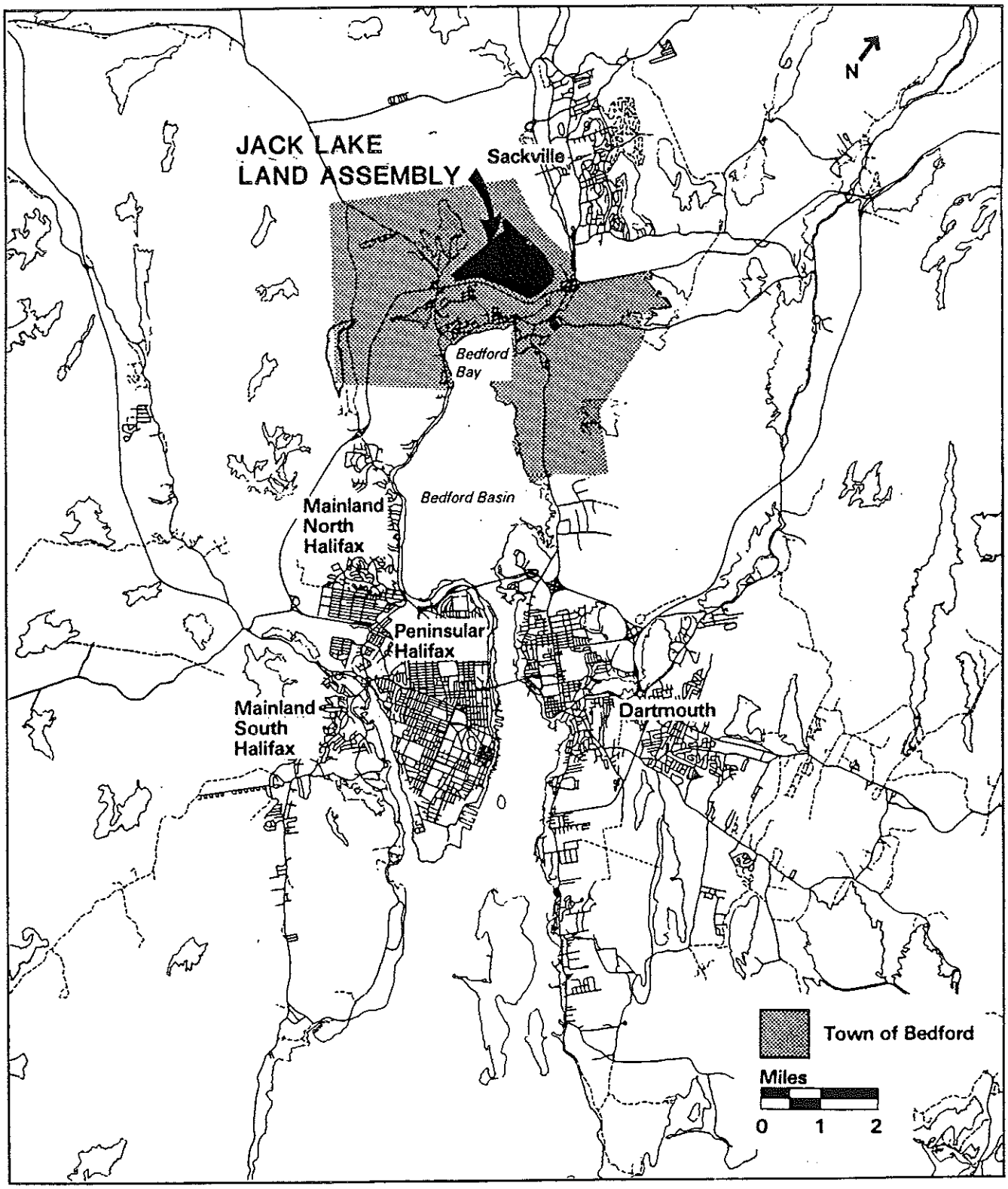



Figure 2-1 Regional Setting for JLLA

# III THE CONCEPT PLAN

The Concept Plan provided the basis for the various analyses that are set in following sections of this document. When impacts and mitigation measures are discussed, they are drawn in relation to the Concept. If a different concept is considered, the impacts would likely change, and in turn, the mitigation measures used to deal with those impacts. For example, to be responsive to dynamic market conditions and housing needs, some flexibility is retained in the Concept Plan. With minor modifications relative to different residential densities, the physical site requirements of the Concept Plan should remain constant and the environmental impacts predicted, generally the same. In the case of major changes to the physical configuration of the Concept Plan for other reasons, specific environmental impacts would be expected to vary correspondingly.

The Concept Plan, contained in this document was not given at the outset of the study. In fact, another earlier Concept Plan, was to have been the basis of the assessment. After certain preliminary findings pertaining to the natural environment and site constraints became apparent, a new concept plan was prepared. This Plan then contained a response to the environment. The reader should be aware that the conceptual planning process was an iterative one. The Plan is therefore already responsive to certain environmental constraints identified. It also reflects certain market conditions, as well as socio-economic considerations.

The concept plan, albeit a single sheet of paper, is the result of a host of studies, analyses and decisions leading to a description of the orderly sequence in the birth of a new community within a 10-15 year time frame. The concept plan is not a "plan of subdivision", but rather the "concept" which will later be shaped into a registered plan and engineering design. The point made is that any more detail than that shown, would at this time be inappropriate.

This section then covers a number of headings, in addition to a narrative describing the Concept Plan. The outline for the balance of this section is:

A. Housing Market Conditions
B. Site Constraints/Development Suitability
C. The Concept Plan
D. Engineering Analysis
E. Summary

## A. Housing Market Conditions

The essential questions for the Jack Lake site from a market perspective are:

- how many units per year could the development demand?
- what is the likely mix of unit types?
- what price range could the development target?

### 1. Population Change in the Region

In the period 1971-1981, the population of the region(1) increased by approximately 27,000, or 10.8 percent. The Municipality of the County of Halifax grew by almost 50 percent. Bedford grew at a similar rate.

The Halifax-Dartmouth Regional Plan Review, which was underway during 1981-1983, produced population projections to 1991 and 2001 based on four scenarios of economic activity in the region, of which only three are realistic at this time. The low scenario assumed the current economic base and reduces the growth rates for certain sectors which drove the economy during the previous decade. The middle scenario was more optimistic and assumed an improved

(1) Region is defined as geographical Halifax County.

**Table 3-1 Population projections for Halifax-Region; alternative scenarios.**

| | | Actual | Projected | | | |
|---|---|---|---|---|---|---|
| | | 1981 | 1986 | 1991 | 1996 | 2001 |
| Regional Plan Review Scenario | Low | 288,100 | 300,500 | 314,800 | 330,100 | 346,300 |
| | Medium | 288,100 | 303,700 | 324,000 | 348,600 | 374,800 |
| | High | 288,100 | 307,700 | 336,700 | 371,500 | 409,900 |
| Department of Development | | 288,100 | 299,553 | 309,036 | | |

Source: Halifax Dartmouth Regional Development Plan Review Population Implications of Alternative Forecasts, June 1982.

W.J. Coffey, Nova Scotia Population, Household, and Family Projections, 1982-1991, N.S. Department of Development.

economic climate in Nova Scotia and Canada, increased levels of employment, productivity, consumer spending and growth in the trade and service sectors. The high scenario was based on substantial offshore petroleum development. These, along with an alternative forecast prepared for the Department of Development by W.J. Coffey, are shown in Table 3-1.

On the basis of recent growth as estimated to 1984, it appeared that the region is tracking the medium growth scenario. We have therefore used this scenario as the basis for our projections of housing demand.

Under the medium scenario, the Regional Plan Review Housing Task Force projects housing requirements in the region as follows:

**Table 3-2 Regional housing requirements as projected by Regional Plan Review Housing Task Force.**

| | Family Households | Non-Family Households | Total |
|---|---|---|---|
| 1981-1991 | 13,300 | 7,700 | 21,000 |
| 1991-2001 | 12,700 | 6,000 | 18,700 |

| | Single Detached | Apartment | Other | Total |
|---|---|---|---|---|
| 1981-1991 | 9,800 | 7,200 | 4,000 | 21,000 |
| 1991-2001 | 8,500 | 6,800 | 3,400 | 18,700 |

These results generated a net housing requirement of 2,100 units per year in the first forecast period (1981-1991) and 1,870 units per year in the second (1991-2001).

In 1981, slightly over 56 percent of occupied private dwellings in the Halifax County Metropolitan Area (CMA) were owner occupied. Over 90 percent of single family units were owner occupied; apartments were the reverse, at over 96 percent rental. Single attached and duplex units were close to evenly split, at 40 percent owner occupied and 60 percent rental. The overall historical pattern is likely to be reflected in future tenure splits. In that case, the rounded yearly totals for the two periods under examination produce the following number of units by tenure:

| | Owned (per year) | Rented (per year) |
|---|---|---|
| 1981-1991 | 1,200 | 1,000 |
| 1991-2001 | 1,100 | 900 |

2. Ownership Market

Table 3-3 shows recent single detached and semi-detached housing price data for the Halifax CMA.

The number of ownership (versus rental) units required will average 1,150 per year over the two forecast periods to 2001. The annual demand in each would therefore be 190 single detached and 40 others.

3. Housing Supply

Land development in the region is dominated by two community builders, one a public agency and the other, a private concern. The Nova Scotia Department of Housing claims up to 35 percent of the market. The other major actor is Clayton Developments, developers of Colby Village and Clayton Park, which is becoming more active again in the Dunbrack Street corridor in Halifax mainland north. Clayton Developments, which offers its developments in the high-

Table 3-3 Absorption prices, (average selling prices) for new units in the Halifax CMA; October, 1984 - February, 1985, Q quintile.

| Month | Selling Prices 1st Q. | 2nd Q. | 3rd Q. | 4th Q. | Median | Mean | No. of Units |
|---|---|---|---|---|---|---|---|
| **Single Detached** | | | | | | | |
| October | 78,900 | 85,600 | 97,000 | 118,120 | 89,000 | 101,753 | 98 |
| November | 76,000 | 84,600 | 96,000 | 150,000 | 89,900 | 105,855 | 159 |
| December | 79,200 | 89,920 | 115,000 | 135,000 | 93,950 | 109,400 | 122 |
| January | 84,960 | 86,000 | 92,300 | 121,800 | 89,000 | 102,194 | 192 |
| February | 76,920 | 85,000 | 89,600 | 119,945 | 85,000 | 95,200 | 62 |
| Weighted-5 month Average (Rounded) | 79,000 | 86,000 | 98,000 | 131,000 | 90,000 | 104,000 | 633 |
| **Semi-Detached** | | | | | | | |
| October | 60,000 | 64,000 | 140,000 | 150,000 | 64,000 | 99,111 | 9 |
| November | 62,000 | 62,000 | 62,000 | 90,800 | 62,000 | 71,272 | 11 |
| December | 63,300 | 70,000 | 70,000 | 72,000 | 70,000 | 62,282 | 32 |
| January | 68,800 | 80,000 | 87,000 | 96,000 | 80,000 | 84,032 | 34 |
| February | 56,200 | 70,000 | 87,600 | 94,000 | 78,000 | 76,833 | 6 |
| Weighted-5 month Average (Rounded) | 64,000 | 72,000 | 83,000 | 92,000 | 73,000 | 76,000 | 92 |

Source: CMHC Market Absorption Survey 1984.

middle and upper ranges of the market, has typically had a market share of around 20 percent. The remainder of the market is distributed among several other commercial developers.

The currently active developers are projecting substantial activity through to the end of the decade (Table 3-4). In general, there appears to be an increasing tendency to produce for the upper part of the market.

These data should only be considered as representing estimates. Unit numbers are approximate and where year by year figures are unavailable, the total for a given development was assigned to the year in which it was likely to commence. For these reasons, it is best to look at average production over the entire period and avoid firm conclusions about specific years.

**Table 3-4 Summary of projected development activity Halifax-Dartmouth Region - 1985-1990.**

| | Years | | | | | | |
|---|---|---|---|---|---|---|---|
| Market | '85 | '86 | '87 | '88 | '89 | '90 | Avg. |
| Upper | 1470 | 625 | 285 | 245 | 245 | 120 | 500 |
| Upper-Middle | 677 | 702 | 565 | 490 | 290 | 290 | 502 |
| Middle | 924 | 891 | (350) | (160) | (195) | (202) | (450) |
| | | | 255 | 65 | 90 | 115 | 390 |
| Lower-Middle | 355 | 100 | (300) | (244) | (195) | (202) | (232) |
| | | | 205 | 149 | 90 | 115 | 169 |
| Lower | | | Estimated additional 20 percent per year - see text | | | | |
| | 330 | 330 | 330 | 330 | 330 | 330 | 330 |
| Total | 3,751 | 2,633 | (1,825) | (1,465) | (1,250) | (1,140) | (2,005) |
| | | | 1,635 | 1,275 | 1,040 | 975 | 1,885 |

A crude estimate based on assumed (or in some cases, known) proportions of different tenure types leads to the conclusion that at least 75 to 80 percent of the production represented will be home ownership units. This represents around 1500 to 1600 units, compared to the estimated requirement of 1200 per year in the period up to 1991.

4. Supply/Demand Balance

The estimated demand through to 1991 is expected to be around 2200 units per year for all types of housing. A comparison of projected annual demand with the estimated production in each range (Table 3-5) suggested that planned developments over the next five to six years would produce an overall surplus of home ownership units of 300 to 400 units per year.

5. A Jack Lake Scenario (Alternative 2 in Section 5.2) in the context of supply/demand.

The Jack Lake development considered would be introduced into a dynamic and affluent local housing market. Bedford is regarded by the real estate and development industries as a very attractive, high growth potential, community because of the town's locational characteristics and amenities. Housing in Bedford is directed for the most part, to the upper-middle and upper income second-time home buyer. Although the obvious preference housing type is single family, there is a modest market for higher density types, especially row housing. It is also notable that very little of the proposed development, including the higher density housing types, is anticipated to be rental accommodation.

Projected annual demand for ownership housing after 1991 will be around 1100, of which 900 or more will be single-family detached units. Given that the Department of Housing will then be largely built-out in its other developments, Jack Lake would simply be filling

Table 3-5 Supply/demand balance - ownership units 1985 - 1990.

| Quintile | Annual Requirement All Types | Estimated Yearly Average Production | Surplus (Shortfall) |
|---|---|---|---|
| 5th | | | |
| Singles 131000+<br>Semis 92000+ | 240 | 350-400 | 110-160 |
| 4th | | | |
| Singles 98-131000<br>Semis 83-92000 | 240 | 380-480 | 140-240 |
| 3rd | | | |
| Singles 86-98000<br>Semis 72-83000 | 240 | 275-330 | 35-90 |
| 2nd | | | |
| Singles 79-86000<br>Semis 64-72000 | 240 | 125-175 | (65-115) |
| 1st | | | |
| Singles under 79000<br>Semis under 64000 | 240 | 250 | 10 |

a gap. For the purposes of this scenario, we envision Jack Lake occupying up to 20 percent of the total ownership market, which would represent some 2600 units over the period 1989 to 2001. Ideally, given the conceivable shortfall in rental accommodation, Jack Lake might include a reasonable proportion of rental units. For now, however, it is assumed that all but apartments are ownership units.

Therefore, we envision a Jack Lake scenario as follows:

| | | |
|---|---|---|
| Total Units: | 2625 | |
| of which | 60% or 1575 | single family |
| | 16% or 420 | semi-detached |
| | 16% or 420 | row |
| | 8% or 200 | apartments |

Price Range for Ownership Units:

Single Family Units - $100,000 and up, averaging $120,000
Semi's and others - average $80,000

6. Phasing

It is likely that the first phases of the project will be primarily single family. This is consistent with a rational marketing strategy, and with the notion of clustering the higher density types close to the community center and Jack Lake.

If land development begins in 1987 and building in the following year, the competition among private developers in the first few years will dictate cautious development. A scenario consistent with both the market and the development requirements of the site is set out below. The years indicated below are those in which units would be expected to appear on the Town's assessment rolls.

| | Singles | Semi's | Row | Apartment | Total |
|---|---|---|---|---|---|
| 1989 | 100 | | | | 100 |
| 1990 | 80 | 35 | | | 115 |
| 1991 | 220 | | | | 220 |
| 1992 | 85 | 75 | 60 | | 220 |
| 1993 | 75 | 50 | 60 | 75 | 260 |
| 1994 | 90 | 50 | 62 | 75 | 277 |
| 1995 | 120 | 45 | | 50 | 215 |
| 1996 | 220 | | | | 220 |
| 1997 | 130 | 40 | 75 | | 245 |
| 1998 | 55 | 60 | 75 | | 190 |
| 1999 | 60 | 85 | 78 | | 223 |
| 2000 | 170 | | | | 170 |
| 2001 | 170 | | | | 170 |
| | 1,575 | 440 | 410 | | 2,625 |

The Concept Plan has been adjusted with these market conditions in mind.

## B. Site Constraints/Development Suitability

In the initial stages of the project, the available biophysical data pertaining to the Jack Lake Land Assembly site were compiled and reviewed.

In addition to the review of the available data, a site reconnaisance and photographic inventory was conducted in order to assess the biophysical features of the site.

biophysical

The factors which were considered to be particularly significant to the proposed development included soils, slopes and drainage. An analysis of each of the major factors was undertaken, with a plan produced for each indicating a ranking (i.e., nil/low, moderate, high) of the severity of constraint for the development (Table 3-6). These results are reflected in the Concept Plan.

Vegetation was not considered to be a factor of major significance in determining the relative suitability for development of the various parts of the site. The majority of the site is forested (posing a minor constraint/major opportunity) and no unique vegetation/outstanding vegetation communities were observed in areas to be developed. It is recognized however, that the existing vegetation should be preserved wherever possible in the proposed development in order to reduce erosion and siltation, provide wildlife habitat and contribute to the overall aesthetics.

**Table 3-6 Ranking of Factors: Development Suitability**

| | Severity of Constraint | | |
|---|---|---|---|
| | Low/Nil | Moderate | High |
| Soils: | | | |
| Thick Till | X | | |
| Bedrock/Veneer | | X | |
| Organic | | | X |
| Slopes: | | | |
| 0-10% | X | | |
| 10-20% | | X | |
| Over 20% | | | X |
| Drainage: | | | |
| Well-drained | X | | |
| Poorly-drained | | X | |
| Permanent Surface Water | | | X |

In addition to the biophysical factors outlined above, the hydro right-of-way was considered to pose a severe constraint for the development.

Using the McHarg overlay technique (McHarg, 1969), a composite map was produced showing four levels of development suitability (Figure 3-1):

- highly suitable (i.e., well-drained, 0-10% slopes, thick till);
- moderately suitable (i.e., presence of one constraint of moderate severity);
- moderately unsuitable (i.e., presence of two constraints of moderate severity);
- highly unsuitable (i.e., presence of three constraints of moderate severity or at least one constraint of high severity).

It was determined that approximately 60% of the site was suited to residential development (Table 3-7).

**Table 3-7 Areal Breakdown: Development Suitability**

| | Estimated Area (hectares) | Percentage |
|---|---|---|
| Highly Suitable | 86 | 22 |
| Moderately Suitable | 140 | 36 |
| Moderately Unsuitable | 43 | 11 |
| Highly Unsuitable | 121 | 31 |
| Total | 390 ha. | 100% |

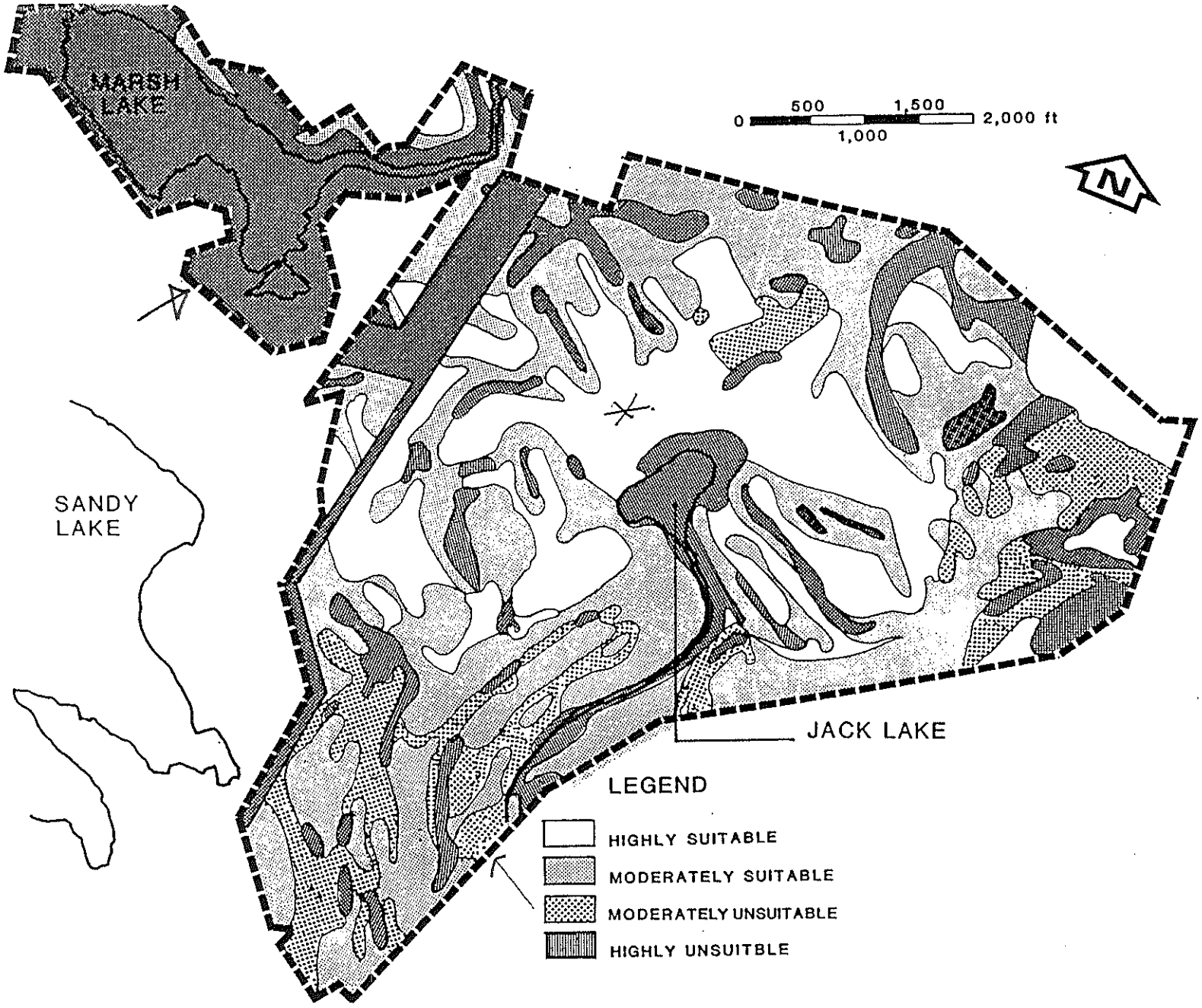



Figure 3-1 Development Suitability on JLLA, 1985

The Development Suitability plan was used during the preparation of the Concept Plan; areas which were identified as being unsuitable for development were generally avoided in the layout of the proposed development.

## C. The Concept Plan

### 1. General

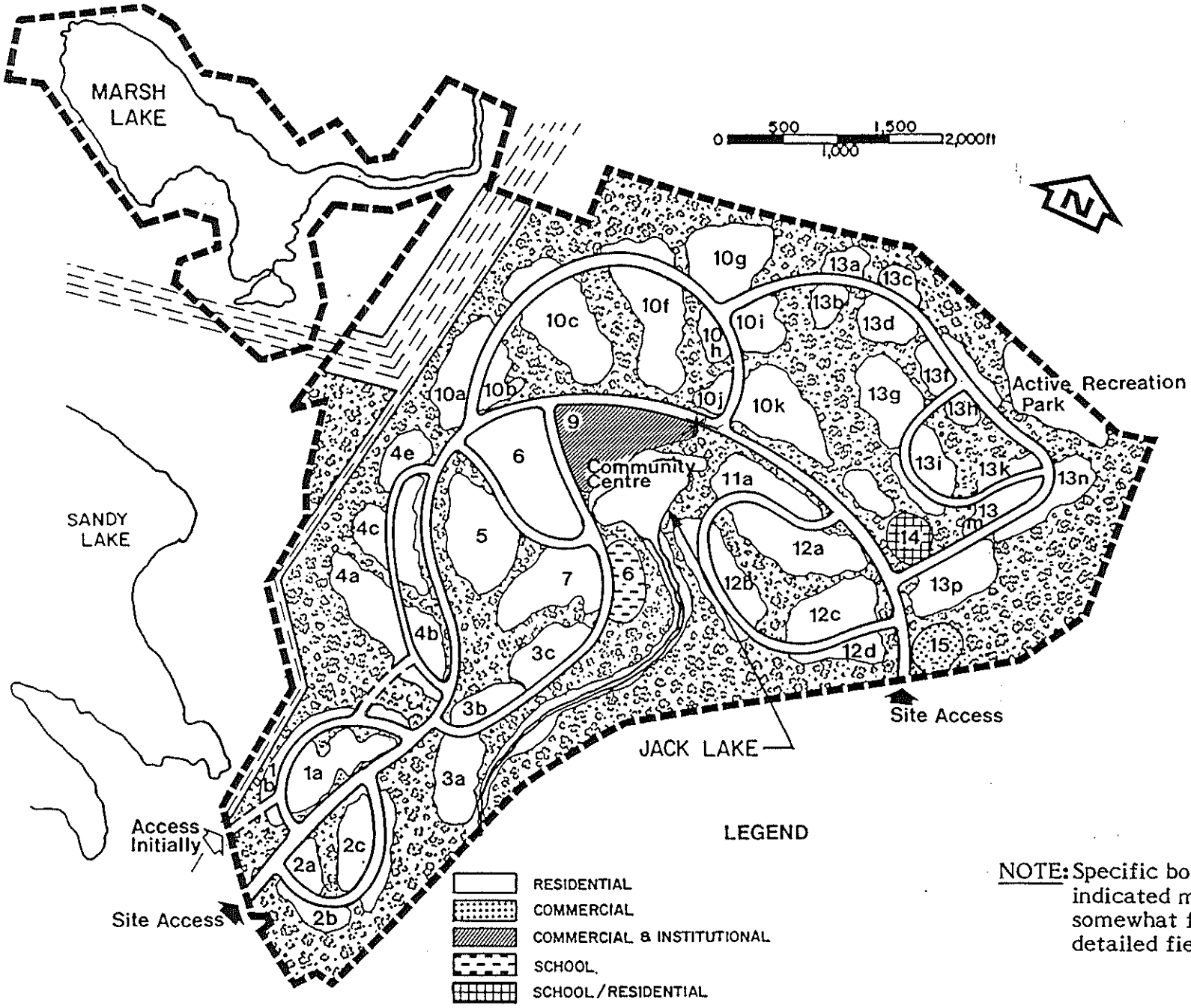
The Concept Plan produced for this study attempted to portray a viable development scenario which is also sensitive to the site conditions. It should not however, be inferred that this plan will necessarily be held as the basis for all subsequent planning. The Concept Plan was simply intended as a means to an end; it provided a focus for the environmental evaluation, which in turn, is an initial step in the planning process. Obviously further modifications/refinements are required in the preparation of a more detailed plan, which will occur later in the planning process. The results of this study are expected to be incorporated into future planning for the proposed Jack Lake development. In this regard, the Concept Plan has served its intended purpose.

