MANITOBA KARST:
A STRATEGY FOR ACTION

BY
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A Practicum
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF NATURAL RESOURCES MANAGEMENT

Natural Resources Institute
University of Manitoba
Winnipeg, Manitoba

December 13, 1991

ISBN 0-315-77785-0

Canada

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ABSTRACT

More than 140 caves, along with other karst landforms such as sinkholes, trenches and pavements are located in Manitoba. Most of these features are situated within the Grand Rapids Uplands, the Gypsumville-Lake St. Martin area and the Dallas-Hodgson area.

These features are not protected by a legal land designation nor are they safeguarded by a management plan. However, some of the karst resources have been damaged by human activities and they remain vulnerable to commercial resource extraction and human visitation.

An overview of the physical, biological and cultural resources of the three areas was prepared, along with an assessment of current and proposed land uses. Karst management strategies from other jurisdictions were reviewed for the purpose of recommending a management plan.

Research showed that the karst topography of the Gypsumville-Lake St. Martin area is the last known example of pristine gypsum-karst in North America. The karst of the Grand Rapids Uplands has been described as a unique Canadian landscape, and the Dallas-Hodgson area supports the largest known bat hibernaculum in Manitoba. However, these resources

are threatened by forestry, quarrying, human visitation and possibly mining.

A management plan should be developed to categorize the karst features into three management classes. Class 1 land should be protected from commercial resource extraction, and human visitation should be restricted. On Class 2 land, commercial resource extraction and visitation should be subject to karst management guidelines, while Class 3 land should not require special karst management.

The optimal method to manage Class 1 land in the Grand Rapids Uplands is to establish a National Park or a Provincial Wilderness Park. Similar lands in the Dallas-Hodgson area would be best managed as an Ecological Reserve.

The province or a private, non-profit organization should attempt to acquire Class 1 sites in the Gypsumville-Lake St. Martin region and manage them as a protected area.

ACKNOWLEDGEMENTS

I am beholden to the members of my practicum committee; Dr. Rick Baydack, Natural Resources Institute; Dr. Jack Romanowski, Geography Department, University of Manitoba; Mr. Jack Dubois, Manitoba Museum of Man and Nature; and Mr. Willard Anderson, Parks Branch, Manitoba Natural Resources, for guiding me through this research project. Thank you gentlemen, I appreciated your advise, technical information and encouragement.

I am grateful to Kim Monson, Dave McRitchie, David Wright, Dale Brown, Hugo Copper, Peter Voitovici, Ruth Bezys and the rest of the Speleological Society of Manitoba for showing and teaching me about caves in Manitoba. I thank Jane and Warren Rawluk for their hospitality while I was in Gypsumville.

I express my gratitude to those many people who provided me with information and I gratefully acknowledge them in the Personal Communications section of this document. A very special thank you is extended to Phil Whitfield, B. C. Ministry of Parks for enthusiastically answering all of my questions and providing me with insight into cave management.

I am also grateful for the generous financial support provided by the Faculty of Graduate Studies and the Natural Sciences and Engineering Research Council of Canada.

Finally I thank my family and Karen, who made many sacrifices so I could complete my education.

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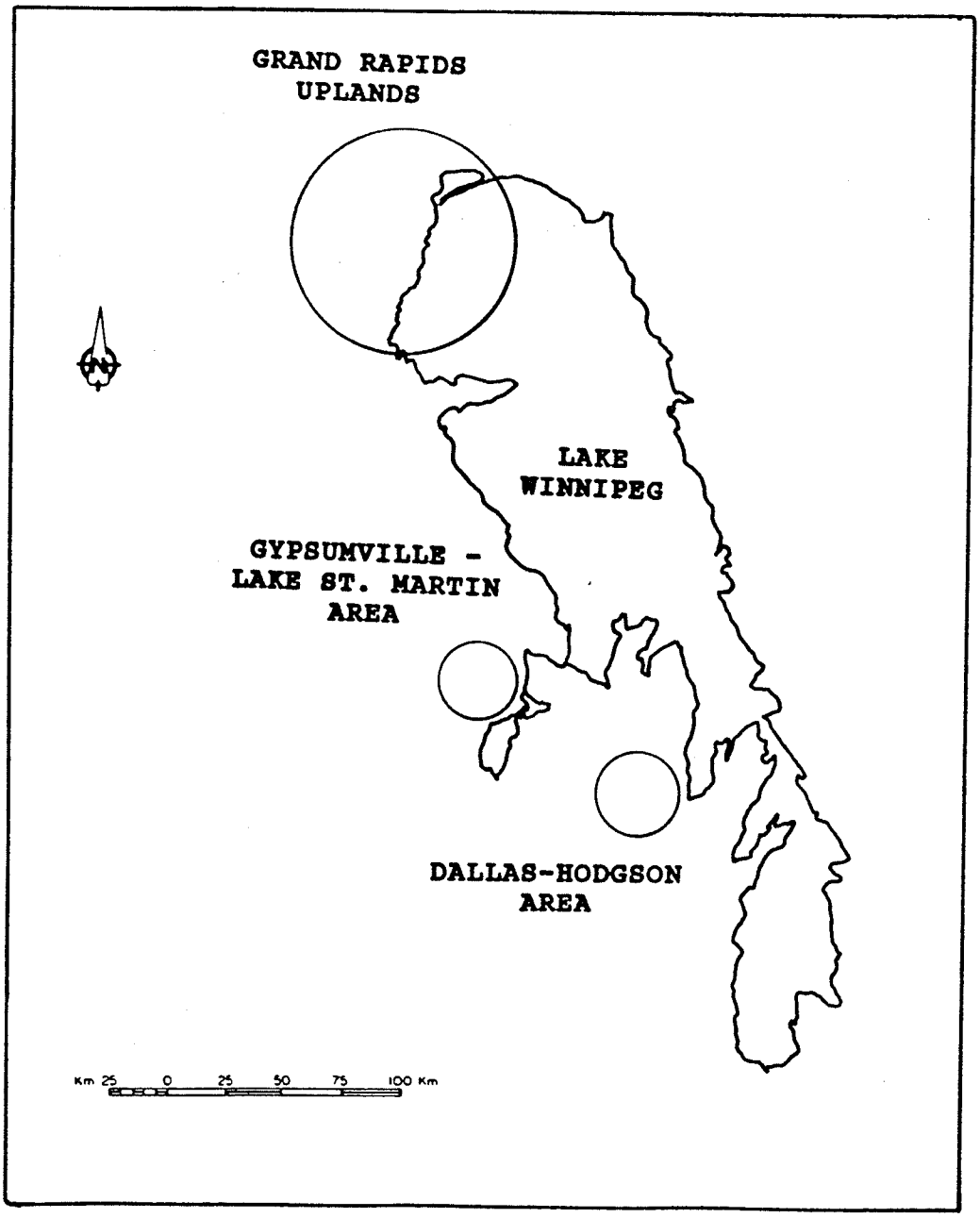
1.0 INTRODUCTION

1.1 BACKGROUND

Karst landforms, such as caverns, sinkholes, trenches and other solution related features are found within Manitoba's Interlake region (Figure 1). This topography forms a unique Canadian landscape, because nowhere else in the country is karst found in a semi-arid continental climate and flat terrain (Sweet et al. 1988).

At present, more than 140 cave entrances have been located within the Grand Rapids Uplands, and in the Southern Interlake near Gypsumville, Dallas, Hodgson, Fairford, Spence and Highrock Lakes, and on Peonan Point (Speleological Society of Manitoba. In Press). Many of these caves have been "discovered" only within the last few years, largely due to the efforts of the Speleological Society of Manitoba. To date, the largest cave system in the province measures more than 200 metres in length and the deepest cave is more than 13 metres. However, "new" caves continue to be found and it is possible that some of these may prove to be larger than those presently known.

FIGURE 1: PRINCIPAL KARST AREAS



SOURCE: Adapted from:
Sweet et. al. 1988; McRitchie and Voitovici 1990;
McRitchie pers. commun.

In general, caves may have geological, hydrological, mineralogical, cultural, biological, paleontological and recreational values (Marceron 1988). For example, Lake St. George's Bat Cave, near Dallas, Manitoba is the largest known Little brown bat (Myotis lucifugus) hibernaculum in the province (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.).

However, cave ecosystems are very fragile and have a low tolerance for disturbance (Murphy 1988). If improperly managed, caves may be damaged by surface and subsurface activities such as resource extraction, waste disposal and human visitation (McAlpine 1983; Culver 1986). For example, after a single visit to a bat hibernaculum, some bat species may leave the cave even if no alternative hibernaculum is available (Culver 1986).

1.2 ISSUE

In spite of the apparent geological and biological significance of the karst regions of Manitoba, these areas are not currently protected by a legal land designation (such as a park or ecological reserve) nor are they safeguarded by a karst management plan.

However, current and proposed land usages such as forestry and human visitation threaten the karst ecosystems.

Further research is necessary to assess the potential values and threats to the karst ecosystems, and to evaluate karst management options.

1.3 OBJECTIVES

The purpose of this project was to recommend a karst management strategy for 3 study areas; the Grand Rapids Uplands, the Gypsumville-Lake St. Martin area, and the Dallas-Hodgson area.

There were 4 major objectives. Objectives 1 and 2 were divided into sub-objectives.

MAJOR OBJECTIVES:

1) To prepare an overview of the physical, biological and cultural resources.

2) To identify existing and proposed land usages and to assess their current and potential impact on the karst environment.

3) To evaluate land management options.

4) To recommend strategies for optimal preservation of the karst environment.

SUB-OBJECTIVES

DESCRIPTIVE OVERVIEW

1) Physical Resources

i) To locate, identify and describe karst features.

ii) To describe the geology and geomorphology.

2) Biological Resources

i) To document the importance of the cave ecosystems as hibernacula for cave fauna.

ii) To survey available biological information pertinent to karst management.

3) Cultural Resources

i) To document significant historical/archaeological sites.

Existing and Proposed Land Usages

1) Resource Extraction

i) To identify current and proposed forestry and mining plans, and other activities that may affect the karst areas; and

ii) To assess their possible impacts on the karst ecosystems.

2) Human Visitation

i) To assess the impact of human visitation on cave ecosystems.

2.0 METHODOLOGY

2.1 METHODOLOGY FOR SECTION 3.0

The purpose of this section was:

1) **To provide a background on karst**. It was essential to understand karst processes in order to evaluate karst impacts and to recommend a karst management strategy.

2) **To examine methods of evaluating karst** so that an evaluation system could be recommended.

3) **To examine possible impacts to karst**. This discussion provided the necessary background to assess the potential threats to karst in Manitoba.

4) **Review karst management strategies**, so that appropriate management techniques from other jurisdictions could be recommended for Manitoba.

Data for this section was obtained from a review of textbooks, scientific papers, speleological journals, cave management conference proceedings, karst management plans

and government documents. Information was also acquired from personal discussions and/or written correspondence with persons knowledgeable and/or responsible for karst management.

2.2 METHODOLOGY FOR SECTION 4.0

2.2.1 METHODOLOGY FOR 4.1

Information for this section was obtained from a review of scientific papers and textbooks.

2.2.2 METHODOLOGY FOR 4.2

The purpose of this chapter was to describe karst in Manitoba, and show that the most significant karst features are located within the 3 study sites.

Descriptive statistics were calculated for each study site, based upon data compiled by the Speleological Society of Manitoba.

Data sources included a literature review (primarily of scientific papers written by the Speleological Society of Manitoba) and personal interviews with individuals currently researching karst in Manitoba.

2.2.3 METHODOLOGY FOR 4.3

Biological data were researched to identify cave fauna, and rare plant and animal species located within the 3 study sites.

Data on cave fauna were obtained through personal communications with, and review of on-going research of personnel from the Manitoba Museum of Man and Nature and the Wildlife Branch of the Manitoba Department of Natural Resources.

Data on rare plant species were obtained from a literature review, search of the Manitoba Museum of Man and Nature's Natural Science Data Base, and discussions with botanists from the Manitoba Museum of Man and Nature, and the University of Manitoba.

2.2.4 METHODOLOGY FOR 4.4

Data for paleontological resources were obtained from a literature review.

2.2.5 METHODOLOGY FOR 4.5

Historical and archeological data were procured by a literature review, a search of the Archeological Site Inventory of the Manitoba Historical Resources Branch, and through personal interviews.

2.2.6 METHODOLOGY FOR 4.6

The purpose of this section was:

1) To determine the amount of productive forest cover on the study sites.

2) Determine current and proposed timber harvesting plans, and potential threat to the karst resources.

Forest cover data were obtained from the Manitoba Forestry Branch's Forest Inventory and from discussions with forestry personnel.

Forest cover data, from the Forest Inventory is displayed on maps at a scale of 1:63,360. Forests of similar composition are called stands, and each stand is outlined and numbered on forest cover maps. Steps for analyzing Forest Cover Data are:

- Forest stands within the Gypsumville-Lake St. Martin and Dallas Hodgson study areas were identified.
- Only stands near known cave sites were identified for the Grand Rapids region.

- Cover type (species composition) for each stand was recorded.
- The percentage of each cover type was calculated, indicating forest type.
- The percentage of cutting class (maturity) was calculated for each region, indicating the level of maturity.
- Large burns (identified by satellite) were recorded.

The limitations of these forestry calculations are:

- Forest stands do not coincide with study site boundaries. Therefore, stand composition of each study site is only approximate.

- Forest cover types are classified as a range of species composition, which results in only an approximation of forest cover type.

- Age of the data may have resulted in inappropriate approximations.

- Only burns large enough to be identified by satellite were noted on the inventory maps.

2) FORESTRY PLANS

Forestry data were gained from a literature review, government publications, five year operating plans of Repap Manitoba Inc. for the years 1988-1992 and 1990-1994. Discussions were also held with regional forestry staff for F.M.U.s 41, 43 and 45.

Harvest locations were cross-referenced with published cave locations to determine the threat of forestry. However, precise cave locations are not published. Therefore, only general conclusions can be made about the threat of forestry.

2.2.7 METHODOLOGY FOR 4.7

Mining data came from the following sources:

Index Map 2A Active Permits, January 1990.
Manitoba Energy and Mines

Index Map 6 Mining Claims, July 1990
Manitoba Energy and Mines

Mineral Development Sector Files,
Federal Department of Energy, Mines and Resources

Literature review and personal interviews.

2.2.8 METHODOLOGY FOR 4.8

Data for aboriginal peoples' interests were obtained by personal interview and literature review.

2.2.9 METHODOLOGY FOR 4.9

Trapping data were acquired from the "Fur Harvest Information System" of the Manitoba Department of Natural Resources., and from personal interviews.

The limitations of this data were that the data collection regions (Registered Trapline Sections and the Open Trapline Section) were considerably larger than the study areas. Therefore this data can only provide an indication of the number of trappers operating in the study sites and the value of their harvest.

Hunting data was not used because the data collection areas were too large.

2.2.10 METHODOLOGY FOR 4.10

Property ownership, and mineral and sand and gravel rights were obtained from:

- The "Crown Land Registry System" of the Crown Lands Branch, Manitoba Department of Natural Resources.
- Land Titles Registry.
- REPROPMAP LTD.

Limitations of the Crown Lands Registry data were that exact locations of land are not given. Also, only the original

land owner is registered. Limitations of the Land Titles "Old" Registry system was that registration was voluntary. Therefore, current ownership is not necessarily recorded. Limitations of REPROPMAP LTD. data was that it pertained only to the L.G.D. of Grahamdale (North).

2.2.11 METHODOLOGY FOR 4.11 AND 4.12

Data was gathered from government publications, statutes and personal interviews.

3.0 ESSENTIALS OF KARST MANAGEMENT

3.1 INTRODUCTION

The purpose of this chapter was to review karst management strategies from other jurisdictions so that appropriate strategies could be adopted for use in Manitoba. The focus is on why and how karst is managed, and what general and specific management prescriptions may be applicable to Manitoba.

3.2 KARST: DEFINITION

The term **karst** is used to describe terrain whose topography and drainage is formed by the dissolution of bedrock in natural water (Jennings 1971). It must be emphasized that the process of dissolution may not be the only land-forming process occurring, nor is it necessarily the dominant process (Jennings 1971). However, dissolution of bedrock is a process that is more significant in karst landscapes than in any other type of landscape (Jennings 1985).

Karst terrain is formed in 3 main rock groups; carbonate (limestone and dolomite), evaporites (gypsum, anhydrite and

rock salt), and quartzite (under extreme tropical conditions) (Bogli 1980).

Solution processes, or corrosion, may produce surface karst features (exokarst) such as hollows, basins, depressions, pavement, etc. (Bogli 1980). It may also produce subsurface karst features (endokarst) such as caverns, which are the result of dissolution of joints, bedding plains and rock pores by underground drainage (Bogli 1980).

Many karst landscapes may be typified by sinkholes, caves, springs and surface drainage that vanish underground (ACCA no date). However, since karst features vary from location to location, and not all karst features are common to all karst regions, karst cannot be defined solely on the basis of features (Jennings 1971). Similarly, although in many karst landscapes organized surface drainage is replaced by centripetal basins and sinks that divert water underground, this does not occur in all karst regions. Therefore, karst can not be defined solely by the lack of surface drainage (Jennings 1971).

The important concept to remember when discussing the formation of karst landscapes is solution (Jennings 1971) and the important concept to remember when discussing karst

management is that the surface and subsurface are interrelated (Aley 1990).

3.3 KARST MANAGEMENT: STEP 1 INVENTORY AND CLASSIFICATION

Many regions have adapted a common first step to karst management, **Inventory and Classification** (Figure 2). This step provides sound information, which is essential for effective management (Sowers 1990).

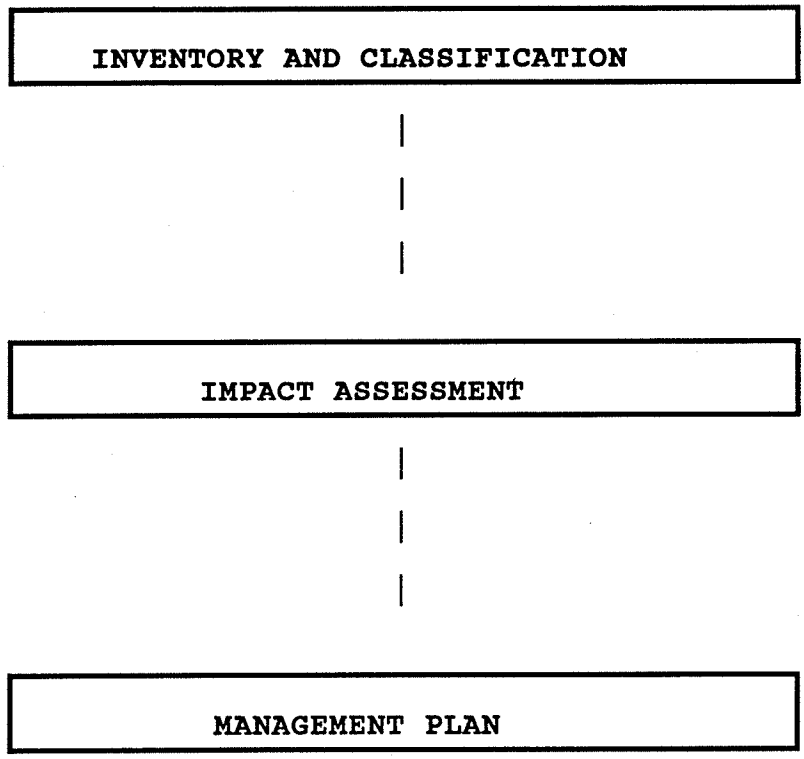
Inventory and Classification involves 2 stages.

3.3.1 INVENTORY

The first stage of the **inventory** is to identify and evaluate the karst resources. Marceron (1988, 1990) discusses 7 potential values of solution caves. They are; geological, hydrological, cultural, biological, paleontological and recreational.

Geological Values: The type, age and stratigraphy of cave rocks may help explain the geological history of the region (Marceron 1988). Also, fossils found within caves may give insight into past environmental conditions (Marceron 1988).

FIGURE 2: GENERAL STEPS TOWARDS KARST MANAGEMENT



Hydrological Values: Karst systems may serve as underground laboratories for studying ground water (Marceron 1988, Palmer 1991). Karst water may also be a source of domestic and commercial water (Werner 1983).

Mineralogical Values: Cave formations may have aesthetic significance; they may be composed of rare minerals, some of which are only found within caves; they may also provide a record of past temperature changes (Marceron 1988).

Cultural Values: Caves may act as "natural museums", preserving evidence of past human activity (Watson 1990).

Biological Values: Caves provide essential habitat for many animal species, some of which spend their entire life cycle within caves, while others depend upon caves for some critical point of their life (Culver 1986).

Cave ecosystems may serve as laboratories for ecological studies, whose findings may be applied to other ecosystems that are more intricate and more economically valuable (Poulson 175).

Paleontological Values: Paleontological remains may provide insight into past plant and animal species and communities (Marceron 1988).

Recreational Values: Many people visit and explore caves.

Karst ecosystems may also have **educational values**, and they may have value as a **unique landscape** within a region.

A second purpose for inventorying karst systems is to understand how the surface and subsurface are interrelated. This knowledge is essential for karst management. If local karst processes are understood, then potential impacts to karst resources can be identified and consequently, ameliorative actions can be proposed (T. Aley, Ozark Underground Laboratory, pers commun.).

3.3.2 CLASSIFICATION

The second stage to the **Inventory and Classification** procedure is to **classify** the karst resources into management class, based upon the **inventory** stage.

