WATER MANAGEMENT ISSUES
IN THE
TURTLE RIVER WATERSHED CONSERVATION DISTRICT:
FROM THEORY TO PRACTICE

BY

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A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
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Abstract

After experiencing the "Flood of the Century" in 1997, government leaders, policy makers and resource managers were reminded of the importance of reliable water management. In order to develop a comprehensive, straight-forward water management plan, many factors needed to be taken into consideration. This thesis reviews important research undertaken in the field of water resource management, and applies it to a practical study area: the Turtle River Watershed Conservation District east of Riding Mountain National Park. After documenting some of the approaches others have tried, the author develops a water management plan that is sensitive to all of the groups in the District and adheres to a watershed model based on the geographic method. The thesis discusses issues such as jurisdictional confusion, the mechanics and causes of erosion and sedimentation within the District, the importance of alluvial fans for conservation, the legacy of Wilson Creek Experimental Watershed, and methods by which various groups within the District could work together to solve the many challenges this study area faces.

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PART I

THE THEORY

a review of literature,
an overview of the study area, methodology, history
and
rationale for water management

Chapter One

Introduction

"The federal and provincial jurisdictions don't cooperate much on managing the landscape. The (feds) have a mandate to preserve the health of the ecosystem. The ecosystem does not end at the park boundaries. That's the essence of it" (Moharib 1999, p 8). These words are spoken by Jack Dubois, the president of the Manitoba Naturalists Society in response to a report released by the Canadian Nature Federation in December 1999. The report ranked Riding Mountain National Park 8th out of ten endangered Canadian national parks. Confusion over jurisdiction is a main cause of poor resource management and is a central issue in this thesis. An excellent example can be found in the relationship between Riding Mountain National Park and the Turtle River Watershed Conservation District.

The essential role of geography in rural land and water management has never been more evident than it is today. Water and land management techniques form a symbiotic relationship and are irrevocably linked. One cannot develop a land practices plan without some aspect of it affecting the water, and one cannot develop a water management plan without some knowledge and understanding of the surrounding soil and vegetation as well as land practices.

The role of the geographer is essential in such endeavors. The geographer is trained to see the spatial relationships between certain variables and how these relationships affect one another. The advantages of seeing the "big picture" are denied at the micro level. This thesis reviews the geographic principles embodied in a water and land management strategy and assesses their validity in an actual situation. The study area for the project is the Turtle River Watershed Conservation District.

The Turtle River Watershed Conservation District, hereafter labelled as TRWCD, covers a land area of 2130 sq. km (824 miles) and was established on August 30, 1975. It is a diverse area from a topographical standpoint, in that it stretches from the rugged east-facing escarpment of Riding Mountain National Park in the southwest down through rolling hills of the sub-escarpment region to the marshy lowlands on the approach to Dauphin Lake in the northeast. The primary concerns of this area have arisen out of: the artificial draining of the lowland areas during the past 100 years; loss of topsoil due to wind and water erosion; erosion along riverbanks and drainage ditches; channel siltation; and the overall gradual loss of productivity on these lands.

It is the aim of this thesis to identify the major issues confronting land and water management in the District, as well as providing some guidance towards a water-and-land management plan based on an integrated geographic approach. The body of the thesis, therefore, is a review of water management issues and initiatives in the Riding Mountain area while the final section will suggest a plan for landowners, policy makers, and park officials to work together to meet the challenges arising from them.

This thesis is concerned with the understanding of the significance of spatial relationships between water and land management issues in the Turtle River Watershed Conservation District. Rather than looking at a problem or challenge from one specialized discipline, the geographer must look at the whole picture and determine the role each piece of the puzzle plays in the grand equation. In this scenario, geography functions as a dominant "mega-discipline" which supersedes all other disciplines. By studying the relationships between human activity and the physical environment, the geographer will lose a certain amount of detail, but will gain far more in terms of overall understanding of the problem than could ever be gleaned from one individual study in one individual discipline, as chronicled in Livingstone's study, "The Geographical Tradition" (1992).

It is imperative to place any research into a theoretical framework. The issues of jurisdictional diversity, water management priority, stewardship responsibility and sustainable development are all addressed in Gro Harlem Brundtland's United Nations report, "Our Common Future" (1987). It is in this report that the term "sustainable development" was originally coined and defined. According to Brundtland, sustainable development is "development that ensures that the needs of the present are met without compromising the ability of future generations to meet their own needs" (Brundtland 1987, p 8).

The Brundtland report also stresses that the traditional way of tackling an environmental problem must be challenged and re-evaluated. "Until recently, the planet was a large world in which human activities and their effects were neatly compartmentalized within nations, within sectors (energy, agriculture, trade) and within broad areas of concern (environmental, economic, social). These compartments have begun to dissolve. This applies in particular to the various global 'crises' that have seized public concern, particularly over the past decade. These are not separate crises: an environmental crisis, a development crisis, an energy crisis. They are all one." (Brundtland 1987, p 4) The suggestion relevant to our purpose is that the old ways of dealing with problems such as water management must not be considered as the only ways, and that a paradigm shift from the specific to the general is essential if the essential perspective is to be achieved.

The Brundtland report supports this idea in terms of resource management when it states, "Environmental stresses are linked to one another. For example, deforestation, by increasing run-off, accelerates soil erosion and siltation of rivers and lakes. Air pollution and acidification play their part in killing forests and lakes. Such links mean that several different problems must be tackled simultaneously. And success in one area, such as forest protection, can improve chances of success in another area, such as soil conservation." (Brundtland 1987, p 37).

Chapter Two

Review of Literature

Section 2.1 Introduction

The study of water in general, and water management in particular, has had a long and varied history. Water is essential to the basic health and nutritional needs of all living things. This review of literature will restrict itself to a selective line of relevant studies. The studies reviewed are primarily North American, specifically agricultural riparian management studies published over the last 30 years. This timeline is not deliberate, but reflects the fact that riparian water management, as a sub-discipline of water management, is a recent phenomenon.

The single most important issue facing the Turtle River Watershed Conservation District is erosion and loss of quality agricultural lands due to near-sighted management of the stream corridors and drainage ditches in the District. It is easy to get sidetracked by other issues that impinge on the District Board's time and resources, so it is essential to realize that an intelligent and integrated approach to managing the

District's riparian zones will lead to less erosion and blockage of drains. The following section reviews some of the research that has been undertaken in the broad area of riparian zone management.

Section 2.2 General Review of Water Management

Riparian zones, defined by Gregory et al. as "narrow, ribbon-like networks of streams and rivers intricately dissecting the landscape and accentuating the interaction between aquatic and terrestrial ecosystems" (1991, p 549), have been studied quite extensively in natural environments such as the American Pacific Northwest. However, relatively few equivalent studies have been undertaken in Canada.

An exception to this is de Villiers' research published in 1999. De Villiers' work is a global survey as to the state of the world's water supply, quantity and most importantly, quality. It assesses areas of the world in which water supply and management are becoming or will become crucial issues. Although the study focuses primarily on the developing world, there are enough examples from North America to show that proper water management is a truly worldwide concern, even for a country as "water rich" as Canada. As Paul Gleick warns in de Villiers' book, "You have to look at total resources, renewable resources, usable renewable resources, the ability to transfer water from water-rich to water-poor places, the development level of the economy, the annual consumption, and the deprivation level, all matched against population trends and economic resources. When you do that, you'll see that there are crises in many places" (de Villiers 1999, pg 56). The following review of literature addresses the different ways in which riparian mananagement can be attempted.

The studies tend to fall into a number of broad categories. These categories are: the ecological functions of stream corridors; the values of human use; the planning and design of stream corridors; and examples of site specific stream corridor regulations which deal with the study area of the Turtle River Watershed Conservation District. Examples follow from each of these broad study areas.

Section 2.3 Review of Ecological Functions of Stream Corridors

Gregory et al. wrote the definitive article on the ecological functions of stream corridors. It is an excellent primer for those who know very little on this relatively new subject (Gregory et al 1991). Brown and Krygier have written several articles on the importance of riparian vegetation on stream temperature and the effects of clear cutting on the ecosystem (Brown and Krygier 1970).

Smith and Hellmund (1993) have edited a book entitled "Ecology of Greenways: Design and Function of Linear Conservation Areas" which is considered an essential reference to this topic. The term "Greenway" is used here to describe the delicate and distinctive ecosystem that is more commonly known as a "riparian zone". Labaree summarizes the concept of Greenways in a handy, quick reference pamphlet (Labaree 1992). Charles Little's book "Greenways for America" celebrates the values of riparian zones (1990) and provides many examples of streams that have been well managed.

Another important topic is the human value placed on stream corridors. During discussions with the Turtle River Watershed Conservation District Board, concern was raised over the aesthetic value of the streams and drains in the District and how recreational aspects of the water network could be considered along with the practical drainage and erosion issues. Much research has been recently undertaken in this area. Alexander *et al.*'s book on designing the ideal community has a chapter on "Access to Water" and how stream buffers should remain in common ownership (Alexander et al., 1977).