### 2. Planning Rationale

Areas indicated in the Concept Plan (Figure 3-2) as suitable for development, represent approximations only. Detailed, local field studies to be carried out immediately preceeding development, may result in some changes to specific boundaries of these areas.

The Concept Plan evolved from the consideration of a number of components, the most significant being the **environmental constraints** of the site. Other important considerations included:

- a vehicular **circulation pattern** consistent with sound traffic engineering principles;
- basic **servicing concepts** to lead to sound engineering practice;
- an arrangement of **land uses** consistent with sound planning principles; and
- a mix of **residential densities** to reflect the current **market conditions**.




NOTE: Specific boundaries of areas indicated may vary somewhat following more detailed field studies.

**Figure 3-2** Concept Plan for JLLA, 1985.

These components are dealt with more specifically below:

a) Environmental Constraints:

The Development Suitability Plan formed the primary basis of the general layout of the proposed development as indicated on the Concept Plan. Wherever possible, lands which were designated as being moderately/highly unsuitable for development were avoided, and the proposed development was restricted to suitable areas. In fact, over half the site has been left undeveloped in the Concept Plan - primarily as a result of the environmental constraints. The undeveloped land should be viewed as a positive asset of the proposed development in contributing to a distinctive image of the Jack Lake development, providing opportunities for recreational activities (e.g., strolling, cross-country skiing) in close contact with nature, and helping to mitigate the few anticipated environmental impacts.

b) Circulation System:

The roadway system is based on three levels of use: major collector, minor collector, and local. The major collector traverses the site from an access-egress point off Hammonds Plains Road to a future access-egress point off the Bicentennial Highway*. The alignment of the collector road was based to a large extent on the natural features of the site (e.g., following the 'lay of the land' to minimize cut/fill), affording access to minor collector roadways which, in turn, lead to all developed areas of the site. No lots would be facing onto the major collector; a buffer strip (with existing vegetation preserved wherever possible) would separate the major collector from the residential use areas. Local streets (not shown on the Concept Plan) would connect to the minor collector roadways from the individual development blocks.

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* These access points to the proposed development were previously identified in the CBCL "Access Study". It is suggested however, that the alternatives be explored further during future planning.

A pedestrian circulation system (not indicated on Figure 3-2) has been proposed, linking the residential areas to the proposed school(s), parks, and community centre; an attempt was made to minimize pedestrian crossings over roadways. The separated pedestrian circulation system would also provide recreational opportunities.

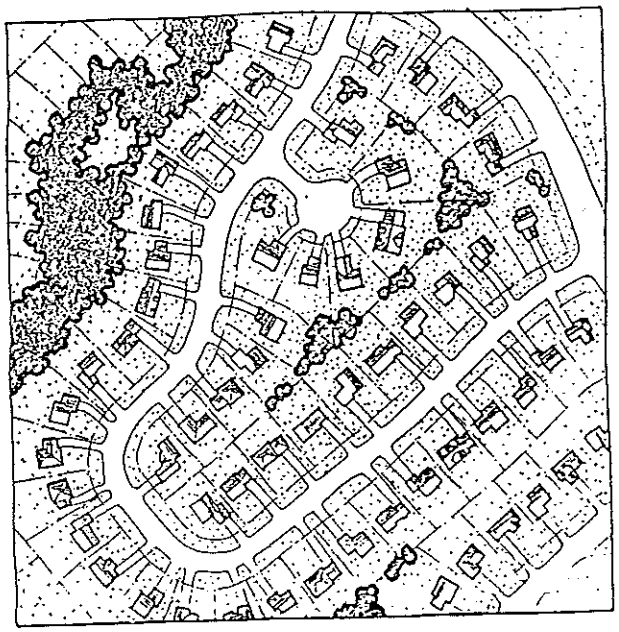
c) Engineering Servicing:

In considering the environmental constraints such as slope and overburden depth, the proposed servicing (water, stormwater and sanitary sewage) schemes would be layed out with the greatest degree of sensitivity. Clearly, it is the actual construction, rather than the layout itself that presents greater risks to the environment. These considerations are discussed in the Engineering Section of this Report.

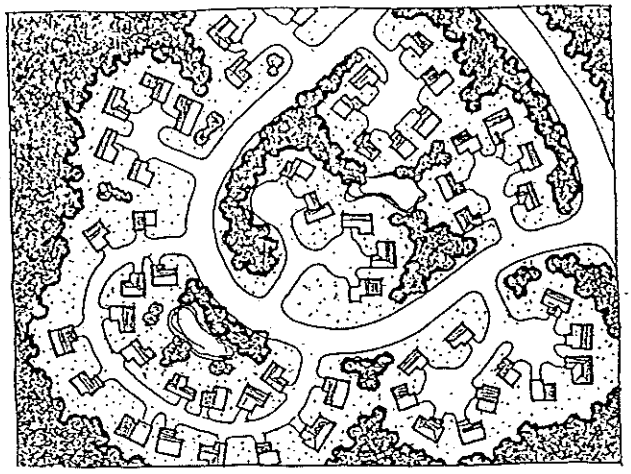
d) Land Use:

The primary use of the proposed development is residential; the other uses (i.e., commercial, institutional, recreational) are intended to serve the needs of the residents of the Jack Lake development. In locating the proposed uses within the site, attempts were made to provide the development with a focal point - this being the proposed community centre with its shopping facilities, school(s), park and other community services (e.g., library, fire station) as deemed appropriate. It is envisioned that the community centre could become a showpiece of high quality urban design in a natural park-like setting centered around Jack Lake. The high and medium density residential uses would be located around the community centre, affording easy access to the commercial and institutional services.

Site constraints also played an important role in determining the locations of the various uses. For example, the community centre, school(s) and developed parks have been placed in areas with minimal slopes. However, some low density residential development was



A. TRADITIONAL SINGLE FAMILY



B. CLUSTERED SINGLES

C. CLUSTERED MULTIPLES

An alternative to the traditional single family subdivision would be a 'clustered' arrangement of homes; the clusters could focus around (existing/proposed) site amenities and would potentially allow more existing site features (e.g., vegetation) to be preserved. The clusters could be in the form of singles, semi-detached or multiples, with higher densities resulting in lower servicing costs per unit.

**Figure 3-3** Alternative housing arrangements.

however, until such time as the major collector is completed (with a second point of access/egress), a secondary access will be required for emergency vehicles*.

As the population growth warrants, the facilities within the community centre would be developed in phases starting approximately halfway through completion of the overall Jack Lake development. The major collector would also be completed about mid-way through the development, and the remainder of the blocks would be developed in an easterly direction. Some adjustments may be required in the staging of the construction in order to maintain higher densities of residential development near the centre of the site; also prevailing market conditions will dictate exactly when each block should be developed. A plausible scenario for phasing of the development was formulated as a basis for the fiscal and socio-economic analysis.

## D. Engineering Analysis

For the purposes of the environmental study, servicing schemes and layouts have been prepared without engineering site surveys. The following results are therefore based on extensive existing data and the implementation of sound municipal engineering principles. The enclosed figures are not to be construed as engineering plans.

### 1. Sanitary Sewers

The sanitary sewer drainage areas are illustrated on Figure 3-4. The areas contributing to the Hammonds Plains and Sackville trunk have been defined based on the natural topography. While most of the area will be serviced by gravity sewers, the northern portion of the site sloping towards Marsh Lake (development 10a to 10j and 13a to 13d) will require a small pumping station. Given the hilly topography in the site, some of the roads and development

* It is suggested that an existing trail extending from Smiths Road could be upgraded as a temporary secondary access.

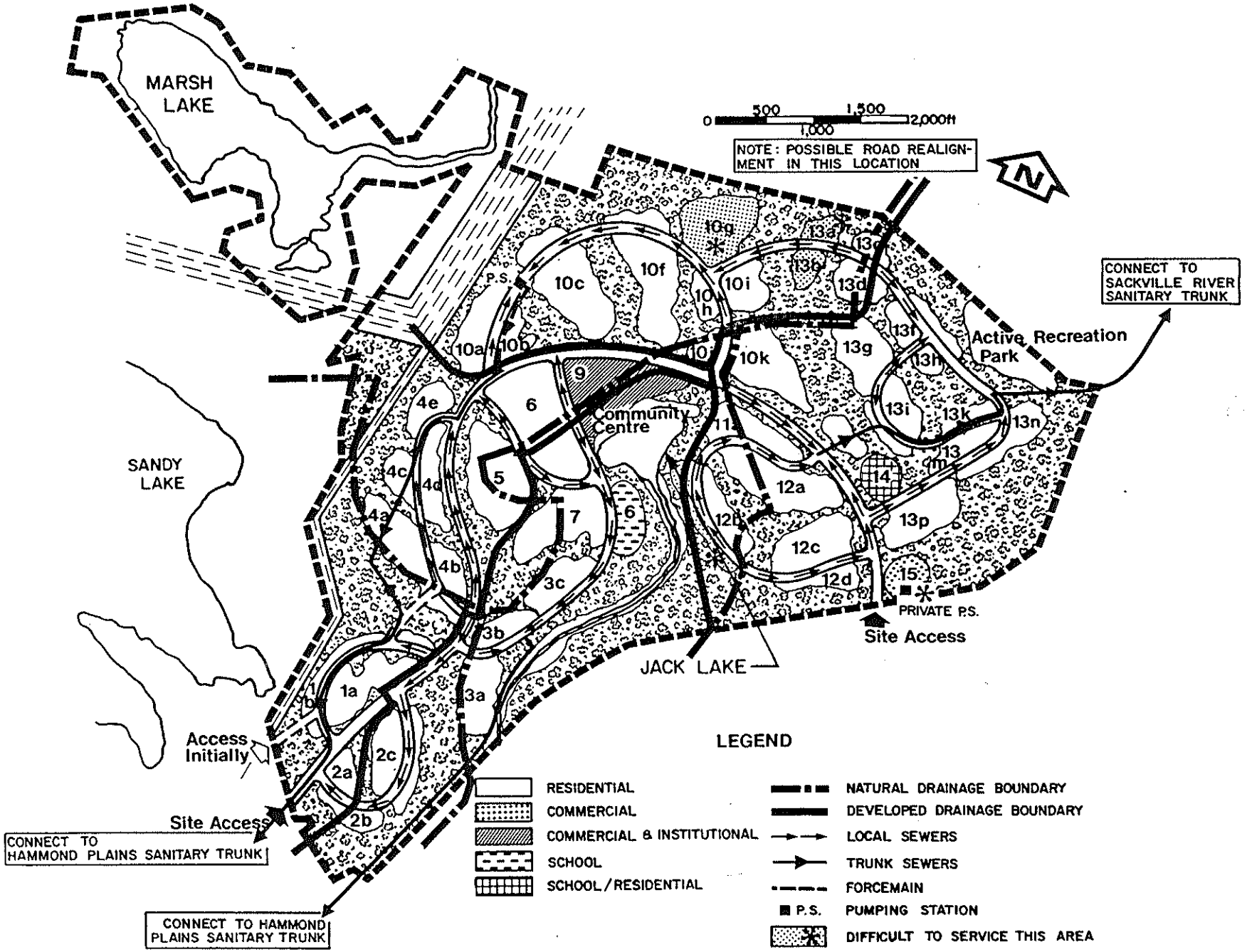



**Figure 3-4** Sanitary sewer layout concept, JLLA.

areas may have to be realigned in order to service certain areas, e.g., 10g, 11b and 13a. It is estimated that the total cost of the sanitary sewer system for this concept would be approximately $5.2 million in 1985 dollars.

2. Storm Drainage (Major and Minor System)

The natural drainage area boundaries have been preserved in the layout of the storm drainage system illustrated on Figure 3-5. Two minor trunk systems will be required for storm drainage. One trunk would provide an outlet for the eastern portion of the JLLA to the Sackville River. To reduce the level of potential impact on the Sackville River, a stormwater management pond is recommended for this system. The other trunk system would parallel Hammonds Plains Road to Paper Mill Lake and provide an outlet for the southwestern drainage area. Alternatively, a storm water detention pond could be used in this location to reduce post development flow rates to pre-development flow rates. The runoff from the development could then be discharged into the grassed ditches along the Hammonds Plains and the trunk sewer could be eliminated.

A storm detention pond will be required near the outflow on Jack Lake just upstream of the Bicentennial Highway to minimize the impact of the Jack Lake development on the downstream watercourse, which meanders through an existing residential neighbourhood.

The northern area of the development would outlet into the existing creek which drains into Marsh Lake. Since the Marsh Lake/Sandy Lake areas, as noted earlier, have been designated for a Regional Park, and to maintain the existing water quality, a stormwater quality control pond should be incorporated into the ample green space area.

The road layout on the concept plan has been reviewed based upon the existing topography, to ensure that continuous overland flow rates would be provided for as the major system. A number of easements and some possible road alignment will be required for this system (overland flow route). It is estimated that the total cost of the storm sewer system would be $7.4 million in 1985 dollars.

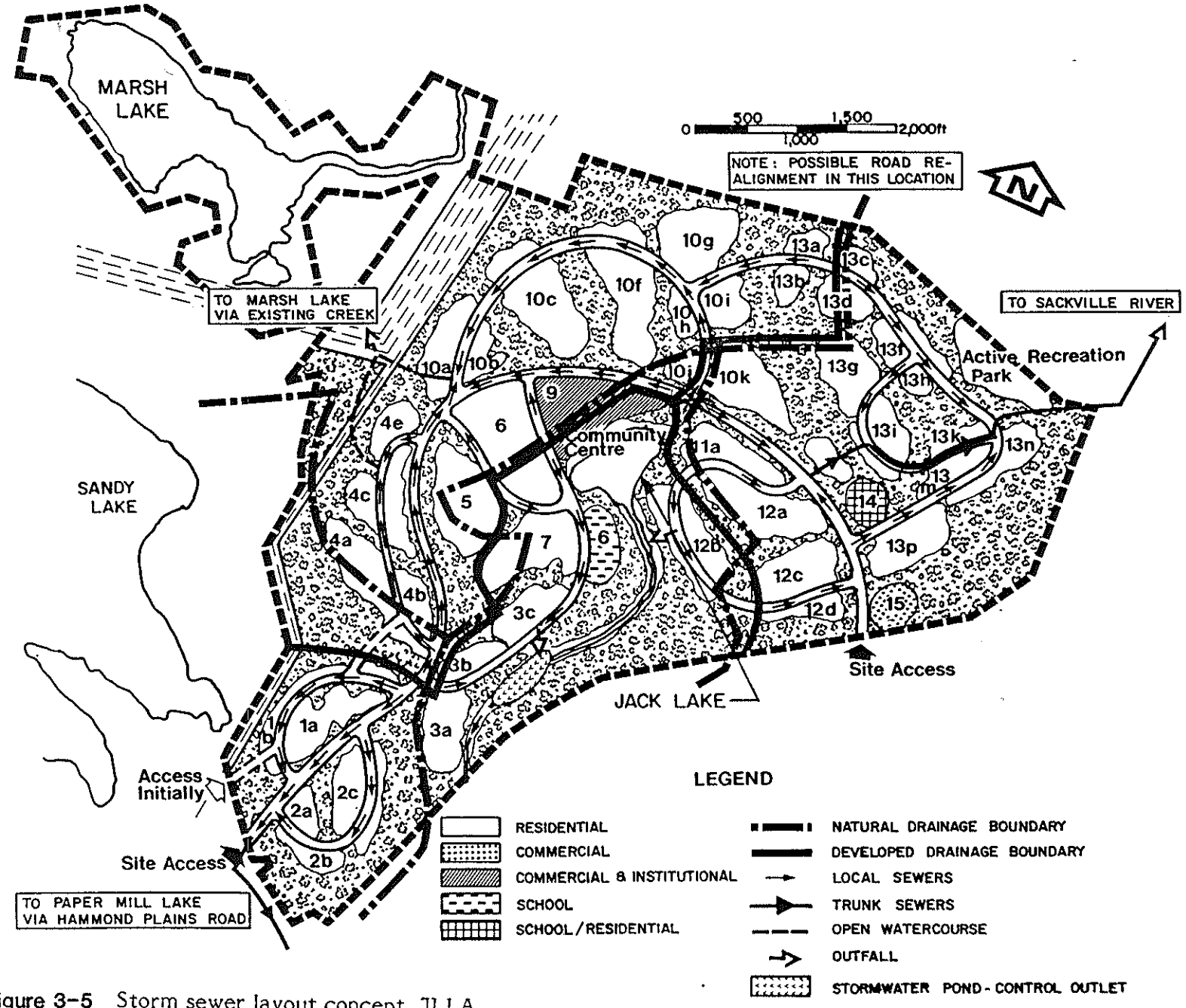



**Figure 3-5** Storm sewer layout concept, JLLA.

## 3. Watermains

Extension of the Meadowbrook High Pressure Zone would require two 300 mm diameter feeder mains across the Bicentennial Highway connecting into the Pockwock water supply system. These feeder mains should be connected with a 300 mm diameter loop through the development along with 200 mm diameter secondary loops.

Along the northern edge of the site there are a number of development areas 4a, c, e, 10a, b and g) just outside the high pressure zone. Individual pressure reducing valves would be needed in these areas.

The pressure zones of the proposed water system are illustrated on Figure 3-6.

Based on 1985 costs, the total water supply system for Jack Lake site is approximately 3.7 million dollars.

## 4. Transportation

The proposed Jack Lake collector road joining Hammonds Plains Road and Bicentennial Highway intersection in the south with a proposed easterly connection at the Bicentennial Highway should be a minimun of two lanes in each direction. This design would accommodate internally generated and through traffic, and would establish a standard hierarchy of roads in the project. This linkage will also be functional for public transit. Development of the JLLA area should proceed from Hammonds Plains Road area in a northerly direction. The development could include development blocks 1 to 9 as illustrated in the concept plan, without overtaxing the capacity of a single connection at Hammonds Plains Road.

The only constraint in this regard is the requirement to ensure that there is at times, an alternative emergency route by which one can enter and leave the area.

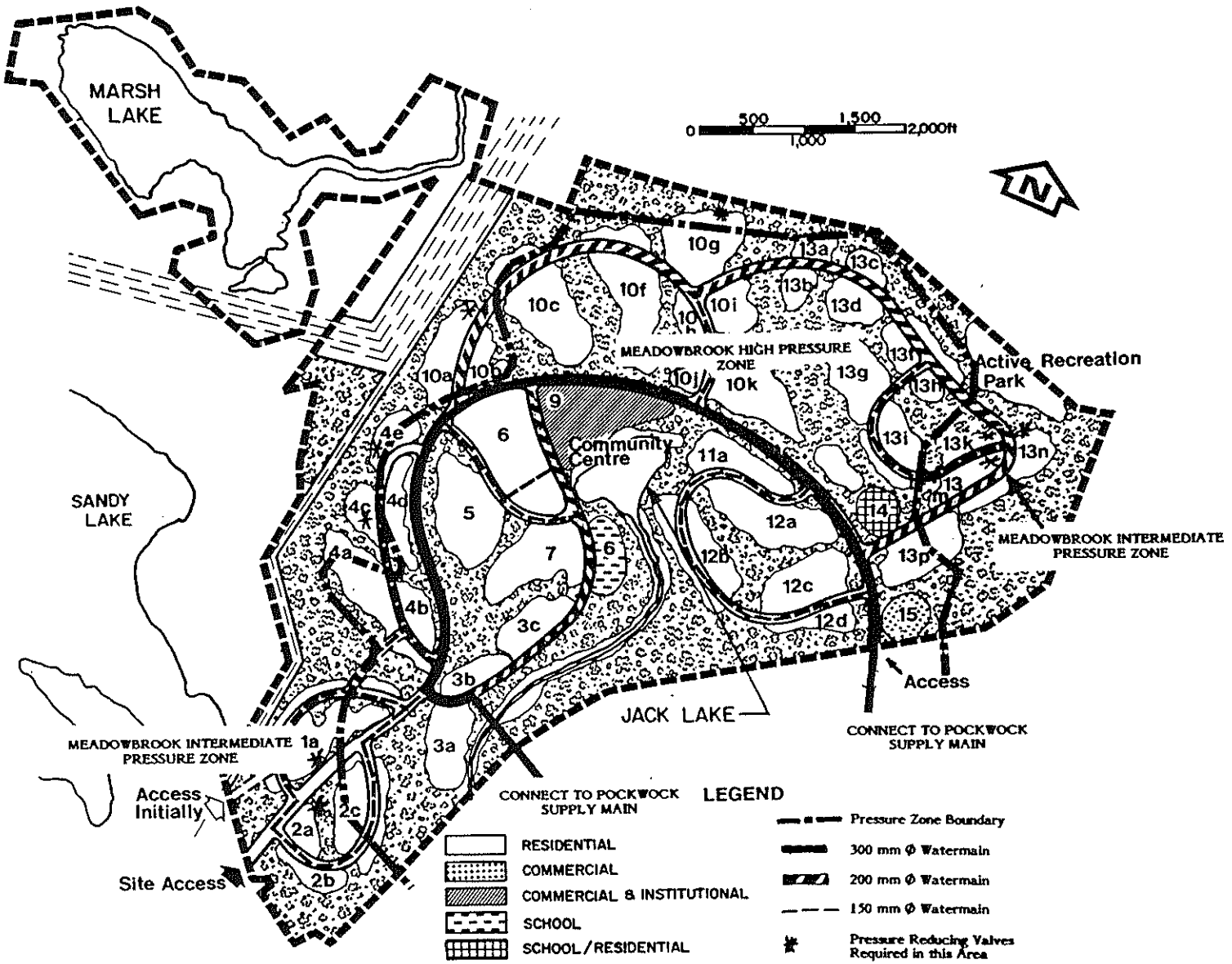



**Figure 3-6** Water supply layout concept, JLLA.

Road profile grades should follow the standard practice for collector roads. However, during the road profile design, particular attention should be given to the preservation of existing vegetation. This would also apply to lot grading.

## E. Summary

The Concept Plan as it responds to the environmental constraints sets the basis for the environmental analysis of land use, roads, and other physical improvements. The Plan is a viable and sensitive scenario upon which to base the assessment of environmental and socio-economic impacts.

The Concept Plan has been utilized in the following analyses of the possible impacts of the proposed Jack Lake development. The findings from the overall assessment are expected to be incorporated into the future planning and more detailed design of the JLLA development.

# IV THE NATURAL ENVIRONMENT

## A. Study Approach

The evaluation of the natural environment included several specific components.

1. Physical and Chemical Limnology
2. Biological Limnology
3. Geology, Soils and Bedrock
4. Hydrology
5. Hydrogeology
6. Vegetation
7. Wildlife

The Approach and/or Study Methodology for these components are discussed here.

### 1. Physical & Chemical Limnology

The main objective of the surface water or limnological component of the environmental study was to develop baseline descriptions of the water resources in the area with special emphasis on Jack Lake. Four major lakes (Sandy, Paper Mill, Marsh and Jack) as well as the Jack Lake outflow to Paper Mill Lake, Marsh Lake outflow to the Sackville River, and the Sackville River were identified as important limnological sites in or adjacent to the study area.

Two field sampling studies were undertaken to collect limnological data for all four study lakes, the Sackville River and Jack Lake outflow. The first sampling study began November 11, 1984 and concluded December 3, 1984. The second was conducted during early spring from May 14 to May 19, 1985. In addition, a preliminary reconnaissance of Jack Lake was undertaken on September 9, 1984.

Sampling stations were selected to best represent baseline conditions of the Jack Lake Land Assembly and surrounding water courses that might be affected by future development of the area.

a) Physical Measurements:

Morphometric maps for Sandy Lake and Paper Mill Lake were modified from similar ones produced in a M.A.P.C. (1972) study. Temperature was measured to 0.1°C and dissolved oxygen to 0.1 mg/1 units using in situ meters.

b) Chemistry Sample Collection:

Water quality samples were collected with a non-metallic Van Dorn water bottle, placed in Nalgene bottles, and transported to the Environmental Chemistry Laboratory at the Victoria General Hospital in Halifax for analysis.

c) Water & Sediment Analytical Methods:

All methods employed by the Environmental Chemistry Laboratory are in accordance with standard procedures and the laboratory has a reputation for superior quality control in sample analysis. Some 30 different sample units were tested through a number of different methods. Suspended solids for instance were filtered then weighed. A test for sodium was also conducted by an Atomic Absorption Spectrometer.

Sediment samples were collected during the first field sampling period with a grab sampler and transferred to glass bottles. Analysis was also undertaken by the Environmental Chemistry Laboratory.

## 2. Biological Limnology

Whenever possible, biological samples were collected concurrently with water chemistry samples and the physical measurements. Previous biological data for the study environments were not available and thus, the data presented here constitute an important baseline for comparisons of future environmental effects.

Samples were collected during both major field collection periods. Seven major biological components were studied: chlorophyll a, phytoplankton, bacteria, zooplankton, benthos, macrophytes and fish. In addition, an independent study of chydorids (microscopic crustaceans inhabiting littoral and benthic habitats), was undertaken by Dr. S.E. Frey of Indiana University in the fall of 1984 and these data were made available for our use.

Data for temperature, dissolved oxygen, water chemistry, chlorophyll, phytoplankton, zooplankton, chydorids, and benthos were entered on an Apple III microcomputer and are available on diskette, as well as hard copy output. Programs have been developed that summarize the data in report formats.

## 3. Geology, Soils and Bedrock

All available information regarding surficial deposits, soils and bedrock was compiled from the previous studies and geologic reports of the N.S. Department of Mines. Geochemical data for soils and bedrock in the Bedford vicinity were also compiled. This information was then field verified and augmented with additional soil and bedrock sample analysis during the field reconnaissance. In addition, the terrain map developed by Water and Earth Sciences (1982) was checked in the field and updated where necessary for bedrock exposure, overburden thickness and organic deposits.

To assess the potential of acid drainage for blasting and rock cuts, a total of 9 bedrock sampling and testing sites representative of the area were selected for detailed evaluation of bedrock mineralization and structure. Testing was

carried out at the Atlantic Industrial Research Institute at the Technical University of Nova Scotia.

A total of nine soil samples representative of the site glacial cover were collected from depths of 0.3 to 0.6 m. These samples were subjected to grain size analysis at the Jacques, Whitford and Associates Ltd. laboratories in Halifax, Nova Scotia.

A total of ten, 500 gram sediment samples were collected from the various lakes and streams influenced by runoff from the JLLA. They were analyzed for trace metals at the Environmental Chemistry Laboratory, Victoria General Hospital.