Some examples of inventory and classification systems in use are:

BUREAU OF LAND MANAGEMENT (BLM) - NEW MEXICO SYSTEM:

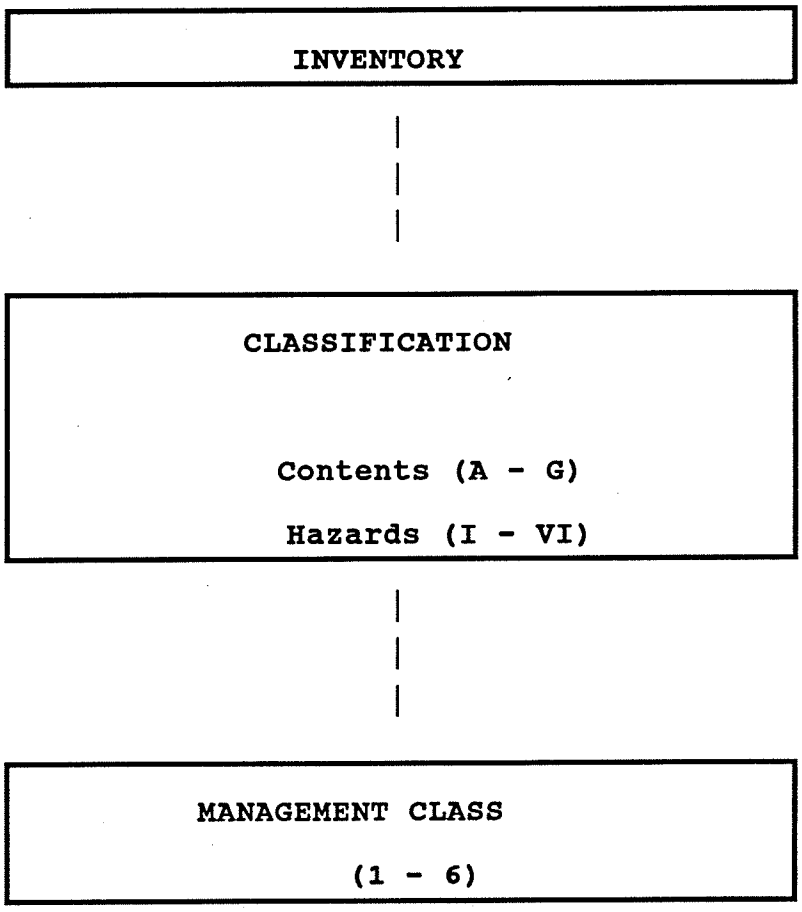
In the Roswell District of New Mexico, the Bureau of Land Management utilizes a "Dual-Coding" inventory and classification system (BLM 1988).

The BLM inventories cave contents and hazards, and ranks caves into 1 of 7 Content classes and 1 of 6 Hazard classes (Figure 3). For example, a Content Class A cave has few or no features of scenic value and it can withstand heavy visitation. In contrast, a **Content Class F** cave is fragile and delicate and is closed to recreational caving. Similarly, **Hazard Class I** caves are safe, while **Hazard Class VI** caves are extremely dangerous.

Based upon contents and hazards, each cave is categorized into 1 of 6 **Management Classes**, which specifies the required level of intensity. For example, **Management Class 1** caves are developed caves intended for visitor use. In contrast, **Management Class 6** caves are closed to almost everyone because of their fragile or sensitive contents, and/or because they are dangerous.

OTHER "DUAL-CODING CLASSIFICATION SYSTEMS:

FIGURE 3: BLM NEW MEXICO INVENTORY AND CLASSIFICATION SYSTEM



In the Ely District, Ely Nevada, the BLM also utilizes a "Dual-Coding" inventory and classification system, whereby caves are assigned a management class based upon cave contents and hazards (BLM 1985).

Likewise, the U.S. National Park Service has also adopted this system for the caves of Buffalo National River, Arkansas (NPS 1984). Similarly, the U.S. National Forest Service uses this system for the Ozark National Forest, Arkansas (Ramey 1990).

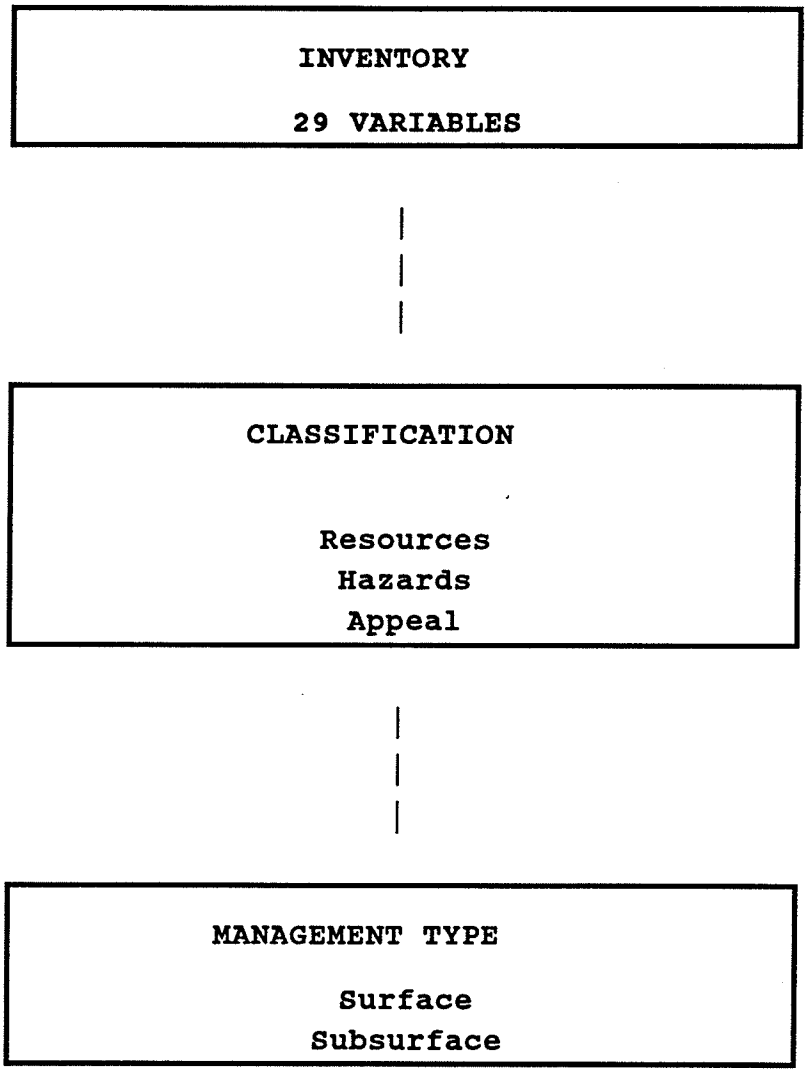
THE BRITISH COLUMBIA MINISTRY OF FORESTS:

The B.C. Ministry of Forests utilizes a modified "New Mexico" inventory and classification system (B.C. Ministry of Forests 1990). They classify caves into 1 of 3 Surface Management Types, and 1 of 3 Subsurface Management Types, based upon cave resources, hazards and appeal (Figure 4).

CRITICISMS OF THE "NEW MEXICO" SYSTEM

The "New Mexico" system focuses on evaluating individual caves and does not necessarily consider the entire karst ecosystem (Marceron 1988). Furthermore, this system may not evaluate the regional or national significance of karst resources (Marceron 1988).

FIGURE 4: B.C. INVENTORY AND CLASSIFICATION



There are similar criticisms about karst management in B.C., where it is argued that management concentrates on cave entrances and not on karst ecosystems (Griffiths 1991).

OTHER INVENTORY AND CLASSIFICATION SYSTEMS

1) A cave management system, based on biological, paleontological, historic/cultural, recreational, geological and educational resources values has been developed by **Nieland** (1990). This system has been proposed for use in **Lava Beds National Monument**, California, where caves would be classified into 4 management types (Sowers et al. 1989).

A drawback of this system is that it is designed to manage visitor access only, and it does not address land use. However, it seems likely that it could be modified to consider both surface and subsurface uses. Another shortfall of this system is that it too fails to evaluate the regional or national significance of a karst ecosystem.

2) The **Spelean Resources Inventory and Evaluation System** considers the quality and sensitivity of cave resources, and the degree to which those resources are threatened (Marceron 1988). The advantage of this system over those systems previously discussed is that it incorporates threats to the karst ecosystem.

3) The Natural History staff of the Nova Scotia Museum utilized a multi-disciplinary approach to acquiring information pertinent to the management of Hayes Cave, Nova Scotia. This team researched the cave environment, the plant and animal life surrounding the cave, and the historical land uses in the area (Morris 1985). Based on this information the team then identified conservation issues and recommended a management plan.

This inventory procedure offers a very useful framework for managing single caves.

SIGNIFICANCE AND APPLICABILITY OF INVENTORY AND CLASSIFICATION SYSTEMS

An inventory and classification system provides a systematic way of obtaining and evaluating information on karst resources. Any of the systems previously mentioned could be tailor-made to evaluate Manitoba's karst and to provide the technical information necessary for karst management. However, the system adopted for Manitoba should evaluate the regional, national and international significance of the province's karst.

Should karst management in Manitoba focus on a single cave, an information gathering framework could be developed from the procedure used for Hayes Cave.

3.4 KARST MANAGEMENT: STEP 2 IMPACT ASSESSMENT

A second common step of karst management is to identify current and potential impacts to karst ecosystems. To thoroughly assess karst impacts, it is essential to:

i) Understand karst fundamentals.

ii) Inventory and evaluate karst resources.

3.4.1 KARST FUNDAMENTALS

Five basic principles of karst that are pertinent to karst impact assessment and management are:

1) In karst terrain the surface and subsurface are interconnected (Aley 1990).

2) Water is the principal instrument that unites the surface and subsurface (Aley 1990).

3) Since autotrophic processes are inconsequential within caves, cave ecosystems depend upon the surface environment for food input (Poulson 1975).

4) The interchange of air and water between the surface and the subsurface affects the cave environment (Tuttle and Stevenson 1977). Consequently, spatial and temporal changes to cave temperature and humidity can impact cave fauna and speleothems (Tuttle and Stevenson 1977).

5) Caves are non-renewable resources (Marceron 1990).

Since the surface and subsurface are interconnected in karst terrain, any activity that interferes with air flow, air temperature, humidity, hydrology, water quality and cave input (such as food sources) may have a serious impact upon karst resources. Also, any activity that restricts the movement of cave fauna, either within the cave or between the cave and the surface, may be detrimental to the cave ecosystem.

3.4.2 KARST IMPACTS

Examples of surface and subsurface actions that may damage karst resources are examined in the following discussion.

FORESTRY OPERATIONS

The British Columbia Ministry of Forests (1983) recognizes 5 potential impacts that forestry operations may have upon karst environments.

1) Road construction and its accompanying blasting operations may; collapse cave ceilings, plug cave entrances and ruin cave formations.

2) Clear-cutting and bulldozing may cause hydrological modifications that could impact water quality, disrupt soils, clog or erode cave corridors, discolour speleothems, and destroy cave organisms.

3) Solid wood residues (trunks, branches, twigs etc.) may block cave entrances which may increase CO_2 levels within the cave. This could harm cave biota and impede the growth of speleothems.

4) Clear-cutting could destroy surface habitat that cave-dwelling animals (eg. bats) depend upon.

5) Construction of logging roads could increase the accessibility of some caves, which could lead to damage by visitors.

Clear-cutting is regarded as the principal threat to karst resources on Vancouver Island (Griffiths 1990a) where 6 significant karst systems have been damaged (Griffiths 1991). Examples of such destruction are (B.C. Ministry of Forestry no date):

1) The entrance to Maquinna Cave, the second deepest cave on Vancouver Island, was completely blocked as a result of road construction.

2) A portion of Minigill Cave was excavated during the expansion of a ballast pit.

3) The forest surrounding Scorch Cave was slash burned. As a result, soot and fouled air penetrated the cave, soiled speleothems and possibly impacted cave ecology.

4) Diesel fuel was spilled into Diesel Cave, either from road construction or timber harvesting. Cave water was polluted and wildlife was destroyed.

Also, clear-cutting near Glory 'Ole Cave, Vancouver Island, has been cited as the cause of windthrow which resulted in 6 trees falling into the cave entrance (Morris 1990).

Logging practices of 20 years ago in the Dry Medicine Lodge Creek area, Wyoming have also had detrimental effects upon karst resources (Aley, Ozark Underground Laboratory, pers commun.). Logging debris, and sediment from roads that were built across sinkholes have plugged karst waterways. However, it has been noted that these forestry operations were poor practices that occurred in steep canyons and in narrow valleys (Aley, Ozark Underground Laboratory, pers commun.). Therefore, these forestry methods may not be typical of operations utilized today.

An indirect example of forestry impacts on karst is Ape Cave in the Pacific northwest of the U.S.A. This cave was readily vandalized after logging roads increased access to the cave (Petty 1977).

IMPACTS OF OTHER VEGETATION MANIPULATION

Cave flooding could possibly result from overgrazing (Petty 1977) which could impact cave fauna (Tuttle and Stevenson 1977). Grazing can also cause soil erosion that may impact upon cave resources (Torgac Cave Management Plan 1989).

MINING IMPACTS

The impacts of mining operations on karst resources may entail (B.C. Ministry of Lands, Parks and Housing 1980):

1) Road construction could break down or modify cave entrances.
2) Local hydrology and water quality could be affected.
3) Debris could be directly dumped into karst systems, or it could enter indirectly through waterways.
4) Caves could be excavated.
5) Mining roads could increase accessibility to caves.

GROUND WATER POLLUTION

Ground water in karst regions may become polluted from:

i) Improper sewage treatment (Aley 1990).

ii) Irresponsible solid waste disposal (Hardwick and Gunn 1989a).

iii) Contaminated surface runoff from parking lots (Aley 1990), farms (Hardwick and Gunn 1989a), etc.

IMPACTS FROM HUMAN VISITATION

Perhaps any time a person enters a cave they alter it in some way (McAlpine 1983). Below is a listing of how visitors may impact the cave environment:

Disturbance of Cave Fauna: Hibernating bats may have only enough stored energy to last the winter (McCracken 1988). If they are disturbed and aroused from hibernation, they will utilize some of their energy savings and thus, they may not have enough energy to survive the winter (McCracken 1988). The outcome of disturbing a bat for several hours during hibernation could be to reduce the bat's ability to remain in hibernation by 2 to 3 weeks (Poulson 1975). Bats are very vulnerable to such disturbances and they have no defense mechanism to protect themselves from such interruptions (Kovats 1989).

Banding hibernating bats is thought to be one of the principal causes of declining bat populations in Czechoslovakia, and since 1980 this practice has been terminated (Murphy 1989). Banding has also hurt bat populations in the United States and consequently, the U.S. Fish and Wildlife Service has implemented a moratorium on bat banding (Fenton 1988).

Also, disturbing bat colonies at nursery sites may cause bats to abandon the sites (McCracken 1988).

Vandalism: Vandalism may be intentional or unintentional and it may take many forms, such as killing cave fauna (Tuttle

1979), disfiguring and littering cave interiors (McAlpine 1983), and discolouring and breaking cave formations (Marceron 1988, McAlpine 1983). For example, recreational caving is the major cause of damage to British caves that are protected for scientific purposes (Hardwick and Gunn 1989b).

Introduction of Foreign Materials: The cave environment may be altered by introducing foreign materials into the cave. For example, human visitors may introduce lint into caves, which is an unnatural food source and it may cause algae growth (Marceron 1988).

Scientific and Hobby Collecting: Cave decorations and fauna are both subject to removal.

The population size and reproductive potential of some cave fauna is so low that collecting specimens for scientific purposes could be devastating (McAlpine 1983) and some species may not be able to recover (Poulson 1975).

IMPACTS OF ALTERING THE CAVE ENVIRONMENT

"Improvements" to caves may modify the cave ecosystem. For example, lighting systems installed in caves may cause

algae, moss and moss protonema to grow (Marceron 1988). Furthermore, the construction of additional entrances may result in cave drying. Such was the case when an elevator shaft was built in Carlsbad Caverns, New Mexico (Petty 1977). Likewise, the enlargement of entrances may also alter the cave microclimate (Poulson 1975).

Installing **gates** at the entrance or within a cave may have very serious impacts upon the cave environment, and consequently cave resources. Gating is done to protect cave fauna, cave formations and landowners from prosecution (Hathorn and Thornton 1986).

Improperly designed gates may cause bat populations to decline (Petty 1977). Gates must not interfere with air flow, cave temperatures or movement of bats (Tuttle 1977). Changes in air flow may alter cave temperatures and consequently, may diminish the quality of the cave as a hibernaculum or as a nursery roost (Tuttle 1977). Gates may also increase bat predation by forcing bats to slow down when entering the cave (Tuttle 1977). There is concern about the effects of gates when they are installed on cave entrances less than 142 cm. (5 ft) in diameter (Tuttle 1977).

As a general guide, bat gate openings should be 14.6 mm (5.75 inches) high and 61mm (24 inches) wide (Hathorn and Thornton 1986). (This should be considered when designing gates in Manitoba).

Within 2 years of gating, bats abandoned 4 of 5 caves in the southeast U.S.A. between 1969 and 1976 (Tuttle 1977). They remained in the fifth cave, but their population was reduced due to increased mortality.

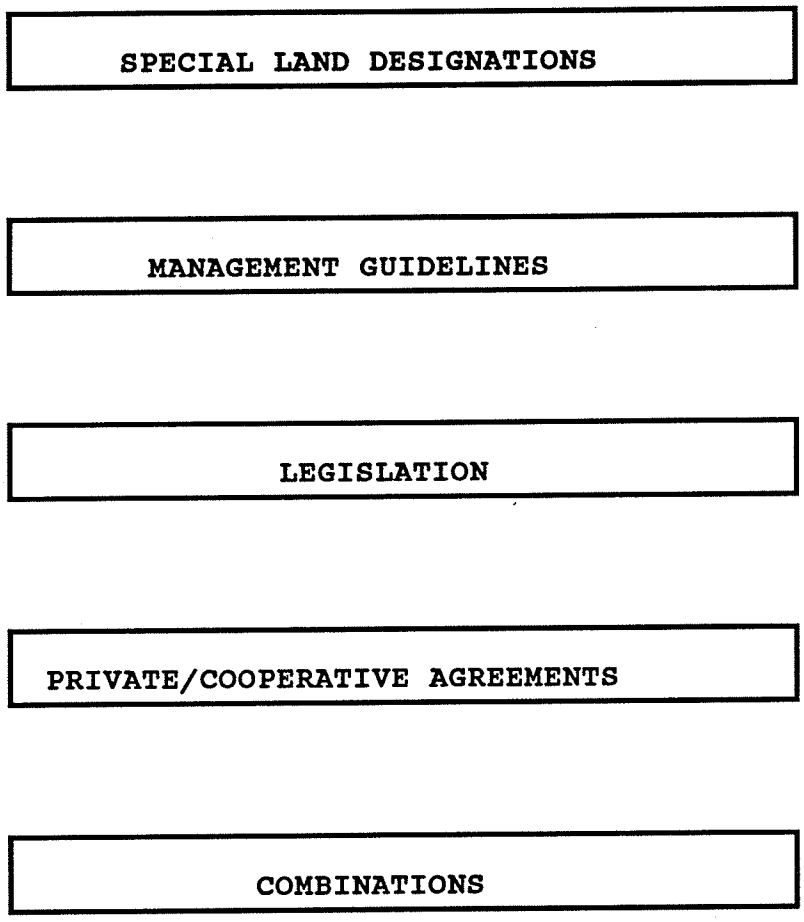
An ill-designed gate was the cause of bats abandoning Dry Cave, New Mexico (Petty 1977). However, once the gate was redesigned, the bats returned.

As an alternative to gates, caves in the Buffalo National River, Arkansas, that are used by endangered bat species are protected by **fences** (NPS 1984). Fencing may be the only suitable alternative to gates in situations where predation and altering air flow is possible (Tuttle 1977).

3.5 KARST MANAGEMENT: STEP 3 GENERAL PRESCRIPTIONS

Once the karst values have been identified and the potential impacts analyzed, a general management approach is prescribed. Figure 5 lists 5 general approaches to karst management.

FIGURE 5: GENERAL MANAGEMENT PRESCRIPTIONS



3.5.1 SPECIAL LAND DESIGNATIONS

One approach to karst management is to legally protect a karst region by establishing a special land designation such as a park, ecological reserve, natural history area, etc. Some examples of special land designations to protect karst resources are; Carlsbad Caverns National Park, New Mexico; Cody Caves Provincial Park, B.C.; Plateau Mountain Ice Cave Natural Area, Alberta, and Rat's Nest Cave Provincial Historic Resource, Alberta.

The inventory and classification systems utilized by the BLM (1985), U.S. Forest Service (U.S. Forest Service Manual 1986) and the B.C. Ministry of Forests (1990) provide for karst sites to be withdrawn from appropriation and safeguarded by a special land designation.

3.5.2 MANAGEMENT GUIDELINES

Another strategy is to establish a set of guidelines recommending what activities are acceptable in a karst area, and how these activities are to be executed.

For example, the U.S. Forest Service (1986) has a list of general concerns about timber harvesting in karst regions and they have developed specific guidelines for harvesting

in particular forests (Gifford Pinchot National Forest Management Plan).

Likewise, the B.C. Ministry of Forests (1990) has also developed a list of forestry guidelines for karst regions. These guidelines evolved through consultation with the provincial government, forest industry and the provincial speleological groups. It is the intention of the Forest Service to elevate the status of these optional guidelines to actual forest policy that forest companies will have to follow (Whitfield, B.C. Ministry of Parks, pers. commun.)

3.5.3 KARST LEGISLATION

Another approach to karst management to establish karst protection legislation.

For example, more than 30 countries and 24 of the U.S. states have some form of cave protection legislation (Griffiths 1990b).

The U.S. has passed the **Federal Cave Resources Protection Act of 1988**, which provides protection for significant caves on federal lands. The act formally recognizes that karst

management requires the mutual cooperation of land managers and the caving community.

The caving community in B.C. has drafted a Cave Protection Act that would safeguard significant caves as natural systems, and the act also delineates prohibited activities and associated penalties (Griffiths 1991).

