FINAL REPORT
ENVIRONMENTAL ASSESSMENT REPORT
HIGHWAY 107 EXTENSION: DARTMOUTH TO SACKVILLE

Project No. E-346

P. LANE AND ASSOCIATES LIMITED
Environmental Consultants

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prepared for

Nova Scotia Department of Transportation and Communication
Environmental Assessment Committee
Mr. Ken O'Brien, Chairman

prepared by

P. Lane and Associates Limited
in conjunction with:

ARA Consulting Group
Davis Archaeological Consultants
Groundwater Technologies Inc.
UMA Group

June 5, 1991

EXECUTIVE SUMMARY

The extension of Highway 107 from Dartmouth to Sackville proposed by the Nova Scotia Department of Transportation and Communications (NSDTC) is a Class II undertaking and therefore requires an environmental assessment report. This report presents the results of the assessment conducted by P. Lane and Associates Limited, in conjunction with ARA Consulting Ltd., Davis Archaeological Consultants, Groundwater Technologies Inc., and the UMA Group.

The assessment includes a description of the reason for the undertaking and alternatives to the undertaking, as well as potential environmental impacts. The reason for the undertaking is to extend the existing controlled access Highway 107 from Highway 118 to Highway 102 at Bedford/Sackville with connections to Burnside Drive and Cobequid Road. The highway should provide welcome relief for commuters between Dartmouth and Sackville and allows for further expansion and inter-connection of the Bedford, Sackville and Burnside Industrial Parks.

This expansion is currently hindered by traffic congestion and limited access to 100-series highways. The highway would also allow for integration of the Metropolitan Area, making it more attractive for outside developers and business interests. The highway would decrease the amount of truck traffic on Rocky Lake Road, which passes through a residential area. Highway construction will take place in five discrete stages so that the length of the alignment under construction during any one phase is short. The study area for the assessment is an area within 500 metres (1640 feet) of the proposed highway alignment.

The study included assessment of social, economic, cultural, physical, and biological impacts. The assessment also included a public scoping exercise to identify public concerns about the project. From public concerns and biophysical investigations, we produced a list of Valued Environmental Components (VECs). The interaction of each project activity (i.e., clearing, grubbing, etc.), with each environmental component was investigated in order to determine significant impacts of the project.

A number of environmental impacts were identified as significant. Measures to mitigate or avoid the impacts were presented, and the residual impacts (impacts remaining after mitigation) were

described. The major potential impact to lakes and streams in the area is erosion and sedimentation, which will be mitigated by erosion control techniques presented in the report. Another potential impact on lakes and streams is acidic drainage from acid-producing bedrock. Samples of rock in the study area showed that the sulphide content is too low to consider them acid producing. Because of the severity of the impacts of acid drainage, NSDTC will test the bedrock in areas to be blasted or excavated to determine their acid-producing potential before construction, so that the impacts can be mitigated.

Because the study was performed during the winter months, assessment of impacts to flora and fauna was based on literature review, interviews with area naturalists, and field visits to examine habitat types and forest associations. The VECs identified were the Whip-poor-will, which has been observed to nest in the Juniper Lake area, the Black-throated Blue Warbler, from the same area, and American Beaver in the Sucker Brook wetland. The Sucker Brook wetland was also identified as valuable habitat for wildlife that will be affected by the undertaking. It was recommended that summer surveys be completed to identify the present distribution of Whip-poor-will and any other rare plants and animals occurring in the area and that an environmental management plan be developed for the protection of any rare species found. NSDTC has agreed not to begin construction of Phase 1 during the 1991 breeding season as a mitigative measure for Whip-poor-will, should they be present. For the Sucker Brook wetland, a short bridge crossing and construction of a dam and sluice at the outflow to mimic beaver activities were recommended. An environmental management plan should also be developed for this area. The summer surveys should be completed by early August so that their results can be included in the Minister's decision concerning the environmental assessment.

Socio-economic concerns included noise and safety impacts on Charles P. Allen High School in Bedford, impacts on land designated as Regional Park Land near the Highway 118 Interchange, and the amount of land that will be landlocked near this interchange. It was suggested that the highway be rerouted to go away from the high school. This route was considered at one time, but it will be necessary to determine the feasibility of acquiring the land before this alternate can be seriously considered. Other socio-economic concerns included areas of access and the design of some interchanges.

No archaeological or cultural VECs were identified in the study area.

ENVIRONMENTAL IMPACT ASSESSMENT FOR HIGHWAY 107 EXTENSION, DARTMOUTH TO SACKVILLE

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1.0 INTRODUCTION

1.1 Background to the Undertaking

The Nova Scotia Department of Transportation and Communications (NSDTC) is proposing construction of a new controlled access, four-lane, divided highway which will extend Highway 107 from Highway 118 to Highway 102 with connections to the Burnside Industrial Park (at Burnside Drive and Akerley Boulevard), the Bedford Industrial Park (at Duke Street) and the Sackville Industrial Park (at Glendale Drive). The proposed highway will also connect with Cobequid Road in the area of First Lake Drive. Direct connections to the highway are proposed at Highway 118 (Portobello Interchange), Akerley Boulevard, Burnside Drive, Bedford Industrial Park (Duke Street), Highway 102 and Cobequid Road (at the terminus of the proposed Second Lake Connector). An extension of Duke Street and Glendale Drive is part of the overall proposal. This extension will link the Bedford Industrial Park with the Sackville Industrial Park and will also provide access to Highway 102. The general orientation of the proposed highway is shown in Figure 1-1. The high capacity highway will generate direct savings in time and fuel for both truckers and commuters.

In total, about 80 kilometre-lanes of roads are proposed for construction. The construction of the proposed Highway 107 extension will be completed over five stages (each stage is described in detail in Section 2.6). Phase I is expected to begin in September 1991, following completion of the environmental assessment. Construction of all five stages is expected to take between eight to ten years and is estimated to cost $65 million (preliminary cost estimate provided by NSDTC). Funding for the project is to be provided from the Transportation Trust Fund, a fund that was established by the Province for the construction of 100-series highways.

1.2 Framework for the Assessment

Regulatory Requirements for Environmental Assessments

The *Regulations Pursuant to the Environmental Assessment Act of Nova Scotia* (RSNS, 1990) stipulate that "the construction of more than one kilometre of a road or other public road network

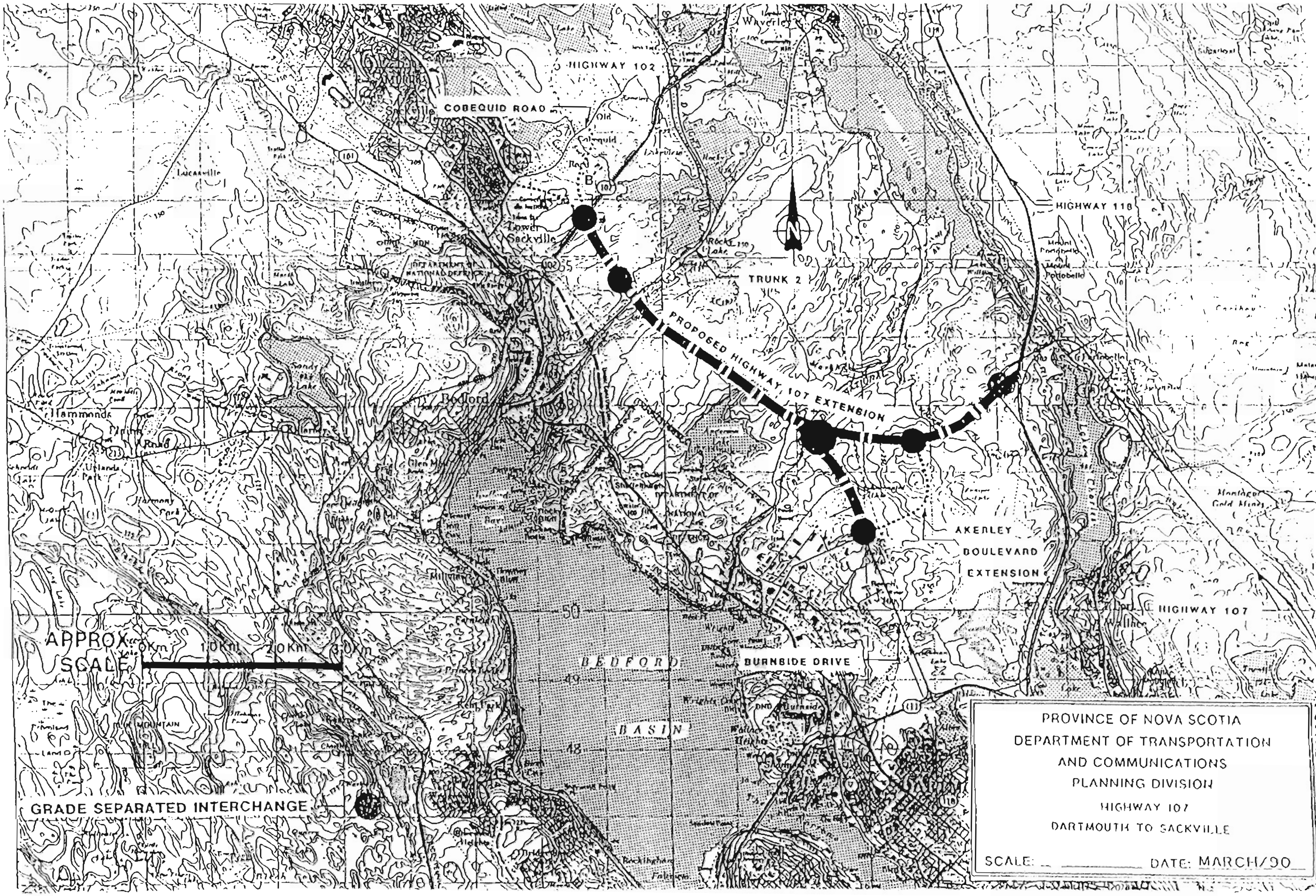


Figure 1-1. Orientation of the proposed Extension of Highway 107

designed for four or more lanes of traffic" is a Class II undertaking and as such requires an environmental assessment report, and that the assessment process shall include public consultation. The regulations require that the project be registered with the Nova Scotia Department of the Environment (NSDOE), and that the registration document contain certain items, such as size, scope, and location of the proposed undertaking, any known public concerns, anticipated environmental effects, project schedules, and land use in the area of the undertaking. The registration document for the Highway 107 Extension, dated May 8, 1990, is shown in APPENDIX A. Within seven days of the registration with NSDOE, the proponent (NSDTC) must publish a notice of the registration in local newspapers. Within 30 days of notifying the proponent that an environmental assessment report is required, the Minister of the Environment must furnish the proponent with draft guidelines for requirements for the report. These draft guidelines list the various parts of the assessment to be included, such as a complete description of the project activities and scheduling, a description of the existing environment, and predicted environmental impacts of the project. These draft guidelines are available for public review, and the final guidelines are also provided to the public. Notification of the availability of the final guidelines is published in local newspapers. The proponent must then write the "Terms of Reference" for the environmental assessment report. The Terms of Reference (found in APPENDIX B) dictate exactly what must be contained in the environmental assessment report. After they have been accepted by the Minister of the Environment, the Terms of Reference are distributed to consultants, who prepare proposals describing how they will conduct an environmental assessment study that will fulfil the Terms of Reference, how long the study will take, and how much the study will cost.

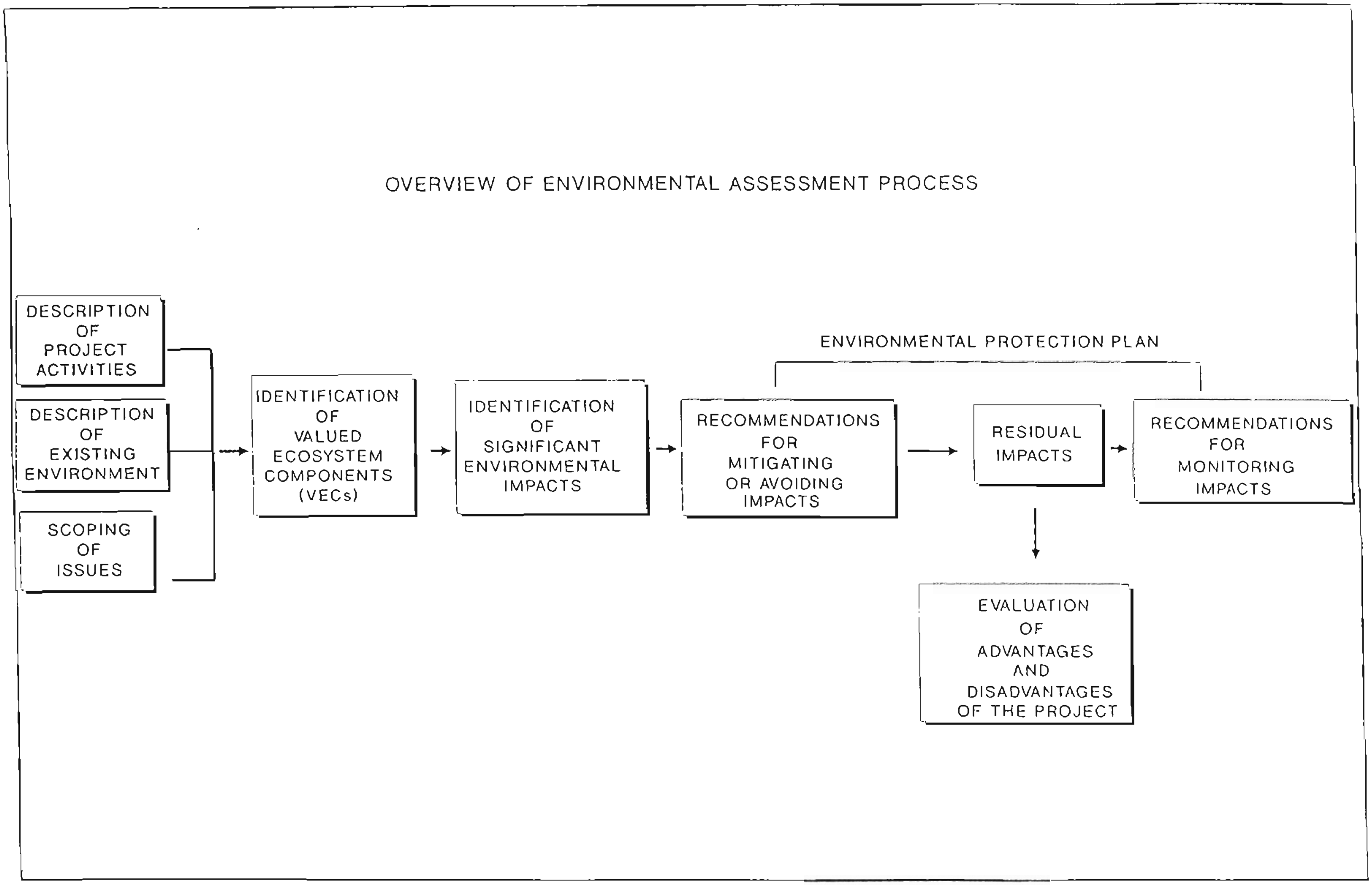
Once a contract is awarded to a consultant, the environmental assessment study is begun. When the study is complete and a draft environmental assessment report has been prepared, the report is submitted to the Minister of the Environment, who has ten days to decide whether the report is acceptable or whether more information is required. Once the report has been accepted, it is turned over to the Environmental Control Council for review and public consultation. The report must be available for public review for 40 days, and a notice of its availability must be published in a local newspaper. Concurrent with the public review, the Environmental Control Council may take up to 100 days to review the report. The Council is required to carry out public consultation according to Section 1b of the Environmental Assessment Act and as outlined in Regulations Made Pursuant to the Act.

Assessment Process

Figure 1-2 presents an overview of the process used in conducting the environmental assessment. The Project Description is found in Section 2 of the Report, and the justification for the project is found in Sections 3 and 4. Scoping of Public Concerns is presented in Section 5, and the Description of the Existing Environment is presented in Section 6. Identification of Predicted Environmental Impacts is presented in Section 7. The Environmental Protection Plan, which includes mitigation, residual impacts, and monitoring, is introduced in Section 8. Mitigation measures, including environmental rehabilitation, are presented in Section 9, residual impacts in Section 10, and recommendations for monitoring in Section 11. Section 12 describes the environmental advantages and disadvantages of the project.

Although the proposed project is still in the design phase and some details of the construction plans are not yet available, it was nevertheless possible to describe the various types of activities that will take place during the preconstruction, construction, and operation phases of the highway. Because the assessment was conducted during the winter months, it is likely that additional environmental components may be found. Therefore, summer surveys are recommended in order to be certain that all environmental components have been considered.

The environmental assessment was carried out by an interdisciplinary team coordinated by P. Lane and Associates Limited and was based on literature review, interviews, a public information session, and field work. Regular meetings among team members and with the Client ensured that all potential areas of concern were investigated and that the results of the different studies were integrated.



P. LANE AND ASSOCIATES LIMITED **Figure 1-2. Overview of Environmental Assessment Process.**

2.0 PROJECT DESCRIPTION

2.1 Project Assumptions and Bounding

It is assumed that the project will be carried out according to the Nova Scotia Department of Transportation and Communications' *Standard Specification* (1980 and revisions) (which includes the "Environmental Construction Practice Specifications" [1982]), *Highway Design Standards* (NSDTC, 1989) and all other laws and specifications pertinent to road construction practice in Nova Scotia. Contracts for construction will include environmental protection measures included in this report. Since the project is in the design phase, specific information such as cut and fill areas and areas of disposal of excavated rock are not yet known. The project will be built in five stages, and the time required for construction of each stage is described below.

Project bounding for the Preconstruction and Construction Phase includes the estimated length of the construction work for each stage of the project and extends to 500 metres (1640 feet) on either side of the proposed corridor. For watercourses, bounding extends to all water bodies that may be affected via drainage. Temporal bounding can only be stated in terms of the estimated number of years each stage will require. Stage 1 is expected to begin in the fall of 1991, pending approval by the Minister of the Environment. Stage 1 is expected to require two years; Stage 2, two years; Stage 3, three years; Stage 4, two years; and Stage 5, two years.

Project bounding for the Operation Phase extends for 20 years into the life of the project and also includes the area within 500 metres (1640 feet) of the corridor. Bounding for socio-economic impacts includes all residents, businesses, institutions and infrastructures directly affected by the undertaking.

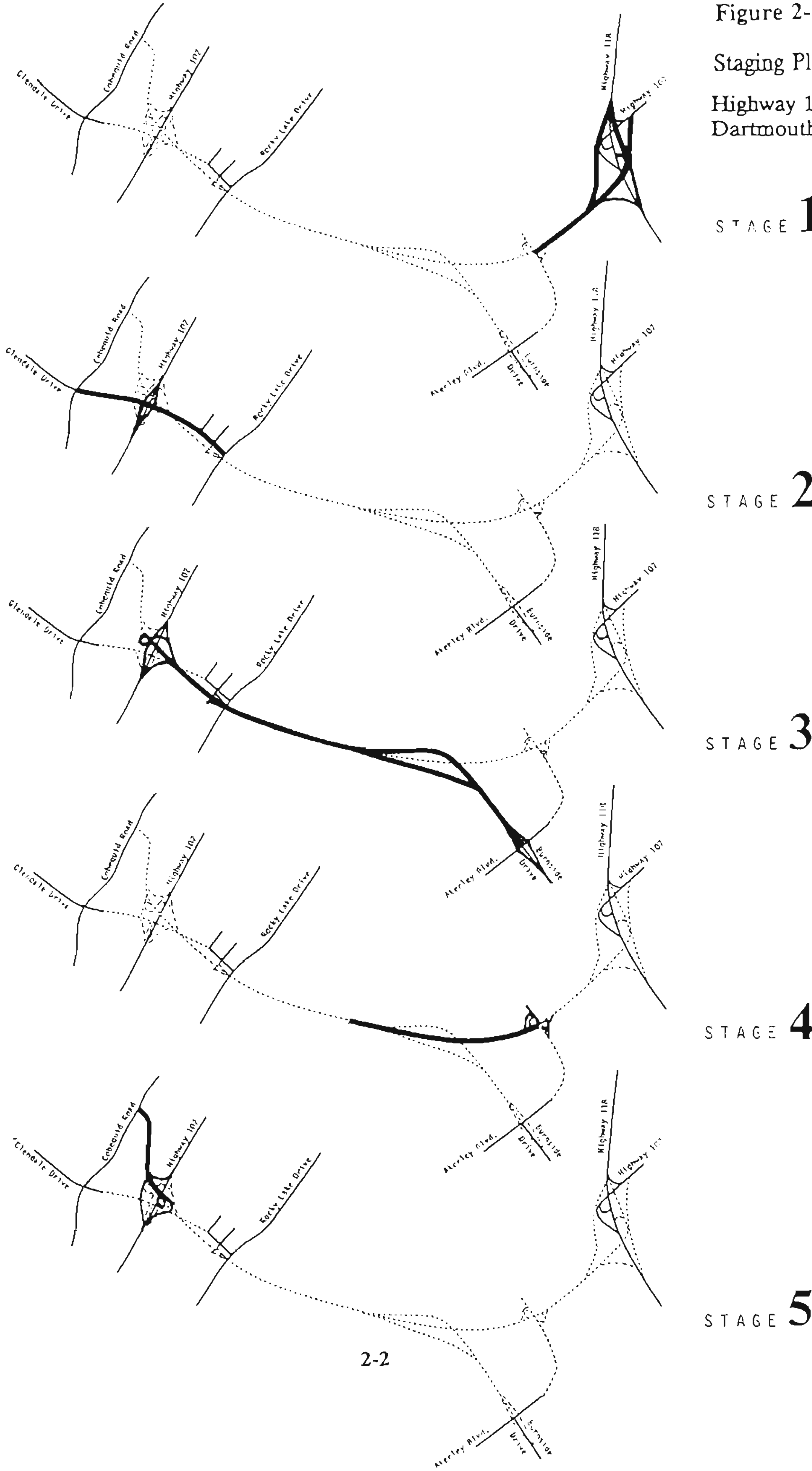
2.2 Staging and Roadway Types

The proposed highway is planned in five stages. The stages are described briefly below and illustrated in Figure 2-1. Roadway types and interchanges are also described for each stage.

Figure 2-1

Staging Plan

Highway 107 Extension
Dartmouth to Sackville



Stage 1 - Highway 107 from Highway 118 to the Akerley Boulevard extension.
- Highway 118/Highway 107 interchange modifications.

Stage 2 - Connector road from Rocky Lake Drive in Bedford to Glendale Drive in Lower Sackville.
- Diamond interchange at Highway 102

Stage 3 - Highway 107 from Burnside Drive to Highway 102.
- Initial stage of a partial directional interchange to connect Highway 107 and Highway 102.
- Burnside Drive extension from Akerley Boulevard to Highway 107.
- Interchange at Akerley Boulevard/Burnside Drive.

Stage 4 - Highway 107 from Akerley Boulevard to Burnside Drive.
- Akerley Boulevard/Highway 107 interchange.

Stage 5 - Connector road from Highway 102 to Cobequid Road in Lower Sackville.
- Completion of partial directional interchange on Highway 102 to connect the connector roads to Highway 102.

Each of the stages of highway development contains two relatively separate construction elements: roads and bridges. The tools, materials and skills required to build the two elements are different. Because of the differences, roadway construction and bridge construction are seldom undertaken as a single activity.

Figure 2-2 outlines the methodology used to plan, design and build a highway. As the figure indicates, the highway is planned as a single unit. However, at the completion of the planning process, two separate activity streams evolve. The methodology shown in Figure 2-2 is general in nature. It does not include pre-construction administrative activities such as right-of-way acquisition and construction tendering. The planning process for a highway has also been simplified. Requirements to mitigate environmental impacts are identified in the Environmental Protection

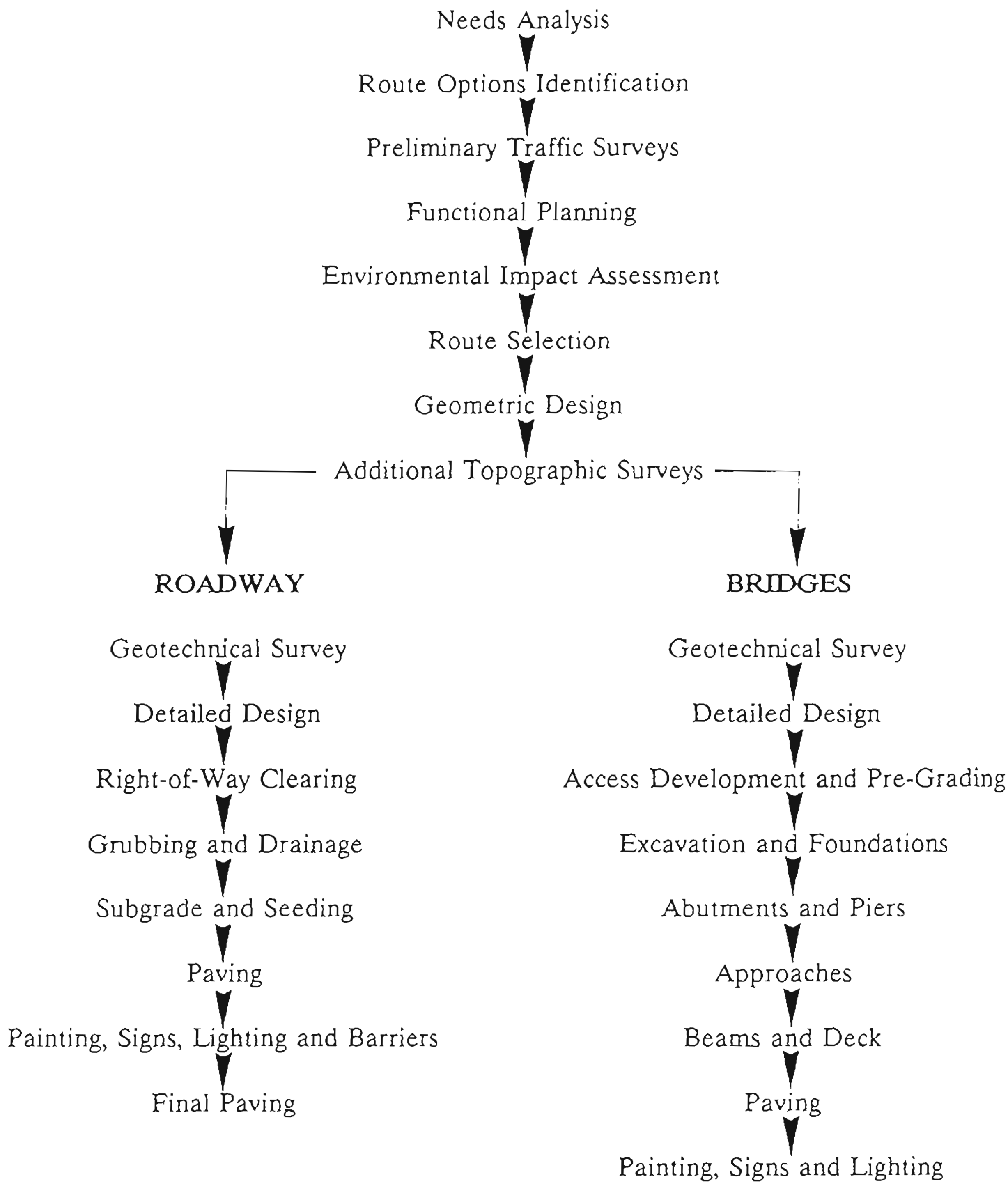


Figure 2-2

Highway Development Methodology

Plan. The specific details of mitigation techniques and works are developed in design steps and are integrated into construction contract documents.

2.3 Pre-construction Phase

Within the scope of the overall Highway Development Methodology it is only after the Detailed Design is complete that environmental impact risk is a significant factor. During the design phase, drilling and soils investigation are carried out to determine the impact of rocky areas on the environment and on project costs. During pre-design and design tasks, field work is limited to topographical and geotechnical surveys. Both activities involve tree cutting. The geotechnical surveys will also involve the use of track-mounted drills. To get the drills to their survey locations, very rough, minor trails will need to be developed. The creation of significant environmental impacts during these activities, however, is highly unlikely.

2.4 Construction Phase - Roads

2.4.1 Normal Activities

2.4.1.1 Clearing

The first phase of the construction activity will be clearing. NSDTC specifications for clearing set out two different approaches to the procedure, depending on how deep the fill will be (Nova Scotia Department of Transportation and Communications, 1980). It should be noted that only the necessary portion of the right-of-way will be cleared, not the entire right-of-way.

Clearing Procedure A

This procedure is carried out in areas where the fill depth is to be greater than 1.5 metres (five feet), and in other areas designated by the engineer. All trees within the right-of-way, except any designated by the engineers to be left standing, will be cut generally to within 0.3 metres (one foot) of the ground. Any shrub less than 1.5 metres (five feet) high may remain. Merchantable softwood and hardwood will be delimbed on site and removed. Non-merchantable material will be collected in piles and burned or chipped. No off-site disposal is allowed. The contractor is required to comply with The Forests Act of the Province of Nova Scotia (RSNS, 1989) before any burning.

Clearing Procedure B

In areas where the fill depth is to be less than 1.5 metres (five feet) and in other areas designated by the engineer, all trees within the right-of-way are cut generally to within 0.3 metres (one foot) of the ground. Merchantable softwood and hardwood will be delimbed on site and removed. Non-merchantable material, including stumps, roots and embedded logs are usually removed by root rake. The material will be piled and then burned. Unburnable material will be loaded and disposed of in an approved area outside the right-of way. The contractor is required to comply with The Forests Act of the Province of Nova Scotia (RSNS, 1989) before any burning.

Right-of-way clearing usually involves the use of chainsaws for cutting. Merchantable material is transported using tractor-skidders that haul the logs to centralized stockpiles. The trees may be either delimbed where they fall, using saws, or mechanically delimbed at the stockpile area. From the stockpile, the logs are loaded by porters onto trailers and removed from the site. Limbs and other non-merchantable materials are normally moved to chippers or burning piles by tractor-drawn brush rakes. Burning is usually initiated with gasoline or a similar product.

The environmental impacts from clearing usually result from:

- poor skid trail planning (e.g., water course crossing, the evolution of drainage channels from skid trails, and resulting soil erosion);
- petroleum product spills and leakage from equipment;
- smoke from fires; and/or
- removal of wildlife habitat.

Noise is not normally considered to be a major problem with clearing operations. Because the activity occurs within a confined space bounded by trees, noise is dissipated very quickly.

Clearing operations are best carried out in winter on frozen ground, which makes the work site more accessible and reduces the cost of haul road development. Frozen skid trails are more efficient than haul roads. Burning can be done with a minimum forest fire risk. By clearing on frozen ground and a frozen root mat, tractors and similar equipment are less likely to break into the ground. Where the equipment does break the ground, soil erosion potential is created. In clearing procedure B, which requires root raking, winter operations are not possible where the ground is frozen.

2.4.1.2 Grubbing

Grubbing for roadway construction is the process of root mat and topsoil removal. All areas where the fill will be less than 1.5 metres (five feet) deep or where excavation is planned will be grubbed. Areas to be covered by deep fills are only grubbed where a structure foundation (bridge, culvert or retaining wall) is to be constructed.

NSDTC specifications for grubbing set out two different approaches, depending on which clearing procedure was used. In both procedures, grubbing may only be carried out after the installation of culverts, settlement ponds and/or sediment traps. This is to minimize the environmental risks associated with erosion and sedimentation caused by grubbing operations.

Grubbing Procedure A

This procedure involves removal of stumps, roots, embedded logs and other objectionable materials. It may only be carried out on designated areas where clearing procedure A has been completed or on clear-cut areas. Often, grubbing procedure A will not be carried out because the area will be under embankments of 1.5 metres (five feet) or more.

Grubbing Procedure B

This procedure requires the excavation of material to a width of two metres (six feet) beyond excavation and embankment slope lines. The excavated material may be used to flatten the slopes along the roadway embankments, or it may be removed.

Grubbing is usually conducted with bulldozers, which are used to scrape the organic material off the underlying soil, and to push the material. If the grubbed material is to be removed from the site, track-mounted excavators are usually used to load the material onto trucks. Where grubbing involves the removal of extensive organic deposits (e.g., in swamps), the material is usually removed by an excavator and loaded directly onto trucks. If the organic deposit is of a size and/or depth that inhibits the efficient operation of a conventional excavator, a drag-line excavator may be used. If the organic material is fluid (contains a high proportion of water) it may be displaced by dumping rock materials into the swamp.

Grubbing operations present a threat to the natural environment, because they expose the inorganic soil and thus create the potential for wind and water soil erosion. Buried stockpiles of grubbed material are potential sources of dissolved organic compounds that may enter the groundwater resource. Stockpiles of grubbed material and material excavated from swamps can contribute to suspended sediment concentrations in the surface runoff. As with any construction operation involving machines, the potential exists for spills to occur when equipment is being fueled. Losses of hydraulic fluid because of the failure of hydraulic seals on equipment also present an environmental risk.

Environmental risks associated with erosion/sedimentation and grubbing operations are minimized through surface runoff management. In Nova Scotia, the development of open ditch drainage systems within the highway right-of-way, prior to grubbing, is used to control surface runoff. The development and use of sedimentation ponds reduces the potential for waterborne sediments to enter natural water courses. Water courses in the highway right-of-way are crossed with either bridges or culverts, and smaller watercourses are usually routed through culverts, which are usually installed as part of the grubbing operation.

Wind-generated erosion and the potential for dust creation are functions of the nature of the soil under the root mat, exposure to the wind and to wind speeds. Dust generated by operating equipment is usually only a problem when the wind speed is low. It becomes a problem because, at low air volume exchange rates, the concentration of dust within the right-of-way is high. With low wind speeds, however, the distribution of the dust is very limited. Grubbing operations generally create minimal dust problems, since the exposed soil is usually wet and the grubbed areas are seldom left exposed for extended periods.

2.4.1.3 Subgrade and Drainage Development

Subgrade development is the excavation and construction of embankments using material excavated within or adjacent to the right-of-way. It also involves removal of organic soil in depressions or swamps. Highways are designed, wherever economically possible, so that the amount of material used to build embankments is balanced by the amount of material excavated. Where a deficit in excavated material occurs, the common practice is to develop a "borrow pit" near the right-of-way. Surplus excavated material, when generated, is disposed of through minor design elevation adjustments on embankment side slopes and in space available next to the roadway and within the highway right-of-way.

Subgrade development for Highway 107 will involve "common" and "rock" excavation. Common excavation is the excavation and moving of soil. Rock excavation is the excavation and moving of bedrock and large boulders. Common excavation may be conducted using conventional excavators, front-end loaders and trucks for moving the material. Alternatively, the common material may be excavated and relocated using scrapers, which are wheel-mounted machines that excavate by "scooping" or scraping the soil into a large box mounted on the vehicle. The vehicle then carries the soil to the embankment area and deposits it there. The choice between the use of excavators, loaders and trucks or scrapers will be based on operational efficiencies. Issues such as haul distance and the size and number of boulders in the soil will affect the choice. Rock excavation will be carried out by drilling, blasting, loading and trucking. Where the rock is soft or heavily fractured, rock excavation may be carried out without blasting. In these cases rippers are used. Rippers are large gouging tools pulled by bulldozers.

Embankments will be built by spreading material that has been excavated and hauled. Spreading will be done by bulldozer. The spread material will be compacted using dozer-towed or self-propelled vibratory rolling equipment. In areas where the road subgrade is an excavated surface, permanent highway drainage ditches will be excavated. Where the road subgrade is raised more than one metre (three feet) above the ground elevation, ditches will not be developed. Culverts will be installed at topographic low points and where the roadbed crosses drainage channels. Much of this work will be carried out in conjunction with the grubbing operation. Because none of the water courses to be crossed for the Highway 107 Extension are large, culverts will be used to carry surface runoff under the roadway. The culverts will prevent the roadbed from acting as a dam. Culverts, settling ponds, and sediment traps will be installed prior to commencement of grubbing operations.

Culverts may be built of corrugated metal or of concrete. The sizes of culverts are determined by estimating the rate of surface runoff discharge from the area drawing to the culvert. The slope of the culvert across the roadway and the availability of space and elevation for the development of a "headpond" at the culvert inlet are also design considerations. Inlets and outlets of culverts are designed to prevent erosion of soil materials at either end. Commonly, larger pieces of rock are used to create headwalls at culvert inlets and outlets. Pieces of rock placed in the drainage channels at the culvert inlet and outlet are used to minimize channel erosion. At the culvert outlet, boulders may also be used to dissipate energy in the water discharging from the culvert.

The first step in culvert installation is the excavation for, and the construction of, the culvert foundation, which may be crushed rock, concrete, or some combination of these materials. The culvert pipe is then placed on the foundation and covered with earth fill. After the culvert is placed and the fill placed over it, rock may be placed at the inlet and the outlet for erosion protection.

Within the overall process of building a highway, the subgrade and drainage development is the task that takes the longest time. It is also the task that presents the highest risk for environmental impact. Common excavation and filling exposes native soil materials to wind and water, which may erode the soil. As outlined in Section 2.4.2, wind erosion and related dust creation are usually limited and localized problems. Water erosion, however, can be significant. Sedimentation ponds, designed to collect runoff and allow time for settling out of particles, are developed as a part of the grubbing operation, and the ponds will be maintained during the subgrade and drainage development operation. These ponds provide the main protection against sedimentation for the water courses.

The installation of culverts also presents a significant risk to surface water courses. The work is normally carried out in stream beds, at the bottom of drainage channels and in swamps. By its nature, culvert installation disturbs these features. The keys to minimizing the environmental risk associated with culvert installation are construction speed and the identification and use of dry periods when little or no surface runoff occurs. The placement of upstream and downstream

6.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

6.1 Introduction

The description of the existing environment provides the basis for determining which ecological components may be impacted by the undertaking. The term "environment" includes biological, physical-chemical, and socio-economic aspects. This section of the report is divided into terrestrial, aquatic and socio-economic environments. A summary of Valued Environmental Components (VECs) is given at the end of this section.

6.2 Terrestrial Environment

6.2.1 Geology and Hydrogeology

In order to determine potential geological and hydrogeological impacts of the undertaking, it is necessary to understand present groundwater supplies and the types of soil and rock that may be excavated during highway construction.

6.2.1.1 Surficial Geology (Soils)

Surficial geology deals with the origin and composition of soils. The predominant soil of the study area is a glacial till, an unsorted, non-layered deposit of both clay and rock fragments ranging in size from pebbles to boulders. Tills were deposited by glaciers which covered the Province from 10,000 to 50,000 years ago.

The till across the study area is generally 1.5 metres (five feet) deep and can be broken down into two main types based on rock type, texture, composition, and origin. The first type is known as quartzite till which was deposited in sheets as the glacier moved across Nova Scotia. It is typically compact, bluish-greenish-grey, silty sand derived from underlying bedrock. The second type, deposited as the glacier melted, is a thin, sandy, grey to greenish-grey, bedrock till veneer containing large boulders.

6.2.1.2 Bedrock Geology

The study area is underlain by two bedrock formations, the Goldenville Formation and the Halifax Formation. Both are comprised of sediments deposited in an ancient ocean approximately five hundred million years ago. Because they are oceanic deposits, the sediments were composed of silt and sand layers. The rock types derived from these layers are known as argillites and greywackes, and the rock layers range in thickness from one to tens of metres. Locations where the rock layers were observed as outcrops are shown in Figure 6-1. The orientation of the rock layers is shown in Figure 6-1 in terms of the strike direction and dip angle of the bedding plane (see Figure 6-2). The strike of the rocks is the horizontal attitude of the layers while the dip is the angle at which the layers plunge into the ground.

The Goldenville Formation underlies the entire study area and consists of a bedded sequence of green to grey meta-greywacke and quartzite grading up and interbedded with units (generally less than one metre [three feet]) of thinly bedded green and black slates.

The interbeds of slate which are observed throughout the study area, especially the northern portion, appear to be closely associated with the argillites of the Halifax Formation. This green to greenish-grey, parallel-laminated argillite conformably overlies the Goldenville Formation and is referred to as the Goldenville-Halifax Transition (Keppie, 1986).

During the process which compressed the sediments into rock, the layers were folded up into anticlines and folded down into synclines. These folds can be viewed on Figure 6-1 as the Waverley anticline and the Bedford syncline. The pressures which folded the rocks also created breaks or faults in the rocks. In the study area a major fault was noted running from Bedford Basin to Lake William (Figure 6-1). Faults and folds are important geologically because their orientations allow one to trace the agrillite and greywacke layers across the study area. This becomes especially important if acid-producing geologic units are encountered.

Acid-producing bedrock contains sulphide-bearing pyrite (foolsgold) which, when exposed to air and water, reacts to produce sulphuric acid. As the acid forms, it may react with other minerals in the rock and dissolve naturally-occurring metals (mercury, arsenic, lead, etc.) which can then be

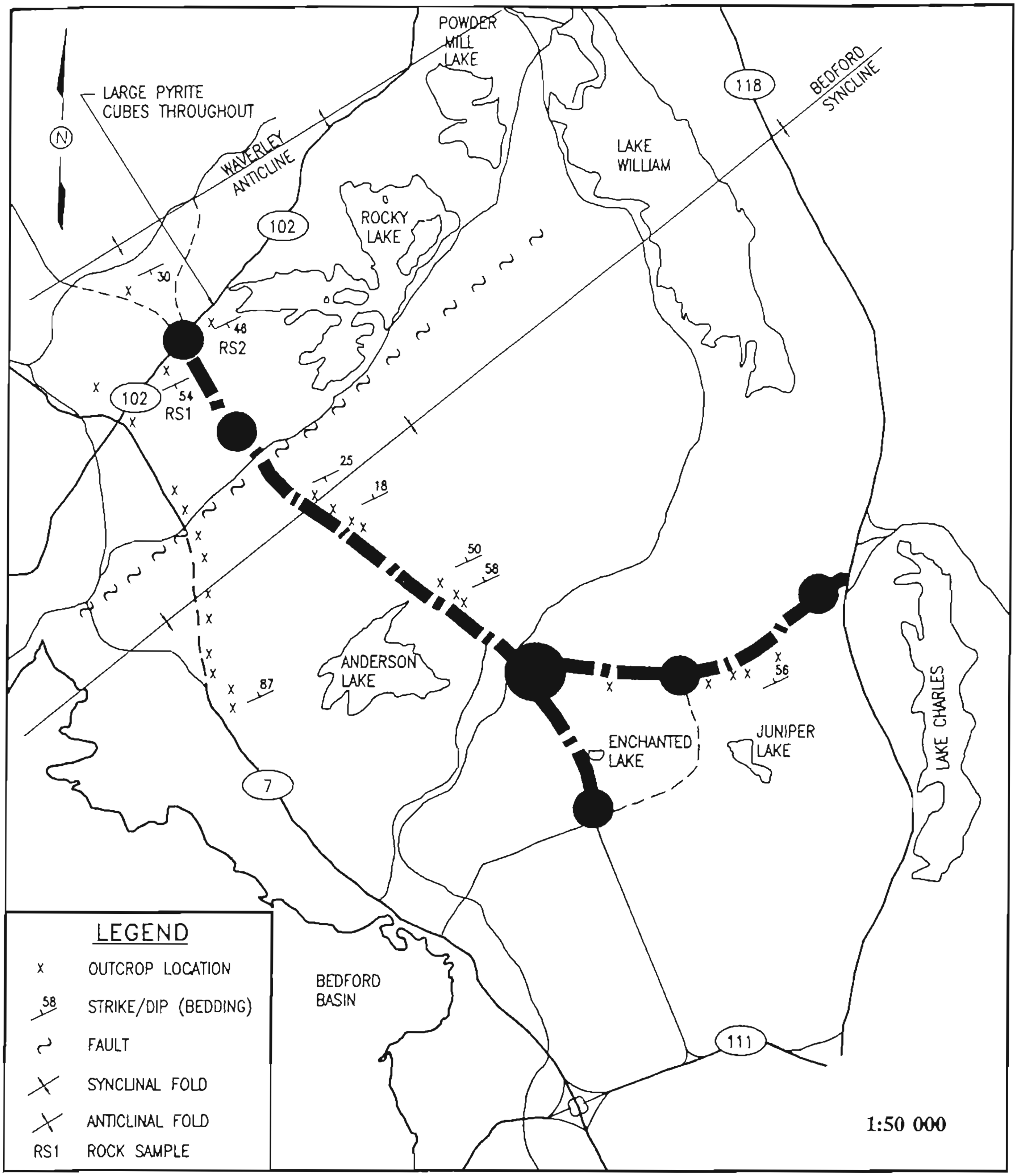


Figure 6-1. Highway 107 Extension, Dartmouth to Sackville: Geology Map

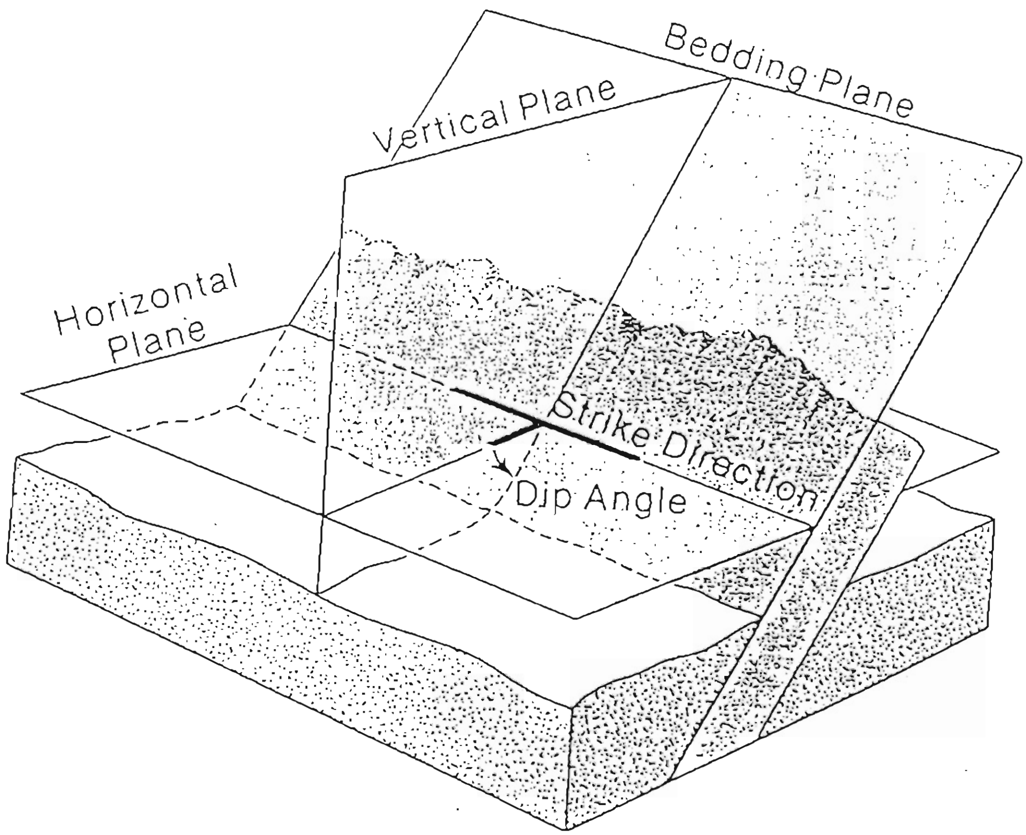


Figure 6-2. Diagram showing strike direction, dip angle, and bedding plane of bedrock.

transported via runoff to ground- and surface water. The excess acid and metals degrade the quality of potable groundwater and aquatic habitats and result in unfit drinking water and fish kills. A single exposure of acid-producing rock can produce acidic runoff for 20 to 50 years.

NSDOE and Environment Canada's *Guidelines for Development on Slates in Nova Scotia* (1989) have provided a criterion for determining if a particular type of rock can be considered acid-producing: if sulphide content exceeds 0.4 percent and the rock does not contain sufficient minerals (e.g., calcium) to neutralize the acid, the rock is considered acid-producing.

Samples of both argillite (RS-1) and greywacke (RS-2) rock types were collected at the locations shown on Figure 6-1. The argillite sample contained 0.04 percent and the greywacke sample 0.28 percent sulphide. Both values are below those necessary for significant acid production. Since these two rock types represent the types found throughout the entire study area, it is unlikely that acid-producing rock will be found. It will, however, be necessary to test for acid-producing bedrock in any areas to be cut or excavated.

6.2.1.3 Groundwater

The average depth to the water table in the study area is 1.5 metres (five feet). Because only a thin layer of till covers the bedrock, the water table is predominantly within the bedrock. Flow rates for wells in the area can vary from five to twenty litres per minute (one to five gallons per minute) and are predominantly fracture-flow controlled. Fracture flow is the movement of groundwater via small fractures and breaks in bedrock. Disturbance of these fractures by, for example, blasting or excavating can alter water quality by introducing new fractures; water quantity can be affected by the closing of existing fracture planes.

Groundwater quality in private wells in the area is generally poor. Two of four wells identified in the study area and sampled contained excessive turbidity and colour. One well water sample contained excessive arsenic (greater than 0.05 mg/L), and only one well (WS-2) was within the Canadian Drinking Water Guidelines for all parameters tested. Test results for the contaminated wells were provided to their owners (APPENDIX E). Water sample results for the four sampled wells are listed in Table 6.1. Domestic wells in the study area are shown on Figure 6-3. Municipal water services are available over the entire study area.

6.2.2 Atmospheric Environment

6.2.2.1 Climate

Climate in the Dartmouth and Bedford areas is influenced by the close proximity of the Atlantic Ocean, and particularly by the southward-flowing cold Labrador Current along the coast. The climate of the region is rarely extreme. Only occasionally do temperatures rise above 32°C (90°F) in summer or drop below minus 18°C (0°F) in winter. Warming in the spring is delayed by frequent sea breezes. In autumn, there is a predominant flow of warmer air off the continent, and that season is characterized by generally comfortable temperatures.

Sea fog, or low level clouds, are most common in spring and early summer with southeasterly and southerly winds, and often persist after a shift to southwesterly winds. Partly for this reason the region reports an annual average of less sunshine than most of southern Canada. True cold fronts with typical and well-defined windshifts at the surface do not occur often. Thunderstorms are rare, even in summer, and seldom reach the intensity experienced in more central continental areas. Meteorological conditions, including wind speeds and directions, precipitation, and temperatures recorded in the vicinity of the Highway 107 Extension are shown in APPENDIX F (Environment Canada, 1982a, b).

The average yearly rainfall range is 810 to 1370 millimetres (32 to 54 inches). Rains are often heavy in the warmer seasons; dying hurricanes also bring on average one heavy rainstorm per year. Total annual snowfall is on average 200 to 300 centimetres (79 - 118 inches) in most sectors of Nova Scotia with the heaviest snowfall occurring during the months of December, January, February and March, and light snowfall in November and April. The frost-free season ranges from less than 100 days in some interior sections of Nova Scotia to over 160 days along the Atlantic Coast.

Table 6.1. Water Sample Results

Station	Chloride (mg/L)	Colour (T.C.U.)	Total Suspended Solids (mg/L)	Specific Conductance (μmhos/cm)	Turbidity (N.T.U.)	Arsenic (mg/L)	Sodium (mg/L)
WS-1	166.0	24	1.6	928	7.65	0.010	50.3
WS-2	44.0	6	1.3	336	0.61	<0.005	28.7
WS-3	82.0	19	<0.5	566	7.19	<0.005	34.8
WS-4	26.6	<3	<0.5	400	0.19	0.108	45.3
C.D.W.G.	<250.0	<15			1.00	0.050	<200.0

Notes:

C.D.W.G. - Canadian Drinking Water Guidelines from: Canadian Council of Resource and Environment Ministers (CCREM, 1987).

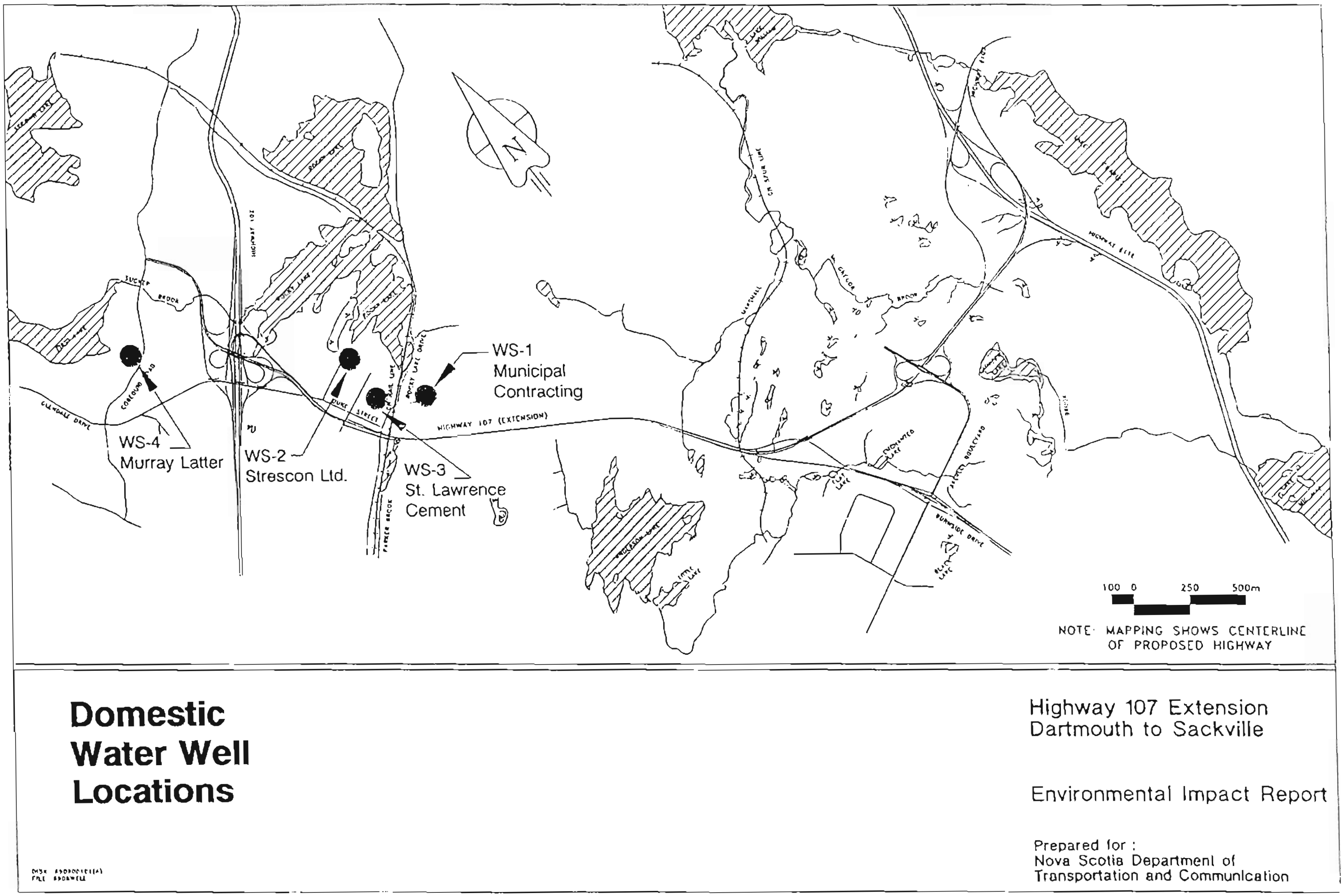


Figure 6-3. Highway 107 Extension, Dartmouth to Sackville: Domestic Water Well Locations.

6.2.2.2 Air Quality

Background air quality in the Dartmouth and Sackville areas is affected by existing large, stationary emission sources ("point sources") such as stacks and vents, and by many small ("non-point") sources such as automomobiles and open fires. Quality of air is defined by the concentrations of various gases, aerosols and hydrosols which are present to some degree in the atmosphere. They may be of a natural or man-made origin. Lower Sackville has a history of complaints received by Environment Canada, Environmental Protection Service (EPS) and NSDOE (Kozak, 1985) regarding wood stove operations. A study conducted in the Lower Sackville area from February to April 1984 reported average concentrations of total Suspended Particulate Matter (SPM) around 15 micrograms per cubic metre ($\mu g/m^3$). Acceptable concentration of the SPM specified in the Ontario Clean Air Act is 120 $\mu g/m^3$; therefore, dust levels associated with the construction of the Highway 107 Extension are well within acceptable values. Average total polynuclear aromatic hydrocarbons (PAH) concentrations were around six nanograms per cubic meter (ng/m^3), relatively low in comparison to other areas in Canada and the U.S. For example, in 1984 the average PAH concentration in Hamilton, Ontario, was 18.67 ng/m^3; in Toronto, it was 11.05 ng/m^3 (Kozak 1985).

The study area is generally undeveloped without influential emission sources in its vicinity. Topography, long-term wind velocity and direction, and the frequency of temperature inversions all prevent air pollutant buildup and persistence in the atmosphere. Generally, air quality in the area is good and is not suffering degradation from any particular source of air pollution.

6.2.2.3 Noise Levels

The proposed construction area of the Highway 107 Extension is in rocky, rugged terrain, covered with shrubs and trees (see Section 6.2.3). Such terrestrial conditions, which have a natural level of around 40 decibels, are responsible for dissipation of noise.

To assess the sound level produced by motor vehicles near Highways 102 and 107, as well as at the Burnside Drive Extension Interchange, members of the assessment team visited the area. It was confirmed that the existing highway transportation system (in terms of highway location, alignment and traffic flow) does not call for a noise measurement survey; there are no excessive noise-producing activities in the area.

Some areas in the vicinity of the proposed highway are affected by a higher-than-natural noise level from the existing roads and highways. For this reason, the following locations on or near the proposed Highway 107 extension are of interest with respect to noise levels:

- Highway 107/Highway 118 interchange;
- Akerley Boulevard/Burnside Drive intersection;
- Rocky Lake Drive and Bedford Industrial Park;
- Highway 102;
- Cobequid Road/Glendale Drive intersection;
- the CN railroad at the extension of Burnside Drive; and
- Charles P. Allen High School.

Charles P. Allen High School is of special concern. This school will be about 70 metres (230 feet) from the highway which will be several meters above ground level. Recognizing the importance of this location, a series of noise level measurements were conducted on March 19 and 21, 1991, during afternoon and morning hours, respectively.

The results of measurements (average values) for existing noise levels were:

- In front of the school = 71 dB(A)
- At the back of the school = 68 dB(A)
- Inside the school, ground level, class time = 63 dB(A)

For comparison purposes, measurements were also taken behind nearby Bedford Junior High School in an area between the school and the Bedford Bypass, approximately 50 metres (160 feet) from the Highway. The average measured noise level for Bedford Junior High School was approximately 79 dB(A). These values are above the Sound Level Limits (see Section 8.2). The school reduced the noise level by covering the windows facing the Highway with plywood. This reduces the noise level, but it also forces the school to use artificial light all the time. Such a method of noise control is not recommended for Charles P. Allen High School.

Wildlife areas which could be affected by anticipated construction noise and highway noise are described in Sections 6.2.3 and 6.2.4.

6.2.3 Flora and Habitats

The study area lies on the Atlantic Coastal Plain and contains a variety of forests ranging from low, dense hardwood to large hardwood and mixed forests. Pure stands of Red Oak (*Quercus rubra*) occur on some of the well-drained uplands especially near Burnside, Anderson Lake, and Juniper Lake. Red Maple (*Acer rubrum*) swamps occur in some of the low-lying areas, while spruce (*Picea* spp.) forest occurs near bogs and other low-lying areas. Herbaceous vegetation in the area has not been well studied (Wilson, 1991), but based on some of the forest associations present (e.g., pure oak, and oak-maple-birch [*Betula* spp.]) may include species typically found further south, and therefore uncommon to rare in Nova Scotia.