Visual observations, terrain analysis and field reconnaissance were combined to assess the potential constraints to development related to the natural physical environment.

## 4. Hydrology

A review and evaluation of information regarding the surface water hydrology of the area was conducted, including the Nova Scotia Department of the Environment watershed mapping inventory, the lake water quality survey (Bedford Institute of Oceanography, 1981), Metropolitan Area Planning Commission (1982), and a study of the Sackville River watershed by (Interprovincial Engineering, 1981). Data on precipitation, temperature, and other meteorological parameters were collected from the Atmospheric Environment Service of Environment Canada.

The Nova Scotia Department of the Environment, Watershed Mapping Series prepared by the Maritime Resource Management Service was utilized to define the drainage divisions and drainage basin areas.

Profiling of the peat bog areas adjacent to Jack Lake was carried out in late November 1984. A contour map of the extent and thickness of bog deposits around Jack Lake was prepared as a development aid.

## 5. Hydrogeology

A review of existing hydrogeologic studies was undertaken. Inventories of groundwater, compilations of data, and case histories of groundwater contamination problems (both natural and anthropogenic) were prepared for the Bedford, Killarney and Lower Sackville areas surrounding the Jack Lake Land Assembly.

A review of available groundwater resources data for a 5 km radius of the Jack Lake site revealed pumping tests, chemical analyses, and about 300 drillers logs for wells completed in quartzite bedrock structurally and hydrogeologically similar to conditions at Jack Lake. In addition, several borehole logs (Canplan, 1967; NSDOE 1975; and Water and Earth Sciences Ltd., 1982) and water quality analyses (NSDOE, 1975) were available for the site. During the course of the study, five additional groundwater quality samples were collected and a program of mini-piezometer installation was conducted in the vicinity of Jack Lake to interpret the relationship between the lake and shallow groundwater flows. Measurements of hydraulic head were obtained from available boreholes.

In addition, a field study of shallow groundwater conditions in the vicinity of Jack Lake was conducted between November 27 and December 5, 1984. Hydraulic head measurements were taken at intervals to determine whether the lake shore was influent or effluent with respect to groundwater.

## 6. Vegetation

Vegetation of the Jack Lake study area was visited from 30 November to 2 December 1984, and again on June 12 and 14th, 1985, with specific objectives as follows:

a. To compare air photos with ground surveys and provide a map of the vegetation for planning purposes;

b. To inventory the vegetation, and

- o develop a comprehensive list of species
- o to identify and determine the variety of vegetation communities on the JLLA site
- o to establish if and when any provincially or locally significant species existed on the JLLA site

c. To identify sample plant communities in the JLLA area, determine general species composition of the communities indicated in Figure 4.4, and to contact other individuals involved in the study for their concerns regarding the vegetation in the Jack Lake area.

Any plant materials not recognized in the field by the botanists involved were collected and identified from Roland & Smith (1983). Still other specimens were submitted to the Nova Scotia Museum for positive identification.

7. Wildlife

The wildlife survey was conducted jointly with the vegetation study and focussed on the avifauna (birds) as it appeared to be the most significant element of the wildlife present and was of most concern to local citizens. Other wildlife were also enumerated.

The survey was carried out in late November 1984 and in June 1985 by two trained avifauna specialists. It consisted of two meandering transects along the same routes taken by the vegetation survey crews. Data were simply recorded and summarized in a field notebook.

## B. Existing Conditions

Existing environmental conditions for the JLLA must be described from two perspectives:

a) The on-site status excluding any external interactions, and
b) The site in the context of the surrounding ecological conditions.

Consist with the Study Approach the same components are covered here with respect to existing conditions.

1. Physical Limnology

a) Table 4-1 summarizes the morphometric data for the four study lakes.

TABLE 4-1 Summary of the morphometric data for the four study lakes. Ranges for temperature and dissolved oxygen are also given.

| | Elevation (m) | Surface Area (ha) | Maximum Depth (m) | Watershed Area (ha) | Retention Time (yrs) | Volume ($m^3$) | Temperature (°C) | Dissolved Oxygen (mg $O_2$/2) |
|---|---|---|---|---|---|---|---|---|
| Sandy Lake | 30.5 | 74.0 | 20.0 | 1670 | 0.34 | $5.1x10^6$ | (2.5-11.5) | ( 9.9-11.7) |
| Paper Mill Lake | 22.5 | 31.5 | 6.1 | 3180 | 0.16 | $5.2x10^5$ | (6.0- 9.5) | (10.6-12.7) |
| Marsh Lake | 23.5 | 22.0 | 2.2 | 493 | .01 | $7.4x10^5$ | (5.0- 9.2) | (10.1-11.2) |
| Jack Lake | 75.0 | 2.75 | 7.0 | 32.8 | 0.18 | $7.4x10^4$ | (2.5-11.5) | ( 9.9-11.7) |

Figure 4-1 shows morphometric maps of the four lakes.

The present lake morphometry and existing peat bog suggests that Jack Lake is slowly receding and filling in. Extensive peat development has occurred in the north and northwestern portions as shown by the site plan and cross section profile. Three factors that contribute to the peat bog development in Jack Lake are: (1)

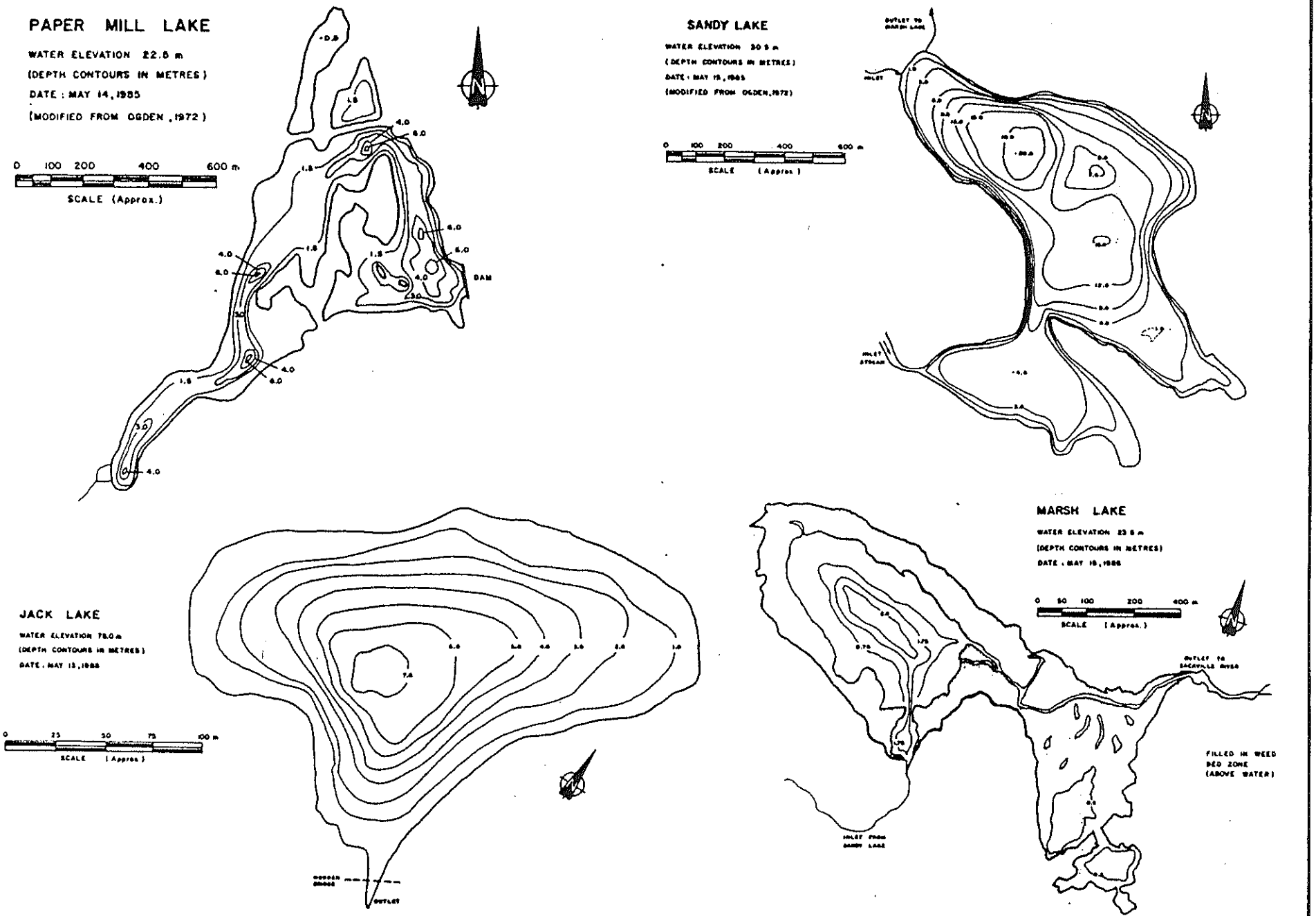



Figure 4-1 Study Area Lake Contour Maps JLLA,1985

(1) increased deposition of litter in lakes situated in isolated forest areas, (2) reduced decomposition of organic matter in acidic water, and (3) slopes of the surrounding land around the bog areas. Tree cover extends down to the edge of the peat bog and surrounds other portions of the lake.

b) Chemical Limnology

Data on water chemistry are given in Tables 4-2 for the four study lakes. Acid-stressed lacustrine environments are common in Nova Scotia since it is one of the most poorly buffered areas in the world.

All four lakes and their two outflows (Sackville River and Highway 102) are acidic and low nutrient environments. Of all of the lakes, Jack Lake is the most different. It is very dilute in most cations and anions, and is generally at the low end of the range of most water chemistry parameters. Jack Lake indicated relatively low values of most metals as can be seen from Table 4-3; these data will serve as an important baseline as the lake's watershed undergoes development.

The Sackville River reflecting the input from a larger, more populated drainage area, exhibited water quality conditions quite different from the lakes. The data suggest a significantly contaminated water body.

2. Biological Limnology

a) Total and fecal coliform abundances were recorded for 21 sampling stations. Generally, the values were low. The Sackville River exhibited the highest levels of total coliforms, but very few fecal coliforms. As expected, Jack Lake had little bacterial contamination. These data will serve as an important baseline should sewage-related pollution occur in the Jack Lake watershed in the future.

b) Phytoplankton are small microscopic plants that support aquatic food webs. For the four lakes, phytoplankton abundances were determined

Table 4-2. Summary of water chemistry values as means over all samples in the four lakes, Sackville River and Jack Lake outflow (Highway 102) for Field Trip No. 1.

| CHEMICAL PARAMETER | Sandy Lake | Paper Mill Lake | Marsh Lake | Sackville River | Jack Lake | Highway 102 |
|---|---|---|---|---|---|---|
| SODIUM (MG/L) | 12.6 | 11.7 | 12.0 | 7.55 | 2.66 | 17.0 |
| POTASSIUM (MG/L) | .520 | .420 | .550 | .430 | .110 | .650 |
| CALCIUM (MG/L) | 4.10 | 3.32 | 4.00 | 3.36 | 1.00 | 7.34 |
| MAGNESIUM (MG/L) | .860 | .716 | 1.72 | .885 | .491 | 1.15 |
| HARDNESS (MG/L) | 13.6 | 11.2 | 13.7 | 12.0 | 4.53 | 21.1 |
| ALKALINITY (MG/L) | 1.38 | 1.96 | 2.85 | 1.67 | < 1.00 | 4.20 |
| SULFATE (MG/L) | 11.6 | 7.20 | 11.5 | 10.7 | 6.65 | 13.0 |
| CHLORIDE (MG/L) | 20.6 | 19.6 | 18.5 | 12.0 | 3.56 | 34.0 |
| FLUORIDE (MG/L) | < .100 | .030 | .113 | < .100 | < .100 | < .100 |
| SILICA (MG/L) | 1.80 | 1.74 | 1.98 | 1.13 | < .500 | 4.85 |
| ORTHO-PHOSPHATE (MG/L) | < .020 | .024 | < .020 | < .020 | < .020 | < .020 |
| NITRATE + NITRITE (MG/L) | < .120 | .056 | < .050 | < .050 | < .050 | < .050 |
| AMMONIA (MG/L) | < .050 | < .050 | < .050 | .085 | < .050 | < .050 |
| ARSENIC (MG/L) | < .005 | < .005 | < .005 | < .005 | < .005 | < .005 |
| IRON (MG/L) | .230 | .116 | .153 | .429 | .048 | .325 |
| MANGANESE (MG/L) | .060 | .022 | .024 | .119 | .079 | .076 |
| LEAD (MG/L) | < .002 | < .002 | < .002 | < .002 | < .002 | < .002 |
| COPPER (MG/L) | < .010 | < .010 | < .010 | .012 | < .010 | < .010 |
| ZINC (MG/L) | < .010 | < .012 | < .010 | < .010 | .015 | .010 |
| TOTAL DISS. SOLIDS (MG/L) | 67.2 | 56.4 | 62.8 | 51.5 | 15.5 | 106. |
| SUSPENDED SOLIDS (MG/L) | 1.36 | 1.50 | 1.30 | 2.70 | .560 | 1.65 |
| COLOR (T.C.U.) | 12.2 | 9.50 | 11.9 | 24.2 | < 2.50 | 57.50 |
| TURBIDITY (J.T.U.) | 1.20 | .936 | .955 | 2.2 | .273 | 1.2 |
| CONDUCTIVITY (MICROMHO/CM) | 99.5 | 95.6 | 102. | 72.8 | 41.4 | 159. |
| PH (UNITS) | 6.14 | 6.42 | 6.10 | 6.27 | 4.63 | 5.80 |
| ALUMINUM (MG/L) | .110 | .090 | .083 | .188 | .172 | .270 |
| TOTAL CARBON (MG/L) | 2.70 | 2.36 | 2.33 | 3.70 | .550 | 8.15 |
| TOTAL PHOSPHATE ($PO_4$) (MG/L) | - | .042 | .028 | .006 | .026 | .035 |
| MERCURY (uG/L) | < 1.00 | < .050 | < .750 | < 1.00 | < 1.00 | < 1.00 |
| HUMIC ACID | 4.03 | 3.30 | 4.85 | 10.6 | < 1.00 | - |

**Table 4-2**
(Continued)

| CHEMICAL PARAMETER | Sandy Lake | Paper Mill Lake | Marsh Lake | Sackville River | Jack Lake | Highway 102 |
|---|---|---|---|---|---|---|
| SODIUM (MG/L) | 17.2 | 22.2 | 14.5 | 16.0 | 2.70 | 16.0 |
| POTASSIUM (MG/L) | .820 | .420 | .700 | 1.27 | < .100 | .300 |
| CALCIUM (MG/L) | 4.64 | 4.64 | 3.95 | 5.53 | 1.18 | 3.35 |
| MAGNESIUM (MG/L) | 1.18 | .932 | 1.05 | 1.27 | .534 | .815 |
| HARDNESS (MG/L) | 16.4 | 15.4 | 14.2 | 19.0 | 5.15 | 11.7 |
| ALKALINITY (MG/L) | 1.40 | 1.28 | < 1.00 | 4.83 | < 1.00 | < 1.00 |
| SULFATE (MG/L) | 11.6 | 7.74 | 9.55 | 8.63 | 5.56 | 7.25 |
| CHLORIDE (MG/L) | 28.4 | 35.8 | 24.5 | 25.3 | 5.20 | 26.0 |
| FLUORIDE (MG/L) | < .100 | < .100 | < .100 | < .100 | < .100 | < .100 |
| SILICA (MG/L) | 2.52 | 2.28 | 2.30 | 2.37 | 1.20 | .800 |
| ORTHO-PHOSPHATE (MG/L) | < .020 | < .020 | < .020 | .030 | .024 | < .020 |
| NITRATE + NITRITE (MG/L) | < .050 | .188 | < .090 | .147 | < .050 | < .050 |
| AMMONIA (MG/L) | < .050 | < .050 | < .050 | < .050 | < .050 | < .050 |
| ARSENIC (MG/L) | < .005 | < .005 | < .005 | < .005 | < .005 | < .005 |
| IRON (MG/L) | .220 | .180 | .175 | .820 | .134 | .250 |
| MANGANESE (MG/L) | .207 | .060 | .184 | .194 | .089 | .062 |
| LEAD (MG/L) | < .002 | < .002 | < .002 | .003 | < .002 | < .002 |
| COPPER (MG/L) | < .010 | .030 | .010 | < .010 | .012 | < .010 |
| ZINC (MG/L) | .220 | .014 | .025 | .017 | .012 | < .010 |
| TOTAL DISS. SOLIDS (MG/L) | 77.4 | 88.6 | 64.0 | 74.7 | 21.8 | 75.0 |
| SUSPENDED SOLIDS (MG/L) | 1.36 | 1.06 | 1.00 | 40.8 | 1.20 | 1.25 |
| COLOR (T.C.U.) | 19.0 | 20.0 | 15.0 | 62.5 | 17.50 | 65.0 |
| TURBIDITY (J.T.U.) | 1.54 | 1.7 | 1.2 | 25.3 | 1.3 | 1.8 |
| CONDUCTIVITY (MICROMHO/CM) | 141. | 154. | 122. | 130. | 42.7 | 133. |
| PH (UNITS) | 5.44 | 5.94 | 5.30 | 6.40 | 4.50 | 4.40 |
| TOTAL ORG. CARBON (MG/L) | 3.76 | 3.20 | 3.50 | 4.27 | 3.00 | 7.70 |
| TOTAL PHOSPHATE ($PO_4$) (MG/L) | .002 | < .001 | .004 | .006 | .002 | < .001 |
| HUMIC ACID (MG/L) | - | - | - | - | - | - |
| ALUMINUM (MG/L) | .348 | .248 | .660 | .876 | .268 | 3.10 |
| MERCURY (uG/L) | < .050 | < .050 | < .050 | < .050 | < .050 | < .050 |
| ACIDITY (MG/L) | - | - | - | - | 4.92 | 6.90 |

Table 4-3 Metal scan of sediments (ug/g) for selected locations (Field Trip No. 1)

| Metal | Jack Lake | Above Hwy. 102 | Below Hwy. 102 | Sandy Lake | Paper Mill Lake | Marsh Lake | Marsh Lake Outlet | Sackville River Above Marsh | Sackville River Below Marsh | Sackville River Above Hwy. 102 |
|---|---|---|---|---|---|---|---|---|---|---|
| ALUMINUM | 17,200. | 19,900. | 17,000. | 33,000. | 17,000. | 14,000. | 14,200. | 25,200. | 11,800. | 26,100. |
| ARSENIC | 9.6 | 11. | 10.2 | 24. | 9.2 | 6.1 | - | 37.9 | 10.9 | 40.3 |
| BORON | 24. | 31. | 35. | 24. | 15. | 14. | 31. | 70. | 38. | 94. |
| BARIUM | 120. | 78. | 70. | 180. | 70. | 70. | 50. | 190. | 47. | 210. |
| BERYLLIUM | 1.0 | <1. | <1. | 2. | 2. | <1. | <1. | <1. | <1. | <1. |
| CARMIUM | 0.2 | <0.2 | <0.2 | 0.3 | 0.3 | 0.2 | <0.2 | 0.5 | <0.2 | <0.2 |
| CHROMIUM | 33. | 31. | 24. | 36. | 18. | 16. | 17. | 36. | 19. | 41. |
| COBALT | <1. | <1. | <1. | 26. | 4. | 6. | <1. | <1. | <1. | <3. |
| COPPER | 23. | 15. | 16. | 51. | 30. | 32. | 15. | 43. | 16. | 46. |
| IRON | 7,000. | 20,600. | 24,600. | 34,000. | 19,000. | 18,000. | 19,900. | 62,200. | 23,500. | 65,100. |
| MANGANESE | 90. | 360. | 490. | 810. | 450. | 670. | 480. | 4,400. | 1,300. | 4,400. |
| NICKEL | 19. | 21. | 22. | 90. | 17. | 24. | 22. | 47. | 21. | 57. |
| LEAD | 21. | 3. | 23. | 27. | 63. | 13. | 13. | 120. | 15. | 140. |
| ANTIMONY | <5. | <5. | <5. | <5. | <5. | <5. | <5. | <5. | <5. | <5. |
| SELENIUM | <10. | <10. | <10. | <10. | <10. | <10. | <10. | <10. | <10. | <10. |
| TIN | 12. | <3. | 9. | 80. | 15. | 8. | <3. | 7. | <3. | <7. |
| VANADIUM | 37. | 42. | 47. | 46. | 44. | 34. | 31. | 62. | 37. | 70. |
| ZINC | 80. | 45. | 60. | 160. | 120. | 80. | 60. | 240. | 70. | 270. |

Collection Data: November - December, 1984

Units: µg/g

from both field trips. Jack Lake had extremely low phytoplankton abundances; only one-sixth as much as Sandy Lake and Marsh Lake, and only about .25% as much as Paper Mill Lake. This result further confirms the low productivity of Jack Lake observed during the first field trip.. All of the lakes except Paper Mill, exhibited more phytoplankton growth in spring than in the fall. None of the algal species were unusual and most are common members of lakes in Nova Scotia.

c) Several types of biological measurements were made. Chlorophyll provides a gross and indirect measure of phytoplankton production as the standing crop of phytoplankton cells. Thus, it can be a useful measure of lake eutrophication caused by nutrient enrichment in a watershed. Generally, these concentrations were low which is indicative of the unproductive nature of these environments. The chlorophyll values found in this study were wholly consistent with the low nutrient concentrations.

d) Zooplankton are small, usually microscopic animals, that live in the water column and feed on phytoplankton and detritus. They form a critical part of the food web in that they are staple foods for fish and benthic invertebrate. Jack Lake exhibited a low density of zooplankton and a very low species diversity, much lower than is common in Nova Scotian lakes. The dominant zooplankton species in Jack Lake was Diaptomus minutus, which is an acid-tolerant form that is usually the last to remain in a severely acid- stressed lake. It can be concluded that the zooplankton community of Jack Lake is stressed. The low abundances of cladocerans (another type of zooplankton) in Jack Lake are a further indication of the stressed nature of the environment. Generally, Sandy and Marsh Lakes were the most productive.

e) Chydorids are microscopic animals that inhabit the inshore areas, soft muds and weed beds of lakes. The structure of littoral cladocerau

communities is greatly affected by watershed development (Whiteside, 1970; Synerholm, 1975) and they have the potential to be good indicators of water quality. Nova Scotian Lakes typically contain very diverse littoral communities and this is evident from the data collected from the study lakes. Given the high diversity of chydorids presently inhabiting Jack Lake, they would be an excellent indicator of excessive development in the water shed and should be monitored as the construction proceeds.

f) Benthic invertebrates were sampled at eleven different sites on both field trips. These are animals that inhabit the sediments of lakes and rivers and feed on detritus and other animals. Generally, the fauna was not diverse in any of the environments. Abundances were much higher in Sandy Lake than in Jack and Paper Mill lakes. This result may reflect the more productive nature of Sandy Lake. There were no unusual or exotic forms in the benthos and the results were standard for Nova Scotian lakes. Since benthic invertebrates are also a main fish food, it would appear that Sandy Lake would contain better fish habitat in terms of food supply.

g) Fish: Brook trout, gaspereau, yellow perch, common white sucker, brown bullhead, American eel, Branded killifish have been collected in Sandy Lake from 1980 - 1983 and brook trout, juvenile Atlantic salmon, American eel, and banded killifish have been caught in Sandy Lake Outlet. Paper Mill Lake contains brook trout (Salvalinus fontinalis), brown bullhead (Ictalurus nebulosus), common sucker (Cafastomus commersoni) and american eel (Anguilla rostrata).

Since there was existing fish records for the above two lakes, and a corresponding lack of data on Marsh and Jake Lakes, the identification of fish species and determination of their abundances in part, relied on the above findings.

Fish were sampled in the outlet from Marsh Lake, upstream of the Sackville River. Brook trout, Atlantic salmon (Salmo solar) (juvenile), American eel and banded killifish (Fundulus diaphanas) were recorded. Two brook trout were caught in the inflow from Sandy Lake.

A fish survey of Jack Lake and the outflow stream to Paper Mill Lake was undertaken on November 23, 1984, using electrofishing equipment. Three brook trout (speckled trout) were taken. The high acidity and low nutrient concentrations of the water quality of Jack Lake may explain the few fish surveyed.

## 3. Geology, Soils and Bedrock

### a) Physiography

Jack Lake Land Assembly is situated within the Southern Upland physiographic region, (Goldthwaite, 1929), which is the southern extension of the much larger Atlantic Uplands, an erosional plain which once extended across the Atlantic provinces (Roland, 1982). This physiographic region underlies most of Southern Nova Scotia.

In the vicinity of Jack Lake, the area is characterized by a rolling topography with broad, smooth ridges and hollows generally following the northeast strike of the underlying bedrock. The substantial road cut by the Bicentennial Highway illustrates the structure of these parallel ridges.

Field reconnaissance has shown that much of the southwestern portion of the land assembly is comprised of bedrock ridge outcrops with intervening boggy depressions.

Rounded hills up to 30 m in height are developed on the bedrock surface on the eastern side of the site. These glacial till drumlins exhibit long axis orientation in a northwest to southeast direction, along the assumed direction of ice movement.

The Jack Lake Land Assembly is situated on a local topographic high ranging between 38 m at the east and west boundaries to 99 m on the top of some of the drumlin hills.

b) Bedrock Geology:

The Bedford area of Nova Scotia is underlain by paleozoic-aged (Cambro-Ordovician Era, 500 million years ago) metasediment of the Meguma Formation, which is locally comprised of graywacke and minor slate of the Goldenville formation. This is conformably overlain by slates and minor quartzites of the Halifax slate formation.

i) Bedrock Structure

Topography and drainage in the study area are controlled by bedrock structure. Field reconnaissance has shown that NE to SW trending ridges and mounds are generally indicative of bedrock outcrop or thin overburden while NW-SE trending elevations are generally indicative of thick glacial till drumlins.

The dominant structural features on the Jack Lake site is the Waverley anticline which is the western continuation of the Moose River anticline. The only groundwater sample exhibiting elevated arsenic concentration occurred in piezometer N3 located on the NE corner of the site, which is on the north side of this anticline and away from the JLLA.

Rock cores collected by Maritime Testing Ltd. (1975) indicate that the rock is fractured by moderately widely spaced joint systems which are frequently tightly closed with only occasional broken or weathered lineations observed (Maritime Testing, 1975). The significance of this is that groundwater flow volumes can be expected to be low and excavation costs can be expected to be high.

ii) Configuration of the Bedrock Surface

Bedrock outcrops exist over much larger areas of this development than was originally estimated. Figure 4-2 shows the locations of bedrock, drumlins, till and organic soils.

c) Surficial Geology:

Glacial action eroded the underlying bedrock depositing a lodgement till as it advanced. Upon its retreat (12,000 - 7,000 years BP), the glacial ice melted and deposited variable thicknesses of overburden materials (abalation till) on the surface. Subsequent erosion processes have resulted in the present landforms and drainage patterns observed in the area.