Section 2.4 Review of Stream Corridor Design and Planning

An important aspect of water management is in the actual designing and planning of stream corridors. The vast majority of the research encountered focuses upon this topic. This area of research is almost exclusively the domain of engineers, biologists and urban planners. This is not to belittle their work, but it usually means that they bring a narrow, specialist focus when an integrated approach is required. Ferguson's 1991 article discusses the technicalities involved in reclamation techniques such as "corridor reservation", a process by which a targeted riparian zone is paradoxically returned to a natural state using artificial means. Croonquist and Brooks (1993) looked at habitat disturbance to bird communities in riparian corridors, and discovered that an undisturbed corridor at least 25 meters across was necessary for sensitive bird species, and that a naturally vegetated stream corridor at least 125 meters in width was essential to support the full complement of bird communities expected in central Pennsylvania. This article is representative of the type of article that is most common in dealing with fauna along stream corridors. Another example is Blakesley and Reese's article on avian use of campgrounds in riparian zones (1988). It suggests that riparian zones are used more than any other habitat by wildlife in western North America, and that soil erosion, trampling, vegetation removal, road construction and timber harvesting all contribute to the degradation of riparian zones (Blakesley and Reese 1988, p 399). Cohen, et al.'s article is one of the few papers that deals with the sustained management of stream corridors and how to maintain a healthy riparian zone (1987).

Section 2.5 Review of Site-Specific Management Plans

Another focus of conern dealt with in the literature depicts individual sites and specific examples on a local scale. Most of these studies are, as mentioned, American and focus on the Pacific Northwest. The Columbia River

Gorge Commission's report is representative of such a study (1992). Keller and Hoffman's paper offers a case study of an urban stream corridor restoration in North Carolina (1977). Desert ecosystems, often forgotten when discussing riparian zones, are addressed in the third chapter of Gore's book (1985). Although not dealt with at all in this thesis, it is important to note that deserts are unique, but tend to be overlooked in riparian studies. Canadian examples of a semi-arid grassland riparian area can be seen in the studies of the Oldman River in Southern Alberta and the problems faced in irrigating a region which could not naturally support agriculture. Russell's historic account of life along the Oldman river and the changes resulting from irrigation projects provides a unique "before and after" look at grassland riparian zones in a semi-arid region(Russell 1987). The Oldman River is also the subject of a Federal study examining the effects of irrigation and the associated dams and reservoirs (Ross, 1992). Tellmen *et al.*'s technical report on the U.S. Department of Agriculture deals with the often overlooked aspect of riparian zones in the "Urban-Rural Interface" (1993). Dobson and Beck's handbook on watershed management stands out as one of the few distinctly Canadian manuals for the conservationist (Dobson and Beck 1999). Not only does it deal with the common problems of riparian management, but it also looks at the working relationship between the water-, carbon-, nitrogen-, sulfur- and phosphorus-cycles and how the habitat surrounding a riparian environment can affect the entire watershed's health. Johnson *et al.*'s report on the first North American Riparian Conference is a general technical report dealing with the major issues that emerge when riparian zones are studied (1985). Omernik *et al*'s article is unique in that it is one of the few dissenting views, suggesting that the degree of superiority of forested riparian zones relative to non-forested riparian zones is negligible (1981, p 227). Most of the water management studies dealing with riparian zones show a statistically significant difference between the biodiversity of naturally vegetated zones as opposed to those which have been substantially interfered with.

The books and articles herein before cited have studied the topic of riparian water management from a decidedly American point of view. More regionally relevant research will now be examined.

On a more regional level, the Manitoba Model Forest Network (MMFN) has emphasized the importance of buffer zones along the Moose River in terms of protecting fish habitat from logging (MMFN 1993). Although this is not in the immediate study area of the thesis, it is included as a representative example of the type of riparian research which is carried on in the Province of Manitoba.

The study area for this thesis, the Turtle River Watershed Conservation District (TRWCD), is discussed in much more detail in the next chapter. It is fortunate that this study area has been a popular one for students and professors of natural resource management, because there has been much research on the Riding Mountain and Escarpment areas. The most well known of these studies has been the research done on Wilson Creek. The various studies which were conducted over a 25-year period are summarized in the Summary Report of the Wilson Creek Experimental Watershed Study 1957-1982 (Newbury 1983). Thomlinson's report on research activities in the Wilson Creek watershed gives the reader an overview of activity at the study site (Thomlinson 1967).

Another important step towards a water management plan was Greg Bruce's survey of the subescarpment region

East of Riding Mountain National Park (Bruce 1984). In this study, Bruce examines the various soil management techniques employed by the agricultural community and evaluates their effectiveness in terms of conservation. A summary of the major soil-water management problems was also completed, and provides excellent background for a District-wide water management plan. Mackling's report on potential sites for the demonstration of conservation techniques in the same study area builds on Bruce's work and bridges the gap between theory and practice in water management (Mackling 1987).

The Dauphin Lake Basin Advisory Board (DLBAB) is another stewardship organization in the vicinity of the study area. Its main concern is to "reduce sediment and nutrient loading to Dauphin Lake and to create and preserve habitat in the Basin" (Ewashko 1996). The Advisory Board has produced numerous reports on water quality in the Basin over the past ten years. One of the more important reports to come out of the Basin was the 1989 Planning Report, which reviewed the major challenges in the Basin and provided tentative solutions to these challenges (DLBAB 1989). DLBAB's Stream Rehabilitation Program Planning Report for 1996-97 is representative of the work done in this active but politically weak organization (Ewashko 1996).

A review of the relevant literature in respect to the land adjacent to the Manitoba Escarpment would not be complete without some mention of the research produced by Riding Mountain National Park. The presence of a national park at the headwaters of many of the streams that empty into Dauphin Lake can result in jurisdictional conflict and uncertainty in terms of watershed-wide plans and conservation programs initiated by the Turtle River Watershed Conservation District and the Dauphin Lake Basin Advisory Board. Despite this, the Park has performed invaluable research in terms of habitat protection, wildlife management, and erosion and sediment control. The wardens in charge of water management are confident that the processes affecting the Clear Lake Basin are understood and fully researched (Rousseau 1999) and that the major issue and basis of future research lies with the streams which flow northeastward off the escarpment and empty into Dauphin Lake. A study representative of the work undertaken by Park officials is the Ecosystem Conservation Plan, revised in 1997 (Tarleton 1997).

Section 2.6 Conclusion

This review of literature stretches from the most general aspects of water resource management to the most specific studies dealing with the Turtle River Watershed Conservation, Riding Mountain National Park, and the water that flows between these jurisdictions. As mentioned in the introduction to this chapter, if we were to look at the dates on the articles in this review of literature, it would strike us that the vast majority of them are from the 1990s, a few from the 1980s, and only one or two appear in the 1970s. This is representative of the fact that riparian research is a very recent sub-discipline and will continue to evolve and adapt with each new study. The more research that is conducted dealing with the delicate balance between water and land, the better informed will we be when management decisions have to be made.

Chapter Three

Study Area

Section 3.1 Introduction

The parameters on which this thesis is based were set up by the Province of Manitoba in August 1975 when the Turtle River Watershed Conservation District was established by an Order-In-Council of the Provincial Cabinet. It is located in Southwest Manitoba, south of Dauphin Lake and East of Riding Mountain National Park. **Figure 3.1** outlines the boundaries of the District on a provincial highway map and shows a portion of the surrounding area. The District covers an area of 2130 sq. km (824 sq miles) (Jenkins 1979, vi).

Figure 3.2 is a map produced by the District. It highlights the legal boundaries of the District and includes the various Rural Municipalities which fall under its jurisdiction. Included are the RM's of Lawrence, Dauphin, Ochre River, Ste. Rose, Alonsa, McCreary and Rosedale. It is also important to note that approximately 25% of the District lies within the area and jurisdiction of Riding Mountain National Park. This

