A FEASIBILITY ANALYSIS OF DEVELOPING GARSON LAKE AS A REGIONAL PARK FOR THE REGIONAL MUNICIPALITY OF SUDBURY

By

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A Practicum Submitted in Partial Fulfillment

of the Requirements for the Degree,

Master of Natural Resources Management

Natural Resources Institute
University of Manitoba
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May, 1982

ABSTRACT

The practicum was initiated in response to a request to the Nickel District Conservation Authority by the Town of Nickel Centre to conduct a feasibility study pertaining to the development of Garson Lake as a multiple use recreation park. The proposed park was intended to serve the Regional Municipality of Sudbury, and areas beyond. It was expected that the development would benefit the Town of Nickel Centre by providing increased recreational opportunities as well as by stimulating the local economy.

An interdisciplinary approach was used to assess costs and benefits resulting from developing the proposed Garson Lake Park. Four areas in particular were examined with respect to developing the park: (1) Provincial Regulations Regarding Park Development; (2) Biophysical Aspects; (3) Socio-economic Benefit-Cost Analysis; and (4) Regional Land Use Interrelationships. A review of provincial policies regarding park development by Conservation Authorities was conducted to determine what limitations, if any, were present under existing legislation. Paramount to the outcome of the study was the biophysical analysis which incorporated a variety of methods to determine carrying capacity of the lake ecosystem. Although water quality was determined to be safe for contact recreation, shoreline constraints, such as steep slopes and swamps placed severe restrictions on carrying capacity. Extensive motorized boating and fishing would not be suitable for Garson Lake due to its extremely shallow nature and small size.

A benefit-cost analysis was conducted to determine if the park should be developed in retrospect of the low volume carrying

capacity. The benefit-cost analysis indicated that development of Garson Lake park was not economical in that costs outweighed benefits. Two factors were responsible for the low benefit/cost ratio; 1) a low carrying capacity reduced the expected value of benefits, and 2) high development costs due to isolation of the lake. The study also determined sufficient varied park land presently exists to meet actual demand by the residents of Nickel Centre. Local demand figures were based upon a recent study conducted by the Ontario Ministry of Culture and Recreation (Nickel District Conservation Authority, 1980).

Even if funding was made available and local demand would increase for local recreation facilities, the anticipated economic benefits to the community would be minimal. The development of a local park implies no additional revenues would be generated by those residing outside Nickel Centre. This assumption presupposes each community has local parks within close proximity to users. Economic benefits or costs which may result from the development of a large-scale project such as a park would normally be considered prior to planning of the area. Since the study determined the development would not be feasible, analysis regarding ancillary benefits and costs were not considered.

ACKNOWLEDGEMENTS

I would like to extend my sincere appreciation to the many individuals who assisted in the preparation and writing of this practicum.

I would like to extend my special thanks to my committee members: Mr. Allan Bonnis, Director of Operations, Nickel District Conservation Authority; Dr. John Gray, Professor of Economics, University of Manitoba; and Mr. David Witty, Planner - Resource Analyst, Hilderman, Feir, Witty and Associates, for their cooperation and guidance during the research process.

Many thanks are also extended to Mr. Richard Pettit for assisting with data collection; Mr. Kenton R. Starko, B.Sc. Eng., for assisting with mathematical computations; the entire staff of the Nickel District Conservation Authority and the Natural Resources Institute Staff, who were always willing to provide assitance.

Last, but certainly not least, my sincere thanks are expressed to Miss Lesley Hart and Mrs. Linda LaChance for typing the manuscript.

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CHAPTER 1.0

INTRODUCTION

> One plans not places or spaces or things. One plans experiences. The places, spaces and things take their form from the planned experience.
>
> John Simonds
> (from Wright et al., 1976)

1.1 Background

Conservation Authorities in Ontario have recognized that many areas under their jursidiction may potentially be developed into recreation sites to provide quality recreational experiences and continue to maintain primary goals of conservation and management.

Clawson (1966) has classified outdoor recreation areas into three categories, as follows:

1. User-oriented areas: The primary function of user-oriented recreation areas is to provide ready accessibility to users. Areas such as city parks and playgrounds are typical examples. Use of these areas closely correlates with free time available each day. Such areas are between several hectares and several hundred hectares and are not too demanding in terms of physical characteristics.

2. Resource-based areas are the opposite extreme. Resource-based areas possess outstanding physical resources such as mountains, sea shores, historic sites and other atttractive natural phenomenon. For most people, visits to resource-based areas involve considerable travel and expense. Typical of this group are national parks, federal wildlife refuges and privately owned resorts catering to a variety of activities.

3. Intermediate areas lie between these extremes both geographically and in terms of use. The parks must be located relatively close to users - typically

> within an hour's driving time, and should be located on the best sites available within this range. These areas are used for all-day outings and weekends and involve less travel time and expense than trips to resource-based areas. Both Provincial and Regional parks are within this category.

In Ontario, intermediate and user-oriented areas are those generally developed by Conservation Authorities, supporting a wide array of recreational opportunities including wildlife preserves, nature trails, swimming areas, picnic grounds and ski trails.

1.2 Problem Statement

Garson Lake, located in the Town of Nickel Centre within the Regional Municipality of Sudbury, is the proposed area for establishment of a regional park (Figure 1.1). The Nickel Centre Settlements Plan, Background Study (Regional Municipality of Sudbury, 1980), states the following with respect to development of Garson Lake Park:

> The Garson Lake area could fulfill in most respects the need for a large-scale Regional Park that would provide for such activities as camping, picnicking, swimming, boating, skiing, golfing, riding, nature study and wilderness enjoyment.

Although the waterbody is only 109 hectares in surface area, its proximity to eight surrounding communities, as well as the City of Sudbury, warrants the study of the Garson Lake area as a potential intermediate area park.

1.3 Study Objectives

The study will assess biophysical and socio-economic factors with the intent of arriving at recommendations concerning the feasibility of developing Garson Lake as a Regional Park.

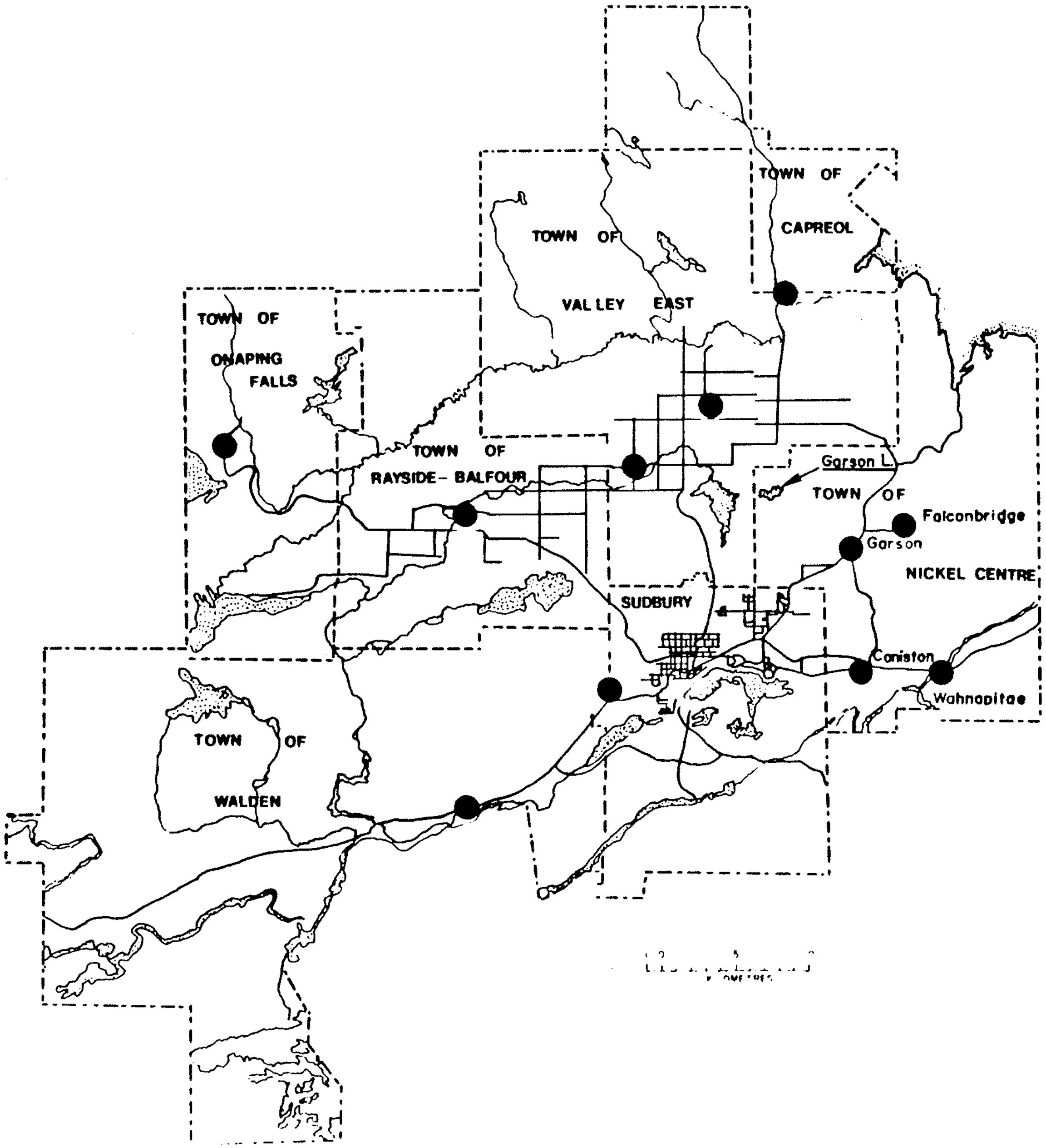
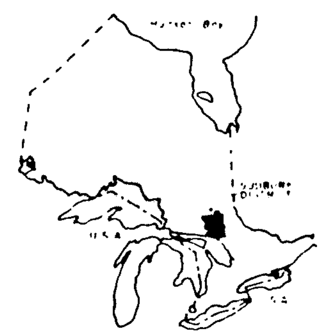


FIGURE I.I

THE REGIONAL MUNICIPALITY OF SUDBURY

SOURCE - The OFFICAL PLAN of the SUDBURY PLANNING AREA 1978



The following aspects were considered in the Garson Lake analysis (refer to Figure 2.1):

1. Provincial regulations concerning park development by Conservation Authorities.
2. The type, quantity and quality of recreational activities the natural resource base of the study area is capable of supporting.
3. Economic considerations such as the needs of the potential user group and the associated costs and benefits which may result from development.
4. Regional land use interrelationships.

1.4 Limitations of the Study

Limnological tests conducted for Garson Lake provided an estimation of water quality and were capable of indicating constraints for water contact sports, such as swimming. Several limitations exist with regard to the use of these data. Firstly, access to Garson Lake was limited due to the nature of the transmission line road, which was prone to flooding after each rainfall. Consequently, chemical and biological tests were conducted on only three occasions during the summer Secondly, no previous water quality testing had been conducted for Garson Lake, therefore limiting the results to a single summer's research. Water quality may fluctuate with time which presents a need for continual monitoring. Finally, the use of comparitor tests, described in detail in Appendix A, subject the evaluation to human error. For some tests such as phosphates and nitrogen, the precision of a field test is lower than a laboratory test.

Although the above factors reduce the accuracy of the limnological analysis, the objectives were still maintained since tests were able to indicate approximate present quality and where potential problems may exist. A detailed limnological analysis was beyond the scope of this study as this would require many man hours over several years.

A second limitation results from economic analysis of a "non price" resource, such as recreation. The Ullman-Volk method described in Chapter 2, requires visitation data from alternative parks in the District of Sudbury which provide similar recreational opportunities. Since there are no "regional" parks in the District of Sudbury which provide the range of recreational opportunities proposed for Garson Lake, provincial park data was used. Although the range of opportunities provided by provincial recreation parks are similar to those for the proposed Garson Lake park, major differences occur in terms of size and aesthetics, Garson Lake possessing less of both. Consequently, a subjective adjustment was made in order to compare Garson Lake to the District provincial parks.

Examining the potential of a park land for public recreational use implies a need for assessing public concerns. Although public concerns are best expressed through public hearings and surveys, limited time and funding resulted in the use of existing information.

1.5 Definition of Terms

Carrying Capacity: The number of people engaged in a particular recreational activity, which the ecosystem can support.

Ecosystem:	A natural complex of plant and animal populations and the particular sets of physical conditions under which they exist (Odum, 1971).
Eutrophic Lake:	Shallow lake with high primary productivity. Littoral vegetation is abundant, plankton populations are denser and blooms are characteristic. (Odum, 1971).
Epilimnion:	The surface area of the lake limited by the penetration of light and approximately equal to the zone of photosynthetic production (Odum, 1971).
Habitat:	The place where an organism lives or where one would go to find it (Odum, 1971).
Hypolimnion:	The colder non-circulating water on the bottom of the lake where photosynthesis does not occur.
Leisure Time:	Essentially time free from work or duties. Recreation takes place during leisure but not all leisure is given up to recreation (Clawson, 1966).
Limnology:	The scientific study of bodies of fresh water in all their aspects (physical, chemical, biological and geomorphological) (Odum, 1971).
Oligotrophic Lake:	Fresh water lakes, relatively young in geologic times. The water bodies are deep with Rypolumnion larger than the epilimnion, and have low primary productivity (Odum, 1971).
Recreation:	The activity or activities (including inactivity if freely chosen) engaged in during leisure time (Clawson, 1966).
Regional Park:	Intermediate recreation area designed to supply high quality recreational experience relatively close to users.
Sudbury District:	Planning area surrounding the Region of Sudbury comprised of 11,120 square kilometers, 131 townships, 3 Indian Reserves and a portion of water within Georgian Bay.

CHAPTER 2.0

METHODOLOGICAL FRAMEWORK

Chapter Two outlines the methodological framework of the Garson Lake study as well as the specific methods which were incorporated to achieve the stated objectives. In establishing a framework for the Garson Lake study, an interdisciplinary approach was used to assess the feasibility of developing the proposed regional park (Figure 2.1).

The first phase of the study was an overview of provincial policies regarding recreational development on Conservation Authority lands. The review established the extent to which Conservation Authorities may develop recreational areas.

The natural resource base of the Garson Lake area was analyzed in terms of potential development alternatives for recreational activities. Based upon the physical capability of the natural resources to support an estimated level of activity the study then focussed on the economic evaluation of development alternatives.

Economic analysis derived an approximate dollar value of benefits to Sudbury recreationists if the park would be developed, which was balanced against capital and maintenance costs.

As a final link in the framework, the surrounding communities were considered in terms of how the proposed park might affect their socio-economic structure. If the park was to be considered for development, the latter consideration would require more in depth study.

Each of the four components of the study are interrelated in that each is dependent upon the outcome of the previous section. For

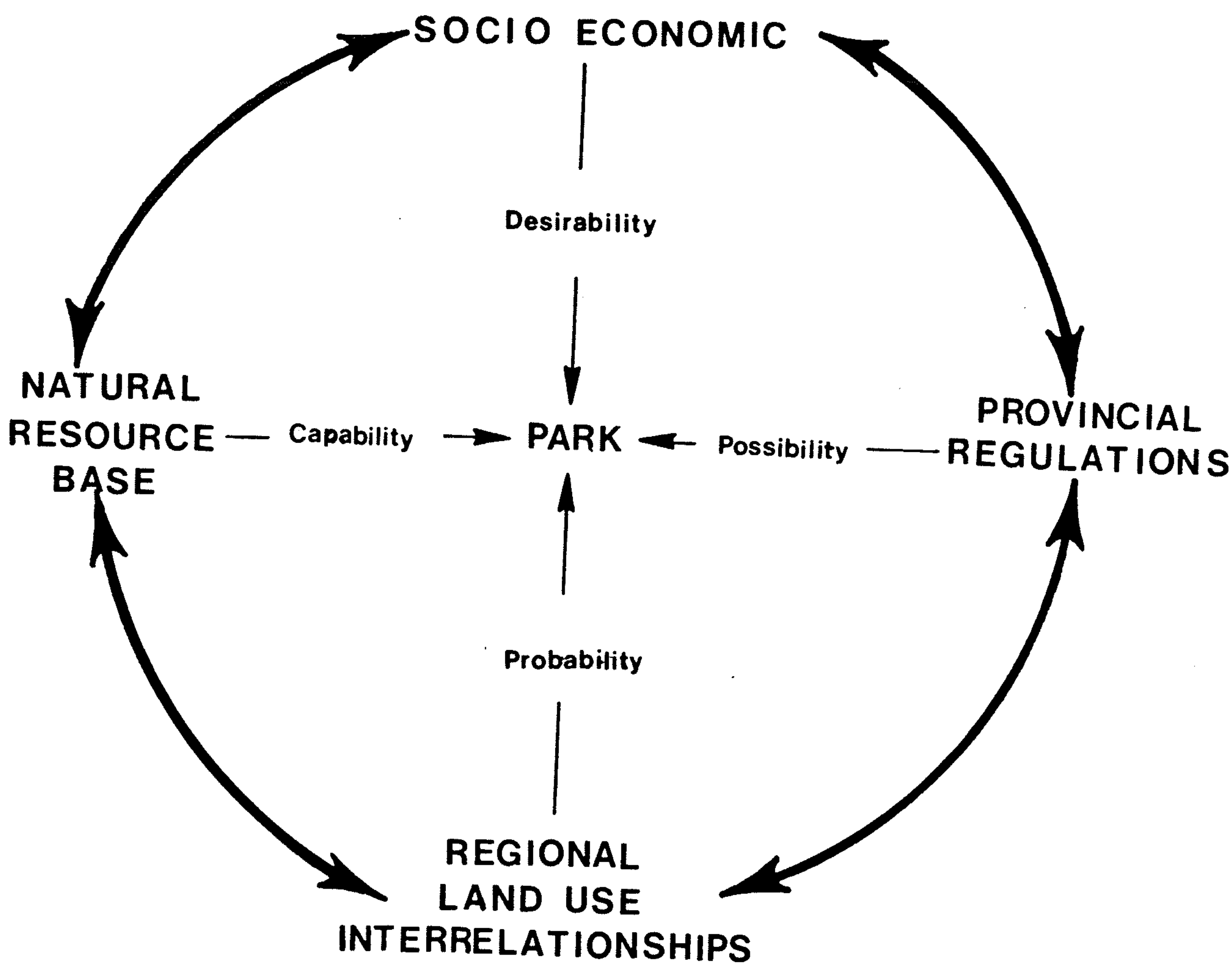


FIGURE 2.1

FRAMEWORK FOR STUDY

Source: D.R.Witty, Resource Planner, Hilderman, Feir, Witty and Associates, Personal Communication, 1981.

example, Provincial Regulations establish what is possible in terms of development. It follows then, that should provincial regulations prohibit development, the study would become redundant.