Surficial geology mapping indicates that the Jack Lake Land Assembly is covered with a thin (1m to 2m) veneer of loose to compact oligomictic sandy silt-till. The sandy tills are developed over much of the resistate upland areas.

Superimposed on the basal till sheet are a number of elongated northwest oriented drumlins ranging in thickness from 3 to 46 metres. The above descriptions are consistent with the geotechnical data available for the JLLA. It appears that most of the lake bottom sediments on Jack Lake and Sandy Lake have been eroded from the surrounding drumlin hills.

The present topsoil series which comprises the upper 0.8 m (2.6 feet) of the overburden are chemically and texturally reflective of the underlying parent tills.

4. Hydrology

Regional drainage appears to be controlled by bedrock structure which also controls the site topography. The Jack Lake Land Assembly lies within two distinct watersheds. Most of the site drains north and east towards Sandy and Marsh Lakes and the Sackville River.

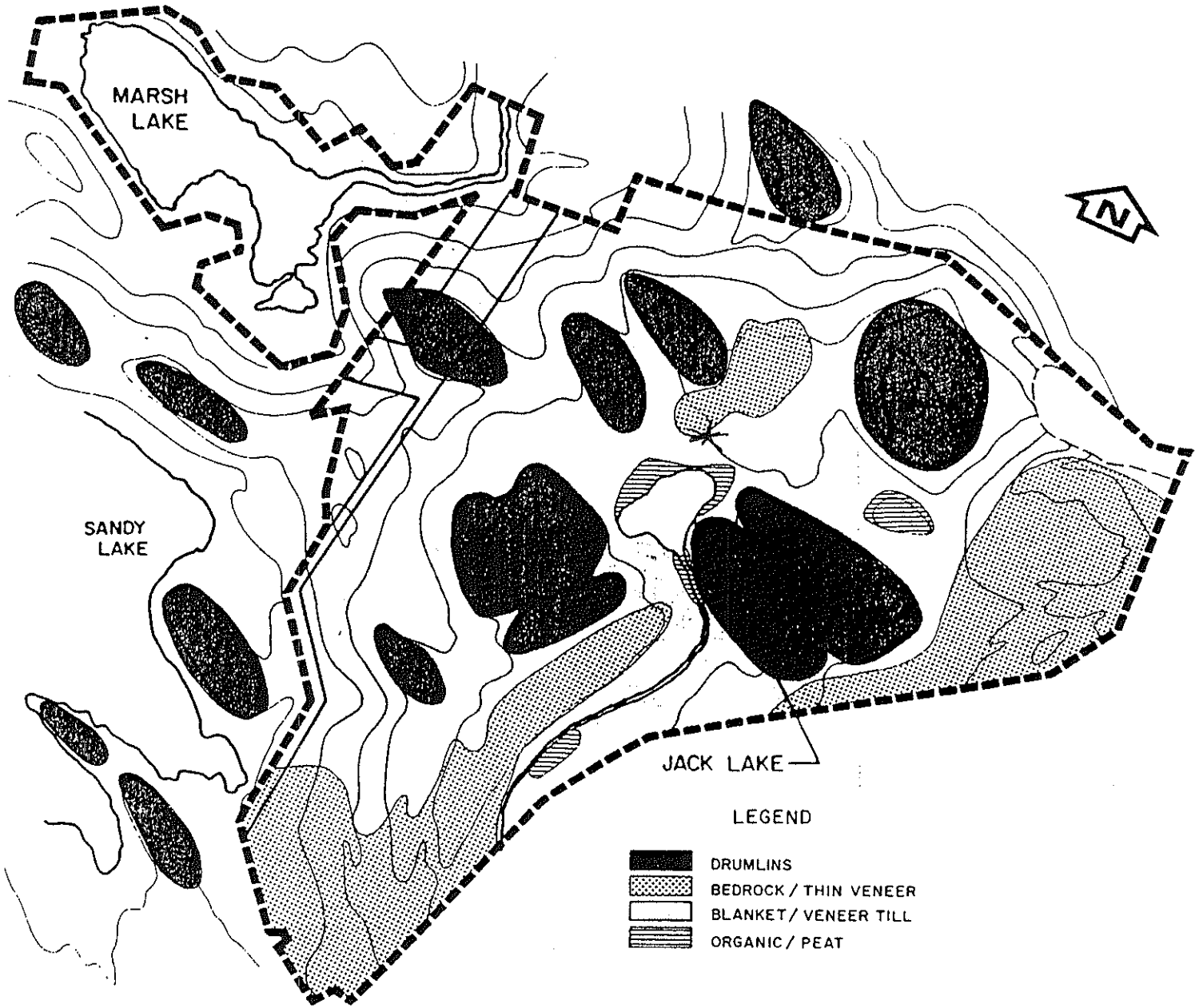



Figure 4-2 Geological Configuration of JLLA

The Jack Lake watershed is a sub-basin of the much larger Kearney Lake sub-basin (area 3430 hectares, 346 ha water) which contains Paper Mill Lake, Kearney Lake and the Birch Cove Lakes. Both Kearney Lake and Jack Lake ultimately discharge to Bedford Basin via Paper Mill Lake at Mill Cove. The Jack Lake watershed is bounded by Highways 102 and 213.

Potential impacts on Paper Mill Lake related to urban development within JLLA include increased runoff, roadsalt and possibly some siltation from the Jack Lake outfall at Highway 102. Sedimentation is expected to be small because of the natural check dam afforded by Highway 102, and the large flat bog area between Jack Lake and the highway. The relative contributions of salt runoff from JLLA and Highway 102 will be difficult to estimate. Baseline profiling of the outfall stream indicates existing salt contamination originating from the highway alignment, extending as far as Paper Mill Lake.

The eastern portion of the site drains directly to the lower reaches of the Sackville River. Historical problems of erosion and consequent siltation, and the steep topographic gradients related to the presence of highly erodible till drumlins indicate a significant sedimentation impact potential to the Sackville River.

In addition to the obvious outflow streams, a number of ephemeral streams discharge from the site (Figure 4-3). The largest is a small stream draining the boggy terrain southeast of Jack Lake. This stream flows most of the year, and parallels Highway 102 to the Sackville River. - Morraine Brook?

To assess the interaction between the lake and shallow groundwater, a number of mini-piezometers were installed along a profile across the outflow from Jack Lake. The lower levels recorded for piezometers near the stream suggest that Jack Lake may recharge the groundwater system, at least during the high flow period.

The anomalous low pH and low alkalinity of Jack Lake seems out of place relative to the chemistries of Sandy, Marsh and Paper Mill Lakes, and other

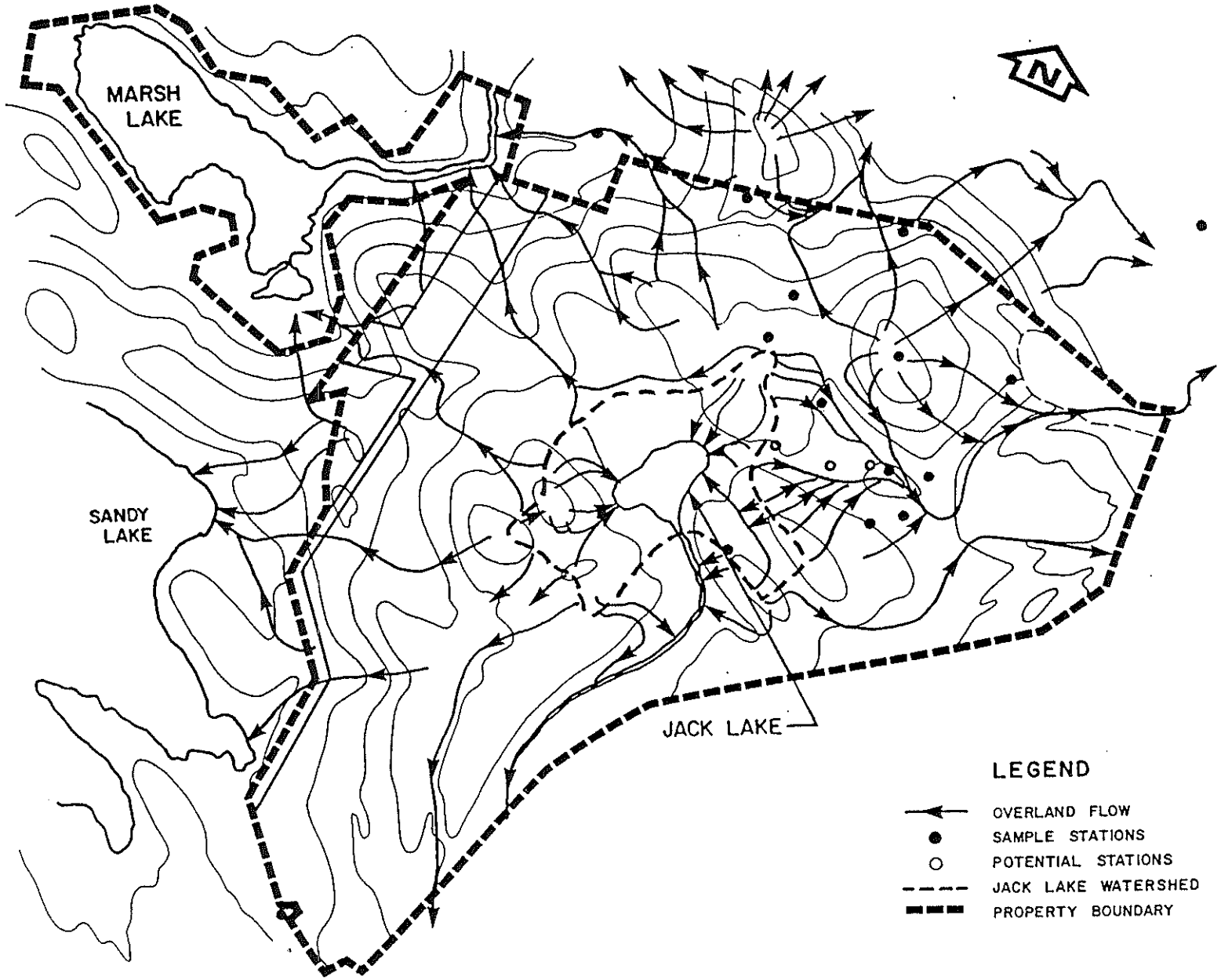



**Figure 4–3** Site hydrology, JLLA, 1985.

lakes in the region. A small lake entirely surrounded by alkaline clay till drumlins would be expected to buffer acidic rainfall to some extent and to exhibit higher pH levels than shown in this study. Utilizing the limited data available, a hypothetical lake-groundwater balance model can be generated for Jack Lake to explain its low pH and productivity.

Chemical data for the JLLA suggest that the water in Jack Lake is derived predominantly from rainfall (pH - 4.5). If there is any input of deeper groundwater from the drumlin till (pH 6.7-7.6, alkalinity 72 mg/l) or quartzite bedrock (pH -7.0-7.8), alkalinity 44-92 mg/l), the rapid rate of lake flushing (5X/year) does not allow sufficient time for adequate buffering action.

In summary, Jack Lake water levels appear to be controlled by the outfall barrier at Highway 102. Interaction between the lake and underlying bedrock aquifer appears to be minimal, and the lake may contribute small amounts of recharge to the bedrock during part of the year. The anomalous water quality appears to be related to direct rainfall input and interflow through organic deposits around the lake.

5. Hydrogeology

Numerous drillers logs and pumping test results for existing wells and abandoned wells in Bedford and surrounding areas are available for the interpretation of the groundwater conditions in the vicinity of the Jack Lake Land Assembly. Because the bedrock geology, structure and hydrogeology of the Meguma Group and overburden in the Birch Cove to Sackville areas is relatively uniform, these data can be applied with a reasonable degree of certainty to the prediction of groundwater conditions underlying the land assembly, and to the assessment of groundwater impact related to urbanization. Case histories of groundwater contamination, and development (NSDOE) and research studies of urban impacts (Cross, 1980) are directly applicable to the Jack Lake Land Assembly. This background information is augmented by site specific geotechnical, hydrogeological and water quality information obtained during this and previous studies.

a) Regional Setting

In the Bedford area, groundwater discharging to lakes and streams, and tapped by drilled wells likely originates from recharge areas on bedrock highs located within a few kilometers.

Water quality is generally good to excellent. The most common water quality concerns in Meguma Bedrock are elevated concentrations of iron and manganese which can cause aesthetic problems that are easily remedied by conventional water treatment equipment. Arsenic concentrations in excess of the 0.05 mg/l health standard can be encountered in arsenopyrite-bearing mineralized zones commonly found on the crests of anticlines, such as the Waverley Anticline situated north of the JLLA.

b) Hydrogeology of the JLLA:

As the entire site is expected to be serviced by a piped potable water distribution network the extent and quality of the groundwater is only significant in terms of construction constraints.

Water table levels (Table 4-4) on the Jack Lake site range from 0 in boggy depressions where groundwater discharges to the surface, to as deep as 15.8 m on the top of drumlin hills.

6. Vegetation

a) Vascular Plant Inventory:

Three rare species were collected during the course of the survey. The first species, Arenaria groenlandica (mountain-sandwort) is an arctic plant which occurs on the exposed rocks or barren areas. It is listed as a rare plant in The Rare Vascular Plants of Nova Scotia, however, Dr. J. Harvey of Dalhousie University suggests that it is not as rare as previously thought. The other rare species was Vaccinium

Table 4-4 Water table elevations.

| DATE | BOREHOLE | ELEV.(m) | (below ground) | M(ASL) |
|---|---|---|---|---|
| July 11/75 | N1 | 32.0 | 3.05 | |
| | N3 | 66.0 | 3.20 | |
| | N4 | 70.0 | 3.25 | |
| | N5 | 70.0 | 5.49 | |
| May 5/76 | H6 | 64.6 | 0.15 | 64.5 |
| | H7 | 75.3 | 0.15 | 75.1 |
| | H8 | 66.4 | 0 | 66.4 |
| | H9 | 69.2 | 0.30 | 68.9 |
| | H10 | 76.8 | 1.37 | 75.4 |
| | H11 | 91.1 | 0.30 | 90.8 |
| | H12 | 77.7 | 0.46 | 77.3 |
| | H13 | 101.8 | 15.85 | 85.9 |
| | H14 | 77.7 | Flowing | 77.7 |
| | H15 | 69.2 | Flowing | 69.2 |
| | H16 | 68.9 | Flowing | 68.9 |
| Dec.21/81 | B3 | 46.0 | 3.38 | 42.6 |
| | B4 | 64.0 | 3.35 | 60.6 |
| | B6 | 56.0 | 3.35 | 52.6 |
| Nov.10/84 | B1 | 88.0 | 2.97 | 85.0 |
| Dec.6/84 | B1 | 88.0 | 3.05 | 85.0 |
| | N4 | 70.0 | 5.03 | 65.0 |
| June 8/85 | H6 | 64.6 | 0.60 | 64.0 |
| | H10 | 76.8 | 0.91 | 75.9 |
| | H11 | 91.1 | 0.80 | 90.3 |

cespitosum (dwarf bilberry) which occurs on rocky cliffs and old clearings. Both species were found on a rocky outcrop which supported a barren type plant community dominated by Corema conradii (broom crowberry). The third is a potentially significant grass (Sporabolus gaviniflorus) and occurs along gravelled roadsides along the northern boundary of the study area.

The sites where these plants are located will remain undisturbed (see concept plan), save for the occasional trampling by people hiking through these wilderness tracts in the future.

b) Trees:

More than 90% of the study area was covered by forest (trees greater than 10 cm DBH) or woodland which will soon become forest. All forest and woodlands have been cut at least once in the past. After cutting, trembling aspen (Populus tremuloides) and white birch (Betula papyrifera) became dominant but these are quickly replaced by conifers (red, white and black spruce, and balsam fir) on most sites within the study area. This type of forest is called "coniferous forest" (Figure 4-4.)

On a smaller number of upland sites (presumably with a warmer microclimate), the trembling aspen and white birch were replaced by a mixture of the conifers mentioned above as well as hemlock (Tsuga canadensis), white and red pine (Pinus strobus and P. resinosa), and approximately equal proportions of the hardwoods listed below:

- sugar maple (Acer saccharum)
- red maple (Acer rubrum)
- red oak (Quercus rubra)
- beech (Fagus americana)
- yellow birch (Betula alleghaniensis)

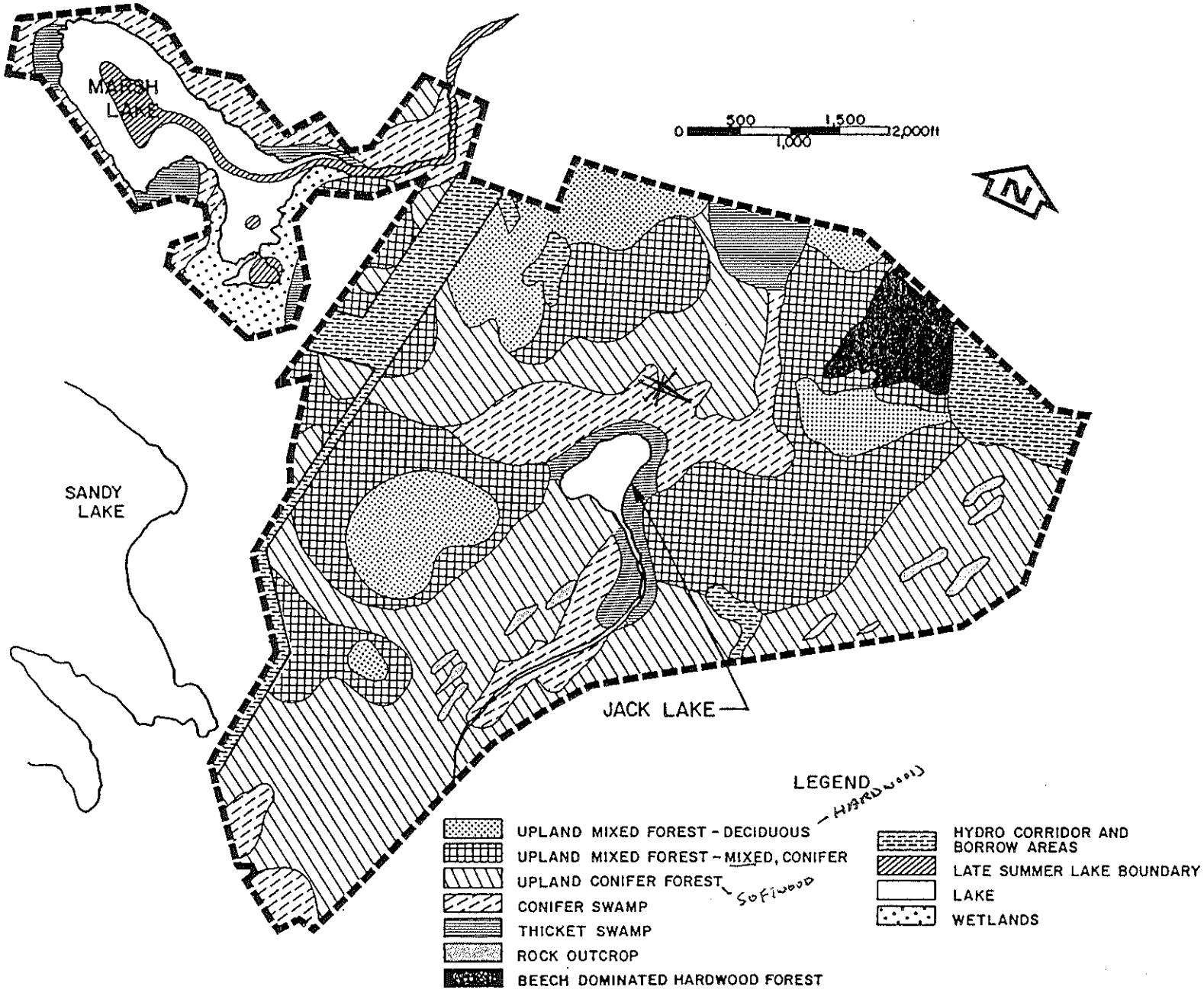



**Figure 4–4** Vegetation cover of JLLA, 1985.

c) Vegetation Community Groupings:

The species diversity found in the JLLA site was an assemblage commonly found in the Halifax County area and beyond. Four community groups were delineated as follows:

1) Disabled Sites

The plant communities found in the borrow pits, roadsides, and on powerline right of ways were identified as habitats having undergone severe anthropogenic disturbance.

2) Boggy Areas

According to the survey approximately 5% of the area in the survey zone is wet for much of the year. A total of 4 sites were located in areas of this type.

3) Barrens

Barrens areas are typically rocky outcrops from which most of the soil has been removed through galcial action and erosion after repeated fires.

4) Forested Areas

Forested areas cover more than 80% of the survey area.

Based on this level of examination, we did not find any unusual or significant communities needing protection.

7. Wildlife

a) Avifauna (Birdlife):

More than 75 species were sited during the over-wintering and spring breeding bird surveys.

Three parts of the Jack Lake site appear to be especially interesting.

i) The area around Jack Lake proper. This consists of the entire boggy margin of the northeast part of the lake and around the outflow. It is possible that a common loon is nesting at this location. Otherwise, the area offers unique habitat for such species as palm warbler, olive-sided flycatcher, and perhaps other species that might be attracted in future.

ii) The mature coniferous (partly mixed) stands southwest of the lake. This is the location of the osprey nest and is also where most of two or three species of wood warblers were found. It could also attract other species not resident at present.

iii) The older hardwood stands along the northeast margin of the site are perhaps the most attractive stands on the whole site. A scarlet tanager sighting was especially noteworthy. The fact that this margin is adjacent to DND lands, with some similar mature woods, is an important feature for those birds that might require larger areas of such habitat. An owl, tentatively identified as the uncommon long-eared owl, was flushed from the DND side of the trail in this area. This bird might use the Jack Lake lands as well.

b) Mammals:

Incidental sightings included all common small mammals found in this region of Nova Scotia, e.g., squirrels, mice and voles. Larger furbearers such as the racoon were not sighted, but signs of their activity were noted particularly near Jack Lake. Signs of white tailed deer activity were noted near the entrance to the Jack Lake access road and in other regenerating deciduous tree stands. In general, however, the areas around Marsh Lake and along the Sackville River (outside the JLLA boundary) provide exceptionally rich habitat conditions for wildlife. During one survey, numerous deer, waterfowl

small mammals were sighted in the Sackville R. riparian zone just north of the JLLA boundary. Inquiries with the Wildlife Division of the Department of Lands and Forests (Nova Scotia) confirmed these findings, namely that the JLLA in all probability does not have any rare or unusual mammals and does not contain any rare, unique or endangered wildlife habitat. The Marsh Lake area has an unusually large, seasonally inundated wetland which potentially could harbour uncommon wildlife.

Of most significance though is the Sackville River Valley outside the JLLA study area.

## C. Environmental Impacts

Emerging from the detailed examinations, as described earlier in this section and the Concept Plan which describes the transformation of a wooded land holding into a residential community, the potential environmental impacts of the Jack Lake development can be observed. The impacts affect two principal components:

- the natural environment, and
- the people and their economic status

Temporally, there are several distinct planning horizons represented which should be addressed:

a) the short term - during the construction period
b) the long term urbanization of the site
c) the cyclical and cummulative impacts of block development that the natural and social environment may experience over the next 15 years.

The following description of potential impacts reflects the level of detail achieved in the component studies. Given the nature of the individual studies, some examinations reached a fine level of detail, eg., to the species level, whereas, others remained at the overview level.

Nine (9) components are examined under impacts on the natural environment being:

1. Groundwater Impacts
2. Erosion
3. Road Salt Impacts
4. Acidic Drainage Impacts
5. Blasting, Excavation and Other Urbanization Impacts
6. Other Impacts on Surface and Groundwater
7. Liminology
8. Flora and Vegetation
9. Wildlife

Considerable detailed analysis went into this aspect of the study, which is covered comprehensively in the Appendix I document mentioned earlier, dealing with the natural environment component of the assessment.

## 1. Groundwater Impacts

It is estimated that approximately 15% of the annual rainfall falling on the JLLA will infiltrate into the underlying bedrock aquifers. The dominant direction of flow is likely to be east, towards the Sackville River, because the development is situated on the southeast limit of the Waverley Anticline and the dominant fracture trend is about 120° and 50°, which favours a southeast flow direction.

This suggests that any contamination of the aquifer which could occur in the recharge areas, would likely move in these directions. The DND well, located 1000 m downgradient of the site has 67' of casing and is unlikely to be affected by overland runoff. Long term water quality degradation by salt loading of the aquifer, however, is a possibility. Most of the Bedford wells are now abandoned, and are not considered to be an impact problem, in relation to distance. It is likely that the Highway 102 would impact these wells long before the JLLA development would. A discussion of various impacts on surface and groundwater resources is presented in the following.

## 2. Erosion

### a) General Statement:

Problems with erosion and resulted siltation of adjacent water courses are widespread throughout Halifax County, and much of Nova Scotia, and are considered to be the primary environmental problem associated with the urban development of JLLA. Disruption of previously forested drumlin slopes can potentially result in greater than a 100 fold increase in erosion rates (Truitt, 1978).

Perhaps the single most effective control of erosion in the natural environment is vegetation cover. The JLLA development, with its large percentage of designated green area, may be considered in a better light than many conventional developments which result in total deforestation. Notwithstanding this, the nature of the physical environment at JLLA is such that careful erosion control practices will be required to mediate any short or long term sedimentation impacts on adjacent water courses.

### b) Erosion Processes:

Erosion is defined as the gradual wearing away of the land surface by water, wind, ice and gravity. Water, usually in the form of rainfall and subsequent runoff, is the primary agent of erosion of concern during and after urban construction.

Although soil type and climate cannot be controlled by the developer, manipulation of vegetation and topography can be implemented through appropriate land use practices (Theakston, 1981). In the JLLA, careful attention to topography and corresponding drainage as well as vegetation buffers both during and after construction, will be the key to erosion control.

c) Impacts Caused by Erosion:

The primary environmental impacts related to erosion at JLLA would result in increased sedimentation of streams and lakes, and possible damage to roads and property located on erosion prone areas. With respect to aquatic systems, increased turbidity could curtail the aesthetic value of the adjacent lakes, with resultant reduced recreation potential.

In the JLLA, the potential for serious erosion is readily apparent from field observations. Considerable erosion has already occurred on the site. Recent problems with erosion of subdivision lands in nearby Sackville further illustrates the potential of this problem.

Construction activities subject to high erosion risk include: right-of-way clearance, earthwork, ditch construction, haul roads, culvert installation, channel changes, temporary stream crossings, work in streams, borrow pit operation, and excavation of individual home foundations and landscaping.