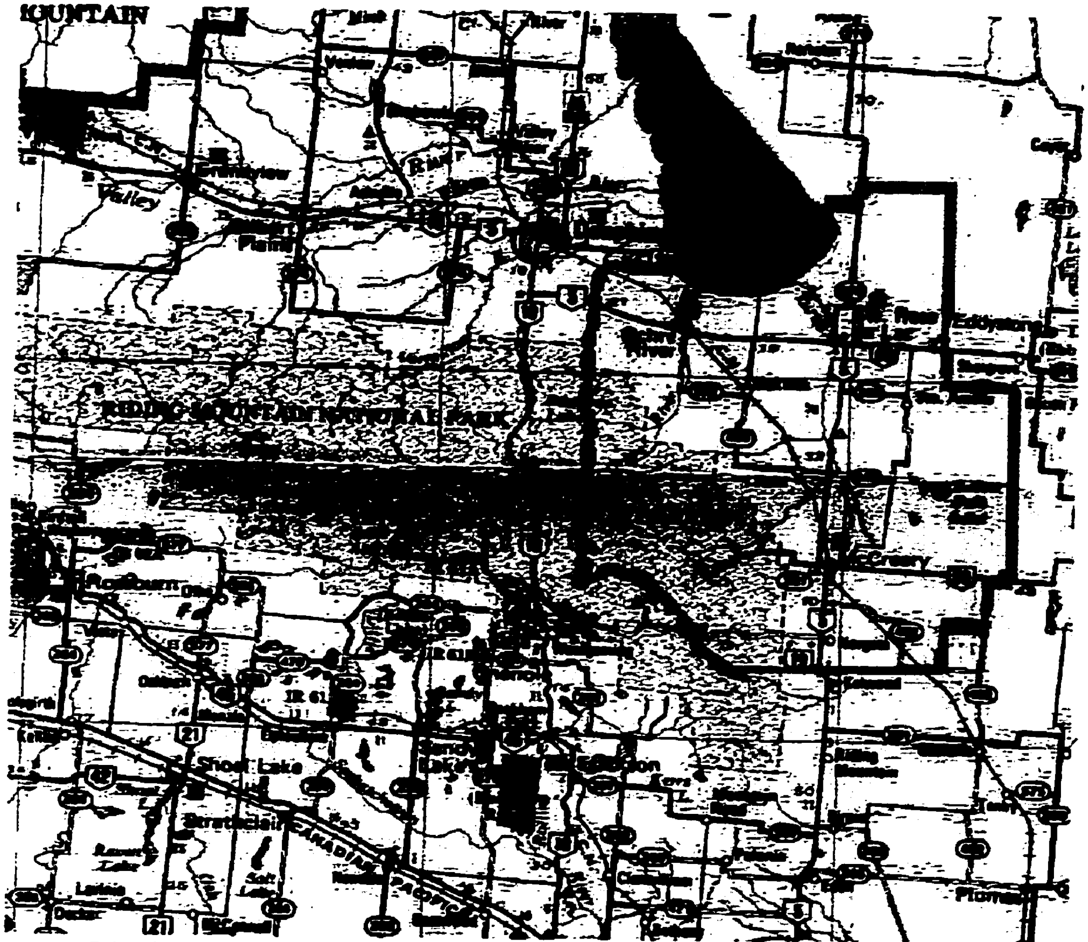


FIGURE 3.1 PROVINCIAL HIGHWAY MAP WITH DISTRICT OUTLINED IN GREEN
SOURCE: MANITOBA HIGHWAYS AND TRANSPORTATION

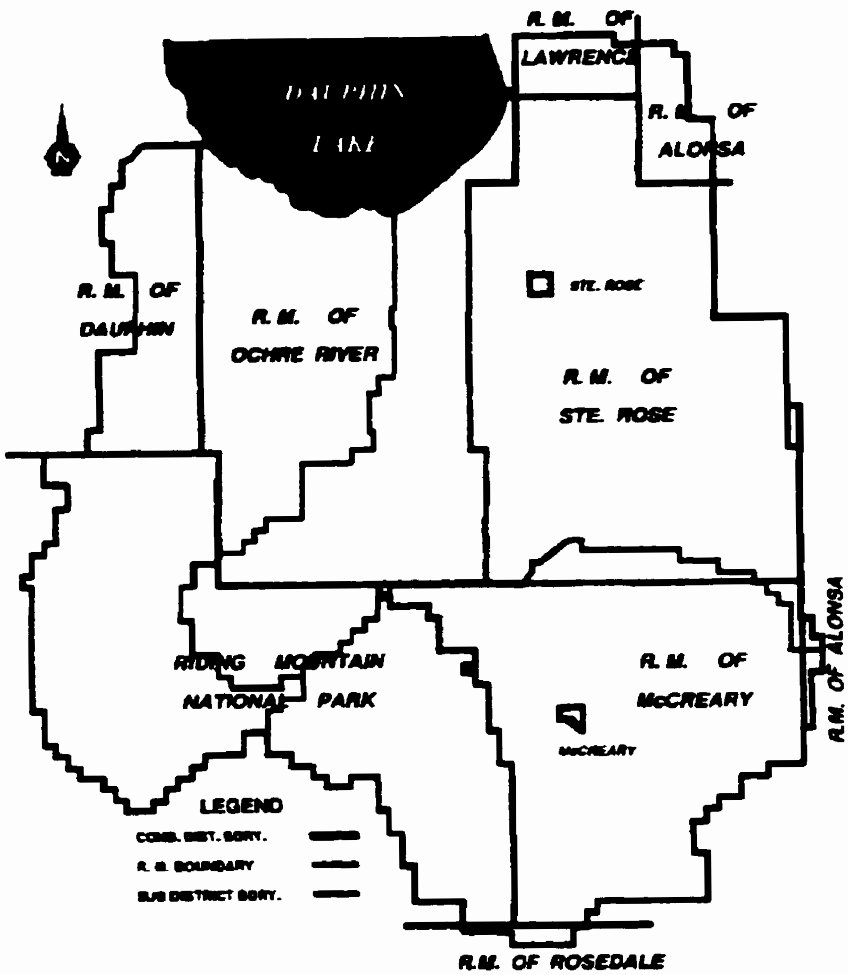


FIGURE 3.2 LEGAL BOUNDARIES OF DISTRICT SOURCE: TRWCD

becomes important when policies developed by the District are implemented and are subjected to unanimous approval encompassing the entire watershed.

The headwaters of all the streams in the District are found in the Uplands of Riding Mountain National Park. The maximum elevation in the Southwest of the District is 675 m above sea level. The topography changes dramatically as the elevation drops at the Manitoba Escarpment from 600 meters to 360 m above sea level. This is seen clearly in the relief map of the District, **Figure 3.3**.

The Turtle River Watershed Conservation District can be subdivided into four unique and separate areas based on physiography. Generally speaking, the four zones run north to south, with Area One covering the easternmost, and Area Four the westernmost portion of the District. **Figure 3.4** is an aerial photograph taken in 1996 of the town of McCreary and its surroundings. It clearly shows the dramatic changes in topography in the District. The dark-toned, rough-textured quality of the escarpment in the bottom left (southwest) corner of the photo gives way to the mixed environment of farm and pasture land. To the right (east) of the town of McCreary, the beach ridges