The other components were interrelated in this same manner. If the biophysical analysis determined development would not be safe, the economics of the development need not be considered. Essentially, one factor flows to the next, and should development potential be considered at any stage, this would preclude the usefulness of the next stage of investigation.

2.1 Provincial Regulations

The Nickel District Conservation Authority is under the auspices of the Ministry of Natural Resources and must follow specific regulations and procedures with respect to park development. The revised edition of Policy and Procedures Manual for Conservation Authorities, produced by the Ontario Ministry of Natural Resources (1980), outlines the policies with respect to development of parks. Policy and procedures for park development were extracted from this manual.

2.2.0 Natural Resource Base

It is the natural resource base which essentially predicates the type, quantity and quality of recreation attainable from a specific site. The intended uses and their potential effects on the ecosystem of the study area alludes to analysis of three important ecological precepts: (1) homeostasis, (2) carrying capacity and (3) limiting factors.

Homeostasis is defined as the tendency for ecological systems to resist change and to remain in a state of equilibrium (Odum, 1971). Substitution of artifical mechanisms into a natural environment may upset the balance between inputs and outputs coincident with an ecosystem. Man's intervention tends to reduce the diversity of species and habitats resulting in monocultures which are more susceptible to natural disasters (Odum, 1971).

In order to survive in a given environment, an organism must have essential materials which are necessary for growth, protection and reproduction. Each organism must be physiologically adjusted to various factors within its environment. The essential material in a "steady state" condition is a variable in amounts approaching the minimum critical level, which will tend to be the limiting factor of that organism (Odum, 1971).

Carrying capacity, in the biophysical sense, may be defined as the tolerable level of human impact on the environment without exceeding the physical capacity of the ecosystem to regenerate itself (Odum, 1971). Human involvement through implementation of artificial maintenance techniques may suport a healthier balance; however, the first step is recognition of various impacts, such as loss of vegetative cover, erosion, and diminishing food supply (Odum, 1971).

Carrying capacity, limiting factors and homeostasis can be determined by examining various components of the ecosystem which will be directly or indirectly affected by recreational activities. In order to determine the environmental limitations of establishing Garson Lake Park, biophysical analysis was conducted in the following three zones (Ontario Ministry of Natural Resources, 1980):

1. Water Resources: analysis of physical, chemical, biological and geomorphological characteristics of the lake itself as these factors relate to the recreation experience.

2. Shoreline: analysis of shoreline to determine potential wet and dry beach areas.

3. Backshore: analysis of topography, geomorphology and vegetation in terms of landscape constraints imposed upon recreational activities which are land based.

2.2.1 Water Resources

The most important recreational experience to be derived by many users of the proposed park will be in the form of water recreation. For the purposes of this study, water recreation included swimming (and associated beach activities), fishing and boating.

Swimming. Ideally, swimming areas should possess water free from harmful chemical or biological pollutants and should retain a level of dissolved oxygen capable of converting organic pollutants into stable, harmless compounds (Mattyasovsky, 1967). For swimming purposes, water temperatures should not be unpleasantly cold, preferably in a range from 20° Centigrade to 24° Centigrade during the summer (Renn, 1969).

Fishing. A wide range of physical, chemical and biological factors affect the diversity and numbers of fish. The suitability of Garson Lake for fishing was determined through limnological analysis as well as personal communications with individuals who fished Garson Lake on a regular basis. An accurate inventory of fish populations is beyond the scope of this study.

Boating. Boating is the most aggressive and space-consuming activity which may take place on the lake. Although the water quality does not affect the boating experience, it is the boating experience which may affect the water quality, and consequently may affect other recreational uses. The primary consideration for boating is the physical size and depth of the water body since overcrowding of boats will increase the likelihood of pollution as well as conflicts with other uses (Hough, Stansbury et al., 1971).

Water Quality. Water quality tests were conducted on June 15, 1981, July 13, 1981 and August 8, 1981. The test sites were chosen to represent three aspects of the water body: (1) recharge and discharge areas, (2) central lake area, and (3) shoreline (Figure 2.2).

The methods used for each test are presented in detail in Appendix A and are discussed in terms of their importance in the following sections.

Dissolved Oxygen. The concentration of dissolved oxygen (DO) is often considered to be the most important indicator of water quality (Nickel District Conservation Authority, 1980). The dissolved oxygen concentration is an important factor in determining which organisms can live in a lake as well as the lake's ability of counterbalance certain pollutants.

In stagnant water, sufficient oxygen is needed to convert organic waste materials to stable, inoffensive and harmless compounds which ultimately will become carbon dioxide and water (Renn, 1970). Some wastes containing sulfur and nitrogen compounds will utilize oxygen in amounts required to produce sulphate, nitrate or other stable sulphur and nitrogen bearing materials (Renn, 1970).

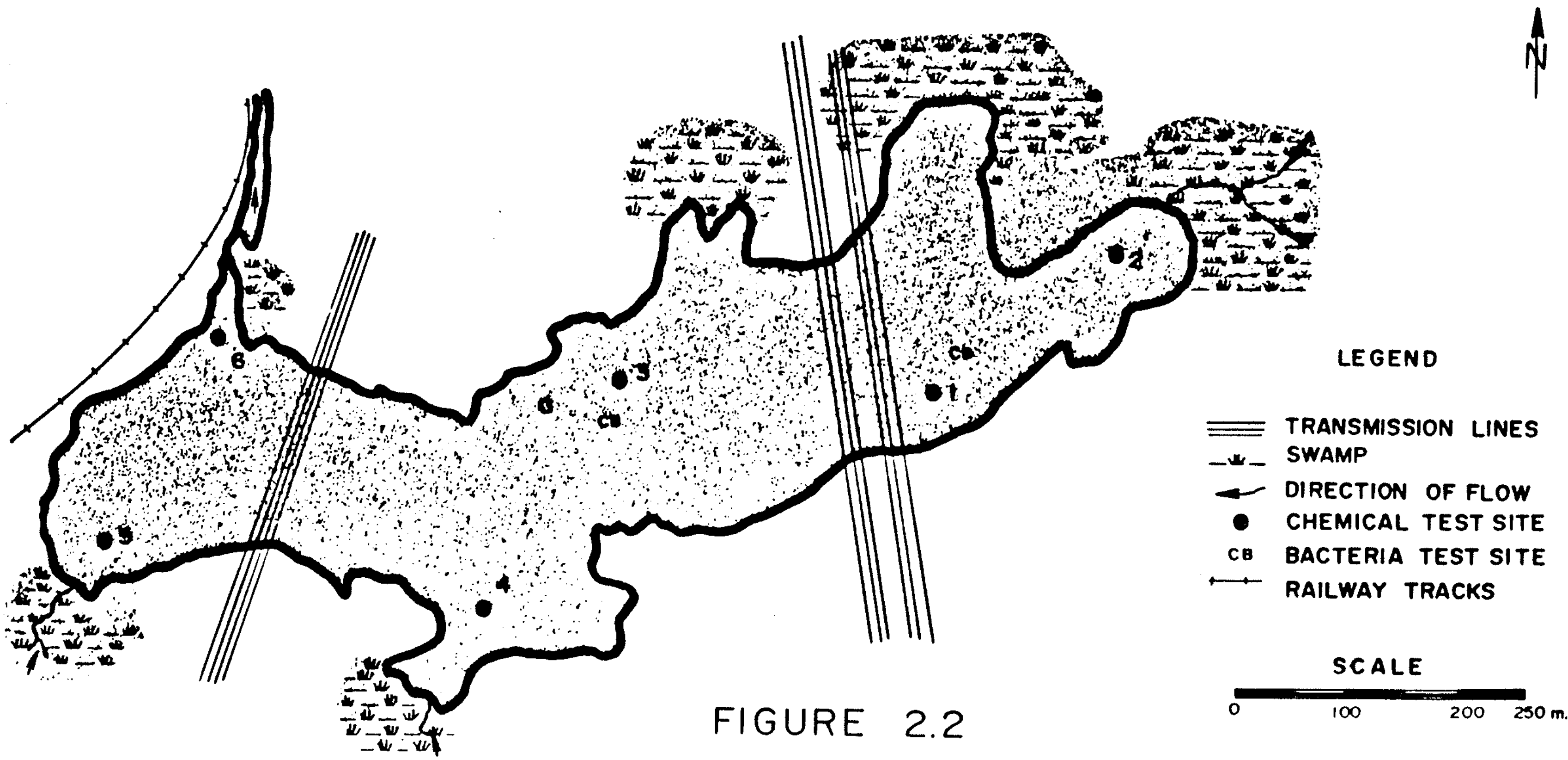


FIGURE 2.2
GARSON LAKE - TEST SITES

The dissolved oxygen concentration depends upon a number of interrelated factors, including temperature of the water, light penetration, living and dead organisms and the depth of the lake. There are two primary sources by which oxygen may enter the water: (1) directly from the atmosphere and (2) from plant photosynthesis (Cole, 1975).

Since oxygen dissolves best in water at temperatures just above freezing, colder waters tend to have higher concentrations of oxygen. Light penetration is important to sustain photosynthetic production, therefore depth and transparency of the lake are important factors in oxygen production (Cole, 1975). Oxygen and carbon dioxide usually behave reciprocally since oxygen is consumed and carbon dioxide is released during the decomposition of plant and animal matter (Odum, 1971).

According to the Ontario Ministry of the Environment (1978), dissolved oxygen levels should never fall below the minimum values shown in Table 2.1.

TABLE 2.1

Minimum Allowable Values for Dissolved Oxygen

Temperature °C	Cold Water Biota mg/l	Warm Water Biota mg/l
0	8	7
5	7	6
15	6	5
20	5	4
25	5	4

pH. The pH scale (an indicator of H^+ concentration) ranges from 0 to 14, with 7.0 being neutral. Acidic substances have values less than 7.0 and alkaline substances have values greater than 7.0 (Ruttner, 1973). The lethal effects of most acids on fish begin to appear near pH 4.5 and of most alkalis near pH 9.5 (Wetzel, 1975). Uncombined carbon dioxide, organic acids such as humic, tannic and uronic acids, mineral acids and salts of strong acids are usually the cause of acidity in natural waters (Wetzel, 1975).

Alkalinity of waters refers to the quantity and kinds of compounds present which collectively shift the pH towards neutrality. As such alkalinity is an indicator of the acid buffering capacity of the water. In the Canadian Shield the predominance of precambrian rock reduces the likelihood of a significant buffering capacity thereby making it possible for lakes in the Sudbury area to be affected adversely by acid rain (Nickel District Conservation Authority, 1980).

Ministry of the Environment (1978) standards for contact recreation state that alkalinity should not be decreased by more than 25 percent of the natural concentration. The pH of the water should not be less than 6.5 or greater than 8.5 since eye irritation may result if the water is too acidic or too alkaline.

pH levels were determined using a wide range phenolphathalein indicator solution. Alkalinity value were determined through a filtration method described in Appendix A.

Hardness. The hardness of water is governed by the concentration of calcium and magnesium salts, expressed as calcium carbonate (Wetzel, 1975). Calcium and magnesium may enter a natural water system as they pass through soil and rock containing large amounts of these elements in mineral deposits (Renn, 1970). Waters containing amounts less than 60 parts per million of calcium carbonate are considered soft, whereas those containing large concentrations are hard. Soft waters are mainly derived from the drainage of acidic igneous rocks and the very hard waters from the drainage of calcareous sediments (Renn, 1970).

Hardness of water does not impose any severe restrictions on recreational use of water unless soap is allowed to enter the ecosystem. Insoluble compounds, or curds, may be formed in hard water when soap is added to the water (Ontario, Ministry of the Environment, 1978).

TABLE 2.2

Hardness Classification
(Nickel District Conservation Authority, 1980)

Hardness Range mg/1 of C_aCO_2	Description
0-60	soft
61-120	moderately hard
121-180	hard
greater than 180	very hard

Hardness, like alkalinity, serves to buffer the influence on pH of acids. The addition of a strong acid to soft water will result in a decrease in pH (increase in acidity), whereas the effect on hard water results in only a minor shift (Beamish and Roff, 1976). The test for total hardness is elaborated upon in Appendix A.

Carbon Dioxide. Carbon dioxide is present in water as a dissolved gas. An inverse relationship generally exists between the level of carbon dioxide and dissolved oxygen since oxygen is reduced by organic wastes while carbon dioxide is produced (Renn, 1970). The rise in carbon dioxide makes it more difficult for fish to use the limited amount of oxygen present. In order to consume fresh oxygen, fish must first discharge the carbon dioxide in their blood stream which is a much slower process when there are high concentrations of carbon dioxide present (Renn, 1970). A majority of the carbon dioxide in freshwater systems occurs as equilibrium products of cabonic acid. A

smaller amount of carbon is evident in organic compounds as dissolved detrital carbon, and an even smaller amount occurs as carbon of living biota (Wetzel, 1975). The total amount of inorganic carbon in a freshwater ecosystem depends on the pH, which is governed largely by the buffering reactions of carbonic acid and the amount of bicarbonate and carbonate derived from the weathering of rocks (Wetzel, 1975). Free carbon dioxide reacts with sodium carbonate or sodium hydroxide to form sodium bicarbonate. The completion of the reaction can be detected by use of a phenolphthalein indicator reagent which is the basis of the test outlined in Appendix A.

Ammonia Nitrogen. Inorganic nitrogen may occur in water as ammonia (NH_4), nitrite (NO_2) and nitrate (NO_3). Ammonia compounds are set free in water by decomposition of protein and they undergo a bacterial oxidation to nitrite and then to nitrate. Water which has not been contaminated by human wastes generally contains only nitrate and trace amounts of ammonia (Wetzel, 1975). Ammonia is an additional source of nitrogen as a nutrient which may contribute to growth of undesirable algae overloading the natural system and causing pollution.

The Ontario Ministry of the Environment (1978) states that concentrations of ammonia (NH_4) should not exceed 0.02 mg/l for the protection of aquatic life.

Ammonia analysis was conducted using the Nessler reagent reaction as outlined in Appendix A.

Nitrate. Nitrate nitrogen is the most highly oxidized state of the element found in natural waters and is also the commonest state (Lind, 1974). Clean, natural waters rarely contain more than 0.1 parts per million of nitrate nitrogen (Renn, 1969). The presence of nitrogen compounds may be taken up by phytoplankton in a eutrophic lake, in fact it is not unusual for nitrates to disappear completely in such cases (Ruttner, 1973).

According to the Ontario Ministry of the Environment (1978), levels of nitrate should not exceed 0.05 mg/l. Test procedures are outlined in Appendix A.

Chlorides. Chloride ions are a dissolved substance commonly present in water. The distribution of chlorine in nature is so wide that it is scarcely absent anywhere (Ruttner, 1973). Chloride does not impose a direct health hazard but the water quality objective for domestic water supplies is 250 mg/l. Concentrations above 250 mg/l impart a salty taste to the water and inhibits the growth of certain aquatic plants, but is not a significant constraint on recreational use (Ontario Ministry of the Environment, 1978).

Phosphate. Phosphate is one of the least abundant nutrients in waterbodies, often being present in inconceivably small amounts which are very difficult to detect. Even though phosphorous occurs in relatively small amounts, it is a limiting factor which may cause excessive growth of algae and phytoplankton which impair the quality of the water (Ruttner, 1973).

Concentrations of phosphate ions should not exceed 0.03 mg/l in order to avoid excessive plant growth in the aquatic ecosystem; however, this test is highly dependent upon the time of year samples are taken. Since phytoplankton is capable of storing up to ten times the required amount of phosphorous, the phosphorous may appear to be absent during the summer and fall. During the winter the aquatic plants decay thereby emitting phosphorous into the lake ecosystem. As a result the spring phosphorous readings will be higher than the summer readings (Ruttner, 1973).

Summer phosphorous levels provide an indication of excess amounts present in the ecosystem which have not been stored by the phytoplankton. Test procedures are discussed in detail in Appendix A.

Temperature. Water temperature plays an important role in the diversity and distribution of organisms in a particular water body. Aerobic and anaerobic biochemical processes are also dependent upon temperature as is the level of oxygen solubility (Odum, 1971). As was mentioned earlier oxygen is an important element in the natural self-purification process and is necessary for most aquatic life.