Temporary erosion control measures must be implemented during construction, and permanent measures must be provided for at the design stage. Any measures will be confounded by the cyclical nature of the development construction, i.e., on and off construction periods with new contractors, etc.

d) Topographic Factors

Topography controls the energy of sheet erosion, and transport and deposition of sediments. Slope length, gradient and shape are all factors to be considered. Long uniform concave slopes are less likely to erode than steep concave slopes. At JLLA, the predominance of drumlin hills suggest steep concave slopes, and hence a greater erosion and sediment transport potential. Large scale transport of sediment from drumlin slopes was observed on road cuts near the microwave tower, the gravel pit and the access road to Jack Lake.

e) Cover Factor

Vegetation cover is an important control of erosion. The tree canopy intercepts rainfall, and reduces the impact intensity of the droplets. Vegetation reduces surfaces runoff velocity and promotes redeposition of sediment. Plants reduce compaction, promote infiltration, and increase soil stability.

The cover factor (C) can be used to reflect the influence of various types of erosion control measures considered for JLLA, such as mulches, revegetation, chemical soil stabilizers and loose or compacted fills.

f) Summary

Based on these factors, calculations were made on the potential erosion impact on the JLLA site. Predicted erosion losses of 0.6/tons/acre/year and 64 tons/acre/year for forested and deforested condition respectively were derived from formulas used for these calculations.

**We have presented a lengthy discussion on erosion in the Appendix, as it is a potentially catastrophic consequence of poor planning, engineering and construction practices. The damage could occur within hours, given a significant storm event in an area cleared of vegetation cover. The JLLA site is highly prone to erosion damage leading to contamination of the surrounding waters.**

An awareness of this factor in planning and development of the site cannot be over emphasized.

3. Road Salt Impacts

a) General:

The winter climate of the Bedford area necessitates the application of road de-icing agents to all roadways for safety purposes.

One of the most common groundwater quality complaints investigated by the Nova Scotia Department of Health and Environment is excessive levels of sodium chloride (salt) resulting from road de-icing operations. Problems include objectional taste, elevated levels of iron and manganese, high conductance and total dissolved solids, and accelerated rates of corrosion in domestic plumbing systems.

b) Impacts Related to Road Salting:

The primary environmental impact associated with road salt application is the degradation of both surface water and groundwater quality in the vicinity of the source (e.g. streets). For the JLLA, the combination of both steep slopes and thin overburden cover increases the probability of salt loading of both surface and groundwater resources. The steep gradients and low permeability associated with the drumlin hills would result in rapid runoff towards Jack, Sandy and Marsh lakes. Over the remainder of the site, the predominance of exposed bedrock, thin overburden cover and vertically-dipping fractures will facilitate the infiltration of salt laden runoff into the underlying bedrock aquifer.

In the JLLA, road salt (from winter sanding) contained in water percolating to bedrock aquifers is expected to migrate vertically downward in to recharge areas, then laterally towards nearby lakes, the Bedford Basin and Sackville River. Since central services are to be provided with this development, impacts on local water wells are not of concern. Furthermore, the distances to the nearest domestic wells (Bedford Highway) are such that the natural processes of dilution and dispersion would be sufficient to attenuate salt concentration to near background levels, such that it would be difficult to differentiate the source of any salt, eg. from the JLLA, the Bicentennial Highway, local street salting, or sea water intrusion. The most likely groundwater impacts would occur in the vicinity of Smith's Road, where increased traffic volumes would likely warrant increased salt applications.

A perhaps greater concern in the JLLA is the potential impact of road salt on nearby aquatic ecosystems, especially the small ones like Jack Lake. Direct salt runoff to lakes and streams increases the overall conductivity of the aquatic system by forming a weak electrolyte because of increased total dissolved solids. This could contribute to the mortality of some salt intolerant flora and fauna.

A further concern is the effect of salinity-induced stratification on lake flushing rates. Delay in oxygen mixing could conceivably contribute to lake eutrophication (Cross, 1980) and death of deep water organisms.

Other potential environmental impacts related to uncontrolled road salting include reduced infiltration capacity of soils because of sodium-induced ion exchange and swelling, which could result in increased runoff component and more erosion. Damage to ornamental shrubs and lawns is also a possibility. Most horticulturalists will warn of the danger of excessive salting near foundation plantings. Other impacts include long term deterioration of paving and concrete curbing or culverts.

4. Acidic Drainage Impacts

a) General:

The presence of naturally occurring sulfide minerals common in the bedrock can, upon exposure to the atmosphere, become oxidized to sulfate and sulfuric acids and various metal complexes such as iron hydroxide. Drainage from such a condition can cause acidic drainage.

b) The JLLA:

Results of the rock testing indicate a very low potential for acidic drainage from rock cuts on the JLLA site. The quartzite bedrock has a much greater potential to consume acid than to generate it. It is therefore concluded that there is minimal potential for acid drainage from shallow excavation work on this site.

Analysis of surface water runoff at JLLA shows that there is little evidence of acidic drainage at present, and that all parameters fall within typical ranges for rainwater runoff.

Because of the low acid generation potential of bedrock at the JLLA, it was not necessary to run similar tests of the glacial tills to assess acid neutralization capacity.

## 5. Blasting, Excavation and Other Urbanization Impacts

In relation to the extensive areas of bedrock outcrop overlying much of the JLLA, it is inevitable that considerable excavation of bedrock for the installation of piped services will be required. Drilling and blasting of rock will be needed.

With consideration of the existing development distribution, it would appear that residences situated close to the southwestern end of the site will be most likely to be affected by blasting. Uncontrolled blasting could potentially damage foundations and masonry structures, and could cause damage to drilled wells and septic tanks (which are likely sitting on bedrock).

A further concern would be the possibility of damage to built phases of the development by blasting for subsequent phases. Homes located in Bedford south of Highway 102 are constructed on bedrock outcrop, and are thus subject to seismic energy from large scale blasting. Many of these homes are excavated directly into bedrock outcrops, and have been built since the construction and twinning of Highway 102.

The presence of extensive road cuts along the south and west perimeter of JLLA illustrates the type of problem to be overcome. It is possible, however, with present technology, to develop in areas such as this. Several examples occur throughout Halifax county, including Basin View subdivision in Bedford, just south of Highway 102, where homes are literally set into the bedrock. Proper preblast surveys, blast monitoring and phased blasting should greatly

reduce any chance of damage to existing residences. Suggested remedial measures are elaborated upon in the following.

Piped surface alignments should follow bedrock depressions which typically exhibit thicker till cover and offer the possibility of being filled with cover material to the required grade. Instead of considering a lot of blasting, perhaps filling of depressions may offer a solution, especially in the western portions. Plenty of fill material is readily available at the site.

### 6. Other Urban Impacts on Surface Water and Groundwater

In addition to the problems of erosion, road salt, acid drainage, blasting and excavation, degradation of the quality of groundwater and surface water may originate from other sources including:

- leakage and underflow from defective and surcharged sanitary or storm sewers
- deposition of air-borne particulates
- pollutants from domestic, institutional or industrial sumps and floor drains
- undetected leakage of fuel oil tanks, automobile leaks
- street material, including animal waste, grit, oil, road salt
- household wastes, including detergents, pesticides, fertilizer
- accidental product spills

Studies of the effect of urbanization on groundwater flow (Eisen and Anderson, 1979) have demonstrated that the most likely water quality impacts are elevated concentrations of chloride, sodium, sulfate, ammonia and metals leached from the soil. Both Eisen et al. (1979) and Cross (1980) agree that the most significant threat to groundwater quality is related to leaking sewers and road salt operations, both of which can cause the release of otherwise immobile natural materials to subsurface flow systems.

## 7. Limnology

The potential impact on all limnological elements of the Jack Lake development, i.e., water, plankton, benthos, invertebrates and fish, are closely linked to erosional processes. The introduction of suspended sediment into the water could severely alter the normal water renewal process and life cycles of many of the organisms now living in the system (Cross, 1980).

Greater numbers of people using the water resources of the JLLA area more frequently will exert a steady strain on the aquatic ecosystem. More fish will be harvested, more habitat will be disturbed and in general, steady urbanization will take place around the larger lakes in the area, as well as Jack Lake.

The proposed municipal park around a portion of Sandy Lake would however moderate any (use related) direct impacts from the development.

In conclusion, we do not foresee any severe negative impact on the limnology of the JLLA study area, provided that adequate mitigation measures and more importantly, environmental construction guidelines are established prior to construction.

## 8. Vegetation

The vegetation will be an affected component of the natural environment as 25-30% of the total natural cover will be removed during the process of development (see Concept Plan). We do not consider these losses significant in terms of the depletion of species or communities as representative species groupings are being preserved in the many green areas planned for the site. Furthermore, the areas around the JLLA contain very similar vegetation habitat. Erosion and its increased potential occurrence in denuded areas, again represents the most significant impact with respect to vegetation clearing.

Another impact on native vegetation will be the increased use of green areas. Trampling of vegetation and cleaning of trails will further alter the vegetation community. This change is not considered to present any major impact to vegetation of the area.

9. Wildlife

a) Avifauna:

The impact of the development on the avifauna in the Jack Lake area will be most pronounced in vegetation communities changing from forest assemblages to more "people-tolerant" and "edge" species association that will dominate the site. However, as the site will retain a significant of area as undisturbed green strip, this transition will be slow with examples of the indigenous species grouping remaining for many years. Furthermore, the areas immediately around the site, consisting of identical habitat, should harbour the original species groupings.

The sites identified as having unusual bird habitat; namely the hardwoods area and the Jack Lake Bog will remain undisturbed.

b) Mammals:

Mammals will be displaced by the development and will experience some mortality in relation to habitat removal (particularly ground-dwelling species). This is not expected to have any effect on the species health or populations. As with the avifauna, species more tolerant of man, e.g., squirrels, chipmunks and raccoons, will become the more dominant mammals as development progresses.

## D. Mitigation Measures

The Concept Plan is considered acceptable from the standpoint of the natural environment. Concern is expressed with the location of the proposed Commercial development adjacent Jack Lake. To reduce negative impacts to the lake itself, a park-like area would be preferred. However, questions have been raised on this point, since the existing condition of the lake is such that it is not certain that more urbanized development in the vicinity of the lake would be all that harmful. The rationale for the Commercial location is based on the suitability of the site, which is generally flat, and its central location to

the rest of the proposed development. The following mitigation measures pertain to those concerns outlined in the previous section under impacts.

1. Mitigative Measures to Reduce Erosion Impacts

Two basic principals should be followed to achieve effective control of soil erosion at construction sites: (1) minimize the amount of exposed soils for the least amount of time, and (2) surface runoff and its velocity should be controlled as much as possible. The concept of minimal vegetation removal, especially on drumlin slopes, cannot be overemphasized.

For the development of the Jack Lake Land Assembly, the following erosion control practices are recommended to mitigate potential mass wasting and sediment impact on sensitive aquatic environments.

Mitigative Action:

- Incorporate erosion control planning into the overall development and site engineering planning. Develop sedimentation collection measures during the planning phase.

- Major construction of roads and land clearing should be carried out during drier periods of the year.

- Minimal vegetation disturbance is essential on drumlin slopes. Temporary cover with mulch or vegetation of disturbed overburden during construction activities must be implemented.

- All roads should be paved, culverted and curbed as soon as possible, after installation of piped services and storm drainage infrastructure and prior to home construction.

- After construction of individual homes, landscaping and sodding should be implemented before the next rainy season.

- The overall site development plan has been adjusted to climatic factors and conditions of topography, soil erodibility and vegetation cover for the various phases of the development. Some refinements may be necessary.

- Application of the Universal Soil Loss Equation for the various overburden conditions could be useful aids in the design of erosion control measures.

- Design storm drainage systems to accommodate increased runoff and sedimentation conditions, caused by changing vegetation cover and surface topography during and after development.

- Surface storm drainage corridors should be well-vegetated, and steep drumlin slopes should be sodded and equipped with gabion sediment traps to reduce flow energy.

- The overall site drainage plan should include measures for control of groundwater discharge from steep embankments.

- All storm runoff corridors to the lakes must be equipped with sediment traps, energy dissipation (rip rap) and a program of monitoring and maintenance.

- Provide monitoring of the effectiveness of sediment traps which control runoff into Sandy and Jack Lakes.

- Minimize the extent of exposed soil control by contract stipulations that specify the maximum area of unprotected soil that can be exposed at any one time.

- Retain and protect natural vegetation where possible.

- Carry out clearing of drumlin slopes in stages to take maximum advantage of topography and natural vegetation buffers.

- Reduce the duration of unprotected soil exposure by requiring staged hydroseeding and/or mulching as work is completed.

- Minimize large cuts into drumlin slopes. Where such cuts are essential, provide for adequate toe drainage to prevent slumping and downslope creep.

- Minimize the slope ratio of any cut into glacial till drumlins.

- Provide protection at inlet and outlet ends of culverts, drainage channels, and other flow junctions, including adequate energy dissipators.

- During construction, use materials from the project (brush, logs, chippings) to control erosion, filter sediment and serve as mulch. Use adaptive mulches to the maximum consistent with the erosion hazard. Apply mulches as soon as possible in the construction sequence, using proven anchoring methods. Anchor hay or straw into the soil, especially in areas of high winds. Seed and mulch by segments of high cuts and fills. Where ever possible, incorporate amendments into the seed bed before seeding and mulching.

- For long term erosion control, mulches should consist of heavy rock and natural vegetation indigenious to the area should be utilized for slope stability control.

- Where possible, utilize the green areas and flat barren areas to dissipate channel flow into sheet flow prior to runoff entering the lakes. This will provide an effective, long term sediment trap.

- Plan for temporary and permanent control of concentrated runoff from construction areas (sediment traps, filter barriers). Convert intercepted surface runoff to sheet flow (level spreader) where there are stable discharge areas, such as woods, sod, rock, or concrete

rubble. Use flat slopes to maximize erosion control by vegetation. Mechanically retard runoff, erosion and sediment in runoff water with check dams, berms, etc.

- Provide measures for sediment control from borrow areas, haul roads, and waste disposal areas during use, with restoration after use.

- Protect bodies of water and running streams from siltation with temporary measures such as berms, dikes, and sediment basins until permanent measures are effective.

2. Mitigative Measures to Reduce Road Salt Impacts

The following remedial actions are recommended to prevent road salt impacts on surface and groundwater:

- Jack Lake is the most sensitive to road salt impact. Careful design of storm drains should be implemented to divert all runoff away from the lake. Drainage from the Jack Lake watershed may be conveyed to Highway 102 along the lake outfall stream.

- Paved streets, curbs and concrete storm sewers should be used on all roads to prevent salt from entering groundwater flow systems.

- All roads should be curbed and paved, such that salt runoff is carried away via the storm drainage system.

- Where paving and/or curbing is not practical, ditches should be asphalted or tarred to minimize infiltration.

- Minimize the amount of salt spread on subdivision streets and institutional grounds.

- Roads should be plowed before salting to prevent overthrow of salted slush on lawns which may then excape from the storm water drainage system. Plowing prior to salting will reduce salt requirements.

- Where possible, all drainage should be diverted towards the Sackville River via suitable storm drainage structures to prevent salt stress on Paper Mill, Jack and Sandy Lakes. The Sackville River drains directly to Bedford Basin, and is already stressed by salt runoff from Highway 102, Bedford and Sackville.

- Drainage should also be directed away from the general Smith's Road area to minimize the potential impact on local water wells.

- Reduce the amount of salt applications within the immediate proximity to the Smith's Road well locations.

- Use a sand/salt mixture on those areas where impacts to nearby lakes are likely. This will require a spring clean-up program with a street sweeper or vacuum truck. Recommend 1:20 salt/sand ratio as minimum required to prevent freezing of aggregate.

- Reduction in amount of salt to safety minimum (U.S.E.P.A., 1974) by:
  - use ground spread controllers
  - calibration of salt spreaders to optimum salt dose (metering)
  - establishment of level of service (eg. more salt for dangerous corners, hills, main arteries, less for feeder, flat streets, etc.)
  - establish rate of application for beginning, during, after storm event
  - emphasizing plowing rather than salting
  - keep records on amount of salt applied per street until optimum level is reached
  - salt before storm, plow without salt, then light salting after storm to prevent freezing.

- Design of road beds for reduced de-icing requirements (eg. minimize steep slopes to intersections) and better collection and disposal of salt runoff.

- Education of municipal and field personnel regarding the environmental hazards of de-icing programs.

- Prewetting of salt with $CaCl_2$ has been found to improve salt melting properties and reduce total required material (U.S.E.P.A., 1974).

- Use salt tolerant grasses and trees along main roadway to reduce overall vegetation kill and improve aesthetics.

- Consider using graders (undercarriage scrapers) in conjunction with conventional snow plows.

- Careful attention to construction of wells, including distance, location, casing, length, grouting.

3. Mitigative Action to Reduce Acid Drainage Potential

Although the present study has indicated a very low potential for acid drainage from road cuts on this development, it is recommended that all significant blast cuts be inspected for mineralized zones after excavation, especially in the vicinity of the Waverley Anticline where mineralized veins are known to occur. Should fractures bearing sulfide mineralization be encountered, the area should be covered with fill material of clay till or a suitable shot-crete mixture, to prevent oxidation of the deposit and subsequent acid drainage.

Minor mineralization typical of the Goldenville Group should pose no environmental hazard. Fresh exposures of sulfide will be rapidly oxidized over the first few months, followed by progressively less leaching. The high positive acid-consuming potential of both the bedrock and the glacial till overburden is expected to be sufficient to attenuate any acid produced in this area.

- Major excavations of quartzite bedrock should be inspected for mineralized fracture zones, especially in the vicinity of subdivision areas adjacent to Jack Lake and Sandy Lake.

- Where significant sulfide mineralization is exposed, steps should be taken to cover the mineral zone immediately with clean, impermeable

glacial till (drumlin till) or a suitable material (clay, portland cement, asphalt). The application of such an oxygen barrier will limit, exposure to air and rainfall and prevent oxidation of the minerals and limit the growth of microorganisms which accelerate the acid production process.

- For piped services excavations, little or no remedial action will be required, provided the excavations are backfilled within a reasonable period of time. Again, major mineralized fractures, if found, should be isolated with a suitable oxygen barriers to prevent leaching by circulating groundwater and interflow which may follow the conduit.

- For a major road cut, exposed mineralized faces should be covered with glacial till or an alkaline cement to prevent oxidation. An alternate method would be to emplace carbonate fill downgradient of the potential acidic runoff to neutralize acid until weathering has occured.

- Minor exposures of mineral are not considered to be a a problem because any acid produced will be readily neutralized by the buffering capacity of the natural rock and glacial till.

- All fill materials used in this development should be clean, non-mineralized quartzite or glacial till, both of which occur on site. No slate fill should be used, unless approved by N.S.D.O.E. who monitor slate quarries.

4. Mitigative Action to Reduce Blasting Damage and Other Urban Impacts

a) Blasting

- A program of blast monitoring should be implemented at the onset of development to efficiently control the size and frequency of bedrock blasting and thus minimize structural damage.

- Prior to excavation of piped services into the western side of the development, a pre-blast survey of domestic wells, septic systems and homes must be carried out for the Smith's Road area to Hammonds Plains Road, or a distance of 300 m from the blasting. This survey should be conducted in a manner similar to the N.S.D.O.E. guidelines for well sampling in conjunction with construction of 100 series highways.

- All blasting in a given development phase should be carried out in a short time frame.

- Development of each phase of the subdivision must consider potential blast damage to previously built-up phases.

- Where possible, piped services should be laid between bedrock ridges.

- Experience gained in the nearby Basin View Subdivision may be valuable in the design of construction strategies at Jack Lake.

b) Other Urban Impacts

- Proper construction of sewerage services should minimize contamination of groundwater and associated surface water resources.

- A set of guidelines should be set up for the proper location and installation of all domestic and industrial fuel product tanks. This will prevent future unnecessary leaks and safety hazards.

- Guidelines for the proper collection and disposal of any waste from light industry and schools should be prepared. For example, disposal of dry cleaning fluids (PCE, TCE), school laboratory chemicals, painting supplies, solvents and other common wastes could cause problems at the Birch Cove Sewage Treatment plant, or local lakes, if dumped in storm drainage systems.

- Bylaws could be enacted to prevent the proliferation of body shops, junk piles, and car repair depots within sensitive watersheds such as Jack Lake.

- Any gasoline or service stations should be sited in areas where major product spills would do the least damage. Sites within the Jack Lake watershed and immediately adjacent to Sandy Lake should be avoided. In addition, avoidance of areas of thin overburden cover where product migration into fractured bedrock could occur, is recommended. The best area would be those relatively flat areas underlain by thick glacial till where direct runoff of contaminated water can be easily controlled.

- All hiking trails and access roads to the many green areas should be designed for erosion control. The present access road to Jack Lake should be stabilized or redirected along contours.

- A by-law against unnecessary removal of vegetation from green areas must be enacted.

5. Avifauna

The hardwoods sites and the Jack Lake bog area will remain undisturbed providing needed habitat for the scarlet tanager and the osprey (which may use the area as a perching territory (not feeding). Beyond these measures no specific mitigation measures are needed.

6. Mammals

No mitigation measures are needed.

7. Environmental Awareness

The Partnership (CMHC and NSHD) should ensure that all developers and builders who might be on the site either under contract or pursuing their own

endeavors, are fully aware of the mitigation measures outlined in this section. Attaching the mitigation requirements to construction contracts, and including them into part of a purchase and sale agreements are measures that should be considered.

# V THE SOCIO-ECONOMIC ENVIRONMENT

## A. Study Approach

As with the natural environment, the existing socio-economic conditions are described as a baseline from which to observe the effects of JLLA. Unlike the situation with the natural environment, however, the socio-economic environment has been, and continues to be, subject to rapid and massive change and it interacts very extensively and unpredictably with the surrounding community. For these reasons, certain cautions are in order.

Bedford is growing quickly, has a complex economic relationship with the rest of the region and is constantly subject to unpredictable major changes. It is not stretching the point too far to say that Bedford has been under the influence of a major project for many years, that project being the development of the Halifax-Dartmouth regional economy itself.

### 1. Major Socio-Economic Elements

Socio-economic conditions were approached under four general headings:

- o population
- o economy
- o land use
- o community attitudes

In each case, the method and sources of data was somewhat different.

Under each of the above four headings, we dealt with present and future conditions without Jack Lake, plus our best assessment of the effects of Jack Lake. In some cases, such as population growth and the demand for services and fiscal changes, the results were quantified. In other cases, we have provided quantitative ranges, but have stressed the rationale more heavily than the numbers.

Finally, in many instances, quantification was simply inappropriate and was avoided entirely.

a) Population:

The main population data source was the 1981 census. Comparative data previous to 1981 are very weak since Bedford was only incorporated in 1980 and was part of another census subdivision up to that time. Present population sizes were estimated using building activity, but other population parameters were described as of 1981. As with other sections, some of the work undertaken for the Halifax-Dartmouth Regional Plan Review, as well as reports by other consultants, proved extremely useful.

Except for overall population size, forecasts have not been undertaken in any formal sense. Bedford is too small a unit of analysis and too "open" in its interactions with the region to make such approaches anything but superfluous. We have contemplated future conditions in the narrative and leave it to the reader to do the same, based on the factual data presented.

b) Economy:

The information available on the economy is somewhat more extensive and up to date than that on population. Main sources include the 1981 census, Department of Development surveys on commercial space and manufacturing, and Regional Plan Review reports.

To describe a town like Bedford as having an "economy" is rather misleading. More accurately, the town's geographical boundaries happen to encompass a number of economic activities whose chief relevance is their assessment and land use impacts. We have nonetheless used the notion of the Bedford economy, for economy of expression if nothing else, although we have avoided normal economic categories of analysis in favour of land use categories.

We have attempted to assess future growth prospects for the main economic land use types based on past trends, development proposals, anecdotal evidence from interviews and our best assessment of the main sources of growth.

c) Land Use:

The town's land use survey, LRIS property mapping (1984), and building and subdivision data were the main sources for this section. We assessed general patterns of change and the pace of land absorption at a generalized level. In the immediate vicinity of Jack Lake, we undertook a more detailed examination, focussing on developability and potential compatability problems.

d) Community Attitudes:

We attempted to assess community attitudes through a number of measures:

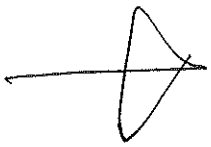
1) Pre-screening of issues: With the advice of town officials, we selected a group of a dozen or so informed residents with whom we discussed the project. We also reviewed past issues of the Bedford Blueprint (local newspaper), in particular, the one dealing with the 1980 attitude survey.

2) We proposed a series of briefing/discussion sessions with the Bedford Planning Advisory Council (BPAC) or with representatives of BPAC. One meeting was held during which the representatives present expressed their explicit disinterest in such meetings and the issue was dropped.

3) Detailed exploration of issues: A number of other interviews were conducted to focus on key issues such as services, population, the economy, transportation, etc.

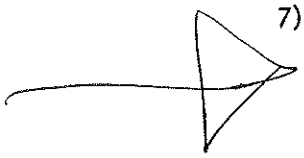
4) First Open House: The first session presented the results of the Existing Conditions analysis to the end of February. Invitations were circulated to over 30 agencies and community groups and other forms of notice were used. The session was open from 5 to 9 p.m. and involved displays and one-to-one discussions between project staff and residents.

5) Follow-up meetings: Four meetings were organized with BPAC, resident associations, community groups and business associations to follow up the open house. The BPAC session was reasonably well attended, but despite personal invitations having been sent up to a month ahead of time, the response to the invitations was poor, with only four people present at one meeting, three at another and none at the last.



In addition, a special meeting was held with the Sandy Lake Residents Association. This was attended by some 50 people.

6) Second Open House: At the second open house, held in mid-June, we presented the results of the Impact Assessment in the same display/discussion format. This session was attended by over 50 people.



7) Follow Up: At express invitation from the Sandy Lake Ratepayers, we attended one of their regular meetings to further discuss issues of particular interest.

## B. Existing Conditions

Bedford is, in part, a suburban commuter town and in that sense it can be compared with other suburban areas in the region. The evidence suggests that since 1981, Bedford has continued to be one of the faster growing areas within the region. Bedford could be described as a more mature urban community than other suburban communities such as Sackville, Clayton Park, Forest Hills and Calby Village. It has a lower proportion of children and a

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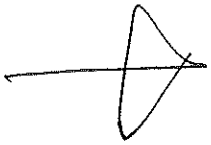

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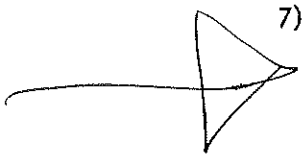


7) Follow Up: At express invitation from the Sandy Lake Ratepayers, we attended one of their regular meetings to further discuss issues of particular interest.

## B. Existing Conditions

Bedford is, in part, a suburban commuter town and in that sense it can be compared with other suburban areas in the region. The evidence suggests that since 1981, Bedford has continued to be one of the faster growing areas within the region. Bedford could be described as a more mature urban community than other suburban communities such as Sackville, Clayton Park, Forest Hills and Calby Village. It has a lower proportion of children and a

lower degree of home ownership (more apartments). Bedford, however, is different from all of the other communities in that it has its own developed economic base, both commercially and industrially. Even so, it is very much dependent upon forces outside its own boundaries. As the region grows, so will Bedford. Growth in Bedford from a development like Jack Lake will not necessarily all accrue to Bedford, some will "spill over" to other areas within the region.