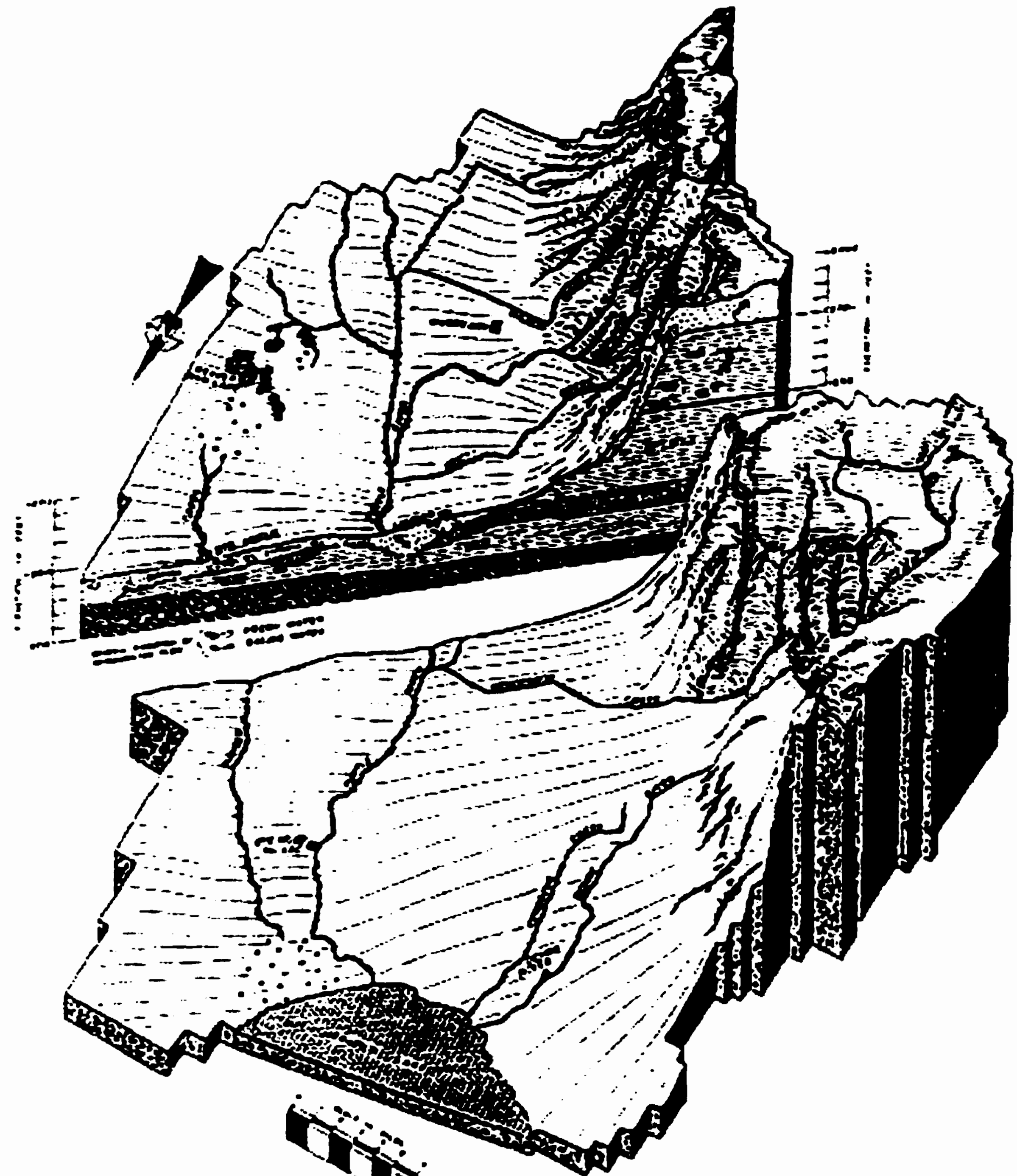


FIGURE 3.3 RELIEF MAP OF TURTLE RIVER WATERSHED CONSERVATION DISTRICT
SOURCE: JENKINS 1979

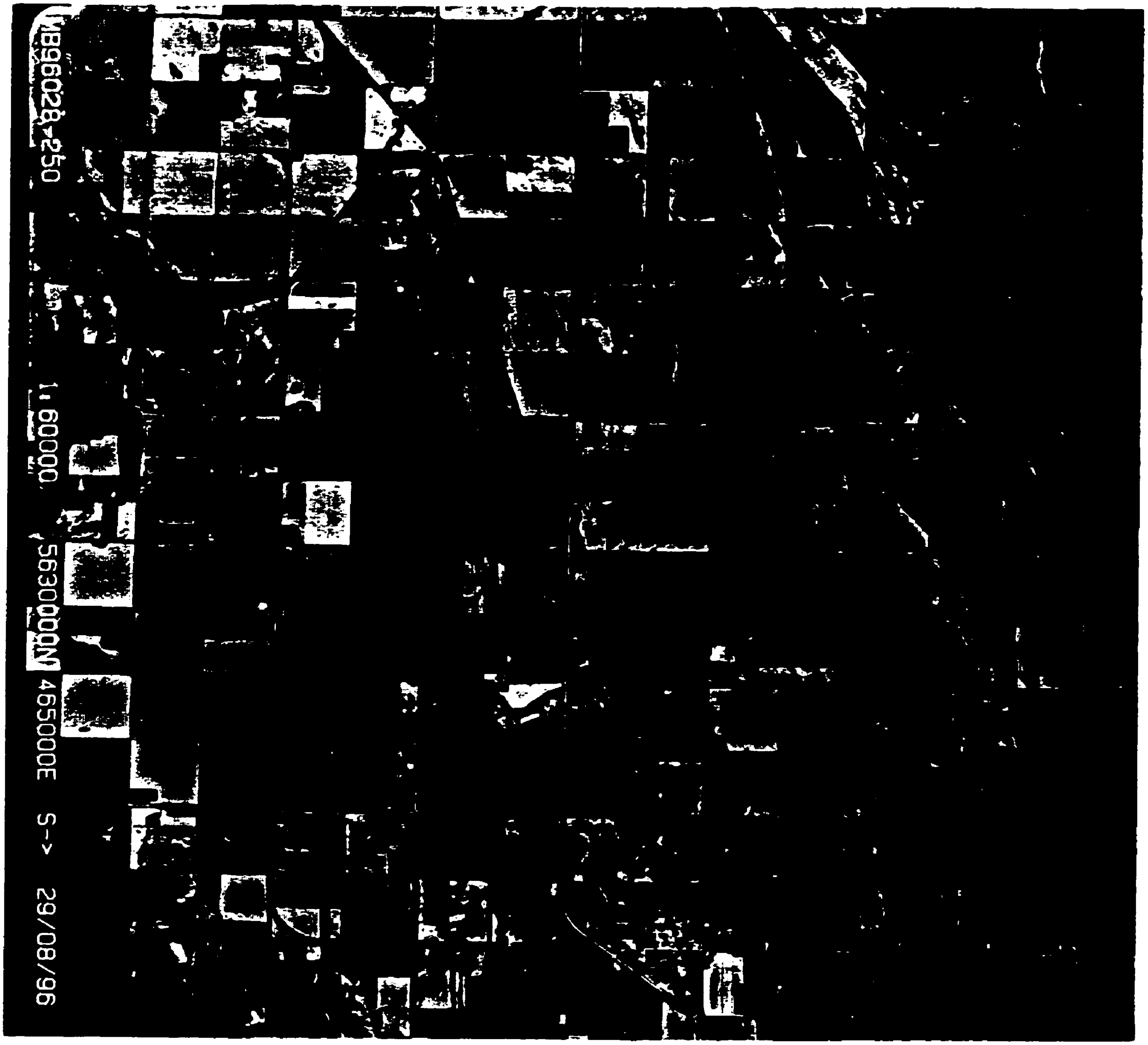


FIGURE 3.4 AERIAL PHOTOGRAPH OF SOUTHERN PORTION OF DISTRICT, INCLUDING THE TOWN OF MCCREARY, 1996

SOURCE: MANITOBA REMOTE SENSING CENTRE

and till deposits of the lowlands can be clearly seen. The characteristics of each of the four physiographic regions of the District will now be discussed.

Section 3.2 Lowlands

The Lowlands zone includes all of the area below the 300 m asl contour. This area covers the greatest amount of land in the District and stretches from the eastern border of the District down to the southern border, which runs between McCreary and Kelwood. Drainage is classified as varying from poor to good, and the surface deposits vary from stone-free to extremely stony. The surface mineral soil texture ranges from gravel to clay, although there is a high percentage of fine lacustrine deposits in this zone (Vitikin 1990, p 3) and the area is dominated by very fine sandy loam, especially of the Plum Ridge series (Mills and Smith 1981). The most common profile in this zone is the gleyed carbonated Rego Black Chernozem, which suggests a high water table (Mills and Smith 1981).

While there is a wide range of vegetation found in the lowland zone, the primary use of the land is for agriculture. The natural vegetation includes aspen, balsam poplar, sedges, willows and meadow grasses (Mills and Smith 1981). The quality of the surface texture dictates whether the land is used for cereal crops, forage crops, or pasture land. A later section on Canadian Land Inventory goes into more detail concerning the different classes of land capability in the District. The parent material is made up of glaciolacustrine and alluvial deposits as well as till deposits. The bedrock is dominated by Jurassic shales, interspersed with limestone and sandstone layers (Vitikin 1990, pg 2). **Figure 3.5** is a photograph of a field in the lowlands. It is important to note the stoniness of the soil as a result of glacial till deposition, as well as the presence of water in the field due to a wet spring and saturated soil conditions.

Section 3.3 The Subescarpment

This zone constitutes a narrow band of terrain between the 300 and 360 m contours. Provincial highway #5 roughly separates the Lowlands zone from the Subescarpment zone. It is characterized by the presence of *alluvial fans and beach ridges. Alluvial fans are* "fan shaped deposits of coarse alluvium (sand and gravel) laid *down by a stream where it issues from a constricted*

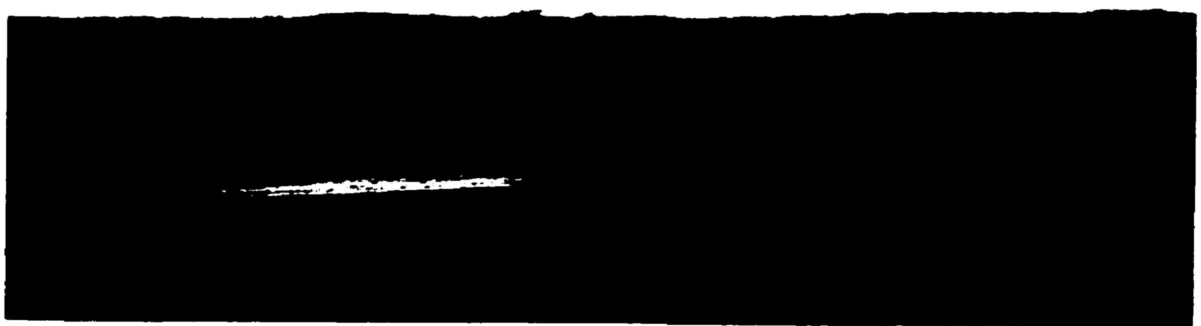


FIGURE 3.5 TYPICAL FIELD CONDITIONS IN THE LOWLANDS. WET AND STONY SPRING 1999

SOURCE: TREVOR LOCKHART

course as from a gorge onto a more open valley or a plain" (Clark 1990, pg 9). Alluvial fans will be discussed in greater detail in a later section. The base of the escarpment is dominated by a deciduous forest. The dominant species is trembling aspen, although hardwood mixes of elm, green ash and Manitoba maple are also found in this transition zone (Tarleton 1997, pg 13). The soil texture ranges from sandy loam to silty clay soils, with a higher percentage of coarse-grained materials than in the lowlands (Vitikin 1990, pg 3). As in the Lowlands, land that has good drainage and soil quality is used for cereal grains or forage crops. Marginal land is used as pasture, and land near the escarpment which has a high slope and rough texture is left undeveloped. This area has well developed and defined stream channels with moderate gradients. Along the Ochre and Turtle Rivers, as well as along a number of smaller streams in this zone, loams of the Turtle River series are found. These rich riparian zones feature gleyed regosols with layers of dark organic matter. Maple, elm and ash trees are common along the riverbanks (Mills and Smith 1981). Soil drainage ranges from good to imperfect. **Figure 3.6** is a photograph of cattle on pasture land in the Subescarpment