In terms of recreational use, water temperatures should not be unpleasantly cold, preferably in a range from 20°C to 24°C during mid-summer and should never exceed 30°C as aquatic life may be endangered (Renn, 1969).

Stratification of temperatures exists in lakes which are generally over 12 meters deep. The warm surface water, referred to as the epilimnion, circulates within itself but does not mix with the water below. The thermocline is the zone immediately beneath the epilimnion and is characterized by a sudden drop in temperature. Below the thermocline is the hypolimnion where the temperature of water decreases downward (Ruttner, 1973).

Water temperatures were recorded for surface waters and at varying depths using a YSI Tele-thermometer at locations indicated in Figure 2.2.

Bacterial Analysis. The number of coliform bacteria present in water is the most widely used indicator of the presence of disease producing organisms. Although the coliform bacteria thermselves are harmless, their presence is an indicator of harder-to-detect disease microorganisms (Odum, 1971). The two coliform groups measured by the Sudbury and District Health Unit were:

1. Total Coliform - bacteria species associated with fecal matter and soil vegetation.
2. Fecal Coliforms- bacteria species associated with animal and human fecal matter and indicates relatively recent pollution input.

Water used for body contact recreation should be free from pathogens including any bacteria, viruses or fungi which may cause enteric disorders or eye, ear, nose, throat and skin infections (Ontario Ministry of the Environment, 1978).

Where it is possible for ingestion to occur, recreational waters can be considered impaired when the total coliform and fecal coliform geometric mean density exceeds 1000 and 100 per ml respectively.

Boat Limit System. The impact of swimmers alone on a lake ecosystem is likely to be minimal. Problems of a different magnitude may result when power boats are allowed to enter the ecosystem. The Lakealert study produced for the Ontario Ministry of Natural Resources has established the following method which determines the number of boats a lake ecosystem may safely support (Hough, Stansbury et al., 1971).

Phase 1: areas of the lake which are suitable for boating without environmental damage or creating a safety hazard were first determined based upon the following criteria:
- 60 meter protection zone around all lake shore
- 30 meter protection zone around all islands and navigation hazards
- 120 meter zone around all public beaches

Phase 2: areas not to be used for boating were marked on an aerial photograph.

Phase 3: using a Planimeter the total non-usable area was measured and subtracted from the total area of the lake to provide the total useable area for boating.

Phase 4: Total capacity for motorized boats was estimated at 1 boat for every 4 hectares and non-motorized boats at 1 boat for every 2 hectares.

Lake Bottom Morphology. Most limnological phenomena and productivity are directly associated with the morphological features of the water basin (Lind, 1974). In addition, certain morphometric features may affect boating, swimming and fishing activities.[1]

[1] Depth and bottom material are presented in the following chapter in terms of morphometric constraints for recreational use.

Lake bottom morphology was determined by using a Garcia Electro Sonic Recorder 9200 AS. The data tape depicted bottom topography as well as the constituent material. The traverses shown in Figure 2.3 were used as representative cross sections of the lake.

2.2.2 Shoreline Analysis

The Ontario Ministry of Natural Resources' publication Ontario Provincial Parks Landscape Design Principles and Guidelines (1980) provided the basic criteria for shoreline and backshore analysis.

A composite map was designed using a series of individual overlay maps which displayed the following shoreline characteristics:

1. Environmentally sensitive areas
   - potential erosion if vegetation is removed
   - hydric ecosystems
   - special habitat areas

2. Slope into water
   - minimum useful beach width is 9 meters from shore to 1.5 meter depth contour
   - maximum useful beach width is 60 meters from shore to 1.5 meter depth contour

3. Subsurface material
   - bottom should be firm and free from dangerous obstructions or sharp objects
   - excessively weedy areas should be avoided due to the nature of the soft bottom and the presence of nuisance aquatic fauna such as leeches

4. Orientation
   - preference should be given to areas receiving the longest sunshine periods
   - prevailing winds should be from the water to the shore to discourage insects

5. Proximity to access point

Data for the shoreline analysis were based upon large scale maps, site surveys, aerial photos and depth sounding.

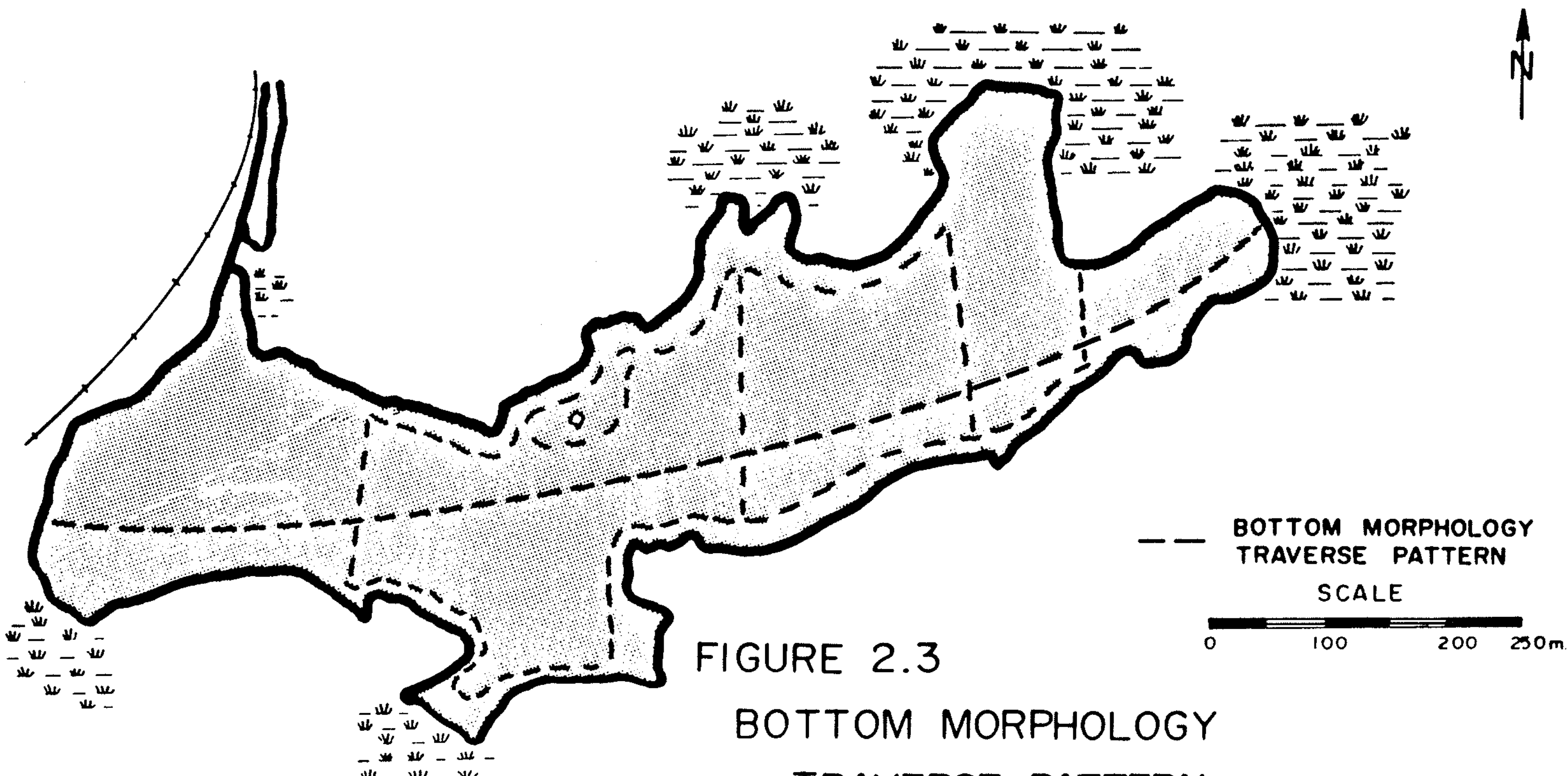


FIGURE 2.3
BOTTOM MORPHOLOGY
TRAVERSE PATTERN

The shoreline of the lake is an important consideration in the development of the park area. Areas with natural sand beaches are generally most favourable due to the gentle slope into the water which provides safe conditions for swimming. Rocky shorelines provide excellent conditions for experienced swimmers, expecially when the water is deep enough for diving. Since Garson Lake does not possess any sand beaches, analysis will focus on areas suitable to creating an artificial beach.

Ideally, a beach should be exposed to the sun for as much of the day as possible with the prevailing wind blowing towards the shore creating sufficient breeze to discourage flying insects (Ontario Ministry of Natural Resources, 1980).

The beach area can be separated into dry beach and wet beach. The wet beach is the area of water activity bounded by the water line and the 1.5 meter depth contour. Minimum useful beach width is 9 meters from the shore to the 1.5 meter depth contour (Ontario Ministry of Natural Resources, 1980).

The dry beach area is utilized primarily for sitting and sun bathing and is most suitable when the beach material is sand, or as a second choice, grass. When a natural beach does not exist, the dry beach may be supplemented by a grassed area back from the water's edge.

Total beach capacity is a function of the user's perception of crowding. The area required per person can be placed within three categories dependent upon perception of crowding, as follows (Ontario Ministry of Natural Resources, 1980):

1. Low Density: 46 square meters of dry beach per person

2. Medium Density: 23 square meters of dry beach per person

3. High Density: 9 square meters of dry beach per person

The following formula was used in the Garson Lake study to determine seasonal capacity in user days based upon a density factor of .0225 persons/m^2[1] (Ontario Ministry of Natural Resources, 1977):

Turn-over Rate ------ 1.5 dry beach/-------- 2.5 wet beach

K Factor[2] ------------ .5 dry beach/-------- .4 wet beach

Season ------------- 62 days

Instantaneous Daily Capacity:

Wet beach area × average number of people/m^2 of wet beach

Dry beach area × average number of people/m^2 of dry beach

Theoretical Daily Capacity:

Instantaneous daily capacity × turnover rate × K factor

Wet Beach:

Dry Beach:

Theoretical Seasonal Capacity:

Theoretical daily capacity × length of season

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[1] Due to the limitations of the proposed park in terms of aesthetics (refer to Section 3) and the higher quality alternatives a "low" density factor was used for Garson Lake.

[2] Since the turn-over rate will vary during the day in accordance with use, a K-factor 15 was used to accommodate the fluctuation in user rates.

2.2.3 Backshore Development Potential

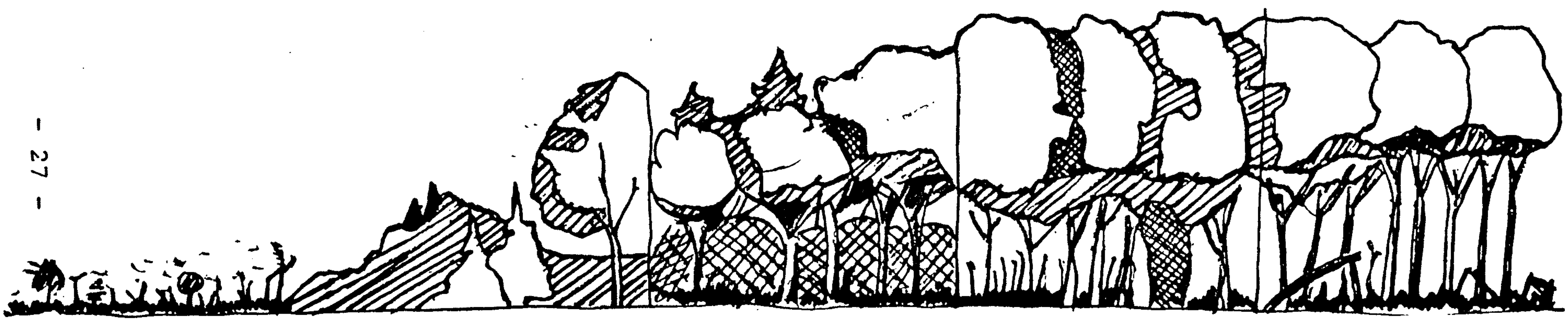
The backshore is the land area designated for an array of uses such as camping, picnicking, nature walks, service buildings and parking facilities. As such, the backshore will become an important element of the park area.

In terms of aesthetic appearance, vegetative cover plays an important role. The difference in age and size of trees can add variation to the area. In addition to scenic value, vegetation provides food and habitat for animal life and prevents erosion in some cases. Mattyasovsky (1967) suggests vegetation be examined in terms of the following:

1. General characteristics of the forest as it stands.
2. The interest of demand of the visitors and its relation to certain recreational activities, e.g. wildlife, hiking, etc.
3. Management practices especially with regard to manipulation.

Typical vegetation on a dry upland area can be classified according to the categories depicted in Figure 2.4.

The composition of a landscape is strongly controlled by landform and vegetative cover (Ontario, Ministry of Natural Resources, 1980). Any development of the backshore area should be proceeded by a detailed terrain analysis to avoid environmental degradation. The Ontario Ministry of Natural Resources (1980) has established a schematic for terrain analysis shown by Figure 2.5. Based upon these criteria, a general description of backshore potential was derived; however, detailed analysis was beyond the scope of this study.



Old field/very open

- Lush herb layer
- Pioneering seedlings
- Hedge rows

Primary succession

- Dense thickets of shrubs and saplings
- Herb layer is reduced

Young forest

- Upper story developing
- Dense shrub layer
- Herb layer still reduced

Mature forest

- 3 tiered forest strata
- Mature trees (80'ht)
- Young trees (40'ht)
- Sparse shrub layer
- Good herb layer

Climax forest

- Single story development
- Closed canopy
- Open understory
- Thick forest litter

FIGURE 2.4

TYPICAL VEGETATION SUCCESSION ON DRY UPLAND

Landforms

LANDFORM DESCRIPTION	BOTTOMLANDS	DRY UPLANDS	RUGGED UPLANDS	MOUNTAINOUS UPLANDS
	- littoral areas - flood plains	- plateaux - glacial plains	- fractured and faulted terrain	- usually uplifted following glaciation
	glacial deposition		glacial degradation	

Environmental considerations

	BOTTOMLANDS	DRY UPLANDS	RUGGED UPLANDS	MOUNTAINOUS UPLANDS
MICROCLIMATE	* humid, foggy	sheltered by terrain and veg. cover	* exposed and xeric	* very exposed and dry
TOPOGRAPHY	very flat (slightly undulated)	gently rolling	abrupt, discontinuous	very steep, precipitous
VEGETATION	thickets of water plants very dynamic	multi-storied vegetation stable	* sparse, shallow rooted	* sparse, shallow rooted and wind trained
DRAINAGE	* very poor (seasonally flooded)	well drained to somewhat poorly drained	* rapid surface run-off, wet in swales	very rapid surface drainage
WATER TABLE	*very high (0-1')	usually lower than 5 feet	perched in places	perched in places
SOILS	* mucky, organic silts peat parent material	sandy loams, clay loams, etc.	thin sandy loams and clay loams	colluvium
PHYSIOGRAPHY	stratified sand and gravel	outwash plain, moraines, etc.	ground moraines, talus	ground moraines, talus
DEV'T POTENTIAL *(Constraints)	usually unsuitable	usually high potential for development	highly restricted, except for small pockets	usually only suitable for primitive campground

FIGURE 2.5 ENVIRONMENTAL SENSITIVITY TO DEVELOPMENT

Ministry of Natural Resources, 1980.

2.3.0 Economic Feasibility of Park Development

The nature of the proposed park must be in accordance with the needs of the potential user group. Lynch (1963), has defined the needs of recreationists into six broad categories, as follows:

1. Choice, variety and diversity of opportunity and experience.
2. Mastery/self-esteem being the experience that provides a sense of challenge to satisfy man's need for self-fulfillment.
3. Balance - the need for relief from tension in terms of providing a balanced existence.
4. Social contact - the need for recognition of our personal values.
5. Self-actualization - the need for self-expression.
6. Contact with nature - to satisfy man's need for renewal, order and identity with the universe.

Parks must be able to provide unique experiences with particular attractiveness, a sense of identity and a comfortable feeling. Paramount to the feasibility of the park is its ability to be both "accessible" and "inviting" (Wright et al., 1976).

Economic analysis is of particular importance since it is the study of processes of human choice. Factors which may affect a recreation experience may be cost per visit, number of visits, personal disposable income, accessibility, management and leisure time (Clawson, 1975). If all interrelationships and magnitudes of each factor are known, the demand for recreation may be estimated. However, as Knetsch and Davis (1967) demonstrate, too often erroneous attempts have been made in predicting demand:

> The myth persists that somehow we are able to multiply population figures by recreation activity participation rates of some form and call it demand, and then use such figures to justify doing just about anything we can in the name of satisfying recreational needs.

Many demand studies have a tendancy of measuring not demand, but consumption, thereby not presenting a means of forecasting how demand will be affected by a change in supply (Knetsch and Davis, 1967).

Due to the very nature of recreational demand, which is absence of a market mechanism, valuation of recreation services must be imputed (Knetsch and Davis, 1967). While outdoor recreation is not marketed in the sense that parks' services are not sold, for the most part, money does become involved in the form of travel, time, equipment and lodging. The majority of demand studies focus on the travel and time costs savings.