A series of physical processes has influenced floral development in the study area. The underlying bedrock provides few nutrients to plants. Glacial activity has left thin, nutrient-poor soils in all but low-lying areas. Fires and cutting, which increased in frequency and extent after the arrival of Europeans, have led to frequent disturbance of vegetation and loss of soil due to erosion. At present, the area is a mosaic of habitats differing primarily according to the frequency and intensity of recent fire disturbances and secondarily to factors such as soil quality and drainage.

A large forest fire burned much of the study area in 1963 (Nova Scotia Department of Lands and Forests [NSDLF], 1991). Smaller, more recent fires occurred in parts of the area, including Juniper Lake, on the order of five to fifteen years ago, as evidenced by the remnant pines (*Pinus*) and pine snags (standing dead trees) in "barren" areas. These sites are thickly covered with Lambkill (*Kalmia angustifolia*), blueberries (*Vaccinium* spp.), Huckleberry (*Gaylussacia baccata*), Rhodora (*Rhododendron canadense*), and Sweet-fern (*Comptonia peregrina*); Red Maple, birches, viburnums (*Viburnum* spp.), Downy Alder (*Alnus crispa*), aspens (*Populus* spp.), Pin Cherry (*Prunus* *pensylvanica*), shadbushes (*Amelanchier* spp.), Red Oak, and pines (*Pinus strobus* and *P. resinosa*) are scattered throughout as shrubs and small trees.

Habitats which have been less recently affected by fire range from young oak-birch hardwoods to more mature pine-oak and pine-oak-spruce stands, a few of which may be approaching old-growth status. Post-fire regeneration in most upland areas appears to have been fairly slow, doubtless a consequence of poor soil quality and intense fires which may have burned through the organic topsoil and exposed underlying mineral soil to erosion. Accordingly, vegetation is most developed in low-lying areas, especially along streams, where it is protected from fire and receives nutrients from elevated areas. The oldest forests in the area are probably no older than 100 to 150 years, as indicated by ring counts of stumps cut for highway survey lines, and are limited in extent, occurring mostly in low-lying and riparian (streamside) patches in the vicinity of Juniper Lake and McGregor Brook.

Most of the remaining mature forest in the area ranges from 35 to 70 years old and is dominated by White Pine and Red Oak, with Red Spruce (*Picea rubens*) being common in some areas. Red Maple, White and Yellow birches (*Betula papyrifera* and *B. allegheniensis*), Balsam Fir (*Abies balsamea*), Large-toothed Aspen (*Populus grandidentata*), and Red Pine (*Pinus resinosa*) are also present albeit less abundant in most areas. In richer riparian habitats, especially along Wrights Brook and McGregors Brook, additional species such as White Ash (*Fraxinus americana*), Eastern Hemlock (*Tsuga canadensis*), American Beech (*Fagus grandifolia*), Hazelnut (*Corylus cornuta*), and Sugar Maple (*Acer Saccharum*) may be found.

Younger forests in which the overhead tree canopy has only recently closed over tend to be dominated by a mix of oaks, birches, and aspens, with Red Maple, White Ash, pines, and Red Spruce common in wetter areas. There are, however, a few small areas of essentially pure Red Oak forest, notably on elevated ground between Juniper Lake and Enchanted Lake and also east of Anderson Lake. These areas have dense shrub layers of birches, Witch-hazel (*Hamamelis virginiana*), viburnums, aspens, Red Maple, and Downy Alder and are quite uncommon in the study area and in the Province generally. Such areas may have a particularly high potential for containing rare plants.

Exposed bedrock outcrops are scattered throughout the area and probably represent the effects of intense fires which exposed mineral soil to erosion. Outcrops are most abundant between Anderson Lake and Rocky Lake Drive.

The shores of lakes and stillwaters generally lack overhead tree cover and instead contain dense associations of such flood-tolerant species as Speckled Alder (*Alnus rugosa*), Sweet Gale (*Myrica gale*), Red Maple, viburnums, sedges (Family: Cyperaceae) and rushes (*Juncus* spp.). The narrow, fast-flowing portions of most streams are covered by an overhead canopy of trees; the ground vegetation consists of mosses, herbs, and ferns. In some areas, a fern indicative of relatively rich habitats (Ostrich Fern, *Pteritis pensylvanica*) is present, suggesting that intervale floral associations may be present.

Wetlands in the area include a number of bogs, some well drained and some waterlogged. Leatherleaf (*Chamaedaphne calyculata*), willows (*Salix* spp.), Bayberry (*Myrica pensylvanica*), Labrador tea (*Ledum groenlandica*), Tamarack (*Larix laricina*), and Black Spruce (*Picea mariana*) dominate the drier bogs while *Sphagnum* moss, Speckled Alder, and birches are additionally found in wetter areas.

Most stillwaters in the area are bordered by substantial floodplains and probably result from a combination of suitable topography and beaver activity, the best example being the Sucker Brook wetland. This wetland covers 3.9 hectares (9.6 acres) and is located along Sucker Brook between Highway 102 and Old Cobequid Road. The large number of snags (standing dead trees) suggests this wetland has expanded recently; at the time of the field survey (February 18, 1991), fresh workings indicated that beavers were still active in the area. Beavers, by cutting trees and building dams, provide valuable habitat features to other types of wildlife. In cut areas, saplings, shrubs, and a great variety of sun-loving herbs grow and provide food for bears, deer, hares, and grouse; stable water levels and snags provide habitat for waterfowl, muskrat, and turtles; fish may overwinter in the pond since it will not freeze to the bottom. Dominant vegetation in these areas includes flood-tolerant species such as Sweet Gale, Red Maple, ashes, alders, aspens, willows, chokeberries (*Aronia* spp.), and Canada Holly (*Ilex verticillata*). The Sucker Brook wetland is classified as a "good" wetland by the Nova Scotia Department of Lands & Forests ("[an] area . . . of value to wildlife . . . which often [has] the potential for development as better wildlife habitat . . . . The value of wetlands in this category should be reviewed before considering any developments on these sites". Nova Scotia Department of Lands and Forests, 1984).

There are at least two other locally significant wetlands within the study area. One of 3.6 hectares (9.0 acres) occurs along the Shubenacadie Canal near the intersection of Highway 118 and Highway 107 at Portobello. It is classified as a "better" wetland by NSDLF ("Areas of local wildlife value or ones that have outstanding wildlife potential. Wetlands in this category should be reserved for wildlife unless a high priority justifies other developments on these sites". NSDLF, 1984). The second "good" wetland occupies 4.7 hectares (11.6 acres) along the eastern shore of Rocky Lake.

Table 6.2 presents a list of rare plants which may be expected in the study area based on Maher *et al.* (1978), Roland and Smith (1969), records of the E.C. Smith Herbarium at Acadia University, Wolfville, and a superficial field survey of the various habitats conducted on February 18, 1991, by Ruth E. Newell, curator of the E.C. Smith Herbarium, Acadia University, and David MacKinnon, terrestrial ecologist with P. Lane and Associates Limited. These possibilities can be neither verified nor disproved until the coming spring and summer. Some of the species have not been reported for Halifax County but are included because of their occurrence in a neighboring county and/or in habitats similar to those in the study area. A species such as Mountain Sandwort (*Arenaria groenlandica*) which has been reported from Halifax County is a good candidate for being present. Relatively little field work has been carried out in the immediate study area to date. There is a chance, therefore, that something completely new to the Province exists in the area, hence the importance of conducting further field work at a more appropriate time of year (i.e., spring and summer).

6.2.4 Fauna

Mammals

A number of larger mammal species were detected in the study area during the winter field survey. The most abundant species, as indicated by the presence of tracks, were Snowshoe Hare (*Lepus americanus*) and Red Squirrel (*Tamiasciurus hudsonicus*). Others included Coyote (*Canis latrans*), Red Fox (*Vulpes vulpes*), White-tailed Deer (*Odocoileus virginiana*), Mink (*Mustela vison*), American Beaver (*Castor canadensis*), Muskrat (*Ondatra zibethicus*), River Otter (*Lontra canadensis*), Ermine

Table 6.2 Some Rare Flora of Nova Scotia and Their Potential Habitat in the Study Area (from Roland and Smith, 1969; Maher *et al.*, 1978).

Species	Habitat
Allium tricoccum Ait.	Rich woods and intervales; Threatened in Nova Scotia
Anenome quinquefolia L.	Shaded river banks and intervales; late May to early June
Anenome riparia Fern.	Stream banks and talus slopes
Antennaria parlinii Fern.*	Dry, open woods
Arenaria groenlandica (Retz.) Spreng.*	Rocky, granite barrens
Aster undulatus L.	Dry, open woods; Rare in Canada
Betula michauxii Spach.	Bogs (collected in Halifax Co. by Newell *et al.*, 1988)
Botrychium simplex E. Hitchc.	Damp or mossy clearings
Carex bromoides Schkuhr.	Swampy woods
Caulophyllum thalictroides (L.) Michx.	Rich woods and intervales; Threatened in Nova Scotia
Conopholis americana (L.) Wallr.*	Oak woods
Eleocharis olivacea Torr.	Bogs (reported from Halifax Co. by N. Hill, 1988)
Fraxinus pensylvanica Marsh. var. *austini* Fern.	Damp woods
Goodyera repens (L.) R.Br.	Damp mossy woods
Goodyera pubescens (Willd.)	Mixed woods (two records for Kings Co. in E.C. Smith Herbarium)
Lilium canadense L.	Intervales and stream banks; Threatened in Nova Scotia
Oryzopsis canadensis (Poir.) Torr.*	Dry woods
Oryzopsis pungens (Torr.) Hitchc.*	Dry barrens
Salix sericea Marsh.*	Wet thickets and stream banks
Viola nephrophylla Greene	Wet woods and streambanks

* indicates especially good candidate for being present in the study area.

(*Mustela erminea*), and Porcupine (*Erethizon dorsatum*). Black Bear (*Ursus americanus*) and Bobcat (*Lynx rufus*) were previously reported from the study area but were not found during field surveys. Others species not detected during field surveys but which may occur in the area include Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), Woodchuck (*Marmota monax*), Eastern Chipmunk (*Tamias striatus*), Northern Flying Squirrel (*Glaucomys sabrinus*), Little Brown Bat (*Myotis lucifugus*), Silver-haired Bat (*Lasionycteris noctivagans*), Red Bat (*Lasiurus borealis*), and Hoary Bat (*Lasiurus cinereus*).

Many of Nova Scotia's small mammal species are expected in the area, although none were seen during winter field surveys. These include Deer Mouse (*Peromyscus maniculatus*), White-footed Mouse (*P. leucopus*), Gapper's Red-backed Vole (*Clethrionomys gapperi*), Southern Bog Lemming (*Synaptomus cooperi*), Meadow Jumping Mouse (*Zapus hudsonius*), Woodland Jumping Mouse (*Napaeozapus insignis*), Meadow Vole (*Microtus pensylvanicus*), Pygmy Shrew (*Microsorex hoyi*), American Water Shrew (*Sorex palustis*), Smoky Shrew (*S. fumeus*), Arctic Shrew (*S. arcticus*), Masked Shrew (*S. cinereus*), Short-tailed Shrew (*Blarina brevicauda*), and Star-nosed Mole (*Condylura cristata*).

Many of the species listed, especially smaller ones, use a variety of habitats and are not particularly sensitive to habitat reduction and isolation. Black Bear, however, requires large, unbroken tracts of wilderness, a mosaic of aquatic, early, and late successional habitats, and remoteness from human disturbance. Black Bear and Bobcat are probably the most sensitive of the terrestrial mammals to highway construction and the subsequent expansion of human activities in the area. White-tailed Deer and Coyote are more tolerant of human disturbance but will probably suffer due to encroachment and traffic-caused mortality. Among the aquatic mammals, Mink and River Otter are especially sensitive to reductions in water quality which affect fish populations; similarly, bats may be sensitive to changes which reduce numbers of flying insects.

In the past, beavers have been active along all of the larger waterways in the study area. They were probably responsible for the creation of large ponds and stillwaters along level portions of Wrights, McGregor, Marshall, and Sucker Brooks. Overtrapping by the European colonists combined with fires which destroyed food trees resulted in the near-extinction of beavers by 1930 (Banfield, 1974). As a consequence, many of the ponds and stillwaters began to fill in with hydric vegetation and peat, forcing the streams to follow meandering courses through the floodplain. Beavers appear to have recovered to some extent in the area, and there is much evidence of intermittent occupation of the streams in the past 10 to 20 years. At present, beavers are active only along Marshall Brook and Sucker Brook. Their reoccupation of Sucker Brook in 1987 (O'Neil and Saunders, 1991) has caused a recent expansion of the wetland and produced many snags from trees which grew in the area during the beavers' absence. Their continued absence from many formerly occupied areas is probably due to a combination of recent forest fires, trapping, and expansion of the Burnside Industrial Park near Wrights Brook.

Birds

Results of a winter survey of habitats and interviews with naturalists familiar with the area indicate that approximately one hundred bird species may use the study area during the breeding season; fifteen to twenty of these would be rare or unlikely to occur in every year. These species are listed in Table 6.3.

Included in Table 6.3 are eight Blue-listed species. (The 1986 Blue List, published by the National Audubon Society, identified 22 species of North American birds appearing to be declining non-cyclically throughout much of their ranges but which did not yet have "official status" [e.g., Threatened or Endangered; (Tate and Tate, 1982; Tate, 1986)] . Habitats in the study area for two of these, Northern Harrier and Short-eared Owl, are marginally acceptable; habitats for the other six, American Bittern, American Black Duck ("Special Concern" but not actually Blue-listed), Sharp-shinned Hawk, Whip-poor-will, Common Nighthawk, and Ruby-throated Hummingbird, range from fair to excellent. Considering the abundance and distribution of these species in Nova Scotia, the only Blue-listed species likely to face a significant threat from the proposed highway project and consequent expansion of human activities in the area is the Whip-poor-will.

Whip-poor-wills were most recently reported in the study area in 1988, when one or two individuals were heard in an area now occupied by a furniture warehouse, in scrubby, pine-dotted habitat 100 to 200 metres east of Enchanted Lake, and approximately 300-400 metres south of Juniper Lake. Their present status in the area is unknown; we have obtained no reports from 1989 or 1990, which may simply mean that no birdwatchers have been to the area at night recently (see next paragraph), that the birds have retreated farther into the forest, or that they have left altogether. They were

Table 6.3 **Birds Likely to be Present in the Study Area during the Breeding Season.** Rare or distributionally limited species are in **bold-faced type**; Blue-listed species are **underlined in bold-faced type**; species requiring especially large territories or remoteness from human disturbance are marked with bold-faced asterisks (**).

Common Loon**	Anderson Lake, Lake William, possibly Rocky Lake
Pied-billed Grebe	possible, cattail or sedge wetlands, Lily Lake
American Bittern	possible, Marshall, Wrights, McGregors, and Sucker Brook and Shubie Canal wetlands
Great Blue Heron	possible foraging habitat along lakes, rivers, and wetlands
Wood Duck	possibly Sucker Brook wetland; associated with beaver ponds
American Black Duck	lakes, ponds, & rivers
Blue-winged Teal	possible, ponds & marshes
Ring-necked Duck	Enchanted Lake, Anderson Lake, Sucker Brook wetland, other lakes & ponds
Hooded Merganser	possible, ponds & streams, especially Sucker Brook wetland; associated with beaver ponds
Common Merganser	possible, ponds, larger streams, lakes
Osprey	Anderson Lake & other lakes, ponds, rivers
Bald Eagle	larger lakes & rivers
Northern Harrier	possible, Marshall, Sucker, and Wrights Brook wetlands
Sharp-shinned Hawk	larger, mature-forest areas
Northern Goshawk**	possible, forest
Broad-winged Hawk	probable, forest, especially riparian forest along Wrights, McGregors, Marshall, and Sucker Brooks
Red-tailed Hawk	probable, forest, open areas
American Kestrel	probable, open areas with snags
Merlin	possible, forest, open areas
Ruffed Grouse	present year-round, abundant in Wrights Brook watershed, early-successional forest, riparian thickets
Virginia Rail	possible, wetlands
Sora	possible, wetlands

Table 6.3 (cont'd.)

Spotted Sandpiper	along rivers & lakes, especially gravelly, rocky, or sandy margins
Common Snipe	possible, along rivers, wetlands, wet thickets
American Woodcock	probably breeds in good numbers, early successional forest
Black-billed Cuckoo	possible, hard- and mixed-wood forests, associated with insect infestations of hardwood forest
Great Horned Owl**	known, forest & open areas
Barred Owl	possible, forest
Long-eared Owl	possible, forest
Short-eared Owl	possible, Marshall and Sucker Brook wetlands, other open areas
Northern Saw-whet Owl	probable, forest
Common Nighthawk	early successional forest
Whip-poor-will	known to breed in Spectacle Lake area, possible behind Anderson Lake as well
Ruby-throated Hummingbird	probable, forest, open areas
Belted Kingfisher	may breed along larger rivers with mud banks or cavity trees
Downy Woodpecker	known, forest
Hairy Woodpecker	probable, forest, open areas
Black-backed Woodpecker	probable, in mature conifer, fire-, or flood-affected woods and swamps; associated with expanding beaver ponds
Northern Flicker	probable, forest, burned, or open areas
Pileated Woodpecker**	possible in old-growth areas; workings observed
Olive-sided Flycatcher	probable, edge of open, burned woodland
Eastern Wood-pewee	probable, forest openings and edges
Yellow-bellied Flycatcher	probably, dense conifer forest
Alder Flycatcher	early-successional forest, shrubby thickets, swales, riparian thickets, floodplains
Least Flycatcher	probable, mature hardwood
Great Crested Flycatcher	possible, hardwood
Eastern Kingbird	possible, riparian habitats, Sucker Brook wetland, open areas

Table 6.3 (cont'd.)

Tree Swallow	possible, burned woodland, flooded swamps; associated with beaver ponds
Gray Jay	possible, dense (usually coniferous) forest
Blue Jay	probable, variety of forest and suburban habitats
American Crow	conifer & hardwood forest, suburban
Common Raven	probable, conifer & hardwood forest, ledges
Black-capped Chickadee	forest & open areas, burns
Boreal Chickadee	conifer forest
Red-breasted Nuthatch	burns, forest, swamp
White-breasted Nuthatch	possible, mature forest, old growth
Brown Creeper	probable, conifer & hardwood forest
Winter Wren	probable, burns, openings, forest
Golden-crowned Kinglet	forest
Ruby-crowned Kinglet	forest
Swainson's Thrush	forest
Hermit Thrush	forest
American Robin	open areas, forest edges, suburbs
Gray Catbird	probable, thickets, riparian, early-successional
Cedar Waxwing	early-successional, hardwood, burns, heath
European Starling	in human-disturbed areas
Solitary Vireo	probable, hardwood, mixedwood
Red-eyed Vireo	hardwood, mixed, and early successional forest
Tennessee Warbler	probable, burned woodland, mid-successional forest, old bogs
Nashville Warbler	possible, conifer, mid-successional forest, tamarack bogs
Northern Parula	probable, anywhere *Usnea* lichen is found (mature and old-growth forest; good indicator of air quality
Yellow Warbler	thickets, riparian, early-successional forest, gardens
Chestnut-sided Warbler	probable, early-successional forest, thickets, shrubby hardwood
Magnolia Warbler	conifer and mixed forest
Cape May Warbler	possible, mature or old-growth conifer

Table 6.3 (cont'd.)

Black-throated Blue Warbler	hardwood undergrowth of hardwood and oak-pine forest; Juniper Lake and nearby upland hardwoods, Anderson Lake; possibly throughout in hardwood undergrowth
Yellow-rumped Warbler	probable, conifer
Black-throated Green Warbler	probable, conifer, hardwood, mid- to late-successional
Blackburnian Warbler	probable, conifer, mixed forest
Palm Warbler	probable, bogs and coniferous, early-successional forest
Bay-breasted Warbler	probable, dense conifer & mixed forest
Black-and-white Warbler	probable, mixed, conifer, hardwood, older stands
American Redstart	possible, early- and mid-successional hardwood
Ovenbird	possible, mature conifer & hardwood forest
Northern Waterthrush	probable, riverine and streamside thickets
Mourning Warbler	possible, burnt woodland, early-successional forest, openings
Common Yellowthroat	probable, riparian zone, thickets, early-successional hardwood
Wilson's Warbler	probable, riparian and wet thickets, burnt woodland at higher elevations
Canada Warbler	possible, wet forest thickets, swales, alders, conifers
Scarlet Tanager	possible, hardwood
Rose-breasted Grosbeak	probable, hardwood
Chipping Sparrow	probable, open areas
Song Sparrow	riparian, open areas, roadsides, burnt woodland, thickets, early-successional forest
Lincoln's Sparrow	possible, heath, low conifers, burnt woodland, brush piles, open swamps, bogs
Swamp Sparrow	heath, low, dense conifers, burnt woodland, swamps, riparian, marshes, bogs
White-throated Sparrow	probable, heath, early-successional, burnt woodland, clearings, dry upland conifer
Dark-eyed Junco	known, burnt woodland, early-successional, open areas, conifers

Table 6.3 (cont'd.)

Red-winged Blackbird	possible, swamps, wetlands, riparian, lakes with marshy fringe
Rusty Blackbird	probable, woodland swamps, rivers, streams
Common Grackle	possible, swamps, wetlands, rivers, forest
Brown-headed Cowbird	probable, forest, open areas
Northern Oriole	possible, hardwood
Pine Grosbeak	possible, mature conifer, open conifer-dotted heath, bogs
Purple Finch	probable, mature conifer or mixed forest
Red Crossbill	possible, mature spruce
White-winged Crossbill	possible, mature spruce
Pine Siskin	possible, pine, conifer woodlands, burnt woodland
American Goldfinch	possible, early-successional, fields, open areas, thistle
Evening Grosbeak	possible, alder thickets, hardwood or conifer forest

previously reported from much of the area, including Beech Hill and Spectacle Lake, but have declined or retreated in the face of industrial park expansion (Lavender, 1991). Potentially, much of the study area is suitable habitat for Whip-poor-will since most of it burned in the 1963 fire and some burned even more recently. Based on a superficial overview of the habitat, there may be suitable breeding sites yet to be found north and west of Burnside.

The Whip-poor-will is a nocturnal, robin-sized, ground-nesting member of the Nightjar family. It hunts on the wing and has a large, gaping mouth surrounded by long "whiskers" to help it catch flying insects. It was added to the Blue List in 1980 after widespread reports of declining and disappearing populations. In 1982 it was removed from the Blue List because populations appeared to be stable, with local declines attributed to habitat succession. Subsequent widespread and rapid declines in the following three years led to its re-inclusion on the 1986 Blue List. In Nova Scotia, the species was described as rare by Tufts (1986), its preferred habitat being a bushy pasture or open woodland. Godfrey (1986) also cites it as a rare breeder in Nova Scotia, giving the habitat as "ungrazed woodlands..., especially those with openings; woodland edges; woodlots. It appears to prefer mixed-wood or deciduous types, but open coniferous woods sometimes harbour good numbers too." More recent data from the Maritimes Breeding Bird Atlas project (Nova Scotia Museum and the Canadian Wildlife Service) suggest that this species is "almost extinct" in Nova Scotia, its population being estimated at fewer than 50 pairs (Dalzell, 1991) and 15 to 25 pairs (Lavender, 1991). The known breeding locations are scattered along the South Shore from Halifax to Shelburne with a few pairs in the Antigonish area. Like most songbirds, Whip-poor-wills appear to return to the same nesting area year after year for as long as the habitat remains suitable.

As suggested by Tate and Tate (1982) and Ehrlich *et al.* (1988), the Whip-poor-will's decline probably has resulted from a number of cumulative factors including urbanization, habitat maturation and fragmentation, fire suppression, and increases in suburban predators like house cats, squirrels, and raccoons. Its winter range (southeastern U.S. to Panama) includes much of Central America, an area presently experiencing explosive human population growth, deforestation, and agricultural expansion with associated pesticide use.

Other possible or known breeders in the area which are rare or distributionally restricted in Nova Scotia include Great Crested Flycatcher, Chestnut-sided Warbler, Black-throated Blue Warbler, Wilson's Warbler, and Scarlet Tanager. Although the presence of Scarlet Tanager may be unlikely, that of Great Crested Flycatcher (of which there may 25 pairs in Nova Scotia; Dalzell, 1991) is possible since it is known from similar, oak-birch hardwood habitat south of Powder Mill Lake and upper Lake William. The abundance of these species in the Province appears to be limited primarily by habitat availability. All species except one are associated either with pure hardwood or oak-pine forest, habitats more common in the eastern deciduous forest association of the northeastern United States. Wilson's Warbler, however, is dependent on wet, shrubby thickets along streams, ponds, and bogs, or in shrubbery at higher elevations in the boreal forest zone of Canada. Both of these habitat types are uncommon to rare in Nova Scotia, and the species is considered to be uncommon and locally distributed.

Several species are uncommon in Nova Scotia because of their requirements for remoteness from human activity, and large territory size. Common Loon, Northern Goshawk, Great Horned Owl, and Pileated Woodpecker have all declined in response to human encroachment, urbanization, and resource exploitation in wilderness areas. The highway project and consequent expansion of human activity in the area will incrementally add to this process of decline.

Amphibians and Reptiles

Rare or distributionally restricted amphibians and reptiles expected in the study area are listed with their typical habitats in Table 6.4. Some, such as Mink Frog and Northern Ringneck Snake are rather rare and habitat-specific and do not generally benefit from anthropogenic disturbances such as road construction and human encroachment. The Four-toed Salamander is among the least-known (and perhaps the rarest) of Nova Scotia's herpetofauna. It has been found as near as Westphal, in deciduous forest near a sluggish stream, and in riparian *Sphagnum* bogs in the Preston-Lake Echo area (Gilhen, 1984; 1991). In the study area, the best potential habitats for this species probably occur in *Sphagnum* dominated, slow flowing portions of McGregor Brook and Marshall Brook and the small, poorly drained, *Sphagnum-Chamaedaphne* bogs scattered throughout the area.

Table 6.4 Rare or distributionally-restricted amphibians and reptiles that may be present in the study area.

Species	Habitat
Four-Toed Salamander	Possible, closely associated with *Sphagnum* areas bordering streams and *Sphagnum* bogs during the spring breeding season; during the summer, can be found in and close to woodlands
Mink Frog	Possible, requires an abundance of aquatic vegetation, particularly lily pads and pickerel weed in ponds, coves of lakes, and quiet stretches of streams
Northern Ringneck Snake	Deciduous and mixed woods, shores of lakes, ponds, and streams; edges of old bogs

A number of the more common species may benefit in the short term from road construction because of the ponding and establishment of open, grassy habitat. Most species, however, will be susceptible to declines in the long term because of the additional industrial expansion encouraged by the road as is presently occurring with ongoing development of the area.

Invertebrates

Virtually nothing is known about invertebrates in the study area, and it was not possible to collect information on these species in the winter.

6.3 Aquatic Environment

6.3.1 Surface Water Quality

Limited data from lakes and streams near the proposed extension of Highway 107 necessitated the collection and analysis of a few additional water samples. Water samples were collected in February and March, 1991 from Anderson Lake and Lily Lake, and from McGregor, Wrights, Marshall and Sucker Brooks. These samples were subsequently analyzed for basic water chemistry parameters at the Victoria General Hospital, Environmental Chemistry Laboratory (Rapid Chemical Analysis [RCA] package plus arsenic and aluminum). This information together with any historical data and recommended guideline values for "recreational uses" and "protection of aquatic life" set out in the

Canadian Council of Resource and Environment Ministers document (CCREM, 1987) are presented in Tables 6.5 to 6.11.

Lake and stream water quality was generally acceptable for all forms of recreational use. Water samples taken from Anderson Lake, and McGregor and Marshall Brook did have low pH values, 4.7 to 4.9 (cf. the CCREM guideline value of 5), but these were identical to values reported during summer months in Kejimkujik Lake (Blouin, 1985). These low values were also well below the minimum CCREM value for "protection of aquatic life", pH of 6.5.

Seasonal changes in pH, and indeed most other water quality parameters, do occur in these water bodies as a consequence of natural, biological and physical-chemical, processes. Lowest pH values (highest hydrogen-ion content) are expected during the winter and early spring when algae (phytoplankton and benthic macroalgae) are least active and inputs of acidic precipitation (rain and snowmelt) dominate the system. The pH values usually increase throughout the summer months as algae photosynthesize large quantities of carbon dioxide and consequently shift the carbonate-bicarbonate equilibrium to reduce water acidity. The pH may rise one to two units between winter and summer (see following section on historical trends in other nearby lakes). Rainfall events and peaks in the activities of microbial decomposers and algae grazers (e.g., copepods) can, however, modify this general trend on shorter-term cycles.

Guideline values for "protection of aquatic biota" (CCREM, 1987) were exceeded in all nearby lakes and streams. Heavy metals (and pH) were frequently in excess of values known to impair the growth or survival of fish and other aquatic organisms. Although the "poor conditions" at some sites could be attributed to "natural" processes (such as acidic precipitation), other sites were probably polluted by nearby residential and/or industrial developments. Other factors or substances at these sites may, however, reduce toxicity levels, or even eliminate the availability of heavy metals to aquatic life. Dissolved organic matter (DOM) is well known to bind with metals, altering their solubility, toxicity and bioavailability. A recent study of 37 lakes in Nova Scotia (Urban *et al.*, 1990) hypothesized that the humic materials fraction of DOM was probably responsible for regulating the concentrations of aluminum and iron in the acidic lakes (those with a pH value less than 5).

Table 6.5 **Water Quality Data for Anderson Lake.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Dec. 13, 1984	Concentration March 6, 1991
Sodium			7.7	1.8
Potassium			0.5	0.3
Calcium			2.2	0.7
Magnesium			0.07	0.2
Hardness				2.57
Alkalinity ($CaCO_3$)			<1.0	<1.0
Carbonate ($CaCO_3$)				
Bicarbonate ($CaCO_3$)				
Sulfate			6.7	3.0
Chloride			12.9	3.4
Silica				1.2
Ortho Phosphorus (P)			<0.01	<0.01
Nitrate+Nitrite (N)			<0.05	<0.05
Ammonia (N)		~ 2	<0.05	0.13
Iron		0.3	0.03	0.03
Manganese			0.04	0.02
Copper		0.002		<0.01
Zinc		0.03		<0.01
Aluminum		0.005	0.09	0.15
Arsenic		0.05		<0.005
Color (TCU)	100		29.0	19.0
Turbidity (NTU)	+5[1]		0.50	0.38
Conductivity (µmhos/cm)			67.0	26.0
pH (units)	5<x<9	6.5<x<9	5.2	4.8
Total Organic Carbon				2.2

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.6 **Water Quality Data for Lily Lake.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration July 27, 1989	Concentration Feb. 17, 1991
Sodium			1.8	11.5
Potassium			<0.1	0.9
Calcium			0.66	3.9
Magnesium			0.35	0.7
Hardness			3.1	12.6
Alkalinity ($CaCO_3$)			1.0	4.0
Carbonate ($CaCO_3$)				0.0
Bicarbonate ($CaCO_3$)				4.0
Sulfate			2.5	7.0
Chloride			3.2	18.0
Silica			<0.5	3.0
Ortho Phosphorus (P)			<0.01	<0.01
Nitrate+Nitrite (N)			<0.05	0.07
Ammonia (N)		~ 2	<0.05	0.09
Iron		0.3	0.29	0.15
Manganese			0.04	0.11
Copper		0.002	<0.01	<0.01
Zinc		0.03	<0.01	0.06
Aluminum		0.005		0.31
Arsenic		0.05		<0.005
Color (TCU)	100		29.0	19.0
Turbidity (NTU)	+5[1]		0.7	2.86
Conductivity (μmhos/cm)			22.0	95.0
pH (units)	5<x<9	6.5<x<9	5.70	6.5
Total Organic Carbon			7.0	3.4

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.7 **Water Quality Data for Marshall Brook.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Feb. 17, 1991
Sodium			2.5
Potassium			0.4
Calcium			2.2
Magnesium			0.7
Hardness			8.37
Alkalinity ($CaCO_3$)			<1.0
Sulfate			8.0
Chloride			3.4
Silica			4.1
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			0.06
Ammonia (N)		~ 2	<0.05
Iron		0.3	0.14
Manganese			0.12
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.005	0.2
Arsenic		0.05	<0.005
Color (TCU)	100		28.0
Turbidity (NTU)	+5[1]		0.3
Conductivity (μmhos/cm)			42.0
pH (units)	$5<x<9$	$6.5<x<9$	4.9
Total Organic Carbon			4.7

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.8 **Water Quality Data for McGregor Brook**. Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Feb. 17, 1991
Sodium			2.9
Potassium			0.2
Calcium			1.7
Magnesium			0.6
Hardness			6.71
Alkalinity ($CaCO_3$)			<1.0
Sulfate			8.0
Chloride			3.7
Silica			4.4
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			<0.05
Ammonia (N)		~ 2	<0.05
Iron		0.3	0.05
Manganese			0.08
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.005	0.21
Arsenic		0.05	<0.005
Color (TCU)	100		21.0
Turbidity (NTU)	+5[1]		0.27
Conductivity (μmhos/cm)			43.0
pH (units)	5<x<9	6.5<x<9	4.7
Total Organic Carbon			4.3

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.9 **Water Quality Data for Sucker Brook - Rocky Lake Inflow**. Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Feb. 17, 1991
Sodium			38.4
Potassium			1.4
Calcium			13.5
Magnesium			1.8
Hardness			41.1
Alkalinity ($CaCO_3$)			16.0
Carbonate ($CaCO_3$)			0.02
Bicarbonate ($CaCO_3$)			16.0
Sulfate			15.0
Chloride			61.0
Silica			1.6
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			0.12
Ammonia (N)		~ 2	0.06
Iron		0.3	0.05
Manganese			0.03
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.1	0.11
Arsenic		0.05	<0.005
Color (TCU)	100		17.0
Turbidity	+5[1]		1.57
Conductivity (μmhos/cm)			280
pH (units)	5<x<9	6.5<x<9	7.2
Total Organic Carbon			2.9

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.10 **Water Quality Data for Sucker Brook - First Lake Outflow.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration May 24, 1989	Concentration Aug. 17, 1989	Concentration Feb. 17, 1991
Sodium			61.0	56.0	42.4
Potassium			1.8	2.1	1.7
Calcium			16.0	18.0	16.4
Magnesium			2.1	2.1	2.0
Hardness			48.6	53.6	49.1
Alkalinity ($CaCO_3$)			23.0	34.0	21.0
Carbonate ($CaCO_3$)					0.05
Bicarbonate ($CaCO_3$)					20.9
Sulfate			19.0	15.0	18.0
Chloride			100	93	71
Silica			<0.5	1.1	1.0
Ortho Phosphorus (P)					<0.01
Nitrate+Nitrite (N)			0.05	<0.05	0.11
Ammonia (N)		~ 2	<0.05	<0.05	0.06
Iron		0.3	0.15	0.15	0.05
Manganese			0.16	0.30	0.03
Copper		0.002	0.02	<0.01	<0.01
Zinc		0.03	<0.01	0.01	<0.01
Aluminum		0.1			0.1
Arsenic		0.05			<0.005
Color (TCU)	100		7.7	10.0	12.0
Turbidity (NTU)	+5[1]		2.3	0.6	2.1
Conductivity (µmhos/cm)			416	426	333
pH (units)	5<x<9	6.5<x<9	7.7	7.6	7.4
Total Organic Carbon			2.9	3.6	2.6

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.11 **Water Quality Data for Wrights Brook.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration March 6, 1991
Sodium			36.2
Potassium			1.6
Calcium			11.5
Magnesium			1.5
Hardness			34.9
Alkalinity ($CaCO_3$)			14.0
Carbonate ($CaCO_3$)			0.02
Bicarbonate ($CaCO_3$)			14.0
Sulfate			13.0
Chloride			59.0
Silica			2.7
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			0.19
Ammonia (N)		~ 2	0.02
Iron		0.3	0.79
Manganese			0.49
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.1	0.22
Arsenic		0.05	<0.005
Color (TCU)	100		33.0
Turbidity	+5[1]		7.2
Conductivity (µmhos/cm)			269
pH (units)	5<x<9	6.5<x<9	7.1
Total Organic Carbon			1.9

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

At the time of sampling, all of the sampled water bodies near the proposed highway route have elevated levels of aluminum, reflecting the leaching action of acidic precipitation on surficial soils and rocks. Aluminum levels were frequently at, or above the highest ones recommended by the CCREM (1987) report for growth and survival of fish and other aquatic organisms. As noted above, levels may not be toxic to all organisms because of DOM-aluminum interactions.

Elevated concentrations of other heavy metals relative to CCREM (1987) guideline values were usually associated with human activities. Lily Lake had high levels of zinc, perhaps as a consequence of its proximity to the Canadian National Railway. Construction and industrial activities in nearby Burnside Industrial Park were probably responsible for elevated levels of iron in Wrights Brook. High levels of copper in Sucker Brook immediately below First Lake (on one occasion only; May 24, 1989 survey conducted by researchers from the Centre for Water Resource Studies [CWRS-TUNS] for the N.S. Dept. of the Environment) probably originates from runoff from roads and communities in Lower Sackville.

6.3.1.1 Impact of Other 100 Series Highways on Surface Water Quality

The principal impacts on water quality associated with construction and operation of highways are from enhanced loading rates of a variety of inorganic and organic materials. The most significant impacts include: increased siltation rates (particularly during construction phases), stormwater drainage from the road (landwash) containing various petroleum products, heavy metals and salt (or other de-icing compounds), and accidental spills of fuels and other chemicals. Appropriate mitigation and application practices should alleviate most concerns about the "normal" activities. Accidental events require further consideration in an a contingency plan (Section 9.6).

In order to predict the magnitude of the "normal" impacts on water bodies near the proposed extension of Highway 107, existing historical data for Anderson Lake and five other lakes near 100-series highways in Halifax County were analyzed for trends over the last twenty years. The relatively isolated nature of Anderson Lake (and its watershed) facilitates its use as a "control" lake for estimating pre-development conditions. Prior to development of this area, lake and stream water chemistry are controlled by weathering processes of the soils and rocks within the watershed (Gorham, 1957; Underwood *et al.*, 1986; Rogers *et al.*, 1990), and by the "dry" and "wet" atmospheric fallout of materials (especially from sea-spray). Acidic precipitation and dry fallout, in particular, are now well known to significantly alter the water chemistry of even the most isolated of lakes (Watt *et al.*, 1979; Stauffer, 1990). Water quality data were gathered from the published studies of Alexander (1972), Ogden (1972), Environment Canada and the Nova Scotia Department of the Environment (1975), Hart et al. (1978), Johnson (1978), Gordon *et al.* (1981), Alexander *et al.* (1986), and Urban *et al.* (1990), and the open files at the Nova Scotia Department of the Environment and the City of Dartmouth.

The water quality database only permits analyses of changes in the inorganic chemistry of the lakes resulting from road-salt (sodium chloride) applications and landwash of the road surfaces (major ions and nutrients). Historical trends in sodium, chloride, pH, and specific conductance (the latter is a measure of the total quantity of dissolved materials in water, specifically the electrically-conducting elements), are summarized in Figures 6-4 to 6-7. The nutrient data were not presented because of the small number of detectable concentrations during the twenty year period (analytical detection limits are often too high for natural levels of these compounds). There are no records for organic contamination (e.g., oil and grease) and very few data on water clarity and levels of heavy metals and suspended particulate matter (silt). Increases in the specific conductance (or conductivity) of a water body would, however, be expected to reflect higher input rates of the more toxic pollutants and perhaps decreased water clarity.

Concentrations of sodium and chloride are useful indicators of road salt contamination and/or industrial and domestic pollution (animal wastes and many detergents are particularly important). Not unexpectedly, the highest concentrations and greatest accumulation rates were evident in First and Micmac Lakes, nearest the busiest roadways and largest population centres (Figures 6-4 and 6-5). Prior to major development, all of the lakes except Micmac, had baseline values approaching those of present-day levels in Anderson Lake, less than 10 milligrams of sodium per litre and less than 20 mg of chloride per litre (abbreviated as mg/L). Salt levels subsequently increased in all lakes except Anderson at rates that probably paralleled municipal growth rates. Twinning of Highway 102 (near Rocky Lake) and Highway 118 (near Lakes William and Charles) also did not appear to alter salt accumulation rates. Seasonal variation in these parameters does occur (maximum in winter and spring, and minimum in summer and fall), but the overall ranges are small,

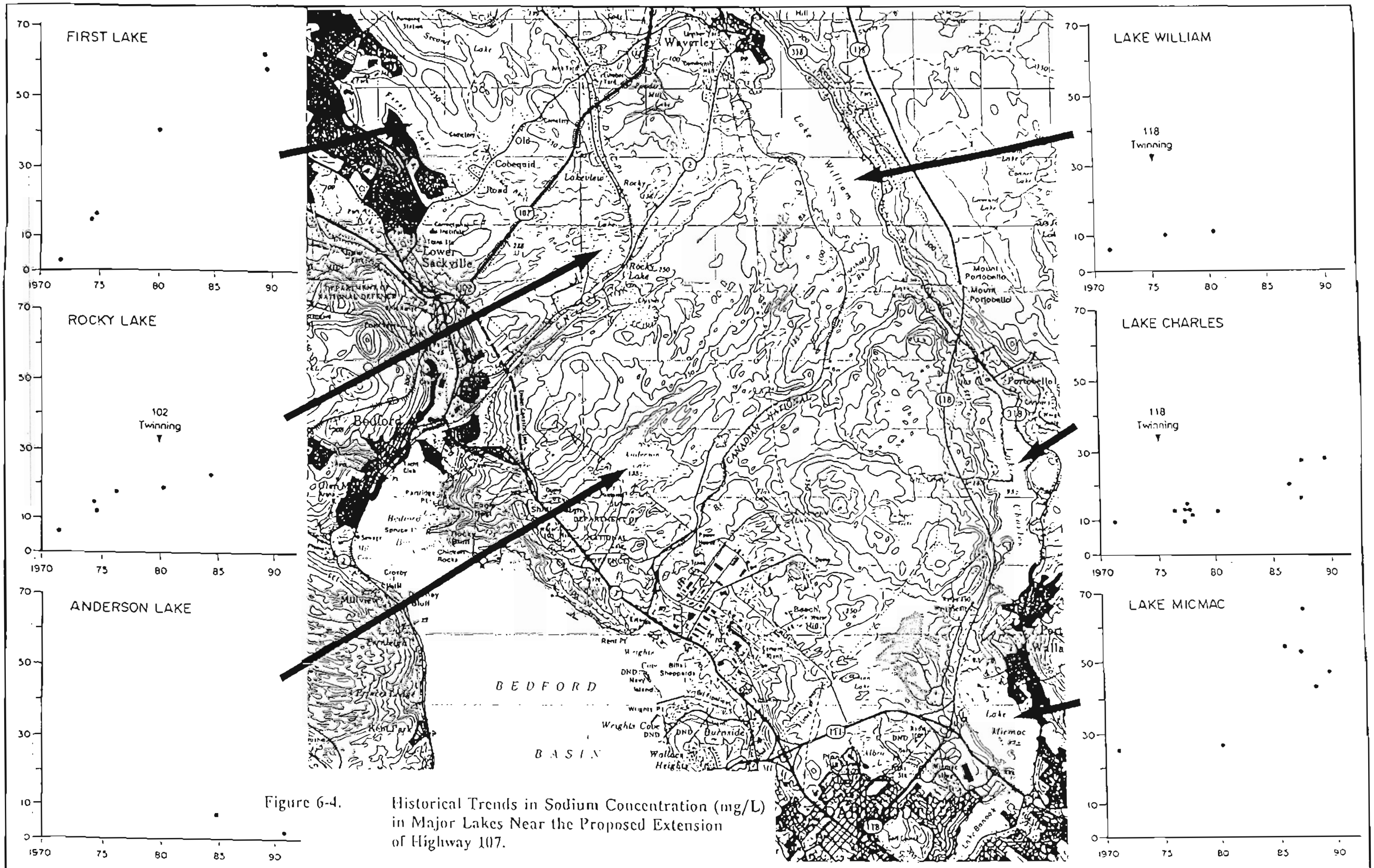


Figure 6-4. Historical Trends in Sodium Concentration (mg/L) in Major Lakes Near the Proposed Extension of Highway 107.

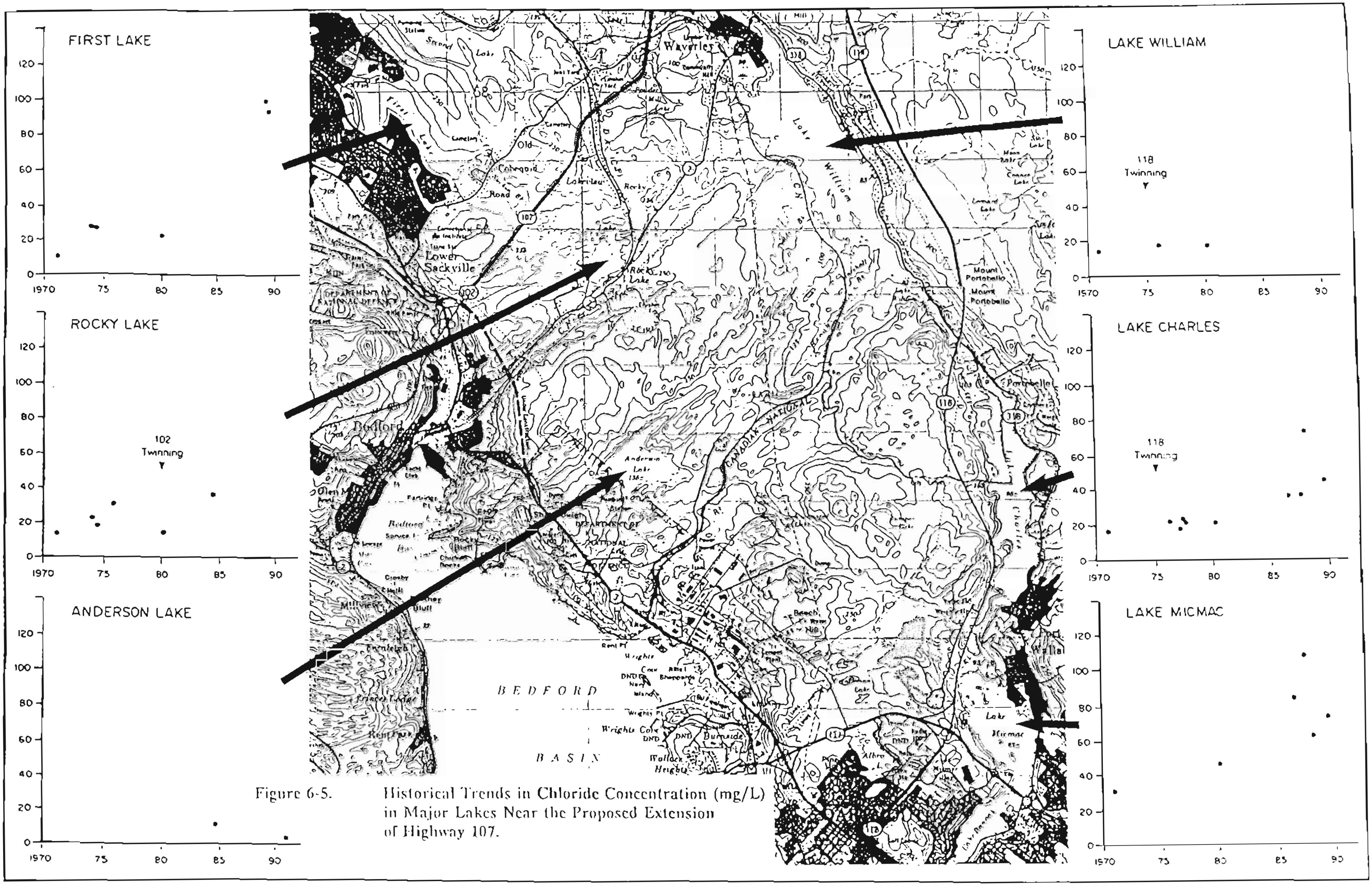


Figure 6-5. Historical Trends in Chloride Concentration (mg/L) in Major Lakes Near the Proposed Extension of Highway 107.

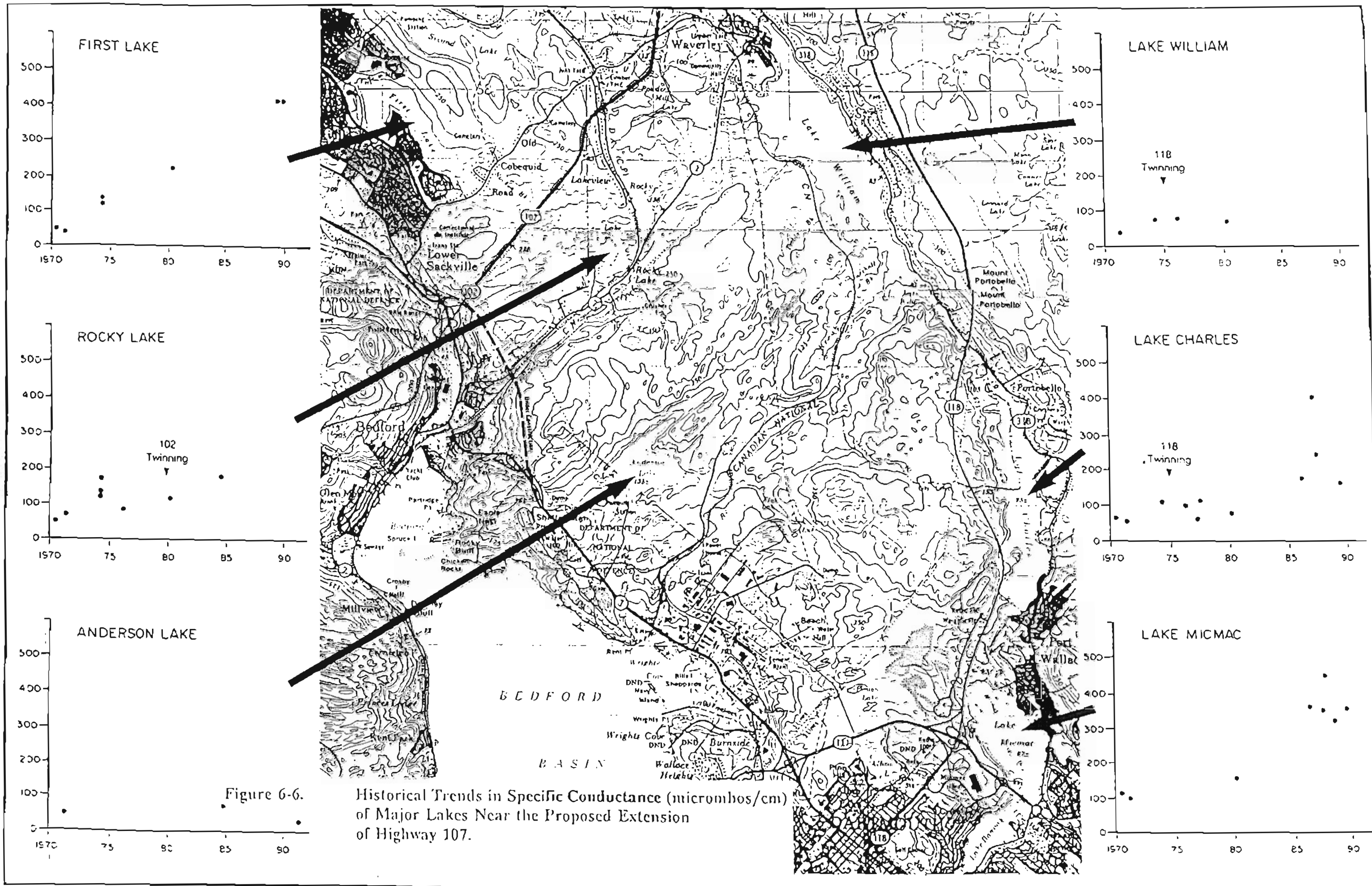


Figure 6-6. Historical Trends in Specific Conductance (micromhos/cm) of Major Lakes Near the Proposed Extension of Highway 107.

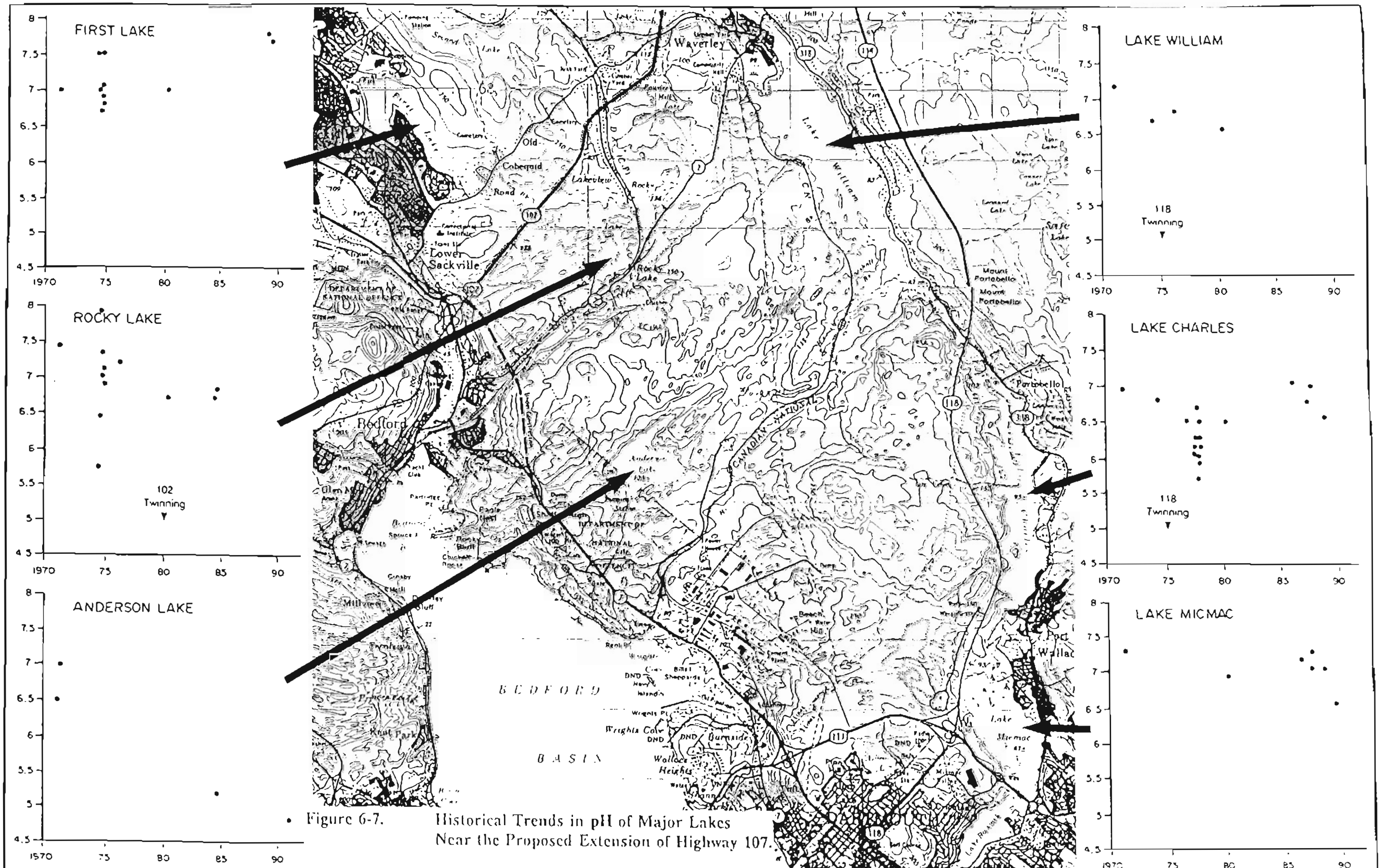


Figure 6-7. Historical Trends in pH of Major Lakes Near the Proposed Extension of Highway 107.

typically 10 percent of the mean (unpublished data collected from Paper Mill Lake near Highway 102 by P. Lane and Associates Limited, 1990).

Conductivity readings show much the same trends as noted for sodium and chloride (Figure 6-6). By inference then, all of the lakes except Anderson Lake are slowly accumulating heavy metals, and a variety of other major ions and trace organic pollutants. In twenty years, the water chemistry of Anderson Lake might be comparable to that of Rocky Lake, Lake William and Lake Charles; assuming similar rates of relatively low-intensity residential development.

Highway construction could alter pH levels of nearby streams and lakes if pyritic slates are exposed or used as roadfill materials. Acidic drainage would markedly depress pH values and increase concentrations of the sulphate ion and a variety of heavy metals. None of the five lakes near existing 100-series highways shows any decline directly attributable to highway construction (Figure 6-6). In fact, pH is well buffered in most lakes on a long-term basis. As noted earlier, seasonal variations do occur (e.g., the 1974 data for First and Rocky Lakes and the 1976 data for Lake Charles), and are believed to represent the combined influence of rainfall events and changing relationships between algae and their consumers. The apparent decline in pH in Anderson Lake may be a consequence of acidic precipitation, or simply a function of when the samples were collected. The two earliest samples (1971) were collected in August and October when pH values are near their annual maximum; the other samples were collected in December (1984) and March (1991), periods with the lowest annual values (when the system is dominated by acidic precipitation, and plant productivity is low). Additional sampling during summer would help clarify the extent, if any, of the apparent pH decline. Similar reasoning applies to the pH decline in Lake William. More recent data have been collected from this lake (CWRS-TUNS, 1991) and should become available for public use in early May 1991. Table 6.12 lists potential surface water impacts during construction of the Highway 107 Extension and their mitigation.

6.3.2 Fisheries

The only fisheries data for the immediate area near the proposed extension of Highway 107 originate from lake surveys carried out by the Nova Scotia Department of Fisheries and the federal Department of Fisheries and Oceans. Much of this information has been summarized in a paper

Table 6.12 Significant Impacts on Surface Waters During the Five Stages of Construction of the Highway 107 Extension.

Construction Stage	Surface Water Body	Potential Concern	Risk Potential	Mitigation
1	McGregor Brook Juniper Lake Lake Charles	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and only one stream crossing	carry oil-absorbing materials for spills
2	Sucker Brook Rocky Lake First Lake	Siltation	low; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and no stream crossings	carry oil-absorbing materials for spills
3	Marshall Brook Wrights Brook Rocky Lake Lily Lake Anderson Lake	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization

Construction Stage	Surface Water Body	Potential Concern	Risk Potential	Mitigation
3 (con't)	Marshall Brook Wrights Brook Rocky Lake Lily Lake Anderson Lake	Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and only two stream crossings	carry oil-absorbing materials for spills
4	McGregor Brook Wrights Brook Juniper Lake	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and no stream crossings	carry oil-absorbing materials for spills
5	Sucker Brook Rocky Lake	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and only one stream crossings	carry oil-absorbing materials for spills

published by Alexander *et al.* (1986). Other information was obtained from open files at the Nova Scotia Department of Fisheries and conversations with officials at the Department of Defence. No creel or stream surveys have been conducted in this area. Personal communications with local residents and fishermen indicate that some of the smaller lakes and streams near the proposed highway do have Brook Trout (Salvelinus fontinalis) populations and are occasionally fished (Enchanted Lake and Wrights, Marshall, and McGregor Brooks).

Historical records of the occurrence of fish species in the lakes that might be impacted by highway construction or operation, and any additional information concerning estimates of fishing intensity by recreational fishermen and stocking records, have been summarized in Table 6.13. Estimates of fishing intensity are usually based on proximity to population centres.

With the exception of the large lakes near population centres (First, William, Charles, and Micmac), fishing intensity is estimated to be low. Based on earlier discussions of water quality impacts, it is unlikely that recreational fisheries in any of the lakes will be significantly impacted by normal highway operations. Short-term impacts from construction activities are also unlikely to impair fisheries or fishery habitats in lakes or streams so long as preventive mitigation measures are carried out (e.g., controls for embankment erosion and siltation). The major "chemical" control on fish distribution and abundance in Nova Scotian lakes appears to be the acidity or pH of the water (see Smith *et al.*, 1986). Unless acidic drainage occurs from exposed rocks or fill, highway construction and operation should not influence the fisheries.