1. Population and Demography

a) Population Change:

Bedford's population has been growing since 1976 much more quickly than the region as a whole and in excess of, or comparable to, other fast growing areas such as Sackville and the Cole Harbour area.

| | 1971 | %Change | 1976 | %Change | 1981 |
|---|---|---|---|---|---|
| Bedford Population | 4759 | 4.6 | 4977 | 36.2 | 6777 |

Bedford will almost certainly continue to grow at a considerably faster rate than the region because it continues to be perceived as a highly attractive residential community with good access to employment and retail centres, good services, and reasonable taxes. With this rationale and past performance in mind, a future growth rate of 3 to 5 percent seems likely, barring any major change in the growth rate in the region as a whole.

The result would be a population range in 1991 and 2001 as follows:

| | @3% | @5% |
|---|---|---|
| 1991 | 9433 | 10792 |
| 2001 | 12677 | 17579 |

b) Age Distribution and Migration:

A comparatively high proportion of families in Bedford are in the middle of their life-cycle compared to other suburban areas.

Indeed, as Table 5-1 shows, Bedford has a highly mobile population. Between 1976 and 1981, total in-migration was 2165, or almost 35 percent of the population.

**Table 5-1 Bedford in and out-migration compared to other suburban areas - 1976-1981.**

| | Population 5 and over | In Migrants | % of Pop | Out Migrants | % of Pop |
|---|---|---|---|---|---|
| Bedford | 6,295 | 2,165 | 34.4 | 1,075 | 17.1 |
| Halifax | 107,235 | 20,720 | 19.3 | 27,775 | 25.9 |
| Dartmouth | 57,420 | 13,635 | 23.7 | 17,720 | 30.8 |
| Sackville | 29,845 | 7,210 | 24.1 | 5,880 | 19.7 |

Source: 1981 Census

c) Occupation and Income:

Bedford has by far the highest average family income of the four areas at over $30,000 per annum in 1981, or about 15 percent higher than Halifax, the next highest.

d) Housing:

Home ownership is comparatively high in Bedford at 61.7 percent, but much lower than Sackville (86.9%). Similarly, the proportion of

apartments to ground-oriented housing types, such as single detached, duplex, and row houses, is much lower than Halifax, but much higher than Sackville. (See Table 5-2.)

**Table 5-2 Housing characteristics, 1981.**
**Bedford, Halifax, Dartmouth, and Sackville (County Subdivision C).**

| | Bedford | Halifax | Dartmouth | Sackville |
|---|---|---|---|---|
| Number of Dwelling Units | 2,235 | 43,780 | 21,165 | 9,380 |
| Type of Tenure | | | | |
| Owned | 61.7 | 39.7 | 48.0 | 86.9 |
| Rented | 38.3 | 60.3 | 52.0 | 13.1 |
| Type of Unit | | | | |
| Single Detached | 64.2 | 35.3 | 44.9 | 70.2 |
| Duplex, Row, etc. | 11.3 | 16.8 | 14.8 | 10.2 |
| Apartment | 24.5 | 46.9 | 38.5 | 4.5 |
| Mobile and Other | 0.0 | 1.0 | 1.8 | 15.1 |

## 2. The Bedford Economy

Unlike most suburban communities, Bedford has a highly developed and diversified economy, which is however, closely tied to economic activity and population growth in the rest of the region.

### a) Industrial Development:

Although numerous small industrial uses exist throughout the town, the great majority of activity is concentrated in the Bedford Industrial

Park and in and around the Atlantic Acres Industrial Park. Together, these parks have around 56 developed acres out of a total available of 232.

Manufacturing has gradually assumed increasing importance in Bedford's employment structure. Since 1975, there has been steady growth to the point where Bedford now has 361 manufacturing jobs distributed among 25 firms in 17 industries. Manufacturing now accounts for 9.5 percent of jobs in Bedford.

b) Office Development:

A combined estimate based on the Department of Development's Survey and Inventory of Commercial Space (1984), and the Town's Planning Department estimates, indicate a total of 165,000 square feet in Bedford in 1984. It is possible that as much as 25 percent of Bedford's office space is not accounted for in this estimate since it is inconsistent with the number of office workers in the town.

It is not surprising that the growth in office space has coincided with the development of Bedford as a retail centre since the two functions tend to be mutually supportive.

c) Retail Development:

Bedford's first shopping center, Sunnyside Mall, was built in 1969, Almost a decade later, the Bedford Place Mall was built resulting in an additional 237,000 square feet. The development of a further 60,000 square feet at Mill Cove in 1983-84 gives Bedford close to 500,000 square feet of retail space in shopping centres, or 6.0 percent of the space in the region in 1984. 78/79?

Around 30 percent of Bedford residents' expenditure on Department Store Type Merchandise (DSTM) is captured by Bedford stores.

Therefore, something like 87 percent of DSTM sales in Bedford are attributable to other areas, notably Halifax Mainland North, Sackville, and the remainder of the county. Moreover, some $10 million or more in food sales (about 60 percent of sales) is being drawn from outside Bedford itself, probably from the same market area as DSTM.

Despite its lack of a full line department store, Bedford clearly serves as something of a regional centre. Therefore, the key questions concerning Bedford's future retail growth center on the issues of overall growth in the region and whether that growth will continue to be distributed as it has in the past 15 years.

## 3. Land Use and Development

### a) Recent Development:

Up to the late 1970's, the land use pattern, like the population in Bedford was relatively stable. Some time after 1976, the growth pattern accelerated dramatically. Over a period of eight years, the Town has added over 1000 dwelling units, an addition of 40 percent.

By far, the majority of activity has occurred in the four planning areas (5,6,7 and 8) which comprise the core of the town (Figure 5-1). Planning areas 5 to 8 inclusive, have experienced roughly similar amounts of development and together account for 83 percent of building permits between 1981 and 1984.

The composition of housing in the town in 1980 was predominantly single detached units, with only apartments comprising a significant additional proportion.

The Town has been reasonably successful in attracting industrial development in the past decade, the bulk of which has occurred at and

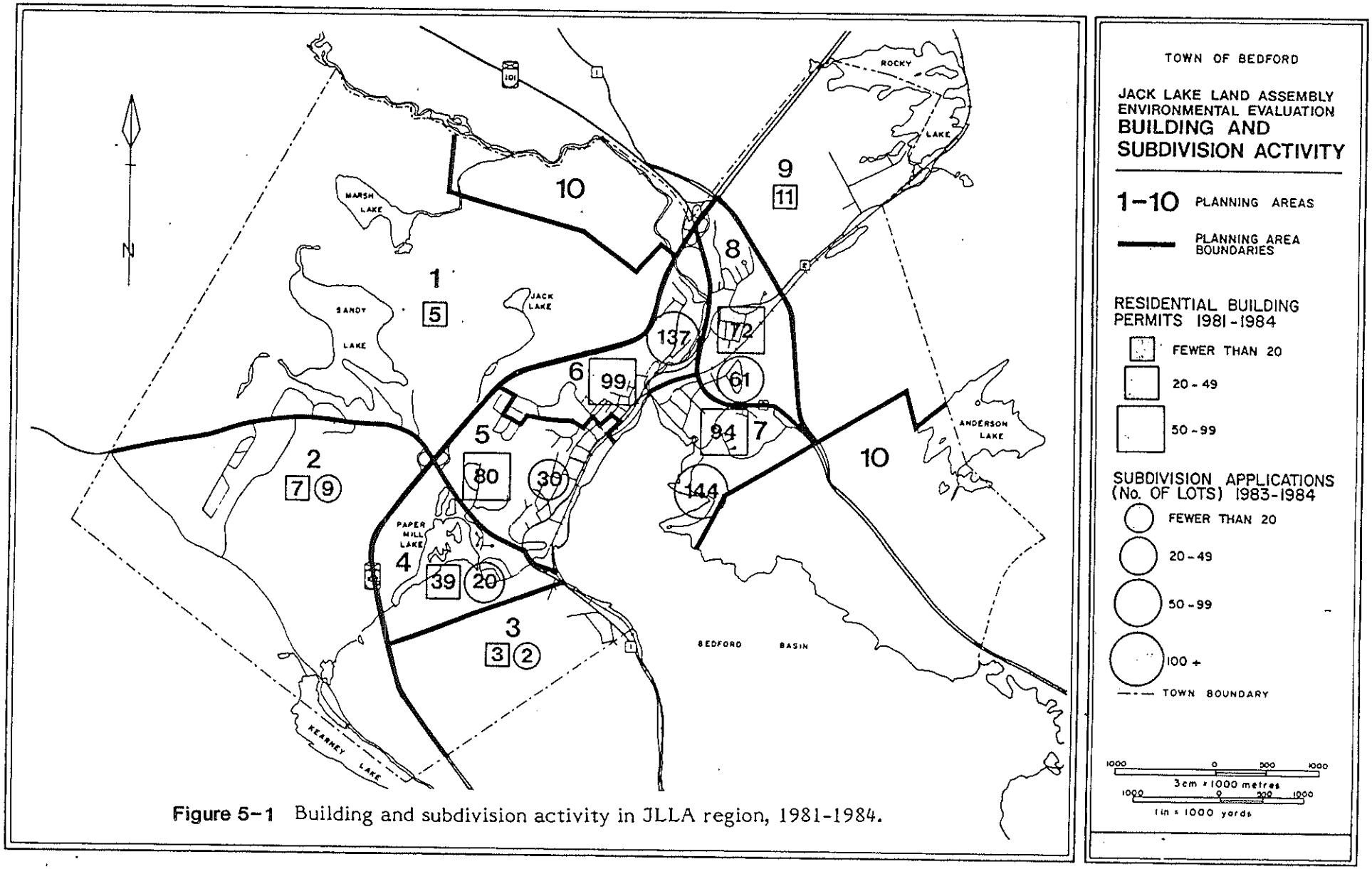



**Figure 5-1** Building and subdivision activity in JLLA region, 1981-1984.

in the vicinity of the Atlantic Acres Industrial Park. Generally, the Hammonds Plains Road area is becoming established as the Town's industrial centre.

Commercial development between 1969 and 1980 focussed on the Sunnyside area, where all significant office and retail development occurred. Since 1980, significant development has occurred at Mill Cove and future proposals for office, hotel, retail and Waterfront Development Corporation developments at Mill Cove seem to present a shift in the commercial centre of gravity.

b) Land Use and Development in the Vicinity of Jack Lake:

The area defined for purposes of this report as the vicinity of the Jack Lake land assembly is essentially equivalent to planning areas 1 and 2 (Figure 5-1). Although the area south of the Bi-Centennial is technically adjacent, the extreme boundary effect of the Highway creates such a strong separation that only the area north of the highway is discussed in this section.

The Hammonds Plains Road area is one of the most established and stable in the town and, unlike the great majority of the rest of the town, its character is essentially rural or suburban fringe. At incorporation, the area contained over 10 percent of the dwelling units in the town. Over 90 percent of these are single detached houses and 83 percent are owner occupied, well above the average for the town. Also, in 1980, 16 percent of residents, or double the proportion in any other area of the town, were life-long residents of Bedford.

The predominant development pattern is comparatively large lot, strip development, interspersed with pockets of more concentrated development, small scale rural industry, and larger scale industrial uses. The area is the poorest served in the Town with no schools or

developed recreation areas, no commercial services to speak of, few paved roads, and no sidewalks. The distinctive character of the area, combined with the strong boundary effect of the Bi-Centennial Highway, tend to create a community which is part of Bedford only in name.

Development in the Hammonds Plains Road area since incorporation has been comparatively strong on the industrial side, but minimal for residential.

The majority of the land in the area is undeveloped. Most parcels are in the range of 3 to 5 acres, are owned by private individuals and would be difficult to develop due to physical constraints such as bed rock, bog, and lack of ~~ae~~cess. Although there are one or two large parcels held by developers, there is no reason to anticipate residential development pressure in the Hammonds Plains Road area in the immediate future.

Industrial development is another matter. It would seem likely that this area will continue to develop as the primary industrial focus of the Town.

In the immediate vicinity of the Jack Lake site itself, there are very few land uses. The majority of the area is in small to moderate size (3 to 15 acres) vacant land parcels held by private individuals. For the reasons mentioned above, it is improbable that most of them will be developed, except perhaps as cottage lots.

4. Attitudes

This section deals with the attitudes of Bedford residents toward their Town in general, and towards future development and community services. Although some survey information is available, it is dated (May 1980), and the rest is based primarily on the views of selected individuals.

Bedford's paradoxical qualities already mentioned, lead to a set of attitudes which are equally paradoxical. The most striking thing about Bedford in view of its rapid growth and the very high proportion of new residents is the strong sense of community. What people like most about Bedford is "the community spirit, participation in directing their own affairs, and volunteer activities". The second most important set of "likes" (reported in the March 1980 "Bulletin") included "views of and access to the Basin, trees, semi-rural setting, hills, large lots, and large proportion of single family homes". A survey of residents carried out in May of the same year reported a generally positive view of growth. Forty percent of respondents viewed recent development as too rapid, while 53 percent thought it was about right and 7 percent considered it too slow.

In our recent discussions with a limited sample of residents, very few expressed the view that there should not be more growth and most of them were resigned to it. Many felt positive about continuing growth, but with the important proviso that it be carefully managed.

The major community amenity which Bedford residents seem to value most highly, is access to recreation facilities, particularly outdoor recreation. The 1980 survey reported that over 70 percent of residents wanted more neighbourhood green belts, public parks, and playgrounds. Over 80 percent wished to see provisions to ensure the protection and continued public access to lakes and watercourses in the town.

Attitudes toward residential development are generally positive, but with an important limitation. Large apartment buildings (over 24 units) were regarded by about 64 percent of respondents to the 1980 survey as being in an over supply in the Town. Almost 80 percent rejected the idea of allowing new homes on smaller lots, and close to half felt that even larger lots should be required.

There is a contradiction here as well. Large lot sizes are wasteful of land and make it more difficult and expensive to preserve public open space. Large lots also mean expensive housing, particularly with the land conditions in Bedford. Most of the individuals to whom we have talked recently were also concerned

about the affordability of living in Bedford for their children. Large lots and restrictions on multiple family housing types are inconsistent with this desire.

In general, the difficulties in interpreting the questionnaire results is that they gave little sense of trade-offs involved, especially fiscally, so it is hard to assess priorities. While one can conclude that Bedford residents would ideally like to have larger lot sizes, more green space, affordable mixed housing for their children, and a competitive tax rate, assessing trade-offs the majority would be prepared to make and in which area, are much more subjective judgements.

Attitudes toward commercial and industrial development are mixed. Over 89 percent of respondents to the survey were favourable to more industrial development.

There is more than one community in Bedford. The Hammond Plains Road community is probably particularly notable in this regard. Bedford is not really a semi-rural community, but the Hammond Plains Road area is. How this affects attitudes is unclear, but one informant expressed the view that Hammond Plains Road residents "don't really feel part of the town", a view which is not surprising given their distance from Town activities, the boundary effect of the Bicentennial and the more rural quality of the area. Residents of the area constitute something like 10 percent of the Town population, so their views are by no means inconsequential. New development in this area would have effects which could be viewed both negatively and positively by the residents. However, with respect to values for their rural environment, development would be negative. To the extent that they value better services, the opposite would hold true.

## C. Socio-Economic Impacts

The impact is assessed and desembled in the terms of the same categories previously covered in this section, i.e., Population Characteristics, Economy, Land Use Patterns, and Community Attitudes. In addition, the impact on the Hammond Plains Road area is also discussed.

Where possible, the effects have been quantified. It is not simple to assess the effects on an overall community that is an integral part of a surrounding region. The only certainty is that there will be some effects and a very high probability that they will be modest.

## 1. Population Characteristics

### a) Effects on Growth

The most obvious and fundamental impact which would arise from a Jack Lake development is the effect on population growth and the Town's overall size. In order to assess the effects of Jack Lake, we have made certain assumptions about projected growth in the Town, with and without the Jack Lake development.

The effect of Jack Lake with the most likely scenario or mid-range scenario is shown in Table 5-3. It can be seen that the rate of growth in the Town accelerates significantly, peaking in 1991 at over 10 percent, and falling more or less steadily until the turn of the century when it returns to levels consistent with recent experience. The rate of growth, however, may be less important than the population increment and the proportion of the Town's population accounted for by Jack Lake. From the outset, Jack Lake would have the effect of shifting the population increment upward to around 800, peaking at 1 300 in the mid 1990's. The annual increment would remain at 1 100 or more through to 2001, or drop after 1997 to the 600 person range. Ultimately, the population of Jack Lake would end up comprising from 34 to 38 percent of the total Town's population.

The final comment that should be made concerns the displacement effect of Jack Lake. It has been assumed that Jack Lake growth would be essentially incremental to "normal" project growth. Depending upon specific housing prices, as well as the perceived image and the amenity value of the development relative to competition in the Town, it is conceivable that some displacement could occur.

## TABLE 5-3

## ESTIMATED BEDFORD GROWTH FACTORS

### Without Jack Lake

| ear | New Units | Total Units | New Population | Total Population | % Growth | House Hold Size |
|---|---|---|---|---|---|---|
| 985 | 132 | 2 777 | 383 | 8 053 | 5.0 | 2.9 |
| 986 | 139 | 2 916 | 396 | 8 449 | 5.0 | 2.8 |
| 987 | 146 | 3 062 | 416 | 8 865 | 5.0 | 2.8 |
| 988 | 153 | 3 215 | 436 | 9 301 | 5.0 | 2.8 |
| 989 | 161 | 3 376 | 459 | 9 760 | 5.0 | 2.8 |
| 990 | 169 | 3 545 | 482 | 10 242 | 5.0 | 2.8 |
| 991 | 142 | 3 687 | 398 | 10 640 | 4.0 | 2.8 |
| 992 | 147 | 3 834 | 412 | 11 -52 | 4.0 | 2.8 |
| 993 | 153 | 3 987 | 428 | 11 480 | 4.0 | 2.8 |
| 994 | 159 | 4 146 | 445 | 11 925 | 4.0 | 2.8 |
| 995 | 166 | 4 312 | 465 | 12 390 | 4.0 | 2.8 |
| 996 | 172 | 4 484 | 482 | 12 872 | 4.0 | 2.8 |
| 997 | 179 | 4 663 | 501 | 13 373 | 4.0 | 2.8 |
| 998 | 187 | 4 850 | 524 | 13 897 | 4.0 | 2.8 |
| 999 | 194 | 5 044 | 543 | 14 440 | 4.0 | 2.8 |
| 000 | 202 | 5 246 | 566 | 15 006 | 4.0 | 2.8 |
| 001 | 210 | 5 456 | 588 | 15 594 | 4.0 | 2.8 |

### With Jack Lake

| ear | New Units | Total Units | New Populuation | Total Population | % Growth | House Hold Size |
|---|---|---|---|---|---|---|
| 985 | 132 | 2 777 | 383 | 8 053 | 5.0 | 2.9 |
| 986 | 139 | 2 916 | 396 | 8 449 | 5.0 | 2.8 |
| 987 | 146 | 3 062 | 416 | 8 865 | 5.0 | 2.8 |
| 988 | 153 | 3 215 | 436 | 9 301 | 5.0 | 2.8 |
| 989 | 261 | 3 476 | 789 | 10 090 | 8.5 | 2.8 |
| 990 | 284 | 3 760 | 862 | 10 952 | 8.5 | 2.8 |
| 991 | 362 | 4 122 | 1 124 | 12 076 | 10.0 | 2.8 |
| 992 | 367 | 4 489 | 1 104 | 13 180 | 9.1 | 2.8 |
| 993 | 413 | 4 902 | 1 166 | 14 346 | 8.9 | 2.8 |
| 994 | 437 | 5 339 | 1 239 | 15 585 | 8.6 | 2.8 |
| 995 | 381 | 5 720 | 1 098 | 16 683 | 7.1 | 2.8 |
| 996 | 392 | 6 112 | 1 186 | 17 869 | 7.1 | 2.8 |
| 997 | 424 | 6 536 | 1 270 | 19 139 | 7.1 | 2.8 |
| 998 | 377 | 6 913 | 1 117 | 20 256 | 5.8 | 2.8 |
| 999 | 417 | 7 330 | 1 241 | 21 497 | 6.1 | 2.8 |
| 000 | 372 | 7 702 | 1 110 | 22 607 | 5.2 | 2.8 |
| 001 | 380 | 8 082 | 1 132 | 23 739 | 5.0 | 2.8 |

This could have both positive and negative implications. It would reduce overall growth to more manageable proportions. But it would also delay the full integration of services within the boundary and it would mean that Jack Lake would comprise a larger proportion of the Town's population. Overall, however, (Table 5-4) indicates that even a significant degree of displacement would not dramatically affect the results of the incremental impact.

TABLE 5-4

ESTIMATED BEDFORD GROWTH FACTORS

Jack Lake Displacement Scenario

| Year | New Units | Total Units | New Population | Total Population | % Growth Without Jack Lake | % Growth Population with Jack Lake |
|---|---|---|---|---|---|---|
| 1985 | 132 | 2 777 | 383 | 8 053 | 5.0 | 5.0 |
| 1986 | 139 | 2 916 | 396 | 8 449 | 5.0 | 5.0 |
| 1987 | 146 | 3 062 | 416 | 8 865 | 5.0 | 5.0 |
| 1988 | 153 | 3 215 | 436 | 9 301 | 5.0 | 5.0 |
| 1989 | 196 | 3 411 | 604 | 9 905 | 3.0 | 6.5 |
| 1990 | 214 | 3 625 | 662 | 10 567 | 3.0 | 6.7 |
| 1991 | 322 | 3 947 | 1 012 | 11 597 | 3.0 | 9.6 |
| 1992 | 325 | 4 272 | 986 | 12 565 | 3.0 | 8.5 |
| 1993 | 369 | 4 641 | 1 043 | 13 608 | 3.0 | 8.3 |
| 1994 | 353 | 4 994 | 1 004 | 14 612 | 2.0 | 7.4 |
| 1995 | 291 | 5 285 | 846 | 15 458 | 2.0 | 5.8 |
| 1996 | 298 | 5 583 | 922 | 16 380 | 2.0 | 6.0 |
| 1997 | 324 | 5 907 | 990 | 17 370 | 2.0 | 6.0 |
| 1998 | 271 | 6 178 | 820 | 18 190 | 2.0 | 4.7 |
| 1999 | 305 | 6 483 | 928 | 19 118 | 2.0 | 5.1 |
| 2000 | 254 | 6 737 | 779 | 19 897 | 2.0 | 4.1 |
| 2001 | 256 | 6 993 | 785 | 20 682 | 2.0 | 4.0 |

Bedford has been described as being more "urban" than other suburban communities in the region and certainly more urban than a small town, despite lingering perceptions to the contrary. A transformation has occurred since the early 1970's, and all the evidence points overwhelmingly to its continuance. With the addition of Jack Lake, the Town would be half again as large in population by 2001, a fact which would probably contribute to the Town's

degree of urbanization. The incremental impact is however, unclear and the effects would be both positive and negative. Those that can be discerned and assessed are the subject matter of the balance of the findings on population.

b) Socio-Economic Profile

Bedford's socio-economic profile, as of the 1981 census, is heavily influenced by a very high proportion of both upper income families and individuals with high levels of education engaged in professional occupations.

Table 5-6 shows the basis for estimating the probable incomes of Jack Lake residents (based on 1984/85 incomes and house prices). Given the probable development costs on the site, it is likely that the predominant type will be the more expensive single family dwelling. If we assume that 40 percent of units are single family dwellings in the $120 000 range, 20 percent are single family at $100 000, 32 percent are ground-oriented multiples, and 8 percent being apartments (assumed average income $25 000), the average (1984) income in the development as a whole would be just under $43 000, or exactly the estimated average for Bedford in total.

Using income as a surrogate for other socio-economic measures, it seems likely that Jack Lake would attract families in similar circumstances to the average which now prevails in the Town.

c) Age Distribution

Bedford in 1981 had an age profile which was older than most suburban communities, but younger than the City of Halifax. Bedford is likely to maintain a younger profile than the CMA, but it too will exhibit a generally aging population.

The main factor working against the aging of a population is immigration or, more particularly, immigration of young families. As long as Bedford continues to grow to a rate in excess of the CMA, its population profile will age more slowly. Thus the effect of the Jack Lake development will be to

significantly offset the effect of the aging of the existing population. The magnitude of this offsetting effect will be determined, in part, by the extent to which new housing in Bedford accommodates young families.

## TABLE 5-6
## FAMILY INCOMES REQUIRED TO PURCHASE NEW HOUSING AT JACK LAKE

Assumptions:

- 25 year amortization period
- 10 percent downpayment
- Interest rates from 10 percent (1 yr) to 12 percent (3-4 yrs)
- Assessment at 100 percent of value
- Taxes at $1.50
- Utilities cost $1 500 per year ($1 200 for semi's and rowhouses)

**Single Family Dwelling**

| | $120 000 | | | $100 000 | | |
|---|---|---|---|---|---|---|
| Interest Rate | 10% | 11% | 12% | 10% | 11% | 12% |
| Mortgage Payments (annual) | 11 592 | 12 474 | 13 373 | 9 767 | 10 510 | 11 268 |
| Taxes | 1 800 | 1 800 | 1 800 | 1 500 | 1 500 | 1 500 |
| Utilities | 1 500 | 1 500 | 1 500 | 1 500 | 1 500 | 1 500 |
| Total | 14 892 | 15 774 | 16 673 | 12 767 | 13 510 | 14 268 |

Semi-Detached/Row Housing

| | $80 000 | | |
|---|---|---|---|
| | 10% | 11% | 12% |
| Mortgage Payments (annual) | 7 728 | 8 316 | 8 915 |
| Taxes | 1 200 | 1 200 | 1 200 |
| Utilities | 1 000 | 1 000 | 1 000 |
| Total | 9 928 | 10 516 | 11 115 |

At the 30% shelter to income ratio, the required family income to purchase each of these homes would range as follows:

| | | |
|---|---|---|
| $120 000 | Single Family | $49 640 to $55 576 |
| $100 000 | Single Family | $42 556 to $47 560 |
| $80 000 | Semi or Rowhouse | $33 093 to $37 050 |

d) Unit Type and Tenure

At present, something over 60 percent of housing units in Bedford are owner occupied and around 38 percent are rented. If all proposed developments go ahead as planned, and no other developments emerge, the effect would be to cause a slight downward shift in the proportion of singles and a corresponding upward shift in ground-oriented multiples. The overall effect is not significant. Bedford is likely to retain its predominant orientation toward low density, owner occupied housing.