Ullman and Volk (1964) developed an applied method of estimating a dollar value for benefits resulting from the development of a new recreation area, based on travel/time cost savings. In their model the initial task was to determine where people of St. Louis, Missouri, travelled to carry out their recreational pursuits. It was noted that attendance rates of St. Louisans, for the surrounding recreational areas, declined by the cube of the distance, and for more unique areas by the square of the distance.[1] A nomograph was developed by plotting distance from St. Louis to the recreation site against per capita

---

[1]Many factors affect people's choice in recreational areas including: alternatives, needs, income, time, mobility and a myriad of others.

annual attendance.[1] An estimated attendance figure for the new recreation area derived by interpolating the value associated with the distance variable.

The difference between the new park and the next farthest park was considered to be a saving of travel costs and time. By placing dollar values on these two variables and subsequently multiplying the resultant figure by the expected number of users at the new recreation area, a dollar value of benefits was determined. Obviously, the inherent difficulty lies in the selection of appropriate values for travel cost and time, however reasonable and modest estimates can provide some valuation of the park even if the error is as great as fifty percent (Ullman and Volk, 1964). Only variable operating costs were used in their study to determine travel costs and a modest value was placed on time. Ullman and Volk also recognized that their method could not be applied universally and that every situation will differ according to recreation needs.

Another factor is that records and available information may differ from place to place which may create a need for further adjustment to their model.

The Ullman-Volk approach was used in the Garson Lake study as a means of deriving dollar benefits for the new park if it were developed. These benefits are used in a benefit-cost analysis of the proposed park, applying the methodology prescribed in the Benefit-Cost Analysis Guide (Government of Canada, 1976). The following approach was used to derive a value for the proposed park:

---

[1] The nomograph possessed a high-medium-low range to account for differences in the quality of the experience.

Calculation of Benefits:

1. The number of recreationists from the Regional Municipality of Sudbury visiting the provincial parks in the District was recorded, based upon Ontario Ministry of Natural Resources data.

2. Capacity calculations for Garson Lake were considered as the total maximum number of users which may be diverted from the more distant parks. The number of users diverted from each park was a proportion relating to distance of the area parks, with the total not exceeding the maximum carrying capacity of Garson Lake.

3. The number of users was multiplied by the distance to the respective park which in turn was multiplied by a per kilometer cost of $0.30.

Calculation of Costs:

4. The sum of these values provided the maximum travel cost savings for the users of Garson Lake Park.

5. Costs for developing the park were considered in terms of both fixed capital costs (road, building, etc.) and variable costs (maintenance of road, building, etc.).

Benefit-Cost Analysis:

6. Present value of benefits and costs were derived by (Government of Canada, 1976):

$$\sum_{j=0}^{n} \frac{b_j}{(1 + i)^j} \quad \text{and} \quad \sum_{j=0}^{n} \frac{c_j}{(1 + i)^j}$$

where: j is the index of the year concerned
i is the social discount rate[1]
b is benefit
c is variable costs.

---

[1] Social discount rate is based upon an assigned rate of interest which is considered to remain commensurate with the inflationary rate (i.e. real dollar values).

7. The net present value of the project is:

$$\sum_{j=0}^{n} \frac{(b_j - c_j)}{(1 + i)^j}$$

A positive net present value is a necessary investment criteria.

8. A benefit-cost ratio for the project is:

$$\frac{\sum_{j=0}^{n} \frac{b_j}{(1 + i)^j}}{\sum_{j=0}^{n} \frac{c_j}{(1 + i)^j}}$$

A benefit-cost ratio of greater than unity is favourable.

The intended result of the benefit-cost analysis was to provide a means of assessing park development in terms of economic feasibility. Although economic analysis is subject to error due to the absence of exact dollar values and interest rates, a close approximation is provided, which was used as a realistic assessment of net social welfare of a project.

2.4 Regional Land Use Interrelationships

Development of a regional park may result in changes to the socio-economic structure of nearby communities. The analysis will focus on present land uses in the Garson Lake area as well as benefits and costs incurred by the surrounding areas. In order to determine possible effects associated with the park development, two primary sources of information were used: (1) Regional Planners, and (2) Nickel Centre Settlements Plan, Background Study (Regional Municipality of Sudbury, 1980).

CHAPTER 3.0

RESULTS AND DISCUSSION

3.1 Provincial Regulations Regarding Park Development

The Nickel District Conservation Authority was established under the provisions of the Conservation Authorities Act R.S.O. 1979 (as amended 1971, 1972, 1973) (Ontario Ministry of Natural Resources, 1981). The conservation and recreation land management program is a cooperative venture between the Ontario Ministry of Natural Resources (Conservation Authorities Branch) and the municipal government.

Any projects proposed by the Conservation Authority must be supported by a Master Plan prepared in accordance with the Guidelines for Master Plans approved by the Minister of Natural Resources (Ontario Ministry of Natural Resources, 1981). Recreational development projects are subject to 50 percent funding by the provincial government contingent upon approval of the Minister of Natural Resources. Priority will generally be given to Water and Related Land Management Programs as opposed to Recreation Land Management Programs.

Appendix HX - $\frac{1}{2}$ of the Policy and Procedures Manual for Conservation Authorities (Ontario Ministry of Natural Resources, 1981) outlines the grant availability for conservation and recreation land management programs as follows:

In decreasing priority:

Projects that have been initiated or are in process; in particular:

provision of inter-municipal recreation opportunities on land resources acquired for water and related purposes,
provision of facilities in areas of inadequate recreation opportunities

Upgrading or redeveloping existing facilities in areas of inadequate recreation opportunities

Establishment of new facilities, in particular:

- provision of intermunicipal recreation opportunities on land resources acquired for water and related purposes and in areas of inadequate recreation opportunities.

NOTE: Within the priorities listed above for the Conservation and Recreation Land Management Program, increased priority will be given for projects which relate to provincial tourism objectives.

Operations and maintenance costs for conservation areas are not subject to provincial grants and are therefore the responsibility of the Conservation Authority in which the facilities are situated. Although the majority of park development projects are maintained by the benefitting municipality, it is within the mandate of the Authority to retain control over the park and levy an entrance fee to cover maintenance and operation costs. This procedure has not been implemented in the Sudbury District. A major deterrent to implementation of an entrance fee by the Conservation Authorities to cover operation and maintenance costs is the requirement is that 50 percent of all park revenues must be turned over to the province, regardless of operation and maintenance costs. Therefore, in order for the park to break even, revenues must double the operating costs.

By order of the Ontario Municipal Board dated March 5, 1973, Garson Lake was rezoned from "A" Greenbelt District to "P" Parkland

District. The legal description of this area includes the north quarter of Lots 6 to 12 in Concession 4, the north half of lots 4 and 5 and Lots 6 to 12 inclusive in Concession 5, and Lots 4 to 8 inclusive in Concession 6, all in the Township of Garson. The land adjacent to these lots is owned by INCO Limited and Falconbridge Nickel Mines Limited (Figure 3.1) (Regional Municipality of Sudbury, November 1980).

Due to legislation governing Conservation Authorities, even if Garson Lake Park was a feasible project in terms of recreational development, the mandate of Conservation Authorities places priority with flood plain management.

3.2 Biophysical Analysis

Biophysical analysis for Garson Lake was conducted in three zones: (1) limnology of Garson Lake, (2) shoreline potential for beach activities, and (3) backshore analysis for land based recreational pursuits. Each of the above was considered in the context of three factors: (a) the state of the natural environment, (b) how this state may affect the user's perception of the recreation experience, and (c) the effect of recreationists on the natural environment in terms of possible negative impacts. The first two deal directly with the type of opportunities available based on biophysical limitations, and the quality of the environment. For example, a highly acidic waterbody may cause eye irritation and thus decrease the recreational experience.[1] The last factor relates to possible effects associated with certain

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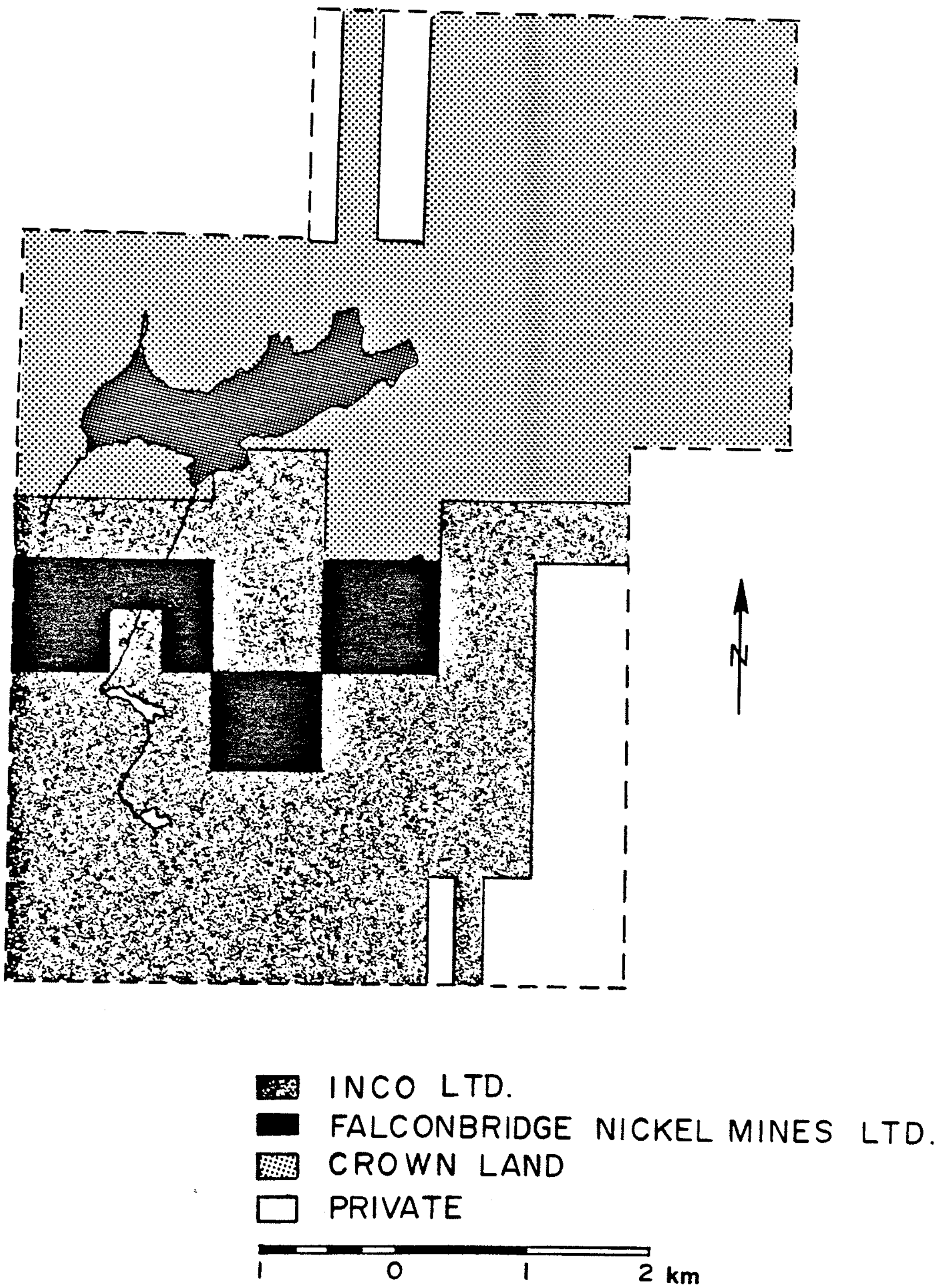
[1]Many factors which affect the user's perception of recreational experience which are not based on purely biological phenomenon, such as, proximity to alterntive recreational areas, density of use, facilities, etc. These other factors are dealt with in subsequent sections.

FIGURE 3.1

LAND OWNERSHIP



Source: Regional Municipality of Sudbury, Department of Planning 1980.

recreational uses, such as boating, which may not be suitable for all lake ecosystems.

3.2.1 Water Resources

The results of tests on Garson Lake were compared against standards set by the Ontario Ministry of the Environment for safe recreational waters which incorporate the most important parameters which were used in this study (Appendix B).

Bacteria. Samples from Garson Lake revealed an average of 39 parts per hundred ml of total coliforms and an average of 9 parts per hundred ml of fecal coliforms. Both are within the accepted standard set by the Ontario Ministry of the Environment (1978) of 1000 parts per hundred ml and 100 parts per hundred ml respectively.

Therefore, at the time of testing, the low level of coliform bacteria present in Garson Lake did not impose any restrictions on the proposed uses. Continual monitoring would be necessary to ensure the level of fecal and total coliforms remain stable.

Temperature. Complete mixing of temperature regimes was evident in Garson Lake as there was no significant variation in temperature from the surface to the bottom (Appendix C). Water temperature ranged from 21°C to 22.5°C over the three month period which is suitably warm for swimming purposes. The lack of a cold water biota will eliminate the likelihood of stenothermal[1] (oligothermal) fish species.

pH, Alkalinity and Hardness. Test results for pH ranged from 5.5 to 7.0, with the lower values being recorded for the western

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[1] Stenothermal (oligothermal) refers to those species which are cold temperature tolerant, such as brook trout (Salvelinus) (Odum, 1971).

portion of Garson Lake (Appendix C). Table 3.1 provides a comparison of pH and alkalinity levels for seven other lakes used for water based recreation in the Sudbury area. It is not uncommon for lakes within the Canadian Shield to possess pH levels of 5.5 or lower as there is minimal buffering due to the acidic nature of Precambrian rock formations (Wetzel, 1975).

TABLE 3.1

Relative pH and Alkalinity Values for Sudbury Lakes
Used for Water Based Recreation
(Nickel District Conservation Authority, 1980)

Name of Lake	Depth of Sample	Average pH	Alkalinity
1. Vermilion	Mixed	7.2	15.0
2. Ramsey	Mixed	7.1	15.0
3. Fairbank	3 meters	7.0	12.0
4. Long	7 meters	7.1	10.0
5. McFarlane	5 meters	7.6	22.0
6. Wanapitei	16 meters	7.1	15.0
7. Whitewater	11 meters	7.0	24.0
8. Garson	Mixed	6.2	12.0

Alkalinity tests revealed a very low buffering capacity of 12 parts per million of total hydroxide, carbonate and bicarbonate. The lack of calcareous rock formations in the Sudbury area prevents the dissolution of carbonates, bicarbonates and hydroxides resulting in a low buffering capacity in the Sudbury lakes. The relatively soft water of Garson Lake (approximately 40 parts per million calcium carbonate) supports the alkalinity findings since there is a corroborative relationship between alkalinity and hardness (Lind, 1974).

Garson Lake is slightly more acidic than the Ontario Ministry of the Environment considers suitable for contact water recreation.

Therefore, the pH results could be considered as a possible limitation for park development since the low pH may reduce the quality of the swimming experience. The low pH as a sole determinant should not preclude the development prospects of Garson Lake since swimming does presently occur in lakes of similar acidity[1]; however, should be considered as a negative factor in the final analysis in context of alternative recreational sites. Alkalinity and hardness impose no severe limitations on development for the levels found in Garson Lake (Ontario Ministry of the Environment, 1978).

Carbon Dioxide. An average of 7 mg/l of total free carbon dioxide was present in Garson Lake. An acceptable level of free carbon dioxide is not stated in the Ontario Ministry of the Environment (1978) standards for water quality. Renn (1970) suggests that water normally contains less than 10 mg/l of free carbon dioxide. Based upon Renn's description of normal water quality with respect to carbon dioxide, the level in Garson Lake is not unusual.

Total Dissolved Solids. Average total dissolved solids for Garson Lake were 315 parts per million. The Ontario Ministry of the Environment (1978) states that levels of total dissolved solids should not exceed 500 parts per million for recreational waters. The value of total dissolved solids is relatively high, but it remains within the standard established by the Ontario Ministry of the Environment (1978).

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[1]Windy Lake Provincial Park, located immediately outside the Regional Municipality of Sudbury, is one such example. pH values for Windy Lake are on average 6.2 (Nickel District Conservation Authority, 1980).

Dissolved Oxygen. The average dissolved oxygen concentration of Garson Lake was 11 mg/l with 13 mg/l as a maximum and 10 mg/l as a minimum (Appendix C). Sufficient oxygen is present in Garson Lake to support fish species during the summer. A different situation may exist during the winter if ice levels are excessive enough to decrease the volume of oxygen to a point where fish species may die off. The winter kill situation is possible due to the shallow nature of Garson Lake; however, testing would have to be conducted during the winter to determine the stability of the lake during the freezeover period. The high summer concentration of dissolved oxygen may be attributable to the large amounts of phytoplankton and vegetation, which produce oxygen through photosynthesis (R. Riewe, Professor, Department of Zoology, University of Manitoba, personal communication, 1981).

The level of dissolved oxygen is within the guidelines established by the Ontario Ministry of the Environment (1978) and as such imposes no contraints on development.

Phosphate. No phosphate was detected in Garson Lake. The presence of phosphates in inconceivably small amounts makes detection difficult, which may account, in part, for their absence (Ruttner, 1973). It is also possible that relatively large amounts of phosphates were stored in the abundant aquatic plant life present in Garson Lake.

Consequently, it is not possible to draw conclusions regarding the phosphate level of Garson Lake without testing spring time levels, which would be representative of the amount of phosphates released during decomposition of plant life during the winter.

Ammonia Nitrogen. Inorganic nitrogenous compounds were not detectable in their unoxidized form of ammonia (NH_4). Generally ammonia will not exist in natural waters unless putrefactive processes are present (Beamish and Roff, 1976). Furthermore, the relatively high dissolved oxygen levels of Garson Lake would aid in rapid oxidization of ammonia (NH_4) to nitrite (NO_2) and nitrate (NO_3)(Renn, 1970).