3.5.4 PRIVATE AND COOPERATIVE CAVE PROTECTION

Private groups such as the Nature Conservancy have been active in several U.S. states acquiring conservation easements, leasing and gating caves, and researching cave fauna (Foster 1989, Opel 1991). They are also promoting cooperative management agreements between landowners, government and non-profit groups (Opel 1991).

Cooperative agreements have also been struck between government agencies and caving clubs, whereby the clubs clean and maintain caves, lead caving tours and conduct cave research (Goodbar 1990).

Also, caving clubs may control access to a cave. For example, Candlestick Cave, Vancouver Island, is managed by the B.C. Ministry of Forests in cooperation with MacMillan Bloedel. However, a cave custodian is appointed from the

caving community to control access to the cave (B.C. Ministry of Forests 1982).

3.5.5 COMBINATIONS

A final approach to karst management is to incorporate more than one of these strategies into a management plan. For example, general guidelines may apply to a karst region, but very sensitive caves may be protected by a special land designation (B.C. Ministry of Forests 1990).

3.6 SPECIFIC APPROACHES TO MANAGEMENT

Some of the specific management tools available are:

- The Roswell BLM have **guidelines** for establishing buffer zones around caves (Safford, BLM, pers. commun.).
- **Visitor access** may be controlled through the use of:

    i) Gates
    ii) Fences
    iii) permits
    iv) Use limits (number of visitors per trip, number of trips per year, time of year etc.)
    v) secrecy

- Visitors may be **diverted** from sensitive to less sensitive caves.
- **Signs** may deter visitors from entering a cave.
- Cave entrances may be **hidden.**

- The public should be **educated** of cave values and cave conservation.
- Short and long-term damage may be evaluated and management plans can be appropriately altered.
- Damage to caves may be repaired.

3.7 CONCLUSIONS

This chapter, Essentials of Karst Management, has discussed the evaluation of karst resources and how these resources may be damaged by surface and subsurface activities. This chapter has also reviewed various ways to manage karst ecosystems in order to ameliorate harmful impacts.

Currently, Manitoba has no karst management plan. However, by adopting appropriate karst management techniques from other regions, a framework can be developed for Manitoba to;

i) Evaluate Manitoba's karst resources,

ii) Assess the potential threats to these resources,

iii) Determine the need for a management plan,

iv) If management is warranted, evaluate management options, and

v) Implement a management plan.

4.0 RESULTS

PART 1: PHYSICAL, BIOLOGICAL AND CULTURAL RESOURCES

4.1 PHYSICAL SETTING

4.1.1 LOCATION

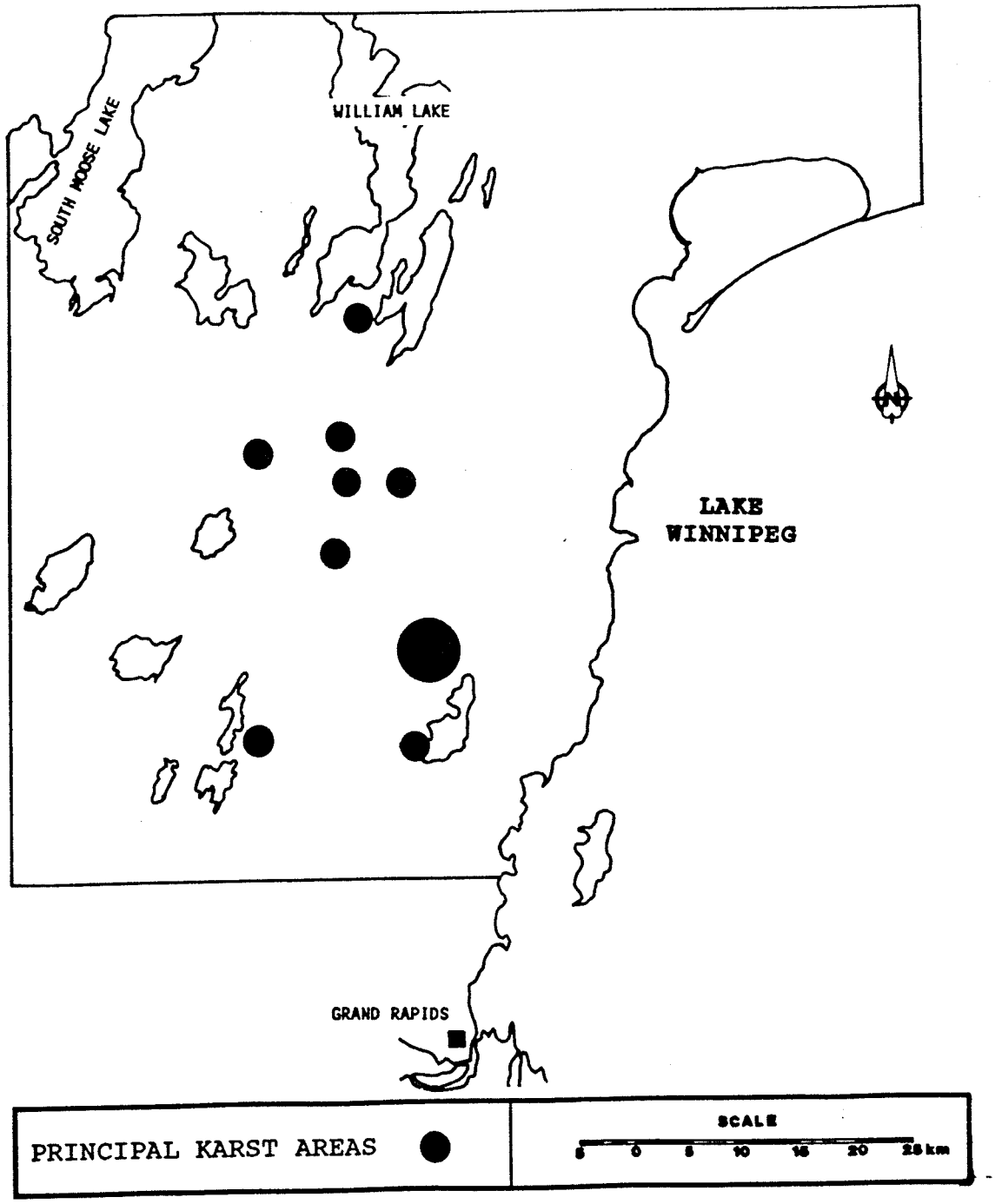
As illustrated in Figure 1, karst features have been identified in Manitoba as far south as Garson (Sweet et al. 1988), in various locations within the southern and northern Interlake (Voitovici and McRitchie, 1989; McRitchie and Voitovici, 1990; Speleological Society of Manitoba. In Press) and as far north as Grass River Provincial Park (Anderson 1988).

Most of the karst exploration in the province has occurred in the Grand Rapids Upland Region, the Gypsumville - Lake St. Martin area, and the Southern Interlake.

4.1.2 STUDY AREA

The three study areas of this practicum were the Grand Rapids Uplands, the Gypsumville - Lake St. Martin area, and the Dallas - Hodgson area (Figures 6-8).

FIGURE 6: GRAND RAPIDS UPLANDS STUDY REGION

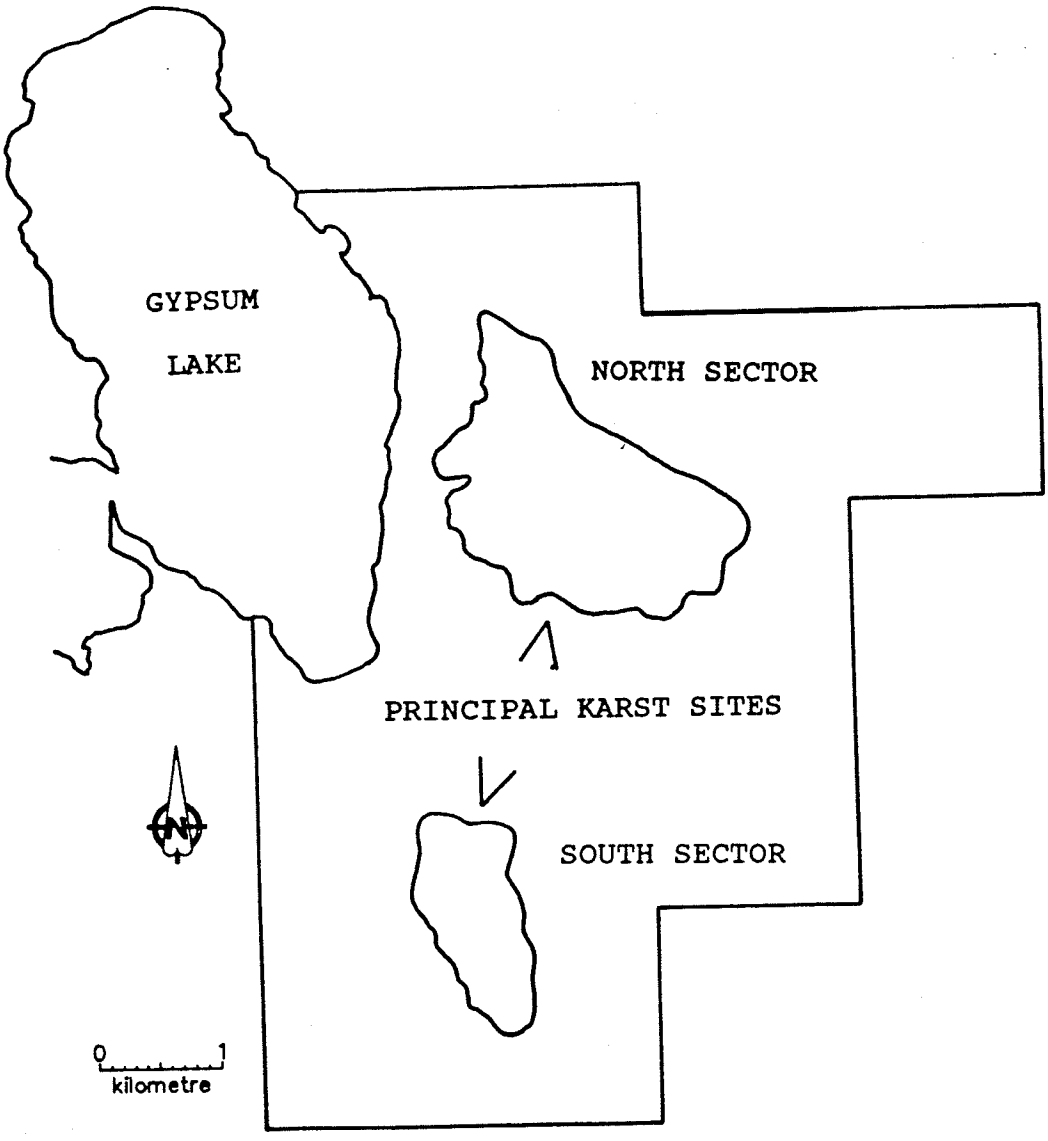


SOURCE: ADAPTED AFTER SWEET ET AL. 1988

FIGURE 7a: GYPSUMVILLE-LAKE ST. MARTIN STUDY AREA

GYPSUM LAKE EAST

TOWNSHIP 33 RANGE 8 WEST



SOURCE: ADAPTED AFTER McRITCHIE AND VOITOVICI 1990

FIGURE 7 b: GYPSUMVILLE-LAKE ST. MARTIN STUDY AREA

NORTH QUARRY

TOWNSHIP 33 RANGE 9 WEST

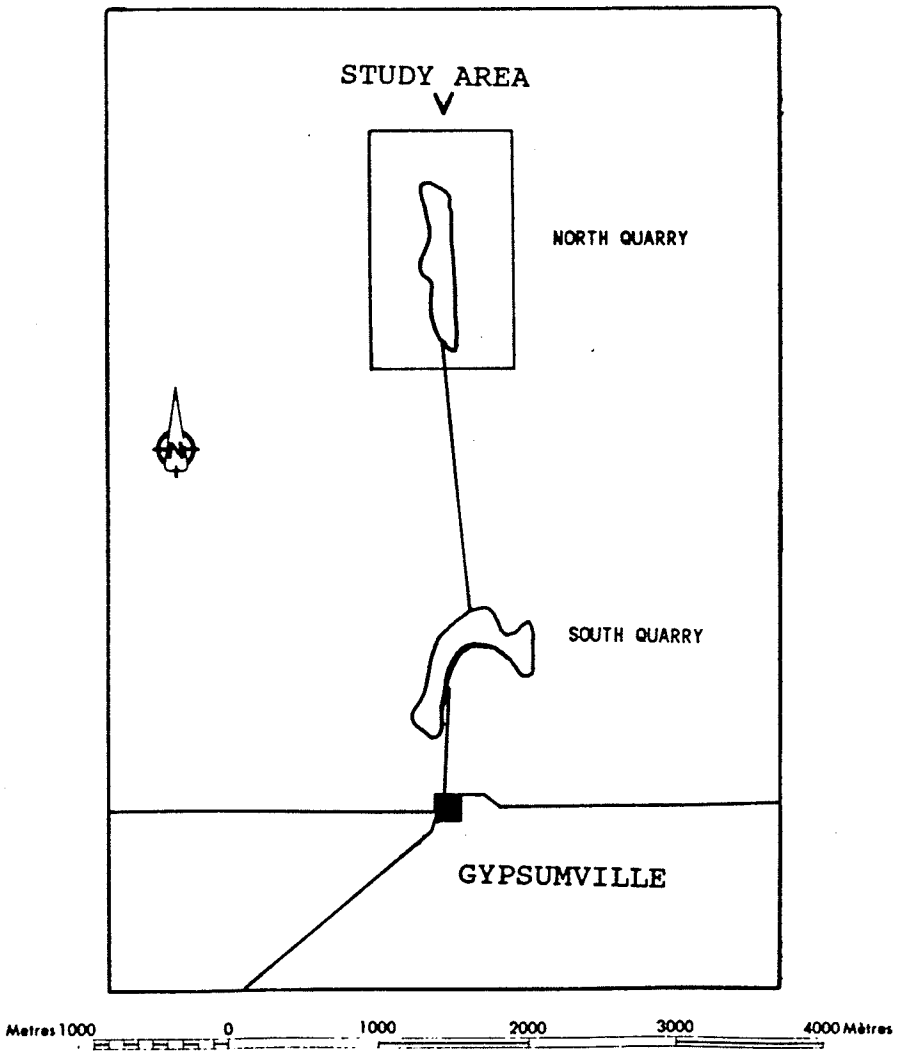
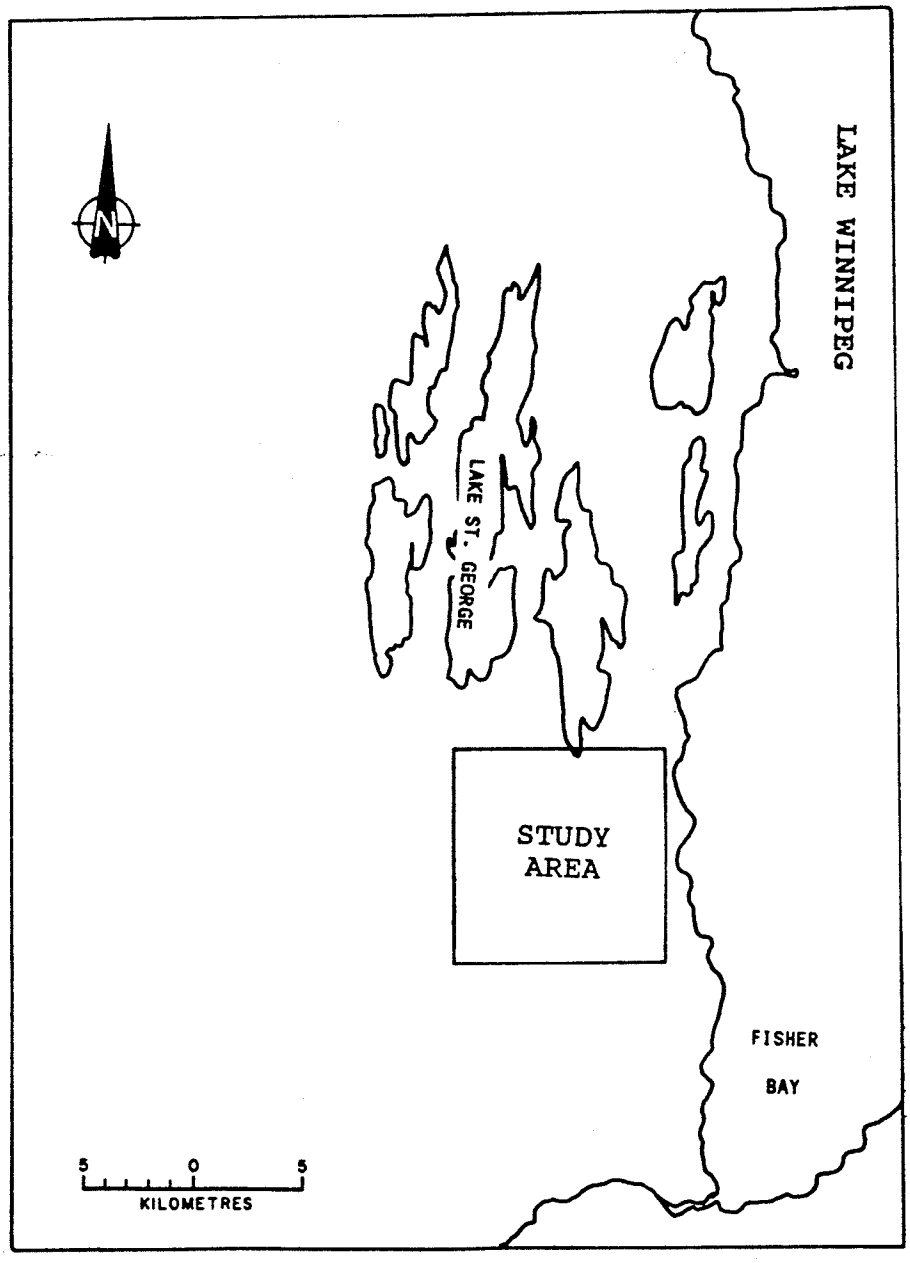


FIGURE 8: DALLAS-HODGSON STUDY AREA

TOWNSHIP 30 RANGE 1 EAST



Although karst features have been reported in several other locations of the southern Interlake (Sweet et al. 1988, Voitovici and McRitchie 1989), this paper will restrict its southern Interlake study area to the Dallas - Hodgson region. This is because very significant caves, in terms of size and biological values have been found within the Dallas - Hodgson area.

4.1.3 BACKGROUND ON WHY CAVES ARE FOUND IN MANITOBA

GENERAL

Karst landforms develop in carbonate and evaporate sedimentary rocks, and in quartzite (Bogli 1980). The karst features of Manitoba are located within the carbonate and evaporite sedimentary rocks of the physiographic (landform) region, the Manitoba Lowlands.

The majority of the Manitoba Lowlands is underlain by sedimentary rock. These rocks were formed from sediments deposited in shallow seas that repeatedly inundated the North American continent during the Paleozoic Era (570 to 225 million years ago).

Not all of the sedimentary bedrock of the Manitoba Lowlands are of Paleozoic age. The sedimentary strata of the Lake St.

Martin crater is approximately Permian in age (200 - 250 million years ago) (McCabe and Bannatyne 1970).

GRAND RAPIDS AREA

In general, the Grand Rapids area is mainly composed of dolomite and to a lesser extent sandstones that lie atop of older Precambrian basement rocks (McCabe and Bezys 1990). The dolomites and sandstones are sedimentary rocks that formed during the Silurian (approximately 430 - 395 million years ago) and Ordovician (approximately 500 - 430 million years ago) periods of the Paleozoic Era.

The Silurian and Ordovician strata are separated from one another by a series of escarpments that range from 2 to 15 metres high and are oriented towards the north and northeast (McCabe and Bezys 1990). On the eastern side of the escarpment is an Ordovician plain, typified by glaciolacustrian deposits (Klassen 1986) and dendritic drainage (Voitovici and McRitchie 1989).

On the western side of the escarpment is the Silurian Uplands, which lacks an organized system of drainage (Voitovici and McRitchie 1989). Much of the snowmelt and rainwater in the region percolate through sinkholes, as opposed to flowing overland.

It is in the dolomites of the Silurian Uplands on the western side of the escarpment that many of the karst features (such as solution caves) of the Grand Rapids region have been found (Sweet et al. 1988).

GYPSUMVILLE-LAKE ST. MARTIN AREA

Within the Gypsumville-Lake St. Martin region is a crypto-explosion crater, approximately 22.5 kilometres in diameter, which may have formed during the Permian or Triassic periods (200 -250 million years ago) (Bannatyne and Watson 1982).

The regional geology is composed of Ordovician and Silurian carbonates. However, within the crater, Paleozoic strata and granitic basement rocks are exposed (McCabe and Bannatyne 1970). These rocks were disturbed during crater formation and are consequently termed the "St. Martin Series".

Overlying the St. Martin Series are younger deposits of "red beds" (reddish-brown dolomitic siltstones, sandstones and shales) and "evaporites" (gypsum and anhydrites) that were formed during the Jurassic Period (175 million years ago) (Gunter 1987).

The red beds reach a depth of 60 metres (Speleological Society of Manitoba. In Press) and the evaporites reach a depth of 42 metres (McCabe and Bannatyne 1970). The evaporite deposits occur as ridges, that in places rise 15 metres above the surrounding terrain (McCabe and Bannatyne 1982). These deposits are located in an arc-shaped belt that is approximately 16 kilometres long and 13 kilometres wide, and runs northeastward from Gypsumville to the eastern side of Gypsum Lake (Gunter 1987).

It is within these gypsum deposits (that occur entirely within the crypto-explosion crater), that the caves of this region occur.

DALLAS-HODGSON AREA

The bedrock geology of the Dallas-Hodgson region is composed of Ordovician carbonates (Minerals Map of Manitoba 1980) and the caves of this region are found in Ordovician limestone and cherty dolomite (Sweet 1989a).