Table 5-7 shows the effect when the Jack Lake development, at the estimated mix, is added on to existing and planned development in the Town. The overall effect is to reduce the proportion of singles slightly and the proportion of apartments somewhat more. Row housing and semi-detached would assume considerably more significance in the Town's housing mix. The overall effect of both planned developments and Jack Lake would probably be to shift

the tenure split toward a greater proportion of owner occupied dwellings, from the assumption that most ground-oriented units would be in freehold or condominium ownership.

TABLE 5-7
ESTIMATED CHANGES IN THE
TOWN'S HOUSING MIX

| | Bedford 1984 | | Planned Developments | | Jack Lake | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Single Family | 1 720 | 65 | 537 | 54 | 1 575 | 60 | 3 832 | 61 |
| Semi's or Row | 265 | 10 | 216 | 22 | 840 | 32 | 1 321 | 21 |
| Apart-ment | 660 | 25 | 228 | 23 | 200 | 8 | 1 088 | 18 |
| | 2 645 | | 980 | | 2 625 | | 6 240 | |

2. The Bedford Economy

The economy of Bedford is growing at a faster rate than the population. Commercial space has increased by around 170 percent, office space has grown by over 80 percent, and manufacturing related employment by 100 percent. Bedford's population, during the same period increased only slightly over 50 percent.

Industrial growth is driven almost entirely by the larger regional economy. Past growth has followed this pattern; most industry in the town is geared to serve the regional consumer market (dairy), the regional construction market (contractors, concrete products, metal doors and windows), and the regional business market more generally (printing, metal products). The office market has a strong regional component (government, consultants) and a trade area component (doctors, lawyers, financial services), of which part is undoubtedly

driven by Bedford demand. Finally, the retail sector is driven predominantly by trade area demand, with Bedford accounting for around 35 to 40 percent of the total.

The rationale for estimating the growth in Bedford's economy is set out in the Socio-Economic Appendix cited earlier. It is estimated that the average annual growth in each of the sectors would be as follows:

| | |
|---|---|
| Industrial: | 1 to 3 acres per year 1985-1991 |
| Office: | 18 500 to 27 000 sq.ft./year 1985-1991<br>10 000 to 20 000 sq.ft./year 1992-2001 |
| Retail: | 10 000 to 17 000 sq.ft./year 1985-2001 |

The office component is broken down into two periods since planned projects give a better basis for estimating to the end of the decade. Table 5-8 showns the effects of these estimates on total industrial and commercial space in Bedford, and on the rate of growth over the period. Over the same period, the population of the Town is projected to grow from 7 670 to over 15 000, or roughly 100 percent.

TABLE 5-8
ESTIMATED FUTURE GROWTH OF COMMERCIAL
AND INDUSTRIAL SPACE IN BEDFORD

| | Approximate in 1984 | Total Growth 1985-2991 | Total In Place 2001 | % Growth |
|---|---|---|---|---|
| Industrial Acreage | 60 | 32-48 | 92-108 | 50-80 |
| Office Space ('000 sq.ft.) | 160-190 | 450-752 | 610-940 | 280-390 |
| Retail Space ('000 sq.ft.) | 540 | 150-270 | 690-810 | 30-50 |

The effect of Jack Lake on these estimates is likely to be very modest. Since the growth which would occur at Jack Lake would simply go elsewhere in the region should the project not go ahead, no impact on industrial development can be anticipated.

Office and retail development are in a different category since they are driven more substantially by growth in the trade area and in Bedford itself. It is probably safe to say that Jack Lake would shift the above range of commercial growth toward the upper end of the estimate. If that population addition locates close to the centre of the trade area (Bedford), the probability of the high scenario occurring is correspondingly greater. Office development would be subject to a similar, but somewhat weaker effect.

In conclusion, it is likely that Bedford will continue to experience strong growth in its economy. The project at Jack Lake would have the effect of shifting the probabilities upward, but exact degrees are difficult to predict.

### 3. Land Use Patterns

Bedford has developed since 1976 in a compact pattern which has, in effect, infilled what was a relatively scattered linear pattern along the Bedford Highway, Highway 7, Rocky Lake Road and Shore Drive. This is shown in Figure 2-1. Virtually all the development has occurred inside the Bicentennial Highway, with the exception of industrial development which has focused in and near the Atlantic Acres Industrial Park.

The effect of Jack Lake in this context would be two-fold. By starting in the late 1980's, it would accelerate, by some five to ten years, the need to expand the boundary. Secondly, it directs the expansion north across the Bicentennial Highway, rather than resulting in any of the other options possible. It is important to discern the objective impact of these two events.

Most of the effects of an accelerated growth rate are dealt with in other sections (in particular, the fiscal impact). Otherwise, the main effect is likely to be on the utilization of existing hard services or the requirement to extend such services. However, under the present circumstances, this does not seem to be a major issue. Given current development proposals, most existing services will be infilled by the late 1980's in any event, and there is sufficient trunk sewer and water available along the Hammond Plains Road to accommodate the proposed development.

The most likely growth options are either towards Jack Lake or south towards the City of Halifax. The key question in assessing the impact of Jack Lake, therefore, is whether the expansion across the Bicentennial Highway would be more or less advantageous to the Town than a southward extension towards Halifax. Both options share similar characteristics. They are both more or less logical extensions of the Mill Cove development focus anticipated for the latter half of the 1980's. Both would be expensive to develop (due to rocky, hilly terrain), although this affects the developer rather than the Town. It is also worth noting, that the "Sewerage, Water and Storm Drainage Study" undertaken for the Halifax-Dartmouth Plan Review, rated both areas as being of equal developability based on topography, storm drainage, and access to trunk services.

With the Jack Lake development, the option exists to provide a second access across the Bicentennial Highway linking directly to Sunnyside. When such an access becomes available, Jack Lake traffic destined for Sunnyside or Dartmouth would be off-loaded from the Bedford Highway. For access to Halifax, the Jack Lake route is clearly the preferable option over a southward rate, because of its near-direct access to the Bicentennial Highway.

In one sense, the long-run balance between the two options, as far as integration with the Town is concerned, is largely dependent upon whether the Town's core actually shifts to Mill Cove. Although some degree of shift has occurred and is occurring, it is most likely that Sunnyside will continue to be a

major growth centre and that the Town will ultimately focus around both centres. In that case, the preferred option would be Jack Lake, which will have ready access to both centres.

4. Community Attitudes

This is the most difficult impact to measure, since the attitudes of Bedford residents toward a Jack Lake development, or any other development, are essentially personal. Whether impacts are viewed as negative or positive, either individually or together, is a question not amenable to objective assessment.

The residents do however, seem to feel very strongly that the profile of the community should not be too radically altered. What does Jack Lake do in this context? Given our suggested scenario, Jack Lake would be a generally low density, mixed income development, leaning toward the upper-middle income levels. Its residents would be young to middle-aged families. Most income earners would work in white collar and professional occupations. They would attend churches and schools, and join clubs and societies. They would work predominantly in Halifax and shop in Bedford, Halifax and Dartmouth. They would do what Bedford residents do now.

All other things being equal, Bedford will be much the same in 2001 with the Jack Lake development as without, except there will be more of it. Community cohesion may breakdown, but probably no more at 20 000 people than at 15 000. The semi-rural character will be compromised beyond recognition in any event, but the Town will still have access to Admiral's Rock, Paper Mill Lake and Sandy Lake. There will be more population pressure on community facilities, but more people to pay for them.

The one outstanding objective issue is the impact of growth on services and finances. Bedford residents understandably wish to avoid disruptive effects on Town services and negative tax consequences. Clearly, more services will be required to accommodate both the Jack Lake development and the Town's normal growth. Pressure will be placed on recreation and economies of scale

will be achieved in areas such as fire service and park development. The balance of advantages and disadvantages is very difficult to calculate.

The fiscal balance, as far as can be judged, will not be notably affected one way or the other. Even though residential growth will outstrip commercial growth, the net impact on expenses and revenues is estimated to be inconsequential. This is because Bedford's fiscal health derives more from its high average residential assessment than it does from its commercial/residential balance. Jack Lake, as anticipated in this Study, would not change this.

Finally, a comment should be made about the orderliness of growth and the timely provisions of services. Some residents, when asked about their concerns with a Jack Lake development, cited the growth of Sackville and the failure to provide services in line with growth. Oversights were mentioned, such as the failure to plan for the location of churches. These concerns are clearly pertinent to Jack Lake. However, they are more properly the subject of the mitigation phase of this study and will be addressed later in the document.

In the end, Bedford will grow in the next two decades and the only issue is whether the growth is reasonably paced and orderly. Jack Lake will almost certainly increase the pace of development, but there is no inherent reason why it should make it any less orderly.

5. Impacts on the Hammond Plains Road Area

Since this area is in the immediate vicinity of the JLLA, it is given special attention here.

It is possible that Jack Lake per se would not affect the area in a major way. The important thing is that such a development would bring with it a reorientation of the residential development boundary and of the growth patterns in the Town. The Hammond Plains Road area would begin to be more subject to urbanizing pressures. Many of the residents now enjoy the

advantages of a stable area, a small and close-knit community and relatively exclusive use of Sandy Lake. Obviously, urbanization of the general area would change this, but Jack Lake would be more of a catalyst, than a direct cause.

As proposed in the Concept Plan, the Jack Lake development would involve relatively little visual intrusion on the Smith's Road, Killarney Drive, or Giles Road communities. Nor would it intrude directly on Sandy Lake, since it is separated from the lake by land which is privately held.

There would undoubtedly be some traffic effects, especially in the Smith's Road area. Once the second access was built further up the Bicentennial Highway, traffic to all northern parts of the development would largely use the new access point, and some of the existing traffic at Hammond Plains would be drawn off.

More specific effects may be felt by a few Smith's Road residents depending upon which access scheme is chosen. One possibility discussed requires the acquisition of one dwelling unit, two vacant lots and parts of two occupied lots. An alternative scheme crosses the Department of Highway's right of way at the interchange, but it avoids any disruption on Smith's Road. None of the schemes envisions the direct use of Smith's Road as an access.

The Jack Lake development could have two effects on the park, both positive. Most importantly, cooperation between the developer and the Town might allow the road system to be designed in such a way as to provide access, which presumably would otherwise require upgrading of Smith's Road. Secondly, it would provide a real "market" and tax base to justify and support development.

There are other potentially beneficial effects of Jack Lake related to its urbanizing effects on the Hammond Plains Road area. The development will bring schools, recreation facilities and commercial services, all of which are non-existent, or virtually so at present.

At least two additional services can be directly attributed to Jack Lake. These are fire (which is dealt with under Fiscal Impact) and transit. It is likely that transit service would eventually be provided to the Jack Lake development. Although there is no reason to believe that the service would extend up Hammond Plains Road beyond the access point, the service would be accessible to residents in the immediate vicinity.

On balance, the effect of Jack Lake on the Hammond Plains Road can be described as neither negative nor positive, at least in objective terms.

## D. Mitigation Measures

Here the impacts were summarized under three general headings: Impact on the Town, Impact on the Hammond Plains Road Area, and Impacts on the site itself. The impacts and mitigating measures are dealt with in that order.

### 1. Impact on the Town

This general heading was further broken down into the following three other categories: a) Community Integration, b) Effect on Services, and c) Fiscal Impacts. The latter will be dealt with in the Fiscal Evaluation section of this report, which follows.

#### a) Community Integration

The rate of growth under the scenario described earlier will challenge the community's ability to handle growth. In light of similar cases, it should be possible. Sackville in the early 1970's experienced a greater growth rate.

The original size of the JLLA was planned at some 17 000 persons. The Concept embodied here envisioned a development population of approximately 9 000 persons. As a result of the development, is is doubtful that the

Town's cultural, commercial and government centres will change from Sunnyside and Mill Cove. It has been concluded that the size of the JLLA development overall will have a natural impact.

The socio-economic profile dictated by the likely development costs and the developers intention to sell lots at market value should be a positive feature of the development from the Town's perspective.

If Jack Lake residents are to have easy access to the Town and particularly to Sunnyside, a second access across the Bicentennial Highway will be important.

b) Effect on Services

Many services will grow incrementally to meet demand. In other cases, the regional nature of the services makes the impact difficult to predict. In still others, Jack Lake would create positive economy of scale effects.

o Fire

Generally, Jack Lake seems to have a positive effect since it would provide both the larger tax base and the geographical shift, which would facilitate the implementation of changes which appear necessary in any event. The larger population base in the Hammond Plains Road area and the new interchange on the Bicentennial would permit new facilities to be built in the Bi-Hi/Hammond Plains Road area. Secondly, the larger assessment base would help to support needed expansion in manpower and equipment.

o Recreation

Again, the impact is essentially positive. Bedford's ambitious recreation plans would be given a substantial fiscal boost. Moreover, the Sandy Lake Park would be facilitated in two important ways. Jack Lake would provide a ready market to spur development and thereby

encourage an earlier "return" on the Town's investment in the land. More importantly, the site is now very difficult to gain access to, a problem possibly resolvable by the design of the Jack Lake road system, if the Town and developer cooperate.

o Education

Jack Lake would add to an already confusing situation regarding the provision of school space, but it would not necessarily make it worse. New senior and junior high schools are likely to be required in any event, and Jack Lake may influence their timing and location. New elementary school facilities will be needed specifically for Jack Lake and they will be provided by the School Board as necessary, although there may be temporary inconvenience for Jack Lake residents if the development proceeds so slowly that a school on the site is not justified in the first few years.

o Other Community Services

Numerous concerns were expressed to us concerning the potential overcrowding of churches, recreation facilities and the like if growth is excessive. Clearly, this is something to monitor, but given appropriate planning measures by the Town, the developer and the varous community groups, there is no reason why this should be a problem.

2. Impact on the Hammond Plains Road Area

The largest and most enduring impact on the Hammond Plains Road area will be to spur urbanization. This would probably happen sooner or later, but Jack Lake will ensure that it is sooner.

Facilities on the Jack Lake site should be built so as to encourage and facilitate use by other area residents. This could include schools, recreation facilities and shopping facilities, to name the most obvious.

All measures should be taken to avoid the disruption of existing property on Smith's Road in gaining access to the JLLA. A related concern is traffic. The Jack Lake development will eventually overload an already congested Hammond Plains Road. This is another reason why construction of the second access is important.

Jack Lake might create a certain amount of visual intrusion and more use of the lake, but the effect of the Town park in this regard, will far outweigh Jack Lake with respect to impact on the Hammonds Plains Road area.

3. Impact on the Site

Since there is not population at present on the site, it is difficult to predict any real socio-economic effects. Nonetheless, one major concern seems best considered as an on-site impact. Various people expressed concern that inadequate attention would be given to space for recreation, schools, churches and commercial facilities. This is obviously a detailed design matter which the Town and the developer will have to sort out, but it is mentioned here because it was raised so consistently and should clearly be given some priority accordingly.

4. Mitigation

Our conclusion that the impact will be minimal is based on the assumed development scenario. Major deviations from the scenario in the size of the development, the pace of development, or lot prices could lead to significantly different conclusions. The areas requiring mitigation under the present development scenario are as follows:

- The most critical single factor affecting the relationship between the development and both the Town and the Hammonds Plains Road area is the second access across the Bicentennial Highway. The access should be built as soon as the road system in the development can be feasibly extended to meet it.

- The effect on Hammond Plains Road traffic will be mitigated eventually by the second interchange. In the meantime, an access option should be chosen which minimizes traffic effects. In particular, the developer and the Town should take all necessary measures to ensure that the Hammond Plains access does not disrupt any of the properties abutting or near Smith's Road.

- The site should be developed so as to integrate it into the Hammond Plains Road community. This could be encouraged by the construction of some community facilities close to the Hammond Plains Road, so as to facilitate access by existing local residents.

- The Town and developer should cooperate in designing the Jack Lake road system to provide access to the Town's park land on Sandy Lake.

- The Town and the developer should pay particularly close attention to the need for community services in the Jack Lake area so as to ensure the ready availability of conveniently located land for churches, parks, schools, corner stores and the like.

- The Town and the developer should establish a mechanism early in the next phase of the project to ensure regular briefings for Hammonds Plains Road area residents concerning the progress of the project and regular consultation to ensure that their concerns are given due consideration.

# VI ENGINEERING EVALUATION

## A. Study Approach

The engineering evaluation relied heavily on existing reports, as well as estimates and other calculations made from the Concept Plan. The engineering components covered in this evaluation included:

- Municipal Services: water, storm sewer and sanitary sewer services
- Traffic and Roads
- Noise

An analytical approach was used in evaluating the engineering components. It must be noted here, that the analysis is based on existing data and proposals for development, actual testing of the various components was of course not possible.

### 1. Municipal Services

a) Municipal Services:

Natural drainage areas for the sewerage and storm sewers were determined using existing topographic maps and compared to the availability of outlets. Water pressure districts within the boundaries of the site were prepared and compared to the servicing Master Plan of the Town of Bedford. Staging of infrastructure requirements was reviewed in conjunction with the phasing of the development as proposed in the Concept Plan. Unit costs for infrastructure estimates were obtained from the Spryfield Land Assembly project.

b) Traffic & Roads:

Traffic data were assembled from existing sources. As those reports were based on unrealistic assumptions (primarily related to future populations), they were used only for assessment of baseline conditions. Future traffic volume was extracted using revised population figures for the JLLA development, consistent by the Concept Plan.

Our assessment of the present and future access and egress problems for the site was also based on the same data, in addition to the present and proposed road configuration and traffic flow for the study area.

c) Noise:

To develop a noise forecast for Jack Lake, traffic data were obtained from the Department of Transportation (DOT). The DOT indicated that trucks, a major noise contributor, comprised from 10-15% of the AADT. Estimated average speed, roadway grade and traffic pattern data were also collected. Using the CMHC methodology which generates 24 hour averages, noise levels within 800-1000' of the BiHy were estimated. Noise forecasts were developed by applying the standard CMHC noise modelling procedure (CMHC, 1977)

4. Sources of Information

Background information concerning this undertaking was obtained from the following reports:

- Bedford Land Assembly Access Study for Canada Mortgage and Housing Corporation, CBCL Limited, November 1982;
- Integrated Servicing Study for the Town of Bedford, Underwood McLellan Limited, July 1984;

- o Origin-Destination Survey Results provided by the Halifax/Dartmouth Regional Authority (survey of 1981);

- o These sources were supplemented with interviews with staff of the Town of Bedford and the county.

## B. Existing Conditions

Detailed engineering descriptions are not possible within the time and dollar constraints of this study and are normally addressed during the predesign phase of development. The components mentioned under the Approach are covered in the following.

### 1. Regional Services (Water Supply and Sewage Treatment)

Bedford is supplied by water from the Pockwich System and adequate capacity for growth exists in both the supply and distribution system. Sewage treatment is provided by the Mill Cove sewage treatment plant and no constraints exist for future growth.

### 2. Local Services

a) Sanitary Sewers:

Two existing sanitary trunk sewers are available to serve the JLLA development. The first is a 450 mm diameter pipe that parallels Hammonds Plain Road and outlets into the Mill Cove pumping station and treatment plant. The second, a 1070 mm diameter pipe, follows the Sackville River and outlets at Fish Hatchery pumping station and then into the Mill Cove treatment plant. Flow measurements indicated that infiltration is in excess of the normally accepted amount. The Town and County are currently undertaking various programs to reduce the amount.

b) Water Distribution:

There are also two existing water supply pressure zones that could be used to service the Jack Lake development. The Meadowbrook High Pressure Zone could be extended to service the majority of the site. The lower elevation areas at the west and east ends of the site could be supplied through the Meadowbrook Intermediate Pressure Zone.

c) Storm Water Drainage:

The eastern portion of the site generally slopes towards the Sackville River, while runoff from the northern portion flows towards Marsh Lake. Jack Lake and its stream and the southwestern portion of the site both drain towards Paper Mill Lake.

During spring runoff and other periods of continuous wet weather, the culverts alone, and the stream from Jack Lake through the existing developments, operate at capacity.

The Sackville River and the little Sackville River have been designated as flood prone areas by the Canada-Nova Scotia Flood Damage Reduction Program. Any development of the watershed should be designed in accordance with the guidelines of this program.

d) Access/Traffic and Noise:

Access to the JLLA site can be provided from the Bicentennial Highway and Hammond Plain Road. The main issues are the high cost of providing the interchange and the type of configuration at the intersection of Hammonds Plain Road. The intended purpose, in addition to providing access to the JLLA development, is to provide a linkage between the existing developed sector of the town and the proposed JLLA development, and the future Regional Parks at Sandy

and Marsh Lakes, in accordance with the Town of Bedford Municipal Development Plan.

The present traffic volume for the Bicentennial Highway in the area between the Sackville River and HPR is about 15 130 (AADT two-way). Based on the Department of Transportation data, traffic volumes have grown at a rate of 5% so that by 2001, the AADT would reach 28 000. This projected volume is slightly more than 50% of the capacity for the Bicentennial Highway, a four-lane interchange expressway. The DOT indicated that trucks comprised 10-15% of the AADT. Without the development of Jack Lake, traffic generated noise at a distance of 30 to 90 metres from the center of the highway in 1984 would be 50-70 dBA, increasing to 55-75 dBA in the year 2001. Noise levels above 55 dBA are normally unacceptable for residential neighbourhoods.

## C. Engineering Impacts

### 1. Urbanization

Engineering undertakings and associated urbanization which have the highest impact potential are:

**Physical**

- water supply and distribution
- sanitary sewers
- storm drainage (major and minor system)
- construction (including storage & use of construction materials)
- transportation facilities

**Socio-Economic**

- costs of installation of infrastructure
- financial costs on existing systems.
- aesthetic degradation

These undertakings are examined in the balance of this section.

2. Physical Impact

a) Water Supply and Distribution:

The existing water supply and distribution system has adequate capacity to supply all water needed for the JLLA development. No impacts were identified here, except for construction activities which are covered later.

b) Sanitary Sewers:

The existing trunk sanitary sewer distribution system, pumping station and treatment plant have sufficient capacity to handle the JLLA development. There is an alarming amount of infiltration into the existing system. Any new system must be built to "high standards" with strict limits of infiltration. Infiltration tests should be performed on the 'as-built-new' system and remedial measures should be taken before the infrastructure is assumed, from the developer, by the Town of Bedford. Therefore the only impacts are those associated with construction of the sanitary system to serve the JLLA.

c) Storm Drainage - Major and Minor Systems:

Urbanization causes changes to the hydrologic cycle (Figure 6-1). The concept plan derived, has about 50% of the developable area left in a natural state. About 25% of the site will produce immediate runoff. This will change the hydrologic cycle for the three watersheds; Sackville River, Marsh Lake and Mill Pond.

The loading to the stormwater receiving areas will increase as a function of persons per hectare of land. If we assume a final population of 9,000 people, the approximate JLLA density would be 30 people per hectare.

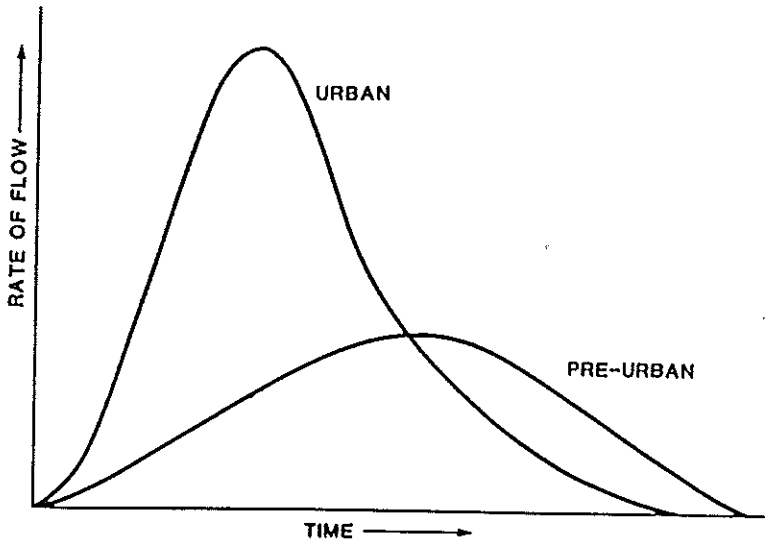



Figure 6-1 Effect of urbanization on surface runoff.

The new runoff flow volumes will be directly related to the amount of impervious area. For example, if we reach 60% imperviousness, after the construction of the last land block (2001), we would expect a total stormwater discharge of about 2.6 million $m^3$ of water.

The flow would be routed to the 3 major drainage basins, Marsh Lake, Sackville River, and Paper Mill Lake via Hammond Plains and Jack Lake. The largest proportion, i.e. 40-45%, of the flow would drain to Marsh Lake. The posibilities of minimizing this impact are discussed in the last part of this section.

d) Construction:

Erosion and sedimentation are natural processes, but the effects of such natural processes are accelerated through site construction. Such erosion is characterized by high rates of soil movement over a short time period.

e) Traffic:

The main issue with respect to the road system is the cost of providing the diamond-type interchange at the Bicentennial Highway. This interchange, although providing a key linkage between the JLLA site and Bedford, would lead to increased local traffic, additional local noise, and road realignments.

In terms of the connection of the "proposed access arterial" to Hammond Plains Road, the preferred scheme would be one in which this arterial would connect directly with an intersection formed by the Bicentennial Highway-Hammond Plains Road interchange, but not necessarily in the form of any of the alternatives described in the Bedford Land Assembly Access Study. A direct connection to the interchange has the advantage of providing a much higher capacity connection to the JLLA area and would not disrupt the existing residential development in the vicinity of Hammond Plains Road.

From the traffic volume information available with respect to Hammond Plains Road, the "proposed access arterial" could be developed in such a manner that it would have a relatively high capacity and, in fact, could accommodate more traffic than the section of Hammond Plains Road west of the interchange. For Hammond Plains Road (HPR), the base (1984) traffic volumes were estimated at 6 000 (AADT two-way). At a growth rate of 5.0% per year, the volume by 2001 will have risen to an AADT of 9 400; a 90% increase. Added to this background traffic would be the 2 000 - 3 000 AADT volume generated by the Jack Lake development, bringing the total projected AADT (9 400+2 500) to 11 900. During peak travel periods, the existing AADT creates congestion on HPR. The total future traffic, including the Jack Lake development, would create severe congestion for the HPR-BiHy interchange.

With the provision of traffic signals at the intersection of the "proposed access arterial" and Hammond Plains Road, the capacity of the "proposed access arterial" could be established, in part, by the timing of the signals, and partly, by the number of approach lanes and turning movements that may be involved. It would appear that, as a basic minimum, a volume of 700 vehicles per hour entering or leaving the JLLA area could easily be accommodated.

As an alternative to the control of traffic at this intersection by traffic signals, serious consideration should be given to a direct connection of the "proposed access arterial" into the Hammonds Plain Road interchange to form the main road alignment. This could be rationalized given the apparent, relatively low traffic volumes on Hammond Plain Road. This would allow an even higher capacity to be developed to serve the JLLA area.

The "proposed access arterial" road should be two lanes wide, regardless of the selected configuration. A more precise description of the intersection configuration should be established once the road pattern has been fixed.