Nitrate. Nitrate (NO_3) was not detected in Garson Lake during the test period. Like phosphates, it is possible for nitrates to disappear completely in a eutrophic lake when fixed by phytoplankton and other aquatic fauna (Ruttner, 1973; Wetzel, 1974). Further testing would be required, however, with more sensitive equipment before concluding the trophic status of the lake based upon nitrogen and phosphate readings.

Transparency. Most of the secchi disc readings for Garson Lake correspond to the actual depth of the test site. (Refer to Appendix C). Total light penetration to the bottom accounts for the presence of substantial rooted plant growth over much of the lake bottom. The transparency readings could be misleading if not considered in relation to the depth of the lake, which is 3.66 meters at its deepest point and not deeper than 2.0 meters for most test sites. The high level of total dissolved solids combined with the secchi readings would indicate that particulate matter normally suspended has been dissolved (Ruttner, 1973). The exact cause of the high level dissolved solids would require further study; however, the clear water is acceptable in terms of recreational use.

Lake Bottom Morphology. Depth and bottom configuration for Garson Lake is presented in Figure 3.2. With the exception of the southern shore between points B and C, the lake was heavily weeded

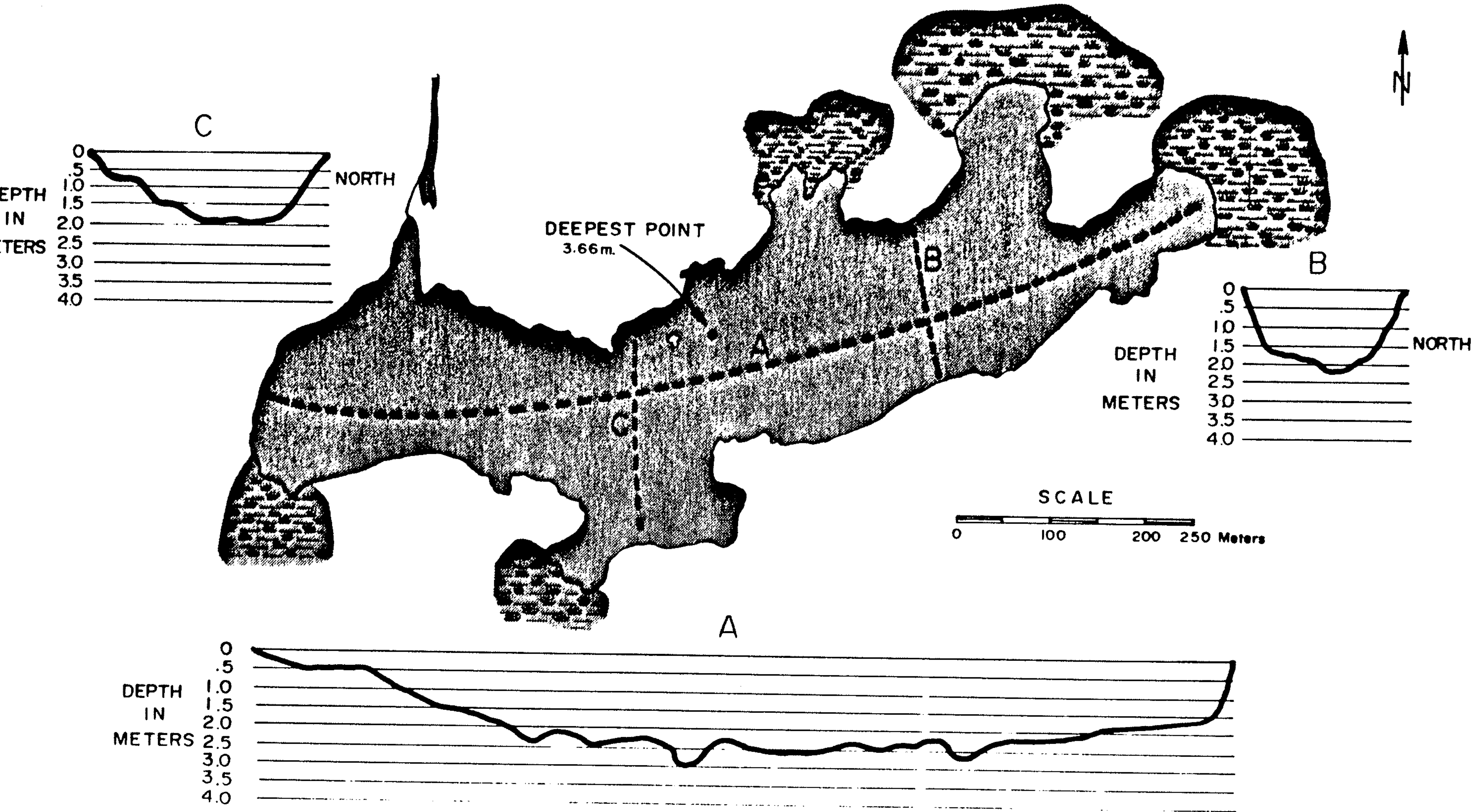

FIGURE 3.2
LAKE BOTTOM MORPHOLOGY

throughout. The northeastern and western sections of the lake were predominated by littoral vegetation. (Refer to Figure 3.4). The ramifications of the lake bottom morphology are considered in subsequent sections pertaining to beach potential and boating.

Boat Limit System. The boat limit system presented in the Lakealert Study described in Chapter 2, approximates the useable surface area for boats and converts this figure into the maximum number of boats suitable for the lake. The boat limit system is based on the physical size and does not take into account directly biological and chemical parameters.

The total area of Garson Lake is 109 hectares with a total useable area of 44.5 hectares for boating purposes. Allowing one motorized boat for every four hectares of useable water space or one non-motorized boat for every 2 hectares of useable water space limits the carrying capacity of simultaneous useage to 11 and 22 boats respectively. (Refer to Figure 3.3.)

Although the physical size of Garson Lake may support a given level of boating, the shallow nature of the lake subjected to boating may result in a disturbance of the aquatic fauna which are present over most of the bottom. The increased turbidity (floating particulate matter) may result in decreasing the quality of the swimming experience.

3.2 Shoreline Analysis

Since much of the proposed park activity will be oriented towards beach use, selection of an appropriate beach area is of para-

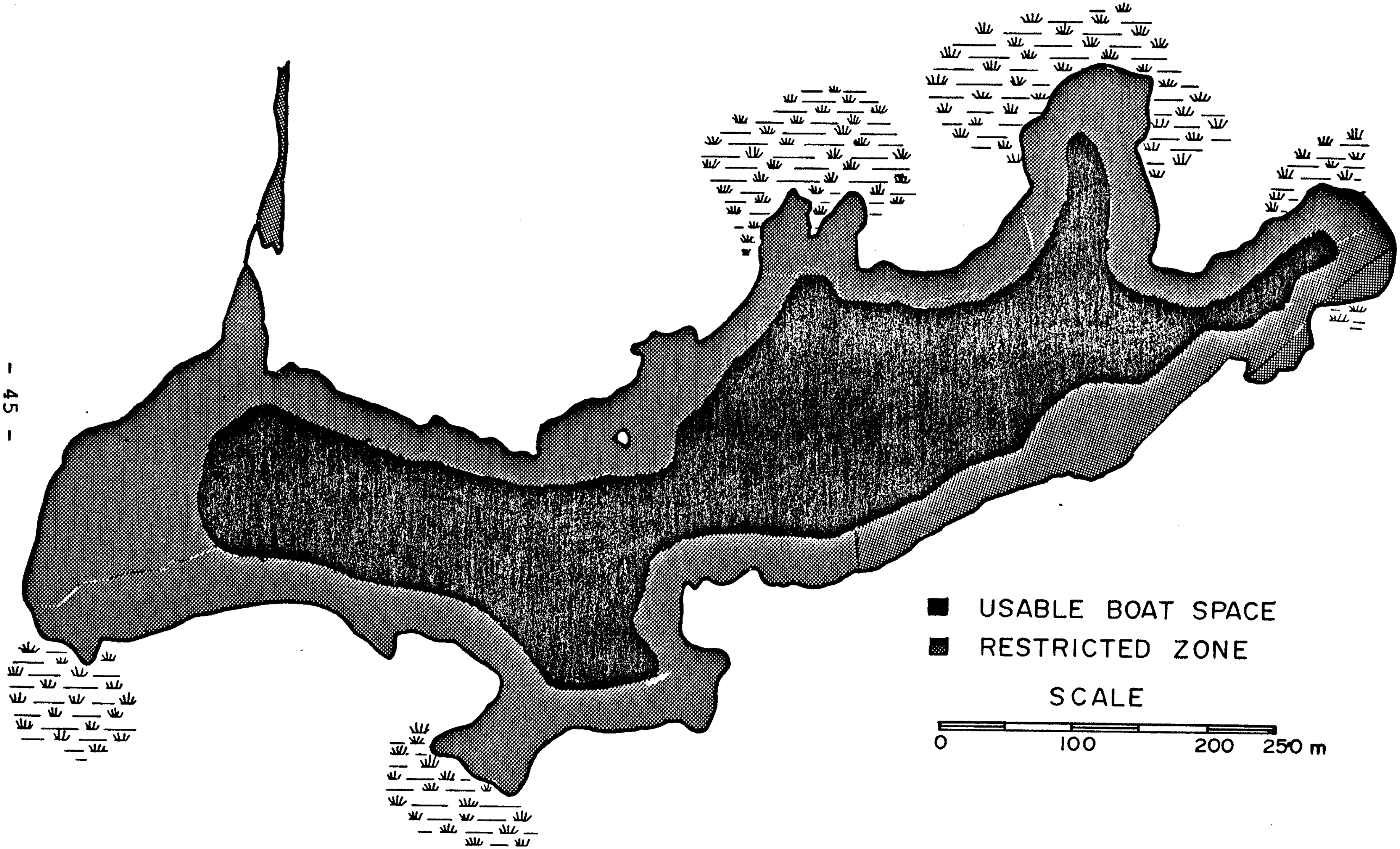

FIGURE 3.3 BOAT CAPACITY

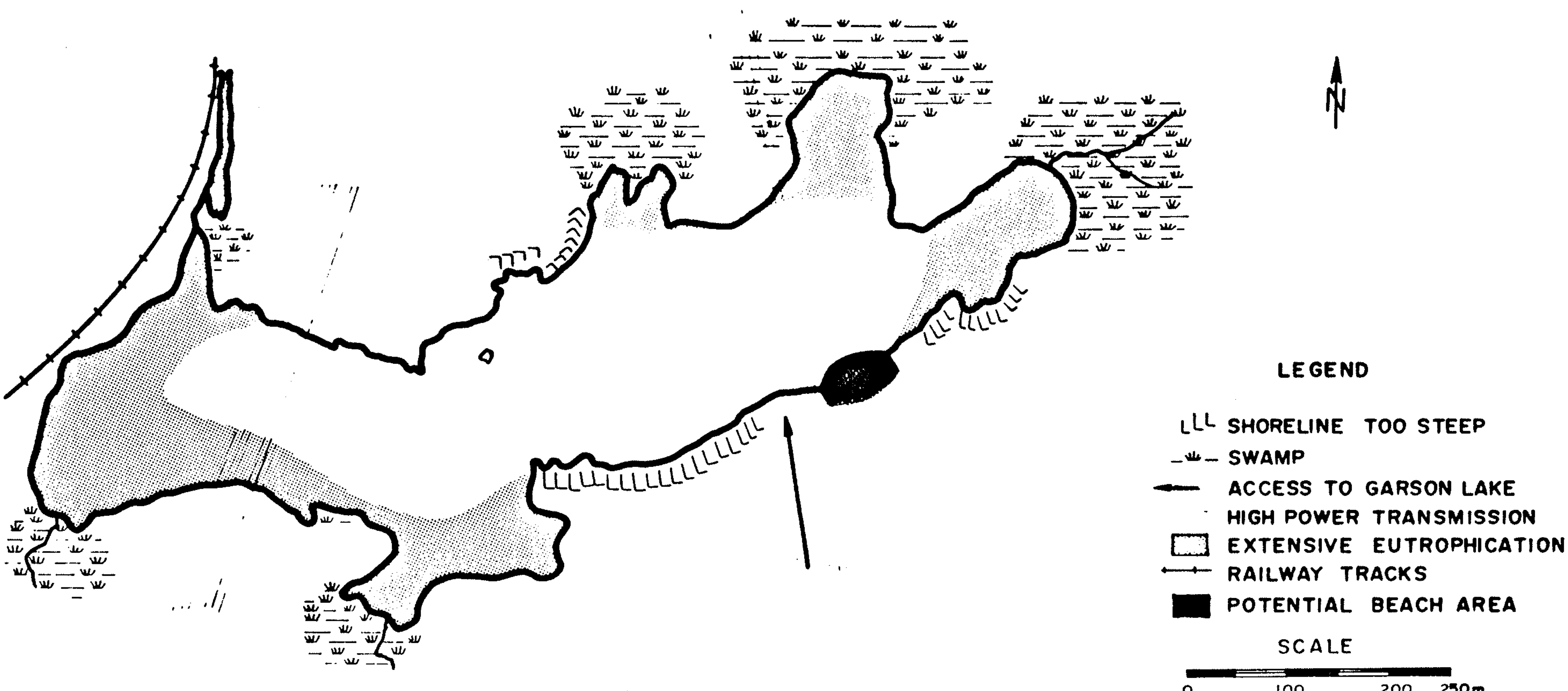

FIGURE 3.4
AREAS NOT SUITABLE FOR BEACH DEVELOPMENT

mount importance. A composite map (Figure 3.4) was derived by the methods discussed in Chapter 2.

It is evident from Figure 3.4 that Garson Lake possesses a very limited amount of potential beach area. Much of the shoreline is steep sloping and rocky shorelines which limits safe entry into the very shallow waters[1] and would be difficult to develop as sand beaches.

Extensive swamp areas also reduce the potential beach area since substantial cost would be required to fill these areas. Alteration of the swamp areas may adversely affect the drainage of Garson Lake since these areas are the sources of recharge and discharge of water. The swamp areas can be considered as environmentally sensitive to development since they are important in flushing and refilling the lake, an important factor in preserving water quality (Renn, 1970).

The active railway line on the western shore of Garson Lake creates a safety hazard and reduces the aesthetic appearance of this area.

There are many possible access route choices which may be considered for Garson Lake; however, a route from the south was chosen for the purposes of this study for the following reasons. Firstly, the majority of the population resides to the south of Garson Lake and diverting these people through a northern route would increase travel by nearly 10 kilometers and would substantially reduce the access for residents of Garson and Falconbridge. Secondly, development potential on the north shore of Garson Lake is limited due to excessive weed

[1] Steep sloping shorelines associated with deep waters may be suitable for diving, however, none exist in Garson Lake.

growth, swamps and steeply sloped shoreline. A southern access point will also provide the most direct access to the area considered as the best possible beach site based upon the limitations presented in Figure 3.4.

The potential beach area as indicated in Figure 3.4 is the only area on Garson Lake which has a relatively firm, even bottom morphometry combined with a flat shoreline suitable for dry beach activities[1]. Figure 3.5 illustrates the topography of the shoreline in this area.

3.2.2.1 Beach Capacity

Having identified the potential beach area, analysis was conducted to determine the approximate carrying capacity. The total dry beach area for capacity calculation was 900 square meters and the total wet beach area was the same (Figure 3.6). User capacity calculations are strongly dependent upon the perceived density of the area, which for the purposes of this study ranged from a low value of 20 persons to a high value of 103 persons using the beach concurrently. Few areas in Northern Ontario experience medium to high density beach use due to the large number of lakes within close proximity to urban areas.