POTENTIAL FOR FURTHER CAVE DISCOVERIES

Solution caves may form in limestone, dolomite, marble, gypsum and rock salt (Palmer 1990). Furthermore, as

previously discussed, the Manitoba Lowlands are underlain by Paleozoic carbonates (limestone, dolomite and dolomitic limestone) and Jurassic evaporites (gypsum and anhydrite) which provide a medium for cave formation.

Although most of the cave exploration in the province has concentrated in the three study areas, exposed cavities have been reported as far north as The Pas and as far south as Garson (Speleological Society of Manitoba. In Press).

Not all areas of the Manitoba Lowlands have been thoroughly explored and therefore significant discoveries may still occur.

4.2 KARST RESOURCES

4.2.1 GRAND RAPIDS UPLANDS

KARST RESOURCES: GENERAL

The Silurian Uplands are characterized by large areas of exposed dolomite bedrock, termed pavements (Voitovici and McRitchie 1989). These pavements are solutional in origin (Sweet, unpublished paper) and may be classified into at least 5 categories (Sweet 1989b).

Several trenches and 2 types of sinkholes (round and shallow, and those resembling enlarged joints) have formed within these pavements (Sweet 1989b). Many of the trenches and sinks in the region have further developed to form caverns (Sweet et. al. 1988).

Other karst features identified within the Silurian Uplands are; Zanjones (enlarged joints which are tens of metres long), clints (a section of rock which has risen out of its corroded joints or bedding planes), grikes (solution-eroded joints), karren (solution cut grooves in karst pavement) and kamenitzas (solution basins) (Sweet, unpublished paper).

The karst resources of the Grand Rapids Region are unique because no where else in Canada are such features found in such arid and flat conditions (Sweet et al. 1988).

CAVES

The following data on caves is based upon information gathered by Voitovici and McRitchie (1989), McRitchie and Voitovici (1990), and the Speleological Society of Manitoba (SSM In Press).

Number of Caves

Of the 146 caves that have been confirmed and located by the SSM, as of November 1990, 44 are located within the Grand Rapids Uplands.

Length of Caves

The longest caves in this region, "MooseArm Pit" and "Lookout Crevice" measure 45.5 metres and 43.0 metres respectively. The shortest caves of the region are "Wet Memory" and "Chain", which measure 2.0 and 3.5 metres, respectively.

Depth of Caves

The depth of the caves of this region range from 13.4 to 0.5 metres. Seven of the province's deepest caves, including Manitoba's deepest cave, "Knoll Chimney" (13.4 metres) are found within this region.

Orientation of Caves

The caves of the Grand Rapids region appear to be the result of the enlargement of joints (fractures in the bedrock) by solution (Sweet 1989b). Consequently, the caves are oriented in the same direction as the main joints (Sweet 1989b). That is, approximately 120 degrees east-west and they are also positioned in a north-south direction (Anderson 1988).

Along these fractures, caves may be situated in groups, or they may appear individually (Sweet 1989a).

Cave Formation

Sweet (1989b) suggests that some, but not all, of the caves in the Grand Rapids region have formed within the last 10,000 years (since the last glaciation) by the dissolving power of snow meltwater and precipitation from thunderstorms. A contrary opinion supposes that the caves of the Grand Rapids region are remnants of larger caverns that formed before the last glaciation (Lammers, Manitoba Museum of Man and Nature, pers. commun.).

Regardless of whether the caves are preglacial or postglacial in origin, there are two fundamental points to be made. First, the caves in the region are still active (G. Lammers, Manitoba Museum of Man and Nature, pers. commun.) and therefore, any land use changes that interfere with karst processes may affect future cave development. Second, and perhaps more importantly, these caves have taken thousands or perhaps millions of years to form and hence, they should be regarded as **non-renewable resources**.

Cave Deposits

In general, few speleothems have been found in the caves of the Grand Rapids region, however, some caves do exhibit

fretted spongework, pseudo-popcorn and micro-gours (Sweet et al. 1988).

4.2.2 GYPSUMVILLE-LAKE ST. MARTIN AREA

KARST RESOURCES: GENERAL

To date, there are 3 principal karst locations within the Gypsumville - Lake St. Martin region (Figures 7a and 7b):

i) The North Quarry region
ii) East of Gypsum Lake: North Sector
iii) East of Gypsum Lake: South Sector

The type of karst found in this area is termed "Cockpit" (small karst depressions) and is characterized by sinkholes and caves. This region supports one of the highest concentrations of "gypsum-sinkholes" in Canada, some of which are more than 100 metres in diameter (Voitovici and McRitchie 1989).

The gypsum topography of the Gypsumville - Lake St. Martin region is unique in Canada, perhaps in North America, and furthermore, it is the last known example of pristine gypsum topography in North America (Stenson 1989).

CAVES

The following data on caves is based upon information gathered by Voitovici and McRitchie (1989), McRitchie and Voitovici (1990), and the Speleological Society of Manitoba (SSM In Press).

Number of Caves

Eighty-five caves, or more than 58% of the caves in Manitoba documented by the SSM occur within the Gypsumville region. Twenty-five are found near the Gypsumville north quarry and 60 are located east of Gypsum Lake; 30 in the north section and 30 in the south section.

Length of Caves

Thirty-nine of the 85 caves found in the Gypsumville region have been measured, and 38 have been mapped.

Cave length ranges from 220.0 to 7.0 metres. Eight of the province's longest caves are in this region, including Manitoba's two longest caves, "The Satin Spar - Catacomb System" (220.0 metres) and "Labyrinth" (189.0 metres). These 2 caves are located in the southern and northern sectors East of Gypsum Lake, respectively.

The average length of the caves in this region is 44.0 metres.

Depth of Caves

Cave depth ranges from 9.0 to 0.5 metres, and the average is 2.3 metres.

Cave Formation

The majority of caves in this area are believed to have formed by dissolution since the last glaciation (K. Monson, University of Wpg., pers. commun.). Like the caves in the Grand Rapids area, these too are believed to be active (Speleological Society of Manitoba, unpubl. data).

Cave Deposits

Gypsum popcorn and ice crystals are among the cave formations found in the region.

4.2.3 DALLAS - HODGSON AREA

KARST RESOURCES: GENERAL

Trenches, sinkholes and caverns have formed in the Ordovician dolomites and cherty dolomitic limestones of this region (Sweet et. al. 1988).

CAVES

The following data on caves is based upon information gathered by Voitovici and McRitchie (1989), McRitchie and Voitovici (1990), and the Speleological Society of Manitoba (SSM In Press).

Number of Caves

Nine caves have been found within this region.

Length of Caves

All of the caves found in this region have been measured. Length ranges from 165.3 metres (Bat Cave) to 11.0 metres (Anklebiter). The average length is 42.9 metres.

Depth of Caves

Cave depth ranges from 12.5 metres (Bat Cave) to 1.8 metres (Anklebiter), and the average depth is 5.8 metres.

"Bat Cave" is the third longest cave in the province and it is also the province's second deepest.

Cave Deposits

"Broccoli" and budding stalagmites have been recorded (Sweet et. al. 1988), as well as small straws, draperies, cascading buttresses and flowstone.

4.3 BIOLOGICAL RESOURCES

A more detailed account of biological resources is located in the first 3 appendices.

4.3.1 BATS

Little brown bats (Myotis lucifugus) and Keen's bats (Myotis keeni) are native to Manitoba and depend upon selected caves for a winter hibernacula. However, only a small percentage of the caves in the province meet the required temperature and humidity conditions suitable for a hibernaculum (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.). Furthermore, these bats appear to be loyal to their hibernating sites (Dubois 1989, 1990, 1991).

For reasons discussed in Chapter 3, under "Karst Impacts", bat caves should not be entered from October 1 to May 15 (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.).

GRAND RAPIDS AREA

Bats have been observed in 9 caves within the Grand Rapids Region (Dubois, 1989, 1990, 1991; SSM In Press). Firecamp, Dale's and Microwave 1 are 3 caves in which several hundred bats have been noted (Dubois 1989) and therefore; appear to be significant hibernacula.

GYPSUMVILLE-LAKE ST. MARTIN AREA

Bats have been seen in 5 caves in the Gypsumville-Lake St. Martin area (Dubois, 1989, 1990, 1991; SSM In Press). Fold Cavern, located east of Gypsum Lake, may be an important

winter roosting site. Although few bats have been observed in this cave, the amount of guano present suggests that this cave may be an important hibernaculum.

DALLAS-HODGSON AREA

The largest bat hibernaculum in Manitoba is St. George's Bat Cave, used by several thousand bats (mostly little brown bats but some Keen's) (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.). So far it is known that bats migrate to this cave from as far away as the Grand Rapids Uplands, the Gypsumville area and Melita (Dubois 1991), which emphasizes the regional importance of the cave as a bat hibernaculum.

Bats have also been observed in Window Cave (SSM In Press).

4.3.2 INVERTEBRATES

GRAND RAPIDS AREA

A new species of midge (Camptocladius sp.) was found in Firecamp Cave, in the Grand Rapids region on September 30, 1990 (McKillop, unpubl. data). This species may spend its larval stage in the bat guano of the cave.

Also, the Herald Moth (Scoliopteryx libratrix) has been found in 9 caves (McKillop, unpubl. data; SSM In Press) and

likewise, the Tissue Moth (Triphosa haesitata) has also been observed in 9 caves (McKillop, unpubl. data). These moths likely utilize the caves as overwintering sites.

In addition, midge-like flies (Exechiopsis sp.) have also been found in a cave in the Grand Rapids region (McKillop, unpub. data). These insects may be able to complete their entire life cycle within the cave environment. Also, mosquitoes (A. earlei) have been observed in 2 caves (McKillop, unpub. data).

GYPSUMVILLE-LAKE ST. MARTIN AREA

The Herald Moth has been located in 6 caves, the Tissue Moth has been seen in 3 caves, and mosquitoes have been observed preparing for hibernation in 1 cave (McKillop, unpubl. data).

DALLAS-HODGSON AREA

The Herald Moth has been observed in 2 caves, while the Tissue Moth has been seen in 1 cave (McKillop, unpubl. data).

4.3.3 RARE VASCULAR PLANTS

Ten rare vascular plant species have been located near the three study sites (White and Johnson 1980). However, it

appears as if none of these plant samples were taken from within these three study regions (Manitoba Museum of Man and Nature Natural Science Data Base; University of Manitoba Herbarium).

These findings should not be interpreted to mean that there are no rare plant species within the study sites. A detailed botanical survey of these sites was not conducted. Therefore, it is unknown whether rare plant species inhabit any of the study areas.

It should be emphasized that some of these species have a wide natural range and therefore it is possible that they could be found within the study regions. For example, the known distribution of Cypripedium arietinum in Manitoba is from Lake Winnipegosis to West Hawk Lake (White and Johnson 1980). Hence, this plant could possibly be found within the Gypsumville or Dallas-Hodgson study regions.

4.4 PALEONTOLOGICAL RESOURCES

Sinkholes and caves have been known to act as natural traps for animals, and they may also act as a preservative environment for faunal remains. Animal skeletons, approximately 5000 years old, were found in a Gypsumville sinkhole in 1987 (Goulet, In Press). An initial examination

of these remains suggests that this area may have been warmer and drier 5,000 years ago (Goulet, In Press).

Animal remains were also discovered in a trench in the Grand Rapids region. If the caves of this region are pre-glacial, it is possible that fossils of extinct species may be found (Goulet, In Press).

4.5 HISTORICAL/ARCHEOLOGICAL RESOURCES

Despite the prehistorical and historical importance of Grand Rapids (McCarthy 1988), major archeological sites have not yet been recorded from the karst sites of the Grand Rapids study area (Manitoba Historical Resources Branch).

Likewise, significant archeological finds have not yet been recovered from the Gypsumville study site, nor have they been found within the Dallas-Hodgson study area (Manitoba Historical Resources Branch). However, late prehistoric (0 - 1,400 A.D.) projectile points and a projectile point scraper were found northwest of the Town of Gypsumville (Manitoba Historical Resources Branch).

Although significant archeological discoveries have not been recorded from the three study sites by the Manitoba Historical Resources Branch, **it is likely that some sites**

within these areas may have cultural significance to aboriginal people who use these lands. For example, it is known that hunting hibernating bears in the Gypsumville caves was a significant activity for natives, a century ago (Tyrrell 1889).

PART 2: LAND USE AND POTENTIAL IMPACTS

4.6 FORESTRY

4.6.1 FOREST INVENTORY

The following section provides an overview of the forest cover in the three study areas to assess whether forestry is a potential threat.

GRAND RAPIDS AREA

All of the caves of the Grand Rapids area are located on at least some Productive Forested Land and some of the cave areas contain segments of Non-Productive Forested Lands. The dominant tree species is Jack pine, and to a lesser extent Black spruce and Trembling aspen.

The region north of Buffalo Lake, which includes the Sturgeon Gill Road, Moose Arm Pit, Trenchland and Cat Trail cave areas, have been burned and Jack pine is starting to regrow. Likewise, the Squeaky cave region (located south of

Jackpine Lake) and 1 stand in the Reedy cave region have also been burned and Jack pine is regrowing.

Mature forests occur in the Porcupine Cluster and Ten Mile Road cave areas. These stands are composed primarily of Jack pine with about 10 to 20% Black spruce.

GYPSUMVILLE-LAKE ST. MARTIN AREA

NORTH QUARRY

The North Quarry cave region is classified as both Non-Productive and Productive Forested Land. In the Productive Forested Land the dominant tree species are Trembling aspen and to a lesser extent, Black spruce.

Approximately 95% of these stands are classified as immature or younger, while only 5% of them are regarded as mature. Trembling aspen is the dominant species in the mature stands.

EAST OF GYPSUM LAKE

Both Non-Productive and Productive Forested Lands occur within this cave region. The most common tree species in the Productive Forested Land appears to be Trembling aspen, followed by Black spruce.

Approximately 90% of the stands are classified as immature or younger. However, the remaining 10% of the forests are mature, the bulk of which are Trembling aspen.

DALLAS-HODGSON AREA

The Dallas-Hodgson study area is classified mainly as Productive Forested Land, with some areas of Non-Productive Forested Land.

This area was burned in 1989. The previous forest cover consisted of Black Spruce, Trembling Aspen, Jack Pine, Balsam Fir, White Birch, Tamarack and White Spruce and Balsam Poplar.

4.6.2 CURRENT AND PROPOSED FORESTRY OPERATIONS

GRAND RAPIDS AREA

The Grand Rapids study region lies within Forest Management Units (F.M.U.s); 82 of the Nelson River Forest Section; and F.M.U.s 51 and 53 of the Saskatchewan River Forest Section.

F.M.U.s 51 and 53 are located within the Repap Manitoba Inc. Forest Management License (F.M.L.) area, while F.M.U. 82 is not.

Repap Manitoba Inc. is currently conducting their forestry operations in accordance with the Repap Manitoba Inc. Five-Year Forest Management Plan 1988 - 1992. This plan gives Repap the authority to harvest timber in an area between William Lake and Little Limestone Lake, in F.M.U. 51 (Figure 9). Sinkholes are known to exist in this area (W. Anderson, Manitoba Parks Branch, pers. commun.) and logging equipment has already collapsed 1 cavern (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.).

According to **Repap's Proposed Five Year Operating Plan January 1, 1990 to December 31, 1994**, Repap plans to harvest 249,000 cubic metres of softwood and 7,000 cubic metres of hardwood from F.M.U. 51. Correspondingly, this company intends to harvest 633,000 cubic metres of softwood and 65,000 cubic metres of hardwood from F.M.U. 53.

Repap also proposes to build 153 kilometres of main all-weather roads in F.M.U. 51 and 177 kilometres of the same type of road in F.M.U. 53. Figure 10 illustrates the location of the proposed harvesting sites within the Grand Rapids study site, for the years January 1, 1990 to December 31, 1994.

This map shows that timber harvesting is scheduled to occur near the **Moon Lake Road and Reedy Lake cave areas**. Also a

winter road is proposed to link these two harvesting sites. It should be noted that Dale's Cave appears to be a significant bat hibernaculum and that it is located in the Reedy Lake cave area. It is possible that other caves in this area may also be bat hibernacula (Speleological Society of Manitoba. In Press).

Timber harvesting and 25 kilometres of all-weather road construction is also proposed for the area between William Lake and Little Limestone Lake (Repap Manitoba Inc. 1989b). As previously mentioned, sinkholes occur in this region and one cave has been damaged from logging. Caves are also located south of the designated cutting area.

GYPSUMVILLE-LAKE ST. MARTIN AREA

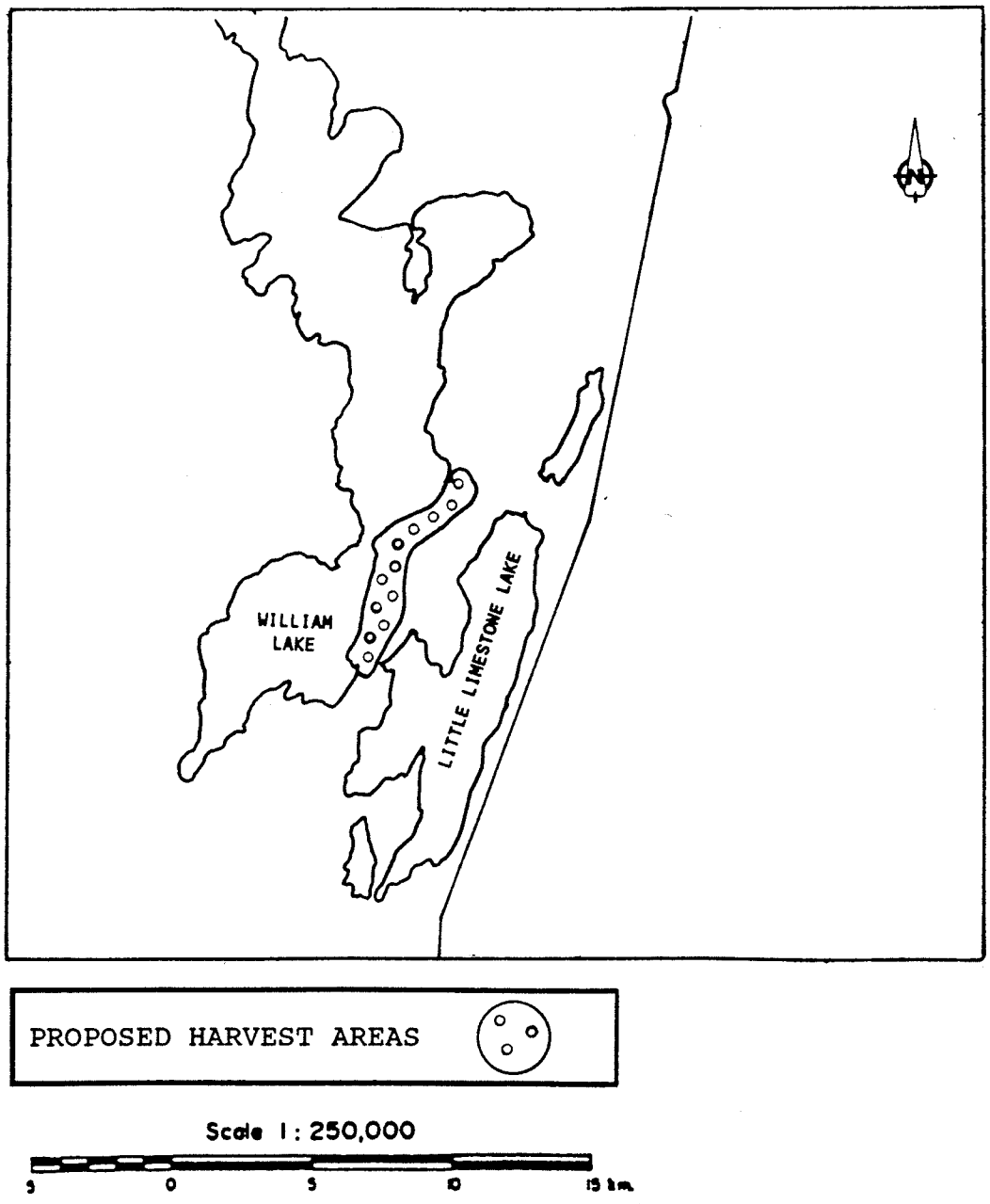
The karst sites near the North Quarry are located within F.M.U. 43, while the karst sites east of Gypsum Lake are in F.M.U. 45.

F.M.U. 43 is located within the Repap Manitoba Inc. F.M.L. area, while the karst sites east and south of Gypsum Lake are located within the Integrated Wood Supply Area #2 (IWSA 2).

FIGURE 9: TIMBER HARVEST PLANS

REPAP MANITOBA INC.