FIGURE 3.6 CATTLE ON PASTURE LAND. A COMMON SIGHT IN THE SUBESCARPMENT

SOURCE: TREVOR LOCKHART

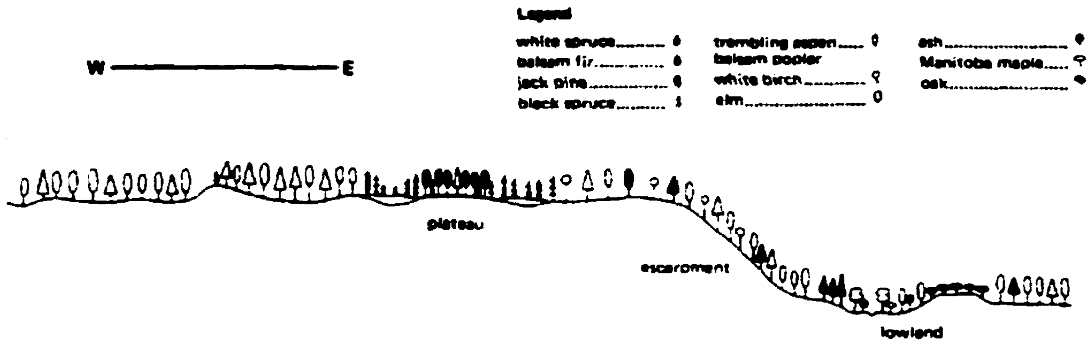
region. The slope and stoniness increases on the approaches to the escarpment. The quality of the land tends to decrease in capability from being able to produce field crops, to producing forage crops and ultimately pasture only for cattle near the base of the escarpment.

Section 3.4 The Escarpment

This is a steeply sloping band of land between the Subescarpment and the uplands areas. This area extends onto Riding Mountain National Park, and therefore is subjected to some jurisdictional overlay. The elevation ranges from 360 to 600 m. Shale outcroppings on the east facing slope are the primary source of the alluvial fan material at the bottom of the escarpment. The soil texture is the same as that of the Subescarpment region, in that it is made up of sandy loams and silty clays. Bur oak and jackpine are common along the eastern edge of the escarpment, where luvisolic and chernozemic soil profiles co-exist (Mills and Smith 1981). Beach ridges and alluvial deposits are common at the base of this zone.

Section 3.5 Uplands

The Uplands area lies completely within Riding Mountain National Park, and is characterized by a hummocky moraine topography. Covering most of the Park is the aspen-white spruce association of the boreal mixed wood forest. Aspen poplar dominate the aspen stands, associated with white birch, while balsam fir and bur oak occupy *north- and south-facing* slopes. Black *spruce and* tamarack dominate the shallow wetlands, and jackpine occurs in a drier, drained area of limited extent in the eastern section of the Park (Tarleton 1997, pg 13). The elevation ranges from 600 to 675 meters. The bedrock geology is primarily made up of Cretaceous shales (Vitikin 1990, pg 2). Most of the upland soil is classified as the Waitville series of Orthic Gray Luvisols, characterized by strongly calcareous medium-textured till (Mills and Smith 1981). Since this area falls under Federal jurisdiction, the water management plan must respect the fact that any conservation practices undertaken within this zone must meet with approval from the Park *administration. A summary of all* of these four zones and their vegetative and soil *characteristics is presented in* **Figure 3.7**.



Parent material	glacial till	coarse outwash	glacial till	peat	glacial till	peat	glacial till	recent alluvium	gravel beach	glacial till
Soil	gray luvisol	gray brown luvisol	gray luvisol	organic	gray luvisol	organic	gray luvisol	Gleyed Regosolic	black	Gray Brown Luvisol
Soil texture	loam to clay loam	coarse sand to sandy loam	loam to clay loam	fibrous	very fine sandy loam to clay loam	fibrous	very fine sandy loam to clay	silty clay loam	loamy sand	fine sandy loam to clay loam
Soil moisture	fresh to very moist	dry	fresh to very moist	wet	dry to fresh	wet	fresh to very moist	very moist	dry	fresh to very moist

FIGURE 3.7 VEGETAITON PROFILE AND SOIL CONDITIONS FROM THE ESCARPMENT TO THE LOWLANDS

SOURCE: CODY 1988 Soil Class Modification made by Author

In addition to the identification of the four physiographic regions of the District, the Canadian Land Inventory is a helpful guide for determining which areas of the District should receive priority attention by the Board. **Figure 3.8** is a map of the CLI soil suitability classification for agriculture. Class 1 represents land best suited for agriculture, and Class 7 land is least suited for agriculture. Organic soils, such as fens and bogs, are designated Class 0 and are not included in the overall inventory. According to the index, **(Figure 3.9)**, classes 1-4 are considered capable of supporting field crops; they receive the highest priority service by the Board. Classes 5-6 are able to support only perennial forage crops and pasturage, and are accorded second highest priority by the Board. Class 7 land cannot support either forage or field crops and is subject to the lowest priority.

Section 3.6 Conclusion

This chapter has provided a general overview of the area studied in this paper. It has appraised the geographical location of the Turtle River Watershed Conservation District in relation to the Province of

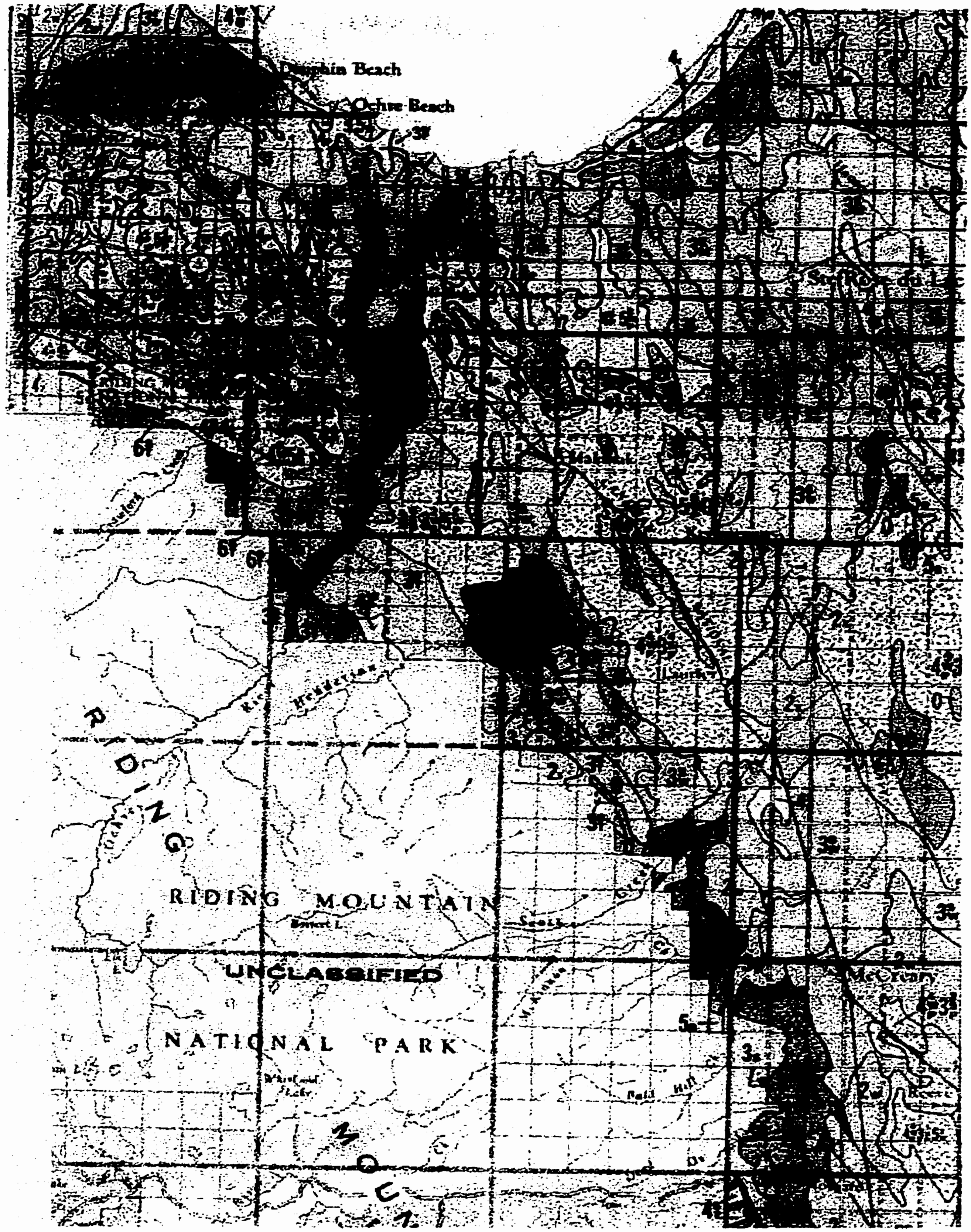
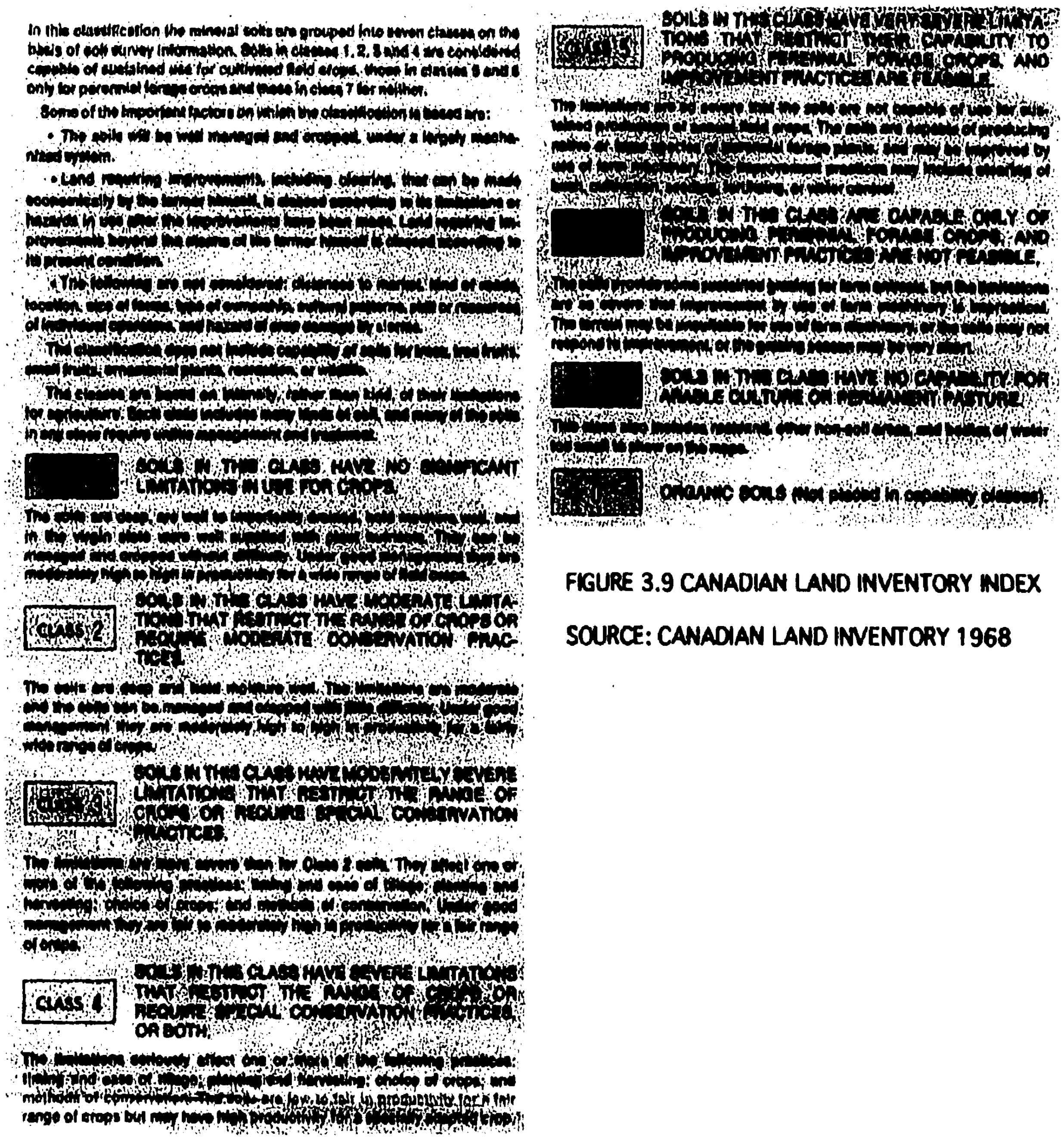