Seasonal carrying capacity was determined using the model presented in chapter 2. The density calculation was based upon a factor of .0225 persons per square meter. Thus, $.0225 \times 900 \approx 20$, which is the value for low density use. The seasonal capacity was derived as follows:

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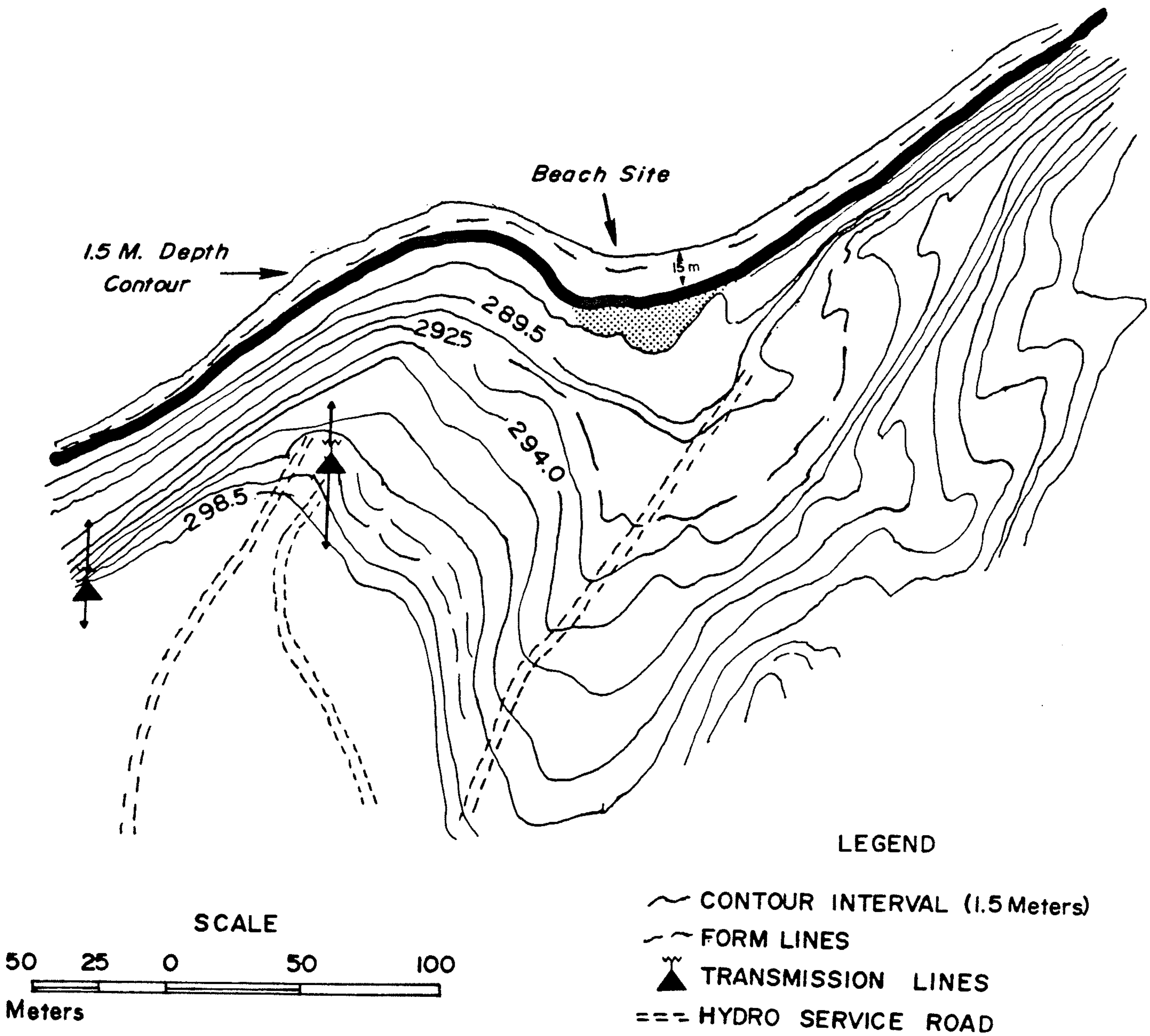
[1] Dry beach activities may include sitting, sun bathing, picnicking, etc.

FIGURE 3.5

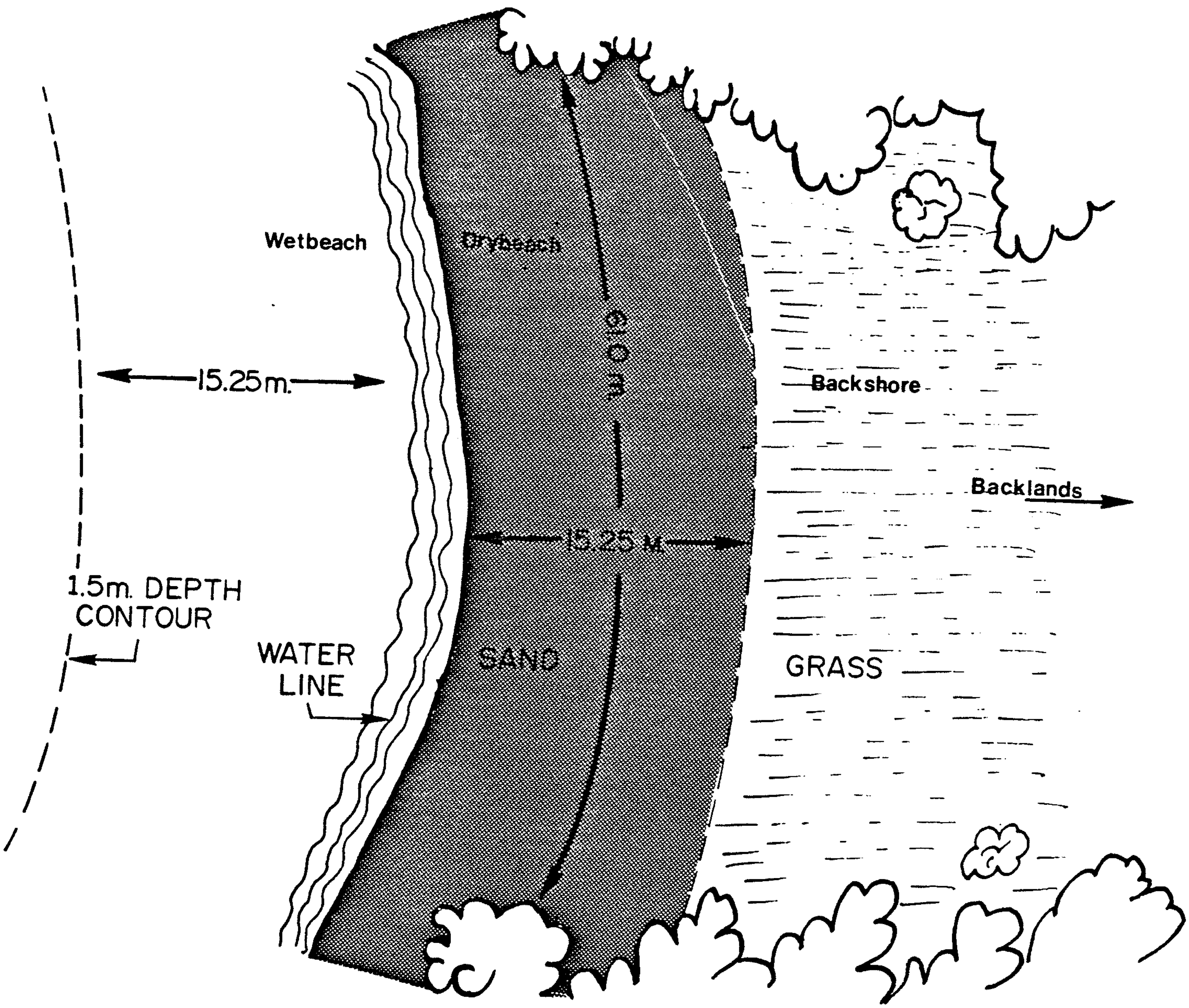
TOPOGRAPHY OF POTENTIAL BEACH SITE



Source: Nickel District Conservation Authority, 1975.

FIGURE 3.6

USEABLE DRY and WET BEACH AREA



Turn-over Rate ------- 1.5 dry beach/------ 2.5 wet beach

K Factor ------------ .5 dry beach/------ .4 wet beach

Season -------------- 62 days

Instantaneous Daily Capacity:

Wet beach area × average number of people/m^2 of wet beach

= 900 m^2 × .0225

= 20

Dry beach area × average number of people/m^2 of dry beach

= 900 m^2 × .0225

= 20

Theoretical Daily Capacity:

Instantaneous daily capacity × turn-over rate × K factor

Wet beach: 20 × 2.5 × .4 = 20

Dry beach: 20 × 1.5 × .5 = 15

Theoretical Seasonal Capacity:

Theoretical daily capacity × length of season

Wet beach: 20 × 62 = 1240

Dry beach: 15 × 62 = 930

Total capacity 2170

The total capacity figure of 2170 does not account for factors such as inclement weather or decreased use on weekdays. The calculated value is therefore a maximum number of expected user days. The projected user day capacity for Garson Lake provides the basis for the benefit-cost analysis which is presented later in this chapter.

3.2.3 Backshore Analysis

The backshore area was considered in terms of both recreational uses, such as ski trails and nature trails, and service facilities, such as parking areas and service buildings. A detailed analysis was beyond the scope of this study; however, aerial photograph interpretation and visual surveys provided adequate information for a preliminary analysis to locate potential uses, or restrictions on certain uses.

The majority of Garson Lake is surrounded by a steep sloping shoreline except in areas where extensive swamps exist. Determining a suitable location for parking areas and service buildings will be a major constraint on development since the only level land available near the proposed beach area is above the escarpment. As a result, extensive excavation would be necessary to prevent the users from having to walk about 3/4 of a kilometer to the beach site.

The rocky slopes surrounding much of Garson Lake are interspersed with stands of young forest. The area above the escarpment, however, is largely comprised on primary succession vegetation, barren rock outcroppings, swamps and devegetated soils. Although nature trails may be suitable for the study area, ski trails face severe limitations. Above the escarpment the lack of suitable tree cover provides little protection from the wind (Figures 3.7 and 3.8). Snow cover may be subject to considerable drifting and may disappear from open areas reducing the quality of the ski trail system. In addition, the presence of swamps tends to limit the length of the ski season depending upon the time of freeze and thaw. Although vegetative cover increases towards the shoreline, the steepnesss of this area reduces the potential for ski trail development (Figure 3.7).

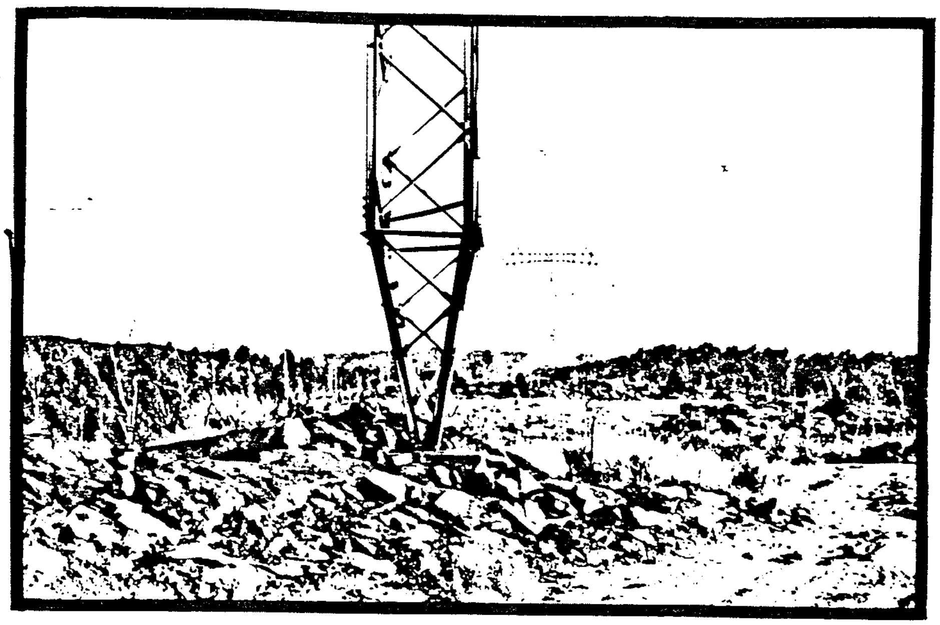


Figure 3.7
The Hydro Transmission Line is a Major Feature of the Lands Above the Escarpment

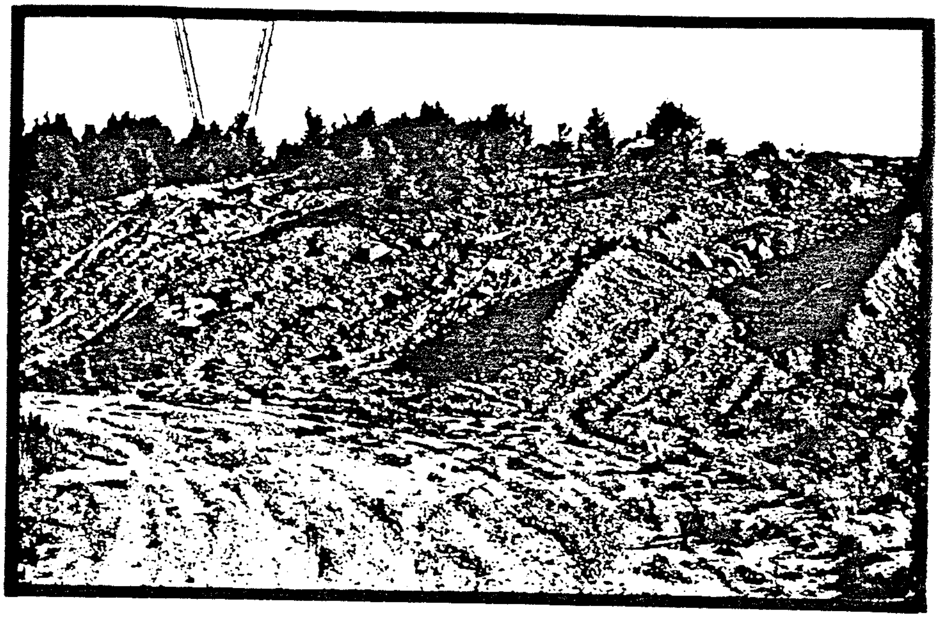


Figure 3.8
Certain Areas of the Backshore are not Suitable for Cross-Country Ski Trail Development Due to Lack of Vegetative Cover

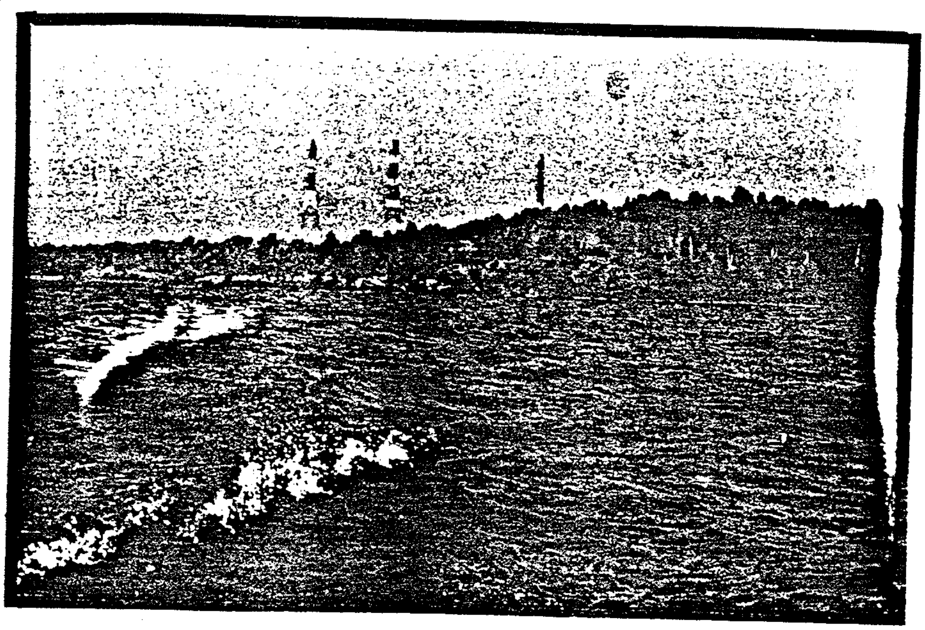


Figure 3.9
Areas Immediately Back of the Shoreline are Steeply Sloped and Interspersed with Young Vegetative Cover

In order to assess the potential of nature study trails, a complete flora and fauna inventory should be conducted to determine if there are any ecologically significant areas for study. Due to the shallow soil cover, consideration should also be given to compaction of the soil which may cause environmental degradation.

3.3.0 Economic Feasibility of Park Development

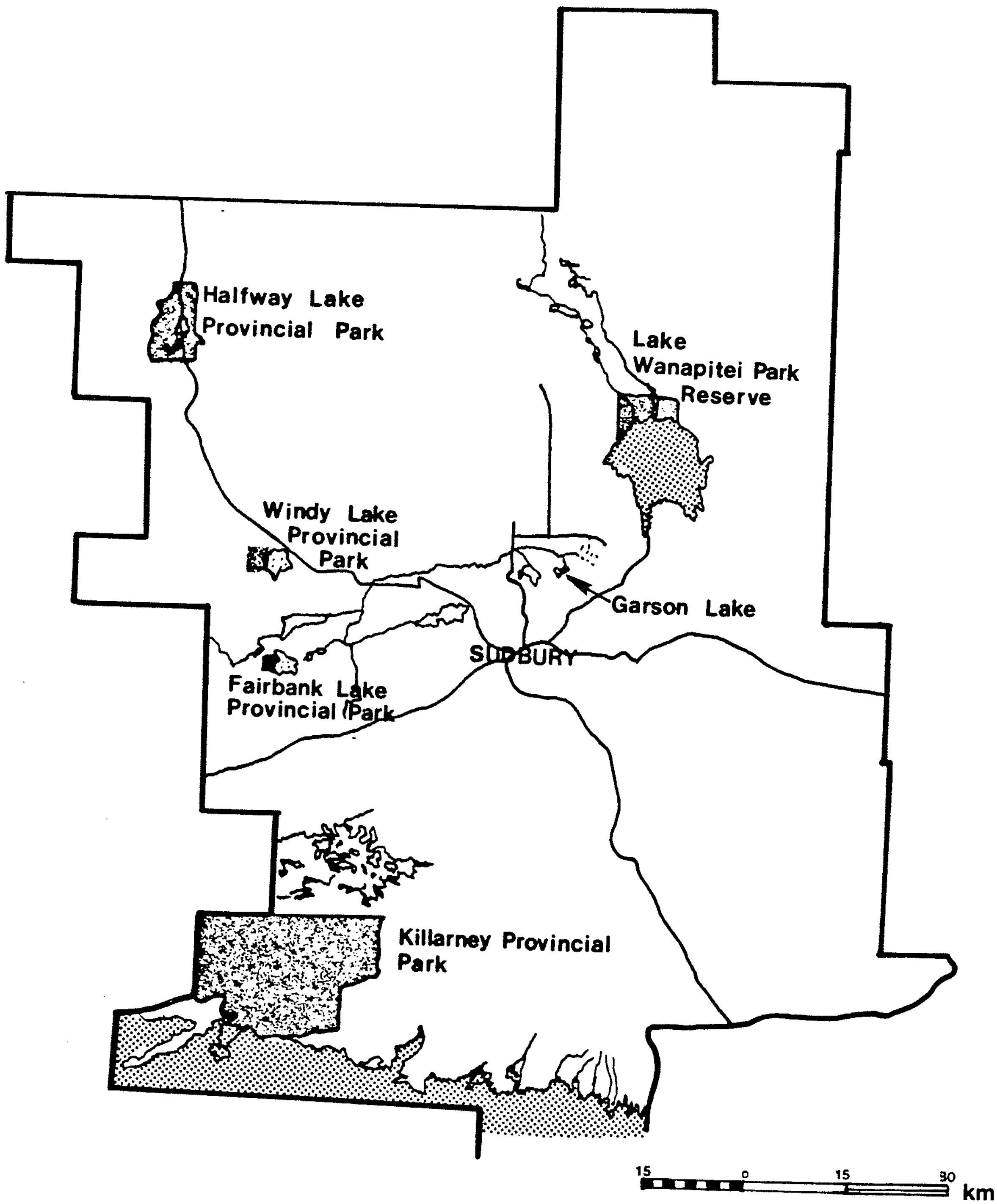
Since the proposed Garson Lake park has the intent of providing residents of the Regional Municipality of Sudbury with additional recreational opportunities, there is an obvious need to determine whether or not the existing supply of parks is adequate to meet existing demand. A second consideration is whether or not the added convenience of a new park closer to Sudbury will be worth the capital expenditure. Garson Lake park was proposed to provide recreational opportunities to the Regional Municipality of Sudbury, therefore was considered as a competing park against Killarney Provincial Park, Windy Lake Provincial Park, Fairbank Lake Provincial Park and Halfway Lake Provincial Park, all of which service the Regional Municipality of Sudbury. (Refer to Figure 3.10.)