1988 - 1992

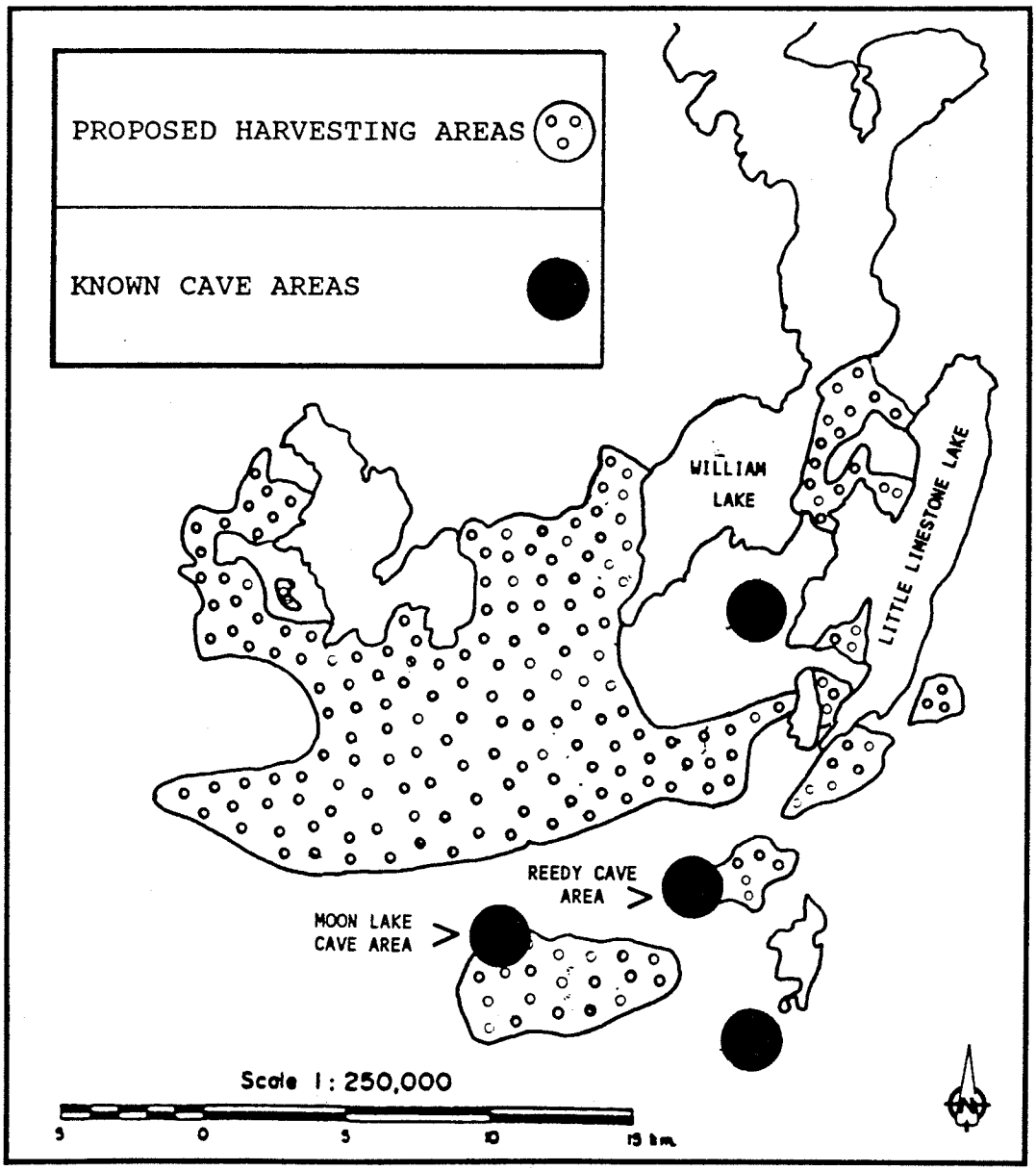


SOURCE: REPAP MANITOBA INC. 1989

FIGURE 10: PROPOSED TIMBER HARVEST PLANS

REPAP MANITOBA INC.

1990 - 1994



SOURCE: ADAPTED FROM
REPAP MANITOBA INC. 1989b
SWEET ET AL. 1988

Repap is not currently harvesting near the Gypsumville karst sites, nor do they plan to in their Five Year Operating Plan 1990 - 1994.

IWSA-2 is managed by the provincial Forestry Branch, and Abitibi-Price Inc. has the first right to purchase or harvest spruce or balsam on Crown land. Current timber harvesting in the Gypsumville study region is mostly accomplished by quota holders. **Harvesting does not occur near the karst sites, but it does take place south of Gypsum Lake near the Dauphin River**.

However, forests on private property can be harvested as the owners desire.

DALLAS-HODGSON AREA

Timber is currently being harvested in the Dallas-Hodgson region and has impacted at least 1 karst site. It was reported to the SSM that in 1989 a cave was deliberately plugged with logging debri (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.).

4.7 MINING

4.7.1 GRAND RAPIDS AREA

Presently there is no commercial mineral extraction occurring within the Grand Rapids study region. However, a private sector company does have an active permit that allows them to explore for minerals in part of the study area (Mining Records Section 1990a), and there are also active mining claims within the study area (Mining Records Section 1990b).

NICKEL-COPPER

Underlying the Paleozoic strata of the Grand Rapids Area is the Precambrian Churchill-Superior Boundary zone. This zone is an area of important mineral deposits, such as the Thompson-Nickel Belt. Consequently, there is the potential for nickel-copper deposits to be located within this boundary zone (W. D. McRitchie, Manitoba Geological Services Br., pers. commun.).

During the late 1960s and early 1970s, nickel was found at three sites within the Grand Rapids study area (Mineral Resources Branch). These locations were located near Baker Lake, southeast of Little Limestone Lake, and northeast of Clearwater Lake.

LEAD-ZINC

The Paleozoic carbonate formations of the Manitoba Lowlands are similar to those of the Mississippi River Valley and

those of Tennessee, which embody significant lead and zinc deposits (Sweet et al. 1988). Furthermore, significant zinc-lead and copper deposits have also been found in Paleozoic limestones in other parts of Canada (Esposito 1986).

Consequently, the Geological Services Branch of Manitoba Energy and Mines is conducting geochemical studies on the Paleozoic strata of Manitoba's Interlake to assess its potential for lead and zinc (McRitchie 1989).

DOLOMITE

Although there are dolomite outcrops within the study area (Bannatyne 1988) this resource has not been quarried at a commercial scale from the area. However, such quarries have existed south of the study area, near Grand Rapids and north of the study area near Minago River (Mineral Map of Manitoba 1980).

Dolomite of the Cedar Lake Formation occurs within the study site (Bannatyne 1988). An analysis of this formation, from a quarry at Fairford, Manitoba, has shown that this dolomite is of high quality and may be used to produce magnesium metal and dolomitic lime (Gunter 1990).

4.7.2 GYPSUMVILLE-LAKE ST. MARTIN AREA

GYPSUM

Gypsum has been extracted from the Gypsumville study region since 1901 (Bannatyne 1985). The four principal gypsum/anhydrite quarries, Gypsumville Quarry North, Gypsumville Quarry South, Whippoorwill Hill Quarry and Elephant Hill Quarry are operated by Domtar Construction Ltd. (Gunter 1990).

At the present time there is a stockpile of gypsum at the Gypsumville Quarries and therefore, gypsum is not being extracted from these locations.

4.7.3 DALLAS-HODGSON AREA

An intermittently used sand and gravel quarry is located approximately 1.5 km (1 mile) south of St. George's Bat Cave.

4.8 ABORIGINAL PEOPLES' INTERESTS

The three study areas may be of interest to the Aboriginal people of Manitoba because of:

i) Unfulfilled Treaty Land Entitlement (land that Indian Bands are entitled to, but never received). This may possibly be an issue in the Grand Rapids and Dallas-Hodgson Study Areas.

ii) Northern Flood Agreement (compensation to be awarded to 5 northern Indian bands for damages caused by hydroelectric development projects on the Churchill and Nelson rivers). This may possibly be an issue in the Grand Rapids Study area.

iii) Traditional Land Use (hunting, trapping, fishing, berry picking, etc.).

iv) Cultural Significance.

4.8.1 GRAND RAPIDS AREA

TREATY LAND ENTITLEMENT

The federal government has agreed that under Treaty No. 5, the Norway House Band is entitled to more land than what they initially received under this Treaty (T.A.R.R. 1984). As of yet, these two parties have not reached a Treaty Land Entitlement Agreement (M. Wagner, T.A.R.R., pers. commun.). Therefore, it is unknown how much land or what land this Band may select.

The federal government is also reviewing whether The Pas Band has received its full Treaty Land Entitlement (T.A.R.R. 1984). Consequently it is uncertain whether this Band may be entitled to, or desire any lands within the Grand Rapids study area.

NORTHERN FLOOD AGREEMENT

In addition to not receiving Full Treaty Entitlement, the Norway House Band is also party to the Northern Flood Agreement. Consequently, the Grand Rapids study area could possibly be of interest to this Band, pursuant to the Northern Flood Agreement.

TRADITIONAL LAND USE AND CULTURAL SIGNIFICANCE

The Norway House Band, The Pas Band, the Moose Lake Band and the Easterville Band likely hunt in the Grand Rapids study area (M. Wagner, T.A.R.R., pers. commun.). Therefore it is possible that these Bands may regard specific sites within this study region as being culturally significant.

4.8.2 GYPSUMVILLE-LAKE ST. MARTIN AREA

TRADITIONAL LAND USE AND CULTURAL SIGNIFICANCE

The Fairford Band, the Little Saskatchewan Band, The Narrows Band and the Dauphin River Band are located near the Gypsumville study region and may utilize this area in traditional ways. Likewise, they may also regard certain sites within this region as being culturally significant.

4.8.3 DALLAS-HODGSON AREA

TREATY LAND ENTITLEMENT

The federal government is currently reviewing whether the Peguis Band has received its full Treaty Land Entitlement (T.A.A.R. 1984). Consequently it is uncertain whether this Band may be entitled to, or desire any lands within the Dallas - Hodgson study area.

TRADITIONAL LAND USE AND CULTURAL SIGNIFICANCE

The Jackhead Band, the Fisher River Band, the Lake St. Martin Band and the Dauphin River Band are located near the Dallas - Hodgson study region and may utilize this area in traditional ways. Likewise, they may also regard certain sites within this region as being culturally significant.

4.9 TRAPPING

A karst management strategy should consider its impact upon other users of the area.

Trapping data were not available specifically for the three study regions, but rather it were available by Registered Trapline Section (for Grand Rapids and Gypsumville) and by Open Area Trapping Section (for Dallas). This data should provide general information on the significance of trapping within the study regions.

4.9.1 GRAND RAPIDS REGISTERED TRAPLINE SECTION

The total number of trappers registered within the Grand Rapids Trapline Section, for the years 1984/85 to 1989/90, ranged from 86 in 1986/87 to 45 in 1989/90 (Manitoba Natural Resources 1991). The average income per trapper for this same time period ranged from $929 in 1986/87 to $274 in 1989/90.

4.9.2 GYPSUMVILLE REGISTERED TRAPLINE SECTION

The total number of trappers registered within the Gypsumville Trapline Section, for the years 1984/85 to 1989/90, ranged from 45 in 1986/87 to 9 in 1989/90 (Manitoba Natural Resources 1991). The average income per trapper for this same time period ranged from $1,682 in 1986/87 to $679 in 1989/90.

4.9.3 DALLAS OPEN AREA TRAPPING SECTION

The total number of trappers registered within the Dallas Open Area Trapping Section, for the years 1984/85 to 1989/90, ranged from 403 in 1986/87 to 141 in 1989/90 (Manitoba Natural Resources 1991). The average income per trapper for this same time period ranged from $824 in 1986/87 $232 in 1989/90.

4.10 LAND OWNERSHIP

The purpose of this section is to summarize what lands of the study areas are owned by the Provincial Crown, by the Federal Crown, or by private entities, and to delineate those parcels of land whose sub-surface and/or surface mineral rights are not owned by the Provincial Crown.

A more detailed analysis appears in Appendix 5.

4.10.1 GRAND RAPIDS STUDY AREA

There are seven parcels of land within the Grand Rapids study region with encumbrances (Crown Land Registry System 1991). However, caves have not yet been documented from these locations. The remainder, and majority of the study area is provincial Crown land, with mineral and gravel rights belonging to the Crown.

4.10.2 GYPSUMVILLE-LAKE ST. MARTIN AREA

NORTH QUARRY REGION

Much of the North Quarry Region, defined as Township 33, Range 9 west, Section 2, is owned by Domtar Limited (Crown Lands Registry System 1991; Land Titles Registry).

GYPSUM LAKE EAST - NORTHERN SECTOR

It appears that the largest concentration of caves in the northern region is situated on private land (Figure 11) (Crown Lands Registry System 1991; Land Titles Registry). The two principle land holders are Domtar Limited and the Canadian Northern Railway (presumably now owned by the Canadian National Railway).

GYPSUM LAKE EAST - SOUTHERN SECTOR

The highest concentration of caves in the Gypsum Lake East - South Sector, which is located near Anhydrite Hill (Figure 11), appears to be located on lands owned by Domtar Limited (Crown Lands Registry System 1991; Land Titles Registry).

The karst locations directly south of Anhydrite Hill are located on and/or near property owned by Domtar Limited and the Canadian Northern Railway Company (Crown Lands Registry System 1991). These karst localities are also situated near lands which are for the use of the Little Saskatchewan Indian Reserve.

The karst features which are located southeast of Anhydrite Hill (in Township 33, Range 8 west, Section 1) are situated on Provincial Crown Land, where the Crown owns the surface and sub-surface mineral rights (Crown Lands Registry System 1991).

4.10.3 DALLAS-HODGSON AREA

The Dallas-Hodgson study area is located on Provincial Crown Land, where the Crown owns the surface and subsurface mineral rights (Crown Lands Registry System 1991). An ecological reserve has been proposed for the north half of the south-east quarter of section 28, and the north-west quarter of section 28, Township 30, Range 1 east (L. Campbell, Land Manager, pers. commun.).

PART 4: EVALUATION OF MANAGEMENT OPTIONS

4.11 CURRENT MANAGEMENT

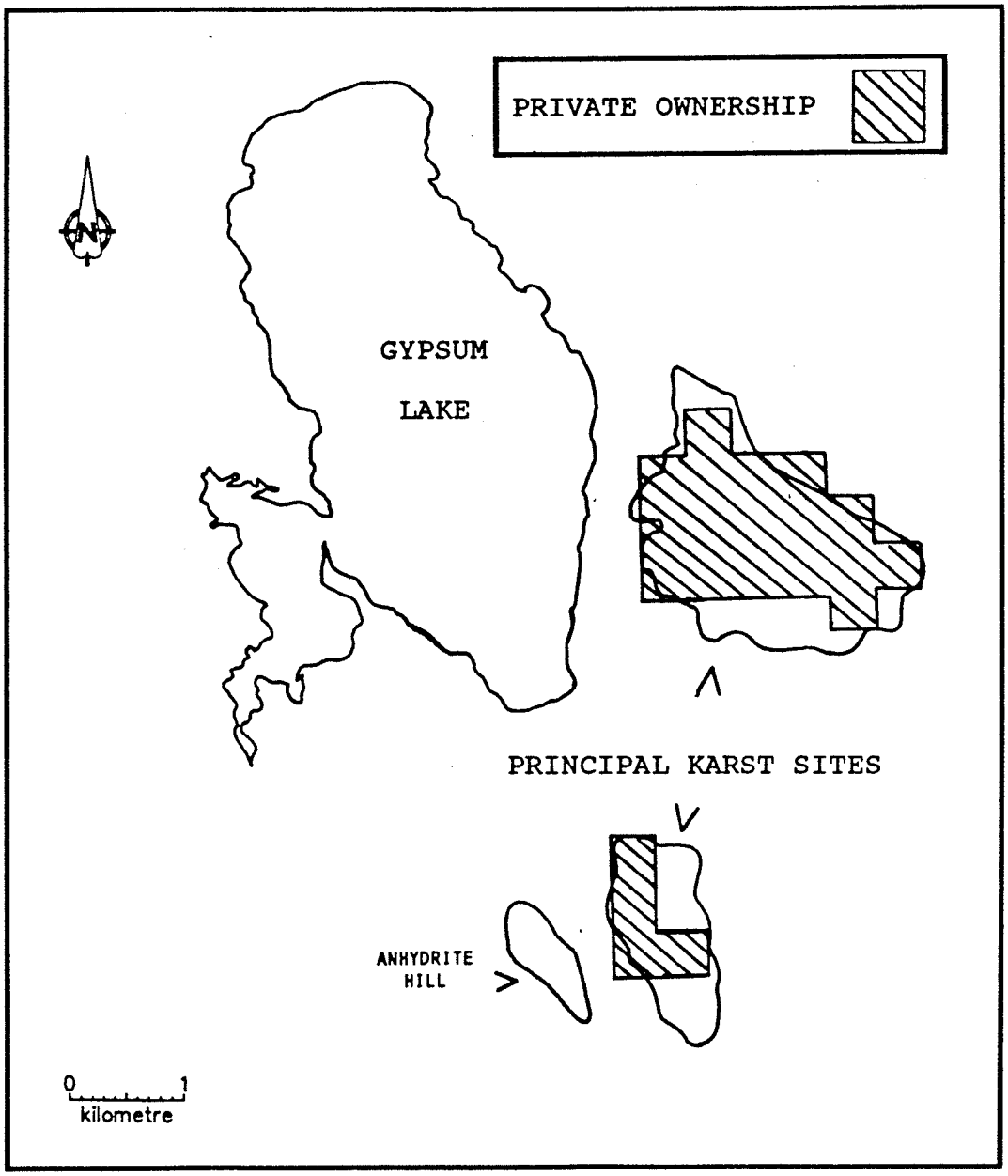
Currently there is no karst management plan per se for any of the 3 study areas, by any jurisdiction.

4.11.1 GRAND RAPIDS AREA

FIGURE 11: LAND OWNERSHIP

GYPSUM LAKE EAST

TOWNSHIP 33 RANGE 8 WEST



SOURCE: ADAPTED FROM
CROWN LANDS REGISTRY SYSTEM 1991
LAND TITLES REGISTRY

In 1984, the Manitoba Department of Natural Resources, through their planning document entitled "The North Interlake Overview Plan and Interim Management Guidelines", recognized the importance of protecting the caves near Little Limestone Lake and the karst topography near Grand Rapids.

This planning document has since expired but, the Little Limestone Lake area was identified as a potential candidate for a provincial park in the latest systems plan of the Manitoba Parks Branch (Parks Branch 1985).

Moreover, the Canadian Parks Service has expressed an interest in establishing a park in the Manitoba Lowlands and one of the possible sites is the Little Limestone Lake area (Canadian Parks Service 1990).

4.11.2 GYPSUMVILLE-LAKE ST. MARTIN AREA

The Crown land in the Gypsumville Study Area is mainly zoned for agriculture, except for the land immediately east of Gypsum Lake which is zoned as "Wildlife Land" (CLCC 1991). However, new land use codes have been proposed for the karst areas east of Gypsum Lake (North and South Sections) where "non-compatible" uses will not be allowed (L. Campbell, Regional Land Manager, pers. commun.).

Furthermore, the Parks Branch of the Manitoba Department of Natural Resources has expressed an interest in the area east of Gypsum Lake (Parks Branch 1990).

However, most of the karst sites appear to be on private property, most of which is managed for gypsum production.

4.11.3 DALLAS-HODGSON AREA

The Crown land for 4 of the 9 cave sites of the Dallas-Hodgson area have been coded as Rare and Unique Sites (Campbell, Regional Land Manager, pers. commun.). This coding stipulates that development will not be allowed in this area.

These sites are also a candidate for an ecological reserve (R. Thomasson, Crown Lands Branch, pers. commun.).

Active cave management consists of gating the entrance to St. George's Bat Cave.

4.12 MANAGEMENT OPTIONS

This section evaluates the advantages and disadvantages of land management options.

4.12.1 PROVINCIAL LAND DESIGNATIONS

PROVINCIAL PARKS

Authority

They are created by Order-in-Council, under the authority of the Provincial Park Lands Act. They are managed by Parks Branch, Department of Natural Resources.

Applicability

They can be designated on Crown land, and private land may be obtained for the park by purchase, lease, exchange, expropriation or other means.

Advantages

1) A feasible land designation for Crown land.
2) Acceptable uses could be stipulated in a park plan.
3) Recreational caving would likely be allowed.
4) Penalties for prohibited acts.
5) Potential for cooperative management agreements.

Disadvantages

1) Park designation, boundaries and uses may be changed at the discretion of the Minister of Natural Resources.
2) Potential difficulty acquiring private land.

3) Possible resistance from current land users.

4) Region may not meet selection criteria for a park.

5) Time Frame. The creation of a park takes time. Potential impacts may necessitate quicker karst management.

6) Creation of a park may increase public awareness of karst resources. This could lead to vandalism of karst resources, and caving accidents.

The advantages and disadvantages of specific types of provincial parks are as follows:

PROVINCIAL NATURAL PARK

Description

An area that displays outstanding examples of Manitoba's natural landscapes. Generally they offer many recreational uses, and commercial resource extraction/harvesting is permitted.

Advantages

1) Multiple land uses are allowed. Therefore the public may be more likely to accept the park if there are fewer land use restrictions.

2) Potential for varying levels of management zones.

Disadvantages

1) Multiple land uses may not provide enough protection for karst resources.

PROVINCIAL WILDERNESS PARK

Description

This designation applies to outstanding landscapes that have undergone little modification by humans.

Advantages

1) Management emphases is on preserving wildland character.

2) All-weather roads and major commercial resource extraction and harvesting are prohibited.

Disadvantages

1) Possible resistance from current land users since commercial resource extraction and harvesting is not allowed.

2) Exceptions to park mandate. Mineral exploration and extraction may be permitted.

PROVINCIAL HERITAGE PARK

Description

This designation applies to unique landscapes within Manitoba. The purpose of the park is to preserve and interpret the natural and cultural history of the province.

Advantages

1) Management emphases is on preservation and interpretation.

2) Major commercial resource extraction/harvesting is not permitted.

Disadvantages

1) Possible resistance from current land users since major commercial resource extraction is not allowed.

ECOLOGICALLY SIGNIFICANT AREAS

Description

This designation is designed to preserve rare, unique and typical ecosystems of Manitoba for scientific, educational and aesthetic purposes.

Authority

Ecologically Significant Areas may be created on Crown land. They may receive long-term "Crown Land Reservation" status or they may be designated as an "Ecological Reserve" (ER). ERs are created by Order-in-Council, under the authority of The Ecological Reserves Act. They are managed by the Manitoba Department of Natural Resources.

On private land, Ecologically Significant Areas may be established by a "handshake agreement" and are termed "Voluntarily Protected Areas".

Applicability

Ecologically Significant Areas are applicable to Crown and private land.

Advantages

1) The ER designation offers a high degree of protection. Use restrictions ordinarily prohibit resource extraction / harvesting.

2) Access to ERs may be controlled by a permit.

3) The Ecological Reserve act offers strong legislation that supersedes other statutes in the same designated area.