FIGURE 3.8 CANADIAN LAND INVENTORY OF SOIL SUITABILITY FOR AGRICULTURE

SOURCE: CANADIAN LAND INVENTORY 1968



In this classification the mineral soils are grouped into seven classes on the basis of soil survey information. Soils in classes 1, 2, 3 and 4 are considered capable of sustained use for cultivated field crops, those in classes 5 and 6 only for perennial forage crops and those in class 7 for neither.

Some of the important factors on which the classification is based are:

- The soils will be well managed and cropped, under a largely mechanized system.
- Land requiring improvements, including clearing, that can be made economically by the farmer himself, is classed according to its limitations or hazards in use after the improvements have been made. [illegible] its present condition.
- The following are not considered: distance to market, kind of roads, location, size of farms, type of ownership, cultural patterns, skill or resources of individual operators, and hazard of crop damage by storms.

The classification does not include capability of soils for trees, tree fruits, small fruits, ornamental plants, recreation, or wildlife.

The classes are based on intensity, rather than kind, of their limitations for agriculture. Each class includes many kinds of soil, and many of the soils in any class require unlike management and treatment.

CLASS 1 — SOILS IN THIS CLASS HAVE NO SIGNIFICANT LIMITATIONS IN USE FOR CROPS.

[illegible]

CLASS 2 — SOILS IN THIS CLASS HAVE MODERATE LIMITATIONS THAT RESTRICT THE RANGE OF CROPS OR REQUIRE MODERATE CONSERVATION PRACTICES.

The soils are deep and hold moisture well. The limitations are moderate and the soils can be managed and cropped with little difficulty. Under good management they are moderately high to high in productivity for a fairly wide range of crops.

CLASS 3 — SOILS IN THIS CLASS HAVE MODERATELY SEVERE LIMITATIONS THAT RESTRICT THE RANGE OF CROPS OR REQUIRE SPECIAL CONSERVATION PRACTICES.

The limitations are more severe than for Class 2 soils. They affect one or more of the following practices: timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation. Under good management they are fair to moderately high in productivity for a fair range of crops.

CLASS 4 — SOILS IN THIS CLASS HAVE SEVERE LIMITATIONS THAT RESTRICT THE RANGE OF CROPS OR REQUIRE SPECIAL CONSERVATION PRACTICES, OR BOTH.

The limitations seriously affect one or more of the following practices: timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation. The soils are low to fair in productivity for a fair range of crops but may have high productivity for a specially adapted crop.

CLASS 5 — SOILS IN THIS CLASS HAVE VERY SEVERE LIMITATIONS THAT RESTRICT THEIR CAPABILITY TO PRODUCING PERENNIAL FORAGE CROPS, AND IMPROVEMENT PRACTICES ARE FEASIBLE.

[illegible]

SOILS IN THIS CLASS ARE CAPABLE ONLY OF PRODUCING PERENNIAL FORAGE CROPS, AND IMPROVEMENT PRACTICES ARE NOT FEASIBLE.

[illegible]

SOILS IN THIS CLASS HAVE NO CAPABILITY FOR ARABLE CULTURE OR PERMANENT PASTURE.

This class also includes rockland, other non-soil areas, and bodies of water too small to show on the maps.

ORGANIC SOILS (Not placed in capability classes).

FIGURE 3.9 CANADIAN LAND INVENTORY INDEX

SOURCE: CANADIAN LAND INVENTORY 1968

Manitoba, and has presented a basic overview of its physical geography.

Chapter Four

Methodology

This section discusses the rationale for, and background of, the entire project, and the methods employed once primary research began.

The origins of this research began in January 1999, subsequent to a meeting with Dr. Ian Dickson of the Provincial Forestry Branch. Subsequent meetings with Phil Weiss and Wayne Hildebrand of the Conservation Districts program, based in Gladstone, MB led to Ste. Rose du Lac and the Turtle River Watershed Conservation District, managed at the time by Mike Boychuk. The District was in need of a Water Management Plan, and had been planning to create one ever since the District's Management Plan was written in 1988. It was unclear as to the appropriate parameters of a water management plan, since none had been written for the District before, and there was no generic standard plan at the time, that could be used with minor modifications from District to District. An added level of difficulty was presented by the unique topography of the District, which featured the Manitoba

Escarpment to the west, Dauphin Lake to the north, and a series of lowland areas at elevations in between. On the management level, the fact that 25% of the District falls under the Federal jurisdiction of Riding Mountain National Park caused further difficulty.

It was decided that the best possible course of action in developing a water management plan for the Board was to develop an inventory of the District's resources. Two basic methods were invoked; review of the appropriate literature, and ground-truthing. In addition to scholarly reports on water resource management, numerous practical publications have been produced by all levels of government in the region. These include annual reports from Riding Mountain National Park, Soil Surveys and Canadian Land Inventory reports, as well as aerial photographs and other remote sensing data.

Ground-truthing involved personal surveys of the District from June to September of 1999. These surveys were carried out on occasion, by the author alone and on other occasions, with the help of Sheldon Anderson, the manager of the Turtle River Watershed Conservation District. During these informal surveying exercises, the District's resources and topography became familiar to the author. This greatly assisted the development of an effective and insightful plan with regards water management in the District.

While the 1999 ground-truthing exercises were being carried out, the accumulated data were augmented and complemented by the appropriate literature germane to water management.