We estimate that the development of the JLLA could proceed from Hammond Plain Road northerly to include all of the areas identified as 1 to 9 inclusive on the Concept Plan, before another outlet for the area is necessary from a traffic capacity standpoint. The only requirement in this regard would be to ensure that, at all times, there is an alternative route by which one can enter and leave the area in the event of an emergency condition, under circumstances in which the only available road connection might be obstructed. For example, the portion of the main spine road through the area north of parcels 1 and 2, is the only means by which one can reach the areas to the north. As the areas to the north develop, a second connection of a temporary

nature would be required to ensure that access to blocks 3, 4, 5, etc. would be possible by two routes.

f) Noise:

Noise is the odd component in that the impact does not stem from the JLLA, but rather the proximity of the Bicentennial Highway would affect the site. As would be the case with Jack Lake, the noise source would be vehicular traffic moving at high speeds on an expressway close to a residential area.

To develop a noise forecast for Jack Lake, traffic data were obtained from the Department of Transportation (DOT). The DOT indicated that trucks, a major noise contributor, comprised from 10-15% of the AADT. Estimated average speed, an important noise factor, on the BiHy is greater than 80 km/h. Using the CMHC methodology(1) which generates 24 hour averages, noise from 30-95 m of the BiHy was estimated to be between 70-74 dBA. At this distance, the development blocks near the roadway would all receive that level of noise.

g) Engineering/Socio-Economic Systems

It is assumed that the developer will pay the entire costs of the installation of on-site infrastructure and a "reasonable pro rate share" of off-site infrastructure improvements as a result of this project. The phasing scheme for the JLLA was presented in the socio-economic section. (The overall costs are summarized by year in Table 6-1).

## D. Mitigation Measures

a) General:

There are generally six premises from which the philosophy of residential development design is based:

- o population will continue to increase;
- o urbanization will continue to increase;
- o population density will continue to increase;
- o environmental problems will escalate with urban and economic expansion;
- o natural resources will continue to become more scarce;
- o urban and economic expansion and environmental concerns are not irreconcilable.

While the developer and the public sector share responsibility for improving the urban environment, the developer has a unique involvement, both at the macro (policy) level and the micro (project) level. The developer's role should not only be that of a participant in improving environmental quality, but by virtue of his profession, it should also be that of a catalyst. The developer has significant impact on the face of our land and carries the responsibility of structuring the habitat of many people over a long period of time with great investments of capital. In short, he must address and foster concern for the environment, and hold some conservation ethic.

b) Measures:

We recommend that environmental construction guidelines be prepared and used as part of the contract document with any developer or contractor.

c) Land Use Conflicts:

Informed land practices alone, will not prevent the conflict between the need for land to develop housing for a moderately increasing population and the preservation of the natural environment. Reforms in land regulatory policy will also help result in the resolution of land use conflicts.

Table 6-4 Approximation of yearly servicing requirements and costs, based on the proposed phasing scheme, for the Jack Lake Land Assembly, 1984 dollars.

| YEAR | LOCAL ROADS | | | | MINOR COLLECTORS | | | | MAJOR COLLECTORS | | | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rock Exc./Fill | | Servicing | | Rock Exc./Fill | | Servicing | | Rock Exc./Fill | | Servicing | | | |
| | Length (feet) | Cost @ $300/ft. | Length (feet) | Cost @ $320/ft. | Length (feet) | Cost @ $350/ft. | Length (feet) | Cost @ $365/ft. | Length (feet) | Cost @ $400/ft. | Length (feet) | Cost @ $406.70/ft. | Length (feet) | Cost* |
| 1989 | 1,175 | $ 352,500 | 1,175 | $ 376,000 | 2,050 | $ 717,500 | 2,050 | $ 748,250 | 2,100 | $ 840,000 | 2,100 | $ 854,070 | 5,325 | $ 3,888,320 |
| 1990 | 1,350 | 405,000 | 1,350 | 432,000 | 2,200 | 770,000 | 2,200 | 803,000 | - | - | - | - | 3,550 | 2,410,000 |
| 1991 | 750 | 225,000 | 5,050 | 1,616,000 | 400 | 140,000 | 2,550 | 930,750 | 1,500 | 600,000 | 2,825 | 1,148,928 | 10,425 | 4,660,678 |
| 1992 | 2,650 | 795,000 | 2,650 | 848,000 | 2,300 | 805,000 | 4,400 | 1,606,000 | - | - | 1,300 | 528,710 | 8,350 | 4,582,710 |
| 1993 | 250 | 75,000 | 3,400 | 1,088,000 | - | - | 1,000 | 365,000 | - | - | - | - | 4,400 | 1,528,000 |
| 1994 | - | - | 4,300 | 1,376,000 | - | - | 2,700 | 985,500 | - | - | - | - | 7,000 | 2,361,500 |
| 1995 | 950 | 285,000 | 3,850 | 1,232,000 | 500 | 175,000 | 2,600 | 949,000 | 500 | 200,000 | 4,750 | 1,931,825 | 11,200 | 4,772,825 |
| 1996 | - | - | 5,020 | 1,606,400 | - | - | - | - | - | - | - | - | 5,020 | 1,606,400 |
| 1997 | - | - | 3,770 | 1,206,400 | - | - | 4,000 | 1,460,000 | - | - | - | - | 7,770 | 2,666,400 |
| 1998 | - | - | 2,040 | 652,800 | - | - | - | - | - | - | - | - | 2,040 | 652,800 |
| 1999 | 2,000 | 600,000 | 2,500 | 800,000 | 1,600 | 560,000 | 5,900 | 2,153,500 | - | - | - | - | 8,400 | 4,113,500 |
| 2000 | - | - | 2,350 | 752,000 | - | - | 2,800 | 1,022,000 | - | - | - | - | 5,150 | 1,774,000 |
| 2001 | - | - | 2,350 | 752,000 | - | - | - | - | - | - | - | - | 2,350 | 752,000 |
| TOTAL | 9,125 | $2,737,500 | 39,805 | $12,737,600 | 9,050 | $3,167,500 | 30,200 | $11,023,000 | 4,100 | $1,640,000 | 10,975 | $4,463,533 | 80,980 | $35,769,133 |

*NOTE: Cost does not include contingency allowance.

A development which is sensitive to environmental and conservation factors will incorporate the following:

- Selecting open space with regard to enhancing the natural characteristics of the land, such as vegetation and water bodies.

- Devising mechanisms to protect natural beauty, while at the same time reserving certain areas for recreational use (distinguishing trails from viewing areas).

- Designing storm drainage facilities as an integral part of the development plan, with an effort made to locate open space near natural drainageways.

- To the extent possible, selecting open space from land lying between the direction of prevailing winds and the areas of human occupancy to foster temperature control, sound control, and clean air.

- Planting vegetation, if the land is devoid of it, in order to foster temperature and sound control, and clean air. Maintaining such vegetation by creating a perpetual organization, e.g., Jack Lake Recreation Committee, to take care of open space as mandated by restrictive covenants.

- Preventing erosion in areas with steep grades and those susceptible to erosion. Insuring that in the future, this land is used for purposes consistent with the preservation of open space.

- Designing drainage systems to minimize the possibility of soil erosion, siltation and groundwater loss and contamination.

- Keeping in mind that the Planned Unit Development principle clearly offers a framework for good design, environmental

concerns and energy conservation through the cluster concept. Furthermore, energy inefficient development patterns are outmoded and add to the cost of housing.

- To mitigate stormwater discharge contamination, we suggest that stormwater settling ponds be installed in front of the Jack Lake and Marsh Lake discharge points.

- Mitigation against excessive noise will have to be addressed as the land blocks near the BiHy are developed. Normally the installation of aesthetically pleasing noise deflectors (barriers) significantly reduces this problem.

- Applying good housekeeping practices to construction as well as the finished product.

- Being aware of water and air contamination, land despoilment, erosion and noise during construction.

- We suggest that an environmental protection awareness briefing be mandatory for each developer or contractor assigned to the project.

# VII FISCAL EVALUATION*

## A. Study Approach

There are two components comprising this section. One involved an inventory of all services provided by the Town and an assessment of future service requirements. The second component involved the development of a fiscal impact model, using DBase III software compatible with the Town's microcomputer.

The model incorporates five years of financial data and a series of relationships between revenues and expenses, and key indicator variables. The model runs from 1984 base population unit, street feet and pipe feet figures, and was input from growth rates and household size for each year. From this, it produces a baseline fiscal projection for Bedford, without the addition of Jack Lake. A separate Jack Lake program addresses yearly details on the number of various types of units, the household size and the number of street feet, as well as average market value for each type of unit. The results are then added to the baseline figures and the program is rerun to assess the effect of the Jack Lake development. All amounts refer to 1984 dollars.

## B. Existing Conditions

Bedford's fiscal situation and community services profile were examined within the context of a fiscal impact model, designed to assess the effects of expected growth levels.

a) Revenue:

Looking at the Town revenue, five main points emerge:

1. As a regional retail sub-centre, Bedford enjoys an unusually well balanced commercial/retail split, for what is essentially a suburban community.

* Material here was summarized from the Appendix document covering work by Cleland Dunsmuir and DeLCan.

2. Bedford has a remarkably high average assessment value per residential unit, relative to other municipalities in the region or province.

3. In its first four years of operation, Bedford has been able to maintain a very competitive tax rate, relative to surrounding municipalities.

4. Because Bedford's assessment revenue and level of services are both relatively high for a town of its size, provincial grants are not likely to play a significant role in the Town's finances.

5. The main reason for Bedford's advantageous fiscal position is its high per unit residential assessment.

Once various provincial transfers are allocated against the applicable cost-centre (e.g., the 75 percent cost-sharing for most Social Service costs is moved to the Social Service expense section as a set-off against the expenses), Bedford's 1984 revenues breakdown is as follows:

37% from residential assessment
23% from commercial assessment
9% from Business Occupancy
9% from the Environmental Health Levy
10% from Grants in Lieu
6% from Deed Transfer Tax
3% from the last installment of the Transitional
Remainder from miscellaneous items of under 1%.

b) Expenses:

Bedford's expenses by major category are:

| | | % of Expenses |
|---|---|---|
| o | General government | 9 |
| o | Protective services (police and fire) | 30 |
| o | Transportation (street and roads) | 14 |
| o | Sewage | 13 |
| o | Health and Social Services | 4.5 |
| o | Environment/Recreation | 5.5 |
| o | Schools and Education | 24 |

## C. Fiscal Impacts

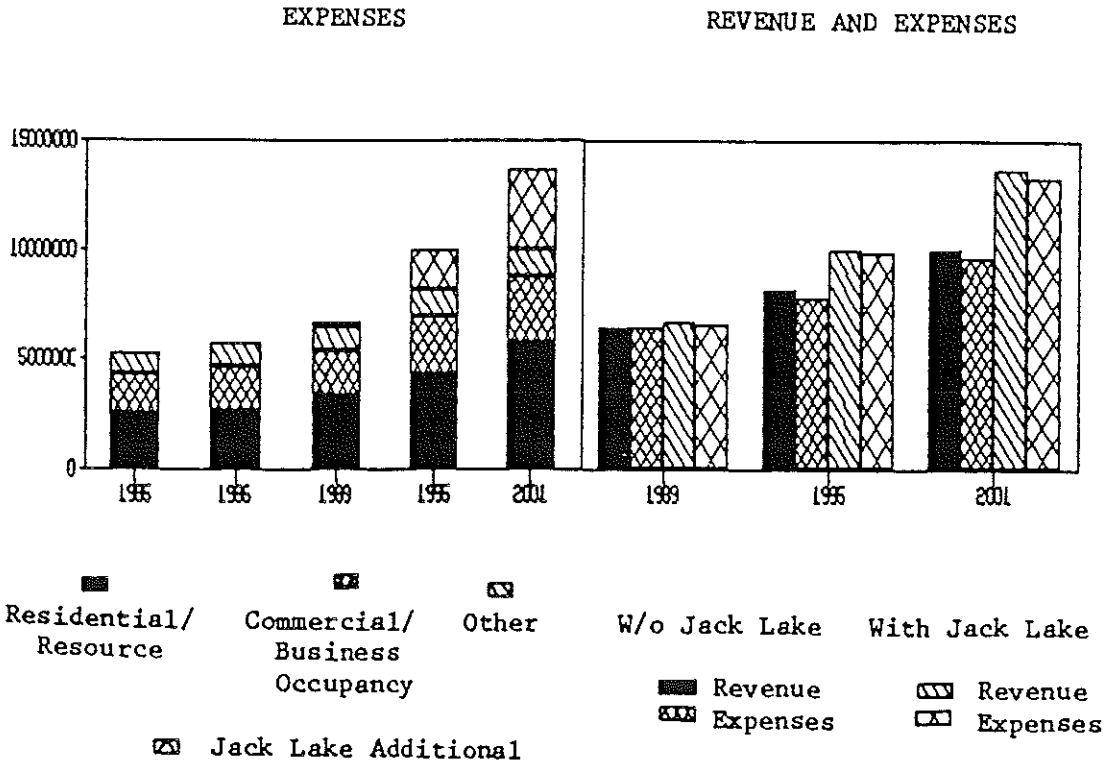
The Jack Lake development, as described in this report, seems to make very little substantive difference as far as the Town finances are concerned. We conclude that the market value of new units used in the scenario must be very close to the value necessary to maintain a balanced budget at the level of service projected. A different average market value for units at Jack Lake might produce quite different results.

In observing the existing fiscal situation, Figure 7-1 illustrates the relative impact on revenue and expenses that can be expected from the Jack Lake development.

Only three classes of expense item seem to call for specific comment: fire, recreation, and education. The main issue with respect to the fire station, is whether a new station or sub-station would be required on the Hammond Plains Road if Jack Lake did not take place. The fiscal impact model assumes that one would be necessary with a population of 12,000. Since this happens to bring the new station into existence in 1991, at which point Jack Lake would be in its third year of development with approximately 300 units requiring fire protection, the timing seems appropriate whichever approach is taken.

Figure 7-1

The Fiscal Impacts of the Jack Lake Development




Regarding recreation, it seems probable that Bedford will increasingly provide a sub-regional recreation centre, in the same way that it provides a sub-regional commercial center. The Range Park, and to an even greater degree, the proposed Sandy Lake Park, are likely to serve a population that bears little resemblance to Bedford's population profile or growth. This already appears to be true of the LeBrun Recreation Centre and the park at Paper Mill Lake. To the extent that this is true, Bedford is better off having regional growth take place within its assessment and tax boundaries, rather than just outside. The

addition of a large taxable population base will allow park development to proceed more rapidly and with less tax rate impact, than would otherwise be the case.

There still seems to be a general perception that greatly increased municipal and educational costs would represent the negative effects of residential development, but this dates from the period before the new provincial cost-sharing mechanism came into place. Any increase in the school population will not add to Bedford's mandatory assessment rate, although it may add to the "excess costs" assessment. However, since the level of excess funding is agreed to by the municipal councils involved, it is an impact that remains largely under Bedford's control.

**D. Mitigation Measures:**

From the earlier sections, we draw the general conclusion that the Jack Lake development will have a number of major effects, but their extent and whether they are negative or positive is often difficult to determine. Particular effects on the immediately adjacent area are easier to identify, but still difficult to describe objectively as either negative or positive.

Our conclusion that the impact would be minimal is based on the assumed preferred development scenario described earlier. Major deviations from the scenario in the size of the development, the pace of development or lot prices could lead to different conclusions. In order to mitigate significant realignments of the Town's social and economic path, we suggest that deviations from the proposed development scenario should be carefully examined and assessed in terms of the impacts discussed in this section.

The Jack Lake site is unique in that the developers are public agencies rather than private companies. CMHC and the Department of Housing have agreed that the emerging Jack Lake Community, and thereby the Town of Bedford as a whole, will share in the net revenue generated by the development, in order

# VIII RECOMMENDATIONS

A number of mitigating measures have been set out for the major components studied in this assessment, i.e., **Environmental, Socio-Economic, Engineering** and **Fiscal**, under each of the sections devoted to those components. **The first recommendation would then be that these mitigation measures be adopted by the Federal-Provincial partnership in consent with the Town of Bedford. Once adopted these measures should be carefully followed in developing the JLLA.**

To determine actual environmental impacts and to ascertain the validity of the mitigation measures, it is important that a monitoring program be set in place. Once development is underway a monitoring program should include the following:

## A. Natural Environment

A systematic, ecologically focussed, monitoring program (as described in the following sections) to be carried out for at least the first three years of construction, is recommended. The program should concentrate on each of the major, environment components dealt with in this assessment, i.e. bedrock, soils, water, vegetation, and wildlife.

After that period, a comprehensive review of the available data and environmental changes should take place. This sequence of activities would yield a comparison of what was projected versus what actually occurred, as well as provide a check on the effectiveness of the suggested mitigation measures. Should the three year review reveal little change, sampling effort could be relaxed. We urge that such a comprehensive review take place every three years. An environmental protection plan and specifications could be drawn up from each review.

What is most important is that a systematic monitoring and sampling program be continued for at least two years after the last land block is developed. If

considerable environmental effects are observed during this initial period, then further mitigation measures could be incorporated to minimize the overall impact of the development.

1. Erosion Control

In addition to the basic principles of limiting the extent of exposed soil and controlling surface runoff as much as possible, the following mitigative actions are recommended.

- Major construction of roads and land clearing should be carried out during the drier periods of the year.
- All roads should be paved, culverted and curbed as soon as possible, after installation of piped services and storm drainage infrastructure and prior to home construction.
- After construction of individual homes, landscaping and sodding should be implemented before the next rainy season.
- Design storm drainage systems to accommodate increased runoff and sedimentation conditions, caused by changing vegetation cover and topography during and after development.
- Surface storm drainage corridors should be well-vegetated, and steep drumlin slopes should be sodded and equipped with gabion sediment traps to reduce flow energy.
- All storm runoff corridors to the lakes should be equipped with sediment traps, energy dissipation (rip rap) and a program of monitoring and maintenance.
- Minimize the extent of exposed soil control by contract stipulations that specify the maximum area of unprotected soil that can be exposed at any one time.

- During construction, use materials from the project (brush, logs, chippings) to control erosion, filter sediment and serve as mulch. Use adaptive mulches to the maximum consistent with the erosion hazard. Apply mulches as soon as possible in the construction sequence, using proven anchoring methods. Anchor hay or straw into the soil, especially in areas of high winds. Seed and mulch by segments of high cuts and fills. Where possible, incorporate amendments into the seed bed before seeding and mulching.

- Where possible, utilize the green areas and flat barren areas to dissipate channel flow into sheet flow prior to runoff entering the lakes. This will provide an effective, long term sediment trap.

2. Water Resources

Additional groundwater monitoring stations will be needed for reliable long term monitoring of urban impacts on the groundwater flow system underlying the overall JLLA. While the present distribution of piezometers may be adequate for the monitoring of groundwater conditions on a local basis, some of these will however, likely be lost during construction and/or because of vandalism.

To monitor groundwater impacts on a regional basis, the following program is suggested:

a) Selected shallow and deep domestic wells at the Smith's road access, the DND drilled well east of the site and a domestic well south of Highway 102 in Basin View Subdivision should be monitored. Borehole N-3 east of area 130 may be a suitable monitoring station for the shallow bedrock downgradient of the development.

b) Groundwater samples should be collected quarterly for the first year and then annually thereafter; with major program review every three years.

c) Annual samples should be analyzed for general chemistry and metal scans. All samples should be filtered to 45 microns in the laboratory

to maintain consistency. Interim samples should be analyzed for the basic indicators of urban pollution (streptococcus bacteria, total and fecal coliforms, sodium, chloride, sulphate, alkalinity, pH, ammonia and trace metals).

Surface water monitoring should be continued for the four study lakes and two outflow areas at the present stations, for the following parameters: (quarterly during active construction phases and annually thereafter, with major a program review every three years).

a) general water chemistry at all stations
b) selected metals (e.g., aluminum)
c) chlorophyll a concentration
d) total and fecal coliforms
e) oxygen/temperature profiles

All sampling and analysis methodologies should be kept consistent with those detailed in this study, and all water chemistry samples should be analyzed by the Environmental Chemistry Laboratory at the Victoria General Hospital. The focus here should be on monitoring the littoral zooplankton, since the littoral zones are the most sensitive in the study area.

The following specific mitigation actions are recommended for the control of both surface and ground water contamination.

- Careful design of storm drains should be implemented to divert all runoff away from the lake. Drainage from the Jack Lake watershed may be conveyed to Highway 102 along the lake outfall stream.

- All roads should be curbed and paved, such that salt runoff is carried away via the storm drainage system.

- Where possible, all drainage should be diverted towards the Sackville River via suitable storm drainage structures to prevent salt stress on Paper Mill, Jack and Sandy Lakes. The Sackville River drains directly to Bedford Basin, and is already stressed by slat runoff from Highway 102, Bedford and Sackville.

- Design of road beds for reduced de-icing requirements (eg. minimize steep slopes to intersections) and better collection and disposal of salt runoff.

- Use salt tolerant grasses and trees along main roadway to reduce overall vegetation kill and improve aesthetics.

- Where significant sulfide mineralization is exposed, steps should be taken to cover the mineral zone immediately with clean, impermeable glacial till (drumlin till) or a suitable material (clay, portland cement, asphalt).

- From major road cuts, exposed mineralized faces should be covered with glacial till or an alkaline cement to prevent oxidation. An alternate method would be to emplace carbonate fill downgradient of the potential acidic runoff to neutralize acid until weathering has occured.

- Proper construction of sewerage services should minimize contamination of groundwater and associated surface water resources.

- Any gasoline or service stations should be sited in areas where major product spills would do the least damage. Sites within the Jack Lake watershed and immediately adjacent to Sandy Lake should be avoided. In addition, avoidance of areas of thin overburden cover where the migration contaminated water into fractured bedrock could occur, is recommended.

3. Fish Resources

- Since there is no creel census data available, the Province or the Department of Fisheries and Oceans should undertake such census to establish base data for this resource.

- In the future when approximately 50% of the JLLA is occupied, a second survey should be undertaken in conjunction with any other fisheries monitoring programs.

## B. Socio-Economic Environment

Monitoring is recommended within the three general areas discussed in previous sections of this report namely community integration, effect on services and fiscal finance.

The economic model we have created was designed to be used as a predictive tool in an iterative fashion. We suggest that Town planners monitor the progress of the development and its impact on Bedford by annually running the model with updated baseline conditions obtained from town records. In this way, past prediction will be validated and improved forecasts will evolve. Forecast could then be used to modify housing type mixes in future JLLA development blocks to meet future demands. In other words, we are suggesting that the fiscal model presents the opportunity for "real-time" fiscal and land use planning (into the future) for Bedford.

Any proposed modification to the phasing plan and housing mix (as described in this report) must be evaluated in terms of ecological as well as socio-economic impacts.

As part of an integrated monitoring scheme, we urge that the three-year progress review suggested for the bio-physical component be conducted jointly with a socio-economic assessment.

Later, community groups in the JLLA development could be surveyed on their awareness of the monitoring program and their awareness on the effectness of an environmental sensitive community and its benefits to the rest of Bedford.

The following mitigative actions are recommended for the control of socio-economic impacts as previously identified.

- The second access road across the Bicentennial Highway should be built as soon as possible to reduce the pressures of development upon the Town and the Hammond Plains Road area.

- Prior to construction of the second interchange, an access option should be chosen which minimizes traffic effects. In particular, the developer and the Town should take all necessary measures to ensure that the Hammond Plains access does not disrupt any of the properties abutting or near Smith's Road.

- The site should be developed so as to integrate it into the Hammond Plains Road community. This could be encouraged by the construction of some community facilities close to the Hammond Plains Road so as to facilitate access by existing local residents.

- The Town and developer should cooperate in designing the Jack Lake road system, specifically to provide access to the Town's park land on Sandy Lake.

- The Town and the developer should pay particularly close attention to the need for community services in the Jack Lake area, to ensure the ready availability of conveniently located land for service facilities.

- It is particularly important that the Town and the developer establish a mechanism early in the project to ensure regular briefings for Hammond Plains Road area residents concerning the progress of the project and regular consultation to ensure that their concerns are given due consideration.

## C. Other

There will be a number of opportunities in the JLLA development to foster an environmental sound and sensitive community. Some that were discussed during the study process are worth highlighting as recommendations:

1) Convenants placed in the land deeds covering tree cutting, lot grading, tree planting, erosion control, and lot landscaping are some common restrictions that should be used to help the individual homeowners protect the natural environment.

2) The Town of Bedford, through its recreation department, could utilize many of the open space areas shown in the Concept Plan as environment interpretive areas, thus increasing the awareness of the importance of the natural environment of the community.

3) Marsh Lake, on the JLLA site could be readily connected to the new Sandy Lake park site acquired by the Town thus extending the environmental sanctuaries on the JLLA to the rest of the community. This would represent an innovative approach in developing the areas surrounding Jack Lake, and in leading to the establishment of park areas around Marsh and Sandy Lakes.

4) The Marsh Lake area on the JLLA site could become a nature conservancy. Such a use would be beneficial both to Bedford and to the JLLA development itself.

5) To reduce or even avoid some of the traffic impacts which were outlined in the preceeding, the traffic engineering issues should be addressed and studied through a concerted approach between the partnership, the Town, and the Provincial Department of Highways.

6) The effects of urban development on the physical environment has been assessed in an ad hoc manner by various agencies. There is a tremendous opportunity for resource managers (Environment Canada,

NSDOE) to undertake a long term research project to study, in definitive terms, the long term quantitative and qualitative impacts of urbanization. It is therefore recommended that the joint venture partnership initiate discussions with Environment Canada and NSDOE to install a permanent, groundwater monitoring device, rain water level gauges on the JLLA, and instantaneous flow gauges on the various tributaries within the project area.

With such data, a groundwater-lake model could be coupled with water quality and biotic responses for Jack Lake and calibrated and verified with monitoring data. This would be a first for urban development and could serve as a general reference for urbanization impacts and their assessment and mitigation. Alternative mitigation measures could be tested for environmental and cost effectiveness prior to implementation.

7) We recommend that the fiscal economy model be used by the Town at least annually to examine the incremental effects of the JLLA on the Town. Results from these model "runs" should be discussed with the Partnership since they may influence the future direction of the JLLA development.

8) This environmental impact evaluation document be used as a supporting reference document for the various processing steps which are legislated for this type of urban land development. As a part of that process, a "stormwater management plan" should be developed which "sizes" and "costs" the various facilities to protect the existing receiving waters from the quality and quantity of impacts. Computer models which can assist in the preparation of this plan should be examined.

9) One of the significant aspects of the proposed development of this site is the sharing of net project revenues with the Town of Bedford for the purpose of making community facilities available on the site of all residents of Bedford. CMHC and the Department of Housing should

open discussions with the Town of Bedford regarding the Terms and Timing of this sharing of net revenues.

10) Finally, we recommend that the entire mitigation/monitoring program be reviewed at a joint ecological-socio-economic exercise every three years. This would be in addition to the monitoring during the first three years as discussed in earlier.