6.4 Historical and Cultural Resources

The historical and cultural resource assessment of the proposed Highway 107 Extension involved a three-phase approach; detailed planning, review of existing heritage resources and a field survey. This methodology was approved by the Nova Scotia Museum and was carried out under Heritage Research Permit (Archaeology) No. A1991NS2.

Detailed Planning

The planning phase was directed at familiarizing the research team with the terrain and potential types of heritages resources along the route. This was accomplished with the aid of aerial

Table 6.13 Major Fish Species and Fishing Intensity in Lakes Near the Proposed Extension of Highway 107 (Information from Alexander *et al.*, 1986, and Nova Scotia Department of Fisheries).

Lake	Fish Species	Estimate Fishing Intensity/ Other Comments
First Lake	White Sucker Brook Trout White Perch American Eel	heavy, especially in spring for hatchery-raised brook trout; active stocking program of yearling trout in 1980 and 1984-1990 (N.S. Dept. of Fisheries Code # 08119)
Rocky Lake	White Perch American Eel Smallmouth Bass Banded Killifish	low to moderate; no stocking information in N.S. Dept. of Fisheries database - Stocking Code # 08885); Sucker Brook drains into this lake
Lily Lake	Brook Trout White Sucker	low to moderate; not stocked
Anderson Lake	White Sucker Brook Trout Rainbow Trout	low; no recent reports of trout catches; rainbow trout stocking as early as 1899, but ceased earlier this century (Stocking Code # 08019)
Lake William	White Sucker White Perch Smallmouth Bass	moderate to heavy; not stocked (Stocking Code # 08853); Marshall and McGregor Brooks drain into this lake; Lake William is unlikely to be impacted by highway construction

Lake Charles	White Sucker White Perch Yellow Perch Atlantic Salmon Smallmouth Bass	moderate to heavy; stocked with yearling brook trout in 1988 (Stocking Code # 08018)
Lake Micmac	White Sucker White Perch Smallmouth Bass	heavy; not stocked (Code # 08907); this lake receives discharge from Juniper Lake via Grassy Brook; Lake Micmac is unlikely to be impacted by highway construction

photographs and large-scale maps. A series of orthophotographic maps was used to define the limits of the proposed highway and study corridor. The combined experience of the team in heritage land use patterns resulted in five areas along the route being designated as having a moderate potential for heritage resources. During this process no area was designated as having high potential.

The five moderate potential areas for heritage resources were:

a) A 600 metre (1970 feet) area around Enchanted Lake.
b) A 700 metre (2300 feet) area on either side of a small tributary of Marshall Brook.
c) An 1800 metre (5900 feet) area of highground north of Anderson Lake.
d) A 500 metre (1640 feet) area northeast of Lily Lake.
e) A 500 metre (1640 feet) area where Connector "B" crosses Sucker Brook.

Heritage Inventories

Phase two involved consultation with heritage agencies and cultural resource managers. Maps of the proposed route and corridor were shown to these individuals and they were asked if any known cultural resources would be impacted by the proposed highway. The consultation process included the following agencies and individuals:

a) Nova Scotia Museum, Halifax
Dr. Brian Preston,
Curator of Archaeology
b) Dartmouth Heritage Museum, Dartmouth
Mr. Sid Gosely, Directory
c) Fultz House Museum, Sackville
Mr. David Grace, Local Historian
d) Town of Bedford Planning Department Bedford
Ms. Donna Lohnes-Davis, Town Planner

The consultative process revealed a single potential cultural resource located where Connector "B" meets the Old Cobequid Road. The first segregated Black school in Sackville was situated at this location. The historical significance of this feature has been greatly diminished in that the entire building was removed in 1960 and relocated. The school is recorded in historic documents with photographs, and additional histories could be obtained from former students still living in the Sackville area. It is doubtful, however, that an archaeological excavation would produce any useful data beyond what are already available. Thus, no mitigative measures are recommended for this site.

Field Survey

Phase three involved a pedestrian survey of the entire length of the corridor. A two-person team of experienced archaeologists walked the route. The survey was timed to correspond to periods when no snow was covering the study area. Particular attention was paid to water crossings and to elevated features. The team conducted checks of exposed bedrock and large boulders in prominent places for petroglyphs, but none were found. This aspect of the study was deemed necessary as known petroglyphs are situated in similar terrain in the Town of Bedford. The survey did not reveal any historical or cultural resources within the corridor.

Although outside of the corridor a section of the Shubenacadie Canal is in close proximity to the proposed Highway 107 Extension, Stage 1 of the construction schedule includes the overpass connecting Highway 107 and Highway 118. Since two major highway bridges have been constructed over the canal near this location without impacting heritage and cultural features along the canal, no mitigation is recommended for this site.

In keeping with the "Terms and Conditions" (Number 2) of the Heritage Research Permit a written preliminary report will be filed with the Curator of Special Places, Nova Scotia Museum. The report will conclude that in terms of the Special Places Protection Act of Nova Scotia (1980 with Amendments from C.45, S.N.S. 1990) the proposed Highway 107 Extension will not impact upon any significant historical or cultural resources.

6.5 Socio-economic Environment

To identify any socio-economic impacts associated with the construction of the Highway 107 Extension, interviews were conducted with various government officials, economic development and planning personnel and business representatives. Potential Valued Environmental Components (VECs) examined from a socio-economic perspective include the following aspects:

- life-style/economic (time saving, safety, travel cost saving, construction and operation cost, impacts on overall economic output);

- demographic and housing (demand for housing, housing development, impact on property values, increased economic activity);

- land use (intrusion on current use of land - visually, noise, pollution, competing land use, impact on land ownership patterns, current and possible future uses of the land base); and

- physical infrastructure and community services (ability to cope with increasing demand, change in the type of demand on these services, change in location of demand).

The highway is expected to improve transportation efficiency by decreasing the time and cost required for transport. It will also contribute to the smooth operation of traffic between the communities of Dartmouth, Bedford and Sackville, provide easier access to markets and suppliers for firms located in the three industrial parks (Burnside, Bedford and Sackville), and provide improved access to the parks by the general public. The highway is also expected to decrease traffic in areas where traffic is heavy in relation to their design capacities (as outlined in Section 3.0). This will in turn reduce the number of motor vehicle accidents occurring in these areas.

Noise resulting from the heavy truck traffic along Rocky Lake Drive will be reduced as trucks are diverted onto Duke Street in order to access either Highway 102 or Highway 107.

A number of specific impacts were identified, and these impacts are described below. The impacts are summarized and their significance categorized in the VEC matrices.

The VECs identified are listed as follows:

- Sackville Industrial Park's access to Highway 107;
- Configuration of the proposed intersection located in the Bedford Industrial Park;

- Charles P. Allen High School;
- Development options for the Bedford Industrial Park;
- Residential properties along Rocky Lake Drive;
- Land near the NSPC transmission tower at the 107/118 interchange;
- Dartmouth regional park land located along Lake Charles; and
- Landlocked area at the interchange of Highway 118 and Highway 107.

These VECs and potential impacts are discussed further in Section 7 of this report.

6.5.1 Existing Zoning and Land Use

EXISTING ZONING

While most of the area to be affected by the highway is forested, the highway does pass through areas where residential, commercial and institutional developments are in place. Specifically, these areas include: the connections to Burnside Drive and Akerley Boulevard, the crossing at Rocky Lake Drive and through the Bedford Industrial Park, the connection at Glendale Drive and the connection to Cobequid Road at First Lake (Connector "B"). The current zoning patterns are as follows:

SACKVILLE AREA

Cobequid Road (Sackville Drive to Glendale Drive)

The north side of this section of the Cobequid Road is primarily zoned as residential. The south side is primarily zoned as light industrial and general business.

Cobequid Road (North of Glendale Drive)

The north side is zoned residential and contains small areas zoned for general businesses. The south side includes the Sackville Industrial Park (zoned light industrial). The area further east on the south side is primarily zoned rural residential.

The proposed highway connects with Sackville Industrial Park as an extension of Glendale Drive, and passes through land zoned for rural residential use where it is proposed to connect to Cobequid Road in the area of First Lake Drive.

Rocky Lake Drive/Bedford Industrial Park

The Highway 107 Extension is expected to cross Rocky Lake Drive in the area of the Bedford Industrial Park. The Bedford Industrial Park, located to the north of Rocky Lake Drive, is zoned light and heavy industrial. To the south of Rocky Lake Drive, the land is zoned residential. NSDTC estimates that six or seven houses along the south side of Rocky Lake Drive will have to be purchased by the Province in order to accommodate the proposed alignment. The Charles P. Allen High School (institutional zone) is located next to the Bedford Industrial Park, and the proposed highway is expected to pass between the school and Duke Street, within approximately 70 metres (230 feet) of the school.

Dartmouth/Burnside Industrial Park

The proposed Highway 107 Extension will connect directly to Burnside Drive and to the Akerley Boulevard extension within the Burnside Industrial Park. Lands in the area of Burnside Drive and Akerley Boulevard are zoned for general industrial use.

EXISTING LAND USE

Sackville Industrial Park

The Sackville Industrial Park has a total area of 91 hectares (225 acres) of which 10 hectares (25 acres) are now developed. In the industrial park, there are currently 350 jobs with 35 companies that are primarily light industrial, small manufacturing and service related. Further development of the Park is limited until direct access to Highway 102 can be provided. In fact, the Sackville Chamber of Commerce has indicated that the Park has lost six tenants that would have located in the Park if 100-series highway access to and from the Park had existed. Moreover, Park authorities are unwilling to undertake any further planning and servicing of the Park until the alignment of the new road and the linkage to Glendale Drive is finalized.

Sackville Community

A transformation of the residential properties to commercial has been taking place along Cobequid Road (primarily between Sackville Drive and Glendale Drive), possibly in anticipation of the new highway. This trend is expected to continue and will most likely escalate once improved access to Highway 102 has been established.

It is intended that Sackville develop a town centre in the area of Sackville Drive and the Beaverbank Road (on the land where the race track was formerly located). This would include highrise buildings in a central business district. Although the Highway 107 Extension may attract businesses away from the town centre and cause them to locate closer to the Sackville Industrial Park (a light industrial and business park), this trend is not expected to adversely affect the development of a downtown core planned for Sackville.

It is expected that the proposed highway will also influence the development of residential properties in the Sackville community (increased development of Millwood and Phase III of the Provincial Housing Authority are two examples). Once the highway is completed, the reduction in time and cost associated with travelling to Burnside, Dartmouth and Halifax will serve as a catalyst to bring people to the Sackville area to live while working in Dartmouth or Halifax.

Bedford Industrial Park

The Bedford Industrial Park has roughly 45 hectares (112 acres) with potential for an additional 81 hectares (200 acres). Presently five hectares (12 acres) of the Park are developed, of which two serviced lots remain. The sale of these lots has been postponed until the alignment for Highway 107 has been finalized. Consequently, there are no serviced lots available for purchase in the Park. Once construction has been completed, access to Highway 102 and to Highway 107 will open up new development opportunities for the Park. Development options are currently constrained by the fact that without access to the 100-series highways, the industrial park has been unsuccessful in attracting new businesses.

The St. Paul's Home For Girls owns a large percentage of the land in the Bedford Industrial Park. While they are not willing to sell the land, they would be willing to negotiate a lease arrangement with the Town of Bedford that would allow the Town to develop the land. Negotiations for the land have been ongoing between the St. Paul's Home for Girls and the Town of Bedford. Because of the heavy truck traffic operating on Rocky Lake Drive, the Town of Bedford is reluctant to encourage development of the Bedford Industrial Park if that would ultimately put more truck traffic on Rocky Lake Drive.

Burnside Industrial Park

The proposed highway is expected to be a major economic benefit to the Burnside Industrial Park. Burnside grew at such a fast rate in the 1980s that unless the Highway 107 Extension is constructed Burnside will "choke on its own success". During the growth over the 1980s, the City of Dartmouth was unable to keep pace with the expansion experienced by the industrial park, and necessary improvements to transportation links serving the park were not made. The proposed highway is expected to alleviate present and future access problems as Burnside continues to be developed.

There is a large area of land to the northeast of Burnside Industrial Park that is currently unserviced and is classified as a holding zone until the City of Dartmouth decides the best use for it. The new highway will open up these areas for additional land use options.

PHYSICAL INFRASTRUCTURE AND COMMUNITY SERVICES

Sackville

The new highway will provide better and more access routes to the Sackville community. This is expected to positively impact a number of the community services such as police, fire and ambulance. The water and sewer services in Sackville are currently operating at capacity. Additional capacity to the system is possible if the existing system can be made to be more efficient; however, new developments will have to be monitored closely. Water and sewer services are available along the Cobequid Road area, and a small number of serviced lots remain in the Sackville Industrial Park. There may be capacity constraints, however, unless the County is able to prolong the existing services by making them more efficient. If additional services are required, priority will be given to extending services in the Sackville Industrial Park.

Bedford

The Highway 107 Extension is not expected to impact community services significantly in the Town of Bedford. Additional services are required to service the Bedford Industrial Park to the fullest extent; however, the existing system will be able to handle the extra capacity generated by development of the Park.

Dartmouth

The Highway 107 Extension is not expected to significantly impact community services in the City of Dartmouth. There remain large areas of undeveloped land within the Burnside Industrial Park and the City of Lakes Business Park. This land can be serviced under present conditions without straining the existing system. Burnside Industrial Park and the City of Lakes Industrial Park are limited, however, in their ability to expand northeast by the grade of the land. Beyond a certain point the sewage and water services will no longer flow by the force of gravity. Therefore, if the lands to the northeast of Burnside are to be serviced, a major trunk sewer would be required, which would circle Lake Micmac and run parallel to Highway 118.

6.6 Summary List of Valued Environmental Components (VECs)

A list of VECs was produced for each stage of the project. These components are defined as follows:

1) components that are generally considered rare or threatened;
2) components that are already being negatively impacted in the area;
3) components that have shown a high environmental sensitivity in other areas;
4) components that play a crucial role in the integrity of the ecosystem; and
5) components that are perceived by the public to be important.

Table 6.14 presents a summary list of VECs for each of the five stages of the project. These components are discussed further in the remaining section of the report. No valued historical or cultural resources were identified. Figure 6-8 shows the location of the terrestrial biological VECs in the study area.

Table 6.14 Summary List of Valued Environmental Components

STAGE	VALUED ENVIRONMENTAL COMPONENT
All Stages	Soils
	Air Quality
	Noise Level
	Potential Rare Plant Species
	Potential Rare Animal Species
	Animal Crossings
Stage 1: Portobello to Akerley Boulevard	Groundwater
	McGregor Brook
	Marshall Brook
	Lake William Water Quality and Fishery
	Juniper Lake Water Quality and Fishery
	Lake Charles Water Quality and Fishery
	Whip-poor-will
	Wetlands Habitat
	Land Near Utilities Transmission Line
	Dartmouth Regional Park Land
	Land Use Near Highway 118 Interchange
	Shubenacadie Canal Lock
Stage 2: Duke Street, Bedford, to Glendale Drive, lower Sackville	Rocky Lake Water Quality and Fishery
	Wetlands Habitat
	Private Well
	Ground Water
	Traffic on Glendale Drive
	Traffic on Rocky Lake Drive
	Access To Industrial Parks

STAGE	VALUED ENVIRONMENTAL COMPONENT
Stage 3: Burnside Industrial Park to Highway 102	Lily Lake Water Quality and Fishery
	Anderson Lake Water Quality and Fishery
	Rocky Lake Water Quality and Fishery
	Marshall Brook Water Quality
	Lake William Water Quality and Fishery
	Wrights Brook
	Enchanted Lake Water Quality and Fishery
	Flat Lake Water Quality
	Three Private Wells
	River Otter
	Wetland Habitat
	Charles P. Allen High School
	Residential Property
	St. Paul's Home for Girls - Property
	Access to Bedford Industrial Park
Stage 4: Akerley Boulevard to Burnside Drive	McGregors Brook Water Quality
	Wrights Brook Water Quality
	Flat Lake Water Quality
	Juniper Lake Water Quality and Fishery
	Whip-poor-will
	River Otter
	Great Horned Owl
	Black-throated Blue Warbler
Stage 5: 102 to Cobequid Road with Connection to Glendale Drive	Sucker Brook Wetland
	Sucker Brook

STAGE	VALUED ENVIRONMENTAL COMPONENT
Stage 5 (cont'd.)	Rocky Lake Water Quality and Fishery
	Three Private Wells
	American Beaver
	Waterfowl
	Land Use Along Cobequid Road
	Traffic on Glendale Drive

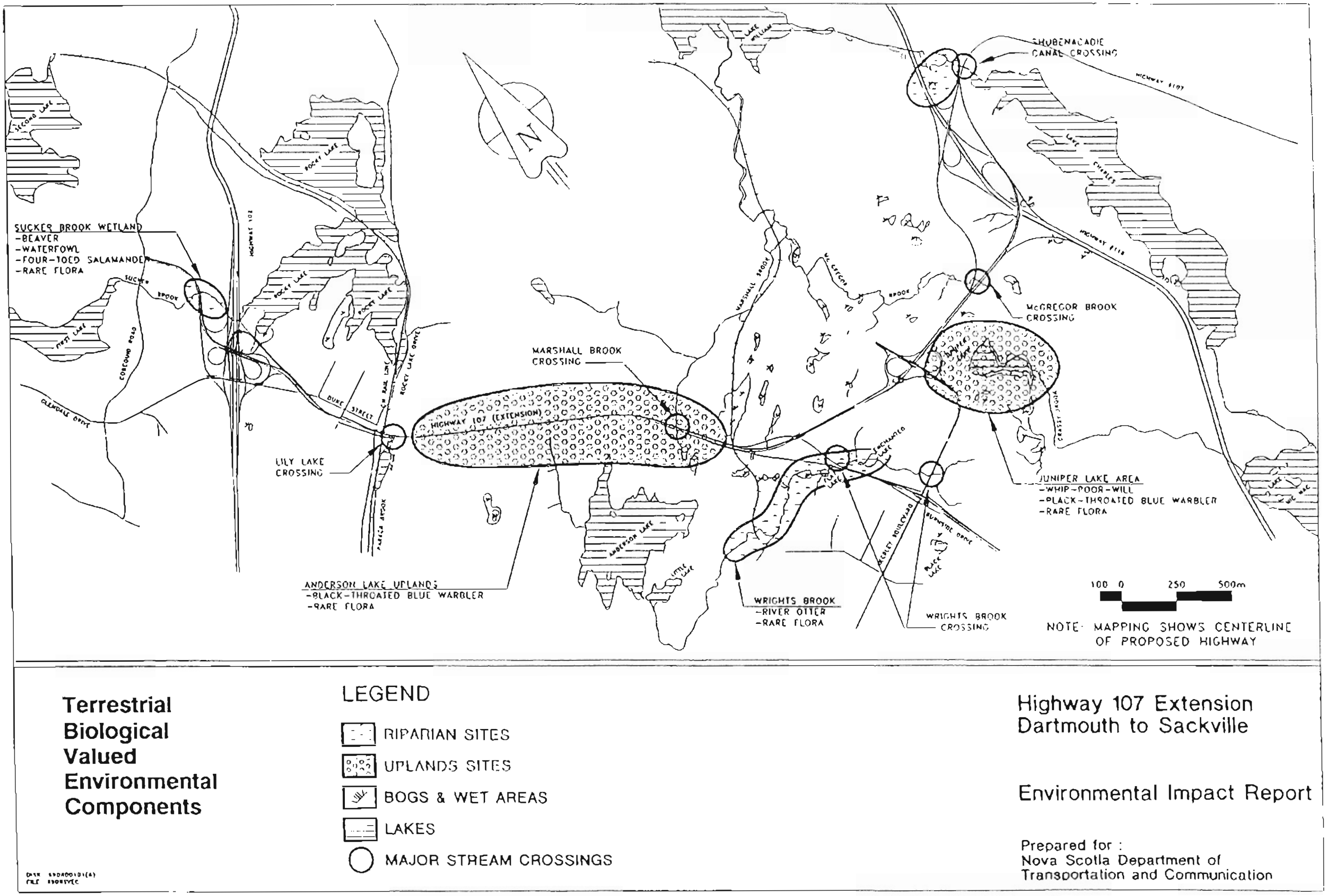


Figure 6-8. Highway 107 Extension, Dartmouth to Sackville: Terrestrial Biological Valued Environmental Components

7.0 IDENTIFICATION OF PREDICTED ENVIRONMENTAL IMPACTS

Once the VECs (Valued Environmental Components) were defined, it was necessary to predict whether the environmental impacts of project activities on the VECs would be significant. Although the determination of significance varied somewhat for the individual disciplines, generally an impact was considered significant if it met the following criteria:

- the impact creates a long-term (longer than one year) effect on the VEC or the environment,

- the impact is of such frequency that the VEC or environment cannot recover between the recurrences of the impact,

- the impact affects an already declining or endangered VEC, or

- the impact is of such magnitude that the environment, or the VEC, cannot recover.

Matrices of site-specific VECs versus project activities were constructed for each stage of the project. In order to score the seriousness of each interaction of project activities with VECs, measures to mitigate, reduce, or avoid the impacts were considered. These measures are discussed in Section 9 of this report. Each impact was scored as follows:

Low impact;
Significant but mitigable;
Significant, not mitigable;
Significance unknown; or
Positive impact.

The unknown categories are added because in many cases the impacts will not be known until further field surveys are carried out. In most of these cases, the occurrence of the VEC, and the extent of the occurrence, are based on known occurrences in other similar areas and have not been confirmed for the study area. Mitigable means that measures are available which can significantly reduce the environmental impact.

Figures 7-1 through 7-5 present the environmental impact matrices for each stage of the project. These impacts are discussed in the remainder of this section of the report.

7.1 Impacts Common to All Stages of Construction

7.1.1 Air Quality

During the time of construction, the primary source of air pollution will be heavy-duty diesel vehicles involved in earth-moving operations and in on-site activities in all stages of construction of roadways, ramps, and bridges. Equipment/activities responsible for air pollution at all stages of the construction are listed in Table 7.1.

The most serious air pollutants released during the construction phase are diesel engine exhausts and particulate matter.

Diesel exhausts are emitted from heavy-duty diesel vehicles at all construction phases. Chemical characterization of exhaust has shown that emission levels of hydrocarbons, carbon monoxide, nitrogen oxides, and particulates are in the range of grams per kilometre driven for a heavy truck moving at an average speed of 22.9 km/h (Westerholm *et al.*, 1991). These pollutants are dispersed into the surrounding air while the vehicle is in motion and therefore do not create air pollution problems. Humans object to smoke and odorous exhausts from the diesel engines near slow-moving vehicles and stationary equipment. Because this phenomenon occurs near individual operating units, the nuisances can be severe at a construction site but usually do not extend throughout the neighbouring community.

Prediction of air pollution levels is often limited to the main components of diesel exhaust which are carbon monoxide (CO) and nitrogen oxides (NO_x). Others, such as particulates, hydrocarbons, and aldehydes, though by no means negligible, are emitted only in low concentrations.

VALUED ENVIRONMENTAL COMPONENTS

STAGE 1.

Portobello to Akerley Boulevard

PROJECT ACTIVITIES	WATER								LAND		TERRESTRIAL BIOLOGICAL						AQUATIC BIOLOGICAL						SOCIO-ECONOMIC			CULTURAL
	Surface Water	- McGregor Brook	- Marshall Brook	- Lake William	- Juniper Lake	- Lake Charles	Ground Water	- General quantity (acid drainage)	Soil Erosion	Soil Contamination	Flora	- potential habitat for rare species	Fauna	- whip-poor-will	- habitat for 4-toed salamander	- animal crossings	- fisheries:	- Lake Charles	- Lake William	- wetlands habitat	- McGregor Brook	- Marshall Brook	- utilities: transmission line	- regional park land	- landlocked area at 118	- Shubenacadie Canal Lock
CONSTRUCTION PHASE																										
Normal Activities:																										
Clearing		O	O	O	O	O			O			*		*	*	*		O	*	O	O	*	•	O	O	
disposal of merchantable timber																										
disposal of non-salvageable material																										
Grubbing		O			O	O			O			*		*	*	*		O	*	O	O	*	•			
disposal of non salvageable material																										
Sub Grade and Drainage																										
- drilling							O							*												
- blasting							O							*												
- excavating		O	*	*	O	O	O		O									O	*	O	O	*				
- filling operation		O	*	*	O	O			O									O	O	O	O	*				
- alteration of stream crossing		O	*						O			*			*	*					O	*				
- disposal of excess material		O	*	*	O	O			O			*			*			O		O	O					
- clean up - slope grading		O			O	O			O																	
- Hydroseeding																										
Gravelling																										
Paving																										
Finishing Activities:																										
- center line painting																										
- installing guard rails																										
- installing lighting																										
- erecting signs																										
Surface Water Runoff		O	O		O	O						*			*			O	*	O	O					
Vehicle / Equipment Movement		O							O			*		*	*	*										
Equipment Noise														*	*	*										
Human Disturbance												*		*	*	*										
Vehicle / Equipment Emissions															*											
Accidental Events:																										
Petrochemicals Spill		●	●	●	●	●						*			*			●	●	●	●	●				
Petroleum Spill		●	●	●	●	●						*			*			●	●	●	●	●				
Other Hazardous Materials Spill		●	●	●	●	●						*			*			●	●	●	●	●				
OPERATION PHASE																										
Normal Activities:																										
Snow Ploughing																*										
Mowing																										
Salting		•	•	•	•	•									*			•	•	•	•	•				
Runoff from Vehicle Traffic		*	*	*	*	*												*	*	*	*	*				
Vehiclular Emissions																										
Increase in Traffic Volume																*										
Increase in Noise														*	*	O										
Changes in Traffic Patterns																										
Repaving																										
Repair																										
Accidental Events:																										
Petrochemicals:																										
Transport Spill		●	●	●	●	●		O							*			●	●	●	●	●				
Petroleum Products:																										
Transport Spill		●	●	●	●	●		O							*			●	●	●	●	●				
Other Hazardous Materials:																										
Transport Spill		●	●	●	●	●		O							*			●	●	●	●	●				

Key:

- • = Low Impact
- O = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-1 Environmental Impact Matrix, Highway 107 Extension: Stage 1

VALUED ENVIRONMENTAL COMPONENTS

STAGE 2.

Duke Street, Bedford, to Glendale Drive, Lower Sackville

PROJECT ACTIVITIES	WATER					LAND			TERRESTRIAL BIOLOGICAL				SOCIO-ECONOMIC			AQUATIC BIOLOGICAL		
	Surface Water	- Rocky Lake	Ground Water	- private well	- general quantity (acid drainage)	Soils	- erosion	- contamination	Flora	- potential habitat for rare species	Fauna	- animal crossings	- traffic outs Glendale Road	- traffic on Rocky lake Drive	- access to industrial parks	Fisheries	- Rocky Lake	wetland Habitat
CONSTRUCTION PHASE																		
Normal Activities:																		
Clearing		○					○			*		*					○	○
disposal of merchantable timber																		
disposal of non-salvageable material																		
Grubbing		○					○			*		*					○	○
disposal of non salvageable material																		
Sub Grade and Drainage																		
- drilling			•	•	*													
- blasting			•	•	*													
- excavating		○			*		○										○	○
- filling operation		○					○										○	○
- alteration of stream crossing		○					○			*		*					○	
- disposal of excess material		○					○			*								
- clean up - slope grading		○					○										○	○
- Hydroseeding		+					+										+	+
Gravelling		+					+										+	+
Paving																		
Finishing Activities:																		
- center line painting																		
- installing guard rails																		
- Installing lighting																		
- erecting signs																		
Surface Water Runoff		○					○			*							○	○
Vehicle / Equipment Movement							○			*		*						○
Equipment Noise												*						
Human Disturbance										*		*						
Vehicle / Equipment Emissions										*								
Accidental Events:																		
Petrochemicals Spill		●	○							*							●	●
Petroleum Spill		●	○							*							●	●
Other Hazardous Materials Spill		●	○							*							●	●
OPERATION PHASE																		
Normal Activities:																		
Snow Ploughing												*						
Mowing																		
Salting		•	•	•														
Runoff from Vehicle Traffic																		
Vehiclular Emissions																		
Increase in Traffic Volume												*						
Increase in Noise												○						
Changes in Traffic Patterns																		
Repaving																		
Repair																		
Accidental Events:																		
Petrochemicals:																		
Transport Spill		●		○	○												●	●
Petroleum Products:																		
Transport Spill		●		○	○												●	●
Other Hazardous Materials:																		
Transport Spill		●		○	○												●	●

Key:

- • = Low Impact
- ○ = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-2 **Environmental Impact Matrix, Highway 107 Extension: Stage 2**

VALUED ENVIRONMENTAL COMPONENTS

STAGE 3.

Burnside Industrial park to Highway 102

PROJECT ACTIVITIES	WATER												LAND		TERRESTRIAL BIOLOGICAL					AQUATIC BIOLOGICAL	SOCIO-ECONOMIC			
	Surface Water and Fisheries	- Lily Lake	- Anderson Lake	- Rocky Lake	- Marshall Brook	- Lake William	- Wright's Brook	- Enchanted Lake	- Flat Lake	Ground Water	- 3 private wells	- General quantity (acid drainage)	Soil Erosion	Soil Contamination	Flora	- rare plant habitat	Fauna	- River Otter	- animal crossings	Wetland Habitat	CP Allen High School	Residential Property	St. Pat's Home for Girls	Access to Bedford Industrial park
CONSTRUCTION PHASE																								
Normal Activities:																								
Clearing		○	○	○	○	○	●	○	○				○			*		●	*	○		○		○
disposal of merchantable timber																								
disposal of non-salvageable material																								
Grubbing		○	○	○	○	○	●	○	○				○			*		●	*	○		○		○
disposal of non salvageable material																								
Sub Grade and Drainage																								
- drilling							*	*	*	○	•	○						*						
- blasting							*	*	*	○	•	○	○					*						
- excavating		○	○	○	○	○	●	○	○	○	•	*	○					●		○				
- filling operation		○	○	○	○	○	●	○	○				○					●		○				
- alteration of stream crossing		○	○		○		●		○				○			*		●	*	○				
- disposal of excess material		○	○	○	○	○	○	○	○				○			*		○		○				
- clean up - slope grading		○	○	○	○	○	●	○	○				○					●		○				
- Hydroseeding		+	+	+	+	+	+	+	+				+					+		+				
Gravelling																								
Paving																								
Finishing Activities:																								
- center line painting																								
- installing guard rails																								
- installing lighting																								
- erecting signs																								
Surface Water Runoff		○	○	○	○	○	●	○	○				○			*		○		○				
Vehicle / Equipment Movement							●	○	○				○			*		○	*	○				
Equipment Noise																		*	*		○			
Human Disturbance							●	○	○							*		○	*	○	○			
Vehicle / Equipment Emissions																								
Accidental Events:																								
Petrochemicals Spill		●	●	●	●	●	●	●	●							*		●		●				
Petroleum Spill		●	●	●	●	●	●	●	●							*		●		●				
Other Hazardous Materials Spill		●	●	●	●	●	●	●	●							*		●		●				
OPERATION PHASE																								
Normal Activities:																								
Snow Ploughing																		*	*					
Mowing																								
Salting		•	•	•	•	•	•	•	•		•	•						•		•				
Runoff from Vehicle Traffic																								
Vehiclular Emissions																								
Increase in Traffic Volume																		●	*					
Increase in Noise																		○	○		○			
Changes in Traffic Patterns																								
Repaving																								
Repair																								
Accidental Events:																								
Petrochemicals: Transport Spill		●	●	●	●	●	●	●	○	○	○	○		○				●		●				
Petroleum Products: Transport Spill		●	●	●	●	●	●	●	○	○	○	○		○				●		●				
Other Hazardous Materials: Transport Spill		●	●	●	●	●	●	●	○	○	○	○		○				●		●				

Key:

- • = Low Impact
- ○ = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-3 **Environmental Impact Matrix, Highway 107 Extension: Stage 3**

STAGE 4.

Akerley Boulevard - Burnside Drive

PROJECT ACTIVITIES	WATER: Surface Water and Fisheries	· McGregor Brook	· Wright's Brook	· Flat Lake	· Juniper Lake	Ground Water	· General quantity (acid drainage)	LAND: Soil Erosion	Soil Contamination	TERRESTRIAL BIOLOGICAL: Flora	· rare plant habitat	Fauna	· whip-poor-will	· River Otter	· Great Horned Owl	-Black-throated Blue Warbler	· animal crossings
CONSTRUCTION PHASE																	
Normal Activities:																	
Clearing		○	●	○	○			○			*		*	○	○	*	*
disposal of merchantable timber																	
disposal of non-salvageable material																	
Grubbing		○	●		○			○			*		*	○	○	*	*
disposal of non salvageable material																	
Sub Grade and Drainage																	
- drilling																	
- blasting																	
- excavating		○	●	○	○		*	○									
- filling operation		○	●	○	○			○									
- alteration of stream crossing		○						○			*						*
- disposal of excess material		○	○	○	○			○			*			*			
- clean up - slope grading		○	●	○	○			○									
- Hydroseeding		+	+	+	+			+									
Gravelling																	
Paving																	
Finishing Activities:																	
- center line painting																	
- installing guard rails																	
- installing lighting																	
- erecting signs																	
Surface Water Runoff		○	●	○	○			○			*			○			
Vehicle / Equipment Movement								○			*		*	○	○	*	*
Equipment Noise													*	*	○	*	*
Human Disturbance											*		*	○	○	*	*
Vehicle / Equipment Emissions																	
Accidental Events:																	
Petrochemicals Spill		●	●	●	●									●			
Petroleum Spill		●	●	●	●									●			
Other Hazardous Materials Spill		●	●	●	●									●			
OPERATION PHASE																	
Normal Activities:																	
Snow Ploughing														*			*
Mowing																	
Salting		•	•	•	•									•			
Runoff from Vehicle Traffic																	
Vehicular Emissions																	
Increase in Traffic Volume													*	●	●	*	*
Increase in Noise													*	○	○	*	*
Changes in Traffic Patterns																	
Repaving																	
Repair																	
Accidental Events:																	
Petrochemicals:																	
Transport Spill		●	●	●	●		○		○					●			
Petroleum Products:																	
Transport Spill		●	●	●	●		○		○					●			
Other Hazardous Materials:																	
Transport Spill		●	●	●	●		○		○					●			

Key:

- • = Low Impact
- ○ = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-4 Environmental Impact Matrix, Highway 107 Extension: Stage 4

STAGE 5.

102 to Cobequid Road; Connections to Cobequid Road and Glendale Drive

PROJECT ACTIVITIES	WATER						LAND		TERRESTRIAL BIOLOGICAL				SOCIO-ECONOMIC	
	Surface Water and Fisheries	- Sucker Brook	- Rocky Lake	Ground Water	- 3 private wells	- General quantity (acid drainage)	Soil Erosion	Soil Contamination	Beaver	Animal crossings	Sucker Brook Wetland	Waterfowl	Land use along Cobequid Road	Traffic onto Glendale Road
CONSTRUCTION PHASE														
Normal Activities:														
Clearing		○	○				○		○	*	○	*		
disposal of merchantable timber														
disposal of non-salvageable material														
Grubbing		○	○				○		○	*	○	*		
disposal of non salvageable material														
Sub Grade and Drainage						*								
- drilling					•	*								
- blasting					•	*								
- excavating		○	○				○				○	*		
- filling operation		○	○				○				○	*		
- alteration of stream crossing		○					○		○		*	*		
- disposal of excess material		○	○				○				○	*		
- clean up - slope grading		○	○				○				○	*		
- Hydroseeding		+	+				+				+			
Gravelling														
Paving														
Finishing Activities:														
- center line painting														
- installing guard rails														
- installing lighting														
- erecting signs														
Surface Water Runoff		○	○				○					*		
Vehicle / Equipment Movement									*	*		*		
Equipment Noise									*	*	*	*	○	○
Human Disturbance									*	*	*	*		
Vehicle / Equipment Emissions														
Accidental Events:														
Petrochemicals Spill		●	●		○	○		○	●		●	*		
Petroleum Spill		●	●		○	○		○	●		●	*		
Other Hazardous Materials Spill		●	●		○	○		○	●		●	*		
OPERATION PHASE														
Normal Activities:														
Snow Ploughing														
Mowing														
Salting		•	•											
Runoff from Vehicle Traffic														
Vehiclular Emissions														
Increase in Traffic Volume									*	*	*	*		
Increase in Noise									*	*	*	*	○	○
Changes in Traffic Patterns														
Repaving														
Repair														
Accidental Events:														
Petrochemicals:														
Transport Spill		●	●			○		○			●	*		
Petroleum Products:														
Transport Spill		●	●			○		○			●	*		
Other Hazardous Materials:														
Transport Spill		●	●			○		○			●	*		

Key:

• = Low Impact
○ = Significant Impact, Mitigable
● = Significant Impact, Non-mitigable
* = Significance of Impact Unknown
+ = Positive Impact

Figure 7-5 Environmental Impact Matrix, Highway 107 Extension: Stage 5

Table 7.1. Sources and Types of Air Pollution

OPERATION	SOURCE OF POLLUTION	TYPE OF POLLUTION
Clearing	Burning of non-merchantable organic material, chainsaw, mechanical delimber, tractor-skidder, porter, tractor-drawn brush, trailer	Smoke, gasoline engine exhaust, diesel engine exhaust, particulate matter
Grubbing	Bulldozer, track-mounted excavator, conventional excavator, drag-line excavator	Diesel engine exhaust, particulate matter
Subgrade and drainage development	Excavator, front-end loader, truck, scraper, drill, bulldozer, blasting	Diesel engine exhaust, particulate matter
Highway base construction	Stone crusher, vibratory roller, truck	Diesel engine exhaust, particulate matter
Highway paving	Asphalt paving vehicle, truck	Engine diesel exhaust, odour
Striping, mounting of signs, lighting, and barriers	Small tools, air compressor, light truck	Gasoline engine exhaust
Bridge construction	Truck and other equipment; welding and painting	Engine exhaust, particulate matter

Fugitive dust (dust picked up by wind from the ground) may lower air quality during construction, especially in summer during dry and windy weather. Some land will be cleared, grubbed, and regraded, according to highway construction requirements. Exposed topsoil and some stored dusty construction materials may generate fugitive dust. According to available geological data, the surficial soils and subsurface strata are rocky, so the occurrence and intensity of fugitive emissions should be rather low, especially when the exposed soil is wet.

Other highway construction activities which are potential sources of dust are drilling and blasting. Fortunately, pneumatic drilling equipment is usually provided with a water spray which reduces dust emissions. Explosions may cause injection of a certain amount of dust into the air. Considering that explosions are of short duration and the material involved will be hard rock, anticipated dust emissions will be low.

Prediction of air quality levels from diesel exhaust for projected conditions involves the use of a mathematical diffusion model, a technique based on the location and quantity of emissions and on meteorological conditions. The calculation procedure used in this project is similar to that described in Ontario's Regulation 308 (Environmental Protection Act, 1988).

Some assumptions corresponding to real conditions have been made to estimate emissions of CO and NO_x from heavy-duty diesel engines which power construction vehicles (bulldozer, excavator, etc.). These assumptions are as follows:

- diesel engine specifications: power 331 kW, 30 rps, compression ratio 16:1, swept volume 14 L;
- emission rate of CO is 60 mg/s and NO_x is 120 mg/s (Westerholm *et al.* 1991);
- three units powered by diesel operate simultaneously on an area small enough that it may be considered as a point source of emission.

Further assumptions are summer meteorological conditions (July) with mean SE-direction wind speed of 11.3 km/h. This is the lowest monthly-average wind speed based on yearly observations at the Shearwater Airport. These meteorological conditions also provide for the worst-case scenario (lower wind speed causes higher concentration of pollutants). It is also assumed that emission rates, meteorological conditions, and pollutants transportation patterns remain essentially uniform for all locations throughout the construction area.

Results from the computer model revealed that the maximum concentration of CO and NO_x (expressed as NO_2) should not exceed 20 parts per million (23 mg/m^3 of air) and 200 parts per billion (0.38 mg/m^3 of air), respectively, near the source of emissions. These concentrations are in the range between desirable and acceptable values given as air quality objectives by the Nova Scotia Department of the Environment (see Section 8.2). Impacts of the project on air quality are therefore considered to be low.

7.1.2 Noise

Construction equipment which will be utilized during construction of the Highway 107 Extension will include a number of machines and devices varying in physical size, horsepower rating, and mode of operation. Consequently, they vary widely in the noise they produce. Even for equipment of a single model, variations in sound level at a fixed distance can be expected (May, 1978). The equipment will be used for the clearing of land, site preparation, excavation, compacting, paving, clean-up, landscaping, etc. As already noted, construction of the highway will be carried out in several reasonably discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics.

Noise may obstruct verbal communication, disturb sleep, and increase the risk of hearing damage. The range of sound levels of three categories of noise impact are given in Table 7.2.

Table 7.2 Noise Exposure, in decibel A [dB(A)], for Different Impact Effects

Noise Effect	Noise Level, dB(A)		
	Slight	Moderate	Severe
Speech Interference	no data	45 - 60	> 60
Sleep Interference	35 - 50	50 - 70	> 70
Hearing Damage Risk	70 - 80	80 - 95	> 100

Despite the variety in type and size of construction equipment, the similarities in the dominant noise sources and patterns of operation are sufficient to permit the review of various construction equipment in the following categories:

1) equipment powered by internal combustion engines,
2) impact equipment,
   and
3) other equipment.

Equipment Powered by Internal Combustion Engines

The internal combustion engine is used to provide propulsion for the wheels of trucks and/or operating power for the working mechanisms such as buckets, dozers, etc. Exhaust noise is usually the most important component of engine noise in the engine; however, noise associated with the air intake, cooling fans, and the mechanical and hydraulic transmission and control systems also can be significant.

Impact Equipment

This category of construction equipment includes pile drivers, rock drills, and small hand-held pneumatically, hydraulically, or electrically powered tools. The primary noise source for conventional pile drivers is the impact of the hammer striking the pile. Engine-related noise sources, such as combustion explosion or release of steam at the head of some equipment, are usually secondary. Engine noise is, however, the predominant noise source for pile drivers, equipment commonly used at bridge construction sites. The predominant sources of noise in pneumatic tools are the high-pressure exhaust and the impact of the tool bit against the material on which it acts.

Other Equipment

The two previous categories comprise a sizable portion of construction equipment; however, many types of construction equipment capable of producing significant noise do not fit either of these categories. For example, a power saw has an intense high-pitched whine, and a concrete vibrator produces noise as it shakes concrete forms.

Classification of road construction equipment according to function at the construction site is as follows:

1) earthmoving equipment (bulldozers, shovels, backhoes, front-end loaders, scrapers, graders, compactors);
2) materials handling equipment (cranes, movers, concrete pumps, asphalt pavers); and
3) stationary equipment (pumps, electric power generators, air compressors).

The noise emanating from construction sites is generally described by the A-weighted equivalent sound level to take into account the time-varying nature of the noise. The A-weighted scale expressed in A-weighted decibels dBA, or dB(A), closely approximates the response of the human ear. Most sound level meters available are equipped with an electronic system with the dBA capability. The ranges of A-weighted sound levels typical for road construction equipment which have been identified as major noise sources are given in Table 7.3 (Harris, 1979).

Prediction of Road Construction Noise Level

Total sound energy is essentially a product of a machine's sound level, the number of such machines in service, and the average length of time they operate. This measure is regarded as the best indication of the priority which should be given to the regulation of noise from the various sources.

Two different methods have been proposed for estimating the amount of noise on construction sites. One method defines acceptable noise levels at the boundary of the site or at the nearest residential or sensitive area. This is the "situation-specific" approach. The second, or "source-specific", approach involves specifying acceptable noise levels from each of the various items of equipment operating on the site.

Often it is impossible to compute levels of sound accurately for a planned construction project because of insufficient data. In such a case, a common practice in predicting noise level is to refer to similar past cases and to adopt reported findings. Typical ranges of equivalent sound level (L_{eq}) at construction sites in the USA (EPA, 1972) on public works, roads and highways were as follows:

- ground clearing 84 & 84 dB(A);
- excavation 88 & 78 dB(A);
- paving 79 & 78 dB(A);
- finishing 84 & 84 dB(A).

The first number refers to all pertinent equipment present at the site, and the second refers to the minimum required equipment at the site. All data concerns day-time operation.

A special case which involves excessive noise is blasting operations. These operations are covered by separate regulations in which safety plays an important role. Blasting will be monitored and results forwarded to NSDOE on a monthly basis unless otherwise decided by the department. Air blast (concussion) noise will not exceed a value of 128 dBA within seven metres (23 feet) of a building located on property other than where the blasting operations occur. Allowed ground vibration is 12.5 mm/s or less at peak particle velocity. Vibration should be measured below grade or less than one metre (three feet) above grade in any part of a building located on a property other than where the blasting occurs. Impacts of the undertaking on noise levels are considered significant but mitigable.

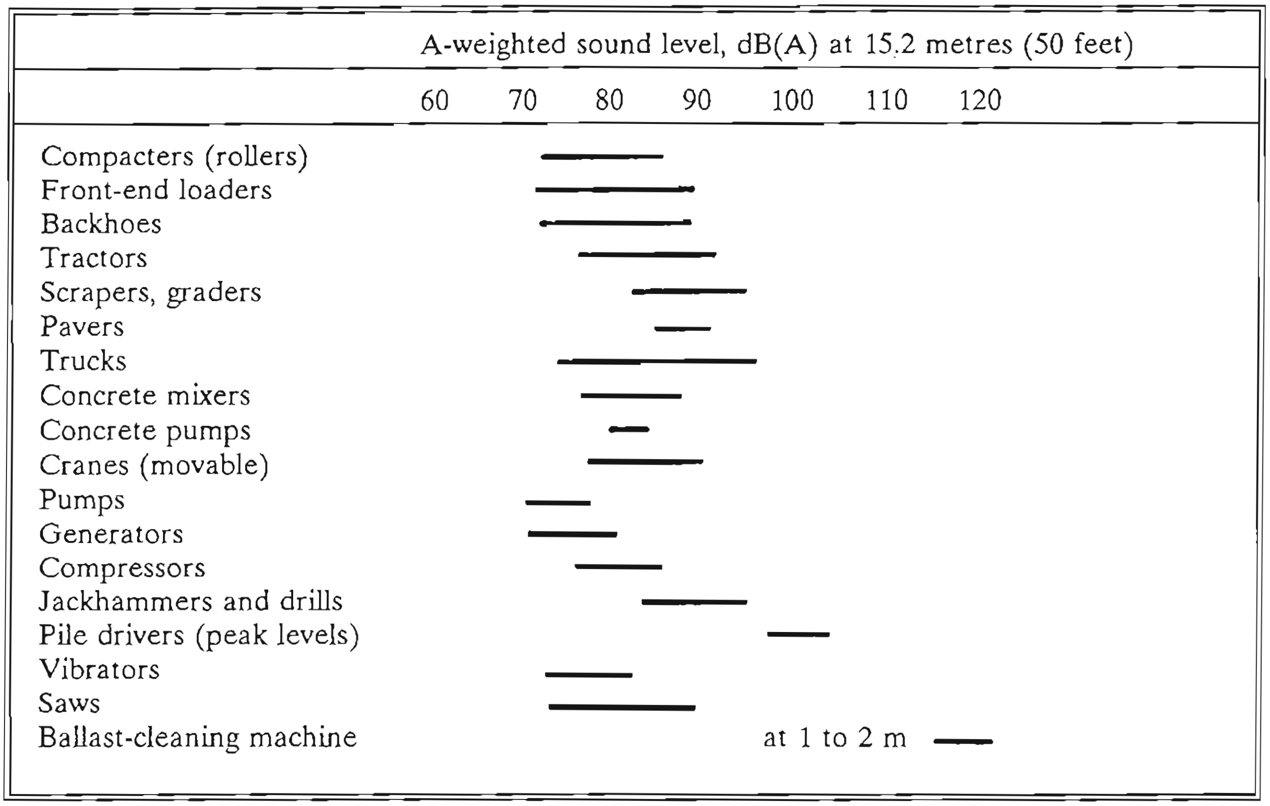
7.1.3 Acid Drainage

As explained in Section 6.2.1.2, exposure of acid-producing bedrock to air and water during excavation and blasting may lead to reduced pH and higher concentrations of such elements as mercury, lead, and arsenic in surface runoff. These conditions can lead to lake and stream acidification, fish kills, and changes in the structure of entire aquatic communities.

Testing of two rock samples from the area suggested that the potential for acidic drainage is low (see Section 6.2.1). Both samples contained less than the 0.4 percent sulphide criteria suggested by NSDOE and Environment Canada (1989) as the lower limit for acid-generating potential. Nevertheless, the impacts of acid-producing bedrock on surface waters and biota are potentially so severe and long-lasting that testing should be done at each location where bedrock will be exposed.

Mitigation methods for acidic drainage are described in Section 9.3. Because samples of rock in specific excavation areas have not been analyzed, these impacts are rated as unknown.

Table 7.3 **A-Weighted Sound Level Ranges of Road Construction Equipment**



7.1.4 Siltation of Water Courses

A primary concern during highway construction is the potential for increased loading of silt into streams, and subsequently into lakes after rainfall events, snowmelt, and movement of vehicles across streams. The silt clogs gravel beds that may be used by spawning Brook Trout and other aquatic organisms. Reduced water flow through the gravel also lowers oxygen concentrations for developing eggs and young, and silt particles are known to adsorb or contain pollutants such as heavy metals and petroleum products. Fortunately, adequate mitigation practices exist and should alleviate most of these concerns (see Section 9.4). Any residual problems, following storm events for example, are expected to be localized and short-lived. These impacts are rated as significant but mitigable.

7.1.5 Accidental Events

Accidents during the construction phase may result in spills of fuels or other toxic materials such as paint. The most significant impacts are on nearby streams and lakes. Although these systems are a small proportion of the total area, the probability of spills at water courses is considerably higher than elsewhere because of steeper slopes and softer ground. Unlike the larger spills that may occur during operation of the highway, these impacts are expected to be short-lived and relatively localized in nature. Excavation of contaminated soil may also lessen the impact on aquatic systems. Although spills can be prevented and contained to some degree by contingency planning and by refuelling off-site where possible, their impacts on surface waters are rated as significant and not mitigable because of the potential severity of spill impacts. Impacts on groundwater quality are rated significant but mitigable, since remedial actions after spills can prevent groundwater contamination.

7.1.6 Other Potential Impacts

Excavation

The excavation of soil or bedrock can influence local groundwater supplies. If a water well is located on the top of a hill and part of the hill is excavated for the highway, the water table will adjust to the change in topography. This will result in the lowering of the water table and possibly the dewatering of a well. Dug wells are especially sensitive to this.

In the study area the potential for the dewatering of water wells is low because no dug wells were identified and all drilled wells were at least 30 metres (100 feet) deep. These impacts are rated as low.

Blast Damage

Blast damage potential appears to be low as only four water wells were identified by the water well survey. The four wells could be affected by blasting during the construction of Stages 2, 3, and 5. Three of the four wells, however, are located near Municipal Contracting's gravel quarry, where blasting is an ongoing operation. It would be nearly impossible to distinguish the effects of this blasting from those of highway construction blasting. Domestic well locations are shown in Figure 6-3.

Blast damage can reduce the quantity of water produced by a well by closing the fractures which feed the well. Water quality may be affected by introducing new fractures, through which lower quality water may enter the well. These impacts are considered low, since owners of wells could easily connect to municipal water supplies. (A municipal water line has been installed on this section of Rocky Lake Road; the only additional line required for hookup would be from the road to the residence.)

Rare Flora

Rare flora have been identified as potentially occurring in all stages of the project but if and where they occur, and what impacts highway construction might have cannot be predicted until summer field surveys are conducted. In general, the major impacts of highway construction on plants occur during clearing and grubbing. Impacts can also arise because of drainage alterations (e.g. ponding) which may affect local soil, drainage, light, or microclimatic conditions which affect plant survival. Whether these impacts can be judged significant or warranting of mitigation depends on the rarity of the species and the likelihood that the project, in concert with other known or reasonably expected threats, jeopardizes the species' survival. These impacts are rated as unknown.

Fauna

The most important impacts common to all stages of the highway are habitat reduction and isolation and increased accessibility to humans. Although the actual areal loss of habitat associated with highway construction will probably be insignificant for most species, fragmentation of the remaining area into smaller parcels between which movement is restricted may potentially have an impact on certain species. For example, those having large territories or undertaking seasonal movements (e.g., Black Bear, White-tailed Deer, and Great Horned Owl) can exhaust the food supply in a small area relatively quickly and therefore travel among a number of food-containing "patches", giving recently-exhausted patches time to recover. By interfering with these movements, a highway can impact habitat over a larger area than that which is disturbed by construction.

Increased accessibility to humans may initially lead to increased hunting pressure, fire potential, and litter, and eventually, industrial expansion, all of which may have attendant impacts on many types of resident fauna. These impacts are rated as either significant, significant but mitigable, or unknown.

7.2 Impacts Specific to Stage 1

There are potential impacts on rare flora and fauna associated with Stage 1 since the area contains potential habitat for a number of rare plants and Four-toed Salamander, and is a reported breeding area for Whip-poor-will and Black-throated Blue Warbler. The exact locations of these species in relation to the highway, and its potential impacts on them, cannot be determined until a summer field survey is conducted. For flora, the optimum time for such a survey will span late May to August; for Four-toed Salamander, a survey could begin in April; and for the two bird species, it could begin in June. These impacts are rated as unknown.

Water Quality and Aquatic Biota

Many of the construction activities listed on the Environmental Screening Impacts Matrix will have significant environmental impacts on the water quality and aquatic biota of nearby streams and lakes. Increased silt inputs to McGregor and Wrights Brook, Lake Charles, and Juniper Lake will occur following clearing and grubbing of the route and excavation of the sub-grades and drainage channels. (Lake William should not be significantly impacted because of its distance from the development, approximately two kilometres [1.2 miles] away). As noted earlier, all of these impacts are mitigable by siltation control measures near streams and by revegetation of exposed soils (see Section 9.4). Gravelling and paving will also further reduce soil erosion and potential siltation of the aquatic environment. These impacts are rated as significant but mitigable.

Nova Scotia Power Corporation Transmission Tower at the Highway 107/118 Interchange

To accommodate the interchange at Highway 107 and Highway 118, the NSPC will have to move one of its transmission towers and possibly raise the transmission line. A representative of Nova Scotia Power Corporation has indicated that the tower will be moved to a location 30 metres (100 feet) away from its present location (Fletcher, 1991). The tower will still be located within the NSPC right-of-way and will not be near any water courses. The construction associated with tower relocation will take place approximately one month before highway construction begins and is expected to last one month. Although no adverse environmental impacts are expected, the plan will be reviewed by the NSPC Environmental Planning and Policy Group. This impact is rated as low.

Dartmouth Regional Park Land Located Along Lake Charles

There is some concern on the part of the City of Dartmouth officials that the amount of land required for the ramp connecting Highway 118 with Highway 107 (located on the Forest Hills side of the Highway 107/118 interchange) may impact the prospects for the City to develop this land, which the City has designated as regional park land. NSDTC has taken this into account in the design of the ramp, and efforts were made to minimize the amount of park land that will be used by the highway. It was also suggested by City of Dartmouth officials that if access could be provided to the park land from the interchange, it would greatly improve the prospects of developing the land as a park. It was suggested by officials at NSDTC, however, that providing access to the park land from the interchange is not feasible. The impact is rated as significant, but mitigable.

Landlocked Area at 118/107 Interchange

The interchange at Highway 107 and Highway 118 landlocks about 30 hectares (75 acres). In consultation with CBCL Ltd., Dartmouth officials estimate that if a change in the current alignment were made, the 30 hectares that would be isolated could be reduced to 19 hectares (47 acres) or even 10 hectares (25 acres). Such changes, however, would require reductions in the design standards which would be detrimental to highway safety. The City of Dartmouth has submitted a letter to NSDTC expressing their concern over the amount of land that will be isolated by the interchange; they have included plans that outline two suggested alignment alternatives. This impact is rated as significant but mitigable.

7.3 Impacts Specific to Stage 2

Because of existing disturbance in the Stage 2 area, there is little potential habitat for either rare flora or fauna.

Water Quality and Aquatic Biota

Increased silt inputs to Rocky Lake may occur following clearing and grubbing of the route and excavation of the sub-grades and drainage channels. Siltation control measures in drainage ditches and revegetation of exposed soils should eliminate most concerns (see Section 9.4). Gravelling and paving will also further reduce soil erosion and siltation of the aquatic environment. This impact is rated significant but mitigable.

Sackville Industrial Park's Access to Highway 102 and Highway 107

Direct access to the 100-series highways is essential for the future development of the Sackville Industrial Park. It has been suggested by members of the Sackville Chamber of Commerce Transportation Committee that more direct access should be provided to Burnside from the Sackville Industrial Park. They do not expect that vehicles will exit the Sackville Industrial Park in order to connect to Highway 107 at Cobequid Road (in the area of First Lake Drive). Rather, they expect vehicles accessing Highway 107 to do so via the Glendale Drive - Duke Street connection, thus creating potential traffic problems at the intersection located inside the Bedford Industrial Park. Although this concern is considered significant to the Sackville Industrial Park, the overall effect of the highway will be to increase the access to all three industrial parks. This particular impact is not rated on the impact matrix.

7.4 Impacts Specific to Stage 3

The Stage 3 area contains potential habitat for rare flora, Four-toed Salamander, Black-throated Blue Warbler, and is known to contain River Otter. Since the area has remained largely unexplored by naturalists, there is little information available on existing flora and fauna, and it is possible that other VECs might be identified. Before impacts can be predicted, the area must be resurveyed during the summer to determine exact locations of potential rare flora and fauna. The impacts are rated as unknown.

The Wrights Brook area is a relatively rich habitat which attracts a number of mammals including White-tailed Deer, Coyote, River Otter, Mink, Ermine, and Snowshoe Hare. Although these species can exist in close proximity to human settlement, the relative amount of habitat directly impacted by highway construction in this area will be large and will result in a large portion of

Wrights Brook being cut off from more extensive, undisturbed habitat to the northeast. This impact is rated as significant, not mitigable.

Water Quality and Aquatic Biota

Increased silt inputs to Marshall Brook, and Lily, Anderson, and Rocky Lake could occur following clearing and grubbing of the route and excavation of the sub-grades and drainage channels. (Note that Lake William, approximately four kilometres (2.5 miles) away, is not expected to be impacted). Siltation control measures near the streams and in drainage ditches should alleviate most of the potential impacts associated with construction. Particular attention is required for construction activities near Lily Lake, because resident trout populations and their food supplies may be severely impacted by water-borne silt. Hydroseeding, gravelling, and paving will be carried out as early as possible to reduce siltation problems.

Because of their proximity to the construction site, Enchanted Lake, Flat Lake, and Wrights Brook may not be adequately protected by available siltation controls. Reducing the duration of construction activities will lessen the environmental impact. These impacts are rated as significant but mitigable.

Configuration of the Proposed Intersection Located in the Bedford Industrial Park

Concerns have been raised over the design of the intersection in the Bedford Industrial Park that provides access to Highway 107. The design is such that two 90-degree turns must be made before a vehicle gains access to the on-ramp. It is expected that this design may hinder the manuverability of mobile home trailer trucks in the Park. This impact is rated positive, however, because the proposed highway will actually provide improved conditions for truck maneuverability.

Charles P. Allen High School

Since the proposed highway will pass within 70 metres (230 feet) of the high school, between the school and Duke Street, there is concern on the part of school personnel and the Halifax County School Board that the highway will be located too close to the school. They expect the highway to disturb the school's academic environment and to pose safety problems for the students and personnel attending the school.