4) An ER may be used for scientific and educational purposes. This could enhance the understanding of karst processes and karst ecosystems. Such uses could also be used as a tool to foster a conservation attitude towards karst.

5) Strong penalties may be inflicted on those persons committing prohibited acts within an ER.

6) ERs are feasible land designations for Crown land.

Disadvantages

1) ERs are created by an Order-in-Council and can be changed at the discretion of the Minister of Natural Resources.

2) ER legislation is very restrictive in terms of acceptable land uses. Therefore there may be strong opposition to this designation from other government departments and from the public.

3) Karst sites with no apparent biological significance may not qualify as an ER.

4) ER designation may not permit recreational caving.

5) ER designation may not apply to a large region. It may be site specific.

6) Ecologically Significant Areas on private land are voluntarily protected and may change with a change in attitude or ownership.

PROVINCIAL HERITAGE SITE

Description

A site that has historic, prehistoric or natural significance.

Authority

Created by Order-in-Council under the authority of The Heritage Resources Act, and managed by the Department of Culture, Heritage and Recreation.

Applicability

Can be designated over Crown, private or municipally owned land.

Advantages

1) This designation offers considerable protection. A heritage resource impact assessment and a subsequent heritage permit may be required for development projects.

2) This designation provides for educational and informational programs.

3) This designation allows for cooperative agreements with other jurisdictions for research, educational programs and restoration.

4) A feasible land designation for Crown land.

5) Penalties may be inflicted for committing prohibited acts.

Disadvantages

1) The Department of Culture, Heritage and Recreation has little expertise in managing "natural" sites and prefers to leave those types of designations to the Department of Natural Resources.

2) This designation is created by an Order-in-Council and can be changed at the discretion of the Minister.

3) This designation is more applicable to a specific site as opposed to an entire region.

4) To date there have been no cooperative agreements with other jurisdictions.

5) There may be strong opposition from other government departments and the public to such a strong designation.

6) Potential difficulty applying this designation on private land.

WILDLIFE MANAGEMENT AREA (WMA)

Description

Crown land set aside for the management, conservation and enhancement of wildlife resources.

Authority

Created by Order-in-Council under the authority of The Wildlife Act and managed by the Department of Natural Resources.

Applicability

WMAs can be designated on Crown land, and private land may be obtained by purchase, lease, exchange, expropriation or other means.

Advantages

1) The Minister of Natural Resources can regulate acceptable activities.

2) Cave access could be controlled by a management plan.

3) A feasible land designation for Crown land.

4) Multiple land uses could be allowed. Therefore, there may be little public resistance from this designation if there are few land use restrictions.

5) Recreational caving could be allowed.

6) Potential for joint management of wildlife and wildlife habitat.

Disadvantages

1) Discretionary power of the Minister of Natural Resources to permit any use, activity or thing within the WMA.

2) Potential difficulty applying this designation on private land.

3) Creation of a WMA may increase public awareness of karst resources. This could lead to vandalism of karst resources, and caving accidents.

4.12.2 PROVINCIAL GUIDELINES

MITIGATION FOR REPAP F.M.L.

Description

Under Section 5 "Mitigation" of the "Guidelines for the Preparation Of An Environmental Impact Assessment For The Repap Manitoba Five Year Operating Plan 1990-1994" areas of concern may be identified.

Authority

The assessment/licensing process of the Department of Environment.

Applicability

To the Repap F.M.L.

Advantages

1) Areas may be identified where timber harvesting cannot occur, or where harvesting may occur but only after further research is conducted into the potential impacts of forestry.

2) Special timber harvesting guidelines could be designed for karst sites.

3) May be quicker and easier to implement guidelines than creating a special land designation, like a park or ecological reserve.

4) Recreational caving may be permitted.

Disadvantages

1) Forestry guidelines in karst regions may be optional and not enforced.

2) This approach addresses only one type of resource extraction activity (forestry) and is not necessarily a comprehensive land management approach.

3) Only applies to the Repap F.M.L.

4) If forestry is withdrawn from karst areas, suitable lands may be provided to Repap as compensation.

CROWN LAND CLASSIFICATION COMMITTEE (CLCC) LAND USE CODES

Description

The CLCC may designate what type of land use is permitted on a parcel of land. Codes such as "Non-Conforming Use" or "Unique/Rare Sites" may be applied.

Authority

The CLCC.

Applicability

Applies only to Crown land in Agro-Manitoba, and on a site specific basis to lands with agricultural potential outside of Agro-Manitoba.

Advantages

1) Employs a multiple use concept for the region.

2) Can identify non-conforming uses.

3) Land can be classified as a "Rare/Unique Site" and no development will be permitted.

Disadvantages

1) Does not apply to the Grand Rapids Study Region.

2) There is a question of permanency regarding land use codes.

3) Does not apply to private land.

4) A "Non-Conforming Use" may continue for the length of the land lease.

4.12.3 FEDERAL LAND DESIGNATION

NATIONAL PARK

Description

A national park is an area protected for its outstanding natural or historic significance.

Authority

A national park is created under the National Parks Act and is managed by the Canadian Park Service, Environment Canada.

Applicability

Lands may be purchased, expropriated or acquired by other means to establish a park.

Advantages

1) A national park offers very strong protection. Park policy prohibits "commercial exploitation, extraction or development of natural resources".

2) "Maintenance of ecological integrity" takes precedence over visitor use.

3) Management plans are tabled in the House of Commons, and are not approved at the sole discretion of the Minister.

4) Traditional resource use may be permitted.

5) Visitor access to resources may be controlled.

6) The park may enter into cooperative management agreements.

7) The park may be segregated into 5 management zones.

8) The Canadian Parks Service has expressed an interest in the Little Limestone Lakes region.

Disadvantages

1) Since resource extraction is prohibited, there may be strong opposition to this designation from provincial government agencies and from the public.

2) Current park policy discourages recreational caving. Written permission may be needed to enter a cave.

3) The region may not qualify as a national park.

4) Creation of a park may increase public awareness of karst resources. This could lead to vandalism of karst resources, and caving accidents.

5) The Canadian Park Service has not expressed an interest in the Gypsumville-Lake St.Martin Area, nor the Dallas-Hodgson Area.

4.12.4 PRIVATE, NON-PROFIT OWNERSHIP

Examples of private, non-profit organizations are **THE NATURE CONSERVANCY OF CANADA,** which is a national, non-profit organization dedicated to preserving biological diversity", and **HABITAT TRUST**, which was established by the Manitoba Wildlife Federation and its affiliates to "retain critical wildlife habitat in Manitoba".

Authority

Land may be purchased or accepted as a donation.

Applicability

A site is evaluated according to selected criteria.

Advantages

1) Land use and activities can be regulated.

2) Private ownership could provide long-term protection from unacceptable land uses and activities.

Disadvantages

1) Site may not meet the site assessment criteria.

2) Organization may not provide land management, labour or expertise.

3) Organization may not be able to acquire a large area.

4) Uncertain fate of land if organization dissolves.

4.12.5 COOPERATIVE AGREEMENTS

At least 6 categories of cooperative agreements are possible between government (federal, provincial and municipal), private landowners and non-government organizations (Table 1).

TABLE 1

CATEGORIES OF COOPERATIVE AGREEMENTS

Private Landowner --- Non-Government Organization(s)
Private Landowner --- Government
Non-government Organization(s) --- Non-Government Organization(s)
Government --- Government
Government --- Non-Government Organization(s)
Private Landowner --- Government + Non-Government Organization(s)

The above agreements may be legally binding (land lease or easement) or they may be non-compulsory (voluntary).

Advantages

1) May be a time-saving approach that does not involve land acquisition, public consultation, nor public funds.

2) Land use and visitor access could be regulated by the terms of the agreement.

Disadvantages

1) Difficulty in striking an agreement.

2) Karst sites may not meet the parties' mandate (or selection criteria).

3) Legal agreements may be for a short duration.

4) Voluntary agreements could easily dissolve.

5) Liability for accidents is likely to be a concern for the landowner.

6) Uncertain fate of land if agreement dissolves.

4.12.9 KARST PROTECTION LEGISLATION

It is premature to consider karst protection legislation because existing management options have not yet been given an opportunity to safeguard the karst resources. Should these options fail to protect karst in Manitoba, such legislation should be considered.

However, legislation could be enacted to protect bat hibernacula/nurseries and hibernating/nursing bats.

5.0 DISCUSSION

By following the first 2 steps to karst management previously discussed, (inventory and classification, and impact assessment) management options can be evaluated and a framework for management can be proposed.

5.1 GRAND RAPIDS AREA

5.1.1 KARST RESOURCE VALUES

Geological

Karst pavements and some caves may be used to interpret the geological stratigraphy of the region.

Hydrological

Hydrological studies have been utilized to explore for lead and zinc.

Mineralogical

Generally their are few cave formations present. Some of the minerals found in caves are, stalactites, dog tooth spar and calcite.

Cultural

To date, no significant historical or prehistoric sites have been found within the study region. However, it is possible that there may be sites of cultural significance to aboriginal people.

Biological Values

Bats have been found within 9 caves, three of which (Firecamp, Dale's and Microwave 1) appear to be significant hibernacula. Moths and mosquitoes also may depend upon caves for overwintering.

A new species of midge was found in Firecamp Cave.

Rare plants are located near the study site and could possibly be found within the region.

Paleontological Values

It is possible that paleontological finds could be used to interpret past climatic conditions. Also, if the caves are pre-glacial in origin, they may contain remains of extinct species. So far within this region a bison horn has been found.

Recreational Values

The caves are of interest to recreational cavers.

Educational/Scientific Values

Karst is currently being researched for a Ph.D. dissertation.

Tourism

As of yet there seems to be little potential for tourist or "show caves". However, outdoor recreational opportunities such as viewing the karst terrain, nature study and activities related to water resources may attract tourists. The region is already fished and hunted by Americans and Manitobans.

Value as a Unique Landscape

Collectively the karst features of the Grand Rapids Uplands may be regarded as a unique landscape within Manitoba. It represents an unmatched example of dolomitic karst within the province.

In a national context this area has been described as a unique landscape because karst landforms are rare in such flat and arid terrain as the Interlake. However, in terms of size, the karst features of Manitoba are very small. For example, the longest cave system in Manitoba is 220.0 m. and the deepest cave is 13.4 m. In comparison, the longest

cave in B.C. is 5.8 km and the deepest cave is 522 m. (B.C. Ministry of Lands, Parks and Housing 1980).

SUMMARY

The above assessment of karst values is rudimentary and based upon inventories conducted by the SSM. Although these inventories are quite extensive, it may be helpful from a management point of view, to rank the karst resource values. As previously discussed, this procedure is utilized by the "New Mexico" and "Nieland" inventory and classification systems. However, ranking karst values in Manitoba may require additional inventory work. Also, through further inventory it is probable that additional karst sites will be discovered.

Also, it may be helpful to incorporate additional information into these inventories. Such information may include:

i) Surficial data, such as plant and animal information.

ii) Cave hazards

iii) Land ownership

It may also be advantageous to establish a file card system, or a computerized data base to store the karst inventory. Such a system would assign a number to each cave for reference purposes, and each number would be posted at the cave entrance.

Furthermore, by classifying the karst features into management classes, such as those of the "New Mexico" system, management could be focussed on those features most deserving of protection.

5.1.2 POTENTIAL IMPACTS

Forestry

1) All of the known cave sites are within the Repap Manitoba Inc. F.M.L. and most of these sites are on or near Productive Forested Lands. Therefore, it is possible that many of the caves could be subject to commercial forestry.

2) Many of the cave sites, such as Sturgeon Gill Road, Moose Arm Pit, Trenchland and Cat Trail have recently been burned by forest fires. Therefore, it would seem likely that these areas will not be suitable for commercial forestry for quite some time. However there are mature forests near the Porcupine Cluster and Ten Mile Road regions.

3) Under Repap's **current** five year operating plan, there is approval to harvest an area between William Lake and Little

Limestone Lake. Sinkholes are known to exist in this region and forestry equipment has collapsed 1 cavern.

4) Repap **proposes** to harvest near the Moon Lake Road and Reedy Cave areas. Within the Reedy Cave area is Dale's Cave, which is a bat hibernaculum. Knoll Chimney, the deepest cave in the province, is also in this the Reedy Cave area.

These areas are proposed to be harvested by 1994. Therefore it is urgent to integrate karst management and forestry operations.

5) The impacts of forestry could be objectively assessed by:

i) Systematically inventorying the karst resources to assess their values (eg. significant cave formations or cave fauna).

ii) Determine how forestry may impact upon these values. (eg. blocking the entrance to a cave may destroy a hibernaculum).

Mining

1) Currently there is no large scale commercial mineral extraction occurring in the study area.

2) There is the potential to discover nickel-copper, and lead and zinc resources. Also, dolomite could possibly become economically valuable.

3) The likelihood of mining becoming a threat to the karst resources is very uncertain. Nevertheless, an inventory and classification of the karst resources could be utilized to assess those karst features most deserving of protection.

Human Visitation

So far, damage to karst resources from human visitation has not been an issue. Many of the cave locations are probably known to few people, some of which guard them through secrecy.

Other Possible Conflicting Land Use Issues

1) Most of the study area is provincial Crown Land. This facilitates the implementation of any management option that involves the provincial government.

2) Aboriginal people may have a proprietary interest in the study area as a result of unfulfilled Treaty Land Entitlement, or as compensation through the Northern Flood Agreement. If so, then it may not be feasible to manage the karst features as a public resource.

A karst management strategy should consider aboriginal peoples' desire to hunt and trap within the area, and it should respect sites that have cultural significance to natives.

SUMMARY

To accurately assess the impacts to karst, it is imperative to understand the karst ecosystem, especially the hydrology. Then meaningful guidelines can be established to mitigate potential harm to the karst features. For example, such guidelines may establish buffer zones to regulate surficial activities such as resources extraction, or they may control visitor use.

5.1.3 EVALUATION OF MANAGEMENT OPTIONS

SYNTHESIS

The karst resources of the Grand Rapids Study Region have value as a unique Manitoba landscape and perhaps as a unique Canadian Landscape. These resources are known to have biological values (eg. hibernacula), mineralogical value (eg. cave formations) and educational/scientific value (eg.

opportunity to study karst processes). They may also posses geological, hydrological, paleontological and tourism values.

Karst resources have been damaged by current timber harvesting and may be threatened by proposed harvesting by the year 1994. However, many karst sites are not likely to be harvested for several years. It is also possible that mining could threaten the karst resources, if minerals of economic value are found within the study area. Another concern is the impact of human visitation. Although it does not appear to be an issue yet, as more people learn about the karst features, active management may be required.

Other management considerations are whether traditional resource uses would be permitted in the area. A plan that excludes these types of uses would likely receive considerable opposition.

MANAGEMENT OPTIONS

LAND DESIGNATION

The preferred management option to protect the karst resources in a **natural state** is "Land Designation". This option is preferred because it is a long-term solution that

is applicable to Crown land, and it can prohibit commercial resource extraction that can damage karst landforms.

The favored designation is a national park because of its strong preservation mandate that precludes commercial resource extraction. Also, national park management plans are tabled in The House of Commons where they receive formal debate from the members of parliament. In contrast, provincial park management plans receive final approval from the Minister of Natural Resources and are not passed by an act of The Manitoba Legislative Assembly.

A disadvantage of creating a national park is that it may not allow recreational caving.

The Canadian Parks Service has expressed an interest in establishing a park in the Grand Rapids region. However, should a national park not be feasible, the next best option would be a provincial park.

Of the provincial parks, the Wilderness Designation is the favoured option because of its mandate to perpetuate an area in a primitive state. However, the regulations to this designation are inconsistent with its stated mandate. For example, mining will be allowed in Atikaki Provincial Wilderness Park if minerals of economic significance are

found. These exceptions weaken the protective status of the Wilderness Designation.

A Provincial Heritage Park, with its preservation and interpretation mandate would also be a favourable designation. However, it appears that it would not be as restrictive in terms of development as a Wilderness Park.

A Provincial Natural Park is not a favoured option because commercial resource extraction is permitted. Park zoning could prohibit such activities in karst areas. However, the ease at which a park could be re-zoned is in question. Therefore, a natural park is not a preferred option.

A significant drawback of creating any type of park is the potential for increased visitation and the possible impact that visitors may have upon caves. Also, most caves are hazardous to some degree and visitor safety is a concern. Therefore, a park plan must be able to control visitor access, inform visitors of potential harm they may cause to caves and warn visitors of cave hazards.

A weakness of all provincial parks is that they are created and can be changed by an Order-in-Council, at the discretion of the Minister of Natural Resources. These parks would

provide stronger protection if they were created by an act of legislature.

An Ecological Reserve is an ideal designation for protecting a karst site. It can prohibit resource extraction and it can control visitor access by a permit system. This designation seems best suited for a small area, such as a cave site, and it could be used to protect caves that are outside of a designated park.

However, ecological reserves are also created by an Order-in-Council and they would provide stronger protection if they were created by an act of legislature.

A Wildlife Management Area has the potential to offer strong protection for a karst site because the Minister of Natural Resources has the authority to prohibit any use of the area that he/she deems inappropriate. However, the Minister also has wide discretion over what uses shall be permitted, and for this reason a WMA is not a preferred option.

A Provincial Heritage Site is not a favoured option because the Department of Culture, Heritage and Recreation lacks expertise in managing a natural site.

KARST MANAGEMENT GUIDELINES

An alternative to establishing a "Land Designation" is to develop surface and subsurface management guidelines to be adopted in Crown land use planning. The advantage of this approach is that it may be quicker and easier to implement than creating a park. This approach has merit since forestry is an immediate threat.

A major disadvantage to guidelines is that they may be optional. Therefore, establishing a "Land Designation" would probably offer more lasting protection.

LAND USE ZONING

Land use codes, such as those used by the Crown Land Classification Committee, could be developed by the Interdepartmental Planning Board (IPB) to regulate land use in karst areas of the Grand Rapids region.

The disadvantage of this approach as compared to setting aside protected areas, is that these land use codes may be changed. Therefore, it is preferential to designate a protected area to safeguard karst.

LAND ACQUISITION BY PRIVATE NON-PROFIT GROUPS

Private, non-profit organizations could possibly purchase karst sites from the Crown and prohibit activities that could harm the karst resources. However, it is questionable

whether these sites are for sale. Also, land costs would limit the amount of property that private organizations could purchase.

This could be a viable option for individual sites.

COOPERATIVE MANAGEMENT AGREEMENTS

Non-government organizations, such as the SSM could endeavour to lease and manage karst sites. The SSM could also provide karst data to the Manitoba Department of Natural Resources and the Canadian Park Service. Furthermore, the SSM could help either, or both of these agencies to adopt a karst inventory and classification system, and they could continue to inventory the karst resources of the region.

Non-government agencies can also play an active role in developing a karst management plan.

5.2 GYPSUMVILLE-LAKE ST. MARTIN AREA

5.2.1 KARST RESOURCE VALUES

Geological Values

The cave interiors may be used to interpret the geological stratigraphy of the region.

Mineralogical Values

Generally there are few cave formations present, but there are examples of "cave popcorn". There are also displays of ice crystals and satin spar (gypsum crystals) in some of the caves.

Cultural Values

To date, no significant historical or prehistoric sites have been found within the study site. It is possible that there may be sites that have cultural significance to aboriginal people. For example, caves were important bear-hunting sites for natives.

Biological Values

Bats have been observed in 5 caves. Four are located in the Gypsum Lake North sector and 1 is in the Gypsum Quarry area. Fold Cavern, which is located in the Gypsum Lake North sector may be a significant bat hibernaculum.

Paleontological Values

Animal skeletons dated at approximately 5,000 years old have been found in a sinkhole in this study region. Such findings give insight into past environmental conditions.

Recreational Value

The caves of this region offer recreational opportunities to caving enthusiasts. However, there appears to be no caves with potential to be "show caves".

The region has potential for hiking and nature viewing.

Educational/Scientific Values

Since this terrain is unique and pristine, there is an opportunity to study karst processes and ecosystems.

Value as a Unique Landscape

The most outstanding value of this region is that it is a unique Manitoba landscape. It is also considered unequaled in Canada and even in North America, for it is the last representation of pristine gypsum karst on the continent.

This region also contains the 2 longest known cave systems in the province.

SUMMARY

Like the assessment of the Grand Rapids Area, this evaluation was based upon inventories conducted by the SSM. This organization has compiled a wealth of information on the caves in Manitoba and they could be a valuable asset to karst management, as have been other speleological groups in other areas of North America.

The suggestions made for the Grand Rapids Area concerning the implementation of an inventory and classification system also applies to this region. They are:

i) Rank karst values.
ii) Continue the karst inventory.
iii) Add additional inventory variables (surficial data, hazards and land ownership).
iv) Create an inventory data base.
v) Assign caves/karst regions to management classes.

5.2.2 POTENTIAL IMPACTS

Forestry

1) Currently there is no commercial forestry near the karst sites.

2) The karst sites are composed of both non-productive and productive forests, much of which is immature.

3) At present, there appears to be little demand for these forests.

4) However, most of the karst sites are on private property. Therefore, the landowners are free to dispose of their timber resources as they desire.

Mining

1) The karst features are located within gypsum deposits, most of which are privately owned by Domtar Limited and the

Canadian Northern Railway Company (presumably now owned by the Canadian National Railway).

2) Currently there is a stockpile of gypsum and none is being quarried from the Gypsumville area.

3) However, caves do exist near the North Quarry and should quarrying continue, caves could be destroyed.

Human Visitation

1) There is little documentation on humans negatively impacting caves east of Gypsum Lake .

2) The area east of Gypsum Lake is quite remote and probably few people enter these caves.

3) However, the caves near the North Quarry are accessible by an all-weather road.

5.2.3 OTHER POTENTIAL CONFLICTS AND INTERESTS

Traditional Land Use

The karst area is likely used by native people for hunting and trapping. Therefore, a karst management plan should consider whether these uses should be permitted.