In the course of development of a water management plan for the Turtle River Watershed Conservation District, the wider issues of water management from a geographic point of view were also addressed. This thesis deals with the issues facing water resource managers and the role that the geographer can play within the framework of water management. The project raised important issues surrounding jurisdictional supremacy and the impact that many levels of government exert on a watershed as well as the role and responsibility that individual landowners must assume to ensure its future functionality and health.

Chapter Five

Analysis

Section 5.1 History of Water Management in the Study Area

5.1.1 Introduction

In order to understand the current issues and challenges faced by the Turtle River Watershed Conservation District and Riding Mountain National Park, a review of the natural and cultural history of the region is essential. For the purposes of this paper, the review will begin at approximately 12 000 years before the present (b.p.) when the Laurentide ice sheet began to recede in southern Manitoba.

5.1.2 Quaternary Research

According to pollen analyses of lake bottom sediments in Riding Mountain National Park, three distinct periods of post-glacial vegetational development can be indentified(Tarleton 1997, pg 12). As the Laurentide ice sheet receded to the northeast, the barren hummocky till landscape dotted with boulder till, sand, gravel and clay deposits was exposed. Spruce-dominated forests quickly established themselves on the exposed till. This period lasted from at least 11 000 to 10 500 years b.p.(Ritchie 1976, p 1804). This period featured birch, poplar and ash, along with lower numbers of juniper, willow and hazelnut. These were succeeded by deciduous communities of oak and elm. Between 12 000 and 10 000 years b.p. many species of wildlife estalished themselves. Fish, insects and mammals were quick to invade the evolving habitat. Large mammals such as moose and woolly mammoth brought early human hunters into this region as well (Tarleton 1997, p 14).

From 10 500 years b.p. to 6000 years b.p. the climate became warmer and drier as a result of the northerly shift of the summer position of the polar front. The drier conditions caused numerous lightning fires, reducing much of the spruce-dominated forest to grassland and tall grass prairie. This herb dominated period consisted mainly of *Artemisia,* Chenopodiineae, Gramineae and Ambrosieae (Ritchie 1976). After 6000 years b.p. the herb cover, along with birch species, was partially succeeded by Corylus and Quercus. Elk, pronghorn antelope and long-horned bison provided a reliable food source for the aboriginal groups who moved into this area. Transformation by fire was continued by the aboriginal peoples through extensive burning. The end result was the ultimate replacement of spruce forest by grassland as the dominant vegetation cover for this period.

From 3000 years b.p. to the present, the area has experienced a gradual return of forest conditions. As early as 6000 years ago, the pollen record shows a steady decrease of grasslands as the dominant vegetation type (Tartleton 1997, pg 12). As the polar front moved south, cooler and wetter climate conditions led to the spread of the aspen parkland zone into upland areas, the migration of deciduous forest along river and stream banks to create natural buffers along riparian zones, and the gradual development of mixed forest in its current distribution. Since 2000 years b.p. spruce, pine and alder have maintained a distribution similar to that of the present (Ritchie 1976).

5.1.3 European Settlement

The earliest influx of European explorers into the Riding Mountain Area was in the mid-18th century, with the establishment of Fort Dauphin by La Verendrye in 1741

(Tarleton 1997, pg 15). Torwards the end of the 18th century and the beginning of the 19th century, The Northwest Company and Hudson Bay Company established forts in the area surrounding Riding Mountain National Park, along with occasional independent fur-trade entrepeneurs. **Figure 5.1** shows the locations of all the fur trade posts in the vicinity of the study area. Note: Pine Fort (Independent 1768-1794) Brandon House I-III (HBC 1793-1832) Fort Pelly I-II (HBC 1821-1900) Fort Ellice I-II (1831-1870) Manitoba House (Independent 1790-1802, NWC 1802-1804, HBC 1806-1821) Curling River House (HBC 1806-1821) Riding Mountain House I-II (1860-1895).

With the exception of the fur traders and traditional indigenous populations, there were no significant permament settlements in the area east of Riding Mountain National Park before 1881. By the late 1870s, most of the agricultural lands in the new province of Manitoba had been surveyed into townships (Tarleton 1997, pg 17). It was not until 1896, the year that the Manitoba and Northwestern Railway completed a line between Gladstone and Dauphin that agricultural activity began in earnest in this region. Up to this point, the area south of Lake Dauphin was not favoured for

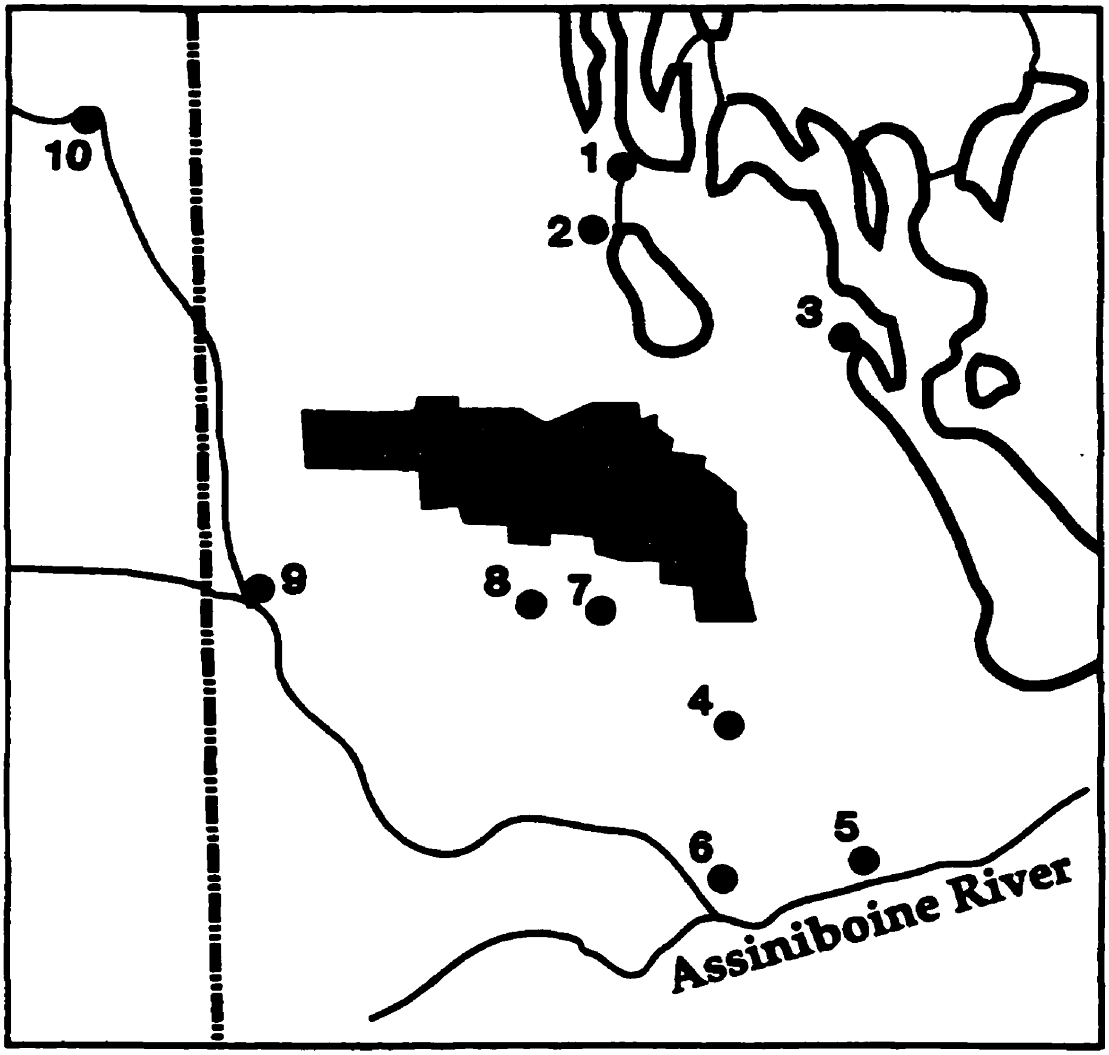


FIGURE 5.1 LOCATION OF FUR TRADE FORTS IN SOUTHERN MANITOBA

1. Dauphin River 2. Fort Dauphin 3. Manitoba House 4. Curling River House 5. Pine Fort 6. Brandon House I-III 7. Riding Mt. House I 8. Riding Mt. House II 9. Fort Ellice 10. Fort Pelly

SOURCE: TARLETON 1997

settlement and agriculture. The area was not connected by road or by rail, and the local urban centres of Dauphin, McCreary and Ste Rose du Lac had yet to be established. Because of this, advertisements and pamphlets encouraging settlement in marginal areas such as the study area were common in the late nineteenth century. One such pamphlet suggested that the area which is now the Turtle River Watershed Conservation District would not suffer from frost in the same way as adjacent regions due to the sheltering effect of the escarpment and the moderating influence of Dauphin Lake.

"The soil is a rich alluvial clay loam, some parts between Valley river and the Duck Mountains are light and sandy. The district is also well adapted for growing all kinds of grain and garden vegetables. In 1888 when [summer] frosts visited some parts of Manitoba and the Northwest as well as Dakota, Minnesota, Michigan and the old provinces of the Dominion, this Lake Dauphin district escaped injury." (Manitoba 1890, pg 11).