Approximately 90 percent of the school's students are bused. There are approximately 12 buses, some making more than one trip, that travel to the school in the morning and afternoon. In addition, there are generally 100 cars, including those of students, parked at the school each day. While the school is now isolated from the heavy truck traffic on Rocky Lake Drive, the new highway will effectively redirect this truck traffic past the school. Although there is some concern regarding the safety of students, the present road beside the school will be maintained as a driveway, so that cars and buses travelling to and from the school do not have to travel on the proposed highway. Since the entry and exit ramps for Highway 107 will also be located between the school and Duke Street, it is expected that noise will be distracting to a number of the school's classrooms. This is especially true because trucks will be gearing down and gearing up to exit off and merge with traffic on Highway 107.

In order to estimate the degree of disturbance to the school, another high school located near a highway (the Bedford Junior High School near the Bedford Bypass) was examined. The school initially had problems with students crossing the highway as a short cut. The problem has been alleviated, however, by erecting a fence along the school grounds next to the highway and implementing a strict policy forbidding students to cross the highway. Plans for Highway 107 near Charles P. Allen include embankments and fences if necessary, to prevent students from crossing the highway. Very few students walk to school at Charles P. Allen, and few students leave the school on foot during lunch. Therefore, the safety problems associated with students crossing the roadways on foot are considered minimal. The high school now has an attendance of roughly 1,020 students, and this student body is expected to reach 1,200 over the next five years. The school is currently operating at or over capacity; if it is to accommodate additional students, it must expand or use portable classrooms. Although the proposed Highway does not require school property, the highway may limit the potential for the school to expand, as members of the Halifax County - Bedford School Board have indicated that they would be less willing to recommend further investment in the school because of its proximity to the proposed highway.

There is also concern that the construction of the highway will adversely affect the functioning of the school because of noise, heavy machinery traffic, and the flow of traffic in and out of the school yard. These concerns are addressed in Section 6.2.2.3 of this report. This impact is rated significant but mitigable.

Residential Properties Along Rocky Lake Drive

It is expected that the proposed highway alignment will require the Province to purchase approximately six or seven properties along the south side of Rocky Lake Drive. This impact is rated as significant but mitigable on the impact matrix, since the properties will be purchased. From the owners' point of view, however, this impact may be considered not mitigable.

7.5 Impacts Specific to Stage 4

Terrestrial Biota

After construction of Stage 3, Stage 4 will probably have a relatively small additional effect on most species. The Stage 4 area, however, contains potential habitat for a number of rare plants, the Blue-Listed Whip-poor-will and the uncommon Black-throated Blue Warbler. The impacts on these species cannot be predicted until summer surveys are conducted according to the schedule for Stage 1 given in Section 7.2. Therefore, the impacts are rated as unknown.

Water Quality and Aquatic Biota

Siltation of Enchanted, Flat and Juniper Lake, and the headwaters of McGregor and Wrights Brook may occur during Stage 4. Siltation control measures outlined in Section 9.4 should reduce the impacts on McGregor Brook and Juniper Lake, but they may be inadequate for Enchanted and Flat Lake and Wrights Brook. Reducing the duration of construction activities will lessen the environmental impact. Hydroseeding, gravelling and paving should also be carried out as soon as possible after completion of construction to reduce siltation problems. These impacts are rated significant but mitigable, except for where the highway crosses Wrights Brook.

7.6 Impacts Specific to Stage 5

As proposed, Stage 5 will cross the Sucker Brook wetland and may potentially have a large impact on the wetland fauna and flora. Beavers appear to have been responsible for creating this wetland, and they are probably the species at greatest risk from highway construction in the area. The area is also potentially a breeding area for such waterfowl as American Black Duck, Wood Duck, and Hooded Merganser. The latter two species are relatively rare cavity-nesters which benefit both from wetland creation and the flooding of potential cavity trees. This impact is rated as unknown.

6.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

6.1 Introduction

The description of the existing environment provides the basis for determining which ecological components may be impacted by the undertaking. The term "environment" includes biological, physical-chemical, and socio-economic aspects. This section of the report is divided into terrestrial, aquatic and socio-economic environments. A summary of Valued Environmental Components (VECs) is given at the end of this section.

6.2 Terrestrial Environment

6.2.1 Geology and Hydrogeology

In order to determine potential geological and hydrogeological impacts of the undertaking, it is necessary to understand present groundwater supplies and the types of soil and rock that may be excavated during highway construction.

6.2.1.1 Surficial Geology (Soils)

Surficial geology deals with the origin and composition of soils. The predominant soil of the study area is a glacial till, an unsorted, non-layered deposit of both clay and rock fragments ranging in size from pebbles to boulders. Tills were deposited by glaciers which covered the Province from 10,000 to 50,000 years ago.

The till across the study area is generally 1.5 metres (five feet) deep and can be broken down into two main types based on rock type, texture, composition, and origin. The first type is known as quartzite till which was deposited in sheets as the glacier moved across Nova Scotia. It is typically compact, bluish-greenish-grey, silty sand derived from underlying bedrock. The second type, deposited as the glacier melted, is a thin, sandy, grey to greenish-grey, bedrock till veneer containing large boulders.

6.2.1.2 Bedrock Geology

The study area is underlain by two bedrock formations, the Goldenville Formation and the Halifax Formation. Both are comprised of sediments deposited in an ancient ocean approximately five hundred million years ago. Because they are oceanic deposits, the sediments were composed of silt and sand layers. The rock types derived from these layers are known as argillites and greywackes, and the rock layers range in thickness from one to tens of metres. Locations where the rock layers were observed as outcrops are shown in Figure 6-1. The orientation of the rock layers is shown in Figure 6-1 in terms of the strike direction and dip angle of the bedding plane (see Figure 6-2). The strike of the rocks is the horizontal attitude of the layers while the dip is the angle at which the layers plunge into the ground.

The Goldenville Formation underlies the entire study area and consists of a bedded sequence of green to grey meta-greywacke and quartzite grading up and interbedded with units (generally less than one metre [three feet]) of thinly bedded green and black slates.

The interbeds of slate which are observed throughout the study area, especially the northern portion, appear to be closely associated with the argillites of the Halifax Formation. This green to greenish-grey, parallel-laminated argillite conformably overlies the Goldenville Formation and is referred to as the Goldenville-Halifax Transition (Keppie, 1986).

During the process which compressed the sediments into rock, the layers were folded up into anticlines and folded down into synclines. These folds can be viewed on Figure 6-1 as the Waverley anticline and the Bedford syncline. The pressures which folded the rocks also created breaks or faults in the rocks. In the study area a major fault was noted running from Bedford Basin to Lake William (Figure 6-1). Faults and folds are important geologically because their orientations allow one to trace the agrillite and greywacke layers across the study area. This becomes especially important if acid-producing geologic units are encountered.

Acid-producing bedrock contains sulphide-bearing pyrite (foolsgold) which, when exposed to air and water, reacts to produce sulphuric acid. As the acid forms, it may react with other minerals in the rock and dissolve naturally-occurring metals (mercury, arsenic, lead, etc.) which can then be

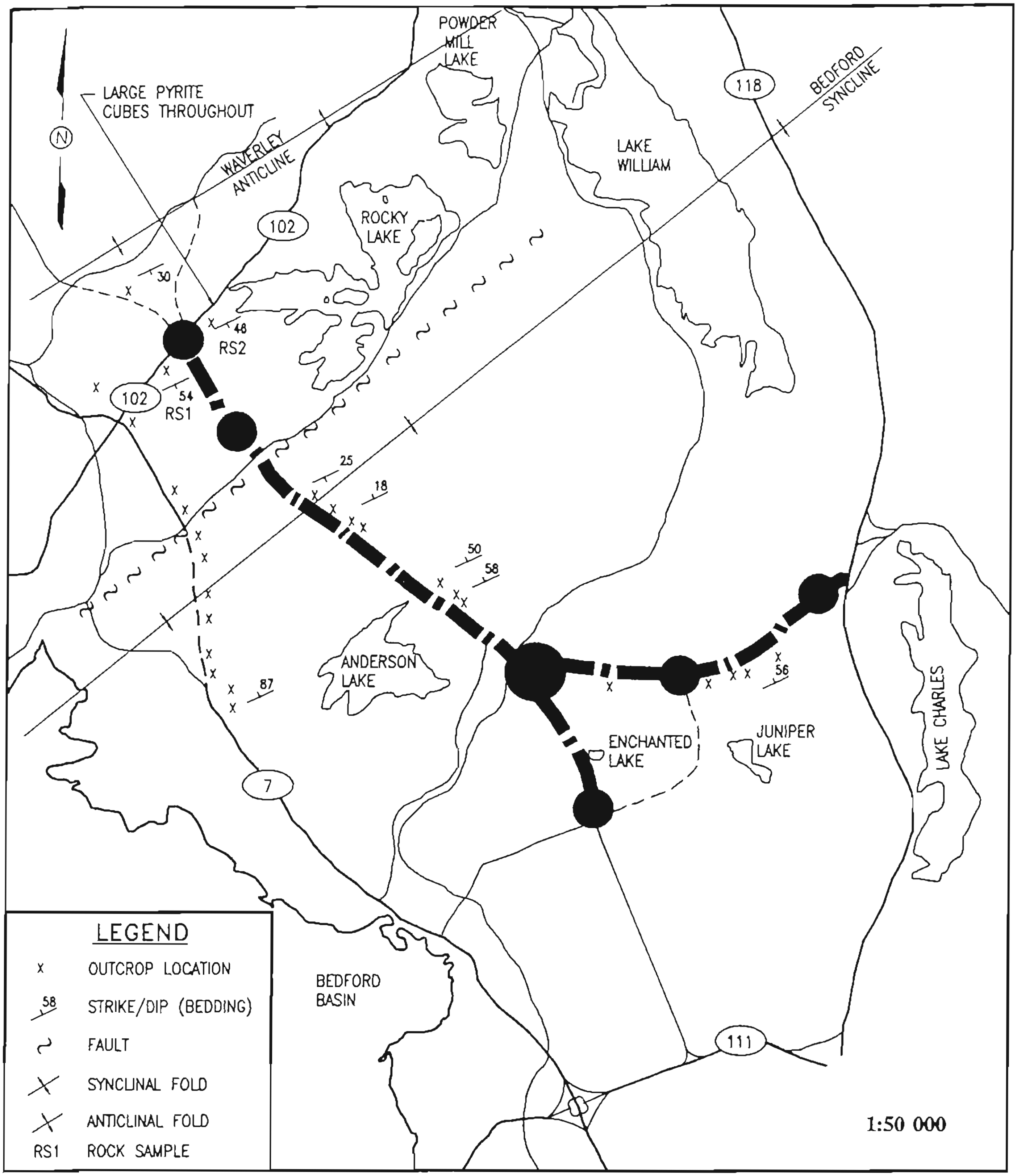


Figure 6-1. Highway 107 Extension, Dartmouth to Sackville: Geology Map

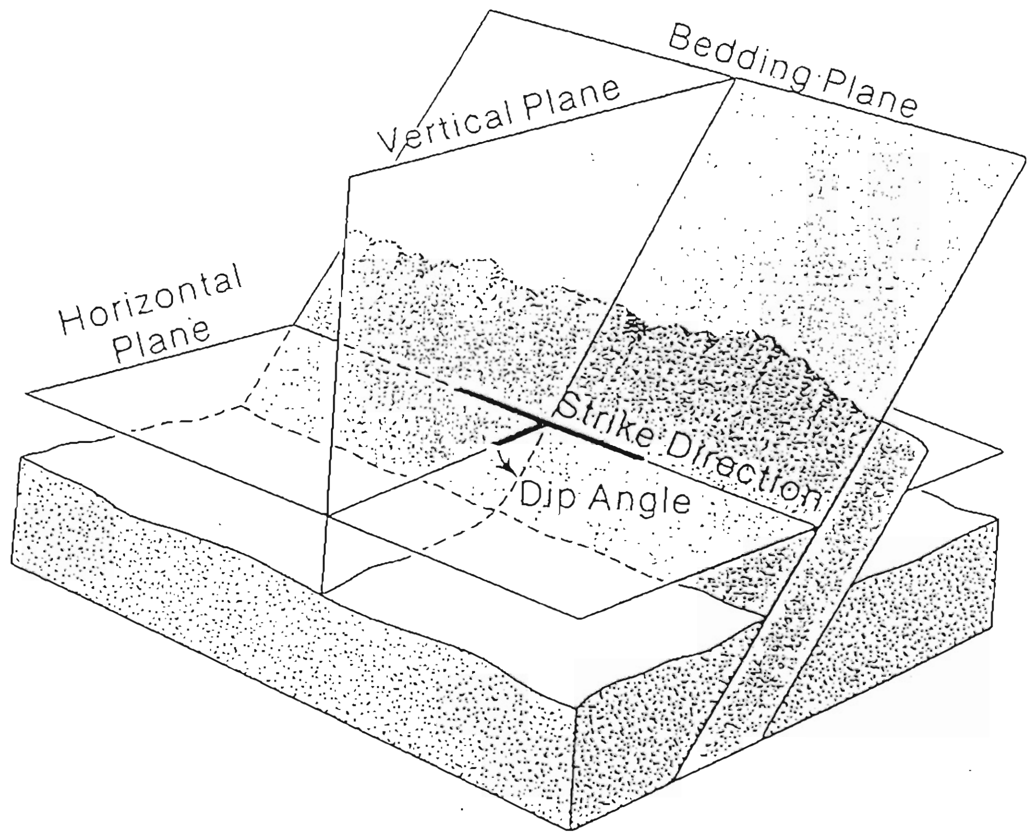


Figure 6-2. Diagram showing strike direction, dip angle, and bedding plane of bedrock.

transported via runoff to ground- and surface water. The excess acid and metals degrade the quality of potable groundwater and aquatic habitats and result in unfit drinking water and fish kills. A single exposure of acid-producing rock can produce acidic runoff for 20 to 50 years.

NSDOE and Environment Canada's *Guidelines for Development on Slates in Nova Scotia* (1989) have provided a criterion for determining if a particular type of rock can be considered acid-producing: if sulphide content exceeds 0.4 percent and the rock does not contain sufficient minerals (e.g., calcium) to neutralize the acid, the rock is considered acid-producing.

Samples of both argillite (RS-1) and greywacke (RS-2) rock types were collected at the locations shown on Figure 6-1. The argillite sample contained 0.04 percent and the greywacke sample 0.28 percent sulphide. Both values are below those necessary for significant acid production. Since these two rock types represent the types found throughout the entire study area, it is unlikely that acid-producing rock will be found. It will, however, be necessary to test for acid-producing bedrock in any areas to be cut or excavated.

6.2.1.3 Groundwater

The average depth to the water table in the study area is 1.5 metres (five feet). Because only a thin layer of till covers the bedrock, the water table is predominantly within the bedrock. Flow rates for wells in the area can vary from five to twenty litres per minute (one to five gallons per minute) and are predominantly fracture-flow controlled. Fracture flow is the movement of groundwater via small fractures and breaks in bedrock. Disturbance of these fractures by, for example, blasting or excavating can alter water quality by introducing new fractures; water quantity can be affected by the closing of existing fracture planes.

Groundwater quality in private wells in the area is generally poor. Two of four wells identified in the study area and sampled contained excessive turbidity and colour. One well water sample contained excessive arsenic (greater than 0.05 mg/L), and only one well (WS-2) was within the Canadian Drinking Water Guidelines for all parameters tested. Test results for the contaminated wells were provided to their owners (APPENDIX E). Water sample results for the four sampled wells are listed in Table 6.1. Domestic wells in the study area are shown on Figure 6-3. Municipal water services are available over the entire study area.

6.2.2 Atmospheric Environment

6.2.2.1 Climate

Climate in the Dartmouth and Bedford areas is influenced by the close proximity of the Atlantic Ocean, and particularly by the southward-flowing cold Labrador Current along the coast. The climate of the region is rarely extreme. Only occasionally do temperatures rise above 32°C (90°F) in summer or drop below minus 18°C (0°F) in winter. Warming in the spring is delayed by frequent sea breezes. In autumn, there is a predominant flow of warmer air off the continent, and that season is characterized by generally comfortable temperatures.

Sea fog, or low level clouds, are most common in spring and early summer with southeasterly and southerly winds, and often persist after a shift to southwesterly winds. Partly for this reason the region reports an annual average of less sunshine than most of southern Canada. True cold fronts with typical and well-defined windshifts at the surface do not occur often. Thunderstorms are rare, even in summer, and seldom reach the intensity experienced in more central continental areas. Meteorological conditions, including wind speeds and directions, precipitation, and temperatures recorded in the vicinity of the Highway 107 Extension are shown in APPENDIX F (Environment Canada, 1982a, b).

The average yearly rainfall range is 810 to 1370 millimetres (32 to 54 inches). Rains are often heavy in the warmer seasons; dying hurricanes also bring on average one heavy rainstorm per year. Total annual snowfall is on average 200 to 300 centimetres (79 - 118 inches) in most sectors of Nova Scotia with the heaviest snowfall occurring during the months of December, January, February and March, and light snowfall in November and April. The frost-free season ranges from less than 100 days in some interior sections of Nova Scotia to over 160 days along the Atlantic Coast.

Table 6.1. Water Sample Results

Station	Chloride (mg/L)	Colour (T.C.U.)	Total Suspended Solids (mg/L)	Specific Conductance (μmhos/cm)	Turbidity (N.T.U.)	Arsenic (mg/L)	Sodium (mg/L)
WS-1	166.0	24	1.6	928	7.65	0.010	50.3
WS-2	44.0	6	1.3	336	0.61	<0.005	28.7
WS-3	82.0	19	<0.5	566	7.19	<0.005	34.8
WS-4	26.6	<3	<0.5	400	0.19	0.108	45.3
C.D.W.G.	<250.0	<15			1.00	0.050	<200.0

Notes:

C.D.W.G. - Canadian Drinking Water Guidelines from: Canadian Council of Resource and Environment Ministers (CCREM, 1987).

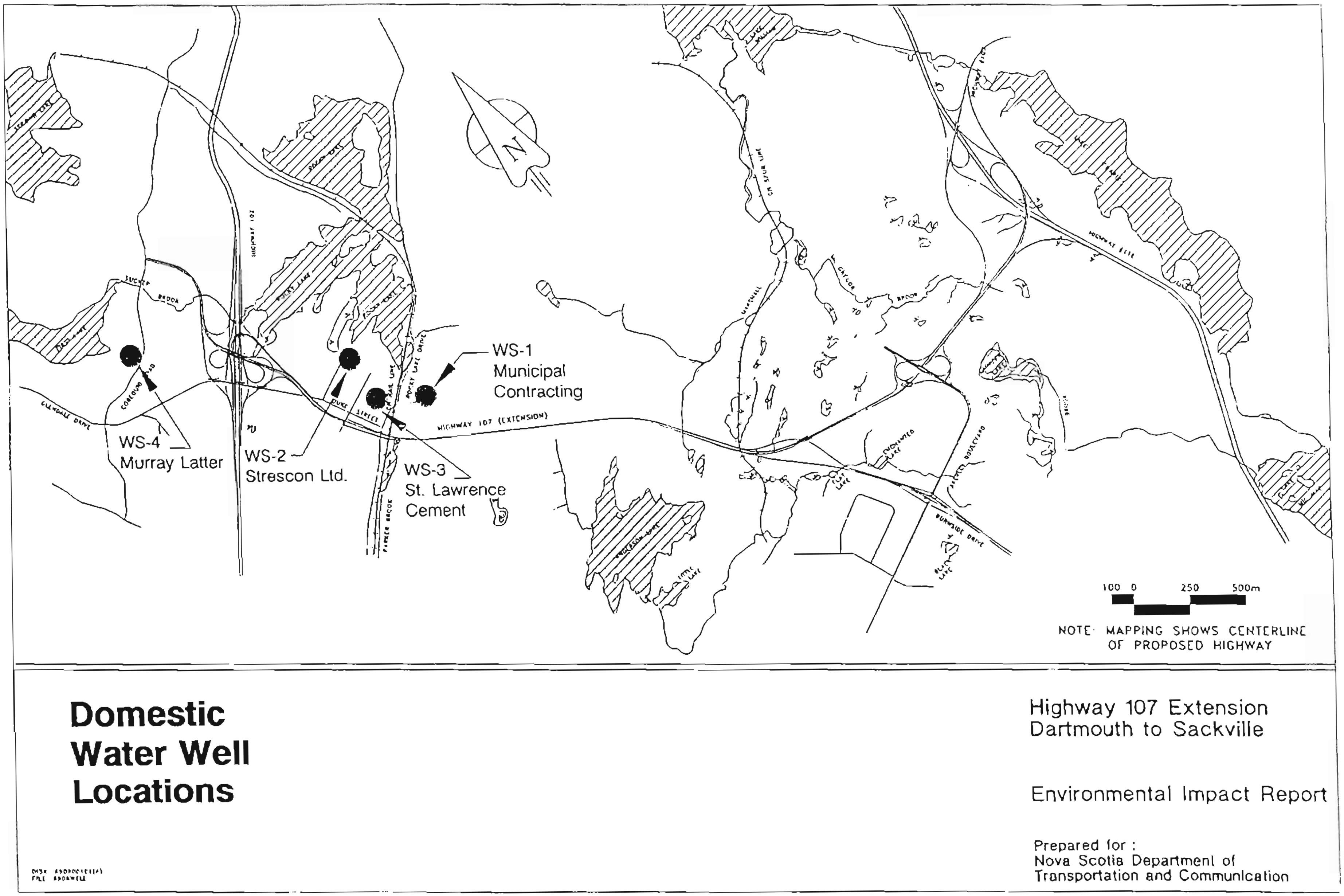


Figure 6-3. Highway 107 Extension, Dartmouth to Sackville: Domestic Water Well Locations.

6.2.2.2 Air Quality

Background air quality in the Dartmouth and Sackville areas is affected by existing large, stationary emission sources ("point sources") such as stacks and vents, and by many small ("non-point") sources such as automomobiles and open fires. Quality of air is defined by the concentrations of various gases, aerosols and hydrosols which are present to some degree in the atmosphere. They may be of a natural or man-made origin. Lower Sackville has a history of complaints received by Environment Canada, Environmental Protection Service (EPS) and NSDOE (Kozak, 1985) regarding wood stove operations. A study conducted in the Lower Sackville area from February to April 1984 reported average concentrations of total Suspended Particulate Matter (SPM) around 15 micrograms per cubic metre ($\mu g/m^3$). Acceptable concentration of the SPM specified in the Ontario Clean Air Act is 120 $\mu g/m^3$; therefore, dust levels associated with the construction of the Highway 107 Extension are well within acceptable values. Average total polynuclear aromatic hydrocarbons (PAH) concentrations were around six nanograms per cubic meter (ng/m^3), relatively low in comparison to other areas in Canada and the U.S. For example, in 1984 the average PAH concentration in Hamilton, Ontario, was 18.67 ng/m^3; in Toronto, it was 11.05 ng/m^3 (Kozak 1985).

The study area is generally undeveloped without influential emission sources in its vicinity. Topography, long-term wind velocity and direction, and the frequency of temperature inversions all prevent air pollutant buildup and persistence in the atmosphere. Generally, air quality in the area is good and is not suffering degradation from any particular source of air pollution.

6.2.2.3 Noise Levels

The proposed construction area of the Highway 107 Extension is in rocky, rugged terrain, covered with shrubs and trees (see Section 6.2.3). Such terrestrial conditions, which have a natural level of around 40 decibels, are responsible for dissipation of noise.

To assess the sound level produced by motor vehicles near Highways 102 and 107, as well as at the Burnside Drive Extension Interchange, members of the assessment team visited the area. It was confirmed that the existing highway transportation system (in terms of highway location, alignment and traffic flow) does not call for a noise measurement survey; there are no excessive noise-producing activities in the area.

Some areas in the vicinity of the proposed highway are affected by a higher-than-natural noise level from the existing roads and highways. For this reason, the following locations on or near the proposed Highway 107 extension are of interest with respect to noise levels:

- Highway 107/Highway 118 interchange;
- Akerley Boulevard/Burnside Drive intersection;
- Rocky Lake Drive and Bedford Industrial Park;
- Highway 102;
- Cobequid Road/Glendale Drive intersection;
- the CN railroad at the extension of Burnside Drive; and
- Charles P. Allen High School.

Charles P. Allen High School is of special concern. This school will be about 70 metres (230 feet) from the highway which will be several meters above ground level. Recognizing the importance of this location, a series of noise level measurements were conducted on March 19 and 21, 1991, during afternoon and morning hours, respectively.

The results of measurements (average values) for existing noise levels were:

- In front of the school = 71 dB(A)
- At the back of the school = 68 dB(A)
- Inside the school, ground level, class time = 63 dB(A)

For comparison purposes, measurements were also taken behind nearby Bedford Junior High School in an area between the school and the Bedford Bypass, approximately 50 metres (160 feet) from the Highway. The average measured noise level for Bedford Junior High School was approximately 79 dB(A). These values are above the Sound Level Limits (see Section 8.2). The school reduced the noise level by covering the windows facing the Highway with plywood. This reduces the noise level, but it also forces the school to use artificial light all the time. Such a method of noise control is not recommended for Charles P. Allen High School.

Wildlife areas which could be affected by anticipated construction noise and highway noise are described in Sections 6.2.3 and 6.2.4.

6.2.3 Flora and Habitats

The study area lies on the Atlantic Coastal Plain and contains a variety of forests ranging from low, dense hardwood to large hardwood and mixed forests. Pure stands of Red Oak (*Quercus rubra*) occur on some of the well-drained uplands especially near Burnside, Anderson Lake, and Juniper Lake. Red Maple (*Acer rubrum*) swamps occur in some of the low-lying areas, while spruce (*Picea* spp.) forest occurs near bogs and other low-lying areas. Herbaceous vegetation in the area has not been well studied (Wilson, 1991), but based on some of the forest associations present (e.g., pure oak, and oak-maple-birch [*Betula* spp.]) may include species typically found further south, and therefore uncommon to rare in Nova Scotia.

A series of physical processes has influenced floral development in the study area. The underlying bedrock provides few nutrients to plants. Glacial activity has left thin, nutrient-poor soils in all but low-lying areas. Fires and cutting, which increased in frequency and extent after the arrival of Europeans, have led to frequent disturbance of vegetation and loss of soil due to erosion. At present, the area is a mosaic of habitats differing primarily according to the frequency and intensity of recent fire disturbances and secondarily to factors such as soil quality and drainage.

A large forest fire burned much of the study area in 1963 (Nova Scotia Department of Lands and Forests [NSDLF], 1991). Smaller, more recent fires occurred in parts of the area, including Juniper Lake, on the order of five to fifteen years ago, as evidenced by the remnant pines (*Pinus*) and pine snags (standing dead trees) in "barren" areas. These sites are thickly covered with Lambkill (*Kalmia angustifolia*), blueberries (*Vaccinium* spp.), Huckleberry (*Gaylussacia baccata*), Rhodora (*Rhododendron canadense*), and Sweet-fern (*Comptonia peregrina*); Red Maple, birches, viburnums (*Viburnum* spp.), Downy Alder (*Alnus crispa*), aspens (*Populus* spp.), Pin Cherry (*Prunus* *pensylvanica*), shadbushes (*Amelanchier* spp.), Red Oak, and pines (*Pinus strobus* and *P. resinosa*) are scattered throughout as shrubs and small trees.

Habitats which have been less recently affected by fire range from young oak-birch hardwoods to more mature pine-oak and pine-oak-spruce stands, a few of which may be approaching old-growth status. Post-fire regeneration in most upland areas appears to have been fairly slow, doubtless a consequence of poor soil quality and intense fires which may have burned through the organic topsoil and exposed underlying mineral soil to erosion. Accordingly, vegetation is most developed in low-lying areas, especially along streams, where it is protected from fire and receives nutrients from elevated areas. The oldest forests in the area are probably no older than 100 to 150 years, as indicated by ring counts of stumps cut for highway survey lines, and are limited in extent, occurring mostly in low-lying and riparian (streamside) patches in the vicinity of Juniper Lake and McGregor Brook.

Most of the remaining mature forest in the area ranges from 35 to 70 years old and is dominated by White Pine and Red Oak, with Red Spruce (*Picea rubens*) being common in some areas. Red Maple, White and Yellow birches (*Betula papyrifera* and *B. allegheniensis*), Balsam Fir (*Abies balsamea*), Large-toothed Aspen (*Populus grandidentata*), and Red Pine (*Pinus resinosa*) are also present albeit less abundant in most areas. In richer riparian habitats, especially along Wrights Brook and McGregors Brook, additional species such as White Ash (*Fraxinus americana*), Eastern Hemlock (*Tsuga canadensis*), American Beech (*Fagus grandifolia*), Hazelnut (*Corylus cornuta*), and Sugar Maple (*Acer Saccharum*) may be found.

Younger forests in which the overhead tree canopy has only recently closed over tend to be dominated by a mix of oaks, birches, and aspens, with Red Maple, White Ash, pines, and Red Spruce common in wetter areas. There are, however, a few small areas of essentially pure Red Oak forest, notably on elevated ground between Juniper Lake and Enchanted Lake and also east of Anderson Lake. These areas have dense shrub layers of birches, Witch-hazel (*Hamamelis virginiana*), viburnums, aspens, Red Maple, and Downy Alder and are quite uncommon in the study area and in the Province generally. Such areas may have a particularly high potential for containing rare plants.

Exposed bedrock outcrops are scattered throughout the area and probably represent the effects of intense fires which exposed mineral soil to erosion. Outcrops are most abundant between Anderson Lake and Rocky Lake Drive.

The shores of lakes and stillwaters generally lack overhead tree cover and instead contain dense associations of such flood-tolerant species as Speckled Alder (*Alnus rugosa*), Sweet Gale (*Myrica gale*), Red Maple, viburnums, sedges (Family: Cyperaceae) and rushes (*Juncus* spp.). The narrow, fast-flowing portions of most streams are covered by an overhead canopy of trees; the ground vegetation consists of mosses, herbs, and ferns. In some areas, a fern indicative of relatively rich habitats (Ostrich Fern, *Pteritis pensylvanica*) is present, suggesting that intervale floral associations may be present.

Wetlands in the area include a number of bogs, some well drained and some waterlogged. Leather-leaf (*Chamaedaphne calyculata*), willows (*Salix* spp.), Bayberry (*Myrica pensylvanica*), Labrador tea (*Ledum groenlandica*), Tamarack (*Larix laricina*), and Black Spruce (*Picea mariana*) dominate the drier bogs while *Sphagnum* moss, Speckled Alder, and birches are additionally found in wetter areas.

Most stillwaters in the area are bordered by substantial floodplains and probably result from a combination of suitable topography and beaver activity, the best example being the Sucker Brook wetland. This wetland covers 3.9 hectares (9.6 acres) and is located along Sucker Brook between Highway 102 and Old Cobequid Road. The large number of snags (standing dead trees) suggests this wetland has expanded recently; at the time of the field survey (February 18, 1991), fresh workings indicated that beavers were still active in the area. Beavers, by cutting trees and building dams, provide valuable habitat features to other types of wildlife. In cut areas, saplings, shrubs, and a great variety of sun-loving herbs grow and provide food for bears, deer, hares, and grouse; stable water levels and snags provide habitat for waterfowl, muskrat, and turtles; fish may overwinter in the pond since it will not freeze to the bottom. Dominant vegetation in these areas includes flood-tolerant species such as Sweet Gale, Red Maple, ashes, alders, aspens, willows, chokeberries (*Aronia* spp.), and Canada Holly (*Ilex verticillata*). The Sucker Brook wetland is classified as a "good" wetland by the Nova Scotia Department of Lands & Forests ("[an] area . . . of value to wildlife . . . which often [has] the potential for development as better wildlife habitat . . . . The value of wetlands in this category should be reviewed before considering any developments on these sites". Nova Scotia Department of Lands and Forests, 1984).

There are at least two other locally significant wetlands within the study area. One of 3.6 hectares (9.0 acres) occurs along the Shubenacadie Canal near the intersection of Highway 118 and Highway 107 at Portobello. It is classified as a "better" wetland by NSDLF ("Areas of local wildlife value or ones that have outstanding wildlife potential. Wetlands in this category should be reserved for wildlife unless a high priority justifies other developments on these sites". NSDLF, 1984). The second "good" wetland occupies 4.7 hectares (11.6 acres) along the eastern shore of Rocky Lake.

Table 6.2 presents a list of rare plants which may be expected in the study area based on Maher *et al.* (1978), Roland and Smith (1969), records of the E.C. Smith Herbarium at Acadia University, Wolfville, and a superficial field survey of the various habitats conducted on February 18, 1991, by Ruth E. Newell, curator of the E.C. Smith Herbarium, Acadia University, and David MacKinnon, terrestrial ecologist with P. Lane and Associates Limited. These possibilities can be neither verified nor disproved until the coming spring and summer. Some of the species have not been reported for Halifax County but are included because of their occurrence in a neighboring county and/or in habitats similar to those in the study area. A species such as Mountain Sandwort (*Arenaria groenlandica*) which has been reported from Halifax County is a good candidate for being present. Relatively little field work has been carried out in the immediate study area to date. There is a chance, therefore, that something completely new to the Province exists in the area, hence the importance of conducting further field work at a more appropriate time of year (i.e., spring and summer).

6.2.4 Fauna

Mammals

A number of larger mammal species were detected in the study area during the winter field survey. The most abundant species, as indicated by the presence of tracks, were Snowshoe Hare (*Lepus americanus*) and Red Squirrel (*Tamiasciurus hudsonicus*). Others included Coyote (*Canis latrans*), Red Fox (*Vulpes vulpes*), White-tailed Deer (*Odocoileus virginiana*), Mink (*Mustela vison*), American Beaver (*Castor canadensis*), Muskrat (*Ondatra zibethicus*), River Otter (*Lontra canadensis*), Ermine

Table 6.2 Some Rare Flora of Nova Scotia and Their Potential Habitat in the Study Area (from Roland and Smith, 1969; Maher *et al.*, 1978).

Species	Habitat
Allium tricoccum Ait.	Rich woods and intervales; Threatened in Nova Scotia
Anenome quinquefolia L.	Shaded river banks and intervales; late May to early June
Anenome riparia Fern.	Stream banks and talus slopes
Antennaria parlinii Fern.*	Dry, open woods
Arenaria groenlandica (Retz.) Spreng.*	Rocky, granite barrens
Aster undulatus L.	Dry, open woods; Rare in Canada
Betula michauxii Spach.	Bogs (collected in Halifax Co. by Newell *et al.*, 1988)
Botrychium simplex E. Hitchc.	Damp or mossy clearings
Carex bromoides Schkuhr.	Swampy woods
Caulophyllum thalictroides (L.) Michx.	Rich woods and intervales; Threatened in Nova Scotia
Conopholis americana (L.) Wallr.*	Oak woods
Eleocharis olivacea Torr.	Bogs (reported from Halifax Co. by N. Hill, 1988)
Fraxinus pensylvanica Marsh. var. *austini* Fern.	Damp woods
Goodyera repens (L.) R.Br.	Damp mossy woods
Goodyera pubescens (Willd.)	Mixed woods (two records for Kings Co. in E.C. Smith Herbarium)
Lilium canadense L.	Intervales and stream banks; Threatened in Nova Scotia
Oryzopsis canadensis (Poir.) Torr.*	Dry woods
Oryzopsis pungens (Torr.) Hitchc.*	Dry barrens
Salix sericea Marsh.*	Wet thickets and stream banks
Viola nephrophylla Greene	Wet woods and streambanks

* indicates especially good candidate for being present in the study area.

(*Mustela erminea*), and Porcupine (*Erethizon dorsatum*). Black Bear (*Ursus americanus*) and Bobcat (*Lynx rufus*) were previously reported from the study area but were not found during field surveys. Others species not detected during field surveys but which may occur in the area include Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), Woodchuck (*Marmota monax*), Eastern Chipmunk (*Tamias striatus*), Northern Flying Squirrel (*Glaucomys sabrinus*), Little Brown Bat (*Myotis lucifugus*), Silver-haired Bat (*Lasionycteris noctivagans*), Red Bat (*Lasiurus borealis*), and Hoary Bat (*Lasiurus cinereus*).

Many of Nova Scotia's small mammal species are expected in the area, although none were seen during winter field surveys. These include Deer Mouse (*Peromyscus maniculatus*), White-footed Mouse (*P. leucopus*), Gapper's Red-backed Vole (*Clethrionomys gapperi*), Southern Bog Lemming (*Synaptomus cooperi*), Meadow Jumping Mouse (*Zapus hudsonius*), Woodland Jumping Mouse (*Napaeozapus insignis*), Meadow Vole (*Microtus pensylvanicus*), Pygmy Shrew (*Microsorex hoyi*), American Water Shrew (*Sorex palustis*), Smoky Shrew (*S. fumeus*), Arctic Shrew (*S. arcticus*), Masked Shrew (*S. cinereus*), Short-tailed Shrew (*Blarina brevicauda*), and Star-nosed Mole (*Condylura cristata*).

Many of the species listed, especially smaller ones, use a variety of habitats and are not particularly sensitive to habitat reduction and isolation. Black Bear, however, requires large, unbroken tracts of wilderness, a mosaic of aquatic, early, and late successional habitats, and remoteness from human disturbance. Black Bear and Bobcat are probably the most sensitive of the terrestrial mammals to highway construction and the subsequent expansion of human activities in the area. White-tailed Deer and Coyote are more tolerant of human disturbance but will probably suffer due to encroachment and traffic-caused mortality. Among the aquatic mammals, Mink and River Otter are especially sensitive to reductions in water quality which affect fish populations; similarly, bats may be sensitive to changes which reduce numbers of flying insects.

In the past, beavers have been active along all of the larger waterways in the study area. They were probably responsible for the creation of large ponds and stillwaters along level portions of Wrights, McGregor, Marshall, and Sucker Brooks. Overtrapping by the European colonists combined with fires which destroyed food trees resulted in the near-extinction of beavers by 1930 (Banfield, 1974). As a consequence, many of the ponds and stillwaters began to fill in with hydric vegetation and peat, forcing the streams to follow meandering courses through the floodplain. Beavers appear to have recovered to some extent in the area, and there is much evidence of intermittent occupation of the streams in the past 10 to 20 years. At present, beavers are active only along Marshall Brook and Sucker Brook. Their reoccupation of Sucker Brook in 1987 (O'Neil and Saunders, 1991) has caused a recent expansion of the wetland and produced many snags from trees which grew in the area during the beavers' absence. Their continued absence from many formerly occupied areas is probably due to a combination of recent forest fires, trapping, and expansion of the Burnside Industrial Park near Wrights Brook.

Birds

Results of a winter survey of habitats and interviews with naturalists familiar with the area indicate that approximately one hundred bird species may use the study area during the breeding season; fifteen to twenty of these would be rare or unlikely to occur in every year. These species are listed in Table 6.3.

Included in Table 6.3 are eight Blue-listed species. (The 1986 Blue List, published by the National Audubon Society, identified 22 species of North American birds appearing to be declining non-cyclically throughout much of their ranges but which did not yet have "official status" [e.g., Threatened or Endangered; (Tate and Tate, 1982; Tate, 1986)] . Habitats in the study area for two of these, Northern Harrier and Short-eared Owl, are marginally acceptable; habitats for the other six, American Bittern, American Black Duck ("Special Concern" but not actually Blue-listed), Sharp-shinned Hawk, Whip-poor-will, Common Nighthawk, and Ruby-throated Hummingbird, range from fair to excellent. Considering the abundance and distribution of these species in Nova Scotia, the only Blue-listed species likely to face a significant threat from the proposed highway project and consequent expansion of human activities in the area is the Whip-poor-will.

Whip-poor-wills were most recently reported in the study area in 1988, when one or two individuals were heard in an area now occupied by a furniture warehouse, in scrubby, pine-dotted habitat 100 to 200 metres east of Enchanted Lake, and approximately 300-400 metres south of Juniper Lake. Their present status in the area is unknown; we have obtained no reports from 1989 or 1990, which may simply mean that no birdwatchers have been to the area at night recently (see next paragraph), that the birds have retreated farther into the forest, or that they have left altogether. They were

Table 6.3 **Birds Likely to be Present in the Study Area during the Breeding Season.** Rare or distributionally limited species are in **bold-faced type**; Blue-listed species are **underlined in bold-faced type**; species requiring especially large territories or remoteness from human disturbance are marked with bold-faced asterisks (******).

Common Loon**	Anderson Lake, Lake William, possibly Rocky Lake
Pied-billed Grebe	possible, cattail or sedge wetlands, Lily Lake
American Bittern	possible, Marshall, Wrights, McGregors, and Sucker Brook and Shubie Canal wetlands
Great Blue Heron	possible foraging habitat along lakes, rivers, and wetlands
Wood Duck	possibly Sucker Brook wetland; associated with beaver ponds
American Black Duck	lakes, ponds, & rivers
Blue-winged Teal	possible, ponds & marshes
Ring-necked Duck	Enchanted Lake, Anderson Lake, Sucker Brook wetland, other lakes & ponds
Hooded Merganser	possible, ponds & streams, especially Sucker Brook wetland; associated with beaver ponds
Common Merganser	possible, ponds, larger streams, lakes
Osprey	Anderson Lake & other lakes, ponds, rivers
Bald Eagle	larger lakes & rivers
Northern Harrier	possible, Marshall, Sucker, and Wrights Brook wetlands
Sharp-shinned Hawk	larger, mature-forest areas
Northern Goshawk**	possible, forest
Broad-winged Hawk	probable, forest, especially riparian forest along Wrights, McGregors, Marshall, and Sucker Brooks
Red-tailed Hawk	probable, forest, open areas
American Kestrel	probable, open areas with snags
Merlin	possible, forest, open areas
Ruffed Grouse	present year-round, abundant in Wrights Brook watershed, early-successional forest, riparian thickets
Virginia Rail	possible, wetlands
Sora	possible, wetlands

Table 6.3 (cont'd.)

Spotted Sandpiper	along rivers & lakes, especially gravelly, rocky, or sandy margins
Common Snipe	possible, along rivers, wetlands, wet thickets
American Woodcock	probably breeds in good numbers, early successional forest
Black-billed Cuckoo	possible, hard- and mixed-wood forests, associated with insect infestations of hardwood forest
Great Horned Owl**	known, forest & open areas
Barred Owl	possible, forest
Long-eared Owl	possible, forest
Short-eared Owl	possible, Marshall and Sucker Brook wetlands, other open areas
Northern Saw-whet Owl	probable, forest
Common Nighthawk	early successional forest
Whip-poor-will	known to breed in Spectacle Lake area, possible behind Anderson Lake as well
Ruby-throated Hummingbird	probable, forest, open areas
Belted Kingfisher	may breed along larger rivers with mud banks or cavity trees
Downy Woodpecker	known, forest
Hairy Woodpecker	probable, forest, open areas
Black-backed Woodpecker	probable, in mature conifer, fire-, or flood-affected woods and swamps; associated with expanding beaver ponds
Northern Flicker	probable, forest, burned, or open areas
Pileated Woodpecker**	possible in old-growth areas; workings observed
Olive-sided Flycatcher	probable, edge of open, burned woodland
Eastern Wood-pewee	probable, forest openings and edges
Yellow-bellied Flycatcher	probably, dense conifer forest
Alder Flycatcher	early-successional forest, shrubby thickets, swales, riparian thickets, floodplains
Least Flycatcher	probable, mature hardwood
Great Crested Flycatcher	possible, hardwood
Eastern Kingbird	possible, riparian habitats, Sucker Brook wetland, open areas

Table 6.3 (cont'd.)

Tree Swallow	possible, burned woodland, flooded swamps; associated with beaver ponds
Gray Jay	possible, dense (usually coniferous) forest
Blue Jay	probable, variety of forest and suburban habitats
American Crow	conifer & hardwood forest, suburban
Common Raven	probable, conifer & hardwood forest, ledges
Black-capped Chickadee	forest & open areas, burns
Boreal Chickadee	conifer forest
Red-breasted Nuthatch	burns, forest, swamp
White-breasted Nuthatch	possible, mature forest, old growth
Brown Creeper	probable, conifer & hardwood forest
Winter Wren	probable, burns, openings, forest
Golden-crowned Kinglet	forest
Ruby-crowned Kinglet	forest
Swainson's Thrush	forest
Hermit Thrush	forest
American Robin	open areas, forest edges, suburbs
Gray Catbird	probable, thickets, riparian, early-successional
Cedar Waxwing	early-successional, hardwood, burns, heath
European Starling	in human-disturbed areas
Solitary Vireo	probable, hardwood, mixedwood
Red-eyed Vireo	hardwood, mixed, and early successional forest
Tennessee Warbler	probable, burned woodland, mid-successional forest, old bogs
Nashville Warbler	possible, conifer, mid-successional forest, tamarack bogs
Northern Parula	probable, anywhere *Usnea* lichen is found (mature and old-growth forest; good indicator of air quality
Yellow Warbler	thickets, riparian, early-successional forest, gardens
Chestnut-sided Warbler	probable, early-successional forest, thickets, shrubby hardwood
Magnolia Warbler	conifer and mixed forest
Cape May Warbler	possible, mature or old-growth conifer

Table 6.3 (cont'd.)

Black-throated Blue Warbler	hardwood undergrowth of hardwood and oak-pine forest; Juniper Lake and nearby upland hardwoods, Anderson Lake; possibly throughout in hardwood undergrowth
Yellow-rumped Warbler	probable, conifer
Black-throated Green Warbler	probable, conifer, hardwood, mid- to late-successional
Blackburnian Warbler	probable, conifer, mixed forest
Palm Warbler	probable, bogs and coniferous, early-successional forest
Bay-breasted Warbler	probable, dense conifer & mixed forest
Black-and-white Warbler	probable, mixed, conifer, hardwood, older stands
American Redstart	possible, early- and mid-successional hardwood
Ovenbird	possible, mature conifer & hardwood forest
Northern Waterthrush	probable, riverine and streamside thickets
Mourning Warbler	possible, burnt woodland, early-successional forest, openings
Common Yellowthroat	probable, riparian zone, thickets, early-successional hardwood
Wilson's Warbler	probable, riparian and wet thickets, burnt woodland at higher elevations
Canada Warbler	possible, wet forest thickets, swales, alders, conifers
Scarlet Tanager	possible, hardwood
Rose-breasted Grosbeak	probable, hardwood
Chipping Sparrow	probable, open areas
Song Sparrow	riparian, open areas, roadsides, burnt woodland, thickets, early-successional forest
Lincoln's Sparrow	possible, heath, low conifers, burnt woodland, brush piles, open swamps, bogs
Swamp Sparrow	heath, low, dense conifers, burnt woodland, swamps, riparian, marshes, bogs
White-throated Sparrow	probable, heath, early-successional, burnt woodland, clearings, dry upland conifer
Dark-eyed Junco	known, burnt woodland, early-successional, open areas, conifers

Table 6.3 (cont'd.)

Red-winged Blackbird	possible, swamps, wetlands, riparian, lakes with marshy fringe
Rusty Blackbird	probable, woodland swamps, rivers, streams
Common Grackle	possible, swamps, wetlands, rivers, forest
Brown-headed Cowbird	probable, forest, open areas
Northern Oriole	possible, hardwood
Pine Grosbeak	possible, mature conifer, open conifer-dotted heath, bogs
Purple Finch	probable, mature conifer or mixed forest
Red Crossbill	possible, mature spruce
White-winged Crossbill	possible, mature spruce
Pine Siskin	possible, pine, conifer woodlands, burnt woodland
American Goldfinch	possible, early-successional, fields, open areas, thistle
Evening Grosbeak	possible, alder thickets, hardwood or conifer forest

previously reported from much of the area, including Beech Hill and Spectacle Lake, but have declined or retreated in the face of industrial park expansion (Lavender, 1991). Potentially, much of the study area is suitable habitat for Whip-poor-will since most of it burned in the 1963 fire and some burned even more recently. Based on a superficial overview of the habitat, there may be suitable breeding sites yet to be found north and west of Burnside.

The Whip-poor-will is a nocturnal, robin-sized, ground-nesting member of the Nightjar family. It hunts on the wing and has a large, gaping mouth surrounded by long "whiskers" to help it catch flying insects. It was added to the Blue List in 1980 after widespread reports of declining and disappearing populations. In 1982 it was removed from the Blue List because populations appeared to be stable, with local declines attributed to habitat succession. Subsequent widespread and rapid declines in the following three years led to its re-inclusion on the 1986 Blue List. In Nova Scotia, the species was described as rare by Tufts (1986), its preferred habitat being a bushy pasture or open woodland. Godfrey (1986) also cites it as a rare breeder in Nova Scotia, giving the habitat as "ungrazed woodlands..., especially those with openings; woodland edges; woodlots. It appears to prefer mixed-wood or deciduous types, but open coniferous woods sometimes harbour good numbers too." More recent data from the Maritimes Breeding Bird Atlas project (Nova Scotia Museum and the Canadian Wildlife Service) suggest that this species is "almost extinct" in Nova Scotia, its population being estimated at fewer than 50 pairs (Dalzell, 1991) and 15 to 25 pairs (Lavender, 1991). The known breeding locations are scattered along the South Shore from Halifax to Shelburne with a few pairs in the Antigonish area. Like most songbirds, Whip-poor-wills appear to return to the same nesting area year after year for as long as the habitat remains suitable.

As suggested by Tate and Tate (1982) and Ehrlich *et al.* (1988), the Whip-poor-will's decline probably has resulted from a number of cumulative factors including urbanization, habitat maturation and fragmentation, fire suppression, and increases in suburban predators like house cats, squirrels, and raccoons. Its winter range (southeastern U.S. to Panama) includes much of Central America, an area presently experiencing explosive human population growth, deforestation, and agricultural expansion with associated pesticide use.

Other possible or known breeders in the area which are rare or distributionally restricted in Nova Scotia include Great Crested Flycatcher, Chestnut-sided Warbler, Black-throated Blue Warbler, Wilson's Warbler, and Scarlet Tanager. Although the presence of Scarlet Tanager may be unlikely, that of Great Crested Flycatcher (of which there may 25 pairs in Nova Scotia; Dalzell, 1991) is possible since it is known from similar, oak-birch hardwood habitat south of Powder Mill Lake and upper Lake William. The abundance of these species in the Province appears to be limited primarily by habitat availability. All species except one are associated either with pure hardwood or oak-pine forest, habitats more common in the eastern deciduous forest association of the northeastern United States. Wilson's Warbler, however, is dependent on wet, shrubby thickets along streams, ponds, and bogs, or in shrubbery at higher elevations in the boreal forest zone of Canada. Both of these habitat types are uncommon to rare in Nova Scotia, and the species is considered to be uncommon and locally distributed.

Several species are uncommon in Nova Scotia because of their requirements for remoteness from human activity, and large territory size. Common Loon, Northern Goshawk, Great Horned Owl, and Pileated Woodpecker have all declined in response to human encroachment, urbanization, and resource exploitation in wilderness areas. The highway project and consequent expansion of human activity in the area will incrementally add to this process of decline.

Amphibians and Reptiles

Rare or distributionally restricted amphibians and reptiles expected in the study area are listed with their typical habitats in Table 6.4. Some, such as Mink Frog and Northern Ringneck Snake are rather rare and habitat-specific and do not generally benefit from anthropogenic disturbances such as road construction and human encroachment. The Four-toed Salamander is among the least-known (and perhaps the rarest) of Nova Scotia's herpetofauna. It has been found as near as Westphal, in deciduous forest near a sluggish stream, and in riparian *Sphagnum* bogs in the Preston-Lake Echo area (Gilhen, 1984; 1991). In the study area, the best potential habitats for this species probably occur in *Sphagnum* dominated, slow flowing portions of McGregor Brook and Marshall Brook and the small, poorly drained, *Sphagnum-Chamaedaphne* bogs scattered throughout the area.

Table 6.4 Rare or distributionally-restricted amphibians and reptiles that may be present in the study area.

Species	Habitat
Four-Toed Salamander	Possible, closely associated with *Sphagnum* areas bordering streams and *Sphagnum* bogs during the spring breeding season; during the summer, can be found in and close to woodlands
Mink Frog	Possible, requires an abundance of aquatic vegetation, particularly lily pads and pickerel weed in ponds, coves of lakes, and quiet stretches of streams
Northern Ringneck Snake	Deciduous and mixed woods, shores of lakes, ponds, and streams; edges of old bogs

A number of the more common species may benefit in the short term from road construction because of the ponding and establishment of open, grassy habitat. Most species, however, will be susceptible to declines in the long term because of the additional industrial expansion encouraged by the road as is presently occurring with ongoing development of the area.

Invertebrates

Virtually nothing is known about invertebrates in the study area, and it was not possible to collect information on these species in the winter.

6.3 Aquatic Environment

6.3.1 Surface Water Quality

Limited data from lakes and streams near the proposed extension of Highway 107 necessitated the collection and analysis of a few additional water samples. Water samples were collected in February and March, 1991 from Anderson Lake and Lily Lake, and from McGregor, Wrights, Marshall and Sucker Brooks. These samples were subsequently analyzed for basic water chemistry parameters at the Victoria General Hospital, Environmental Chemistry Laboratory (Rapid Chemical Analysis [RCA] package plus arsenic and aluminum). This information together with any historical data and recommended guideline values for "recreational uses" and "protection of aquatic life" set out in the

Canadian Council of Resource and Environment Ministers document (CCREM, 1987) are presented in Tables 6.5 to 6.11.

Lake and stream water quality was generally acceptable for all forms of recreational use. Water samples taken from Anderson Lake, and McGregor and Marshall Brook did have low pH values, 4.7 to 4.9 (cf. the CCREM guideline value of 5), but these were identical to values reported during summer months in Kejimkujik Lake (Blouin, 1985). These low values were also well below the minimum CCREM value for "protection of aquatic life", pH of 6.5.

Seasonal changes in pH, and indeed most other water quality parameters, do occur in these water bodies as a consequence of natural, biological and physical-chemical, processes. Lowest pH values (highest hydrogen-ion content) are expected during the winter and early spring when algae (phytoplankton and benthic macroalgae) are least active and inputs of acidic precipitation (rain and snowmelt) dominate the system. The pH values usually increase throughout the summer months as algae photosynthesize large quantities of carbon dioxide and consequently shift the carbonate-bicarbonate equilibrium to reduce water acidity. The pH may rise one to two units between winter and summer (see following section on historical trends in other nearby lakes). Rainfall events and peaks in the activities of microbial decomposers and algae grazers (e.g., copepods) can, however, modify this general trend on shorter-term cycles.

Guideline values for "protection of aquatic biota" (CCREM, 1987) were exceeded in all nearby lakes and streams. Heavy metals (and pH) were frequently in excess of values known to impair the growth or survival of fish and other aquatic organisms. Although the "poor conditions" at some sites could be attributed to "natural" processes (such as acidic precipitation), other sites were probably polluted by nearby residential and/or industrial developments. Other factors or substances at these sites may, however, reduce toxicity levels, or even eliminate the availability of heavy metals to aquatic life. Dissolved organic matter (DOM) is well known to bind with metals, altering their solubility, toxicity and bioavailability. A recent study of 37 lakes in Nova Scotia (Urban *et al.*, 1990) hypothesized that the humic materials fraction of DOM was probably responsible for regulating the concentrations of aluminum and iron in the acidic lakes (those with a pH value less than 5).

Table 6.5 **Water Quality Data for Anderson Lake.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Dec. 13, 1984	Concentration March 6, 1991
Sodium			7.7	1.8
Potassium			0.5	0.3
Calcium			2.2	0.7
Magnesium			0.07	0.2
Hardness				2.57
Alkalinity ($CaCO_3$)			<1.0	<1.0
Carbonate ($CaCO_3$)				
Bicarbonate ($CaCO_3$)				
Sulfate			6.7	3.0
Chloride			12.9	3.4
Silica				1.2
Ortho Phosphorus (P)			<0.01	<0.01
Nitrate+Nitrite (N)			<0.05	<0.05
Ammonia (N)		~ 2	<0.05	0.13
Iron		0.3	0.03	0.03
Manganese			0.04	0.02
Copper		0.002		<0.01
Zinc		0.03		<0.01
Aluminum		0.005	0.09	0.15
Arsenic		0.05		<0.005
Color (TCU)	100		29.0	19.0
Turbidity (NTU)	+5[1]		0.50	0.38
Conductivity (µmhos/cm)			67.0	26.0
pH (units)	5<x<9	6.5<x<9	5.2	4.8
Total Organic Carbon				2.2

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.6 **Water Quality Data for Lily Lake.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration July 27, 1989	Concentration Feb. 17, 1991
Sodium			1.8	11.5
Potassium			<0.1	0.9
Calcium			0.66	3.9
Magnesium			0.35	0.7
Hardness			3.1	12.6
Alkalinity ($CaCO_3$)			1.0	4.0
Carbonate ($CaCO_3$)				0.0
Bicarbonate ($CaCO_3$)				4.0
Sulfate			2.5	7.0
Chloride			3.2	18.0
Silica			<0.5	3.0
Ortho Phosphorus (P)			<0.01	<0.01
Nitrate+Nitrite (N)			<0.05	0.07
Ammonia (N)		~ 2	<0.05	0.09
Iron		0.3	0.29	0.15
Manganese			0.04	0.11
Copper		0.002	<0.01	<0.01
Zinc		0.03	<0.01	0.06
Aluminum		0.005		0.31
Arsenic		0.05		<0.005
Color (TCU)	100		29.0	19.0
Turbidity (NTU)	+5[1]		0.7	2.86
Conductivity (μmhos/cm)			22.0	95.0
pH (units)	5<x<9	6.5<x<9	5.70	6.5
Total Organic Carbon			7.0	3.4

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.7 **Water Quality Data for Marshall Brook.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Feb. 17, 1991
Sodium			2.5
Potassium			0.4
Calcium			2.2
Magnesium			0.7
Hardness			8.37
Alkalinity ($CaCO_3$)			< 1.0
Sulfate			8.0
Chloride			3.4
Silica			4.1
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			0.06
Ammonia (N)		~ 2	<0.05
Iron		0.3	0.14
Manganese			0.12
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.005	0.2
Arsenic		0.05	<0.005
Color (TCU)	100		28.0
Turbidity (NTU)	+5[1]		0.3
Conductivity (μmhos/cm)			42.0
pH (units)	$5<x<9$	$6.5<x<9$	4.9
Total Organic Carbon			4.7

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.8 **Water Quality Data for McGregor Brook**. Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Feb. 17, 1991
Sodium			2.9
Potassium			0.2
Calcium			1.7
Magnesium			0.6
Hardness			6.71
Alkalinity ($CaCO_3$)			<1.0
Sulfate			8.0
Chloride			3.7
Silica			4.4
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			<0.05
Ammonia (N)		~ 2	<0.05
Iron		0.3	0.05
Manganese			0.08
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.005	0.21
Arsenic		0.05	<0.005
Color (TCU)	100		21.0
Turbidity (NTU)	+5[1]		0.27
Conductivity (μmhos/cm)			43.0
pH (units)	5<x<9	6.5<x<9	4.7
Total Organic Carbon			4.3

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.9 **Water Quality Data for Sucker Brook - Rocky Lake Inflow**. Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration Feb. 17, 1991
Sodium			38.4
Potassium			1.4
Calcium			13.5
Magnesium			1.8
Hardness			41.1
Alkalinity ($CaCO_3$)			16.0
Carbonate ($CaCO_3$)			0.02
Bicarbonate ($CaCO_3$)			16.0
Sulfate			15.0
Chloride			61.0
Silica			1.6
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			0.12
Ammonia (N)		~ 2	0.06
Iron		0.3	0.05
Manganese			0.03
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.1	0.11
Arsenic		0.05	<0.005
Color (TCU)	100		17.0
Turbidity	+5[1]		1.57
Conductivity (µmhos/cm)			280
pH (units)	5<x<9	6.5<x<9	7.2
Total Organic Carbon			2.9

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.10 **Water Quality Data for Sucker Brook - First Lake Outflow.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration May 24, 1989	Concentration Aug. 17, 1989	Concentration Feb. 17, 1991
Sodium			61.0	56.0	42.4
Potassium			1.8	2.1	1.7
Calcium			16.0	18.0	16.4
Magnesium			2.1	2.1	2.0
Hardness			48.6	53.6	49.1
Alkalinity ($CaCO_3$)			23.0	34.0	21.0
Carbonate ($CaCO_3$)					0.05
Bicarbonate ($CaCO_3$)					20.9
Sulfate			19.0	15.0	18.0
Chloride			100	93	71
Silica			<0.5	1.1	1.0
Ortho Phosphorus (P)					<0.01
Nitrate+Nitrite (N)			0.05	<0.05	0.11
Ammonia (N)		~ 2	<0.05	<0.05	0.06
Iron		0.3	0.15	0.15	0.05
Manganese			0.16	0.30	0.03
Copper		0.002	0.02	<0.01	<0.01
Zinc		0.03	<0.01	0.01	<0.01
Aluminum		0.1			0.1
Arsenic		0.05			<0.005
Color (TCU)	100		7.7	10.0	12.0
Turbidity (NTU)	+5[1]		2.3	0.6	2.1
Conductivity (μmhos/cm)			416	426	333
pH (units)	5<x<9	6.5<x<9	7.7	7.6	7.4
Total Organic Carbon			2.9	3.6	2.6

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

Table 6.11 **Water Quality Data for Wrights Brook.** Parameters given in mg/L except where noted. Blank spaces indicate data on guideline not available.