Killarney Provincial Park. This park encompasses 22,421 hectares of high quality recreational land on the north shore of Georgian Bay. The park is primarily oriented towards wilderness experience for such activities as canoeing, hiking, cross-country skiing and camping, with emphasis on non-mechanical means of recreation. Facilities also include a junior ranger camp, 122 tent and trailer sites and 60 kilometers of designated canoe routes. Killarney Provincial Park is

PROVINCIAL PARKS WITHIN THE SUDBURY DISTRICT

FIGURE 3.10

(Ontario, M. N. R. July 1980)



the only park in the Sudbury District which is at capacity during the period (Ontario Ministry of Natural Resources, July 1980).

Fairbank Lake Provincial Park. Fairbank Lake Provincial Park is located off Highway 17 West, encompasses 105 hectares of primarily deciduous forest and contains 160 tent and trailer sites and a 1300 foot (400 meters) sand beach. Generally the park is never filled to capacity during the summer and attendance has been declining over the past few years (Ontario Ministry of Natural Resources, July 1980).

Windy Lake Provincial Park. This park is located off Highway 144 North and is 119 hectares in size. A recent addition to the public beach facilities has increased the attendance relative to the decline evident at the other area Provincial Parks. In addition to the sand beach, Windy Lake Provincial Park offers 87 tent and trailer sites and a junior ranger camp comparable to that of Killarney Provincial Park (Ontario Ministry of Natural Resources, July 1980).

Halfway Lake Provincial Park. Halfway Lake Provincial Park is the most recent addition to the Sudbury park scene and is located within 4,739 hectares of land in the northwest corner of the Sudbury District. The park offers 215 tent and trailer sites, a 2400 foot (730 meter) sand beach, interpretive trails and canoe routes (Ontario Ministry of Natural Resources, July 1980).

The provincial parks within the Sudbury District are resource based parks which offer recreational experiences presently unattainable within closer proximity to the city. As is characteristic of most provincial parks, these are areas which possess extremely high attractivity to relatively distant populations, therefore placing particular emphasis on the biophysical component. All of the parks possess mature forests relatively unaffected by the devastation of the early 1900's.[1] In this sense, provincial parks display a marked difference from intermediate area parks and user oriented parks which cater to specific needs within close proximity of population centers.

According to the Ontario Ministry of Natural Resources (July 1980):

> At the present, the District is adequately endowed with Provincial Recreation Parks (Fairbank, Halfway and Windy) and has one primitive park - Killarney.

Lake Wanapitei. An additional park in the Sudbury District is being considered at Lake Wanapitei, which is considerably closer to Sudbury than all of the other provincial parks. The Wanapitei park reserve is approximately 116 hectares in size and has an extensive natural sand beach. Lake Wanapitei is the largest water body in the Sudbury District and is presently used as a source of drinking water for the City of Sudbury. In relation to the town of Garson, the park reserve is approximately 25 kilometers northwest.

Garson Lake. In contrast, Garson Lake is substantially smaller and is surrounded by relatively young forest on the perimeter of the lake and primary succession forest further into the backshore. The proposed park area includes 37.6 hectares of land and a water body

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[1] During the late 1890's and early 1900's much of the area near Copper Cliff and Coniston-Garson was devegetated due to open roasting of ores and massive fires. Lumbering operations removed many of the larger trees leaving the smaller, more sensitive trees which were destroyed by sulphur emissions.

109 hectares in size. In terms of aesthetic appeal, Garson Lake is much lower in relation to the previously described parks.

Several features detract from the aesthetic appearance of the Garson Lake area including an active railway line of the northwestern shore, four high voltage transmission lines crossing the lake, large expanses of swamp on the northeast and southwest shores and a backland which is devoid of vegetation in some areas. In addition, the water body is very shallow and possesses a bottom almost entirely covered by weeds. Aesthetic values are highly subjective, however they are necessary considerations. Due to the low visual quality of the Garson Lake area the tendency for use would be towards the low range of values of benefits in the ensuing benefit cost analysis.[1]

The Ullman-Volk method used in this study to estimate a dollar value of benefits for a new park, is based upon the hypothesis that there is a strong correlation between visitation rates and distance travelled. Since people incur additional travel costs and time opportunity costs with increased distance, money will usually be saved by travelling to a closer park. The Ullman-Volk method presupposes that all parks possess a similar level of quality in terms of services provided and recreational experiences attainable. When parks differ to any noticeable degree, as is the case with Garson Lake and the area provincial parks, adjustments must be made to reflect the differences.

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[1]Benefits of developing Garson Lake were estimated high whereas costs of developing the park were estimated low so as to provide a conservative estimate. A range was used of high, medium and low for the benefit-cost analysis.

Table 3.2 compares user days for the provincial parks in the Sudbury area as well as the estimated figures for Garson Lake[1].

TABLE 3.2

Distances from Sudbury and User Days
for Area Parks 1981
(Cathy Varney, Parks Branch, Sudbury District Office,
Ontario Ministry of Natural Resources,
personal communication, 1981)

Name of Park	User Days	Distance (km)
Killarney Provincial Park*	43,384	100
Fairbank Lake Provincial Park	5,197	59
Windy Lake Provincial Park	14,598	49
Halfway Lake Provincial Park	2,306	86
Garson Lake (Proposed) Park	825	22

*Killarney Provincial Park was at capacity for most of the summer, all other parks experienced a decline in attendance. Figures shown for Killarney are 1978 as more recent information was not available.

Killarney Provincial Park, being a wilderness park, provides a range of recreational pursuits which are not possible at any of the other parks in the Sudbury District. Its uniqueness contributes to user rates which are markedly inconsistent with data from the other parks, thereby making it necessary to omit Killarney Provincial Park from the model. Furthermore, since Garson Lake does not possess a comparable natural resource base to Killarney Provincial Park, few, if any park users would be diverted to the closer park.

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[1]Distances are measured from the Central Business District (CBD) of Sudbury to provide uniformity to the analysis.

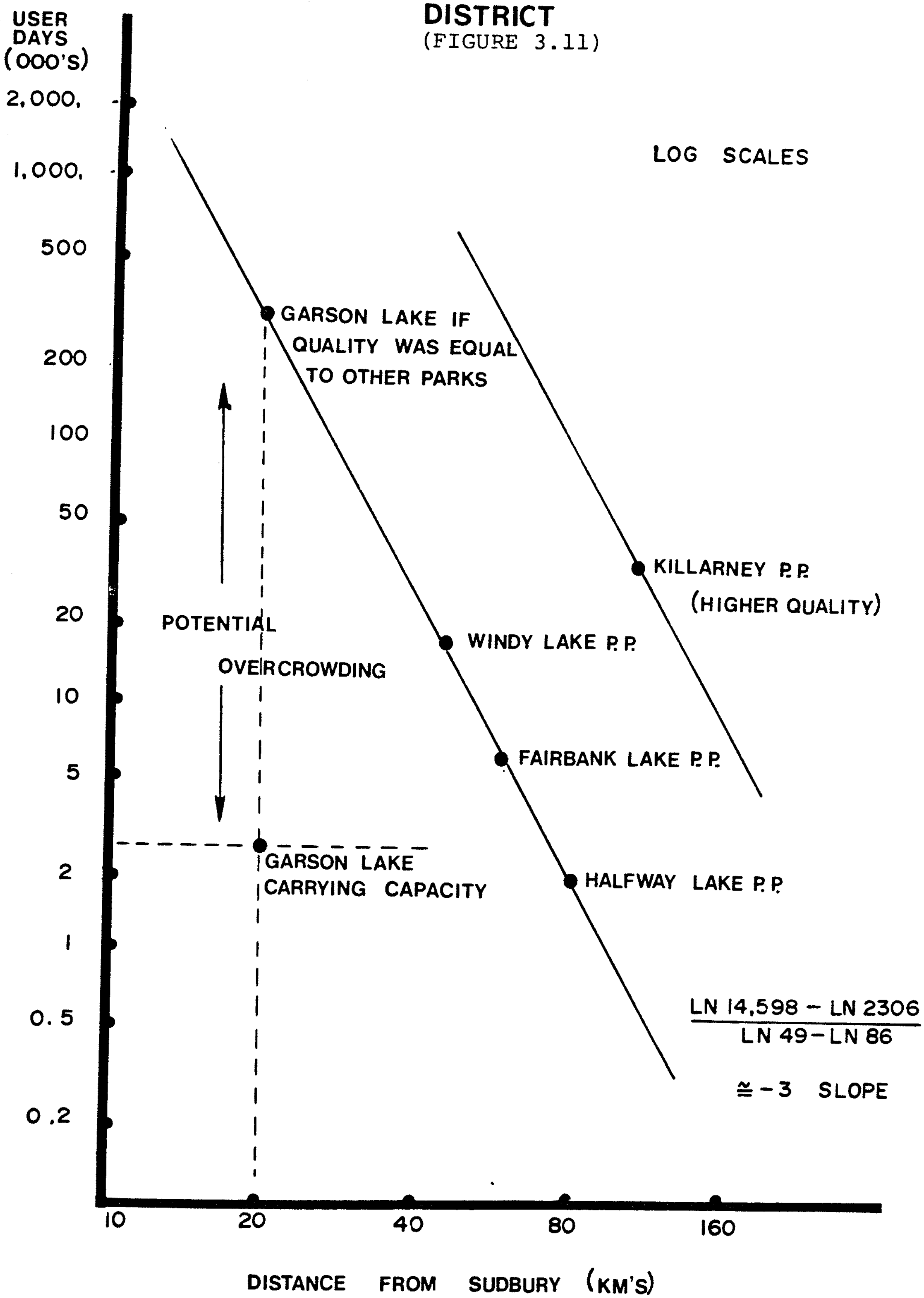
Figure 3.11 illustrates the relationship between distance and user rates for the area provincial parks. The results shown are consistent with the findings of Ullman and Volk (1964) in that user rates decline by approximately the cube of the distance. If the biophysical carrying capacity of the proposed park was not limited, the expected user days which would be diverted from the Area parks to Garson Lake could be determined by interpolation of the values from Figure 3.11. However, Garson Lake has a limited carrying capacity which theoretically would not exceed 2170 user days per annum. Consequently, the estimated carrying capacity for Garson Lake remains at 2170 user days per annum.

If the parks were all of equal quality there would be potential for overcrowding at Garson Lake as illustrated by Figure 3.11. Since there is a definite difference in the quality of the Garson Lake area in relation to the other parks overcrowding is likely to be less of a problem than is indicated by the graph. As fuel prices rise, Garson Lake may become a more viable alternative which could result in overcrowding and consequently additional environmental degradation.

Costs for developing the proposed Garson Lake Park were considered as either fixed capital costs (i.e. road, service building, beach, etc.) or variable costs (maintenance and up-keep). Total fixed costs were estimated to be $328,000 while variable costs were estimated to be $9000 per annum. Variable costs, which are incurred each year for the life of the project, were converted to present value terms to reflect the future costs. The total costs ranged from $388,000 to $506,630 in present value terms (see Appendix D).

THE EFFECT OF DISTANCE ON VISITATION RATES FOR PROVINCIAL PARKS IN THE SUDBURY DISTRICT

(FIGURE 3.11)



Benefits were based upon the results of the Ullman-Volk travel/cost savings model. Total benefits were $21,100 in the current year. Since benefits would be accrued in future years for the life of the park, present value terms were used to account for the future value resulting in benefits ranging from $190,500 to $419,000.

The calculated range of net benefits was from -$87,630 to -$247,500 in present value terms. According to the Guide to Benefit-Cost Analysis (Canada Treasury Board Secretariat, 1976), net benefits should be positive if a project is to be undertaken.

The benefit-cost ratio was from .36 to .82, which is considerably less than unity. The Guide to Benefit-Cost Analysis (Canada Treasury Board Secretariat, 1976), states that only when the benefit-cost ratio is greater than unity should an undertaking procede. Based upon the findings of the benefit-cost analysis, it is apparent that a regional park developed at Garson Lake would not be feasible. The extremely low benefit-cost ratio was to be expected in consideration of the lake's carrying capacity.

3.3.1 User-Oriented Park Alternative for Garson Lake

Benefit-cost analysis overlooks one very important component of decision making - that of human need; or stated another way, the demand by society for a particular commodity. It is possible that a project may be implemented regardless of economic costs if the social benefit to a community is deemed by decision making to outweigh the monetary costs. If the supply of local recreational facilities was considered inadequate for the Town of Nickel Centre, a user-oriented park alternative could be considered, in spite of high development costs and low economic returns.

A recreational needs analysis published by the Nickel District Conservation Authority in September 1980 correlated the amounts of varied parkland with population figures for each area municipality. The Ontario Ministry of Culture and Recreation standard of 6 hectares per 1000 population was applied and the results are shown in Table 3.3.

TABLE 3.3

Supply of Varied Recreational Parkland
Within the Regional Municipality of Sudbury
(From: Nickel District Conservation Authority, 1980)

Area Municipality (Refer to Figure 1.1)	Population (1979)	Surplus/Deficit
Sudbury	92,406	+ 1200 hectares
Nickel Centre	12,282	+ 400 hectares
Valley East	20,157	- 31 hectares
Capreol	3,912	+ 5.6 hectares
Rayside-Balfour	15,074	+ 200 hectares
Onaping Falls	6.031	+ 24 hectares
Walden	10,254	+ 400 hectares

From the above data it appears that, with the exception of Valley East, the existing supply of parkland is commensurate with the level of demand based upon the Ontario Ministry of Culture and Recreation standard.

The Ontario Ministry of Culture and Recreation standard can only serve as an approximation to localized recreational needs, since it is obvious that residents will use recreational facilities in nearby municipalities. Furthermore, the standard overlooks specific recreational needs, such as water based recreational areas. The Nickel District Conservation Authority (1980) conducted an inventory of recreational facilities in the Regional Municipality of Sudbury, which revealed the Town of Nickel Centre as having only one outdoor swimming area. In consideration of the lack of suitable lakes within the Town of Nickel Centre and the alternatives available immediately outside the municipal boundary (eg. Moonlight Beach, Lake Wanapitei), the observation is not surprising. It would be difficult to ascertain whether or not there is sufficient supply of swimming areas immediately outside the Town of Nickel Centre based upon the data presently available; however, there exists sufficient varied parkland according to the Ontario Ministry of Culture and Recreation standard.

In the sense that recreational needs in a given area are a function of population[1], it is important to consider the possible trends of population growth or decline. Trend analysis of population for the Town of Nickel Centre is presented in the following section.

3.3.2 Future Recreation Demands

Like most other area municipalities in the Region of Sudbury, Nickel Centre depends primarily on nickel mining as its economic base; however, the trend is gradually changing toward greater diversity in the secondary sector. Census data available at the time of the study show 80 percent of Falconbridge males and about 33 percent of the female labour force as being attached to mining and smelting. Figures for Garson and Neelon show 57 percent of the male labour force and 5 percent of the female labour force employed in the mining and smelting sector. The service industry accounted for 13 percent of the males and 56 percent of the females in Falconbridge and for Garson and Neelon, 26

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[1]There are many factors which affect the needs of an area including tastes, previous experiences, perception of density, etc. Here it is assumed that as population increases (decreases) there will be additional (less) stress on existing facilities.

and 79 percent respectively. Coniston showed similar labour force divisions to Garson and Neelon (Statistics Canada, 1971).