Hunting

A karst management plan should consider whether sport hunting should be permitted. Resident and non-resident bear

hunting is an important source of income to the local economy (J. Dubois, Manitoba Museum of Man and Nature, pers. commun.).

Visitor Safety

Visitor safety should be addressed in any cave management plan. Cave hazard levels should be assessed as part of the inventory and classification procedure. Visitors should be made aware of hazard levels and access should be controlled to dangerous caves.

Land Ownership

Most of the karst sites are on private property. This could make land management difficult. Several options are available:

1) A private, non-profit organization and/or government could strike a cooperative agreement with the landowners to manage the karst sites. The agreement could be legally binding (eg. lease or easement) or it could be voluntary, but the landowners would retain title to their land.

2) Government could acquire this land and manage it as a public resource, or assign management to a private, non-profit organization(s), or assign management to an entity composed of both government and private agencies.

3) Private, non-profit organization(s) could acquire this land and manage it as a private resource.

4) Private, non-profit organization(s) could acquire this land and donate the title to the provincial government, but under certain land use restrictions.

5.2.4 EVALUATION OF MANAGEMENT OPTIONS

SYNTHESIS

The karst terrain east and south of Gypsum Lake has been described as a pristine landscape of national significance. Similar features are also located near the North Quarry, north of Gypsumville. These features are valuable in terms of their scientific/educational, biological and geological attributes.

Although there does not appear to be an immediate threat to these resources, features of such significance should be appropriately managed. This karst terrain is concentrated into a smaller space than that of the Grand Rapids region. Thus, it may be easier to manage. However, a stumbling block may be that much of the land is privately owned.

MANAGEMENT OPTIONS

The optimal management options to protect these karst resources in a natural state are:

i) For the Province of Manitoba to acquire the most significant sites and manage them as a protected area.

ii) For a private, non-profit organization, or organizations, to acquire the most significant sites and manage them as a protected area.

LAND DESIGNATION

Since the Canadian Parks Service is not interested in this area, a national park is not a feasible option. But the area east of Gypsum Lake is a significant karst region and the Province of Manitoba should attempt to purchase the most significant karst sites. For the same reasons stated in the discussion of Grand Rapids, a Wilderness Park is the most suitable option.

Should a provincial park not be feasible, individual karst sites could be protected as Ecological Reserves.

LAND USE ZONING

Should the Province of Manitoba acquire these lands, an alternative to establishing a protected area is to restrict commercial development through CLCC land use codes. The drawback of this approach is that these codes can be changed if all members of the CLCC agree.

New, restrictive codes are pending for this area, but they apply only to Crown land.

LAND ACQUISITION BY PRIVATE, NON-PROFIT ORGANIZATIONS

Private, non-profit organizations should attempt to purchase prime karst sites and manage them as a protected area. The SSM could play a critical role in acquiring land by soliciting support from organizations like the Nature Conservancy of Canada, the World Wildlife Fund, the Manitoba Naturalists Society, the Critical Wildlife Habitat Program, Manitoba Habitat Trust, etc.

COOPERATIVE MANAGEMENT AGREEMENT

A cooperative management agreement between the landowner and another party (eg. Province of Manitoba, private organization, or both) may be the simplest solution. It could permit scientific study, recreational caving and it could control access to the area.

Some possibilities are:

i) a land lease

ii) land protection in lieu of taxes

iii) voluntary protection as an Ecologically Significant Area

However, such agreements may last only a short time, as either party may become disinterested. Also, **landowner liability** may be an issue.

5.3 DALLAS-HODGSON AREA

5.3.1 KARST RESOURCE VALUES

Geological Values

Mineral samples from some of the caves have helped to explain local stratigraphy.

Mineralogical Values

Some of the caves of this region contain cave formations such as "flowstone", "soda straws" and "broccoli". Minerals such as calcite, goethite, limonite, sulphides, quartz, magnetite, and others have also been found in some of these caves.

Biological Values

St. George's Bat Cave is the largest known bat hibernaculum in the province. In addition, bats also utilize Window Cave. Furthermore, moths have been observed in both of these caves.

Educational/Scientific Values

St. George's Bat Cave offers a valuable opportunity to study all aspects of Little brown bat ecology.

5.3.2 POTENTIAL IMPACTS

Forestry

The karst resources of this region occur on Productive Forested Lands and in some Non-Productive forests. Much of this area was burned in 1989, but timber harvesting does occur in the region and it is very important to Abitibi Price.

One cave has been deliberately plugged with logging debri. However, land that has been proposed as an ecological reserve has been withdrawn from forestry plans. Therefore, forestry is not a threat to caves on these lands. But, caves found outside of this area could be threatened by forestry.

Mining

An intermittently used sand and gravel quarry is located approximately 1.5 km (1 mile) south of St. George's Bat Cave.

Human Visitation

The temporary gate at St. George's Bat Cave has been removed several times. Disturbing the overwintering bats in this cave could cause their death and abandonment of the cave. The cave should not be entered from October 1 to May 15.

5.3.3 OTHER ISSUES

The karst resources of this region are on provincial Crown land. An Ecological Reserve is proposed to safeguard 4 of the 9 caves known in the region ("St. George's Bat Cave", "Mineral Samples Cave", "Moosehead Cave" and "Lucky Cave"). St. George's Bat Cave is included in the proposed reserve. However, Window Cave is also used by bats and it has been excluded from the reserve.

5.3.4 EVALUATION OF THE PROPOSED ECOLOGICAL RESERVE

An ecological reserve is a very appropriate management approach for the caves of this region. Some of these caves, such as St. George's Bat Cave is a sensitive bat hibernaculum and therefore deserve strong legislative protection.

Access to St. George's Bat Cave should be controlled, especially during bat hibernation. Currently, access to this

cave is controlled by a gate. Particular attention should be paid to the width and length of the gate openings so that they do not alter the micro-climate of the cave, and so that bat behavior is not altered. There is concern when gates are used on entrances that are less than 152 cm. (5 ft.) in diameter, such as this cave's entrance. However, this may not be a problem for all bat species.

Should vandalism persist at this cave, education may be of help. A sign could be posted in the general vicinity of the cave, but not at the cave entrance, explaining the sensitivity of the hibernating bats. The sign could also warn of the potential of contracting rabies and other diseases from entering a hibernaculum. This approach could discourage those people who do not wish to intentionally harm the bat population.

6.0 CONCLUSIONS AND RECOMMENDED ACTIONS

6.1 CONCLUSIONS

6.1.1 GENERAL CONCLUSIONS

1) The karst ecosystems of Manitoba are valuable, non-renewable resources that deserve legal protection.

2) Manitoba karst is not, but deserves to be, represented in Manitoba's Provincial Park System and the National Parks System.

3) The karst ecosystems of Manitoba have been damaged by surface and sub-surface human activities and remain vulnerable to current and proposed land uses.

4) Few caves in the province are suitable as bat hibernacula. These caves should not be entered while they are occupied by hibernating bats.

5) Over one half of the confirmed karst sites are concentrated on relatively small areas of private land.

6) In contrast, the karst sites located on Crown land are widely dispersed, and additional karst sites are likely to

be found. Therefore, karst management will likely require more than one management option.

7) Karst management should be an integral component of Provincial Land Use Panning.

8) Formal karst management is likely to increase public awareness of karst locations. Therefore, sensitive karst sites must be protected from possible damage caused from increased visitation.

9) The SSM has the most comprehensive inventory of karst in Manitoba and they should be an active participant in karst management.

10) To date, no caves are suitable as commercial "show caves".

11) There is a lack of information on rare plant species in all of the study areas.

12) A major weakness of a provincial park and an ecological reserve is that these designations are created by an Order-in-Council and can be changed at the discretion of the Minister of Natural Resources.

6.1.2 CONCLUSIONS: GRAND RAPIDS AREA

OBJECTIVE 1

1) The karst resources of the Grand Rapids region have value individually (as individual caves) and collectively (as a unique region).

2) Individual caves have biological values (significant bat hibernacula, habitat for newly discovered species of midge), mineralogical values (significant cave formations) and educational/scientific values.

3) Karst inventory is on-going and additional karst values will likely be determined by the SSM.

4) Thirty percent of Manitoba's caves are located within this region.

5) Additional caves are likely to be found within, as well as outside of the study area by the SSM.

OBJECTIVE 2

6) All of the karst resources in this region are on Crown land.

7) Caves are currently threatened by forestry operations in the William Lake-Little Limestone Lake region. Repap

Manitoba's Proposed Five Year Operating Plan 1990 - 1994, threaten caves in the Moon Lake Road and Reedy Lake cave areas.

8) Mining is a potential threat to the karst resources.

9) Aboriginal people likely use this area in traditional ways, and they may also have proprietary interests in this region.

OBJECTIVE 3

10) A National Park will provide optimal preservation.

11) A Provincial Wilderness Park will also provide strong preservation.

12) Ecological Reserves and land acquisition by private, non-profit organizations (such as the SSM, Nature Conservancy of Canada, Manitoba Naturalists) would be ideal management options for individual karst sites.

13) Forestry guidelines for karst areas could be an effective management option, if collectively developed by Forestry Branch, Repap Manitoba, Inc. and the SSM.

OBJECTIVE 4

14) Land should be set aside to protect the most significant karst sites. The optimal designation is a National Park. The second best alternative is a Provincial Wilderness Park.

15) A park is not likely to encompass all karst sites.

16) Karst sites that may not be located within park boundaries would be best managed as Provincial Ecological Reserves, or purchased and managed by private, non-profit organizations (such as the SSM, Nature Conservancy of Canada, World Wildlife Fund, Manitoba Habitat Trust).

17) An inventory and classification system should be adopted to:

i) Find additional karst sites.
ii) Rank karst resource values.
iii) Place karst sites into 3 management classes.
iv) Management class 1 sites should be managed by "Land Designation"
v) Management class 2 sites should be managed by "Guidelines".
vi) Management class 3 sites require no special management.

18) Aboriginal rights to hunt, fish and trap should continue in karst areas, subject to regulations that protect the survival of wildlife and wildlife habitat.

6.1.3 CONCLUSIONS: GYPSUMVILLE-LAKE ST. MARTIN AREA

OBJECTIVE 1

1) The karst terrain of the Gypsumville North Quarry, and the area east and south of Gypsum Lake are valuable, non-renewable resources that deserve preservation.

2) Individual caves have biological, mineralogical and educational/scientific values.

3) More than 50% of the known caves in Manitoba are in this area.

OBJECTIVE 2

4) Most of the karst resources in this area appear to be on private property.

5) These resources do not appear to be threatened by **current** land uses. However, future demands for gypsum could be a threat, especially to those caves adjacent to the north quarry. Also, privately owned forests could be harvested without assessing the impact to caves.

6) Bear hunting, for sport, is an important activity in this area.

OBJECTIVE 3

7) Land acquisition by the provincial government and establishment of a Provincial Wilderness Park is the optimal

management option. Establishment of an Ecological Reserve(s) would be ideal for an individual site(s), should a park not be feasible.

8) Land acquisition by a private, non-profit organization (SSM, Nature Conservancy of Canada, Manitoba Habitat Trust, Critical Wildlife Habitat Program, etc) would also be ideal for an individual site(s), should a park not be feasible.

9) A cooperative management agreement between the landowners, and the Manitoba Department of Natural Resources and/or private organizations (such as those stated in #8) may be the most feasible and quickest solution. However, longevity of the agreement is a concern.

OBJECTIVE 4

10) The Provincial Government should attempt to acquire karst sites east of Gypsum Lake and establish a Wilderness Park. If enough land can not be acquired to create a park, an ecological reserve(s) would be the next best type of designation. (The sites adjacent to the North Quarry would not likely be for sale, because that land would probably be utilized if the quarry operation expanded).

11) Should the province not be interested in acquiring these lands, the SSM should raise financial support from other

non-profit organizations and attempt to purchase the most significant karst sites.

12) Should land acquisition fail, the Department of Natural Resources, the SSM, Critical Wildlife Habitat and other organizations should attempt to cooperatively manage the karst sites with the landowners.

13) The SSM should identify the most significant cave sites and present this list to the Department of Natural Resources and the landowners, as a first step in acquiring or cooperatively managing this area.

6.1.4 CONCLUSIONS: DALLAS-HODGSON AREA

1) The proposed ecological reserve is the appropriate management approach for the caves of this region.

2) Access to St. George's Bat Cave should be prohibited between October 1 and May 15, when bats are hibernating.

3) Locations of sensitive caves, such as St. George's Bat Cave should not be publicized.

4) Gate design should be carefully researched so that gates do not disrupt bat behavior nor alter the cave micro-

climate. Bat caves that are gated should be monitored to detect such changes. Alternatives to gating (such as a single bar or fence) should be explored.

5) Signs that explain the sensitivity of the hibernating bats and cave formations, and the potential to contract rabies and other diseases associated with caves, may reduce the number of cave visitors and hence, vandalism. However, these signs should not be placed at cave entrances, but at trail-heads.

6) Caves in the region (especially Window Cave), that are not included within the ecological reserve, should be assessed to determine if they should be included.

6.2 RECOMMENDED ACTIONS

6.2.1 GENERAL RECOMMENDATIONS

To The IPB and CLCC

1) Integrate karst management into land use planning by adopting (modifying where appropriate) the B.C. Inventory and Classification System. Prohibit commercial resource extraction and development from Class 1 sites, and develop land use guidelines for Class 2 sites.

2) Solicit active participation from the SSM and industry to adopt and implement this system.

To Manitoba Parks Branch, DNR.

3) Amend The Provincial Park Lands Act so that provincial parks are created by an act of the Legislative Assembly of Manitoba, not by Order-in-Council.

4) Amend The Provincial Park Lands Act so that the various types of provincial parks are defined within the Park Lands Act. Develop regulations that define what activities are permitted and prohibited in each type of park.

To The Resource Allocation and Economics Branch, DNR

5) Amend the Ecological Reserves Act so that ecological reserves are created by an act of the Legislative Assembly of Manitoba, not by Order-in-Council.

To The Manitoba Wildlife Branch

6) Amend The Wildlife Act so that it is illegal to:

- enter a cave, without a permit, when occupied by hibernating or nursing bats.
- disturb, harm or kill bats when they are hibernating or nursing in a cave.

- modify, without a permit, a cave used as a bat hibernaculum/nursery, or one that is significant habitat for other cave fauna.

7) Consult with personnel at the Manitoba Museum of Man and Nature to determine dates when bat caves should be closed.

To The Manitoba Museum Of Man And Nature

8) Assess cave gate design and the impact that gates may have on cave fauna.

To the SSM

9) Adopt the B.C. Inventory and Classification System (modify where appropriate).

6.2.2 RECOMMENDATIONS: GRAND RAPIDS AREA

To The Canadian Parks Service

1) Conduct a joint feasibility study with the Manitoba Parks Branch, for the purpose of establishing a park in the Grand Rapids Uplands.

2) Seek access to karst inventory data from the SSM.

To the Parks Branch, Manitoba Department of Natural Resources (DNR)

3) Conduct a joint feasibility study with the Canadian Parks Service, for the purpose of establishing a park in the Grand Rapids Uplands.

4) Seek access to karst inventory data from the SSM.

To The Manitoba Interdepartmental Planning Board (IPB)

5) Work with Repap Manitoba Inc. and the SSM to adopt the B.C. Inventory and Classification System to:

i) Find additional karst sites.
ii) Rank karst resource values.
iii) Place karst sites into 3 management classes.

6) Prohibit commercial resource extraction and restrict visitation on Management Class 1 sites.

7) Develop general land use guidelines and regulate visitation for Management Class 2 sites. Develop policy specific to forestry by adopting (and modifying where appropriate) B.C.'s forest management guidelines for karst areas. Forestry Branch, Repap Manitoba Inc. and the SSM should have an active role in modifying these guidelines. Forestry Branch should be responsible for implementing these guidelines.

Base general land use policy on the forestry guidelines.

To the Forestry Branch, DNR

8) Implement forest management guidelines.

To The Resource Allocation and Economics Branch, DNR

9) Evaluate Management Class 1 sites for their suitability as ecological reserves.

To the SSM

10) Adopt the B.C. Inventory and Classification System.

11) Coordinate karst classification with the IPB.

12) Prepare and present a list of the most significant karst sites, for the purpose of protection, to:

- the Canadian Parks Service.
- Parks Branch, DNR.
- Forestry Branch, DNR.
- Resource Allocation and Economics Branch, DNR.
- Mines Branch, Manitoba Department of Energy and Mines.
- Repap Manitoba Inc.
- the Clean Environment Commission hearings concerning the assessment/licencing process for Repap Manitoba Inc. Five Year Operating Plan, 1990-1994.

13) Establish a working relationship with those organizations cited in Recommendation #12.

14) Approach private, non-profit organizations (such as the Nature Conservancy of Canada, World Wildlife Fund, Manitoba Habitat Trust, etc.) for financial support to purchase karst sites.

15) Attempt to purchase and/or co-manage karst sites from/with the Department of Natural Resources.

6.2.3 RECOMMENDATIONS: GYPSUMVILLE-LAKE ST. MARTIN AREA

To Manitoba Parks Branch, DNR

1) Conduct a feasibility study for the purpose of establishing a Wilderness Park. Consider Management Class 1 and 2 sites for inclusion.

2) Seek access to karst inventory and classification data from the SSM.

3) Attempt to acquire karst sites.

To The Resource Allocation and Economics Branch, DNR

4) Evaluate Management Class 1 sites for their suitability as ecological reserves, should a provincial park not be feasible.

5) Should the Provincial Government fail to acquire karst sites, attempt to secure a long-term land lease for the scientific and educational study of karst.

6) Should a land lease fail, seek voluntary protection of karst sites as Ecologically Significant Areas.

To The SSM

7) Using the B.C. Inventory System, classify caves into 3 levels of Management Classes.

8) Inform the following organizations of Class 1 and Class 2 sites:

- Parks Branch, DNR
- Resource Allocation and Economics Branch, DNR
- Crown Land Classification Committee
- Domtar Limited
- Canadian National Railway

9) Should the Provincial Government not be interested in acquiring karst sites, solicit support from organizations such as the Nature Conservancy of Canada, World Wildlife Fund, Manitoba Habitat Trust, Critical Wildlife Habitat Program, etc. and attempt to purchase karst sites.

10) If land acquisition is unsuccessful, arrange a cooperative management agreement with the landowners (preferably a long-term lease).

To Wildlife Branch, DNR

11) Evaluate the impact of bear hunting upon caves and cave ecology.

6.2.4 RECOMMENDATIONS: DALLAS-HODGSON AREA

To The Resource Allocation and Economics Branch, DNR

1) Preserve "St. George's Bat Cave", "Mineral Samples Cave", "Moosehead Cave" and "Lucky Cave" as an ecological reserve.

2) Prohibit access to "St. George's Bat Cave" and other bat caves (using gates, fences, secrecy, camouflage, etc.) from October 1 to May 15. Change these dates if required to protect bat populations.

3) Install educational signs at trail-heads to warn of "sensitive" cave resources, cave hazards and possible diseases associated with cave fauna.

4) Assess other caves in the area for ecological reserve status.

To The CLCC

5) Should the ecological reserve proposal fail, continue to prohibit commercial land uses in the proposal area.

6) Work with the SSM to implement the B.C. Inventory and Classification System to:

i) Find additional karst sites.
ii) Rank karst resource values.
iii) Place karst sites into 3 management classes.

7) Prohibit commercial resource extraction and restrict visitation on Management Class 1 sites.

8) Develop general land use guidelines and regulate visitation for Management Class 2 sites. Develop policy specific to forestry by adopting (and modifying where appropriate) B.C.'s forest management guidelines for karst areas. Forestry Branch, forest companies, and the SSM should have an active role in modifying these guidelines. Forestry Branch should be responsible for implementing these guidelines.

Base general land use policy on the forestry guidelines.

To The Manitoba Museum Of Man And Nature

9) Ensure cave gates are properly designed, especially for St. George's Bat Cave. Research alternative control measures (bars, fences etc).

10) Monitor bat caves for changes in bat behaviour, bat population and cave climate, that might be due to cave gates and human visitation.

To The SSM

11) Should the ecological reserve proposal fail, attempt to co-manage the area with the Department of Natural Resources. Evaluate the use of gates to prohibit visitation during bat hibernation.

12) Continue to investigate the area for cave discoveries.

13) Work with the CLCC, to categorize "new caves" into management classes, using the B.C. Inventory System.

PERSONAL COMMUNICATIONS

I am very grateful to the following people, who donated their time to help me with this project.

Mr. Phil Whitfield, Manager
Planning and Conservation
B.C. Ministry of Parks
- SUBJECT: Cave management in B.C., including information from; the Ministry of Forests, the Ministry of Lands, Parks and Housing, the British Columbia Speleological Federation, and from cave management symposium proceedings.

Mr. Doug Herchmer, Regional Recreational Officer
B.C. Ministry of Forests
- SUBJECT: B.C. Ministry of Forests' cave management policy and strategy

Mr. Martin Davis, President
British Columbia Speleological Federation
- SUBJECT: Cave management policy and problems in B.C.

Mr. John Rintoul,
Natural and Protected Areas Section
Land Management Branch
Alberta Forestry, Lands and Wildlife
- SUBJECT: Cave management policy and legislation, protected areas designation, and the management of 3 specific caves.

Mr. Wayne Nordstrom, Ecological Reserves Planner
Alberta Recreation and Parks
- SUBJECT: Management of Plateau Mountain Ice Cave.

Mr. Norm R. Richards, Director
Provincial Parks and Recreational Areas Branch
Ontario Ministry of Natural Resources
- SUBJECT: Cave management in Ontario. Topics included; jurisdiction, protection, policy and administration, and damages and threats.

Mr. Doug Mason, Land Use Planner
Crown Lands Branch
New Brunswick Department of Natural Resources and Energy
- SUBJECT: Possibility of managing caves through the Ecological Reserves Program and by forest management licences.