Parameter	Guideline Value for Recreational Water Quality	Guideline Value for Protection of Aquatic Life	Concentration March 6, 1991
Sodium			36.2
Potassium			1.6
Calcium			11.5
Magnesium			1.5
Hardness			34.9
Alkalinity ($CaCO_3$)			14.0
Carbonate ($CaCO_3$)			0.02
Bicarbonate ($CaCO_3$)			14.0
Sulfate			13.0
Chloride			59.0
Silica			2.7
Ortho Phosphorus (P)			<0.01
Nitrate+Nitrite (N)			0.19
Ammonia (N)		~ 2	0.02
Iron		0.3	0.79
Manganese			0.49
Copper		0.002	<0.01
Zinc		0.03	<0.01
Aluminum		0.1	0.22
Arsenic		0.05	<0.005
Color (TCU)	100		33.0
Turbidity	+5[1]		7.2
Conductivity (µmhos/cm)			269
pH (units)	5<x<9	6.5<x<9	7.1
Total Organic Carbon			1.9

[1] Turbidity should not be increased by more than 5 NTU over natural levels.

At the time of sampling, all of the sampled water bodies near the proposed highway route have elevated levels of aluminum, reflecting the leaching action of acidic precipitation on surficial soils and rocks. Aluminum levels were frequently at, or above the highest ones recommended by the CCREM (1987) report for growth and survival of fish and other aquatic organisms. As noted above, levels may not be toxic to all organisms because of DOM-aluminum interactions.

Elevated concentrations of other heavy metals relative to CCREM (1987) guideline values were usually associated with human activities. Lily Lake had high levels of zinc, perhaps as a consequence of its proximity to the Canadian National Railway. Construction and industrial activities in nearby Burnside Industrial Park were probably responsible for elevated levels of iron in Wrights Brook. High levels of copper in Sucker Brook immediately below First Lake (on one occasion only; May 24, 1989 survey conducted by researchers from the Centre for Water Resource Studies [CWRS-TUNS] for the N.S. Dept. of the Environment) probably originates from runoff from roads and communities in Lower Sackville.

6.3.1.1 Impact of Other 100 Series Highways on Surface Water Quality

The principal impacts on water quality associated with construction and operation of highways are from enhanced loading rates of a variety of inorganic and organic materials. The most significant impacts include: increased siltation rates (particularly during construction phases), stormwater drainage from the road (landwash) containing various petroleum products, heavy metals and salt (or other de-icing compounds), and accidental spills of fuels and other chemicals. Appropriate mitigation and application practices should alleviate most concerns about the "normal" activities. Accidental events require further consideration in an a contingency plan (Section 9.6).

In order to predict the magnitude of the "normal" impacts on water bodies near the proposed extension of Highway 107, existing historical data for Anderson Lake and five other lakes near 100-series highways in Halifax County were analyzed for trends over the last twenty years. The relatively isolated nature of Anderson Lake (and its watershed) facilitates its use as a "control" lake for estimating pre-development conditions. Prior to development of this area, lake and stream water chemistry are controlled by weathering processes of the soils and rocks within the watershed (Gorham, 1957; Underwood *et al.*, 1986; Rogers *et al.*, 1990), and by the "dry" and "wet" atmospheric fallout of materials (especially from sea-spray). Acidic precipitation and dry fallout, in particular, are now well known to significantly alter the water chemistry of even the most isolated of lakes (Watt *et al.*, 1979; Stauffer, 1990). Water quality data were gathered from the published studies of Alexander (1972), Ogden (1972), Environment Canada and the Nova Scotia Department of the Environment (1975), Hart et al. (1978), Johnson (1978), Gordon *et al.* (1981), Alexander *et al.* (1986), and Urban *et al.* (1990), and the open files at the Nova Scotia Department of the Environment and the City of Dartmouth.

The water quality database only permits analyses of changes in the inorganic chemistry of the lakes resulting from road-salt (sodium chloride) applications and landwash of the road surfaces (major ions and nutrients). Historical trends in sodium, chloride, pH, and specific conductance (the latter is a measure of the total quantity of dissolved materials in water, specifically the electrically-conducting elements), are summarized in Figures 6-4 to 6-7. The nutrient data were not presented because of the small number of detectable concentrations during the twenty year period (analytical detection limits are often too high for natural levels of these compounds). There are no records for organic contamination (e.g., oil and grease) and very few data on water clarity and levels of heavy metals and suspended particulate matter (silt). Increases in the specific conductance (or conductivity) of a water body would, however, be expected to reflect higher input rates of the more toxic pollutants and perhaps decreased water clarity.

Concentrations of sodium and chloride are useful indicators of road salt contamination and/or industrial and domestic pollution (animal wastes and many detergents are particularly important). Not unexpectedly, the highest concentrations and greatest accumulation rates were evident in First and Micmac Lakes, nearest the busiest roadways and largest population centres (Figures 6-4 and 6-5). Prior to major development, all of the lakes except Micmac, had baseline values approaching those of present-day levels in Anderson Lake, less than 10 milligrams of sodium per litre and less than 20 mg of chloride per litre (abbreviated as mg/L). Salt levels subsequently increased in all lakes except Anderson at rates that probably paralleled municipal growth rates. Twinning of Highway 102 (near Rocky Lake) and Highway 118 (near Lakes William and Charles) also did not appear to alter salt accumulation rates. Seasonal variation in these parameters does occur (maximum in winter and spring, and minimum in summer and fall), but the overall ranges are small,

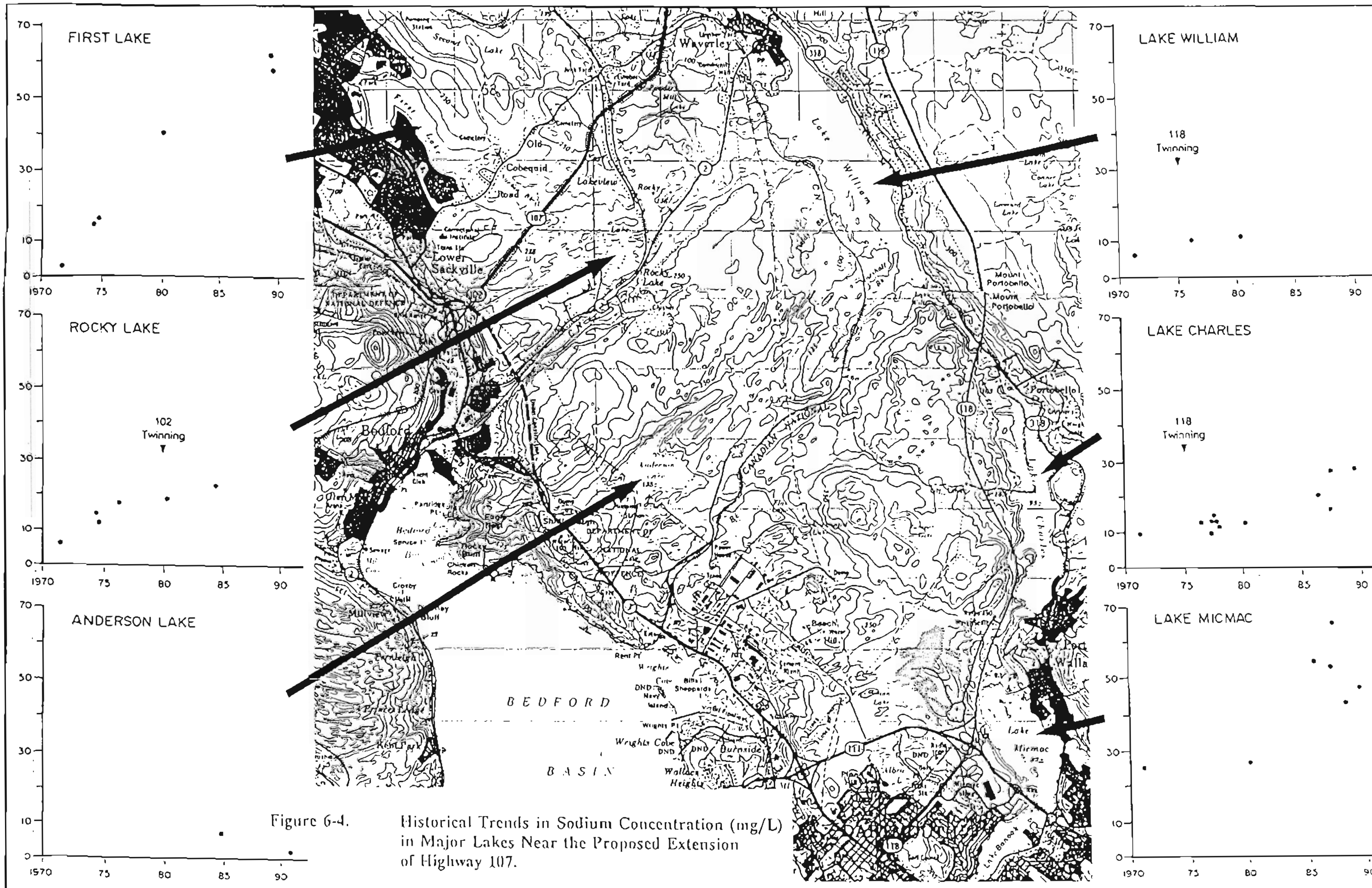


Figure 6-4. Historical Trends in Sodium Concentration (mg/L) in Major Lakes Near the Proposed Extension of Highway 107.

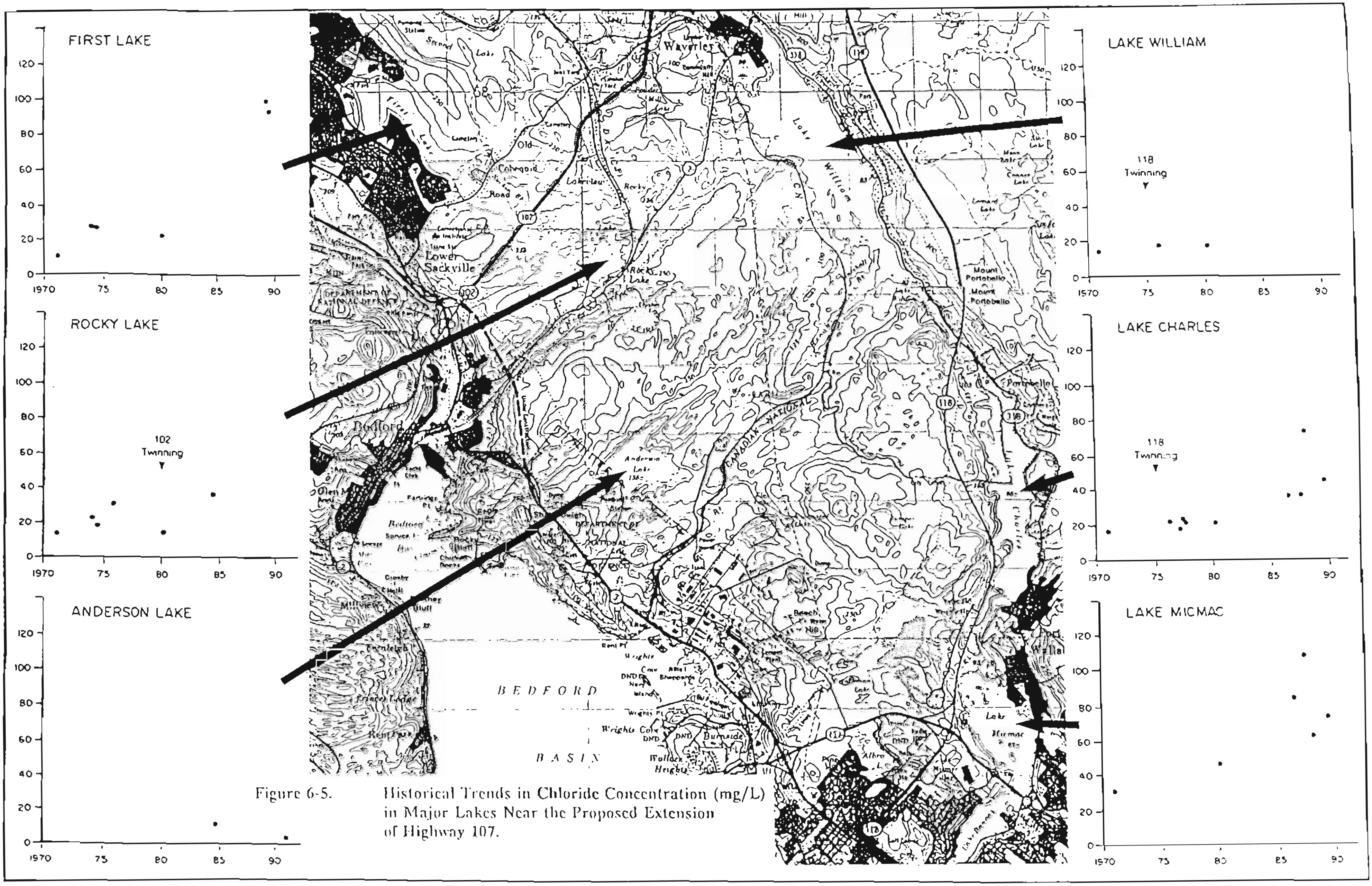


Figure 6-5. Historical Trends in Chloride Concentration (mg/L) in Major Lakes Near the Proposed Extension of Highway 107.

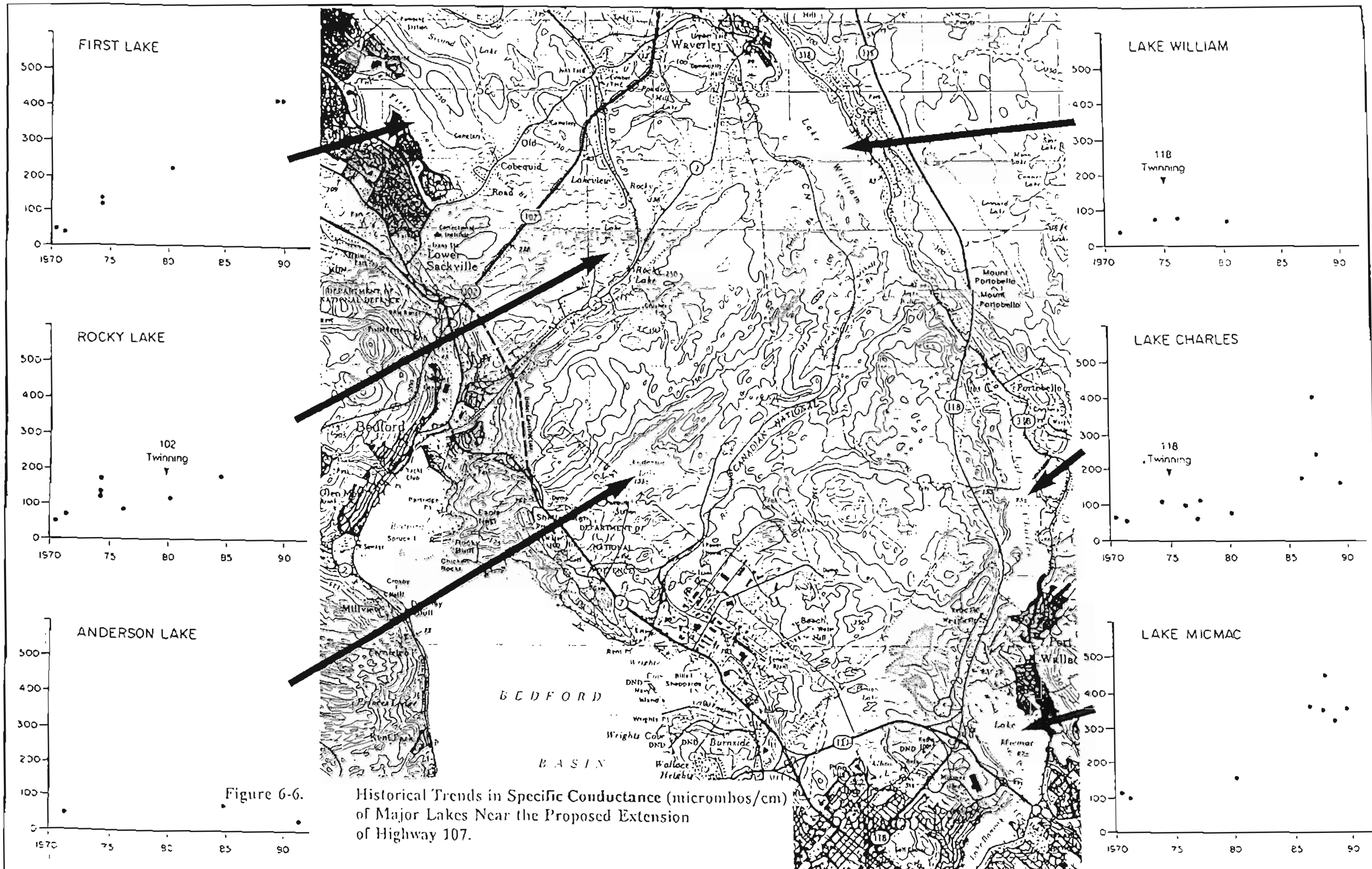


Figure 6-6. Historical Trends in Specific Conductance (micromhos/cm) of Major Lakes Near the Proposed Extension of Highway 107.

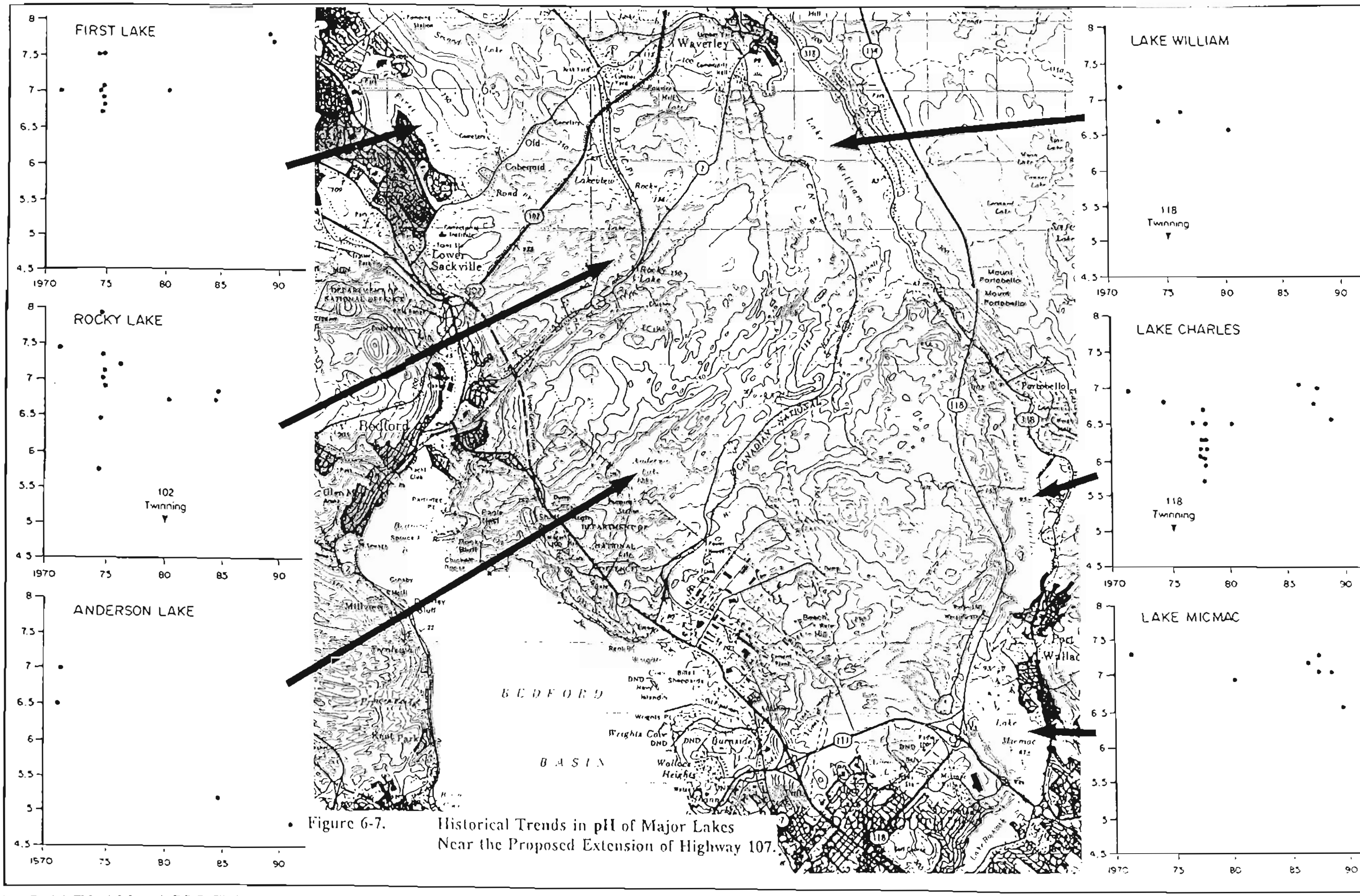


Figure 6-7. Historical Trends in pH of Major Lakes Near the Proposed Extension of Highway 107.

P. LANE AND ASSOCIATES LIMITED

typically 10 percent of the mean (unpublished data collected from Paper Mill Lake near Highway 102 by P. Lane and Associates Limited, 1990).

Conductivity readings show much the same trends as noted for sodium and chloride (Figure 6-6). By inference then, all of the lakes except Anderson Lake are slowly accumulating heavy metals, and a variety of other major ions and trace organic pollutants. In twenty years, the water chemistry of Anderson Lake might be comparable to that of Rocky Lake, Lake William and Lake Charles; assuming similar rates of relatively low-intensity residential development.

Highway construction could alter pH levels of nearby streams and lakes if pyritic slates are exposed or used as roadfill materials. Acidic drainage would markedly depress pH values and increase concentrations of the sulphate ion and a variety of heavy metals. None of the five lakes near existing 100-series highways shows any decline directly attributable to highway construction (Figure 6-6). In fact, pH is well buffered in most lakes on a long-term basis. As noted earlier, seasonal variations do occur (e.g., the 1974 data for First and Rocky Lakes and the 1976 data for Lake Charles), and are believed to represent the combined influence of rainfall events and changing relationships between algae and their consumers. The apparent decline in pH in Anderson Lake may be a consequence of acidic precipitation, or simply a function of when the samples were collected. The two earliest samples (1971) were collected in August and October when pH values are near their annual maximum; the other samples were collected in December (1984) and March (1991), periods with the lowest annual values (when the system is dominated by acidic precipitation, and plant productivity is low). Additional sampling during summer would help clarify the extent, if any, of the apparent pH decline. Similar reasoning applies to the pH decline in Lake William. More recent data have been collected from this lake (CWRS-TUNS, 1991) and should become available for public use in early May 1991. Table 6.12 lists potential surface water impacts during construction of the Highway 107 Extension and their mitigation.

6.3.2 Fisheries

The only fisheries data for the immediate area near the proposed extension of Highway 107 originate from lake surveys carried out by the Nova Scotia Department of Fisheries and the federal Department of Fisheries and Oceans. Much of this information has been summarized in a paper

Table 6.12 Significant Impacts on Surface Waters During the Five Stages of Construction of the Highway 107 Extension.

Construction Stage	Surface Water Body	Potential Concern	Risk Potential	Mitigation
1	McGregor Brook Juniper Lake Lake Charles	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and only one stream crossing	carry oil-absorbing materials for spills
2	Sucker Brook Rocky Lake First Lake	Siltation	low; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and no stream crossings	carry oil-absorbing materials for spills
3	Marshall Brook Wrights Brook Rocky Lake Lily Lake Anderson Lake	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization

Construction Stage	Surface Water Body	Potential Concern	Risk Potential	Mitigation
3 (con't)	Marshall Brook Wrights Brook Rocky Lake Lily Lake Anderson Lake	Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and only two stream crossings	carry oil-absorbing materials for spills
4	McGregor Brook Wrights Brook Juniper Lake	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and no stream crossings	carry oil-absorbing materials for spills
5	Sucker Brook Rocky Lake	Siltation	moderate; native till is thin and predominantly coarse materials	drainage control and surface stabilization
		Acidic drainage	low; native bedrock has low total sulfur content (less than 0.4%)	geotechnical drilling should be conducted before construction begins; acid producing areas should be exposed for short periods of time and then capped by proven methods
		Accidental spills of petroleum, etc.	low; only small volumes carried and only one stream crossings	carry oil-absorbing materials for spills

published by Alexander *et al.* (1986). Other information was obtained from open files at the Nova Scotia Department of Fisheries and conversations with officials at the Department of Defence. No creel or stream surveys have been conducted in this area. Personal communications with local residents and fishermen indicate that some of the smaller lakes and streams near the proposed highway do have Brook Trout (Salvelinus fontinalis) populations and are occasionally fished (Enchanted Lake and Wrights, Marshall, and McGregor Brooks).

Historical records of the occurrence of fish species in the lakes that might be impacted by highway construction or operation, and any additional information concerning estimates of fishing intensity by recreational fishermen and stocking records, have been summarized in Table 6.13. Estimates of fishing intensity are usually based on proximity to population centres.

With the exception of the large lakes near population centres (First, William, Charles, and Micmac), fishing intensity is estimated to be low. Based on earlier discussions of water quality impacts, it is unlikely that recreational fisheries in any of the lakes will be significantly impacted by normal highway operations. Short-term impacts from construction activities are also unlikely to impair fisheries or fishery habitats in lakes or streams so long as preventive mitigation measures are carried out (e.g., controls for embankment erosion and siltation). The major "chemical" control on fish distribution and abundance in Nova Scotian lakes appears to be the acidity or pH of the water (see Smith *et al.*, 1986). Unless acidic drainage occurs from exposed rocks or fill, highway construction and operation should not influence the fisheries.

6.4 Historical and Cultural Resources

The historical and cultural resource assessment of the proposed Highway 107 Extension involved a three-phase approach; detailed planning, review of existing heritage resources and a field survey. This methodology was approved by the Nova Scotia Museum and was carried out under Heritage Research Permit (Archaeology) No. A1991NS2.

Detailed Planning

The planning phase was directed at familiarizing the research team with the terrain and potential types of heritages resources along the route. This was accomplished with the aid of aerial

Table 6.13 Major Fish Species and Fishing Intensity in Lakes Near the Proposed Extension of Highway 107 (Information from Alexander *et al.*, 1986, and Nova Scotia Department of Fisheries).

Lake	Fish Species	Estimate Fishing Intensity/ Other Comments
First Lake	White Sucker Brook Trout White Perch American Eel	heavy, especially in spring for hatchery-raised brook trout; active stocking program of yearling trout in 1980 and 1984-1990 (N.S. Dept. of Fisheries Code # 08119)
Rocky Lake	White Perch American Eel Smallmouth Bass Banded Killifish	low to moderate; no stocking information in N.S. Dept. of Fisheries database - Stocking Code # 08885); Sucker Brook drains into this lake
Lily Lake	Brook Trout White Sucker	low to moderate; not stocked
Anderson Lake	White Sucker Brook Trout Rainbow Trout	low; no recent reports of trout catches; rainbow trout stocking as early as 1899, but ceased earlier this century (Stocking Code # 08019)
Lake William	White Sucker White Perch Smallmouth Bass	moderate to heavy; not stocked (Stocking Code # 08853); Marshall and McGregor Brooks drain into this lake; Lake William is unlikely to be impacted by highway construction

Lake Charles	White Sucker White Perch Yellow Perch Atlantic Salmon Smallmouth Bass	moderate to heavy; stocked with yearling brook trout in 1988 (Stocking Code # 08018)
Lake Micmac	White Sucker White Perch Smallmouth Bass	heavy; not stocked (Code # 08907); this lake receives discharge from Juniper Lake via Grassy Brook; Lake Micmac is unlikely to be impacted by highway construction

photographs and large-scale maps. A series of orthophotographic maps was used to define the limits of the proposed highway and study corridor. The combined experience of the team in heritage land use patterns resulted in five areas along the route being designated as having a moderate potential for heritage resources. During this process no area was designated as having high potential.

The five moderate potential areas for heritage resources were:

a) A 600 metre (1970 feet) area around Enchanted Lake.
b) A 700 metre (2300 feet) area on either side of a small tributary of Marshall Brook.
c) An 1800 metre (5900 feet) area of highground north of Anderson Lake.
d) A 500 metre (1640 feet) area northeast of Lily Lake.
e) A 500 metre (1640 feet) area where Connector "B" crosses Sucker Brook.

Heritage Inventories

Phase two involved consultation with heritage agencies and cultural resource managers. Maps of the proposed route and corridor were shown to these individuals and they were asked if any known cultural resources would be impacted by the proposed highway. The consultation process included the following agencies and individuals:

a) Nova Scotia Museum, Halifax
Dr. Brian Preston,
Curator of Archaeology
b) Dartmouth Heritage Museum, Dartmouth
Mr. Sid Gosely, Directory
c) Fultz House Museum, Sackville
Mr. David Grace, Local Historian
d) Town of Bedford Planning Department Bedford
Ms. Donna Lohnes-Davis, Town Planner

The consultative process revealed a single potential cultural resource located where Connector "B" meets the Old Cobequid Road. The first segregated Black school in Sackville was situated at this location. The historical significance of this feature has been greatly diminished in that the entire building was removed in 1960 and relocated. The school is recorded in historic documents with photographs, and additional histories could be obtained from former students still living in the Sackville area. It is doubtful, however, that an archaeological excavation would produce any useful data beyond what are already available. Thus, no mitigative measures are recommended for this site.

Field Survey

Phase three involved a pedestrian survey of the entire length of the corridor. A two-person team of experienced archaeologists walked the route. The survey was timed to correspond to periods when no snow was covering the study area. Particular attention was paid to water crossings and to elevated features. The team conducted checks of exposed bedrock and large boulders in prominent places for petroglyphs, but none were found. This aspect of the study was deemed necessary as known petroglyphs are situated in similar terrain in the Town of Bedford. The survey did not reveal any historical or cultural resources within the corridor.

Although outside of the corridor a section of the Shubenacadie Canal is in close proximity to the proposed Highway 107 Extension, Stage 1 of the construction schedule includes the overpass connecting Highway 107 and Highway 118. Since two major highway bridges have been constructed over the canal near this location without impacting heritage and cultural features along the canal, no mitigation is recommended for this site.

In keeping with the "Terms and Conditions" (Number 2) of the Heritage Research Permit a written preliminary report will be filed with the Curator of Special Places, Nova Scotia Museum. The report will conclude that in terms of the Special Places Protection Act of Nova Scotia (1980 with Amendments from C.45, S.N.S. 1990) the proposed Highway 107 Extension will not impact upon any significant historical or cultural resources.

6.5 Socio-economic Environment

To identify any socio-economic impacts associated with the construction of the Highway 107 Extension, interviews were conducted with various government officials, economic development and planning personnel and business representatives. Potential Valued Environmental Components (VECs) examined from a socio-economic perspective include the following aspects:

- life-style/economic (time saving, safety, travel cost saving, construction and operation cost, impacts on overall economic output);

- demographic and housing (demand for housing, housing development, impact on property values, increased economic activity);

- land use (intrusion on current use of land - visually, noise, pollution, competing land use, impact on land ownership patterns, current and possible future uses of the land base); and

- physical infrastructure and community services (ability to cope with increasing demand, change in the type of demand on these services, change in location of demand).

The highway is expected to improve transportation efficiency by decreasing the time and cost required for transport. It will also contribute to the smooth operation of traffic between the communities of Dartmouth, Bedford and Sackville, provide easier access to markets and suppliers for firms located in the three industrial parks (Burnside, Bedford and Sackville), and provide improved access to the parks by the general public. The highway is also expected to decrease traffic in areas where traffic is heavy in relation to their design capacities (as outlined in Section 3.0). This will in turn reduce the number of motor vehicle accidents occurring in these areas.

Noise resulting from the heavy truck traffic along Rocky Lake Drive will be reduced as trucks are diverted onto Duke Street in order to access either Highway 102 or Highway 107.

A number of specific impacts were identified, and these impacts are described below. The impacts are summarized and their significance categorized in the VEC matrices.

The VECs identified are listed as follows:
- Sackville Industrial Park's access to Highway 107;
- Configuration of the proposed intersection located in the Bedford Industrial Park;

- Charles P. Allen High School;
- Development options for the Bedford Industrial Park;
- Residential properties along Rocky Lake Drive;
- Land near the NSPC transmission tower at the 107/118 interchange;
- Dartmouth regional park land located along Lake Charles; and
- Landlocked area at the interchange of Highway 118 and Highway 107.

These VECs and potential impacts are discussed further in Section 7 of this report.

6.5.1 Existing Zoning and Land Use

EXISTING ZONING

While most of the area to be affected by the highway is forested, the highway does pass through areas where residential, commercial and institutional developments are in place. Specifically, these areas include: the connections to Burnside Drive and Akerley Boulevard, the crossing at Rocky Lake Drive and through the Bedford Industrial Park, the connection at Glendale Drive and the connection to Cobequid Road at First Lake (Connector "B"). The current zoning patterns are as follows:

SACKVILLE AREA

Cobequid Road (Sackville Drive to Glendale Drive)

The north side of this section of the Cobequid Road is primarily zoned as residential. The south side is primarily zoned as light industrial and general business.

Cobequid Road (North of Glendale Drive)

The north side is zoned residential and contains small areas zoned for general businesses. The south side includes the Sackville Industrial Park (zoned light industrial). The area further east on the south side is primarily zoned rural residential.

The proposed highway connects with Sackville Industrial Park as an extension of Glendale Drive, and passes through land zoned for rural residential use where it is proposed to connect to Cobequid Road in the area of First Lake Drive.

Rocky Lake Drive/Bedford Industrial Park

The Highway 107 Extension is expected to cross Rocky Lake Drive in the area of the Bedford Industrial Park. The Bedford Industrial Park, located to the north of Rocky Lake Drive, is zoned light and heavy industrial. To the south of Rocky Lake Drive, the land is zoned residential. NSDTC estimates that six or seven houses along the south side of Rocky Lake Drive will have to be purchased by the Province in order to accommodate the proposed alignment. The Charles P. Allen High School (institutional zone) is located next to the Bedford Industrial Park, and the proposed highway is expected to pass between the school and Duke Street, within approximately 70 metres (230 feet) of the school.

Dartmouth/Burnside Industrial Park

The proposed Highway 107 Extension will connect directly to Burnside Drive and to the Akerley Boulevard extension within the Burnside Industrial Park. Lands in the area of Burnside Drive and Akerley Boulevard are zoned for general industrial use.

EXISTING LAND USE

Sackville Industrial Park

The Sackville Industrial Park has a total area of 91 hectares (225 acres) of which 10 hectares (25 acres) are now developed. In the industrial park, there are currently 350 jobs with 35 companies that are primarily light industrial, small manufacturing and service related. Further development of the Park is limited until direct access to Highway 102 can be provided. In fact, the Sackville Chamber of Commerce has indicated that the Park has lost six tenants that would have located in the Park if 100-series highway access to and from the Park had existed. Moreover, Park authorities are unwilling to undertake any further planning and servicing of the Park until the alignment of the new road and the linkage to Glendale Drive is finalized.

Sackville Community

A transformation of the residential properties to commercial has been taking place along Cobequid Road (primarily between Sackville Drive and Glendale Drive), possibly in anticipation of the new highway. This trend is expected to continue and will most likely escalate once improved access to Highway 102 has been established.

It is intended that Sackville develop a town centre in the area of Sackville Drive and the Beaverbank Road (on the land where the race track was formerly located). This would include highrise buildings in a central business district. Although the Highway 107 Extension may attract businesses away from the town centre and cause them to locate closer to the Sackville Industrial Park (a light industrial and business park), this trend is not expected to adversely affect the development of a downtown core planned for Sackville.

It is expected that the proposed highway will also influence the development of residential properties in the Sackville community (increased development of Millwood and Phase III of the Provincial Housing Authority are two examples). Once the highway is completed, the reduction in time and cost associated with travelling to Burnside, Dartmouth and Halifax will serve as a catalyst to bring people to the Sackville area to live while working in Dartmouth or Halifax.

Bedford Industrial Park

The Bedford Industrial Park has roughly 45 hectares (112 acres) with potential for an additional 81 hectares (200 acres). Presently five hectares (12 acres) of the Park are developed, of which two serviced lots remain. The sale of these lots has been postponed until the alignment for Highway 107 has been finalized. Consequently, there are no serviced lots available for purchase in the Park. Once construction has been completed, access to Highway 102 and to Highway 107 will open up new development opportunities for the Park. Development options are currently constrained by the fact that without access to the 100-series highways, the industrial park has been unsuccessful in attracting new businesses.

The St. Paul's Home For Girls owns a large percentage of the land in the Bedford Industrial Park. While they are not willing to sell the land, they would be willing to negotiate a lease arrangement with the Town of Bedford that would allow the Town to develop the land. Negotiations for the land have been ongoing between the St. Paul's Home for Girls and the Town of Bedford. Because of the heavy truck traffic operating on Rocky Lake Drive, the Town of Bedford is reluctant to encourage development of the Bedford Industrial Park if that would ultimately put more truck traffic on Rocky Lake Drive.

Burnside Industrial Park

The proposed highway is expected to be a major economic benefit to the Burnside Industrial Park. Burnside grew at such a fast rate in the 1980s that unless the Highway 107 Extension is constructed Burnside will "choke on its own success". During the growth over the 1980s, the City of Dartmouth was unable to keep pace with the expansion experienced by the industrial park, and necessary improvements to transportation links serving the park were not made. The proposed highway is expected to alleviate present and future access problems as Burnside continues to be developed.

There is a large area of land to the northeast of Burnside Industrial Park that is currently unserviced and is classified as a holding zone until the City of Dartmouth decides the best use for it. The new highway will open up these areas for additional land use options.

PHYSICAL INFRASTRUCTURE AND COMMUNITY SERVICES

Sackville

The new highway will provide better and more access routes to the Sackville community. This is expected to positively impact a number of the community services such as police, fire and ambulance. The water and sewer services in Sackville are currently operating at capacity. Additional capacity to the system is possible if the existing system can be made to be more efficient; however, new developments will have to be monitored closely. Water and sewer services are available along the Cobequid Road area, and a small number of serviced lots remain in the Sackville Industrial Park. There may be capacity constraints, however, unless the County is able to prolong the existing services by making them more efficient. If additional services are required, priority will be given to extending services in the Sackville Industrial Park.

Bedford

The Highway 107 Extension is not expected to impact community services significantly in the Town of Bedford. Additional services are required to service the Bedford Industrial Park to the fullest extent; however, the existing system will be able to handle the extra capacity generated by development of the Park.

Dartmouth

The Highway 107 Extension is not expected to significantly impact community services in the City of Dartmouth. There remain large areas of undeveloped land within the Burnside Industrial Park and the City of Lakes Business Park. This land can be serviced under present conditions without straining the existing system. Burnside Industrial Park and the City of Lakes Industrial Park are limited, however, in their ability to expand northeast by the grade of the land. Beyond a certain point the sewage and water services will no longer flow by the force of gravity. Therefore, if the lands to the northeast of Burnside are to be serviced, a major trunk sewer would be required, which would circle Lake Micmac and run parallel to Highway 118.

6.6 Summary List of Valued Environmental Components (VECs)

A list of VECs was produced for each stage of the project. These components are defined as follows:

1) components that are generally considered rare or threatened;
2) components that are already being negatively impacted in the area;
3) components that have shown a high environmental sensitivity in other areas;
4) components that play a crucial role in the integrity of the ecosystem; and
5) components that are perceived by the public to be important.

Table 6.14 presents a summary list of VECs for each of the five stages of the project. These components are discussed further in the remaining section of the report. No valued historical or cultural resources were identified. Figure 6-8 shows the location of the terrestrial biological VECs in the study area.

Table 6.14 Summary List of Valued Environmental Components

STAGE	VALUED ENVIRONMENTAL COMPONENT
All Stages	Soils
	Air Quality
	Noise Level
	Potential Rare Plant Species
	Potential Rare Animal Species
	Animal Crossings
Stage 1: Portobello to Akerley Boulevard	Groundwater
	McGregor Brook
	Marshall Brook
	Lake William Water Quality and Fishery
	Juniper Lake Water Quality and Fishery
	Lake Charles Water Quality and Fishery
	Whip-poor-will
	Wetlands Habitat
	Land Near Utilities Transmission Line
	Dartmouth Regional Park Land
	Land Use Near Highway 118 Interchange
	Shubenacadie Canal Lock
Stage 2: Duke Street, Bedford, to Glendale Drive, lower Sackville	Rocky Lake Water Quality and Fishery
	Wetlands Habitat
	Private Well
	Ground Water
	Traffic on Glendale Drive
	Traffic on Rocky Lake Drive
	Access To Industrial Parks

STAGE	VALUED ENVIRONMENTAL COMPONENT
Stage 3: Burnside Industrial Park to Highway 102	Lily Lake Water Quality and Fishery
	Anderson Lake Water Quality and Fishery
	Rocky Lake Water Quality and Fishery
	Marshall Brook Water Quality
	Lake William Water Quality and Fishery
	Wrights Brook
	Enchanted Lake Water Quality and Fishery
	Flat Lake Water Quality
	Three Private Wells
	River Otter
	Wetland Habitat
	Charles P. Allen High School
	Residential Property
	St. Paul's Home for Girls - Property
	Access to Bedford Industrial Park
Stage 4: Akerley Boulevard to Burnside Drive	McGregors Brook Water Quality
	Wrights Brook Water Quality
	Flat Lake Water Quality
	Juniper Lake Water Quality and Fishery
	Whip-poor-will
	River Otter
	Great Horned Owl
	Black-throated Blue Warbler
Stage 5: 102 to Cobequid Road with Connection to Glendale Drive	Sucker Brook Wetland
	Sucker Brook

STAGE	VALUED ENVIRONMENTAL COMPONENT
Stage 5 (cont'd.)	Rocky Lake Water Quality and Fishery
	Three Private Wells
	American Beaver
	Waterfowl
	Land Use Along Cobequid Road
	Traffic on Glendale Drive

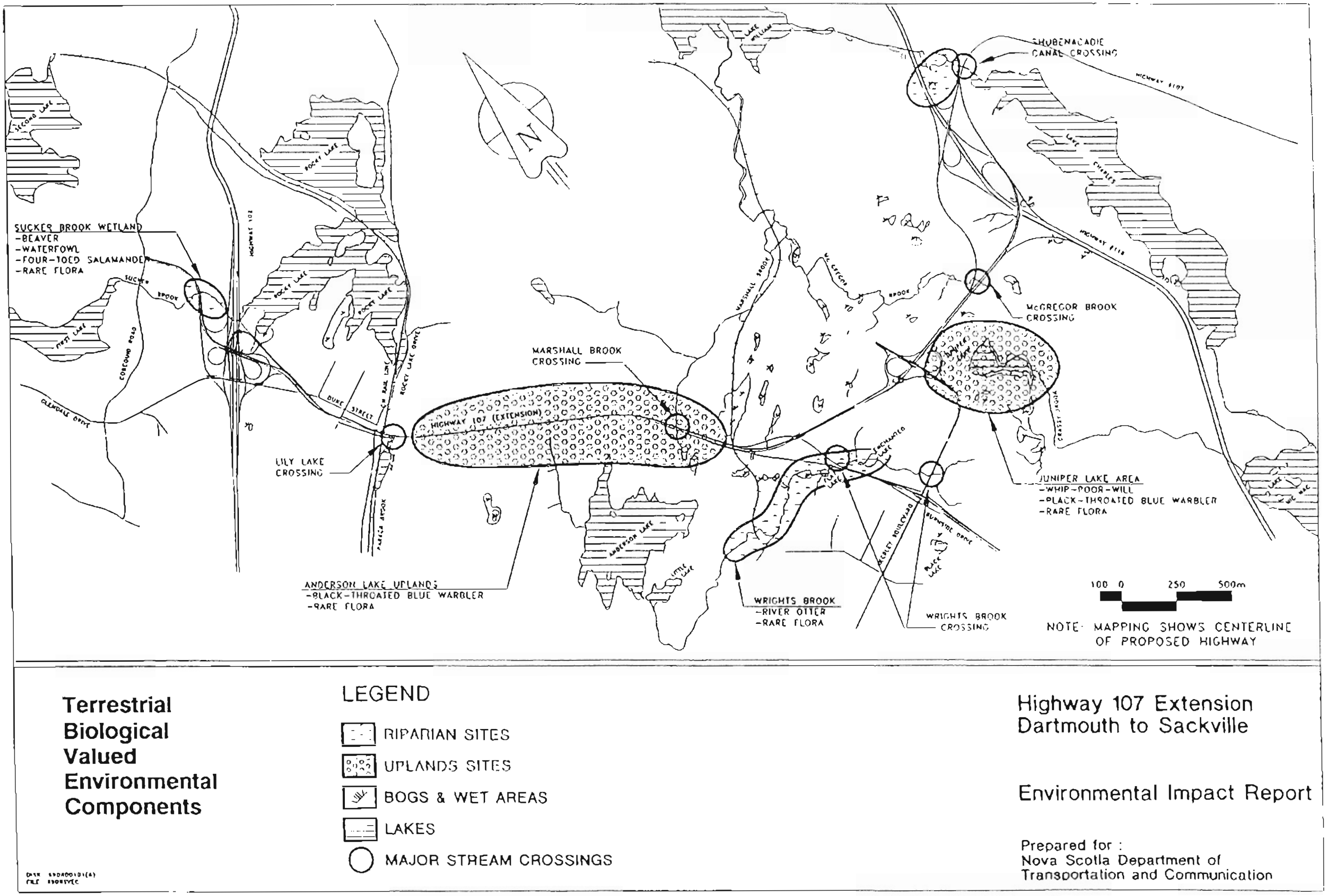


Figure 6-8. Highway 107 Extension, Dartmouth to Sackville: Terrestrial Biological Valued Environmental Components

7.0 IDENTIFICATION OF PREDICTED ENVIRONMENTAL IMPACTS

Once the VECs (Valued Environmental Components) were defined, it was necessary to predict whether the environmental impacts of project activities on the VECs would be significant. Although the determination of significance varied somewhat for the individual disciplines, generally an impact was considered significant if it met the following criteria:

- the impact creates a long-term (longer than one year) effect on the VEC or the environment,

- the impact is of such frequency that the VEC or environment cannot recover between the recurrences of the impact,

- the impact affects an already declining or endangered VEC, or

- the impact is of such magnitude that the environment, or the VEC, cannot recover.

Matrices of site-specific VECs versus project activities were constructed for each stage of the project. In order to score the seriousness of each interaction of project activities with VECs, measures to mitigate, reduce, or avoid the impacts were considered. These measures are discussed in Section 9 of this report. Each impact was scored as follows:

Low impact;
Significant but mitigable;
Significant, not mitigable;
Significance unknown; or
Positive impact.

The unknown categories are added because in many cases the impacts will not be known until further field surveys are carried out. In most of these cases, the occurrence of the VEC, and the extent of the occurrence, are based on known occurrences in other similar areas and have not been confirmed for the study area. Mitigable means that measures are available which can significantly reduce the environmental impact.

Figures 7-1 through 7-5 present the environmental impact matrices for each stage of the project. These impacts are discussed in the remainder of this section of the report.

7.1 Impacts Common to All Stages of Construction

7.1.1 Air Quality

During the time of construction, the primary source of air pollution will be heavy-duty diesel vehicles involved in earth-moving operations and in on-site activities in all stages of construction of roadways, ramps, and bridges. Equipment/activities responsible for air pollution at all stages of the construction are listed in Table 7.1.

The most serious air pollutants released during the construction phase are diesel engine exhausts and particulate matter.

Diesel exhausts are emitted from heavy-duty diesel vehicles at all construction phases. Chemical characterization of exhaust has shown that emission levels of hydrocarbons, carbon monoxide, nitrogen oxides, and particulates are in the range of grams per kilometre driven for a heavy truck moving at an average speed of 22.9 km/h (Westerholm *et al.*, 1991). These pollutants are dispersed into the surrounding air while the vehicle is in motion and therefore do not create air pollution problems. Humans object to smoke and odorous exhausts from the diesel engines near slow-moving vehicles and stationary equipment. Because this phenomenon occurs near individual operating units, the nuisances can be severe at a construction site but usually do not extend throughout the neighbouring community.

Prediction of air pollution levels is often limited to the main components of diesel exhaust which are carbon monoxide (CO) and nitrogen oxides (NO_x). Others, such as particulates, hydrocarbons, and aldehydes, though by no means negligible, are emitted only in low concentrations.

STAGE 1.

Portobello to Akerley Boulevard

	WATER								LAND		TERRESTRIAL BIOLOGICAL						AQUATIC BIOLOGICAL						SOCIO-ECONOMIC			CULTURAL
PROJECT ACTIVITIES	Surface Water	- McGregor Brook	- Marshall Brook	- Lake William	- Junber Lake	- Lake Charles	Ground Water	- General quantity (acid drainage)	Soil Erosion	Soil Contamination	Flora	- potential habitat for rare species	Fauna	- whip-poor-will	- habitat for 4-toed salamander	- animal crossings	- fisheries:	- Lake Charles	- Lake William	- wetlands habitat	- McGregor Brook	- Marshall Brook	- utilities: transmission line	- regional park land	- landlocked area at 118	- Shubenacadie Canal Lock
CONSTRUCTION PHASE																										
Normal Activities:																										
Clearing		O	O	O	O	O			O			*		*	*	*		O	*	O	O	*	·	O	O	
disposal of merchantable timber																										
disposal of non-salvageable material																										
Grubbing		O			O	O			O			*		*	*	*		O	*	O	O	*	·			
disposal of non salvageable material																										
Sub Grade and Drainage																										
- drilling							O							*												
- blasting							O							*												
- excavating		O	*	*	O	O	O		O									O	*	O	O	*				
- filling operation		O	*	*	O	O			O									O	O	O	O	*				
- alteration of stream crossing		O	*						O			*			*	*					O	*				
- disposal of excess material		O	*	*	O	O			O			*			*			O		O	O					
- clean up - slope grading		O			O	O			O																	
- Hydroseeding																										
Gravelling																										
Paving																										
Finishing Activities:																										
- center line painting																										
- installing guard rails																										
- installing lighting																										
- erecting signs																										
Surface Water Runoff		O	O		O	O						*			*			O	*	O	O					
Vehicle / Equipment Movement		O							O			*		*	*	*										
Equipment Noise														*	*	*										
Human Disturbance												*		*	*	*										
Vehicle / Equipment Emissions															*											
Accidental Events:																										
Petrochemicals Spill		●	●	●	●	●						*			*			●	●	●	●	●				
Petroleum Spill		●	●	●	●	●						*			*			●	●	●	●	●				
Other Hazardous Materials Spill		●	●	●	●	●						*			*			●	●	●	●	●				
OPERATION PHASE																										
Normal Activities:																										
Snow Ploughing																*										
Mowing																										
Salting		·	·	·	·	·									*			·	·	·	·	·				
Runoff from Vehicle Traffic		*	*	*	*	*												*	*	*	*	*				
Vehiclular Emissions																										
Increase in Traffic Volume																*										
Increase in Noise														*	*	O										
Changes in Traffic Patterns																										
Repaving																										
Repair																										
Accidental Events:																										
Petrochemicals: Transport Spill		●	●	●	●	●		O							*			●	●	●	●	●				
Petroleum Products: Transport Spill		●	●	●	●	●		O							*			●	●	●	●	●				
Other Hazardous Materials: Transport Spill		●	●	●	●	●		O							*			●	●	●	●	●				

Key:

· = Low Impact
O = Significant Impact, Mitigable
● = Significant Impact, Non-mitigable
* = Significance of Impact Unknown
+ = Positive Impact

Figure 7-1 Environmental Impact Matrix, Highway 107 Extension: Stage 1

STAGE 2.

Duke Street, Bedford, to Glendale Drive, Lower Sackville

PROJECT ACTIVITIES	WATER: Surface Water	WATER: - Rocky Lake	WATER: Ground Water	WATER: - private well	WATER: - general quantity (acid drainage)	LAND: Soils	LAND: - erosion	LAND: - contamination	TERRESTRIAL BIOLOGICAL: Flora	TERRESTRIAL BIOLOGICAL: - potential habitat for rare species	TERRESTRIAL BIOLOGICAL: Fauna	TERRESTRIAL BIOLOGICAL: - animal crossings	SOCIO-ECONOMIC: - traffic outs Glendale Road	SOCIO-ECONOMIC: - traffic on Rocky Lake Drive	SOCIO-ECONOMIC: - access to industrial parks	AQUATIC BIOLOGICAL: Fisheries	AQUATIC BIOLOGICAL: - Rocky Lake	AQUATIC BIOLOGICAL: wetland Habitat
CONSTRUCTION PHASE																		
Normal Activities:																		
Clearing		○					○			*		*					○	○
disposal of merchantable timber																		
disposal of non-salvageable material																		
Grubbing		○					○			*		*					○	○
disposal of non salvageable material																		
Sub Grade and Drainage																		
- drilling			•	•	*													
- blasting			•	•	*													
- excavating		○			*		○										○	○
- filling operation		○					○										○	○
- alteration of stream crossing		○					○			*		*					○	
- disposal of excess material		○					○			*								
- clean up - slope grading		○					○										○	○
- Hydroseeding		+					+										+	+
Gravelling																		
Paving																		
Finishing Activities:																		
- center line painting																		
- installing guard rails																		
- Installing lighting																		
- erecting signs																		
Surface Water Runoff		○					○			*							○	○
Vehicle / Equipment Movement							○			*		*						○
Equipment Noise												*						
Human Disturbance										*		*						
Vehicle / Equipment Emissions										*								
Accidental Events:																		
Petrochemicals Spill		●	○							*							●	●
Petroleum Spill		●	○							*							●	●
Other Hazardous Materials Spill		●	○							*							●	●
OPERATION PHASE																		
Normal Activities:																		
Snow Ploughing												*						
Mowing																		
Salting		•	•	•														
Runoff from Vehicle Traffic																		
Vehicular Emissions																		
Increase in Traffic Volume												*						
Increase in Noise												○						
Changes in Traffic Patterns																		
Repaving																		
Repair																		
Accidental Events:																		
Petrochemicals:																		
Transport Spill		●		○	○												●	●
Petroleum Products:																		
Transport Spill		●		○	○												●	●
Other Hazardous Materials:																		
Transport Spill		●		○	○												●	●

Key:

- • = Low Impact
- ○ = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-2 Environmental Impact Matrix, Highway 107 Extension: Stage 2

VALUED ENVIRONMENTAL COMPONENTS

STAGE 3.

Burnside Industrial park to Highway 102

PROJECT ACTIVITIES	WATER: Surface Water and Fisheries	- Lily Lake	- Anderson Lake	- Rocky Lake	- Marshall Brook	- Lake William	- Wright's Brook	- Enchanted Lake	- Flat Lake	Ground Water	- 3 private wells	- General quantity (acid drainage)	LAND: Soil Erosion	Soil Contamination	TERRESTRIAL BIOLOGICAL: Flora	- rare plant habitat	Fauna	- River Otter	- animal crossings	AQUATIC BIOLOGICAL: Wetland Habitat	SOCIO-ECONOMIC: CP Allen High School	Residential Property	St. Pat's Home for Girls	Access to Bedford Industrial park
CONSTRUCTION PHASE																								
Normal Activities:																								
Clearing		○	○	○	○	○	●	○	○				○			*		●	*	○		○		○
disposal of merchantable timber																								
disposal of non-salvageable material																								
Grubbing		○	○	○	○	○	●	○	○				○			*		●	*	○		○		○
disposal of non salvageable material																								
Sub Grade and Drainage																								
- drilling							*	*	*	○	•	○						*						
- blasting							*	*	*	○	•	○	○					*						
- excavating		○	○	○	○	○	●	○	○	○	•	*	○					●		○				
- filling operation		○	○	○	○	○	●	○	○				○					●		○				
- alteration of stream crossing		○	○		○		●		○				○			*		●	*	○				
- disposal of excess material		○	○	○	○	○	○	○	○				○			*		○		○				
- clean up - slope grading		○	○	○	○	○	●	○	○				○					●		○				
- Hydroseeding		+	+	+	+	+	+	+	+				+					+		+				
Gravelling																								
Paving																								
Finishing Activities:																								
- center line painting																								
- installing guard rails																								
- installing lighting																								
- erecting signs																								
Surface Water Runoff		○	○	○	○	○	●	○	○				○			*		○		○				
Vehicle / Equipment Movement							●	○	○				○			*		○	*	○				
Equipment Noise																		*	*		○			
Human Disturbance							●	○	○							*		○	*	○	○			
Vehicle / Equipment Emissions																								
Accidental Events:																								
Petrochemicals Spill		●	●	●	●	●	●	●	●							*		●		●				
Petroleum Spill		●	●	●	●	●	●	●	●							*		●		●				
Other Hazardous Materials Spill		●	●	●	●	●	●	●	●							*		●		●				
OPERATION PHASE																								
Normal Activities:																								
Snow Ploughing																		*	*					
Mowing																								
Salting		•	•	•	•	•	•	•	•		•	•						•		•				
Runoff from Vehicle Traffic																								
Vehiclular Emissions																								
Increase in Traffic Volume																		●	*					
Increase in Noise																		○	○		○			
Changes in Traffic Patterns																								
Repaving																								
Repair																								
Accidental Events:																								
Petrochemicals: Transport Spill		●	●	●	●	●	●	●	○	○	○	○		○				●		●				
Petroleum Products: Transport Spill		●	●	●	●	●	●	●	○	○	○	○		○				●		●				
Other Hazardous Materials: Transport Spill		●	●	●	●	●	●	●	○	○	○	○		○				●		●				

Key:

- • = Low Impact
- ○ = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-3 **Environmental Impact Matrix, Highway 107 Extension: Stage 3**

STAGE 4.