Although the trend is toward increased diversification away from the mining industrial base, mining employment is expected to continue as the economic base in the future (Regional Municipality of Sudbury, 1978). One of the major problems associated with this dependence on mining is the fluctuations inherent in the mining industry which have direct effect on the population of the Regional Municipality of Sudbury. As was stated earlier, recreational demand is a function of population.

Three population projections have been prepared based upon the Region's Population Projections 1978-2000 (Regional Municipality of Sudbury, 1979) for each of the towns in Nickel Centre reflecting high-medium-low values. (Refer to Table 3.4).

Based upon these predictions, even if maximum growth was obtained, the present allottment of varied recreational parkland would remain above the Ontario ministry of Culture and Recreation standard.

TABLE 3.4

Population Projections for Nickel Centre for Year 2000
(number of additional or fewer people)

	High	Medium	Low
Garson	3286	1893	0
Falconbridge	219	0	-185
Coniston	603	0	-499

3.4 Regional Land Use Interrelationships

Planners for the Regional Municipality of Sudbury recognized the need for economic diversity in order to stabilize the economy of Nickel Centre. The primary reason for proposing Garson Lake park as a potential regional level park was to achieve increased economic diversification, as is stated in the following quotation from the Nickel Centre Settlements, Secondary Plan, Background Study (Regional Municipality of Sudbury, 1980).

> Parkland, existing and potential, in the study area and beyond is probably the major economic resource upon which depends the future growth of the settlements and genuine communities with a level and diversity of central functions sufficient to generate a strong sense of community identification and social cohesion. Considered from an economic perspective, the potential of parkland ... strengthens the municipality's economic base by attracting visitors, tourists, new residents and new sales and investment dollars.

The previous statement is likely true of a large scale regional park, however such a park must possess a unique natural resource base in order to compete with the area provincial parks. Although the central location of Garson Lake may appear ideal in terms of proximity to user groups, the biophysical limitations imposed by inadequate shoreline, size of the water body and low aesthetics precludes any such development.

CHAPTER 4.0

CONCLUSIONS AND RECOMMENDATIONS

The objective of this practicum was to determine to what extent, if any, Garson Lake should be developed.

The interdisciplinary approach to the study of Garson Lake was developed around a framework which encompasses the following parameters:[1]

1. Provincial Regulations — Possibility for Development

2. Resource Base — Biophysical Analysis

3. Economic Analysis — Public Needs, Costs and Benefits

4. Regional Land Use Interrelationships — External Impact of Park

Guidelines for submitting a proposal for park development were outlined in Chapter 3. Provincial regulations established by the Ontario Ministry of Natural Resources (1981), Conservation Authorities Branch, have been designed to give priority funding to water management projects over recreation projects; however, this does not limit the Conservation Authority from making a submission for funding if the project is deemed to be feasible.

In terms of water quality there were no serious limitations discovered regarding park development for swimming and water contact activities. The water was suitably warm, relatively clear and free from harmful chemical and biological contaminants. It is possible,

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[1]Framework developed by Mr. David R. Witty of Hilderman, Fier, Witty and Associates.

however, that boats may disturb the weed growth which covers much of the bottom which may result in increased turbidity thereby reducing the water quality for swimming. Fishing is limited to the more tolerant species of fish, such as pike and catfish, and in consideration of the size and depth of Garson Lake, stocks would be quickly depleted unless a fisheries management plan was implemented.

The geomorphology of the area imposes a major constraint on development. The shoreline of Garson Lake is predominated by swamps or slopes which are too steep for beach development. The only area determined as suitable for swimming purposes was a 900 m^2 section on the southern shore. Carrying capacity calculations based upon the size of beach allowed for 2170 user days per year.

An additional constraint was recognized in terms of suitable terrain for a parking area and a service building. The terrain immediately behind the beach area is very steep (30 percent slope) and would require substantial excavation in order to accommodate these facilities.

The area above the escarpment normally would be the most likely area for skiing and hiking; however, this area's usefulness for skiing is limited due to primary succession, sporadic growth which would provide minimal shelter for the skier from the wind and would project the trails to drifting of snow.

Nature study may be possible due to the large swamps which exist, providing an interesting habitat for observation of a variety of species. However, further study would be required to assess the diversification and numbers of species prior to determining the areas usefulness for nature study.

Economic analysis indicated that the economic costs outweigh economic benefits of developing the park. In addition to the economic factors aesthetic appearance of the Garson Lake area is much lower than for alternative parks in the Sudbury District.

A Regional Park was considered an unacceptable development alternative due to carrying capacity constraints and high economic costs against low benefits. Development of a local park would also be unfeasible based upon existing studies which show there is adequate mixed parkland within the Town of Nickel Centre. Although a shortage of water based activity areas is evident within the municipality itself, substantial opportunities exist immediately outside the municipality. Furthermore, a declining or stable trend in population implies a possible decrease or stable pressure on the existing facilities for the future.

Based upon the above conclusions, the following recommendations have been derived:

1. Garson Lake should not be developed as a multiple use recreation park based upon the limited carrying capacity of the lake and its surrounding environment.

2. The isolation of Garson Lake and terrain constraints lend to high development costs regardless of the type of recreational use proposed. Although nature study may be possible in the Garson Lake area, development costs may be a major constraint unless the area can be determined to have some significant ecological or geological occurrences not to be found within closer proximity to Sudbury.

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APPENDIX A

Limnology Tests

Limnology Tests

Three basic methods were used for the variety of tests performed: (1) colorimetric comparator, (2) Hach kit, and (3) titration. The colorimetric comparator method is based on the fact that certain organic dyes when dissolved in water will change their colour according to the hydrogen ion concentration of the water. For each dye (reagent) there is a specific pH range over which the intensity of the colour corresponds to the hydrogen ion concentration. Test kits have been calibrated in such a way that the colour shown is compared against set standards (Beamish and Roff, 1976).

The Hach 10 kit used for determining dissolved oxygen levels is a prepackaged chemical method which works on the basis of colour changes in water colour as certain reagents are added. The method is similar to the colorimetric comparator (Lind, 1974).

Titration procedures were carried out by means of a calibrated micro burette which accurately measures the amount of titration reagent used. The micro burette is essentially a calibrated syringe which is filled with a particular reagent which is placed in a special bottle containing the sample. As the plunger is depressed micro quantities of the titration are released until the colour of the sample changes. At this point the result is read from the scale on the syringe (Renn, 1970).

Alkalinity. Titration was conducted using reagents bromocresol green-methyl red, sulphuric acid and phenophthalein indicator solution. This standard limnological test is described in Renn (1970) and Lind (1974) should the exact procedure be desired.

Ammonia Nitrogen. Ammonia analysis was conducted using the Nessler reagent reaction, which is basically a colorimetric comparator test. Further reference can be made to Beamish and Roff (1976).

Carbon Dioxide. Total free CO_2 was determined using the standard sodium hydroxide titration method, as described by Renn (1970).

Hardness. A measure of hardness was titrated using reagents, borate buffer, eriochrome black, ethylene diamine tetra acetic acid, and sodium hydroxide. The method is described by Renn (1970) in "Investigating Water Problems".

Nitrates. Using a colorimetric comparator test kit, nitrate levels were determined. Four reagents were added: sulfanilamide solution, hydrochloric acid, zinc dust and NaCl mixture, and ethylene-diamine dihydrochloride. The method is described in detail by Renn (1970).

Phosphates. The phosphate test was conducted using a colorimetric comparator test. Two reagents were used: ammonium vandadate-molybdate in sulphuric acid and stannous chloride in glycerin. Even under strict laboratory conditions, phosphates are difficult to detect. The outcome of the comparator method can only serve as an approximation.

Oxygen. A Hach 10 kit was used for determination of dissolved oxygen. For further information consult Hach 10 manual, Hach Chemical Co., Ames Iowa.

Total Dissolved Solids. Dissolved solids were determined through the titration procedure described by Renn (1970). Three reagents were used: hydrochloric acid, sodium hydroxide and methyl orange indicator.

APPENDIX B

Ministry of the Environment

Water Quality Standards

(1978)

Water Quality Standards for Contact Recreation

Coliform: Total coliform and fecal coliform and/or enterococcus geometric mean density should not exceed 1000, 100 and/or 20 per 100 ml respectively.

Temperature: Edge of a mixing zone must not exceed the natural ambient water temperature by 10°C. The maximum temperature of the receiving body of water must not exceed 30°C due to input from point sources.

pH: Should be within 6.5 and 8.5.

Alkalinity: Should not be decreased by more than 25% of natural concentrations.

Chloride: Should not be greater than 250 mg/l.

Dissolved Oxygen: Should not be less than 4 mg/l at 20°C.

Organic Nitrogen: Should not be greater than 0.15 mg/l.

Phosphorous: Should not be greater than 0.03 mg/l.

APPENDIX C

Limnological Test Results

for Garson Lake

Summer 1981

Limnological Test Results (15.06.81)

Test Site (Map 2.2)		1	2	3	4	5	6	AVG.
pH		6.8	7.0	6.5	6.0	6.0	5.5	6.3
Alkalinity (ppm)		12.0	12.0	11.0	12.0	12.0	12.0	11.8
Hardness (ppm)		40	42	38	40	39	43	40
Dissolved Oxygen (mg/l)	S	11	11	11	10	11	11	10.8
	B	10	12	11	10	11	11	10.8
Carbon Dioxide (mg/l)		9.0	8.5	8.5	9.0	9.5	9.5	9.0
Secchi Reading (meters)		.8	1.5	2.0	1.0	1.5	1.0	
Depth of Lake (meters)		.8	1.5	2.4	1.0	1.5	1.0	
Temperature °C		20	21	22	22	21	20	21
Total Dissolved Solids (ppm)		330	320	298	305	315	318	314
Nitrogen as NH_4 (ppm)		<.02	<.02	<.02	<.02	<.02	<.02	
Nitrogen as NO_3 (ppm)		<.02	<.02	<.02	<.02	<.02	<.02	
Phosphates (ppm)		<.01	<.01	<.01	<.01	<.01	<.01	

---- Test not taken
< limit of equipment sensitivity

S = Surface
B = Bottom

Limnological Test Results (13.07.81)

Test Site (Map 2.2)		1	2	3	4	5	6	AVG.
pH		6.5	6.5	6.5	6.0	5.5	6.0	6.2
Alkalinity (ppm)		11.0	11.0	12.0	12.0	12.0	12.0	11.7
Hardness (ppm)		40	42	41	40	42	43	41.33
Dissolved Oxygen (mg/l)	S	10	10	11	10	12	11	10.67
	B	10	11	11	11	12	11	11.0
Carbon Dioxide (mg/l)		---	7.0	---	6.5	---	6.5	6.67
Secchi Reading (meters)		.8	1.5	2.0	1.0	1.5	1.0	
Depth of Lake (meters)		.8	1.55	2.15	1.0	1.5	1.1	
Temperature °C		22.5	21	21	22	22	22.5	21.8
Total Dissolved Solids (ppm)		305	---	---	320	315	300	310
Nitrogen as NH_4 (ppm)		<.02	<.02	<.02	<.02	<.02	<.02	
Nitrogen as NO_3 (ppm)		<.02	<.02	<.02	<.02	<.02	<.02	
Phosphates (ppm)		<.01	<.01	<.01	<.01	<.01	<.01	

---- Test not taken
< limit of equipment sensitivity

S = Surface
B = Bottom

Limnological Test Results (10.08.81)

Test Site (Map 2.2)		1	2	3	4	5	6	AVG.
pH		7.0	6.5	6.5	6.0	6.0	6.0	6.3
Alkalinity (ppm)		12.0	----	12.0	11.0	12.0	13.0	12.0
Hardness (ppm)		---	---	---	---	---	---	---
Dissolved Oxygen (mg/l)	S	12	12	13	10	11	13	11.8
	B	11	11	13	10	11	12	11.3
Carbon Dioxide (mg/l)		5.0	5.8	6.5	5.5	5.6	5.2	5.6
Secchi Reading (meters)		.8	1.5	2.1	1.2	1.5	1.0	
Depth of Lake (meters)		.8	1.5	2.2	1.2	1.5	1.0	
Temperature °C		21	20	20	20.5	21	20	20.4
Total Dissolved Solids (ppm)		320	326	315	---	---	330	323
Nitrogen as NH_4 (ppm)		<.02	<.02	<.02	<.02	<.02	<.02	
Nitrogen as NO_3 (ppm)		<.02	<.02	<.02	<.02	<.02	<.02	
Phosphates (ppm)		<.01	<.01	<.01	<.01	<.01	<.01	

---- Test not taken
< limit of equipment sensitivity

S = Surface
B = Bottom

APPENDIX D

Benefit-Cost Calculations

1. Distance Saved by Visiting Garson Lake Park:

Halfway Lake Provincial Park	86 km - 22 km	= 64 km
Fairbank Lake Provincial Park	59 km - 22 km	= 37 km
Windy Lake Provincial Park	49 km - 22 km	= 27 km

2. Proportion of Users Diverted from Area Parks (this assumes a linear relationship which would result if all parks provided equal recreation opportunities):

Halfway Lake Provincial Park $\frac{2300 \text{ user days}}{22,401 \text{ user days}} \approx .10$

$\therefore$ 2170 user days × .10 ≈ 220 user days diverted

Fairbank Lake Provincial Park $\frac{5100 \text{ user days}}{22.401 \text{ user days}} \approx .23$

$\therefore$ 2170 user days × .23 ≈ 500 user days diverted

Windy Lake Provincial Park $\frac{14,598 \text{ user days}}{22,401 \text{ user days}} \approx .65$

$\therefore$ 2170 user days × .65 ≈ 1400 user days diverted

3. Dollars Saved by Recreationists:

Halfway Lake Provincial Park

$0.30 × 220 user days × 64 km ≈ $4224.

Fairbank Lake Provincial Park

$\$0.30 \times 500$ user days $\times$ 37 km $\approx$ \$5550.

Windy Lake Provincial Park

$\$0.30 \times 1400$ user days $\times$ 27 km $\approx$ \$11,340

Approximate Total Savings \$21,110 /annum

4. Converting to Present Value:

It is not realistic to assume an infinite value on a park since environmental quality may change through time. Unfortunately, only subjective measures are available to determine the life expectancy of a park. Consequently, a range from 50 years to 100 years was used. A range in social discount rate was also applied (5, 10, 15 percent) as is suggested in the Benefit-Cost Analysis Guide (Government of Canada, 1976).

Present Value of Benefits: For 50 years at 5 - 10 - 15 percent social discount rate.

$$\sum_{j=0}^{50} \frac{\$21,110}{(1.05)^j} = \$385,400.$$

$$\sum_{j=0}^{50} \frac{\$21,110}{(1.10)^j} = \$209,200.$$

$$\sum_{j=0}^{50} \frac{\$21,110}{(1.15)^j} = \$140,500.$$

Present Value of Benefits: For 100 years at 5 - 10 - 15 percent social discount rates.

$$\sum_{j=0}^{100} \frac{\$21,110}{(1.05)^j} \approx \$419,000.$$

$$\sum_{j=0}^{100} \frac{\$21,110}{(1.10)^j} \approx \$211,000.$$

$$\sum_{j=0}^{100} \frac{\$21,110}{(1.15)^j} \approx \$140,700.$$

CAPITAL COSTS OF PARK DEVELOPMENT

Beach Construction	$ 3,000
Road Construction[1] (minimum $20,000/km × 10 km)	$200,000
Parking Lot Construction[2]	25,000
Service Building[3]	100,000
Total Fixed Costs	$328,000

VARIABLE COSTS OF PARK DEVELOPMENT

Maintenance Costs (to whomsoever they may accrue) - grading road, repairs to building, etc. ($3,000/annum is < 1% total fixed costs	$ 3,000 /annum
Personnel Costs 2 persons (seasonal)	$ 6,000 /annum
Total Variable Costs	$ 9,000 /annum

[1] Ray Graham, Ontario Ministry of Natural Resources, Engineering Services Branch, Personal communication.

[2] Based upon 3.5 people per vehicle with maximum capacity occurring only on weekends; 24 cars per weekend — This parking area is similar in size to the parking area constructed at Langdon Park by the N.D.C.A. in Sudbury which cost approximately $25,000.

[3] This is a modest estimate considering the service building at Simon Lake Park, funded by the N.D.C.A. was in excess of $120,000.

Capital (fixed) costs are presumed to be allocated in the current year. Variable costs will occur over the lifetime of the project, and although they would tend to get larger with time due to obsolescence, for simplicity they will be considered at a constant rate.

Personnel will be an essential component of the park due to a need for management of the resource. The remote location of Garson Lake makes supervisory personnel necessary. Due to the limited carrying capacity of the area, a management problem may exist, also requiring personnel. Although not essential, beach supervisors would make the area more attractive. In addition, the usual activities such as cutting grass, picking up litter and enforcing rules are necessary for proper functioning of the park.

Present Value of Maintenance Costs for 50 Years:

$$\sum_{j=0}^{50} \frac{\$9000}{(1.05)^j} = \$164,300.$$

$$\sum_{j=0}^{50} \frac{\$9000}{(1.10)^j} = \$89,200.$$

$$\sum_{j=0}^{50} \frac{\$9000}{(1.15)^j} = \$60,000.$$

Present Value of Maintenance Costs for 100 Years:

$$\sum_{j=0}^{100} \frac{\$9000}{(1.05)^j} = \$178,630.$$

$$\sum_{j=0}^{100} \frac{\$9000}{(1.10)^j} = \$90,000.$$

$$\sum_{j=0}^{100} \frac{\$9000}{(1.15)^j} = \$60,000.$$