Mr. Mel Fitton, Coordinator of Ecological Reserves
Fish and Wildlife Branch,
New Brunswick Department of Natural Resources and Energy
- SUBJECT: Cave management and the Ecological Reserves Program.

Mr. Allan Steele, Director
Land Resources,
Nova Scotia Department of Lands and Forests
- SUBJECT: Cave management in Ontario. Topics included; jurisdiction, protection, policy and administration, and damages and threats.

Mr. Barry Diamond, Director
Parks and Recreation,
Nova Scotia Department of Lands and Forests
- SUBJECT: Management of Hayes Cave.

Mr. Robert Ogilvie, Curator
Special Places,
Nova Scotia Museum Complex
- SUBJECT: Cave management and the Special Places Program. Topics included; jurisdiction, protection, policy and administration, and damages and threats.

Mr. Doug Husting, Director
Newfoundland Wilderness and Ecological Reserves Program
- SUBJECT: Cave management.

Mr. Bob Warren, Director
Land Management Division,
Newfoundland Department of Environment and Lands
- SUBJECT: Cave management and policy.

Mr. Kurt Seel, Sr. Resource Management Planner
Western Region,
Canadian Parks Service
- SUBJECT: Agreement between the Minister of Environment and the Alberta Speleological Society.

Mr. John Weisberg, Policy and Operations Officer
Visitor Services, Western Region
Canadian Parks Service
- SUBJECT: General caving policy.

Mr. J. Turnbull, Chief Park Warden
Mount Revelstoke and Glacier National Parks
Canadian Parks Service
- SUBJECT: Nakimu Caves Management Policy.

Mr. Phil Hammon, Assistant Chief Park Warden
Fathom 5 and Bruce Peninsula National Park
Canadian Parks Service
- SUBJECT: Resource management study of caves on Georgian Bay Islands National Park.

National Speleological Society
Huntsville, Alabama
- SUBJECT: Cave management in the U.S.A.

Ms. Judy Peterson, Education Director
American Cave Conservation Association, Inc.
Horse Cave, Kentucky
- SUBJECT: Information on developing a karst management plan.

Ms. Terri Marceron, Assistant District Ranger
Rocky Mountain Ranger District, Lewis and Clark National Forest
- SUBJECT: Cave management in the National Park Service.

Mr. Matthew Safford, Cave Specialist
Bureau of Land Management
Roswell Resource Area, New Mexico
- SUBJECT: Cave management in the Roswell Resource Area.

Mr. Paul Happel, Cave Specialist
Bureau of Land Management
Roswell Resource Area, New Mexico
- SUBJECT: Cave management in the Roswell Resource Area.

Mr. Eric Natti
Bureau of Land Management

Eastern States Office, Alexandria, Virginia
- SUBJECT: Karst management in the eastern states.

Mr. Tom Aley, Director
Ozark Underground Laboratory
Springfield, Missouri
- SUBJECT: Forestry and karst management, and logging impacts at Dry Medicine Lodge Creek, Wyoming.

Ms. Kim Monson
Department of Geography,
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- SUBJECT: Cave formation.

Ms. Gerri Sweet
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- SUBJECT: Cave formation.

Dr. D. W. McRitchie, Director
Geological Services Branch,
Manitoba Energy and Mines
- SUBJECT: Cave formation, mining data.

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- SUBJECT: Cave formation.

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- SUBJECT: Bats

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- SUBJECT: Rare Vascular Plants

Ms. Gloria Keleher
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- SUBJECT: Rare Vascular Plants

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Manitoba Department of Natural Resources

Mr. Ron Larche,
Department of Natural Resources

Mr. Ross Thomasson, Chief
Land Use Planning, Crown Lands Branch
Manitoba Natural Resources
- SUBJECT: Crown land use planning

Mr. Lyle Campbell, Land Manager
Interlake Region
Department of Natural Resources
- SUBJECT: Current and proposed CLCC land use codes

Ms. A. Elliott, Program Coordinator
Endangered Spaces Campaign, Manitoba
- SUBJECT: Land protection mechanisms and accepted land uses

Mr. Edward M. Ledohowski,
Historic Resources Architectural History
Manitoba Department of Culture, Heritage and Recreation
- SUBJECT: Heritage Site Designation

Ms. Jane Roots, Project Coordinator

Nature Conservancy of Canada
- SUBJECT: Land protection and management

Mr. Steven Price, Head
Conservation Team
World Wildlife Fund
- SUBJECT: Conservation programs and strategies

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APPENDIX 1

BAT CAVE LOCATIONS

CAVE NAME	LOCATION
SQUEAKY	GRAND RAPIDS
DALE'S CAVE	GRAND RAPIDS
THE SQUEEZE	GRAND RAPIDS
"T" CAVE	GRAND RAPIDS
MICROWAVE 1	GRAND RAPIDS
FIRECAMP	GRAND RAPIDS
ICE CAVE	GRAND RAPIDS
MOOSE ARM PIT	GRAND RAPIDS
BAT (WALTER COOK'S)	GRAND RAPIDS
STORMCLOUD	GYPSUMVILLE
FOLD CAVERN	GYPSUMVILLE
PHANTOM BEAR	GYPSUMVILLE
MEANDER	GYPSUMVILLE
LONG CRAWL	GYPSUMVILLE
ST. GEORGE'S BAT CAVE	DALLAS-HODGSON
WINDOW CAVE	DALLAS-HODGSON

SOURCE: Dubois 1989, 1990, 1991; SSM. In Press

APPENDIX 2

HERALD MOTH

CAVE NAME	CAVE LOCATION
MICROWAVE	GRAND RAPIDS REGION
BEAR CAVE	GRAND RAPIDS REGION
SQUEAKY	GRAND RAPIDS REGION
BALDWIN'S LAIR	GRAND RAPIDS REGION
HUGO'S GASH	GRAND RAPIDS REGION
FIRECAMP	GRAND RAPIDS REGION
DALE'S CAVE	GRAND RAPIDS REGION
ICE CAVE	GRAND RAPIDS REGION
CRYSTAL KINGDOM	GYPSUMVILLE REGION
LONG CRAWL	GYPSUMVILLE REGION
MAZE	GYPSUMVILLE REGION
STORMCLOUD	GYPSUMVILLE REGION
PHANTOM BEAR	GYPSUMVILLE REGION
ICESLIDE	GYPSUMVILLE REGION
ST. GEORGE'S BAT CAVE	DALLAS-HODGSON REGION
WINDOW	DALLAS-HODGSON REGION

DATA SOURCE: McKillop, unpubl. data.

APPENDIX 2 (CONTINUED)

TISSUE MOTH

CAVE NAME	CAVE LOCATION
SQUEAKY	GRAND RAPIDS REGION
BALDWIN'S LAIR	GRAND RAPIDS REGION
FIRECAMP	GRAND RAPIDS REGION
ICE CAVE	GRAND RAPIDS REGION
KNOLL CHIMNEY	GRAND RAPIDS REGION
LONG CRAWL	GYPSUMVILLE REGION
PHANTOM BEAR	GYPSUMVILLE REGION
STORMCLOUD	GYPSUMVILLE REGION
WINDOW	DALLAS-HODGSON REGION

DATA SOURCE: McKillop, unpubl. data.

APPENDIX 3

RARE VASCULAR PLANTS FOUND NEAR THE STUDY SITES

GENUS	SPECIES
CYPRIPEDIUM	ARIETINUM
DROSERA	LINEARIS
HETERANTHERA	DUBIA
PELLAEA	GLABELLA VAR. OCCIDENTALIS
POTAMOGETON	PUSILLUS VAR. TENUISSIMUS
RHYNCHOSPORA	CAPITELLATA
SILENE	MENZIESII
SMILACINA	RACEMOSA
UTRICULARIA	CORNUTA
WOODSIA	GLABELLA

SOURCE: WHITE AND JOHNSON 1980

APPENDIX 4

FOREST COVER

GRAND RAPIDS STUDY REGION

BUFFALO LAKE

STAND	COVER	SPECIES	TOWNSHIP	RANGE
72	6	JP5,BS4,TA1	51	13
78	4	JP10	51	13

STURGEON GILL ROAD

STAND	COVER	SPECIES	TOWNSHIP	RANGE
6	4		52	13
721				

MOOSE ARM PIT CLUSTER

STAND	COVER	SPECIES	TOWNSHIP	RANGE
6	4		52	13

TRENCHLAND

STAND	COVER	SPECIES	TOWNSHIP	RANGE
59	4		52	13

CAT TRAIL

STAND	COVER	SPECIES	TOWNSHIP	RANGE
56	4	JP9,BS1	52	13
59	4			

840				
38	4			
SQUEAKY				
STAND	**COVER**	**SPECIES**	**TOWNSHIP**	**RANGE**
50	4	JP9,BS1	53	13
MICROWAVE ROAD				
STAND	**COVER**	**SPECIES**	**TOWNSHIP**	**RANGE**
47	4	JP8,BS2	53	14
20	4	JP9,BS1	53	14
823			53	14
PORCUPINE CLUSTER				
STAND	**COVER**	**SPECIES**	**TOWNSHIP**	**RANGE**
1	4	JP8,BS2	54	14
3	4	JP9,BS1	54	14
6	4	JP8,TA2	54	14
10	4	JP9,BS1	53	14
REEDY LAKE				
STAND	**COVER**	**SPECIES**	**TOWNSHIP**	**RANGE**
49	4		54	14
40	4	JP9,BS1	54	14
80	4	JP9,TA1	54	14
82	4	JP10	54	14
MOON LAKE ROAD				

STAND	COVER	SPECIES	TOWNSHIP	RANGE
53	6	JP7,BS1,TA2	54	15
57	4	JP10	54	15
59	4	JP8,TA2	54	15
LITTLE LIMESTONE LAKE				
STAND	**COVER**	**SPECIES**	**TOWNSHIP**	**RANGE**
104	4	JP10	55	13
105	4	JP8,TA2	55	13
30	4	JP10	55	14
34	44	JP7,TA3	55	14
TEN MILE ROAD (BAT CAVE)				
STAND	**COVER**	**SPECIES**	**TOWNSHIP**	**RANGE**
52	4	JP8,BS2	51	15
56	6	JP7,BS3	51	15
57	4	JP9,BS1	51	15
SOURCE: ADAPTED FROM FOREST INVENTORY				
	FORESTRY BRANCH, MNR			

APPENDIX 4

FOREST COVER

GYPSUMVILLE: NORTH QUARRY

STAND	COVER	SPECIES	TOWNSHIP	RANGE
701	0		33	9
721	0		33	9
822	0		33	9
823	0		33	9
845	0		33	9
162	13	BS9,TA1	33	9
144	53	BS6,TA4	33	9
31	82	TA7,BS3	32	9
107	82	TA6,BS3,BA1	33	9
128	82	TA7,BS3	33	9
21	90	TA10	32	9
27	90	TA8,BS1,WS1	32	9
27	90	TA9,BS1,WS1	32	9
28	90	TA10	32	9
120	90	TA9,BS1	33	9
122	90	TA9,BA1	33	9
123	90	TA8,BS2	33	9
124	90	TA9,BS1	33	9
127	90	TA9,BS1	33	9
140	90	TA8,BS1,WS1	33	9
141	90	TA10	33	9
142	90	TA8,BS1,WS1	33	9
143	90	TA10	33	9
160	90	TA9,BS1	33	9

COVER TYPE

(13) BLACK SPRUCE 71-100%

(53) BLACK SPRUCE 51%+

(82) TREMBLING ASPEN WITH 26-50% SOFWOOD

(90) TREMBLING ASPEN LESS THAN 25% SOFTWOOD

(13) BS9, TA1

(53) BS6,TA4

(82) TA60-70%, BS 30%, BA10%

(90) TA 80-100%, BS 10-20%, WS10%

SOURCE: ADAPTED FROM FOREST INVENTORY
FORESTRY BRANCH, MNR

APPENDIX 4 (CONTINUED)

FOREST COVER

EAST OF GYPSUM LAKE

STAND	COVER	SPECIES	TOWNSHIP	RANGE
701	0		33	8
721	0		33	8
65	4		33	8
41	6	JP6,BS4	33	8
229	13	BS10	33	7
233	13	BS10	33	7
241	13	BS9,TL1	33	7
242	13	BS10	33	7
243	13	BS8,TL2	33	7
244	13	BS10	33	7
8	13	BS8,TA2	33	8
19	13	BS10	33	8
31	13	BS10	33	8
33	13	BS8,TA2	33	8
35	13	BS10	33	8
43	13	BS8,TA2	33	8
44	13	BS8,TA2	33	8
47	13	BS8,TA2	33	8
49	13	BS8,JP1,TA1	33	8
50	13	BS8,JP2	33	8
58	13	BS10	33	8
67	13	BS10	33	8
81	13	BS10	33	8
83	13	BS10	33	8
126	13	BS10	33	8
127	13	BS10	33	8
129	13	BS8,TA2	33	8
134	13	BS8,TA2	33	8
135	13	BS10	33	8
136	13	BS10	33	8
137	13	BS10	33	8
139	13	BS10	33	8
140	13	BS10	33	8
154	13	BS10	33	8
284	13	BS8,TA2	33	8
287	13	BS10	33	8
228	14	BS7,JP3	33	7
240	14	BS7,TA2,JP1	33	7

34	14	BS7,JP3	33	8
46	14	BS6,JP4	33	8
10	15	BS7,BF2,TA1	33	8
24	15	BS6,WS3,TA1	33	8
53	16	BS6,TL4	33	8
156	31	TL6,BS4	33	8
32	53	BS6,TA4	33	8
52	53	BS6,TA4	33	8
62	53	BS6,TA4	33	8
79	53	BS7,TA3	33	8
124	53	BS7,TA3	33	8
146	53	BS7,TA3	33	8
162	53	BS6,BF1,TA3	33	8
163	53	BS6,BF1,TA3	33	8
166	53	BS6,TA4	33	8
231	54	BS4,TA4,JP2	33	7
236	58	BS4,WS2,JP2TA2	33	7
36	82	TA7,BS2,WS1	33	7
222	82	TA7,BS2,WS1	33	7
239	82	TA7,TL2,BS1	33	7
245	82	TA7,BS2,JP1	33	7
20	82	TA7,BS3	33	8
45	82	TA7,BS3	33	8
48	82	TA6,BS4	33	8
57	82	TA7,BS2,JP1	33	8
63	82	TA6,BS4	33	8
80	82	TA7,BS3	33	8
131	82	TA6,BS4	33	8
132	82	TA7,BS3	33	8
144	82	TA6,BS4	33	8
145	82	TA7,BS3	33	8
159	82	TA6,BS4	33	8
167	82	TA7,WS3	33	8
9	90	TA7,BA1,BS2	33	8
21	90	TA8,BS2	33	8
22	90	TA8,BS2	33	8
123	90	TA8,BA2	33	8
128	90	TA10	33	8
130	90	TA10	33	8
138	90	TA8,BS2	33	8
141	90	TA8,BS2	33	8
143	90	TA9,BS1	33	8
147	90	TA9,BS1	33	8
148	90	TA10	33	8

149	90	TA8,BS2	33	8
151	90	TA8,BS2	33	8
153	90	TA8,BA2	33	8
157	90	TA8,WS2	33	8
160	90	TA9,WS1	33	8
161	90	TA10	33	8
164	90	TA8,BS2	33	8
286	90	TA8,BS2	33	8
831			33	8
835			33	8
848			33	8

TREMBLING ASPEN AND BALSAM POPLAR EQUAL 51%(90)
TREMBLING ASPEN (82) 26 - 50% SOFTWOOD
BLACK SPRUCE (58) 50% OR LESS - WHITE SPRUCE
BLACK SPRUCE (54) 50% OR LESS - JACK PINE
BLACK SPRUCE (53) 51% OR MORE
TAMARACK (31) 40 - 70% - SPRUCE
BLACK SPRUCE (14,15,16) 40 - 70%
BLACK SPRUCE (13) 71-100%
JACK PINE (6) 40-70%
JACK PINE (4) 71 - 100%

SOURCE: ADAPTED FROM FOREST INVENTORY
FORESTRY BRANCH, MNR

APPENDIX 5

LAND OWNERSHIP

GRAND RAPIDS STUDY AREA

TOWNSHIP	RANGE	SECTION	MINERAL RIGHTS	SAND & GRAVEL RIGHTS
53	13W	8, PART	CROWN	CROWN
MANITOBA HYDRO ELECTRIC BOARD				
55	13W			
MOOSE LAKE INDIAN RESERVE				
56	13W			
MOOSE LAKE INDIAN RESERVE				
56	12W	31, PART	CROWN	CROWN
MANITOBA HYDRO ELECTRIC BOARD				
56	12W	31, PART	CROWN	CROWN
PROPOSED HYDRO STATION SITE				
56	12W	31, PART	CROWN	CROWN
MANITOBA HYDRO ELECTRIC BOARD				
57	12W	32, PART	CROWN	CROWN
MANITOBA HYDRO ELECTRIC BOARD				

DATA SOURCE: CROWN LANDS REGISTRY SYSTEM
CROWN LANDS BRANCH
MANITOBA NATURAL RESOURCES

APPENDIX 5

PRIVATE LAND OWNERSHIP

GYPSUMVILLE STUDY AREA

TOWNSHIP	RANGE	SECTION	LEGAL SUB DIV.	MINERAL RIGHTS	SAND & GRAVEL RIGHTS
33	8W	2	13	CROWN	PRIVATE
DOMTAR LIMITED					
33	8 W	3	16	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY COMPANY					
33	8W	10	1,8	CROWN	PRIVATE
DOMTAR LIMITED					
33	8W	12 PART	NE QTR	CROWN	PRIVATE
DOMTAR LIMITED					
33	8W	13	12-14	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY					
33	8W	13 PART	S /EAST	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY					
33	8W	14, NNE		CROWN	PRIVATE
DOMTAR LIMITED					
33	8W	14	13-16	CROWN	PRIVATE
DOMTAR LIMITED					

DATA SOURCE: CROWN LANDS REGISTRY SYSTEM,
CROWN LANDS BRANCH,
MANITOBA NATURAL RESOURCES.
LAND TITLES REGISTRY

		APPENDIX 5			
	PRIVATE LAND OWNERSHIP				
	GYPSUMVILLE STUDY AREA				
					SAND &
			LEGAL SUB	**MINERAL**	**GRAVEL**
TOWNSHIP	**RANGE**	**SECTION**	**DIV.**	**RIGHTS**	**RIGHTS**
33	8W	15, PART	NE	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY COMPANY					
33	8W	15, PART	SE	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY COMPANY					
33	8W	23 SOUTH	HALF	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY COMPANY					
33	8W	23	11	PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY COMPANY					
33	8W	24	4	CROWN	PRIVATE
DOMTAR LIMITED					
33	8W	26	NW	PRIVATE	PRIVATE
HUDSON'S BAY COMPANY					
33	8W	26	SOUTH	PRIVATE	PRIVATE
HUDSON'S BAY COMPANY					
33	8W	26	NW	PRIVATE	CROWN
PROVINCE OF MANITOBA					
33	8W	26	SW	PRIVATE	CROWN
PROVINCE OF MANITOBA					
33	8W	26	SE	PRIVATE	CROWN
PROVINCE OF MANITOBA					
DATA SOURCE: CROWN LANDS REGISTRY SYSTEM,					
		CROWN LANDS BRANCH			
		MANITOBA NATURAL RESOURCES			
	LAND TITLES REGISTRY				

APPENDIX 5

PRIVATE LAND OWNERSHIP

GYPSUMVILLE STUDY AREA

TOWNSHIP	RANGE	SECTION	LEGAL SUB DIV.	MINING RIGHTS	GRAVEL RIGHTS
33	9W	2 PART	NE	CROWN	PATENT
DOMTAR LIMITED					
33	9W	2 PART	NE	CROWN	CROWN
DOMTAR LIMITED					
33	9W	2	BNE	CROWN	CROWN
SCHOOL LAND 1					
33	9W	2 PART	NW	CROWN	PATENT
DOMTAR LIMITED					
33	9W	2	BNW	CROWN	CROWN
SCHOOL LAND 1					
33	9W	2 PART	SE	CROWN	CROWN
DOMTAR LIMITED					
33	9W	2 PART	SE	CROWN	CROWN
DOMTAR LIMITED					
33	9W	2	BSE	CROWN	CROWN
SCHOOL LAND 1					
33	9W	2 PART	SW	CROWN	CROWN
DOMTAR LIMITED					

DATA SOURCE: CROWN LANDS REGISTRY SYSTEM
CROWN LANDS BRANCH
MANITOBA NATURAL RESOURCES
LAND TITLES REGISTRY

		APPENDIX 5			
	PRIVATE LAND OWNERSHIP				
	GYPSUMVILLE STUDY AREA				
					SAND &
			LEGAL SUB	**MINING**	**GRAVEL**
TOWNSHIP	**RANGE**	**SECTION**	**DIV.**	**RIGHTS**	**RIGHTS**
33	8,W	12,PNE		CROWN	PRIVATE
DOMTAR LIMITED					
33	8W	26,NE		PRIVATE	CROWN
SCHOOL LAND 2					
32	8W	34 PNE		CROWN	PRIVATE
DOMTAR LIMITED					
32	8W	34, PART		--	--
LITTLE SASKATCHEWAN INDIAN RESERVE					
32	8W	34, SE		CROWN	--
LITTLE SASKATCHEWAN INDIAN RESERVE					
32	8W	34, SW		CROWN	--
LITTLE SASKATCHEWAN INDIAN RESERVE					
32	8W	35, PNW		PRIVATE	PRIVATE
CANADIAN NORTHERN RAILWAY COMPANY					
32	8W	35, SW		CROWN	--
LITTLE SASKATCHEWAN INDIAN RESERVE					
DATA SOURCE: CROWN LANDS REGISTRY SYSTEM					
	CROWN LANDS BRANCH				
	MANITOBA NATURAL RESOURCES				
	LAND TITLES REGISTRY				