Akerley Boulevard - Burnside Drive

PROJECT ACTIVITIES	WATER: Surface Water and Fisheries	- McGregor Brook	- Wright's Brook	- Flat Lake	- Juniper Lake	Ground Water	- General quantity (acid drainage)	LAND: Soil Erosion	Soil Contamination	TERRESTRIAL BIOLOGICAL: Flora	- rare plant habitat	Fauna	- whip-poor-will	- River Otter	- Great Horned Owl	-Black-throated Blue Warbler	- animal crossings
CONSTRUCTION PHASE																	
Normal Activities:																	
Clearing		○	●	○	○			○			*		*	○	○	*	*
disposal of merchantable timber																	
disposal of non-salvageable material																	
Grubbing		○	●		○			○			*		*	○	○	*	*
disposal of non salvageable material																	
Sub Grade and Drainage																	
- drilling																	
- blasting																	
- excavating		○	●	○	○		*	○									
- filling operation		○	●	○	○			○									
- alteration of stream crossing		○						○			*						*
- disposal of excess material		○	○	○	○			○			*			*			
- clean up - slope grading		○	●	○	○			○									
- Hydroseeding		+	+	+	+			+									
Gravelling																	
Paving																	
Finishing Activities:																	
- center line painting																	
- Installing guard rails																	
- Installing lighting																	
- erecting signs																	
Surface Water Runoff		○	●	○	○			○			*			○			
Vehicle / Equipment Movement								○			*		*	○	○	*	*
Equipment Noise													*	*	○	*	*
Human Disturbance											*		*	○	○	*	*
Vehicle / Equipment Emissions																	
Accidental Events:																	
Petrochemicals Spill		●	●	●	●									●			
Petroleum Spill		●	●	●	●									●			
Other Hazardous Materials Spill		●	●	●	●									●			
OPERATION PHASE																	
Normal Activities:																	
Snow Ploughing														*			*
Mowing																	
Salting		•	•	•	•									•			
Runoff from Vehicle Traffic																	
Vehicular Emissions																	
Increase in Traffic Volume													*	●	●	*	*
Increase in Noise													*	○	○	*	*
Changes in Traffic Patterns																	
Repaving																	
Repair																	
Accidental Events:																	
Petrochemicals:																	
Transport Spill		●	●	●	●		○		○					●			
Petroleum Products:																	
Transport Spill		●	●	●	●		○		○					●			
Other Hazardous Materials:																	
Transport Spill		●	●	●	●		○		○					●			

Key:

- • = Low Impact
- ○ = Significant Impact, Mitigable
- ● = Significant Impact, Non-mitigable
- * = Significance of Impact Unknown
- + = Positive Impact

Figure 7-4 Environmental Impact Matrix, Highway 107 Extension: Stage 4

VALUED ENVIRONMENTAL COMPONENTS

STAGE 6.

102 to Cobequid Road; Connections to Cobequid Road and Glendale Drive

PROJECT ACTIVITIES	WATER						LAND		TERRESTRIAL BIOLOGICAL				SOCIO-ECONOMIC	
	Surface Water and Fisheries	- Sucker Brook	- Rocky Lake	Ground Water	- 3 private wells	- General quantity (acid drainage)	Soil Erosion	Soil Contamination	Beaver	Animal crossings	Sucker Brook Wetland	Waterfowl	Land use along Cobequid Road	Traffic onto Glendale Road
CONSTRUCTION PHASE														
Normal Activities:														
Clearing		○	○				○		○	*	○	*		
disposal of merchantable timber														
disposal of non-salvageable material														
Grubbing		○	○				○		○	*	○	*		
disposal of non salvageable material														
Sub Grade and Drainage						*								
- drilling					•	*								
- blasting					•	*								
- excavating		○	○				○				○	*		
- filling operation		○	○				○				○	*		
- alteration of stream crossing		○					○		○		*	*		
- disposal of excess material		○	○				○				○	*		
- clean up - slope grading		○	○				○				○	*		
- Hydroseeding		+	+				+				+			
Gravelling		+	+				+							
Paving														
Finishing Activities:														
- center line painting														
- installing guard rails														
- installing lighting														
- erecting signs														
Surface Water Runoff		○	○				○					*		
Vehicle / Equipment Movement									*	*		*		
Equipment Noise									*	*	*	*	○	○
Human Disturbance									*	*	*	*		
Vehicle / Equipment Emissions														
Accidental Events:														
Petrochemicals Spill		●	●		○	○		○	●		●	*		
Petroleum Spill		●	●		○	○		○	●		●	*		
Other Hazardous Materials Spill		●	●		○	○		○	●		●	*		
OPERATION PHASE														
Normal Activities:														
Snow Ploughing														
Mowing														
Salting		•	•											
Runoff from Vehicle Traffic														
Vehiclular Emissions														
Increase in Traffic Volume									*	*	*	*		
Increase in Noise									*	*	*	*	○	○
Changes in Traffic Patterns														
Repaving														
Repair														
Accidental Events:														
Petrochemicals:														
Transport Spill		●	●			○		○			●	*		
Petroleum Products:														
Transport Spill		●	●			○		○			●	*		
Other Hazardous Materials:														
Transport Spill		●	●			○		○			●	*		

Key:

• = Low Impact

○ = Significant Impact, Mitigable

● = Significant Impact, Non-mitigable

* = Significance of Impact Unknown

+ = Positive Impact

Figure 7-5 Environmental Impact Matrix, Highway 107 Extension: Stage 5

Table 7.1. Sources and Types of Air Pollution

OPERATION	SOURCE OF POLLUTION	TYPE OF POLLUTION
Clearing	Burning of non-merchantable organic material, chainsaw, mechanical delimber, tractor-skidder, porter, tractor-drawn brush, trailer	Smoke, gasoline engine exhaust, diesel engine exhaust, particulate matter
Grubbing	Bulldozer, track-mounted excavator, conventional excavator, drag-line excavator	Diesel engine exhaust, particulate matter
Subgrade and drainage development	Excavator, front-end loader, truck, scraper, drill, bulldozer, blasting	Diesel engine exhaust, particulate matter
Highway base construction	Stone crusher, vibratory roller, truck	Diesel engine exhaust, particulate matter
Highway paving	Asphalt paving vehicle, truck	Engine diesel exhaust, odour
Striping, mounting of signs, lighting, and barriers	Small tools, air compressor, light truck	Gasoline engine exhaust
Bridge construction	Truck and other equipment; welding and painting	Engine exhaust, particulate matter

Fugitive dust (dust picked up by wind from the ground) may lower air quality during construction, especially in summer during dry and windy weather. Some land will be cleared, grubbed, and regraded, according to highway construction requirements. Exposed topsoil and some stored dusty construction materials may generate fugitive dust. According to available geological data, the surficial soils and subsurface strata are rocky, so the occurrence and intensity of fugitive emissions should be rather low, especially when the exposed soil is wet.

Other highway construction activities which are potential sources of dust are drilling and blasting. Fortunately, pneumatic drilling equipment is usually provided with a water spray which reduces dust emissions. Explosions may cause injection of a certain amount of dust into the air. Considering that explosions are of short duration and the material involved will be hard rock, anticipated dust emissions will be low.

Prediction of air quality levels from diesel exhaust for projected conditions involves the use of a mathematical diffusion model, a technique based on the location and quantity of emissions and on meteorological conditions. The calculation procedure used in this project is similar to that described in Ontario's Regulation 308 (Environmental Protection Act, 1988).

Some assumptions corresponding to real conditions have been made to estimate emissions of CO and NO_x from heavy-duty diesel engines which power construction vehicles (bulldozer, excavator, etc.). These assumptions are as follows:

- diesel engine specifications: power 331 kW, 30 rps, compression ratio 16:1, swept volume 14 L;
- emission rate of CO is 60 mg/s and NO_x is 120 mg/s (Westerholm *et al.* 1991);
- three units powered by diesel operate simultaneously on an area small enough that it may be considered as a point source of emission.

Further assumptions are summer meteorological conditions (July) with mean SE-direction wind speed of 11.3 km/h. This is the lowest monthly-average wind speed based on yearly observations at the Shearwater Airport. These meteorological conditions also provide for the worst-case scenario (lower wind speed causes higher concentration of pollutants). It is also assumed that emission rates, meteorological conditions, and pollutants transportation patterns remain essentially uniform for all locations throughout the construction area.

Results from the computer model revealed that the maximum concentration of CO and NO_x (expressed as NO_2) should not exceed 20 parts per million (23 mg/m^3 of air) and 200 parts per billion (0.38 mg/m^3 of air), respectively, near the source of emissions. These concentrations are in the range between desirable and acceptable values given as air quality objectives by the Nova Scotia Department of the Environment (see Section 8.2). Impacts of the project on air quality are therefore considered to be low.

7.1.2 Noise

Construction equipment which will be utilized during construction of the Highway 107 Extension will include a number of machines and devices varying in physical size, horsepower rating, and mode of operation. Consequently, they vary widely in the noise they produce. Even for equipment of a single model, variations in sound level at a fixed distance can be expected (May, 1978). The equipment will be used for the clearing of land, site preparation, excavation, compacting, paving, clean-up, landscaping, etc. As already noted, construction of the highway will be carried out in several reasonably discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics.

Noise may obstruct verbal communication, disturb sleep, and increase the risk of hearing damage. The range of sound levels of three categories of noise impact are given in Table 7.2.

Table 7.2 Noise Exposure, in decibel A [dB(A)], for Different Impact Effects

Noise Effect	Noise Level, dB(A)		
	Slight	Moderate	Severe
Speech Interference	no data	45 - 60	> 60
Sleep Interference	35 - 50	50 - 70	> 70
Hearing Damage Risk	70 - 80	80 - 95	> 100

Despite the variety in type and size of construction equipment, the similarities in the dominant noise sources and patterns of operation are sufficient to permit the review of various construction equipment in the following categories:

1) equipment powered by internal combustion engines,
2) impact equipment,
   and
3) other equipment.

Equipment Powered by Internal Combustion Engines

The internal combustion engine is used to provide propulsion for the wheels of trucks and/or operating power for the working mechanisms such as buckets, dozers, etc. Exhaust noise is usually the most important component of engine noise in the engine; however, noise associated with the air intake, cooling fans, and the mechanical and hydraulic transmission and control systems also can be significant.

Impact Equipment

This category of construction equipment includes pile drivers, rock drills, and small hand-held pneumatically, hydraulically, or electrically powered tools. The primary noise source for conventional pile drivers is the impact of the hammer striking the pile. Engine-related noise sources, such as combustion explosion or release of steam at the head of some equipment, are usually secondary. Engine noise is, however, the predominant noise source for pile drivers, equipment commonly used at bridge construction sites. The predominant sources of noise in pneumatic tools are the high-pressure exhaust and the impact of the tool bit against the material on which it acts.

Other Equipment

The two previous categories comprise a sizable portion of construction equipment; however, many types of construction equipment capable of producing significant noise do not fit either of these categories. For example, a power saw has an intense high-pitched whine, and a concrete vibrator produces noise as it shakes concrete forms.

Classification of road construction equipment according to function at the construction site is as follows:

1) earthmoving equipment (bulldozers, shovels, backhoes, front-end loaders, scrapers, graders, compactors);
2) materials handling equipment (cranes, movers, concrete pumps, asphalt pavers); and
3) stationary equipment (pumps, electric power generators, air compressors).

The noise emanating from construction sites is generally described by the A-weighted equivalent sound level to take into account the time-varying nature of the noise. The A-weighted scale expressed in A-weighted decibels dBA, or dB(A), closely approximates the response of the human ear. Most sound level meters available are equipped with an electronic system with the dBA capability. The ranges of A-weighted sound levels typical for road construction equipment which have been identified as major noise sources are given in Table 7.3 (Harris, 1979).

Prediction of Road Construction Noise Level

Total sound energy is essentially a product of a machine's sound level, the number of such machines in service, and the average length of time they operate. This measure is regarded as the best indication of the priority which should be given to the regulation of noise from the various sources.

Two different methods have been proposed for estimating the amount of noise on construction sites. One method defines acceptable noise levels at the boundary of the site or at the nearest residential or sensitive area. This is the "situation-specific" approach. The second, or "source-specific", approach involves specifying acceptable noise levels from each of the various items of equipment operating on the site.

Often it is impossible to compute levels of sound accurately for a planned construction project because of insufficient data. In such a case, a common practice in predicting noise level is to refer to similar past cases and to adopt reported findings. Typical ranges of equivalent sound level (L_{eq}) at construction sites in the USA (EPA, 1972) on public works, roads and highways were as follows:

- ground clearing 84 & 84 dB(A);
- excavation 88 & 78 dB(A);
- paving 79 & 78 dB(A);
- finishing 84 & 84 dB(A).

The first number refers to all pertinent equipment present at the site, and the second refers to the minimum required equipment at the site. All data concerns day-time operation.

A special case which involves excessive noise is blasting operations. These operations are covered by separate regulations in which safety plays an important role. Blasting will be monitored and results forwarded to NSDOE on a monthly basis unless otherwise decided by the department. Air blast (concussion) noise will not exceed a value of 128 dBA within seven metres (23 feet) of a building located on property other than where the blasting operations occur. Allowed ground vibration is 12.5 mm/s or less at peak particle velocity. Vibration should be measured below grade or less than one metre (three feet) above grade in any part of a building located on a property other than where the blasting occurs. Impacts of the undertaking on noise levels are considered significant but mitigable.

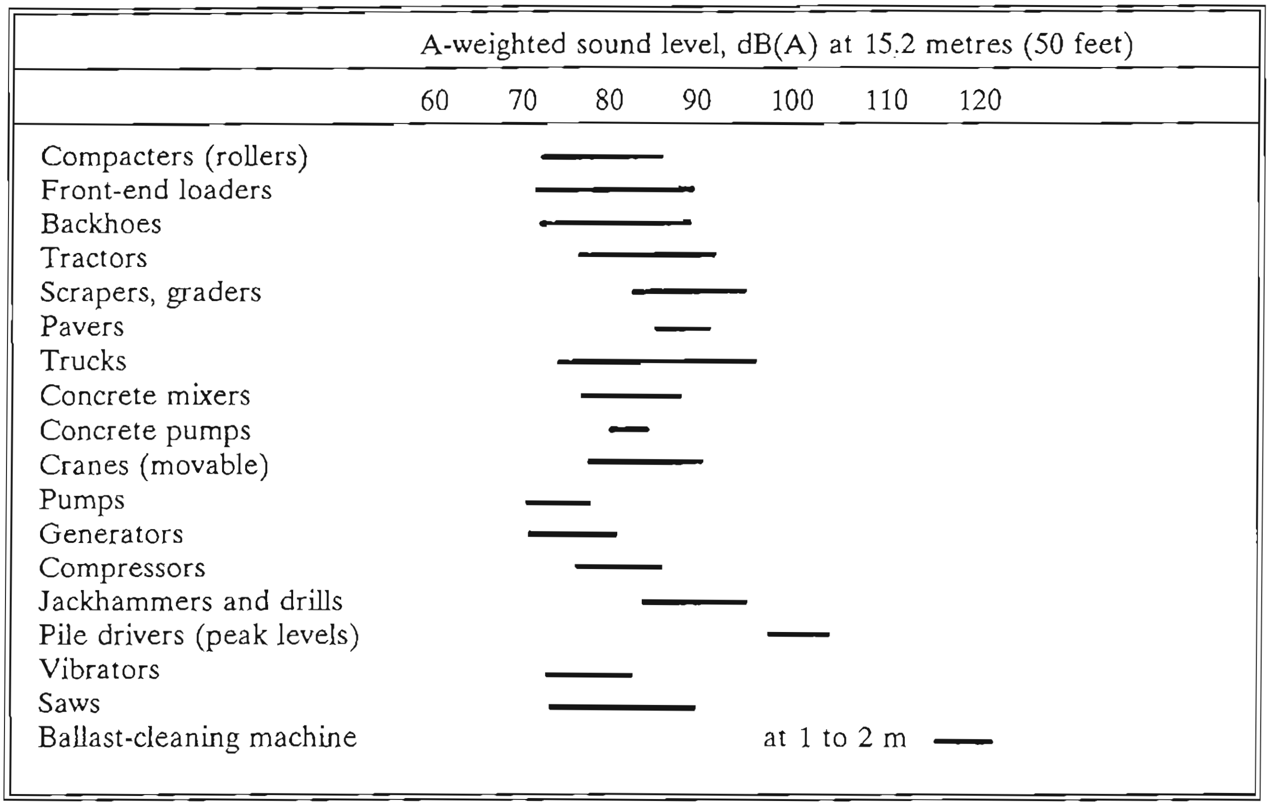
7.1.3 Acid Drainage

As explained in Section 6.2.1.2, exposure of acid-producing bedrock to air and water during excavation and blasting may lead to reduced pH and higher concentrations of such elements as mercury, lead, and arsenic in surface runoff. These conditions can lead to lake and stream acidification, fish kills, and changes in the structure of entire aquatic communities.

Testing of two rock samples from the area suggested that the potential for acidic drainage is low (see Section 6.2.1). Both samples contained less than the 0.4 percent sulphide criteria suggested by NSDOE and Environment Canada (1989) as the lower limit for acid-generating potential. Nevertheless, the impacts of acid-producing bedrock on surface waters and biota are potentially so severe and long-lasting that testing should be done at each location where bedrock will be exposed.

Mitigation methods for acidic drainage are described in Section 9.3. Because samples of rock in specific excavation areas have not been analyzed, these impacts are rated as unknown.

Table 7.3 A-Weighted Sound Level Ranges of Road Construction Equipment



7.1.4 Siltation of Water Courses

A primary concern during highway construction is the potential for increased loading of silt into streams, and subsequently into lakes after rainfall events, snowmelt, and movement of vehicles across streams. The silt clogs gravel beds that may be used by spawning Brook Trout and other aquatic organisms. Reduced water flow through the gravel also lowers oxygen concentrations for developing eggs and young, and silt particles are known to adsorb or contain pollutants such as heavy metals and petroleum products. Fortunately, adequate mitigation practices exist and should alleviate most of these concerns (see Section 9.4). Any residual problems, following storm events for example, are expected to be localized and short-lived. These impacts are rated as significant but mitigable.

7.1.5 Accidental Events

Accidents during the construction phase may result in spills of fuels or other toxic materials such as paint. The most significant impacts are on nearby streams and lakes. Although these systems are a small proportion of the total area, the probability of spills at water courses is considerably higher than elsewhere because of steeper slopes and softer ground. Unlike the larger spills that may occur during operation of the highway, these impacts are expected to be short-lived and relatively localized in nature. Excavation of contaminated soil may also lessen the impact on aquatic systems. Although spills can be prevented and contained to some degree by contingency planning and by refuelling off-site where possible, their impacts on surface waters are rated as significant and not mitigable because of the potential severity of spill impacts. Impacts on groundwater quality are rated significant but mitigable, since remedial actions after spills can prevent groundwater contamination.

7.1.6 Other Potential Impacts

Excavation

The excavation of soil or bedrock can influence local groundwater supplies. If a water well is located on the top of a hill and part of the hill is excavated for the highway, the water table will adjust to the change in topography. This will result in the lowering of the water table and possibly the dewatering of a well. Dug wells are especially sensitive to this.

In the study area the potential for the dewatering of water wells is low because no dug wells were identified and all drilled wells were at least 30 metres (100 feet) deep. These impacts are rated as low.

Blast Damage

Blast damage potential appears to be low as only four water wells were identified by the water well survey. The four wells could be affected by blasting during the construction of Stages 2, 3, and 5. Three of the four wells, however, are located near Municipal Contracting's gravel quarry, where blasting is an ongoing operation. It would be nearly impossible to distinguish the effects of this blasting from those of highway construction blasting. Domestic well locations are shown in Figure 6-3.

Blast damage can reduce the quantity of water produced by a well by closing the fractures which feed the well. Water quality may be affected by introducing new fractures, through which lower quality water may enter the well. These impacts are considered low, since owners of wells could easily connect to municipal water supplies. (A municipal water line has been installed on this section of Rocky Lake Road; the only additional line required for hookup would be from the road to the residence.)

Rare Flora

Rare flora have been identified as potentially occurring in all stages of the project but if and where they occur, and what impacts highway construction might have cannot be predicted until summer field surveys are conducted. In general, the major impacts of highway construction on plants occur during clearing and grubbing. Impacts can also arise because of drainage alterations (e.g. ponding) which may affect local soil, drainage, light, or microclimatic conditions which affect plant survival. Whether these impacts can be judged significant or warranting of mitigation depends on the rarity of the species and the likelihood that the project, in concert with other known or reasonably expected threats, jeopardizes the species' survival. These impacts are rated as unknown.

Fauna

The most important impacts common to all stages of the highway are habitat reduction and isolation and increased accessibility to humans. Although the actual areal loss of habitat associated with highway construction will probably be insignificant for most species, fragmentation of the remaining area into smaller parcels between which movement is restricted may potentially have an impact on certain species. For example, those having large territories or undertaking seasonal movements (e.g., Black Bear, White-tailed Deer, and Great Horned Owl) can exhaust the food supply in a small area relatively quickly and therefore travel among a number of food-containing "patches", giving recently-exhausted patches time to recover. By interfering with these movements, a highway can impact habitat over a larger area than that which is disturbed by construction.

Increased accessibility to humans may initially lead to increased hunting pressure, fire potential, and litter, and eventually, industrial expansion, all of which may have attendant impacts on many types of resident fauna. These impacts are rated as either significant, significant but mitigable, or unknown.

7.2 Impacts Specific to Stage 1

There are potential impacts on rare flora and fauna associated with Stage 1 since the area contains potential habitat for a number of rare plants and Four-toed Salamander, and is a reported breeding area for Whip-poor-will and Black-throated Blue Warbler. The exact locations of these species in relation to the highway, and its potential impacts on them, cannot be determined until a summer field survey is conducted. For flora, the optimum time for such a survey will span late May to August; for Four-toed Salamander, a survey could begin in April; and for the two bird species, it could begin in June. These impacts are rated as unknown.

Water Quality and Aquatic Biota

Many of the construction activities listed on the Environmental Screening Impacts Matrix will have significant environmental impacts on the water quality and aquatic biota of nearby streams and lakes. Increased silt inputs to McGregor and Wrights Brook, Lake Charles, and Juniper Lake will occur following clearing and grubbing of the route and excavation of the sub-grades and drainage channels. (Lake William should not be significantly impacted because of its distance from the development, approximately two kilometres [1.2 miles] away). As noted earlier, all of these impacts are mitigable by siltation control measures near streams and by revegetation of exposed soils (see Section 9.4). Gravelling and paving will also further reduce soil erosion and potential siltation of the aquatic environment. These impacts are rated as significant but mitigable.

Nova Scotia Power Corporation Transmission Tower at the Highway 107/118 Interchange

To accommodate the interchange at Highway 107 and Highway 118, the NSPC will have to move one of its transmission towers and possibly raise the transmission line. A representative of Nova Scotia Power Corporation has indicated that the tower will be moved to a location 30 metres (100 feet) away from its present location (Fletcher, 1991). The tower will still be located within the NSPC right-of-way and will not be near any water courses. The construction associated with tower relocation will take place approximately one month before highway construction begins and is expected to last one month. Although no adverse environmental impacts are expected, the plan will be reviewed by the NSPC Environmental Planning and Policy Group. This impact is rated as low.

Dartmouth Regional Park Land Located Along Lake Charles

There is some concern on the part of the City of Dartmouth officials that the amount of land required for the ramp connecting Highway 118 with Highway 107 (located on the Forest Hills side of the Highway 107/118 interchange) may impact the prospects for the City to develop this land, which the City has designated as regional park land. NSDTC has taken this into account in the design of the ramp, and efforts were made to minimize the amount of park land that will be used by the highway. It was also suggested by City of Dartmouth officials that if access could be provided to the park land from the interchange, it would greatly improve the prospects of developing the land as a park. It was suggested by officials at NSDTC, however, that providing access to the park land from the interchange is not feasible. The impact is rated as significant, but mitigable.

Landlocked Area at 118/107 Interchange

The interchange at Highway 107 and Highway 118 landlocks about 30 hectares (75 acres). In consultation with CBCL Ltd., Dartmouth officials estimate that if a change in the current alignment were made, the 30 hectares that would be isolated could be reduced to 19 hectares (47 acres) or even 10 hectares (25 acres). Such changes, however, would require reductions in the design standards which would be detrimental to highway safety. The City of Dartmouth has submitted a letter to NSDTC expressing their concern over the amount of land that will be isolated by the interchange; they have included plans that outline two suggested alignment alternatives. This impact is rated as significant but mitigable.

7.3 Impacts Specific to Stage 2

Because of existing disturbance in the Stage 2 area, there is little potential habitat for either rare flora or fauna.

Water Quality and Aquatic Biota

Increased silt inputs to Rocky Lake may occur following clearing and grubbing of the route and excavation of the sub-grades and drainage channels. Siltation control measures in drainage ditches and revegetation of exposed soils should eliminate most concerns (see Section 9.4). Gravelling and paving will also further reduce soil erosion and siltation of the aquatic environment. This impact is rated significant but mitigable.

Sackville Industrial Park's Access to Highway 102 and Highway 107

Direct access to the 100-series highways is essential for the future development of the Sackville Industrial Park. It has been suggested by members of the Sackville Chamber of Commerce Transportation Committee that more direct access should be provided to Burnside from the Sackville Industrial Park. They do not expect that vehicles will exit the Sackville Industrial Park in order to connect to Highway 107 at Cobequid Road (in the area of First Lake Drive). Rather, they expect vehicles accessing Highway 107 to do so via the Glendale Drive - Duke Street connection, thus creating potential traffic problems at the intersection located inside the Bedford Industrial Park. Although this concern is considered significant to the Sackville Industrial Park, the overall effect of the highway will be to increase the access to all three industrial parks. This particular impact is not rated on the impact matrix.

7.4 Impacts Specific to Stage 3

The Stage 3 area contains potential habitat for rare flora, Four-toed Salamander, Black-throated Blue Warbler, and is known to contain River Otter. Since the area has remained largely unexplored by naturalists, there is little information available on existing flora and fauna, and it is possible that other VECs might be identified. Before impacts can be predicted, the area must be resurveyed during the summer to determine exact locations of potential rare flora and fauna. The impacts are rated as unknown.

The Wrights Brook area is a relatively rich habitat which attracts a number of mammals including White-tailed Deer, Coyote, River Otter, Mink, Ermine, and Snowshoe Hare. Although these species can exist in close proximity to human settlement, the relative amount of habitat directly impacted by highway construction in this area will be large and will result in a large portion of

Wrights Brook being cut off from more extensive, undisturbed habitat to the northeast. This impact is rated as significant, not mitigable.

Water Quality and Aquatic Biota

Increased silt inputs to Marshall Brook, and Lily, Anderson, and Rocky Lake could occur following clearing and grubbing of the route and excavation of the sub-grades and drainage channels. (Note that Lake William, approximately four kilometres (2.5 miles) away, is not expected to be impacted). Siltation control measures near the streams and in drainage ditches should alleviate most of the potential impacts associated with construction. Particular attention is required for construction activities near Lily Lake, because resident trout populations and their food supplies may be severely impacted by water-borne silt. Hydroseeding, gravelling, and paving will be carried out as early as possible to reduce siltation problems.

Because of their proximity to the construction site, Enchanted Lake, Flat Lake, and Wrights Brook may not be adequately protected by available siltation controls. Reducing the duration of construction activities will lessen the environmental impact. These impacts are rated as significant but mitigable.

Configuration of the Proposed Intersection Located in the Bedford Industrial Park

Concerns have been raised over the design of the intersection in the Bedford Industrial Park that provides access to Highway 107. The design is such that two 90-degree turns must be made before a vehicle gains access to the on-ramp. It is expected that this design may hinder the manuverability of mobile home trailer trucks in the Park. This impact is rated positive, however, because the proposed highway will actually provide improved conditions for truck maneuverability.

Charles P. Allen High School

Since the proposed highway will pass within 70 metres (230 feet) of the high school, between the school and Duke Street, there is concern on the part of school personnel and the Halifax County School Board that the highway will be located too close to the school. They expect the highway to disturb the school's academic environment and to pose safety problems for the students and personnel attending the school.

Approximately 90 percent of the school's students are bused. There are approximately 12 buses, some making more than one trip, that travel to the school in the morning and afternoon. In addition, there are generally 100 cars, including those of students, parked at the school each day. While the school is now isolated from the heavy truck traffic on Rocky Lake Drive, the new highway will effectively redirect this truck traffic past the school. Although there is some concern regarding the safety of students, the present road beside the school will be maintained as a driveway, so that cars and buses travelling to and from the school do not have to travel on the proposed highway. Since the entry and exit ramps for Highway 107 will also be located between the school and Duke Street, it is expected that noise will be distracting to a number of the school's classrooms. This is especially true because trucks will be gearing down and gearing up to exit off and merge with traffic on Highway 107.

In order to estimate the degree of disturbance to the school, another high school located near a highway (the Bedford Junior High School near the Bedford Bypass) was examined. The school initially had problems with students crossing the highway as a short cut. The problem has been alleviated, however, by erecting a fence along the school grounds next to the highway and implementing a strict policy forbidding students to cross the highway. Plans for Highway 107 near Charles P. Allen include embankments and fences if necessary, to prevent students from crossing the highway. Very few students walk to school at Charles P. Allen, and few students leave the school on foot during lunch. Therefore, the safety problems associated with students crossing the roadways on foot are considered minimal. The high school now has an attendance of roughly 1,020 students, and this student body is expected to reach 1,200 over the next five years. The school is currently operating at or over capacity; if it is to accommodate additional students, it must expand or use portable classrooms. Although the proposed Highway does not require school property, the highway may limit the potential for the school to expand, as members of the Halifax County - Bedford School Board have indicated that they would be less willing to recommend further investment in the school because of its proximity to the proposed highway.

There is also concern that the construction of the highway will adversely affect the functioning of the school because of noise, heavy machinery traffic, and the flow of traffic in and out of the school yard. These concerns are addressed in Section 6.2.2.3 of this report. This impact is rated significant but mitigable.

Residential Properties Along Rocky Lake Drive

It is expected that the proposed highway alignment will require the Province to purchase approximately six or seven properties along the south side of Rocky Lake Drive. This impact is rated as significant but mitigable on the impact matrix, since the properties will be purchased. From the owners' point of view, however, this impact may be considered not mitigable.

7.5 Impacts Specific to Stage 4

Terrestrial Biota

After construction of Stage 3, Stage 4 will probably have a relatively small additional effect on most species. The Stage 4 area, however, contains potential habitat for a number of rare plants, the Blue-Listed Whip-poor-will and the uncommon Black-throated Blue Warbler. The impacts on these species cannot be predicted until summer surveys are conducted according to the schedule for Stage 1 given in Section 7.2. Therefore, the impacts are rated as unknown.

Water Quality and Aquatic Biota

Siltation of Enchanted, Flat and Juniper Lake, and the headwaters of McGregor and Wrights Brook may occur during Stage 4. Siltation control measures outlined in Section 9.4 should reduce the impacts on McGregor Brook and Juniper Lake, but they may be inadequate for Enchanted and Flat Lake and Wrights Brook. Reducing the duration of construction activities will lessen the environmental impact. Hydroseeding, gravelling and paving should also be carried out as soon as possible after completion of construction to reduce siltation problems. These impacts are rated significant but mitigable, except for where the highway crosses Wrights Brook.

7.6 Impacts Specific to Stage 5

As proposed, Stage 5 will cross the Sucker Brook wetland and may potentially have a large impact on the wetland fauna and flora. Beavers appear to have been responsible for creating this wetland, and they are probably the species at greatest risk from highway construction in the area. The area is also potentially a breeding area for such waterfowl as American Black Duck, Wood Duck, and Hooded Merganser. The latter two species are relatively rare cavity-nesters which benefit both from wetland creation and the flooding of potential cavity trees. This impact is rated as unknown.

The most important potential environmental impact of Stage 5 activities is abandonment of the wetland by beavers. Subsequent draining of the wetland will occur if the dam is no longer maintained. Abandonment could be caused by increased human disturbance, traffic, noise, or reduction in the foraging area available to beavers because of wetland fragmentation. This impact is rated significant but mitigable.

A summer survey would be required to count the beavers, determine what other species are present, predict impacts of the highway, and recommend mitigative measures.

Water Quality and Aquatic Biota

Sucker Brook and its wetland will be significantly affected by construction of the Cobequid Road Connector "B". Siltation from construction activities and vehicle movement in the wetland area will undoubtedly alter water quality and perhaps severely affect aquatic flora and fauna. The degree of impact will depend on a number of factors, which were discussed in Section 6.0. The impact is rated as significant but mitigable.

7.7 Traffic Impact Assessment - Highway 107 Extension

Purpose

The purpose of this section is to describe the effect of the proposed highway on traffic flow on the existing roadway network in Sackville. The main collector roadways of Glendale Drive, Sackville Drive, Cobequid Road, First Lake Drive, and Beaverbank Road are assessed in terms of future volumes (Average Annual Daily Traffic or AADT) and capacity of the existing roads to handle projected volumes as the various stages are completed. Roads at the Dartmouth end of the highway were not assessed. Roads there are either high capacity, 100-series highways (107 and 118) or located within Burnside Industrial Park. One intent of the proposed Highway 107 Extension is to improve traffic flow in Burnside. The net impact should, therefore, be positive.

Methodology

A review was conducted of a 1987 study called "Highway 107 Feasibility Study (Sackville Expressway/Burnside Drive Extension", which was undertaken by the Nova Scotia Department of

Transportation and Communications. This study focused on traffic volumes on the highway as it was proposed in 1987.

To ascertain the effects on Sackville roads, growth scenarios for Sackville and current local traffic volumes were examined.

Recent origin/destination (O/D) information was not available for Sackville. A study of entry point traffic volumes to Sackville and employment area attraction were used to approximate the missing O/D data. The derived data agreed reasonably well with regional network traffic counts.

Existing Network - Sackville

The County of Halifax estimates that the 1990 population of Sackville was 27,500 people, up from 22,230 in 1986. This represents a growth rate of 5.9 percent per year, which is somewhat higher than the Halifax Census' Metropolitan Area growth rate of 1.4 percent over the same period. Currently, the majority of the Sackville labour force, which works outside of Sackville, exits the community by car or bus via one of two points: the Beaverbank Interchange (Exit 2) or the Sackville interchange (Exit 1) on Highway 101.

Average annual daily traffic (AADT) volumes for these points in 1990* were:

Exit 1:	33,500
Exit 2:	10,500
Total	**44,000**

* Factored at a rate of six percent per year from latest counts (1988) based on annual rate of population growth from 1986 to 1990.

Within Sackville, four roads make up the main collector network. They are listed with their relative share of traffic volume in 1990 in Table 7.4

Collectively, these five roads serve to funnel commuter traffic to the two exits on Highway 101. For example, although Cobequid Road which has only ten percent of the relative volume of collector road traffic over most of its length, experiences a high proportion of traffic at the end nearest Exit 1.

The final column of Table 7.4 shows Level of Service (LOS) on each of the roads. Level of service is essentially a measure of congestion on the roadway. Since level of service "A", "B" and "C" are generally considered as acceptable, LOS is currently acceptable on all five roads. (LOS "D", "E" and "F" are considered unacceptable.) Traffic capacity calculations for the five roads were carried out by the Department of Transportation and Communications, and LOS is based on a comparison of capacity and peak hour volumes (which were estimated at 11 percent of AADT).

Travel Projections - New Highway

In the absence of recent O/D data for Sackville, it was necessary to estimate the direction of traffic flow based on consideration of such factors as location of employment centres and distance to place of work. The main employment areas in Metro are Burnside Industrial Park and downtown Halifax. As there are many other possible destinations, however, it was necessary to limit destinations to arterial roads. For instance, the Bedford Bypass leads to Burnside and continues beyond Burnside to provide access to the two bridges and to downtown Dartmouth. The following chart (Table 7.5) shows estimated traffic volumes for 1990, assuming the Highway 107 Extension has been constructed.

Effect of Highway 107 on Existing Network

In the following assessment, base traffic volume is forecast to increase at a constant rate of six percent per year, which was the rate of population increase between 1986 and 1990 in the Sackville area. This reflects the area's popularity from the point of view of costs, amenities, and proximity to place of work. This is a high rate compared to that of the Halifax Census Metropolitan Area rate of 1.4 percent per year.

It is projected that Sackville and neighboring areas will sustain a high growth rate over the next decade despite the fact that it is approaching maximum build-out relative to in-ground servicing capacity. The proposed highway itself will be one factor influencing this growth by making the area more convenient to workers bound for Burnside, Bedford and Halifax. Also, soil and bedrock conditions are such that there are few other areas around Halifax where land can be developed as

Table 7.4 1990 Traffic Volumes - Sackville Collector Roads

Road	Relative Share of Traffic Volume	Approx. Volume (AADT)*	LOS
Beaverbank Road	24%	10,560	C
Sackville Drive	42%	18,480	C
Glendale Drive	24%	10,560	B
Cobequid Road/First Lake Drive	10%	4,400	B
TOTAL VOLUME	100%	44,000	

* These are average volumes along each of the roadways named, not at intersections, which can be disproportionately high, particularly on Cobequid Road.

cheaply as it can be in Sackville. Therefore, it is expected that development pressure will require an upgrading of sewer capacity and opening up of the Second Lake lands within the time frame of the development of the proposed highway.

Stage 1 This stage will connect Akerley Boulevard and Highway 107 and will have no effect on traffic flow in Sackville.

Stage 2 This stage involves the construction of part of the previously named Sackville Expressway. This connection of Glendale Drive in the Sackville Industrial Park to Duke Street in Bedford Industrial Park (Rocky Lake) could be completed by 1994. The road will provide a diamond interchange at Highway 102. The primary effect for daily commuter traffic will be to provide an alternate exit from Sackville for vehicles bound for Highway 102, with destinations such as Halifax International

Table 7.5 **Estimated Arterial Utilization (1990 AADT Volumes) Assuming Highway 107 Extension Has Been Constructed**

Commuter Traffic	Existing	1990 Volumes Assuming Highway 107 Constructed		
	1990 Volume AADT	Highway 102/ Bedford Hwy.	Bedford Bypass	Expressway/107 Extension
Exit 1 (Sackville Interchange)	33,500	15,100*	7,400	11,000**
Exit 2 (Beaverbank Interchange)	10,500	4,700***	5,800	
TOTAL	44,000	19,800	13,200	11,000

* Some of this traffic would exit from Glendale Drive onto Highway 102.

** This traffic would enter the Expressway on Glendale Drive.

*** Some of this traffic might use Glendale Drive to gain access to the Expressway/Highway 107 Extension.

Airport, Bedford and Halifax. Many of the vehicles currently using Exit 1 would shift to the new exit, relieving congestion on Cobequid Road. Glendale Drive would experience a fifty percent increase in traffic volume growth over 1990. Some truck traffic would be rerouted from Rocky Lake Drive via Duke Street, and truck traffic between Sackville and Bedford would be rerouted. The relative share of traffic volume on the collector roads is summarized below in Table 7.6, together with average annual daily traffic (AADT) volume and level of service (LOS) for each road.

Level of service would decline in all cases to below acceptable levels. Roadway improvements (such as adding lanes) would be required to improve service.

Stage 3 This stage will connect Highway 102 to Burnside Drive extension by 1997. It will allow connection from Sackville, although it will be awkward, requiring two 90 degree turns off Duke Street for access onto the highway from the Bedford Industrial Park (Rocky Lake). Nevertheless, this connection will significantly alter the relative share of traffic volume on Sackville's collector roads, because much of the commuter traffic bound for Burnside will switch to this new route. Also, there will be a significant reduction in truck traffic on Rocky Lake Drive and in Bedford. The projected relative share of traffic volume is shown in Table 7.7. By this time, traffic volumes of Glendale Drive will double from 1994. Without significant roadway improvements, however, level of service will be extremely poor. Glendale Drive will replace Sackville Drive as the most important collector road in the community, and traffic volumes on Sackville Drive will even drop marginally over the period.

Stage 4 This stage will be the completion of Highway 107 between Akerley Boulevard extension and Burnside Drive extension. While its completion could result in a small increase in traffic in Sackville. This increase is not anticipated to be significant.

Stage 5 The final phase, which could be complete as early as 1999, is the completion of Highway 107 to Cobequid Road at First Lake Drive. By itself this should not have a significant impact on traffic patterns in Sackville, because it leads to currently undeveloped lands. Also, First Lake Drive is a fairly low volume road, as it is currently built.

Two other factors could influence the impact of Stage 5. One is the development of the Second Lake lands of the Nova Scotia Department of Housing. There are 303 hectares (750 acres) here outside the Regional Development Boundary. If the boundary is extended, a population of 7,400 could be accommodated. This would add a significant amount of traffic volume to Highway 107. The second factor is the Second Lake collector highway, proposed to ring Sackville and eventually connect with Highway 101 in the Middle Sackville area. This would essentially be an

Table 7.6 1994 Traffic Volumes - Sackville Collector Roads

Road	Relative Share After Stage 2 (1994)	Approx. Volume (AADT)	LOS
Beaverbank Road	22%	12,210	D
Sackville Drive	38%	21,090	D
Glendale Drive	30%	16,650	D
Cobequid Road/First Lake Drive	10%	5,550	D
TOTAL VOLUME	100%	55,500	

Table 7.7 1997 Traffic Volumes - Sackville Collector Roads

Road	Relative Share After Stage 3 (1997)	Approx. Volume (AADT)	LOS
Beaverbank Road	19%	13,240	D
Sackville Drive	27%	18,540	C
Glendale Drive	43%	29,800	F
Cobequid Road/First Lake Drive	11%	7,300	E
TOTAL VOLUME	100%	68,800	

extension of Highway 107. The effect of this would be to simplify access to Beaverbank, Millwood, Middle Sackville and the Second Lake lands.

Therefore, the following traffic flow projections for Stage 5 assume that the Second Lake Collector is complete to at least Millwood.

The projected relative share of traffic volume on the collectors, and the AADT volume and LOS for each after Stage 5 are shown in Table 7.8.

Table 7.8 1999 Traffic Volumes - Sackville Collector Roads

Road	Relative Share After Stage 5 (1999)	Approx. Volume (AADT)	LOS
Beaverbank Road	10%	7,350	C
Sackville Drive	25%	18,400	C
Glendale Drive	30%	22,050	F
Second Lake Drive	35%	25,700	unknown
TOTAL VOLUME	100%	73,500	

Impacts of the project on traffic patterns and flow are considered to be positive. At some time during the development period, upgrading of Glendale Drive will be necessary to increase its capacity. The Glendale Drive corridor is wide enough to accommodate this upgrade.

7.8 Other Impacts During Operation

7.8.1 Air Pollution

Air pollution caused by highway traffic consists of suspended particulate matter and vehicle exhaust gases. The gasoline engine exhaust is likely to consist of the following gases in varying concentrations, according to driving conditions: carbon monoxide, hydrocarbons, oxides of nitrogen, sulphur dioxide, aldehydes, carbon dioxide, hydrogen, oxygen, water vapour, and nitrogen. Carbon monoxide, hydrocarbons, and oxides of nitrogen are recognized as the most serious pollutants; the considerable variation in their exhaust concentrations with driving modes is shown in Table 7.9 (Temple, 1971).

Table 7.9 **Typical Exhaust Gas Constituents**

Pollutant	Driving Modes			
	Idling	Acceleration	Cruising	Deceleration
Carbon monoxide %	4-9	0-8	1-7	2-9
Hydrocarbons (as hexane) ppm	500-1000	50-800	200-800	3000-12000
Oxides of nitrogen ppm	10-50	1000-4000	1000-3000	5-50

Engine conditions (speed, fuel-air ratio, manifold vacuum, etc.) exert a significant influence on the exhaust composition, and these conditions are largely determined by various vehicle driving modes. For example, optimum fuel-air ratio depends on the varying demands of the several driving modes. Maximum power requires a fuel-air mixture 10 to 15 percent richer than theoretically required, while cruising is normally most economical because it requires a 10 percent leaner mixture. At idle, most engines require even richer mixtures to compensate for residual combustion products in the cylinder. At acceleration, induction manifold pressure suddenly falls, resulting in condensation of fuel on the manifold walls and temporary weakening of the mixture entering the engine. On deceleration, throttle closure results in a high induction manifold vacuum, which draws exhaust gas back into the cylinders, reducing the air intake and produces exceedingly rich fuel-air mixtures. Typical engine emissions from gasoline- and diesel-powered vehicles are shown in Table 7.10.

Air pollution problems caused by motor vehicles can be classified into three types:

1) nuisances in the vicinity of single vehicles;
2) direct effects from exposure to contaminants from a large number of vehicles; and
3) photochemical air pollution.

Table 7.10 **Comparison of Typical Emissions of Hydrocarbons, Carbon Monoxide, and Oxides of Nitrogen from Uncontrolled Gasoline- and Diesel-Powered Vehicles[a]**

Emission Source	Gasoline-Powered Automobiles	Diesel-Powered Automobiles
Exhaust		
Hydrocarbons, ppm	500-1200	200-500
Carbon monoxide, %	2.5-4.5	0.1-0.3
Oxides of nitrogen, ppm	300-2000	2000-3000
Crankcase Hydrocarbons, g/day	Approx. 100	Very low
Fuel tank and carburetor Hydrocarbons, g/day	Approx. 80	Very low

[a] From the California State Department of Public Health, and the Air Resources Board (1971).

The severity of these problems depends on the nature of the contaminant, quantity of emission, and meteorological conditions.

Operational impacts on air quality from future increased traffic volume may be evaluated by reviewing similar cases where a study of impacts has been completed, or by referring to a developed procedure for the evaluation of air pollution from complex sources. The theoretical treatment of gas dispersion and consequent reduction in motor vehicle emission concentrations is quite complicated, because traffic represents a continuous line source of pollution which is difficult to quantify precisely. Traffic density, driving patterns, structural characteristics of buildings and surrounding terrain, and meteorological conditions cause large fluctuations in vehicular pollution. Nevertheless, assessment of the magnitude of air pollution in the vicinity of a planned highway is necessary to judge the burden on the public as well as for planning the development of areas near the highway.

A recent air pollution study conducted in the vicinity of a four-lane highway (Wanner, 1990) indicated that the concentration of air pollutants decreases with distance from the highway. Measured concentrations of some pollutants in an underdeveloped area near a four-lane highway with a traffic volume of 22 vehicles per minute (freely flowing) are presented in Table 7.11 as reported by Wanner (1990).

Table 7.11 **Concentration of Air Pollutants in the Vicinity of a Four-Lane Highway.**

Substance (Concentration Unit)	Distance from the Centre Line (Metres)			
	0	20	40	80
Carbon Oxide (ppm)	8.3	1.9	1.8	1.6
Nitrogen Oxide (ppb)	8.5	36	12	15
Nitrogen Dioxide (ppb)	50	25	21	20
Nitrogen Oxides NO_x (ppb)	250	57	30	36

Results of measurements indicate that the concentrations measured on the highway should be considered high. Concentrations rapidly decrease with increasing distances from the highway. The concentrations of air pollutants on the future Highway 107 Extension may be expected to be somewhat lower because of the lower traffic levels, the good dispersion conditions associated with the open area, and favourable meteorological conditions influenced by the ocean.

Evaluation of air pollution from complex sources is based on a method developed by the Department of Pollution Control in the State of Florida (Cross and Forehand, 1975). The general technique is to estimate the impact (ground level concentration) from the complex source, add this to the background (values obtained by carbon monoxide sampling) and compare this total with ambient air standards. The order of evaluation is as follows:

1) Emission density based on known emission rate (in g/vehicle-hour or g/mile) is calculated and expressed in g of pollutant/sec m^2.
2) Traffic count in number of vehicles per hour is assumed.
3) Distance of receptor from road edge is assumed.
4) Wind angle and speed are specified.
5) Road width is determined.
6) A correction factor for vehicle speed is read from the graph given in the manual.

Computation for predicted mixed traffic (automobiles, light and heavy trucks) of 10,000 vehicles per day has been completed for the following conditions:

- moderate atmospheric stability;
- receptor located 15 metres from road edge;
- wind angle 22.5 degrees;
- road width 30.5 metres;
- wind speed one metre/second;
- population mix of autos with rate of emission of 50 grams/mile; and
- vehicle speed correction factor equal to 0.95.

The estimated air pollutant concentrations are:

- carbon monoxide	35 ppm
- nitrogen oxide	43 ppb
- nitrogen dioxide	58 ppb

These concentrations are similar to those reported in the technical literature (Wanner, 1990). Impacts on air quality during the operation of the Highway 107 Extension are not considered to be significant. No mitigative measures are recommended.

7.8.2 Noise

Highway noise is the collective contributions of the noise produced by individual motor vehicles. To assess the noise impact of the proposed Highway 107 Extension on the local community, and to identify situations where noise attenuation features may be required, it is necessary to assess the sound levels that will be produced by these vehicles. This task may be completed by calculating sound levels using one of several mathematical models based on experimental data taken for each individual type of motor vehicle noise source. Another way of computing highway noise level is the step-by-step nomogram procedure involving a determination of the equivalent continuous sound level L_{eq} for a straight roadway segment at a single observer position. Nomogram or mathematical methods of noise assessment have several important advantages. For example, conditions typical of a particular site may be evaluated, and possible effects of temporary noise sources may be eliminated from the calculation. In addition, it is possible to assess the noise impact prior to highway construction as well as for future years when traffic conditions may change.

Attempts to correlate highway noise level and noise characteristics with traffic conditions have led to the development of several computer programs for the assessment of future sound levels in the vicinity of a proposed highway. A computer program has been developed by staff members of the Noise Assessment and Systems Support Unit, Approvals Branch of the Ontario Ministry of the Environment. STAMSON 4.0 is a computer program for road and rail traffic noise prediction designed for IBM PCs or compatible computers. It can be used for any time period from one hour to 24 hours, and can predict both day-time and night-time noise impacts in one run.

STAMSON 4.0 was used for the noise level calculation at the main segments of the Highway 107 Extension. Input data were based on the survey conducted in 1986 for the Highway 107/Highway 118 Interchange and for the Highway 107/Sackville Expressway/Burnside Drive extension interchange. Since the annual traffic volume growth rate on Magazine Hill (Trunk 7) from 1980 to 1986 was six percent, this growth rate was used to calculate 20-year design volumes for the proposed highway network. All the traffic volume data have been adopted from the Highway 107 Feasibility Study conducted by the Nova Scotia Department of Transportation, Traffic Engineering Division (April 1987).

Prediction of noise level is based on the assumption that 75 percent of all vehicles are on the highway during the day and the remaining vehicles are present during the night. Vehicles are categorized into three groups:

1) automobiles (passenger cars), with two axles and four wheels, and weighing less than 4500 kg;
2) medium trucks, with two axles and six wheels, and weighing less than 12000 kg, including city buses; and
3) heavy trucks, with three or more axles, and weighing more than 12000 kg, including intercity buses.

The number of vehicles in each category driving on the highway may change; traffic patterns depend greatly on time of day or night. The assumed vehicle distribution on the Highway 107 Extension for 9,100 vehicles over 24 hours (predicted traffic volume on the Cobequid Road-Highway 102 segment) is given in Table 7.12.

Table 7.12 **Predicted Vehicle Distribution on the Highway 107 Extension**

Conditions		Automobiles		Medium Trucks		Heavy Trucks	
		Percent	Number	Percent	Number	Percent	Number
A	Day-time Night-time	67.50 22.50	6142 2047	3.75 1.25	341 114	3.75 1.25	341 114
B	Day-time Night-time	63.75 21.25	5801 1933	7.50 2.50	682 227	3.75 1.25	341 114
C	Day-time Night-time	60.00 20.00	5460 1820	7.50 2.50	682 227	7.50 2.50	682 227
D	Day-time Night-time	59.25 18.75	5119 1706	11.25 3.75	1024 341	7.5 2.5	683 228

Table 7.13 shows the predicted noise levels computed with the STAMSON 4.0 Noise Assessment Model for all the main segments of the Highway 107 Extension. The point of sound reception is 50 metres above the centre of the highway in an open area (no shielding). It appears that the highest noise level of 79.7 dB(A) is expected at the intersection of the extensions of Highway 107 and Burnside Drive for day-time conditions with a vehicle type distribution of 75 percent automobiles, 15 percent medium trucks and 10 percent heavy trucks.

The STAMSON 4.0 noise assessment computer program was also used for the prediction of noise levels at Charles P. Allen High School. The posted speed limit is 100 km/h, and the numbers of vehicles per hour used in the model were 1000 automobiles, 50 light trucks, and 50 heavy trucks. The distance between the receiver (school) and the source (vehicle) was 50 metres, and the receiver height was 1.50 metres. For these conditions computed L_{eq} (equivalent continuous sound level) was 68.54 dB(A).

Another set of computer models was run with consideration of a two-metre high noise barrier placed along the highway five metres away from the outside traffic line. The length of the barrier formed approximately a 68 degree angle ϕ with the receiver. Other parameters were as in a no-barrier case. Computed noise level L_{eq} for this arrangement was 57.43 dB(A). Results suggest a substantial reduction of the noise around the school with the noise barrier in place. As already

Table 7.13 Predicted Noise Levels for Different Traffic Conditions

Road - Segment	Total Vehicles Per 24 Hrs	Noise Level dB (A)							
		A		B		C		D	
		Day	Night	Day	Night	Day	Night	Day	Night
1 Cobequid Rd - Hwy 102	9,100	70.9	69.1	71.7	69.9	73.0	68.3	73.5	68.8
2 Hwy 102 - Trunk 2	10,000	71.3	69.6	72.1	67.3	73.5	68.7	73.9	69.2
3 Trunk 2 - Intersection	11,700	72.0	67.2	72.8	68.0	74.1	69.4	74.6	69.8
4 Intersection - Hwy 118	11,100	71.8	67.0	72.6	67.8	73.9	69.2	74.4	69.6
5 Burnside Dr. Extension	14,600	72.3	68.2	73.7	69.0	75.1	70.3	75.6	70.8
6 Intersection - Hwy 107 Burnside Dr. Extension	18,700	74.0	69.3	74.8	70.0	79.2	71.4	79.7	71.9

reported in Section 6.2.2.3, current background noise levels at the high school are 71 dB(A) in front of the school and 68 dB(A) at the back of the school.

In general, noise impacts during highway operation are not considered to be significant except in the case of Charles P. Allen High School, and possibly for the Beaver, the Whip-poor-will, and any other sensitive fauna that are identified. Where warranted, noise mitigation is possible.

7.8.3 Water Pollution

As with all other highways, the major impacts on the aquatic environment during normal operation of the Highway 107 Extension are related to runoff of a variety of pollutants that are applied to, or accumulate on, the road surface. Surface runoff may contain petroleum hydrocarbons (oil, grease and other organic contaminants from vehicles and the asphalt), heavy metals, asbestos from brake linings, paint, and sheared rubber. Some of these will be adsorbed onto soils and vegetation, others will find their way into the groundwater, and the balance will flow into nearby brooks and lakes. Provided a good groundcover is established along the roadway, most contaminants will be trapped by surrounding vegetation cover. Problems occur where the cover is damaged by wind or water erosion. These areas should be revegetated or protected by a gravel/cobble cover as soon as possible.

Winter de-icing of the road surface will introduce additional contaminants to local water courses, groundwaters and soils. The type and degree of impact will depend on both the de-icer that is used (sodium chloride, urea, or calcium-magnesium-acetate are currently available) and its application rate. At present, the only means of reducing the impact on nearby streams and lakes is through reductions in application rate. These impacts are considered significant but mitigable.

8.0 ENVIRONMENTAL PROTECTION PLAN

8.1 Responsibility for Environmental Protection

NSDTC has responsibility for environmental protection associated with its undertakings. The Resident Engineer for the Project is the individual specified in NSDTC's *Standard Specification* (1980 and revisions) as the person responsible for routinely overseeing the environmental protection measures.

In order to ensure proper use and maintenance of mitigation measures proposed, it is recommended that a Site Committee be set up for the construction phase of the project, with members from the following departments or organizations:

- NSDTC: Resident Engineer,
- The General Contractor,
- NSDOE,
- Environment Canada, Environmental Protection Service (EPS),
- Department of Fisheries and Oceans (DFO), and
- Representatives of Municipalities, Halifax County, or other interested local organizations.

In the case of Stages 1, 3, and 4, the Site Committee could include a representative of the City of Dartmouth and the Dartmouth Lakes Advisory Board, as these organizations have been involved in other site committees for 100-series highways in this area. The Dartmouth Lakes Advisory Board has also requested that before construction begins, NSDTC submit to the board a lake protection package, outlining details of specific construction and mitigation plans and schedules (APPENDIX H).

The purpose of this committee is to visit the construction site and to see that the protective measures are working as anticipated. The Site Committee could also recommend protective measures for any unexpected environmental impacts. It is recommended that members of this committee review the environmental assessment report (EAR) and the site-specific mitigation plans drawn up by NSDTC. It is further recommended that the committee convene on-site before construction begins, for each stage of the project. Further meetings could be arranged as needed.

8.2 Existing Regulations and Guidelines

Federal regulations pertinent to the current project are: The Canadian Environmental Protection Act (CEPA), The Government Organization Act Environmental Assessment and Review Process (EARP) Guidelines Order, The Canada Water Act, The Fisheries Act, the Clean Air Act, and the Transportation of Dangerous Goods Act. Environment Canada's *Environmental Code of Good Practice for Highways and Railways* (Storgaard and Associates, 1979) and *Environmental Guidelines for Resource Road Construction* (Case and Rowe, 1978) are also pertinent. Because the proposed extension of Highway 107 may be partly supported by federal funds, the environmental assessment report must be reviewed by officials of relevant federal departments. In practical terms, this means the assessment will be reviewed by an officer of the Environmental Services Unit of Public Works Canada (for Environment Canada) and by an officer of DFO.

Provincial regulations which apply to the proposed Highway 107 Extension include: The Environmental Protection Act, The Environmental Assessment Act, Regulations Made Pursuant to the Environmental Assessment Act, and Regulations Made Pursuant to The Environmental Assessment Act Respecting Environmental Assessment Hearings. These regulations have been described in Section 1.2 of this report. In addition, the Special Places Protection Act, the Water Act, the Dangerous Goods and Hazardous Wastes Management Act, and the Dangerous Goods Transportation Act are pertinent. Guidelines which apply to the proposed undertaking are the NSDTC's *Standard Specification* (1980 and revisions) and *Highway Design Standards* (1989); and NSDOE's *Erosion and Sedimentation Control Handbook for Construction Sites* (1988), *Guidelines for Development on Slates in Nova Scotia* (NSDOE and Environment Canada, 1989), and *Pit & Quarry Guidelines* (1988).

Once the EAR has been approved, NSDTC is responsible for carrying out the environmental protection plans included in the assessment. These plans will be included in the contracts for the work, and NSDTC must also apply for Water Rights Permits for all of the stream crossings listed in the Project Description (Section 2 of this report). The Water Rights Permit application requires that NSDTC describe all water course crossings and culvert installations and provide protection plans for the water courses. The Nova Scotia Minister of the Environment has the authority to suspend or cancel permits which violate water quality standards with reference to pH, iron, toxicity, chemical oxygen demand, suspended solids, biological oxygen demand, or heavy metals, and other violations of the terms set out in the Water Rights Permit (Regulations Pursuant to Section 23 of the Environment Protection Act [Nova Scotia], 1986).

At the provincial level, air quality objectives have been issued by NSDOE and are shown below in Table 8.1.

Table 8.1 Current Air Quality Objectives in Nova Scotia

Contaminant	Time Average	Desirable		Acceptable	
		ppm	µg/m³	ppm	µg/m³
Sulphur Dioxide	1-hour 24-hour	0.17 0.06	450 150	0.34 0.11	900 300
Carbon Monoxide	1-hour 8-hour	13 5	15 6	31 13	35 15
Nitrogen Dioxide	Annual 1-hour 24-hour	0.03	60	 0.21 0.11	 400 200
Total Suspended Particulate (TSP)	24-hour				120

Dust emissions from pit and quarry operations are regulated by the Clean Air Ambient Air Quality Objectives as adopted NSDOE, which for suspended particulate matter are as follows:

- *Acceptable*
  - (a) 60-70 micrograms per metre (µg/m³) annual geometric mean
  - (b) 0-120 micrograms per metre (µg/m³) average concentration over a 24-hour period
- *Desirable*

  0-60 µg/m³ annual geometric mean

The sound level limits recommended by the Nova Scotia Department of the Environment (1988) shall be observed at the property boundaries of the construction site. They define the equivalent (L_{eq}) sound level limits for day, evening, and night conditions as follows:

- *Night* (23:00 H - 07:00 H, all day Sunday and statutory holidays) **55 dB(A)**
- *Evening* (19:00 H - 23:00 H) **60 dB(A)**
- *Day* (07:00 H - 19:00 H) **65 dB(A)**

The sound level limit for concussion (air blast) is 128 dB(A).

9.0 MITIGATION OF IMPACTS AND ENVIRONMENTAL REHABILITATION

9.1 Mitigation of Air Pollution

Air pollution will be mitigated by controlling emissions at the sources. For power equipment, trucks, and other vehicles, required air pollution devices will be maintained in good working order. This is particularly important for catalytic convertors which are compulsory components of a vehicle's exhaust system, and are responsible for substantial reductions in the emission rates of engine fuel combustion products.

Fugitive dust emissions (dust picked up by wind) from pit and quarry operations will be mitigated by applying water spray wherever possible and by covering open areas of potential fugitive particulate sources with a material cover (straw, plastic sheets, etc.) if air quality objectives are exceeded. Prior to closure, all pits or quarries will be rehabilitated according to NSDOE's *Pit & Quarry Guidelines* (1988).

9.2 Mitigation of Noise Impacts

Noise control may be achieved at the source, in the path of spreading, or at the receiver. The most effective source reduction in the case of the Charles P. Allen High School would be to alter the planned route of the highway to a new location away from the sensitive area. Another method of noise reduction at the source is to impose a speed and/or acceleration limit in the area near the school. Greater vehicle engine noise is produced during acceleration and at high speed.

Traffic noise mitigation may be achieved in the propagational path through the use of partial barriers, such as screens and fences. This option is only partially effective, and depending on the situation may be expensive. In fact, a barrier of a reasonable height (not more than five metres [16 feet]) is limited to a maximum attenuation of 20 decibels A [dB(A)] (Holland and Attenborough, 1981), no matter how massive and thick it is. Effective noise barriers can consist of a concrete, brick, or wooden fences, banks or mounds of earth, hillocks, or, in fact, any impervious structure (i.e., without air gaps) that is erected between the highway and sensitive buildings or areas.

Planting rows of high-growing coniferous trees will effectively reduce dust pollution and noise level. This technique of noise control, however, will reach full effectiveness only after the trees mature.

Noise level reduction at the receiving end may be achieved by use of an absorptive material on the surfaces of the receiving room. The walls of the receiving building may need to be thicker, and they should be reasonably airtight. Windows may need to be triple-glazed with an appreciable air gap, and be kept closed. At Charles P. Allen High School, windows are positioned at 45° angles to the proposed highway, which may reduce the noise levels entering the building because of sound wave reflection.

Users of construction equipment (such as contractors), must meet the requirements of two types of noise control legislation: (1) product noise emission standards which place limits on the amount of noise the equipment may produce, and (2) construction site noise standards which establish maximum sound levels permissible at the boundaries of a construction site.

9.3 Mitigation of Acid Drainage

Mitigative techniques for the alleviation or prevention of acidic drainage can be incorporated into both the construction and operation phases of the Highway 107 Extension. These techniques are reviewed in the *Guidelines for Development on Slates in Nova Scotia* (NSDOE and Environment Canada, 1989). They include limiting the amount of acid-producing rock exposed during construction, and routing surface drainage away from such rock.

Special blasting permits (in addition to those normally required) are required for blasting in acid-producing bedrock (NSDOE and Environment Canada, 1989).

Following construction any acid-producing material should be immediately covered and sodded or seeded. This will prevent the long-term leaching which occurs when acid-producing rock is exposed to the elements. Excavated rock with acid production potential should not be used for construction purposes.

9.4 Mitigation of Erosion and Sedimentation

Introduction

The following recommendations come from guidelines and specifications set out by provincial and federal departments responsible for stream, lake, and wetland protection. The bibliography (Section 15.0) lists publications which provide specific advice on the design, construction, and maintenance of these mitigative structures. NSDTC's *Standard Specification* (1980 and subsequent revisions) contains a number of environmental procedures for road-building which contractors are required to perform. NSDOE's *Erosion and Sedimentation Control Handbook for Construction Sites* (1988), which contains information of great value to those who must design and install these structures, should be consulted prior to attempting the mitigative techniques identified below.

These recommendations are general in nature; evaluation, design, and installation of appropriate mitigative structures will require the assistance of a soils engineer or someone trained in the use of erosion and sediment controlling devices.

Erosion and Sedimentation

Soil erosion is the process by which soil particles are removed from an area by a physical force such as water or wind. Eroded soil particles which enter surface runoff may be transported a great distance downstream before they finally settle out of the water column (via sedimentation or siltation). If soil erosion is not treated, sediment entering waterways and water bodies may damage wildlife and their habitats, recreational values, and drinking water supplies. The direct effects of silt on wildlife include the smothering of fish eggs, small fish, and aquatic invertebrates, and the clogging of fish gills and spawning beds. Other direct effects include the reduction of dissolved oxygen concentrations, and interference with feeding in visual predators such as trout and salmon. The indirect and cumulative effects are numerous and may pervade the entire food web.

Sediment yields from exposed construction areas may exceed 38 000 tonnes/km^2/yr (109,000 tons/mi^2/yr), compared to 304 tonnes/km^2/yr (868 tons/mi^2/yr) from agricultural lands and 38 tonnes/km^2/yr (109 tons/mi^2/yr) from forested land (NSDOE, 1988). Therefore, it is imperative that proper erosion and sedimentation controls be used both during and after construction.

The key to erosion control is prevention. A small preventive measure can be effective in averting a larger erosion or sedimentation problem. Erosion control requires that both the source and the cause of erosion be eliminated. The source, usually exposed soil, can be eliminated by securing the subsurface; the cause, usually waterflow, can be addressed through drainage control. The subsurface or erodible material can be secured through proper grading practices or the addition of stabilizing materials. Grading practices such as surface scarification and terrace-building are effective in preventing channel development and thus erosion. Stabilizing materials such as rip rap, vegetative buffers, and geotextile fabrics, work by dispersing runoff and promoting sheet flow. Drainage can be controlled through the construction of diversion ditches, seepage drains, barriers, or sedimentation ponds. These methods channel overland flow through structures that reduce the potential for erosion. Barriers and sedimentation ponds also reduce water velocity and allow eroded particles to settle out. Securing of the subsurface (through surface stabilization) is used primarily in areas where there is no active drainage source (waterway), while drainage control is used primarily in areas within an active drainage source.

There are several major areas of erosional concern along the Highway 107 Extension route:

- Lake Charles, Stage 1;
- Wrights Brook, Stage 3;
- McGregor Brook, Stages 1 and 4;
- Marshall Brook, Stage 3 (Stages 1 and 4 because of McGregors Brook);
- Sucker Brook, Stages 2 and 5;
- Juniper Lake, Stages 1 and 4;
- Enchanted Lake, Stages 1 and 3;
- Anderson Lake, Stage 3;
- Rocky Lake, Stages 3 and 5; and
- Lily Lake, Stage 3.
- Grassy Brook (outflow of Juniper Lake), Stages 1 and 4;

Clearing and Grubbing

To control erosion and siltation during clearing and grubbing, a number of procedures should be followed. Before the site is grubbed, sedimentation ponds should be installed so that all site runoff which may potentially enter water courses or water bodies can be treated. As a general rule, sedimentation ponds should have a capacity of 190 m^3 (6742 ft^3) for every hectare cleared (NSDOE, 1988). Capacity should be increased on soils high in clay and silt or where off-site runoff increases the volume of water to be treated. On average, the basin should be twice as long as it is wide and at least 1.2 metres (3.9 feet) deep. This design increases the amount of time in which settling may occur, and reduces the frequency of required clean-outs.

Collection ditches will be lined with sheet plastic where deemed necessary and practical by the Engineer. These ditches should contain check dams to reduce silt content and should channel all site runoff to sedimentation ponds. However, small areas of exposed soil on shallow slopes may sometimes be more effectively treated using filter-fabric fencing along the lower boundary of exposed soil. Off-site sheet flow can be prevented from entering the site (and increasing the volume of runoff to be treated) by using diversions. Care should be taken that diversions neither add sediment to off-site runoff nor create erosion problems of their own.

The area to be cleared of natural vegetation should be as small as possible and exposed for the shortest possible time prior to use. Much erosion can be prevented simply by leaving natural cover on the site for as long as possible. To protect remaining trees, stumps should not be grubbed within two metres (6.6 feet) of standing timber at the edge of the area to be cleared. Grubbing equipment tends to compact the soil and damage tree roots, leading to blowdown. If grubbed areas are not to be used immediately, they should be covered with a mulch such as brush, straw, chipped wood, or brush. Chips made on-site from non-merchantable wood, brush, etc. may be the most economical mulch at construction sites for the Highway 107 Extension. This will also reduce the amount of burning required.

Subgrade and Drainage

Stockpiles of fill and topsoil should be covered with sheet plastic or coarse material, or surrounded by filter-fabric fences until use. Grading should be finished as soon as possible after it is begun, and the gravelling work should start as soon as possible after grading is completed. Grading of large or highly-erodible areas should not take place during periods of high rainfall (i.e., spring and fall). Graded slopes should be terraced, roughened, or scarified perpendicular to the direction of water flow to retard runoff and minimize erosion. Such surface preparations will also aid in the re-establishment of vegetation by inhibiting seed and mulch loss. Soils on more or less flat areas can be rolled and compacted to reduce erodibility. If topsoil is required, it should be bonded to the site by roughening the exposed soil prior to topsoil application.

Graded areas should be revegetated as soon as possible after grading is completed. Revegetation should be conducted in a step-wise fashion; it can begin in one area while grading is still in progress in another area. This may reduce the need for and cost of sediment control devices on the site perimeter.

Hydroseeding is probably the most effective way to quickly establish a vegetation cover. It involves application of a slurry of water, mulch, seed, fertilizer, and lime (if required) onto exposed soils when there is sufficient time left in the growing season for growth to occur. Some steeper areas may require sods or temporary vegetative matting to ensure rapid revegetation. If, because of seasonal considerations, slopes cannot be revegetated immediately, temporary matting should be used as a protective mulch. All revegetation schemes require watering, periodic additions of fertilizer and lime, and reseeding or resodding of washed out areas. If possible, seed mixtures containing non-native species should be avoided.

Excavation

During excavation, silt-laden water should be pumped into a sedimentation pond and, if necessary, filtered before discharge downstream. Again, fill from excavations and topsoil from clearings should be covered with sheet plastic or coarse material if not to be used immediately.

Stream Crossings and Culvert Installation

Where the highway right-of-way crosses streams, the area extending to 30 metres (100 feet) on either side of the water course should be cleared by hand only, not by heavy equipment. Silt fences and sedimentation ponds should be installed near the stream prior to any grubbing or excavation in the area. No heavy equipment should enter or cross the water course. If, however, water course crossings are unavoidable, they should be limited to one site; approaches to the crossing should be covered with a non-erodible material such as clean crushed stone for a distance of 15 metres (50 feet) on either side of the crossing to facilitate soil drop-off, and the banks should be stabilized with rip rap. If silt-laden runoff cannot be prevented from entering the stream, a filter-fabric fence should be installed. Fill should be stored away from the water course and covered with sheet plastic or coarse material. Backfilled, streamside, and other disturbed areas should be hydroseeded or mulched as soon as construction is completed.

To minimize siltation during the installation of culverts, a diversion channel should be built from the downstream end upward to channel the streamflow through the culvert. Work should not be undertaken in the stream. The channel should be lined with gravel and have outlet and inlet drainage protection (rip rap) to prevent undermining before the streamflow is channelled into it. Once the diversion channel is complete, the existing stream should be diverted with sheet metal rather than fill. The culvert should run parallel, and as close as possible, to the original streambed. There should be no drop at the outlet as this will prevent the passage of fish. The angle of the culvert should be such that it does not cause undercutting of the bank at the downstream end. To allow fish passage, water depth in the culvert should always exceed 150 millimetres (0.5 feet) and the slope should be no more than 0.5 percent. It may be necessary to use pipe arches or stilling basins to ensure that water depth and velocity requirements are met, particular when the culvert follows the stream gradient.

A permit is required from NSDOE before any stream alterations or culvert installations can take place. Stream alterations (and therefore culvert installation) should only be undertaken during periods of low water flow (i.e., in the summer).

Road shoulders and embankments in the vicinity of streams and lakes tend to be steep and require more effort to prevent erosion. Steep slopes should be covered with geofabric matting or rip rap, followed by hydroseeding if the season is appropriate. Otherwise, the slopes should be temporarily mulched to help prevent washouts. Since washouts are highly likely on steep slopes, special attention must be paid to the repair and maintenance of mitigative structures. Gabion baskets or large rip rap should be used to shore up stream banks where slopes are steep. Steep embankments are likely to occur at Anderson Lake and Lily Lake and at the large Wrights and McGregors Brook crossings; there are also several smaller tributary crossings at which the same precautions should be taken.

General Maintenance

All erosion and sediment control practices require frequent follow-up inspection and maintenance in order to be effective. Sedimentation ponds need to be periodically cleaned out, silt fences unclogged, graded areas checked for rill or gully erosion (and regraded if necessary), washouts resodded or reseeded, and silt content of water leaving the site monitored. During construction, inspections should be made and weather forecasts checked daily in order that necessary preparations can be made.

9.5 Mitigation of Other Impacts

Rare Flora VECs

Rare flora may occur in all stages of the project, but until their presence and location are determined by a summer (late May to August) field survey, no mitigation can be recommended. Depending on which, if any, rare species are found, mitigative options may include no mitigation, artificial propagation and transplanting, and/or recommended route alteration of the Highway 107 Extension. It is recommended that summer surveys be performed, beginning with the study area for Stage 1 of the project; if rare plants are found, an environmental management plan should be developed for their protection.

Rare Fauna VECs

As indicated in Sections 6 and 9, rare fauna may be affected during all stages of the project, but impacts are more likely in Stages 1 and 4. Because field work for this assessment was carried out during the winter, occurrences, locations, and numbers of these species are not now known. It will be possible to predict impacts and recommend an environmental management plan to deal with any rare fauna species found only after a summer field survey identifies their locations and abundance.

In the case of the Whip-poor-will and other potential animal VECs that may be found in the Stage 1 area, it should be noted that the area near Juniper Lake is scheduled for expansion by the Burnside Industrial Park, and that this expansion does not require an environmental assessment.

Sucker Brook Wetland

The upper end of the Sucker Brook wetland is zoned for industrial use, and the lower end is zoned for residential use. With some creative mitigative measures, the highway construction could actually help to protect the wetland from further development. There is a range of mitigative options which can be employed to reduce the highway's impact on the Sucker Brook wetland. The only option which can completely preserve the wetland in its present form is a route alteration which not only bypasses the wetland, but leaves a substantial buffer zone of undisturbed forest to protect the wetland from noise and other disturbances and provides an adequate food supply for the resident beavers. NSDTC is limited by surrounding land use constraints in the area, however, and has no option of altering the route. Therefore, the mitigation measures should mimic the wetland-creating and maintenance activities of beavers through the construction of a dam, sluice, and fish ladder at the lower end of the wetland. Cavity-nesting waterfowl such as Wood Ducks and Hooded Mergansers will use nest boxes erected on poles in the water as a substitute for flooded cavity trees. The effects of habitat disturbance on wildlife in general can be reduced via vegetative barriers to sight and sound placed between the road and the wetland.

As to the actual crossing of the Sucker Brook wetland, both a bridge and a causeway with culvert will have large impacts on the area during construction. In the longer term, however, a short bridge (five to ten metres, or 16 to 33 feet long) will allow greater movement by more species between the upper and lower sections of the wetland. Ducks are well-known for their avoidance of culverts when moving their broods between sections of wetland divided by a road. A bridge would allow movement beneath the road and lead to fewer road kills involving ducklings.

Dartmouth Regional Park Land Located Along Lake Charles

NSDTC has endeavoured to minimize the impact on Dartmouth's designated regional park land in consultation with City of Dartmouth officials. There are limitations to possible adjustments, however. Moving the highway would place it nearer to lakes, and adding an exit to an interchange ramp would create greater potential for traffic accidents.

Landlocked Area at Highway 118/Highway 107 Interchange

The NSDTC has indicated that redesign of the interchange at Highway 107 and Highway 118 will require a reduction in design standards which, in turn, has an impact on highway safety. If access to the landlocked area were provided, it would allow this land to be developed for a park or other use.

Sackville Industrial Park's Access to Highway 107

Members of the Sackville Chamber of Commerce (Transportation Committee) would like to see more direct access from the Sackville Industrial Park to Highway 107. It was suggested that the interchange in the Bedford Industrial Park should include more direct entry and exit ramps.

Charles P. Allen High School

A separate driveway is being considered by the NSDTC to provide direct access for the school to Rocky Lake Drive (Trunk 2). This will allow traffic to and from the school to avoid the truck traffic that is expected to be diverted to Duke Street. Plans for the Highway 107 Extension near Charles P. Allen may also include embankments and fences, if they are necessary, to prevent students from crossing the proposed highway.

Damage to Wells or Contamination of Wells

Damage to the four domestic wells identified in the study area could occur in the Stage 2, 3, or 5 areas as a result of damage by blasting, or contamination by chemical spills, road salt, or de-icing compounds. The easiest mitigation in such cases would be to connect the users to central water services. Municipal water services are available in all areas where domestic wells are located. Hookup would require installation of lines from Rocky Lake Road to the individual residences.

If a water well is dewatered by excavation activities, there are two possible solutions: (1) have the well user connected to municipal services, or (2) have a new well installed. If a water well is contaminated by geotechnical drilling, the easiest mitigative technique is to have the well user connected to municipal services as described above.

9.6 Contingency Plan for Accidental Events

Accidental events in an environmental emergency associated with the construction and operation of the Highway 107 Extension must be addressed in the Environmental Impact Assessment. An environmental emergency may be defined as a sudden, unexpected, or apprehended introduction into the environment of a pollutant in a sufficient quantity to pose a direct threat to man or other forms of life.

The most probable events which are common for the construction and operational phases are spills and fire. The requirement for assessment of impacts from these events is specified in the Final Guidelines for the environmental study, issued by Nova Scotia Department of the Environment.

Categories of Accident Scenarios

Accidents may be classified as non-transport or transport related. They may occur in outdoor areas as a result of human error or mechanical failure, and they may involve vehicle accidents, or leakage from equipment, trucks, or pumps.

Non-transport related accidents may occur during the operation of equipment at the construction site or as the result of a fire associated with the stored flammable material. Spills of fuel, oil, and asphaltic material are also possible. The storage of flammable material in a larger volume and for an extended time is not foreseen for the normal road construction practices. However, when an operation at the site indicates that leaks, spills, or fire are likely, the procedure recommended in the *Manual of Spills of Hazardous Materials* (Environment Canada, 1984) will be followed.

Emergencies most likely to occur are transport related, especially during the regular operation of the highway once construction is completed. Because of a greater variety of materials carried on the highway, the type of accidents and environmental impacts are more difficult to predict.

Environmental Impacts

Environmental impacts of accidental events are related to emissions of vapour or hazardous products of combustion into the atmosphere. Intensive emissions involving a volatile substance in a large volume, in combination with unfavourable meteorological conditions (calm weather or temperature inversion), may create the hazardous conditions which could require protection of people to avoid health impacts, by enforcing a hazard zone for the duration of the event. Such an event often involves a temporary evacuation from the affected area.

Fire accidents should also be considered as a source of hazardous emissions, and action must be taken to prevent the spreading of fire and to avoid contamination by water used to extinguish the fire. Human safety must be considered during fire control.

An environmental emergency in the form of a chemical or petroleum spill may result in surface or groundwater contamination. This is likely to happen at water crossings where spilled material can flow freely to a water body or be washed out by rain water.

Contingency Plan

The emergency response process involves two main forms of action: immediate and post emergency actions.

The immediate action will be taken by properly equipped emergency response personnel at the site of a land spill under different weather conditions. Action plans should be guided by the Dangerous Goods Transportation Act, *Manual for Spills of Hazardous Materials* (Environment Canada, 1984), EnviroTIPS Manuals, Quarterly Spill Technology Newsletter, and the Atlantic Regional Environmental Emergency Team Contingency Plan (Environment Canada).

Post emergency action will involve sampling of soil, groundwater, and plants for the contaminant(s). Polluted soil will be removed and trucked away to the municipal landfill or disposed in an otherwise environmentally acceptable manner, depending on the type and concentration of the contaminant(s).

According to the Regional Environmental Emergency Team (REET) Contingency Plan, the polluter has the first responsibility for initiating effective action to counteract an environmental emergency. The polluter also has financial responsibility for damage and clean-up costs incurred as a result of the spill. If the polluter chooses not to initiate clean-up actions, or if the situation is of such magnitude that the polluter is incapable of responding adequately, other organizations will become involved.

In Nova Scotia, the following institutions may be involved in emergency response:

- Environment Canada,
- the Canadian Coast Guard,

- the Canada Oil and Gas Lands Administration,
- the Canada-Newfoundland Offshore Petroleum Board, and
- the appropriate provincial environment departments.

The REET has been formed in the Atlantic Region to coordinate the efforts of government and industry in dealing with environmental emergencies. It encompasses a number of federal, provincial, municipal and industrial organizations who have a role to play in emergency response.

The REET functions in two separate modes depending on the particular situation at hand. These modes, management and response, are described in detail in APPENDIX H. This appendix also contains a list of organizations (with their phone numbers) which should be contacted if an environmental emergency occurs on the Highway 107 Extension during construction and operation.

10.0 RESIDUAL IMPACTS

Residual impacts are those environmental effects remaining after mitigation measures have been applied. The description of residual impacts is based on the assumption that the mitigatory measures recommended in Section 9 will be followed and that the effectiveness of the measures will be monitored during construction. Since some of the impacts are still unknown because of a lack of data, these impacts are included in this section but are distinguished from known residual impacts.

10.1 Residual Terrestrial Impacts

Geology and Hydrogeology - Unknown Impacts

Although it appears unlikely that acid-producing bedrock will be exposed, geotechnical drilling will be carried out before construction has begun and rock samples will be analyzed for their acid-producing potential. In the event that acid-producing bedrock is discovered in the area to be excavated, the mitigation measures described in Section 9.3 and in the Nova Scotia Guidelines for Construction on Slate (NSDOE and Environment Canada, 1989) can prevent significant residual impacts.

Terrestrial Biological Impacts - Known

The major residual impact of highway construction and subsequent expansion of human activities in the study area will probably be habitat fragmentation and increased accessibility. This will ultimately lead to a faunal association in which species sensitive to disturbance, such as Black Bear and Great Horned Owl, are rare or infrequent, and species tolerant of disturbance, such as American Crow, European Starling, and Rock Dove (Pigeon), are more abundant.

Serious residual impacts on most water courses can be avoided through vigorous use and maintenance of the erosion and sedimentation control methods described in NSDOE's handbook. Preventing silt from entering streams will benefit many species besides salmon and trout. River Otter, Mink, Four-toed Salamander, Mergansers, Osprey, and most other species depend to some extent on the quality of stream and lake water.

Residual impacts will be unavoidable at Wrights Brook and Sucker Brook. At Wrights Brook, a large proportion of the rich riparian habitat and probably much of the associated wildlife value will be directly lost because of highway construction. At Sucker Brook, the worst-case scenario is that the wetland would eventually drain enough to become choked with vegetation, making it no longer a valuable wetland. The best-case scenario would be that the area becomes a managed wetland valuable for wildlife, recreation, and public education. The only significant residual impact under the latter scenario would be that beavers would no longer manage the wetland, although they may continue to use it.

Terrestrial Biological - Unknown

A large number of potential impacts of the project are presently unknown because all fieldwork for this environmental assessment was conducted during the winter. Without knowing what species are present, it is impossible to predict impacts and recommend mitigation. Based on our present knowledge, there is evidence for significant residual impacts occurring if no further study of rare species is undertaken. For example, the only recent evidence available suggests that anywhere from two to twelve percent of the Province's small Whip-poor-will population may still breed in the Juniper Lake area and that additional potential breeding habitat may occur in the larger study area. At the present low population level, a further unmitigated decline of two to twelve percent due to highway construction could significantly jeopardize the species' chances for survival in Nova Scotia. There may be analogous situations for rare flora in the study area. Again, it is noteworthy that Burnside Industrial Park will be expanding even if no highway construction occurs.

10.2 Socio-Economic Impacts

Limitations on the use of land designated by the City of Dartmouth as Regional Park Land will remain as a residual impact.

Limitations on the use of the land-locked area at the Highway 118/Highway 107 interchange may also remain as a residual impact. Because of the current lack of access, this land is not usable; therefore, this is considered a minor impact.

If a route alteration is possible near Charles P. Allen High School, then there should be no residual impacts to the school. If the highway is constructed along the current route, there will be residual noise and aesthetic impacts during construction and operation of the Highway 107 Extension.

11.0 COMPLIANCE AND EFFECTS MONITORING

11.1 Compliance Monitoring

Compliance monitoring determines whether regulated parameters, such as toxic chemicals, are in accord with regulations or guidelines. As stated previously, NSDTC will comply with all existing regulations. While at present, there are no specific compliance monitoring requirements, these may be indicated in the NSDOE Water Rights Permit applications.

11.2 Environmental Effects Monitoring

The aims of environmental effects monitoring include: detection of environmental effects, early warning signs of environmental changes, and verification of predicted environmental impacts.

11.2.1 Environmental Effects Monitoring During Construction

Since most of the potential adverse environmental impacts are expected to occur during the construction period, it is recommended that the effectiveness of the mitigation measures be monitored during construction. The Resident Engineer for the Project will monitor the working condition of equipment to make sure that noise, dust, and emission controls are effective. It is recommended that the Site Committee or a consultant also monitor the effectiveness of sedimentation controls, including the length of time that the surface is left uncovered and the effectiveness of sedimentation ponds. These ponds should be monitored monthly during construction to determine the level of water in the ponds, to make sure that silt traps are not clogged, and to visually inspect the effluent for suspended solids (turbidity). The Resident Project Engineer should inspect the ponds after rainstorms or during rainy periods. It is also recommended that during construction the lakes in the vicinity be monitored biweekly for pH, aluminum, and suspended particulate matter.

Sucker Brook Wetland

Water quality monitoring should begin in the wetland at least one year before construction starts, include wetland portions upstream and downstream of the construction site, and continue several years after construction is completed. Monthly sampling would probably be adequate to identify the natural range of variation in water quality; for the purposes of statistical comparison, samples should be collected in triplicate from each sampling location. Water quality parameters affected by road construction might include turbidity, dissolved oxygen, pH, sulphate, aluminum, and numerous other metals.

In consultation with the Nova Scotia Department of Lands and Forests, waterfowl brood surveys should begin before road construction and continue for a number of years after the dam and sluice are installed. Monitoring may suggest that additional habitat-rehabilitating measures are necessary to attract wildlife to the area.

11.2.2 Monitoring During Operation

Routine monitoring of lake and stream water quality following completion of construction activities is not warranted. Periodic lake surveys are already being conducted by the City of Dartmouth and the federal and provincial Departments of the Environment and Fisheries. Of the nearby lakes, only Anderson Lake is not routinely monitored. The ongoing survey programs will facilitate continued monitoring of long-term trends in loading rates in water bodies of road salt and other pollutants from future developments in the area and vehicular traffic. Consideration should also be given to periodic sampling of the bottom muds of the lakes since many pollutants tend to accumulate there. A regional baseline dataset already exists for many heavy metals (Rogers *et al.*, 1985, includes the 1977 survey data from Anderson Lake, First Lake and Lake William). Future samples from these lakes could then be compared to this dataset for a better indication of heavy metal loading.

12.0 ADVANTAGES AND DISADVANTAGES OF THE PROJECT

12.1 Advantages

The proposed Highway 107 Extension is designed to relieve both current and anticipated problems associated with vehicular traffic in the Metropolitan Area. Specific areas where existing traffic congestion and safety problems will be alleviated are the following:

- the Burnside Drive/Highway 111 interchange,
- Commodore Drive at Burnside Drive,
- the Circumferential Highway (Highway 111),
- Magazine Hill and Bedford Bypass (Trunk 7),
- heavy truck traffic on Rocky Lane Drive, and at the junction of Trunk 1 and Rocky Lake Drive in Bedford,
- Cobequid Road, and
- Sackville Drive (Trunk 1).

For the industrial parks in Burnside, Bedford and Sackville, the proposed project will provide direct access to 100-series highways, thus improving transportation links amongst the parks and between the parks, the rest of the Metropolitan Area, and Halifax International Airport. Access to markets and suppliers for firms located in these parks will be improved. This, in turn, will improve each park's marketability and increase the attractiveness of all three parks to prospective tenants and clients. The highway will facilitate the further development and promotion of the industrial parks.

Without the proposed project, current traffic problems at the sites noted above and within the three industrial parks can be expected to become more severe in the future. Population forecasts coupled with the fact that Burnside Industrial Park's plans to expand are not contingent upon the completion of the Highway 107 Extension, indicate that with only the present transportation network, current traffic difficulties will become acute.

The highway will connect the two fastest growing suburban centres in the Metropolitan area (the community of Sackville and the Cole Harbour/Forest Hills area) with one another and provide both areas with more direct access to Burnside, Dartmouth and Halifax. This will be a boon to individuals, families, and businesses wishing to take advantage of the lower costs and environmental amenities associated with the newly developing suburban areas. Since the majority of employed individuals in these two areas travel elsewhere in Metro to work, the proposed project would decrease their commuting time. It is anticipated that the highway will also facilitate development of town centres for these areas.

In addition to providing increased access and marketability for the three parks, the highway will allow overall expansion of the industrial, commercial and residential aspects of the region and will integrate the different sections of the Metropolitan Area to make it more attractive to out-of-province developers and business interests.

12.2 Disadvantages

The disadvantages are the residual environmental impacts described in Section 10 of this report. They include the impacts on Sucker Brook Wetland, and the potential impacts on the Whip-poor-will and other as yet unknown flora and fauna. Potential impacts could occur if acid-producing bedrock is exposed, but this is not anticipated. The concerns expressed as socio-economic impacts include impacts on the Charles P. Allen High School, limitations of land use at the Dartmouth end, i.e. Dartmouth regional park land and the landlocked area near the 118 interchange. Because of current lack of access and therefore lack of usage of this land, however, this is not considered a serious disadvantage. Other socio-economic concerns regard preference of particular communities for access to the highway, such as requests by the Sackville Industrial Commission for direct access to the highway.

As with most developments, there will be certain losses of natural areas and wildlife habitat. It should be noted, however, that much of the land in the study area is currently zoned for industrial use and may be developed whether or not the highway is constructed. The loss of natural areas and habitat must be weighed against the need for the highway as expressed in the report and the advantages to the metropolitan area of the development.

13.0 PUBLIC INFORMATION PROGRAM DURING CONSTRUCTION

In addition to the tender call that will be published in local newspapers, the Nova Scotia Department of Transportation and Communications will issue a press release at the beginning of each stage of the project. The release will describe generally what is planned for the project and will notify the public that plans for the project may be viewed in the office of the Resident Engineer. Signs identifying the project, the amount of money being spent, the name of the Minister of Transportation and Communications, and the name of the contractor will be erected on Highway 107 and Highway 118 during construction. The Department will also follow suggestions of the Site Committees with regard to public consultation.

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APPENDIX "A"

REGISTRATION DOCUMENT

NOVA SCOTIA
ENVIRONMENTAL ASSESSMENT ACT
REGISTRATION

NATURE OF UNDERTAKING:

Highway 107 - Dartmouth to Sackville

LOCATION OF UNDERTAKING:

From Highway 118 at Porto Bello to Highway 102 at Bedford/Sackville with connections to Burnside Drive and Cobequid Road

PROPONENT:

i) Name of Proponent: Nova Scotia Department of Transportation & Communications

ii) Address: P. O. Box 186
Halifax, Nova Scotia
B3J 2N2

iii) Chief Executive Officer:

Name: L. L. Centa, P. Eng.
Title: Deputy Minister
Telephone: (902) 424-4036

iv) Contact Person:

Name: Ralph W. Spares, P. Eng.
Title: Director of Planning
Telephone: (902) 424-4193

THE UNDERTAKING:

i) NATURE OF THE UNDERTAKING: Construction of a new controlled access, four-lane, divided highway.

ii) PURPOSE/RATIONALE/NEED FOR THE UNDERTAKING: To extend the existing controlled access facility (Highway 107) from Highway 118 to Highway 102 at Bedford/Sackville, with connections to Burnside Drive and Cobequid Road.

SCHEDULE: The earliest possible start of construction, for Phase I (see descriptions below), would be the spring of 1991, upon the completion of survey and design work. The earliest start of operation of Phase I is estimated to be the fall of 1992.

DESCRIPTION OF THE UNDERTAKING:

i) GEOGRAPHICAL LOCATION: (See attached 1:50,000 scale map) The undertaking involves construction of a four-lane, divided highway beginning at the existing Highway 107/Highway 118 interchange near Porto Bello, thence in a southwesterly direction to the extension of Akerley Boulevard, thence in a westerly direction to the CNR tracks at the Dartmouth City Limits, thence in a northwesterly direction to Highway 102 at Bedford/Sackville. The undertaking also includes the extension of Burnside Drive to Highway 107 and connections to Cobequid Road in Sackville.

ii) PHYSICAL FEATURES: The proposed highway is a four-lane, divided facility with overpass structures required for grade-separation of roads and railways. The area to be affected is mostly wooded forest land; however, near Trunk 2 (Rocky Lake Drive), in Bedford, the alignment passes through a section of mixed residential/commercial/institutional development.

iii) CONSTRUCTION DETAILS: The total construction period is estimated to be in excess of five years. It is intended to construct the highway in five phases, with each phase dependent upon the availability of financing. Construction of Phase I is scheduled to start in the spring of 1991 and Phase II in 1993;

Potential sources of pollutants during construction would be those normally associated with highway construction.

The following is the phasing proposed for Highway 107 and connectors:

Phase I: Highway 107; from Highway 118 to the extension of Akerley Boulevard including associated interchange ramps at Highway 118.

Phase II: Connector Road 'A'; from Glendale Drive in Sackville to Trunk 2 (Rocky Lake Drive) in Bedford; including an interchange at Highway 102.

Phase III: Highway 107; from Highway 102 to the Extension of Burnside Drive near Dartmouth City Limit, including interchanges at Highway 102 and Bedford.
Burnside Drive; from Highway 107 to Akerley Boulevard, including an interchange at Akerley Boulevard.

Phase IV: Highway 107, from the extension of Akerley Boulevard to the extension of Burnside Drive at the Dartmouth City Limits, including interchanges at Akerley Boulevard and Burnside Drive.

Phase V: Connector Road 'B'; from Highway 102 to Cobequid Road in the vicinity of First Lake Drive, including completion of Interchange at Highway 102.

iv) OPERATION: The operation of the undertaking will be on a permanent basis. Potential sources of pollutants would be those normally associated with the operation of a highway facility.

v) OCCUPATIONS: The occupations involved during both construction and operation are those associated with highway facilities.

vi) PROJECT RELATED DOCUMENTS:

1) Manual of Geometric Design Standards for Canadian Roads, 1986 Edition, Roads and Transportation Association of Canada.

2) Standard Specifications, January 1, 1980 Metric Edition Province of Nova Scotia, Department of Transportation and Communications.

APPROVAL OF THE UNDERTAKING:

1) Water Rights Applications - N.S. Department of the Environment.

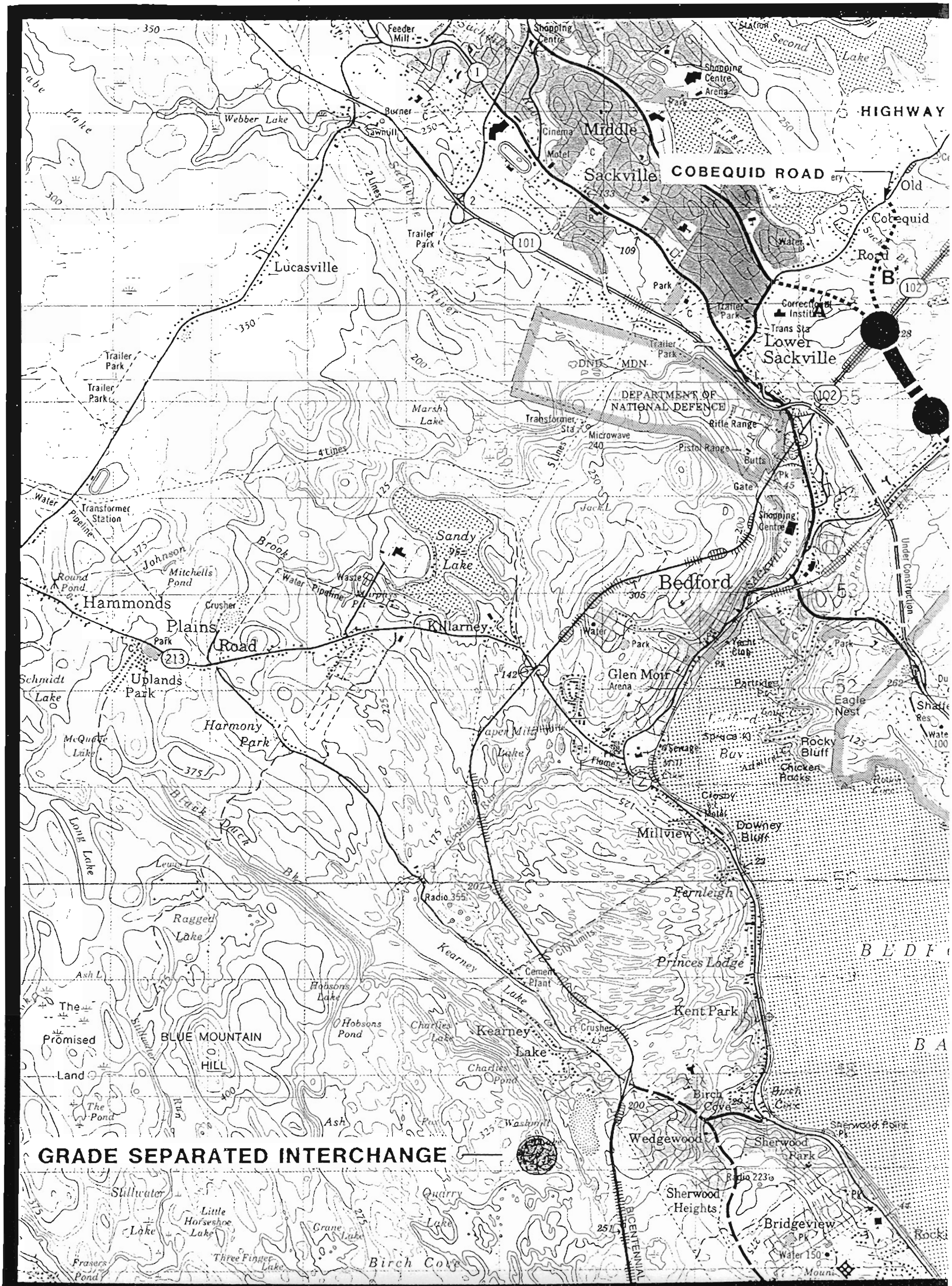
2) Federal Environmental Assessment Review Office.

FUNDING:

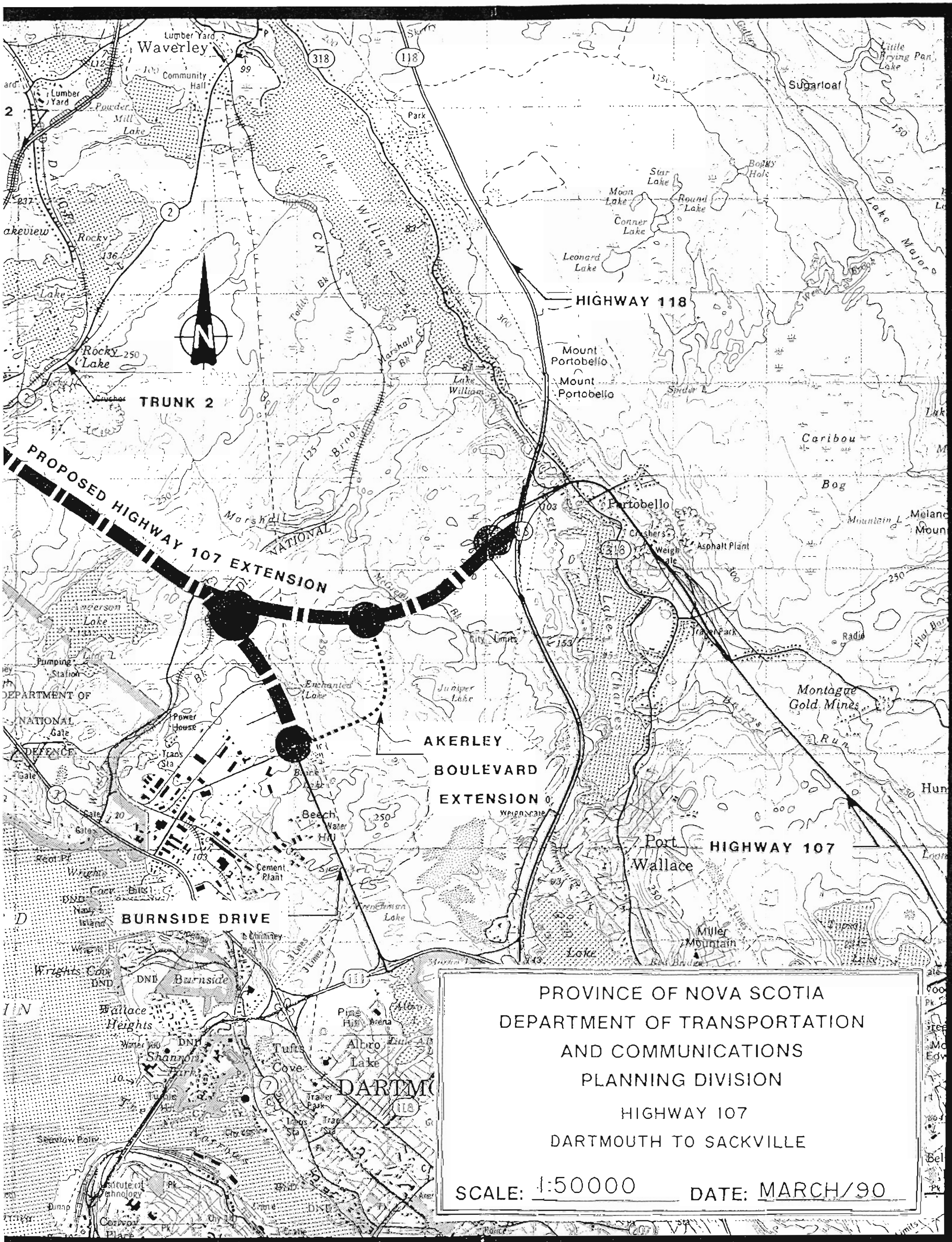
Although cost sharing with the Federal Government is not now available, an effort will be made to include Highway 107 in future Highway Improvement Agreements.

MAY 8, 1990 — Date

L. L. Lenta — Deputy Minister



HIGHWAY
COBEQUID ROAD
GRADE SEPARATED INTERCHANGE
Middle Sackville
Lower Sackville
Cobequid Road
Old
A
B
Lucasville
Webber Lake
DEPARTMENT OF NATIONAL DEFENCE
Rifle Range
Pistol Range
Marsh Lake
Sandy Lake
Bedford
Hammonds Plains Road
Killarney
Uplands Park
Schmidt Lake
Glen Moir
Harmony Park
McQuade Lake
Long Lake
Black Duck Bk
Millview
Downey Bluff
Fernleigh
Princes Lodge
Kent Park
Kearney Lake
Ragged Lake
Hobsons Lake
Hobsons Pond
Charlies Lake
Charlies Pond
The Promised Land
BLUE MOUNTAIN HILL
Birch Cove
Wedgewood
Sherwood Park
Sherwood Heights
Bridgeview
Stillwater
Little Horseshoe Lake
Three Finger Lake
Crane Lake
Quarry Lake
Frasers Pond
Eagle Nest
Rocky Bluff
Chicken Rocks
Under Construction
Radio 355
BICENTENNIAL



PROPOSED HIGHWAY 107 EXTENSION
TRUNK 2
HIGHWAY 118
AKERLEY BOULEVARD EXTENSION
HIGHWAY 107
BURNSIDE DRIVE
Waverley
Lake William
Portobello
Port Wallace
Caribou Bog
Montague Gold Mines
Burnside
Tufts Cove
Albro Lake
DARTMO
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF TRANSPORTATION
AND COMMUNICATIONS
PLANNING DIVISION
HIGHWAY 107
DARTMOUTH TO SACKVILLE
SCALE: 1:50000
DATE: MARCH/90

APPENDIX "B"

TERMS OF REFERENCE

ENVIRONMENTAL ASSESSMENT REPORT
TERMS OF REFERENCE

HIGHWAY 107

DARTMOUTH TO SACKVILLE

NOVA SCOTIA
DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

OCTOBER, 1990

Nova Scotia

Department of
Transportation
and Communications

P.O. Box 186
Halifax, Nova Scotia
B3J 2N2

October 26, 1990

Ms. Pat Lane
P. Lane & Associates Ltd.
5439 Cogswell Street
Halifax, Nova Scotia
B3J 1R1

Dear Ms. Lane:

Re: Request for Proposal,
Environmental Assessment Report,
Highway 107 - Dartmouth to Sackville

The terms of reference for the above study are enclosed for your consideration.

Proposals will be evaluated by the Environmental Assessment Steering Committee of the Nova Scotia Department of Transportation and Communications with the reference to the following:

1) Capability to carry out the work
2) Management of the work
3) Methodology proposed
4) Quality of proposal
5) Schedule of work
6) Cost

If you have any questions, please call me at (902) 424-4406.

Sincerely,

K. R. O'Brien, P.Eng.
Assistant Director of Planning

KRO'B/sem

Terms of Reference

ENVIRONMENTAL ASSESSMENT REPORT

Highway 107 - Dartmouth to Sackville

1. INTRODUCTION

The Nova Scotia Department of Transportation and Communications is proposing construction of a new controlled access, four-lane, divided highway (to extend the existing controlled access Highway 107) from Highway 118 to Highway 102 at Bedford/Sackville, with connections to Burnside Drive and Cobequid Road.

Since the Highway 107 project is a Class II undertaking as defined by Schedule "A" of the Environmental Assessment Act Regulations, an environmental assessment report is required.

2. OBJECTIVE

The objective of this study is to prepare an Environmental Assessment Report for the proposed Highway 107 - Dartmouth to Sackville.

3. STUDY AREA

The study area for this project is shown on the attached 1:50,000 map. The proposed roadway generally will extend Highway 107 from its present terminus at Highway 118 to Highway 102 at Bedford, with connections to Burnside Drive and Cobequid Road.

4. DUTIES OF THE CONSULTANT

(a) Meet with Department of Transportation & Communications Environmental Assessment Steering Committee to review the project for which an Environmental Assessment Report is to be prepared.

(b) Review available preliminary plans and profiles for the proposed highway.

(c) Review Department of Transportation & Communications Standard Specifications and Highway Design Standards.

(d) Review Guidelines for Development on Slates and other recent guidelines supplied by Department of the Environment.

(e) Prepare an Environmental Assessment Report which will address the requirements of the "Highway #107 Extension Project - Final Guidelines", August 10, 1990, a copy of which is included in the attached Appendix. The Report shall be prepared from the position that only preliminary plans exist for this project, and that many of the Guideline requirements may be satisfied by existing Specifications, Standards and Guidelines.

(f) Provide 25 draft copies of the Report for review by the Department of Transportation & Communications and the Minister of the Environment.

(g) Provide 75 copies of the final Report.

5. DUTIES OF THE DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS

(a) Meet with the Consultant on an arranged schedule.

(b) Provide the Consultant with a copy of all available plans and profiles for this project.

(c) Provide the Consultant with a copy of the Nova Scotia Department of Transportation & Communications Standard Specifications and Highway Design Standards.

6. STUDY SCHEDULE

The Consultant shall complete this project in accordance with the time frame indicated in his proposal submission.

7. STUDY CONTROL

The Consultant will report to the Environmental Assessment Steering Committee of the Nova Scotia Department of Transportation & Communications.

8. MEETINGS

The Consultant is to meet with the Environmental Assessment Steering Committee at a Project Initiation Meeting, and then on a bi-weekly basis for the duration of the contract.

9. OWNERSHIP OF INFORMATION

The Consultant agrees that all information collected, materials gathered and reports produced shall be the sole property of the Department of Transportation & Communications. The Consultant shall not be permitted to publish or in any way use said information, materials or reports without the express and prior approval of the Department of Transportation & Communications.

10. PAYMENT SCHEDULE

Payments for professional services rendered will be made monthly in arrears upon receipt of invoices detailing programs of work completed. The total of such payments is not to exceed 80% of the fixed price for the contract. The remaining 20% will be paid upon acceptance of the Draft Report by the Minister of the Environment, and delivery of 75 copies of the Final Report to the Department of Transportation & Communications.

11. PROPOSAL SUBMISSIONS

Project Proposals addressing the Terms of Reference shall contain the following information:

a) a detailed description of how the project will be organized and conducted, including time schedule for work;

b) the proposed consultant team including a curriculum vitae for each professional member;

c) a list of client references;

d) a schedule of fees and expenses, setting out the rates of remuneration for Consultant Team members and an estimate of the amount of time each member will devote to the project;

e) a maximum price for project completion.

Ten copies of Consultant proposals shall be submitted to the Steering Committee:

c/o Mr. Ken O'Brien, P. Eng.
Assistant Director of Planning
P. O. Box 186
Halifax, Nova Scotia
B3J 2N2

Deadline for the proposals submissions is November 19, 1990.

The lowest price or any proposal will not necessarily be accepted.

12. ENQUIRIES

All enquiries concerning this request for proposal should be directed to Mr. Ken. O'Brien at (902) 424-4406.

a:Environt.KOB

APPENDIX

ENVIRONMENTAL ASSESSMENT REPORT

FINAL GUIDELINES

FOR THE PREPARATION OF

TERMS OF REFERENCE

NOVA SCOTIA DEPARTMENT OF
TRANSPORTATION AND COMMUNICATIONS

HIGHWAY # 107 EXTENSION PROJECT

Dartmouth to Sackville, Halifax County
Nova Scotia

NOVA SCOTIA

DEPARTMENT OF THE ENVIRONMENT

August 10, 1990

TABLE OF CONTENTS

FOREWORD

This document presents Final Guidelines for the preparation of Terms of Reference for an Environmental Assessment Report in accordance with the requirements of the Environmental Assessment Act, Chapter 149 RSNS, 1989 and the Regulations thereto.

These Final Guidelines were prepared in consideration of comments and concerns expressed by government reviewers and following a public review period from June 20 to July 25, 1990. The content of these Guidelines is consistent with the requirements of Section 13(1) of the Environmental Assessment Regulations.

Since the Report may be examined by those without technical backgrounds it shall include an executive summary prepared in non-technical terms. The Report shall use non-technical language wherever possible.

The Nova Scotia Department of Transportation and Communications (Proponent) shall prepare an Environmental Assessment Report (Report) which shall include, but not necessarily be limited to, the following major sections:

1. Introduction
2. Project Description
3. Reason for the Undertaking
4. Other Methods of Carrying out the Undertaking
5. Alternatives to the Undertaking
6. Existing Environment
7. Predicted Environmental Impacts
8. Evaluation of the Advantages and Disadvantages to the Environment of the Undertaking
9. Proposed Mitigation, Including Rehabilitation
10. Residual Impacts
11. Proposed Compliance and Effects Monitoring Programs
12. Public Information Program

1. INTRODUCTION

This section introduces readers to the Report. It shall describe the organized framework, including study strategy and methodology, within which the Environmental Assessment Report will be prepared. The requirements for organizing and conducting ecological studies as proposed by Beanlands and Duinker, "An Ecological Framework for Environmental Impact Assessment in Canada" (1983) provide a good example and are included for the guidance of the proponent:

(a) identify an initial set of valued ecosystem components to provide a focus for subsequent activities;
(b) define a context within which the significance of changes in the valued ecosystem components can be determined;
(c) show clear temporal and spatial contexts for the study and analysis for expected changes in valued ecosystem components;
(d) develop an explicit strategy for investigating the interactions between the project and each valued ecosystem component, and to demonstrate how the strategy is to be used to co-ordinate the individual studies undertaken;
(e) state impact predictions explicitly and accompany these with the basis upon which they were made; and
(f) demonstrate and detail a commitment of a well defined programme for monitoring project effects.

The following sections outline specific concerns and requirements related to the description of the project, the existing environment, predicted environmental impacts, environmental monitoring, contingency planning, site rehabilitation, and residual environmental impacts that the proponent is to address in their Environmental Assessment Report for the proposed undertaking.

2. PROJECT DESCRIPTION

This section of the Report shall describe the project as it is planned from the corridor clearing, and site preparation and construction phases, to the completion of the highway.

Items to be addressed shall include, but not necessarily be limited to:

(a) highway corridor location - ultimate boundaries of the proposed corridor and highway route in a regional context showing infrastructure such as road networks, railways, power lines, proximity to settled areas, individual and community water supplies, archaeological sites, etc.;

(b) area geography, including features such as lakes, streams, wetlands, and topography within a minimum of five hundred (500) metres of proposed highway corridor;

(c) description of general construction practices, including but not limited to blasting methods, erosion control and sedimentation control;

(d) identification of cut and fill areas;

(e) sources of fill and aggregate if known;

(f) construction vehicle operations including vehicle types, truck routes, hours of operation;

(g) areas of disposal of excess excavated rock, if know;

(h) areas and methods of overburden and organic soil disposal, including cleared vegetation and wood fibre; and

(i) community information and public liaison plans during construction and operation.

3. REASON FOR THE UNDERTAKING

In recognition of the fact that the project has a potentially negative impact upon the environment, this section shall discuss the public need for the undertaking.

4. OTHER METHODS FOR CARRYING OUT THE UNDERTAKING

Describe the viable options to the proposed method(s) of carrying out the undertaking and provide reasons for the selection of the proposed methods.

5. ALTERNATIVES TO THE UNDERTAKING

Describe the alternatives to the proposed undertaking including alternate sites and the null or "do nothing" alternative. The environmental, social and economic reasons for the preferred highway route shall be discussed.

6. EXISTING ENVIRONMENT

This section of the Report shall identify the study area(s) and shall describe the existing environment in the study area through the use of original baseline studies or existing data where appropriate.

Components of the environment to be described shall include, but not necessarily be limited to the following:

(a) atmospheric conditions including air quality, dust levels, wind speeds and directions, and precipitation;

(b) ambient noise levels at various locations along the corridor, and in different areas of bordering land uses, such as open areas, residential areas, institutional areas, wooded areas, etc.;

(c) surface water and groundwater - general hydrologic and hydrogeologic characteristics, including domestic water wells and water quality;

(d) pre-blast survey of structures within the predicted impact area along the highway route where blasting is planned;

(e) well water quantity and quality survey to include all domestic and other wells within the predicted impact area for proposed blasting operations;

(f) flora and fauna

   (i) flora - including identification of any rare or endangered plants,

   (ii) fauna - including identification of any rare or endangered animals,

   (iii) fishery - fresh water habitat descriptions shall include stream size, bottom composition, gradients at 0.5 km intervals, cover, annual temperatures, sediment loading, etc.;

(g) identification of valued ecosystem components along the highway corridor and proposed access roads to the highway;

(h) description of existing regulatory environment, including guidelines;

(i) existing land uses and zoning;

(j) geology - bedrock and surficial geology of the study area, including mineralology and acid generating potential of excavated bedrock; and

(k) archaeological sites including the identification of areas containing features of social or cultural importance.

7. PREDICTED IMPACTS UPON THE ENVIRONMENT

The Report shall identify and predict the magnitude and importance of project impacts, both positive and negative, on the environment. This section shall address socio-economic and community impacts as well as impacts on the bio-physical environment.

The proponent shall address the following but not necessarily restrict discussion to these items:

(a) impacts to surface water quality, fish habitat, directions of surface water flow;

(b) impacts to groundwater quality and quantity;

(c) community and social impacts

  (i) impact on residential property values,

  (ii) anticipated changes in traffic speed and intensity in adjacent residential and commercial areas;

(d) predicted increases in noise levels at various locations along the highway route, including residential and commercial areas, institutional areas, wooded and open areas; and

(e) anticipated changes to air quality during construction.

8. EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

9. PROPOSED MITIGATION, INCLUDING REHABILITATION

The Report shall discuss proposed environmental mitigation devices and policies as well as procedures intended to avoid or minimize negative impacts and enhance positive impacts.

10. RESIDUAL ENVIRONMENTAL IMPACTS

The Report shall list and contain a detailed discussion of residual impacts. The Report will clearly distinguish those impacts that cannot be mitigated or avoided from those impacts that will not be mitigated or avoided.

These impacts become very important in the evaluation of a proposed project as they represent the environmental cost of the project.

11. PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

The Report shall include a framework upon which compliance monitoring will be based throughout the life of the proposed project. Proposed compliance monitoring programs shall be presented for examination by reviewers.

12. PUBLIC INFORMATION PROGRAM

This section of the Report shall detail the public information program initiated by the proponent. The results of public consultation shall be reported along with any commitments made by the proponent.


HIGHWAY
COBEQUID ROAD
GRADE SEPARATED INTERCHANGE
B
Middle Sackville
Lower Sackville
Old
Cobequid Road
Lucasville
Webber Lake
Trailer Park
DEPARTMENT OF NATIONAL DEFENCE
Marsh Lake
Sandy Lake
Jack L
Bedford
Hammonds Plains Road
Round Pond
Mitchell Pond
Killarney
Uplands Park
Schmidt Lake
Glen Moir
Harmony Park
McQuade Lake
Paper Mill Lake
Bedford Bay
Eagle Nest
Rocky Bluff
Chicken Rocks
Crosby
Downey Bluff
Millview
Long Lake
Lewis L
Ragged Lake
Radio 355
Fernleigh
Kearney Lake
Princes Lodge
Kent Park
Ash L
The Promised Land
BLUE MOUNTAIN HILL
Hobsons Lake
Hobsons Pond
Charles Lake
Charles Pond
Kearney Lake
Birch Cove
Wedgewood
Sherwood Park
Sherwood Heights
Bridgeview
The Pond
Stillwater Lake
Little Horseshoe Lake
Crane Lake
Quarry Lake
Three Finger Lake
Birch Cove
Second Lake
First Lake
Shopping Centre
Cinema
Motel
Correctional Institute
Trans Sta
Feeder Mill
Sawmill
Under Construction
BEDF
BA
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213
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53
52
50
49
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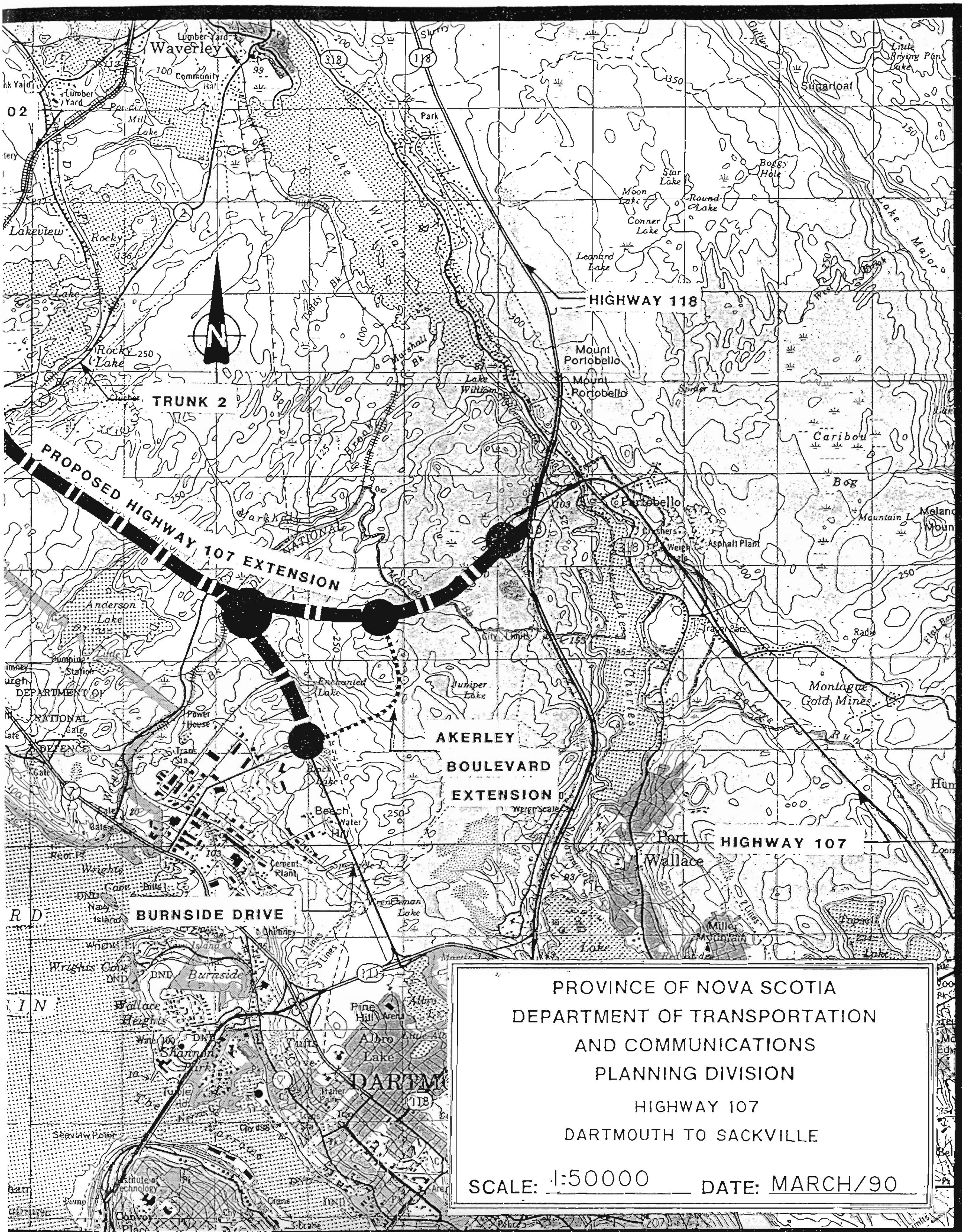


HIGHWAY 118
TRUNK 2
PROPOSED HIGHWAY 107 EXTENSION
AKERLEY BOULEVARD EXTENSION
HIGHWAY 107
BURNSIDE DRIVE
N
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF TRANSPORTATION
AND COMMUNICATIONS
PLANNING DIVISION
HIGHWAY 107
DARTMOUTH TO SACKVILLE
SCALE: 1:50000 DATE: MARCH/90

APPENDIX "C"

FACT SHEET AND QUESTIONNAIRE

FACT SHEET

HIGHWAY 107: Dartmouth to Sackville

The Program

The Nova Scotia Department of Transportation and Communications is proposing construction of a new controlled access, four-lane, divided highway to extend the existing controlled access Highway 107 from Highway 118 to Highway 102 at Bedford/Sackville, with connections to Burnside Drive and Cobequid Road.

The Economy

The increased capacity of the new highway will generate direct savings in time and fuel to both truckers and other motorists. The proposal includes connectors to the Burnside Industrial Park and both the Bedford and Sackville Industrial Parks. This proposal will provide direct connections for these three industrial parks to Highway 102 and Highway 118. It is expected that this new highway will reduce traffic congestion in the Burnside Industrial Park and the Bedford/Sackville area as well as reduce truck movements through the Bedford Area.

The Environment

The Department of Transportation and Communications has registered this project under the Environmental Assessment Act. This Environmental Assessment Process requires detailed environmental studies, and public scrutiny of the reports. Public hearings will be conducted before final approval is given.

P. Lane and Associates Limited, Environmental Consultants, are conducting an Environmental Assessment Study for this project. The Environmental Assessment Report will be released and written comments invited from the public in May or June of 1991. Public hearings will be held by the Environmental Control Council during the summer of 1991.

The Department of Transportation and Communications supports the provincial commitment to environmental protection, and will conform with the mitigative measures recommended through this process.

Property Negotiation

Contrary to popular belief, the Province rarely expropriates property for highway right of way. When the route is approved, surveyed, and designed, the Department will determine local market values and Right of Way officers will contact property owners to negotiate a mutually acceptable price. Approximately 95 % of properties purchased are settled through this process.

Schedule

The total construction period for this program is estimated to be in excess of five years. It is intended to construct the highway in five phases, with each phase dependant upon the availability of funding. The phasing proposed for Highway 107 and its connectors is as follows:

Phase I — Highway 107; from Highway 118 to the extension of Akerley Boulevard including associated interchange ramps at Highway 118.

Schedule cont. . . .

Phase II — Connector Road "A"; from Glendale Drive in Sackville to Trunk 2 (Rocky Lake Drive) in Bedford including an interchange at Highway 102.

Phase III — Highway 107; from Highway 102 to the Extension of Burnside Drive near the Dartmouth City Limit, including interchanges at Highway 102 and Bedford. Burnside Drive; from Highway 107 to Akerley Boulevard, including an interchange at Akerley Boulevard.

Phase IV — Highway 107; from the extension of Akerley Boulevard to the extension of Burnside Drive at the Dartmouth City Limit, including interchanges at Akerley Boulevard and Burnside Drive.

Phase V — Connector Road "B"; from Highway 102 to Cobequid Road in the vicinity of First Lake Drive including completion of the interchange at Highway 102.

Phase I will begin in 1991 following the Environmental Assessment Process. This process is expected to be completed by September 1991.

Funding

The total project from Highway 118 to Highway 102 at Bedford / Sackville, with connections to Burnside Drive and Cobequid Road is estimated to cost approximately $65 million. Much of this funding will be provided by the Transportation Trust Fund. This fund, established by the Province, has been allocated for 100 - Series Highways.

For More Information

This Open House session is the first opportunity for the community to review and react to the proposal. If you wish additional information, contact:

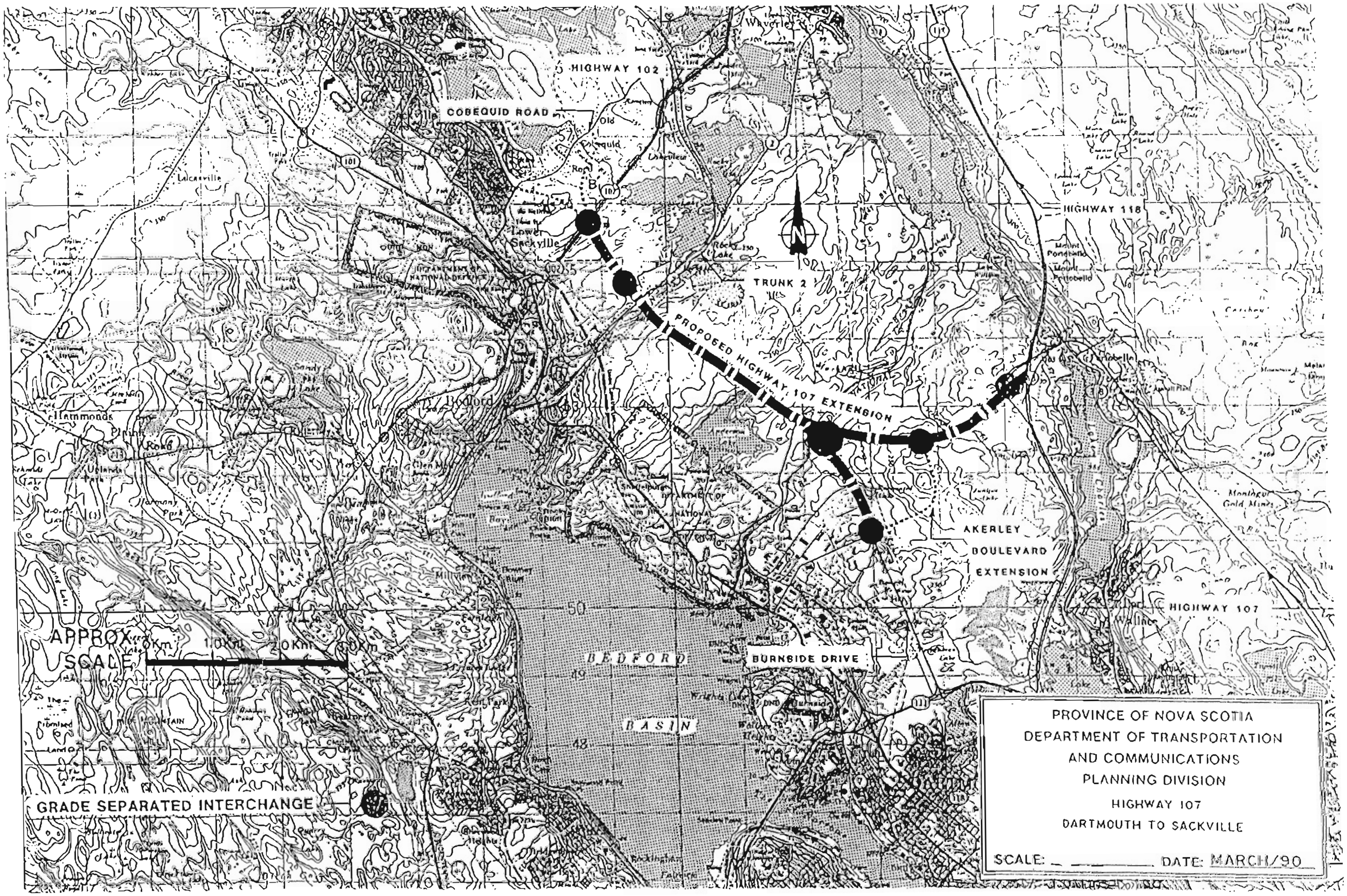
Nova Scotia Department of Transportation
and Communications
Planning Division 424-4193

P.O. Box 186, Halifax, N.S. B3J 2N2

Nova Scotia Department of Environment
Environmental Assessment
Administrator 424-6307

P.O. Box 2107, Halifax, N.S. B3J 3B7

January 1991


HIGHWAY 102
COBEQUID ROAD
HIGHWAY 118
TRUNK 2
PROPOSED HIGHWAY 107 EXTENSION
AKERLEY
BOULEVARD
EXTENSION
HIGHWAY 107
BURNSIDE DRIVE
BEDFORD
BASIN
APPROX.
SCALE
GRADE SEPARATED INTERCHANGE
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF TRANSPORTATION
AND COMMUNICATIONS
PLANNING DIVISION
HIGHWAY 107
DARTMOUTH TO SACKVILLE
SCALE: ______ DATE: MARCH/90

QUESTIONNAIRE

Thank you for taking the time to visit with us today and to review the plans for the proposed routing of the new 4 lane extension of Highway 107, from Highway 118 to Highway 102 at Bedford / Sackville with connections to Burnside Drive and Cobequid Road.

It would be helpful to the planning process for this and future highways if you would take a few moments to complete the following questionnaire.

1. Name ______________________________
   Mailing Address ______________________________
   ____
   ____

2. Location of your house, cottage, business or property ______________________________
   ____

3. How close is your house, cottage or business to the proposed highway?
   ____

4. How are you affected by the proposed highway?

   { } My house, cottage or business is on the proposed right of way.

   { } My property will be divided by the proposed right of way.

   { } My business will be by-passed.

   { } My home or business is close to the new road.

   { } Has no effect on my property.

5. What, in your opinion, are the main benefits of the proposed highway?
   ____
   ____
   ____

6. What are your major concerns with regards to the proposed highway?
   ____
   ____
   ____

Continued . . . . .

7. Do you approve of the proposed highway location?

{ } Yes { } No

Comments ____

____

____

8. What improvements or route changes would you suggest?

____

____

____

____

9. Did this meeting provide the information you needed or expected? What additional information would you have wanted today?

____

____

____

____

10. General Comments Concerning .....

(a) this information session ______________________________

____

____

(b) the planning process ______________________________

____

____

(c) the proposed new Highway 107 ______________________________

____

____

Thank you for your comments.

Nova Scotia Department of
Transportation and Communications
Planning Division
P.O. Box 186
Halifax, Nova Scotia
B3J 2N2
Phone (902) 424-4193

January, 1991

APPENDIX "D"

COMMUNICATIONS CONCERNING ALTERNATE ROUTES CONSIDERED

Nova Scotia

Department of
Transportation
and Communications

PO Box 186
Halifax, Nova Scotia
B3J 2N2

Our file no:

January 10, 1991

Dr. Sally Walker
P. Lane & Associates Ltd.
5439 Cogswell Street
Halifax, Nova Scotia
B3J 1R1

Dear Dr. Walker:

Re: Highway 107 Environmental Assessment Study, 1984 Correspondence with Department of Environment concerning three alternates for Sackville Expressway (Highway 107)

Further to our meeting of January 4, 1991, I am enclosing a plan and four letters concerning three alternates for the Sackville Expressway (Highway 107) referred to the Department of the Environment in 1984.

The plan (scale 1:5,000) shows three proposed alignments for the roadway between the Dartmouth City limits and Cobequid Road. Alternate #3 between the Dartmouth City limits and the Duke Street area of Bedford is the roadway that has been registered with the Department of the Environment and is the subject of this Environmental Assessment Study. The section of Alternate 3 between Duke Street, Highway 102, and the Cobequid Road is no longer being considered due to the need for a complex interchange to Highway 102 and the realization that a single T-intersection between the Sackville Expressway and Cobequid Road would not provide a satisfactory level of service. This section of roadway has been replaced by the Highway 102/107 interchange proposal and connector roadways to Glendale Drive and Cobequid Road near First Lake Drive as shown on the 1:5,000 scale plan provided to you on January 4, 1991.

The four letters include the following information concerning the three alternates:

1) February 24, 1984 - The Department of Environment reviewed Altnernates 1 and 2 and indicated that "both routes are environmentally acceptable but Route #2 is definitely preferable."

2) February 27, 1984 - The same information as 1, above.

3) June 12, 1984 - This is an internal Planning Division document indicating that Alternate #3 is proposed to avoid plans for development within the Bedford Industrial Park. The at-grade access to the Sackville Expressway indicated in this letter is no longer being considered since the Sackville Expressway has been upgraded to freeway status with grade separations and interchanges.

4) November 8, 1984 - This is a letter from the Department of the Environment to the Department of Transportation indicating that they have completed a preliminary review of plans for the third alignment and that "this alignment can be constructed in an environmentally acceptable manner."

The original concept of the Sackville Expressway was to extend Burnside Drive from its intersection with Akerley Boulevard to the Dartmouth City limits and then by Alternate 3 to Duke Street, Highway 102, and Cobequid Road. Although consideration had been given to extending Akerley Boulevard to connect with Highway 118 at or near the Highway 107 interchange, the extension of Highway 107 from the existing Highway 118 interchange to interchange with Akerley Boulevard and then to Burnside Drive at the City limits has only been developed during the past three years. This change in roadway proposals for this part of Burnside was considered necessary for the following reasons:

1) The Sackville Expressway which had been proposed as a four-lane divided roadway with intersections was upgraded to a 100 kilometre per hour design speed freeway with interchanges and will be designated as Highway 107.

2) A suitable interchange configuration could not be provided to accommodate anticipated traffic volumes where Sackville Expressway (Highway 107) would meet with Burnside Drive and Akerley Boulevard.

3) Akerley Boulevard, as a low speed collector roadway, would not provide the satisfactory level of service for traffic between Highway 118 and Sackville Expressway (Highway 107).

If you or Jeff Ward have any questions concerning this letter and attachments please do not hesitate to contact me at 424-4406.

Yours truly,

K.R. O'Brien, P.Eng.
Assistant Director Planning

KRO'B/sem

cc: Greg Vail

Nova Scotia

Department of the
Environment

File: 1750-H43

PO Box 2107
Halifax, Nova Scotia
B3J 3B7

November 8, 1984

Mr. R. M. MacDonald, P. Eng.
Director of Planning
Nova Scotia Department of
Transportation
P. O. Box 186
Halifax, Nova Scotia
B3J 2N2

Dear Mr. MacDonald:

RE: SACKVILLE EXPRESSWAY

The Nova Scotia Department of the Environment has reviewed preliminary plans for a third alignment for the extension of the above. We feel this alignment can be constructed in an environmentally acceptable manner.

Before we send your department our detailed comments, we would like you to provide us with a comprehensive site plan for the proposed crossing of Wrights Brook. Separate Water Rights Permits will be required for the drainage structure at Wrights Brook and for the infilling of a portion of the swamp at the north end of Lily Lake.

If you have questions regarding the above, please contact Gerald Porter at 424-5300, local 166.

Yours truly,

C. F. Reardon, P. Eng.
Chief, Construction &
Government Programs

GKP/soc
c.c. N. E. MacEachern
W. J. D'Eon
W. Butler

Form 97

PROVINCE OF NOVA SCOTIA

DEPARTMENT OF HIGHWAYS

(INTER-DEPARTMENT CORRESPONDENCE)

June 12, 19 84
LOCATION AND DATE

TO PL

NAME	POSITION	ADDRESS

YOUR FILE	SUBJECT	H. O. FILE
	Re: Sackville Expressway	

In January 1984 we forwarded copies of two alternate alignments of the Sackville Expressway to the N.S. Dept. of the Environment for their approval and comments. We received correspondence from the Department of the Environment on February 27, 1984 indicating that they felt that both alternates could be constructed in environmentally acceptable manners, however, Alternate #2 would be their preference.

After several subsequent meetings with representatives of the Town of Bedford and C.N. Rail, a third alignment or Alternate #3 was developed. This alternate follows approximately the same alignment as Alternates #1 and #2 from the Cobequid Road, through the Sackville Industrial Park to a proposed interchange at Highway 102, then follows an alignment passing between Duke Street and C.P. Allan High School, over Trunk 2, passing north of Lily Lake and merging with Alternate #1, approximately 1,200 meters east of Trunk 2.

This Alternate #3 avoids C.N. Rail's proposed multi-modal facility location in the Bedford Industrial Park. An At-Grade access is proposed by an extension of the Strescon's Driveway from Duke Street to the By-Pass. This access thus permits access for truck traffic from Trunk 2 via Duke Street. The existing driveway from Duke Street to C.P. Allan High School would have to be relocated directly to Trunk 2. This Alternate #3 is preferred over Alternates #1 and #2 by staff of the Town of Bedford's Planning Division and by C.N. Rail representatives.

The 90 meter(300 foot) right-of-way shown could be reduced to an approx. 45 meter right-of-way subject to completion of survey and final design.

Greg G. Vail

G.G. Vail
Design Eng.

GGV/sem

Nova Scotia

Department of the
Environment

File: 1750-H43

PO Box 2107
Halifax, Nova Scotia
B3J 3B7

February 27, 1984

C. A. Thomas, P. Eng.
Director of Planning
Nova Scotia Department
of Transportation
Halifax, Nova Scotia

Dear Mr. Thomas:

Burnside Expressway

RE: ALIGNMENT REVIEW - PROPOSED EXTENSION OF HIGHWAY #111

The Nova Scotia Department of Environment has reviewed preliminary plans for the above and we feel that both routes could be constructed in an environmentally acceptable manner, however, route # 2 would probably be our preference.

A separate Water Rights Permit will be needed for the drainage structure at Wrights Brook.

Comments from Gerald Porter of this department are attached. If you have questions regarding the above, please contact him.

Yours truly,

Charles F. Reardon

C. F. Reardon, P. Eng.
Chief, Approval of Gov't Services

GKP/soc
c.c. N. E. MacEachern
W. J. D'Eon
M. Bernard
W. Butler

Attachment

DEPARTMENT OF TRANSPORTATION
RECEIVED
FEB 28 1984
18+
DIRECTOR OF PLANNING

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

MEMORANDUM File: 1750-H43

To: C. F. Reardon, P. Eng., Chief, Approval of Gov't Services

From: Gerald K. Porter, Environmental Technologist

Date: February 24, 1984

SUBJECT: PROPOSED EXTENSION OF HIGHWAY 111 FROM AKERLEY BOULEVARD TO OLD COBEQUID RD.
Burnside Expressway

On October 5, 1982, this department received plans for the proposed extension of Highway 111, from Akerley Boulevard to the Old Cobequid Rd. Copies of the proposed alignment were sent to Dr. Lin, Mr. Lee Lewis, of this department and to the County of Halifax, City of Dartmouth, Nova Scotia Department of Health and Fisheries & Oceans Canada.

On January 26, 1984, we received an alternate alignment from Nova Scotia Department of Transportation. Plans for the second alignment were sent to the same agencies as for the first alignment with the exception of the City of Dartmouth. Plans for the alternate alignment were not sent to Dartmouth because the alternate route would not pass through any portion of that city.

Bedford Staff only

Mr. C. A. Thomas of Nova Scotia Department of Transportation advised he had sent plans for the first alignment to the Town of Bedford. Comments from the Town of Bedford had resulted in the second proposed alignment. As concerns of the Town of Bedford had already been considered, I did not send plans for the both alignments to the Town.

Both alignments follow the same route from the Old Cobequid Rd. to Highway 102. At this point they diverge. Route # 1 goes southeast and passes just south of Lily Lake. Routh # 2 goes through the Bedford Industrial Park and crosses Highway # 2 south of Rocky Lake. The two alignments meet at a point approximately 1000 meters southeast of Highway # 2 and then follow the same route to Akerley Boulevard.

Geology

A. Bedrock

Both proposed alignments are entirely underlain by greywacke quartzite and minor amounts of slate of the Cambrian-aged Goldenville Formation. Goldenville Formation bedrock, which contains excessive amounts of pyrite mineralization, could be a source of acid drainage from exposed road cuts and crushed rock used for fill. A considerable amount of blasting will be necessary for both alignments.

B. Surficial

Bedrock is at the surface over a majority of both alignments. Overburden is a sandy gravelly glacial till and less than 1.5 meters deep. Considering the above, siltation of watercourses should not be a major concern.

Watercourses

Except for one, all watercourses crossed by both alignments are quite small. The exception is Wrights Brook. It leads from Enchanted Lake to Flat Lake and is large and scenic. The two proposed alignments cross this stream at the same point. A detailed Water Rights Permit should be required for the crossing of this watercourse.

Groundwater

Both proposed alignments cross Highway # 2 at points where there are quite a few residences nearby. However, these homes are serviced by a central water system. At the point where the alignments intersect the Old Cobequid Rd., there are a number of homes that get their water from wells. Water from the County of Halifax water system is available but only a small percentage of the homes have hooked up.

Land Use Issues

Operation of the highway will increase traffic noise for people living near the proposed intersection at Old Cobequid Rd.

Route # 1 will require the removal of two homes that presently are on the northwest side of Highway # 2. This route would pass approximately 140 meters northeast of a Junior High School. The existing Bedford By-Pass passes approximately 125 meters southwest of the same school. Construction of this route would therefore cause there to be two four lane highways within 140 meters of the school. There are quite a few homes along Highway # 2 that would be close to this alignment and they definitely would be affected by noise from the highway.

No homes would need to be removed if route # 2 is constructed. The nearest dwelling would be on Highway # 2 and situated approximately 250 meters southwest of the alignment. Homes along Highway # 2 would be affected by noise, but not as significantly as by Route # 1. Route # 2 would pass at grade through the Bedford Industrial Park and approximately 375 meters northeast of C. P. Allan High School.

We should advise Nova Scotia Department of Transportation that both routes are environmentally acceptable, but Route # 2 is definitely preferable.

Gerald K Porter

GKP/soc

APPENDIX "E"
SAMPLE
NOTIFICATION LETTER
CONCERNING WELL CONTAMINATION

Date: ______ Ref. #: ___

RR#3
Lower Sackville, Nova Scotia
B4C 3A9

ATTENTION: __________

SUBJECT: Water Sample Results for __________
Sackville, Nova Scotia

Dear ______:

Please find enclosed the results of the water analysis for ___________.

Samples were collected from existing wells in the area to determine water quality before construction of Highway 107 extension begins.

The results shown on the enclosed table are for samples taken on January 28, 1991.

As indicated in table, unacceptable levels of Arsenic were indicated in the sample collected. From these results it is determined that regular resampling by the Department of Health and Welfare is warranted.

I hope this report is suitable for your purposes at this time. If you have any questions, please feel free to contact me at your earliest convenience.

Yours truly,

GROUNDWATER TECHNOLOGY CANADA LTD.

Michael C. Campbell
Geologist

enc.

APPENDIX "F"

METEOROLOGICAL CONDITIONS

Precipitation Data for Lower Sackville, Bedford, and

Halifax International Airport

TOTAL PRECIPITATION 1951-80
PRECIPITATIONS TOTALES 1951-80

	JAN JAN	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE
NOVA SCOTIA NOUVELLE-ECOSSE														
LOWER SACKVILLE	150.4	143.8	123.0	111.5	111.8	84.4	96.6	100.5	93.8	123.8	154.7	153.8	1448.1	8
BEDFORD	169.8	135.0	125.9	114.1	107.2	87.8	93.5	104.7	71.0	129.6	147.3	153.4	1439.3	8
HALIFAX INT'L A	152.8	133.5	128.4	114.8	106.4	89.4	94.2	111.3	93.7	133.5	152.5	180.1	1490.6	3

MEAN RAINFALL 1951-80
HAUTEUR MOYENNE DE PLUIE 1951-80

	JAN JAN	FEB FÉV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE
NOVA SCOTIA NOUVELLE-ECOSSE														
LOWER SACKVILLE	102.0	84.3	75.3	89.4	108.5	84.4	96.6	100.5	93.8	120.4	145.0	106.0	1206.2	8
BEDFORD	115.9	74.4	84.0	107.1	105.2	87.8	93.5	104.7	71.0	127.7	138.4	119.9	1229.6	8
HALIFAX INT'L A	91.0	70.0	83.2	89.3	102.8	89.4	94.2	111.3	93.7	129.9	140.7	128.3	1223.8	3

MEAN SNOWFALL 1951-80
HAUTEUR MOYENNE DE NEIGE 1951-80

	JAN JAN	FEB FÉV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE
LOWER SACKVILLE	55.6	62.8	50.4	17.7	4.1	0.0	0.0	0.0	0.0	3.6	8.5	48.3	251.0	8
BEDFORD	52.2	62.6	39.8	11.0	1.5	0.0	0.0	0.0	0.0	1.7	9.8	35.8	214.4	8
HALIFAX INT'L A	63.1	65.5	45.5	24.1	3.4	0.0	0.0	0.0	0.0	3.6	11.9	53.9	271.0	3

Wind Data for the Halifax International Airport

HALIFAX INT'L A N.S.

PERIOD 1961-80 PERIODE

Lat. 44°53'N Long. 063°31'W

Elevation 145 m Altitude

PERCENTAGE FREQUENCY / FRÉQUENCE EN %

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	8.8	8.8	11.5	11.3	8.8	7.3	4.7	5.7	8.3	7.9	9.5	8.4	8.4	N
NNE	4.0	3.7	4.9	5.2	4.5	3.5	2.3	2.5	4.3	3.7	4.3	3.7	3.9	NNE
NE	2.0	2.6	2.2	2.6	2.6	1.8	1.5	1.6	1.8	1.7	2.2	2.3	2.1	NE
ENE	1.2	1.4	1.3	1.7	1.6	1.2	0.7	1.0	1.1	1.1	1.7	1.3	1.3	ENE
E	2.5	2.4	2.4	3.1	3.3	1.8	1.8	1.6	2.0	2.0	3.2	3.0	2.4	E
ESE	3.3	3.6	3.7	3.5	4.0	2.4	2.7	2.2	3.1	3.0	3.8	3.9	3.3	ESE
SE	4.1	4.2	4.0	5.5	6.7	5.6	4.9	3.8	4.1	3.8	5.9	5.1	4.8	SE
SSE	4.4	4.1	4.8	6.4	7.9	7.7	8.4	6.5	5.1	5.8	5.6	5.1	6.0	SSE
S	5.9	6.1	8.0	8.0	13.4	18.1	18.1	17.6	12.5	11.0	8.5	6.1	11.1	S
SSW	7.3	6.6	8.3	7.5	11.4	17.3	19.7	17.2	13.6	11.8	7.4	6.0	11.2	SSW
SW	5.6	5.2	5.1	4.8	6.0	7.7	8.6	8.4	7.5	8.5	5.2	5.4	6.5	SW
WSW	5.4	5.2	4.1	3.6	3.9	3.4	4.0	4.6	4.7	6.8	5.4	5.4	4.7	WSW
W	11.3	11.3	8.7	7.3	5.2	4.9	5.4	7.4	7.5	8.8	8.9	9.7	8.0	W
WNW	12.7	12.3	10.7	9.0	5.9	4.8	5.3	6.9	7.6	7.9	8.8	10.8	8.6	WNW
NW	10.5	10.9	9.5	9.2	6.3	5.2	4.9	5.5	7.1	6.8	9.4	11.8	8.1	NW
NNW	8.3	8.5	8.5	8.6	6.0	4.1	3.6	4.1	6.1	6.3	7.7	9.0	6.7	NNW
Calm	2.7	3.1	2.3	2.3	2.5	3.2	3.4	3.4	3.6	3.1	2.5	3.0	2.9	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMÈTRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	19.7	20.7	21.6	20.4	19.8	17.4	14.0	15.0	14.7	18.5	19.1	17.6	18.2	N
NNE	18.3	18.7	19.4	18.2	16.9	15.9	13.4	13.4	14.1	15.7	16.2	15.8	16.3	NNE
NE	15.2	17.4	16.9	15.4	15.2	14.1	11.8	12.7	13.2	13.7	14.3	14.4	14.5	NE
ENE	16.2	19.0	17.0	17.8	16.5	13.4	11.2	14.0	11.6	13.2	16.0	16.2	15.2	ENE
E	20.2	21.2	18.5	21.1	16.3	15.5	12.8	13.2	13.8	14.9	18.8	19.7	17.2	E
ESE	23.1	25.0	24.8	21.9	18.7	17.7	15.9	14.0	15.1	20.3	18.7	24.0	19.9	ESE
SE	19.6	19.8	21.9	19.5	18.0	16.4	14.7	13.8	15.2	17.2	19.3	21.6	18.1	SE
SSE	20.4	20.2	19.4	18.6	18.1	16.5	15.1	14.4	16.0	17.5	18.9	21.1	18.0	SSE
S	20.6	20.6	20.1	18.7	18.9	18.5	17.2	17.1	17.8	18.1	19.6	20.0	18.9	S
SSW	23.3	21.3	23.2	21.9	22.0	21.3	20.3	18.8	19.9	19.1	21.8	21.2	21.2	SSW
SW	21.3	19.9	20.1	19.7	19.1	18.1	17.2	16.8	17.6	18.5	18.8	20.6	19.0	SW
WSW	17.9	18.2	17.7	16.5	16.5	15.1	14.6	13.9	14.5	16.3	16.8	19.5	16.5	WSW
W	21.2	19.7	20.1	17.8	17.7	15.3	14.3	13.6	13.7	16.7	18.2	20.7	17.4	W
WNW	22.5	20.6	22.5	21.6	20.4	17.5	15.2	15.4	16.1	18.1	19.6	22.6	19.3	WNW
NW	21.0	20.7	22.1	19.7	19.3	17.7	15.4	15.8	16.9	18.4	19.9	21.6	19.0	NW
NNW	21.1	20.9	23.5	20.8	20.6	17.9	15.2	15.0	16.0	18.0	19.8	20.2	19.1	NNW
All Directions / Toutes directions	20.2	19.7	20.7	19.2	18.5	17.3	15.9	15.4	15.7	17.2	18.5	19.8	18.2	
Maximum Hourly Speed / Vitesse horaire maximale	80 SSW	89 ESE	77 SSW	71 E	64 SSW	64 N	79 SE	51 SSW	64 SSW	68 SE	69 SSE	85 ESE	89 ESE	
Maximum Gust Speed / Vitesse maximale des rafales	117 SSE	127 SW	126 SW	111 E	92 SSE	97 N	130 SSE	85 SSE	93 SSW	109 SE	111 SSW	132 SE	132 SE	

Height of anemometer 10.1 m hauteur de l'anémomètre

STATION INFORMATION

Located at the airport 30 km north, northeast of the city of Halifax. The tower is situated 610 m east of the south end of the terminal building. The land in the immediate areas is flat but approximately 915 m away, the land becomes rolling. From July 1960 to October 28, 1960 the cups were at a height of 5.5 m. From October 28, 1960 to November 16, 1970 they where at 8.5 m. From November 16, 1970 to present, height has been standard 10.1 m.

DONNEES RELATIVES À LA STATION

Situé à l'aéroport, à 30 km au nord/nord-est de la ville d'Halifax. Le mât es à 610 m à l'est de l'extrémité sud du terminal. Dans la région immédiate, le terrain est plat mais il devient vallonné à 915 m environ de là. De juillet au 28 octobre 1960, les coupelles étaient à une hauteur de 5.5 m. Du 28 octobre 1960 au 16 novembre 1970, elles étaient à une hauteur de 8.5 m; depuis le 16 novembre 1970, elles sont placées à la hauteur standard de 10.1 m.

Wind Data for the Shearwater Airport

SHEARWATER A N.S.

PERIOD 1955-80 PERIODE

Lat. 44°38'N Long. 063°30'W

Elevation 51 m Altitude

PERCENTAGE FREQUENCY — FRÉQUENCE EN %

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	8.1	8.1	10.1	9.9	7.4	5.2	3.0	3.6	6.5	7.5	7.4	7.7	7.1	N
NNE	4.2	4.2	5.9	4.8	3.6	3.2	1.9	2.4	4.3	4.2	4.6	4.4	4.0	NNE
NE	3.5	3.2	3.5	3.2	2.3	1.8	1.3	1.9	3.0	3.0	4.2	4.1	2.9	NE
ENE	4.0	3.3	4.2	3.6	3.1	2.1	1.6	2.3	2.7	2.8	3.6	3.2	3.0	ENE
E	4.4	4.6	5.5	6.6	8.5	6.8	4.4	3.4	3.3	3.6	4.1	3.7	4.9	E
ESE	2.2	2.9	3.3	3.8	5.0	5.0	3.2	2.8	2.9	2.5	2.6	2.4	3.2	ESE
SE	1.6	1.6	2.2	2.9	3.2	3.2	2.8	2.4	2.2	2.0	2.6	2.0	2.4	SE
SSE	2.3	2.4	2.8	4.3	5.8	6.4	7.1	4.8	3.7	3.6	3.5	2.8	4.1	SSE
S	3.4	4.4	6.0	7.1	11.0	13.3	16.6	12.9	8.4	7.1	5.8	4.8	8.4	S
SSW	4.1	4.1	4.1	5.2	7.4	10.1	11.3	9.8	8.4	6.2	5.4	4.1	6.7	SSW
SW	4.8	4.5	4.7	6.2	7.8	10.3	11.3	11.7	9.4	7.5	5.3	4.5	7.3	SW
WSW	5.7	7.0	6.1	5.9	6.7	8.4	8.7	9.3	8.3	9.9	7.4	6.5	7.5	WSW
W	10.6	10.1	8.6	7.0	5.2	4.8	5.0	6.5	6.9	9.0	10.4	11.1	8.0	W
WNW	14.0	13.4	10.5	8.7	6.0	4.3	4.8	6.7	8.1	9.4	10.9	12.6	9.1	WNW
NW	12.4	11.3	9.1	7.7	4.9	4.2	4.1	6.2	8.1	7.9	9.2	12.4	8.1	NW
NNW	11.2	10.6	9.8	9.0	6.6	4.4	4.3	5.0	7.8	7.5	8.4	9.6	7.9	NNW
Calm	3.5	4.3	3.6	4.1	5.5	6.5	8.6	8.3	6.0	5.4	4.6	4.1	5.4	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMETRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	20.0	20.9	24.0	21.8	22.1	19.5	14.6	14.6	16.9	18.1	19.4	18.5	19.2	N
NNE	20.6	21.6	23.9	22.4	20.5	19.3	15.1	16.2	17.7	19.1	20.8	20.2	19.8	NNE
NE	17.4	18.9	19.6	19.6	14.8	14.4	12.7	14.2	15.0	16.3	18.4	17.9	16.6	NE
ENE	24.5	23.1	24.2	24.0	19.4	17.2	13.6	15.7	16.7	18.5	21.8	18.8	19.8	ENE
E	27.2	28.8	24.5	23.1	19.0	17.4	15.2	15.4	15.2	18.7	22.4	25.4	21.0	E
ESE	26.9	24.7	24.3	19.4	16.0	14.7	12.7	13.1	17.8	20.8	21.8	27.7	20.0	ESE
SE	23.1	21.1	18.0	17.4	12.4	12.0	11.3	11.4	16.0	20.3	20.8	25.5	17.4	SE
SSE	24.1	21.3	17.7	17.2	15.4	13.8	13.5	13.2	16.4	20.0	22.3	25.3	18.4	SSE
S	21.8	20.2	19.6	17.3	16.4	15.1	14.0	14.3	16.3	18.0	21.0	21.3	17.9	S
SSW	23.9	21.2	21.2	20.1	18.0	16.8	15.3	15.4	17.8	19.0	21.9	21.9	19.4	SSW
SW	22.2	21.8	19.3	19.1	18.3	16.8	14.7	14.4	17.5	17.3	19.5	20.4	18.4	SW
WSW	19.2	18.5	20.2	16.7	16.8	15.1	13.1	13.3	15.0	16.3	18.3	20.9	17.0	WSW
W	21.0	19.8	19.5	16.9	15.3	12.8	11.6	12.5	13.9	16.8	18.7	21.6	16.7	W
WNW	22.8	21.6	22.9	20.3	18.7	16.1	13.2	13.6	15.6	17.9	20.6	22.9	18.9	WNW
NW	19.9	18.6	19.0	17.7	17.8	15.2	12.7	13.4	14.4	15.9	17.5	19.5	16.8	NW
NNW	20.7	19.1	22.9	19.9	19.8	16.9	14.2	13.9	14.9	16.7	17.4	17.7	17.8	NNW
All Directions / Toutes directions	20.9	19.9	20.8	18.8	16.8	14.8	12.7	12.9	15.0	16.7	18.8	20.1	17.4	

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL
Maximum Hourly Speed / Vitesse horaire maximale	77 SVL	97 E	77 SVL	85 ENE	72 E	77 N	87 SSE	60 ENE	97 SVL	80 ENE	89 SSE	89 SVL	97 SVL
Maximum Gust Speed / Vitesse maximale des rafales	127 SSW	146 SSW	148 SW	122 ENE	106 W	111 NNW	114 SSW	84 SW	126 NNE	132 SSW	121 ENE	130 SE	148 SW

Height of anemometer 10.1 m hauteur de l'anémometre

STATION INFORMATION

Located on the east coast of Halifax Harbour, 1.5 km east of McNab Island. Surrounding country consists of rolling hills, tree covered with numerous lakes and ponds. The anemometer tower is located on the airfield clear of all obstructions.

DONNÉES RELATIVES À LA STATION

L'aéroport se trouve sur la côte est du port de Halifax, à 1.5 km à l'est de l'île McNab. On trouve dans les environs des collines ondulées couvertes d'arbres et bon nombre de lacs et d'étangs. La tour de l'anémomètre s'élève sur le terrain d'aviation dans un espace tout à fait découvert

APPENDIX "G"

COMMUNICATION FROM
DARTMOUTH LAKES ADVISORY BOARD

Nova Scotia

Department of Transportation and Communications

PO Box 186
Halifax, Nova Scotia
B3J 2N2

Our file no:

March 19, 1991

Dr. Sally Walker
P.Lane & Associates Limited
5439 Cogswell Street
Halifax, Nova Scotia

Dear Dr. Walker:

Re: Highway 107 - Environmental Assessment Study

Correspondence dated September 13, 1989 from the Dartmouth Lakes Advisory Board was sent to Mr. Ken O'Brien following a briefing on the plans for Highway 107 from Burnside Drive to Highway 118.

The briefing and subsequent discussions produced several recommendations. One recommendation specifically requested that a Site Committee be formed similar to the Highway 107 and Highway 118 Construction Site Committee. This committee should be set up with the Nova Scotia Department of Transportation and Communications, Dartmouth Lakes Advisory Board, City of Dartmouth, Nova Scotia Department of the Environment and the General Contractor to monitor the environmental protection measures and concerns during construction.

In a telephone conversation with Mr. Bob Spares, Regional Construction Engineer with this department, I was informed that the Highways 107 and 118 Construction Site Committee was composed of at least the following:

1. Federal and Provincial Departments of the Environment
2. Department of Fisheries
3. City of Dartmouth - Mark Bernard
4. Dartmouth Lakes Advisory Board - Audrey Manzer
5. N.S. Department of Transportation -
   Resident Engineer, Don Feeney
6. General Contractor

The meetings held by this committee were of an informal nature and were held on site "off and on" throughout construction. Minutes were not kept for the meetings. Mr. Spares did not know if pre-construction meetings were held but felt that they would be beneficial.

If you have further questions regarding this committee either Mr. Bob Spares at 424-5328 or Mr. Don Feeney at 865-1049 of N.S. Department of Transportation could be contacted.

Yours truly,

Greg G. Vail, P.Eng.
Planning Design Engineer

GGV/sem

cc: Ken O'Brien
Assistant Director of Planning

APPENDIX "H"

CONTINGENCY PLAN REFERENCES

Source:

Atlantic Region Contingency Plan
for Spills of Oil
and Other Hazardous Materials
Conservation and Protection
Environment Canada
Atlantic Region
November 1989

LEAD AGENCIES IN RESPONDING TO A SPILL

Depending on the source of a spill of oil or other hazardous materials, specific organizations within government are expected to assume the role of lead agency to ensure that appropriate clean-up measures are taken and that the environment is adequately protected.

Provincial Environment Departments assume the role of lead agency in situations where a spill emanates from a land-based facility under provincial jurisdiction.

Canadian Coast Guard assumes the role of lead agency during ship spills and drill rig spills when the rig is not in a drilling mode. CCG is also lead agency during marine spills which threaten to cross international boundaries. Coast Guard/Canada Ports agreements designate Canada Ports Corporation (CPC) as the lead agency for ship spills and drill rig spills in ports under CPC administration.

The Department of Energy, Mines and Resources (COGLA) assumes the role of lead agency when a spill emanates from an offshore drilling exploration or production operation in the Maritimes.

The Canada-Newfoundland Offshore Petroleum Board (CNOPB) assumes the role of lead agency for an offshore exploration or production spill in Newfoundland and Labrador.

Environmental Protection, Conservation and Protection, Environment Canada assumes the role of lead agency where the source of a spill is unidentified (i.e. a mystery spill) or when a spill emanates from a federal facility (e.g. federal government department or Crown corporation) or impacts waters frequented by fish (in situations exclusive of those where the Province, CCG, CNOPB or COGLA assume the lead).

ESCALATION OF RESPONSE TO AN ENVIRONMENTAL EMERGENCY

The response to an environmental emergency may come from one or more organizations, depending on the source, magnitude, location and type of material spilled. The cleanup efforts may escalate from a local response to an international response as shown below.

The Polluter (ship, offshore or shore facility) may successfully contain and cleanup a minor spill utilizing its own resources.

A Local Cooperative may assist in the cleanup of a spill caused by one of its members by combining the entire equipment inventory and expertise of the participants.

The Provinces may become involved to varying degrees, providing assistance to the polluter or assuming responsibility for the entire response.

The Federal Government in turn may become involved to varying degrees, providing assistance and monitoring the response to assuming responsibility for the containment and cleanup operation.

An International Response effort may be required in cases where spilled materials cross or threaten to cross international boundaries.

CLASSIFICATION OF ENVIRONMENTAL EMERGENCIES

A spill is the uncontrolled release into the environment of a pollutant, including oil or other hazardous materials. The type of response to a spill is dependent on the classification of the spill incident. Classifying spills in relation to their size is always arbitrary and highly subjective. It should be recognized that any incident may be or become "major" if one or more of the following conditions are met:

- danger to human life;
- large amount of pollutant spilled;
- potential health hazard (e.g. spill in vicinity of water intakes);
- fire hazard;
- damage to valuable property;
- damage to natural resources;
- inability of local forces to deal with the incident;
- possibility of pollutant crossing international boundary;
- hazardous materials spill.

A minor incident can be controlled and cleaned up readily by the polluter and has little significant effect on natural resources, the environment and public property.

A moderate incident generally requires additional resources to effect a cleanup and the spilled material may pose a potential serious threat to natural resources, the environment and public property and usually generates public concern.

A major incident involves large resources to effect a cleanup, a spill which is out of control or an incident involving boundary waters or one which seriously affects natural resources, the environment or public property, and usually generates a significant amount of public concern.

NOTIFICATION AND ALERTING PROCEDURES

Spill reports or pollution complaints, received by any REET member in the Atlantic Region are passed on immediately to the Coast Guard Traffic Center (CCGTC) (Maritimes 1-800-565-1633 number or 902-426-6030, Newfoundland 709-772-2083). The EP Environmental Emergency Division is informed of the incident by CCGTC and if the scope of the emergency warrants notifies the appropriate REET members to ensure that a response to the incident is initiated

The caller should ensure that as much information as possible is included in the notification and in particular the following:

-- time at observation of spill;
-- reported by;
-- probable sources of the spill;
-- probable time of spill;
-- nature of material spilled;
-- probable volume of spill;
-- probable duration of spill;
-- area affected;
-- mobility of spill;
-- weather, water or geographic conditions;
-- action being taken to contain and/or control the spill;
-- personnel at the scene of the spill;
-- resources threatened (e. g., water supply, bird colony, fish kills, etc.);
-- other agencies contacted;
-- other pertinent information.

SPILL DISCOVERY AND NOTIFICATION

Canadian Coast Guard Traffic Center,
Maritimes (902) 426-6030/1-800-565-1633;
Newfoundland (709) 772-2083 who will
in turn notify specific organizations including:

Environmental Protection
Maritimes (902) 426-6200 (24-hr);
Newfoundland (709) 772-5488

Who will in turn contact the other
REET organizations as required.

→ APPROPRIATE EP PERSONNEL

→ ATLANTIC PETROLEUM ASSOCIATION OFFSHORE OPERATORS

- for incidents where a spill originates from a petroleum industry facility or where assistance is required from the oil industry equipment inventory

→ CANADIAN CHEMICAL PRODUCERS' ASSOCIATION / PROPANE GAS ASSOCIATION AND CANUTEC

- for incidents where technical data and expertise on pollution and handling of hazardous materials is required.

→ CANADIAN COAST GUARD (MARITIME AND NFLD. REGION)

- For spills resulting from marine activities
- For spills which may cross international boundaries

→ IJC REGIONAL OFFICE

- for information purposes when spill incidents occur in international waters.

→ NATIONAL HEADQUARTERS - NATIONAL ENVIRONMENTAL EMERGENCY CENTRE

- For all cases, notification will be done by telephone, telex or in writing, depending on the severity of the spill incident

→ OTHER FEDERAL GOVERNMENT DEPARTMENTS AND BOARDS

- in the event the spill originates from a federal facility, the appropriate department is alerted. If the spill originates from any drilling activity related to offshore hydrocarbon exploration or production. COGLA or CNOPB will be advised.

→ OTHER REET MEMBERS

- For instances when specific expertise and information is required on equipment, logistics, safety and environmental sensitivities, etc.

→ PROVINCIAL ENVIRONMENT DEPARTMENTS

- in all cases.

→ PROVINCIAL EMERGENCY MEASURE ORGANIZATION

- For instances where danger to life and property is a concern.

→ EMERGENCY PREPAREDNESS CANADA

- For instances where danger to life and property is a concern or situations where DND resources are required.

Transport Canada - Transport of Dangerous Goods (TDG)

TDG inspectors are responsible for the enforcement of the Transport of Dangerous Goods Regulations as they apply to land, water and air transport. They maintain a 24-hour call-out system and provide investigations during transport emergencies involving dangerous goods.

Atlantic Region 24-hour contact number: 902-458-9023

Contacts: G. Hepworth
Regional Manager
Transport of Dangerous Goods Branch
Transport Canada
5670 Spring Garden Road
7th Floor
Halifax, Nova Scotia
B3J 1H6

Phone: 902-426-9351 (O) (regular office hours)
902-835-6617 (H)
613-996-6666 (after hours) CANUTEC

R. Smith
Inspector
Transport of Dangerous Goods Branch
Transport Canada
5670 Spring Garden Road, 7th Floor
Halifax, Nova Scotia
B3J 1H6

Phone: 902-426-9461 (O)
902-835-6442 (H)

Contacts: C. Tremblay, Inspector
Transport of Dangerous Goods Branch
Transport Canada
5670 Spring Garden Road
7th Floor
Halifax, Nova Scotia
B3J 1H6

Phone: 902-426-2370 (O)
902-864-1807 (H)

R. Putnam, Inspector
Transport of Dangerous Goods Branch
Transport Canada
5670 Spring Garden Road, 7th Floor
Halifax, Nova Scotia
B3J 1H6

Phone: 902-426-6532 (O)
902-876-7335 (H)

Provincial Environmental Departments (NBMAE) (NSDOE) (NDEL) (PEI DCAE)

The Provincial environment departments act as lead agencies for spills that fall under provincial jurisdiction and are responsible for the designation of disposal sites and disposal procedures and, in addition, are resource agencies for manpower, surveillance, cleanup, and environmental advice. They are normally responsible for providing provincial environmental advice and, where appropriate, soliciting input to REET from other provincial agencies such as fisheries, health, and mines and energy.

Nova Scotia Department of the Environment (NSDOE)

Contact: H. Windsor
A/Director
Field Services Division
Nova Scotia Department of the Environment
Box 2107
Halifax, Nova Scotia

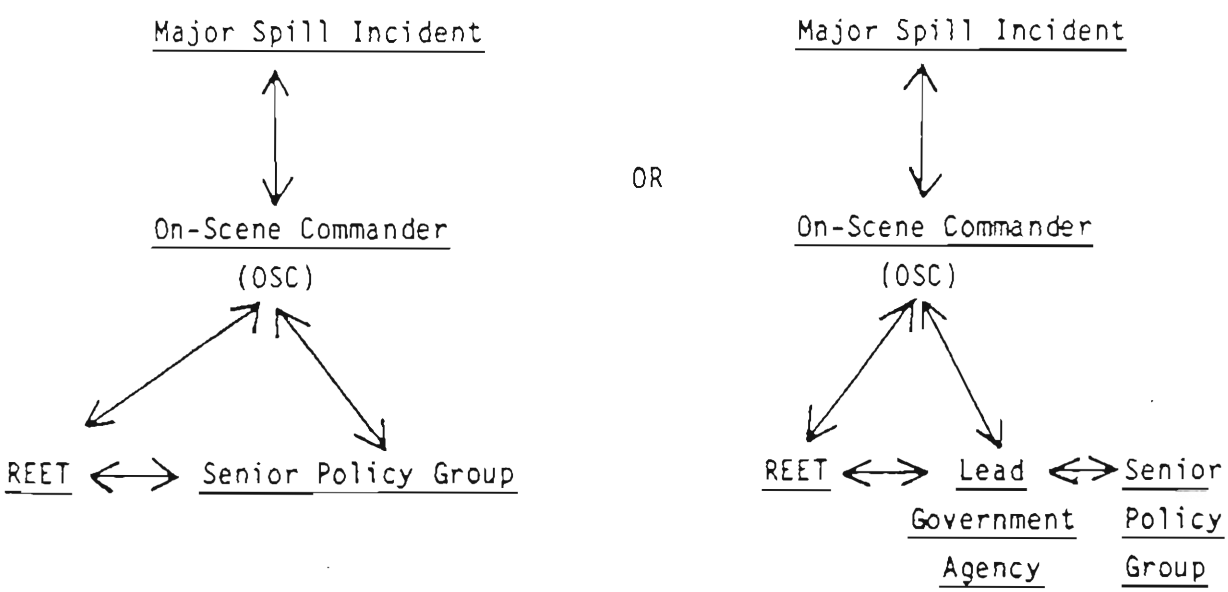
Phone: 902-424-5300 (O)
902-466-5436 (H)

ROLE OF REGIONAL ENVIRONMENTAL EMERGENCIES TEAM (REET)

I. MANAGEMENT MODE* - (Meets annually)

- Discussion of response strategies
- Forum for exchange of information on:
    - contingency planning
    - countermeasures equipment
    - general response methods
    - study needs

II. RESPONSE MODES - (During emergencies only)



MAJOR RESPONSE ROLES AND ACTIVITIES

By REET:

- Reporting, alerting, call-out, updating;
- Exchange of information and observers;
- Assistance in securing air/water monitoring equipment;
- Provision of gas plume dispersion information, spill trajectories, and weather/ice forecasts via AES;
- Advice relative to environmental monitoring needs and program design;
- Identification of resources at risk;
- Shoreline reconnaissance;
- Photographic/video coverage of containment and cleanup operations;
- Current and oceanographic factors via DFO;
- Advice and recommendations on containment and cleanup techniques, equipment and priorities;
- Identification of temporary and permanent sites for disposal of oil and oily debris via the appropriate provincial environment department;
- Requests for technical support from OSC's.

From REET to OSC, Senior Policy Group and/or Lead Agency:

- Recommendations on environmental monitoring program, polluter and government initiatives;
- Briefing narratives on environmental issues prepared for REET member agencies;
- Information on resources at risk;
- Advice on remote sensing options;
- Dispersant use recommendations;
- Coordination of input and advice from federal and provincial agencies in order to recommend environmental protection and cleanup priorities to lead agency or OSC;
- Assist lead agency with media briefings on environmental matters;
- Implemention of sample collection and analysis programs in support of OSC/lead agency activities, and to verify and augment REET information bases and advice.
- Recommendations on longer-term study needs identified by research scientists in government and private sector;
- Observers, as required, for monitoring containment/cleanup and environmental sampling programs undertaken by polluter.
- Recommendations and senior policy advice to OSC or lead agency on matters associated with broader federal and provincial interests;
- Forum for resolution of conflicts which from time to time may arise;
- Identification and approval of major agency resource commitments.

ABBREVIATED CONTACT LIST

Lead Agencies Within REET

Canada-Newfoundland Offshore Petroleum Board
(24-hr contact number: 709-778-1400)

	Office	Home
Primary: J.E. McComisky	709-778-1403	709-834-9857
Secondary: B. Jonasson	709-778-1413	709-739-9541

Environmental Protection, Environment Canada

(a) Maritimes: (24-hr EP phone number: 902-426-6200)

	Office	Home
- R. J. Percy, REEC, EED	902-426-2576	902-889-2260
- W. S. Dewis, Coord. Biol., EED	902-426-6318	902-463-6593
- R. G. Simmons, Manager, Ops. Center., EED	902-426-6317	902-435-7760
- G. Lindsay, Dist. Dir., N. B.	506-452-3286	506-450-3215
- L. Hildebrand, A/Dist. Dir., P.E.I.	902-566-7042	902-368-2227
- I. Travers, A/Dist. Dir., N.S.	902-426-7606	902-435-1587
- EED Response Vehicle (Maritimes)	YJ7-2535 (mobile phone)	
- EED Response Vehicle (Maritimes)	902-456-3699 (cellular phone)	

Nova Scotia Department of the Environment

		Office	Home
Primary:	R. Langdon	902-424-5300	902-798-4053
	C. Oldreive	902-424-5300	902-434-8947
Alternate:	H. Windsor, A/Director	902-424-5300	902-466-5436

		Office	Home

Petroleum Industry:

(a) Atlantic Petroleum Association

		Office	Home
Primary:	Lester G. Stewart		902-457-1289

(b) Canadian Petroleum Association - Offshore

		Office	Home
Primary:	K. A. Oakley	709-726-7270	709-753-3859
Alternate:	L. E. Taylor	902-421-1159	

Transport Canada - Canadian Coast Guard (24-hr phone number: 1-800-565-1633 (toll-free)

(a) Maritimes:

		Office	Home
Primary:	K. Emmerson, RMEO	902-426-3699	902-434-0634
Alternate:	B. MacMillan, REOO	902-426-3699	902-466-5098

Transport Canada - Transport of Dangerous Goods Branch (24-hr phone number: (1-613-996-6666) CANUTEC

		Office	Home
Primary:	G. Hepworth, Reg. Mgr.	902-426-9351	902-835-6617
	R. Smith, Inspector	902-426-9461	902-835-6442

Alternate: Transport Canada Dangerous Goods Center, CANUTEC, Ottawa, Ontario 613-996-6666 (24-hr)

	Office	Home

Advisory and Support Agencies
Within REET

1. Canadian Chemical Producers Assoc. (TEAP)

	Office	Home
Primary: B. Goodman (Dalhousie, N.B.)	506-684-2831	506-684-5956

TEAP may be contacted by calling CANUTEC at 1-613-996-6666 (24-hour).

2. Canadian National Railways

	Office	Home
Primary: S. Oickle	506-853-2634	506-384-8522

3. Atlantic Marine

	Office	Home
Primary: G. Keeping	506-858-3708	506-384-5538

4. Canadian Atlantic Railways (24-hr contact number: 506-635-2200)

Primary: B. D. Wilson 506-635-2200 (24-hour)

5. Canada Ports Corporation

(a) Halifax, N. S.

	Office	Home
Primary: C. Ball, Manager	902-426-3642	902-435-0317
Alternate: G. Malec, Pollution Officer	902-426-3115	902-434-1269

6. National Transportation Agency

Primary: D. M. Mollins	506-388-7040	709-532-9472

7. Energy, Mines and Resources

(a) Atlantic Geoscience Centre

Primary: Dr. D. Ross	902-426-2367	902-835-6579

(b) Canada Oil and Gas Lands Administration (24-hr N.S. contact number: 902-453-2640)

Primary: R. H. Bailey (NS)	902-426-8570	902-469-2910
Alternate: S. Gill (Ottawa)	613-993-3760	613-832-1661
	Office	Home

8. Emergency Preparedness Canada

(a) Nova Scotia

Primary: R. B. O'Sullivan	902-426-2082	902-435-5074

9. Environment Canada

(a) Atmospheric Environment Service

Primary:	R. Nelis AES Mobile	902-426-9131	902-469-1472
Response Unit		902-421-1234	(ask for Mobile YJ4-9063)

(b) Canadian Wildlife Service

Primary:	B. Johnson (Sackville, N. B.)	506-536-3025	506-536-3150
Alternate:	G. H. Finney	506-536-3025 Office	506-536-1938 Home

(c) Parks Canada

Primary:	L. Brown	902-426-2063	

(d) Inland Waters/Lands

Primary:	D. Cullen	506-857-6606	506-855-4825

10. Fisheries and Oceans

(a) Atlantic Fisheries Service (Scotia-Fundy)

Primary:	R. Sweeney	902-426-2253	902-883-9774
Alternate:	B. Jollimore	902-426-2549	902-876-7556

11. Labour Canada (24-hr contact number: 506-857-6644)

Primary:	G. Mitton	506-857-6640	506-858-0868

12. National Defence

(a) MARCOM (24-hr contact number: 902-427-6359)

Primary:	Lt. Col. E. L. Schrader	902-427-6356	902-835-1422

(b) Queens Harbour Master (24-hr contact number: 902-427-3199)

Primary:	Cmdr. J.S.H. Gadd	902-427-3199

13. Provincial Emergency Measures Organizations

Nova Scotia

Primary:	M. R. Lester, Director	902-424-5620	902-889-3291

14. Public Works Canada

Primary:	J. R. Johnson, Manager, Safety	902-426-6300	902-835-1341

15. Royal Canadian Mounted Police

(a) Nova Scotia

Primary:	902-426-7766 (24-hr)