The optimistic expectation of turning this into a productive and populated region is evident in the closing remarks of that same pamphlet from 1890. "The time is not far distant when this settlement will be in direct communication with the outside world...In short we predict that time and the onward march of civilization only are wanting to make this hitherto unknown region one of the richest and most prosperous gardens of the Province." (Manitoba 1890, p 12).

Even though this area has been settled for only a little over 100 years, it is one of the most developed and altered regions, agriculturally speaking, in all of Manitoba. Recently, the local area residents have come to comprehend the damage done to the land and are interested in taking steps to reverse this trend.

Before settlement, naturally flowing streams emerged from the eastern side of the escarpment at approximately 10 km intervals. During flood events, these streams were heavy with sediment and would create alluvial fans at the base of the escarpment as their velocity decreased. Excess water from above the escarpment was retained in the lowland wetlands, relinquishing their sediment loads before emptying out into Dauphin Lake. The area below the escarpment experienced less flooding and higher water tables before agriculture became the primary use of the land (Vitikin 1990, p 6). **Figure 5.2** is a photograph of a typical alluvial fan. An inactive alluvial fan is characterized by vegetation which tends to be salt tolerant and able to grow in gleyed soils subject to high water tables.

Section 5.2 Early Drainage Methods

The arrival of settlers meant that these meandering streams and alluvial fans were perceived as a hindrance to production, and so steps were taken to drain the fields quickly. A network of drainage ditches was constructed to move surface water quickly from the fields and downstream into Dauphin Lake. Although these drains did the job they were intended for, there were a number of detrimental side effects. Because the streams coming off the escarpment were no longer allowed to slow down and drop their sediment in the alluvial fans, the sediment was carried further downstream and dropped in the drainage ditches, clogging them. Another problem was the increased erosion from the fields that were being drained. Since quick drainage was a priority for the early settlers, the drains were designed to remove water in the spring and after rain events. With the runoff came

FIGURE 5.2 PHOTOGRAPH OF CRAWFORD CREEK ALLUVIAL FAN FROM THE GROUND SUMMER 1999

SOURCE: TREVOR LOCKHART

high quality topsoil which ended up downstream along with the sediment from the escarpment. Because of the increased velocity in the drainage ditches, much of the sediment made it all the way to Dauphin Lake. This has caused the Lake to begin filling in with sediment and it has effectively killed the lake's fishery. Unfortunately, it has only been in the last few years that serious attention has been paid to these problems, and in many areas serious damage has already been done. **Figure 5.3** shows the distribution of population in Southern Manitoba at the turn of the last century. It is interesting to note that, according to this figure, there is no record of any settlement larger than 50 people within the area occupied by present day Riding Mountain National Park. This survey was conducted in 1901, and according to most accounts the area now known as Riding Mountain National Park was not designated as a forest reserve until 1906, five years later (Lothian 1987, p 74). This reflects the fact that the escarpment area was not suited for agriculture because of the steep slope and dense forest, and that it was by default rather than design that the area ended up as a National Park. A later section will deal with Riding Mountain National Park in more detail.

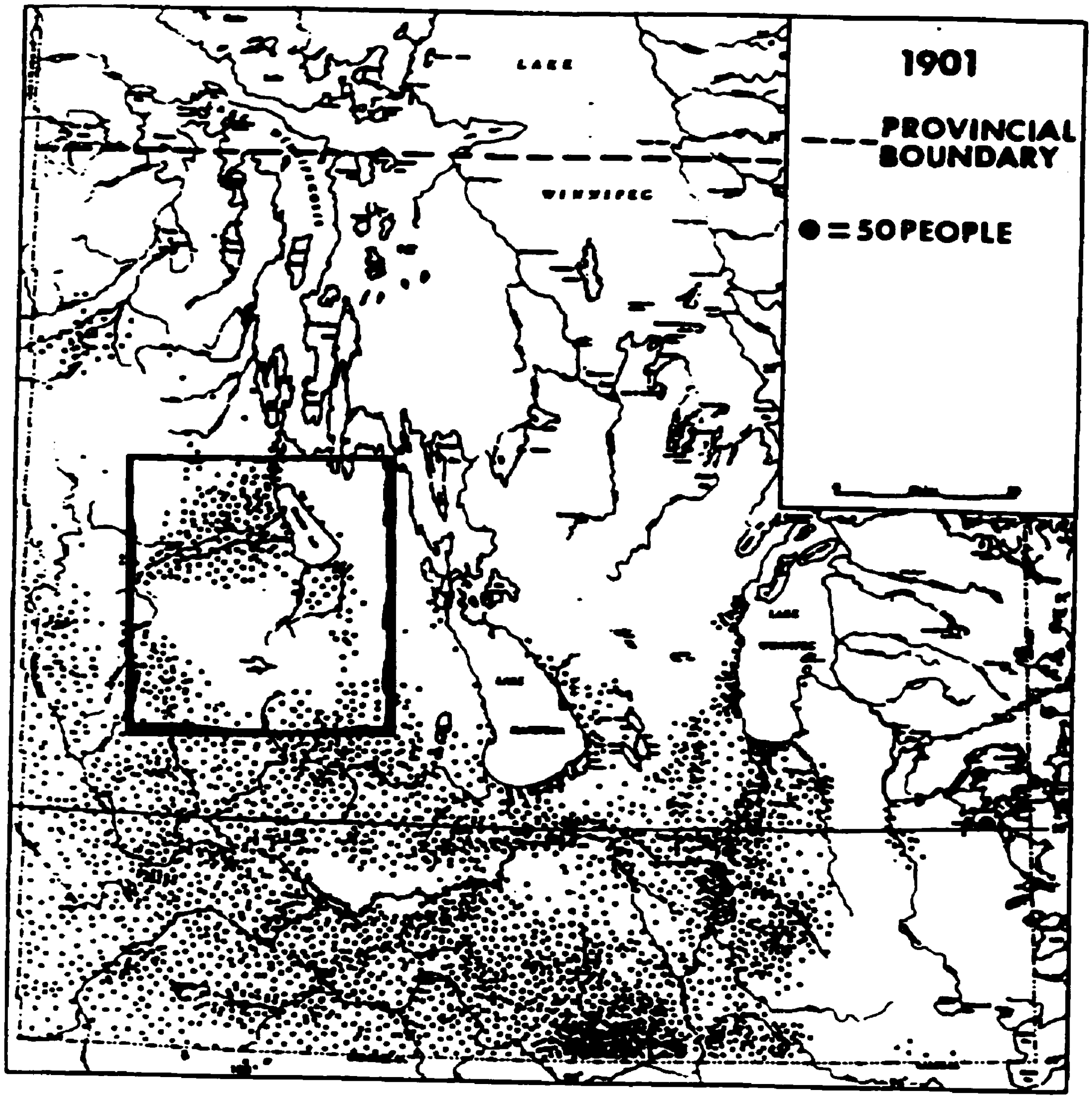


FIGURE 5.3 POPULATION DISTRIBUTION IN SOUTHERN MANITOBA, 1901 (STUDY AREA INSIDE BOX)
SOURCE: MANITOBA PROVINCIAL ARCHIVES

5.2.1 Provincial drainage legislation

The management of the drainage east of Riding Mountain has had a long and curious history over the last century. The first piece of provincial legislation passed in respect to this area was the Land Drainage Act of 1895 (Mackling 1987, p 3). This Act created the various drainage districts in areas of high agricultural activity. The first settlement in the subescarpment alluvial fan area was in 1908, and in 1916 the first major drainage works were constructed to drain marshy meadows and swamps that retained the flood flows and sediment from the escarpment (Newbury 1983 p 3). By 1920, 21 Drainage Districts had been created and over 4000 km of drains existed in the province. During the 1930s Depression, costs soared and the districts were taxed for "foreign waters" brought onto districts by the drains. "Foreign waters" were defined as water which originated outside a given district, and merely flowed through the district. This differs from water which drained directly from land located within a given district. A distinction was made between "Drainage Ditches" which actually drained fields directly, and "Conveyance Channels" which moved foreign waters between one area and another. The districts couldn't afford the upkeep. The response was embodied in the Land Drainage Act of 1935, under which the drainage districts were replaced by Drainage Maintenance Districts. These Drainage Management Districts were based on the watershed model of water management and were forerunners of the present day Conservation Districts. It is clear from this that the watershed model is not a new idea to resource managers in Manitoba, in fact it has been in use for over sixty years. The Province paid for a third of the maintenance costs of the Districts which amounted to $40 000/year at that time. In 1952, the province agreed to pay for two-thirds of the construction and maintenance costs for those drains carrying foreign waters, and a third of the cost for those drains carrying local water. The Federal Government became involved in partially funding floodways, control structures and channel improvements after a devastating flood on Edwards Creek in 1947 (McGinn 1979, p 2).

During the 1960s, it became unclear as to who would take responsibility for water management. The control, use, distribution and conservation of water came under the Department of Agriculture in the Water Control and Conservation Branch. In 1966 this Branch was transferred to the Dept. of Highways. In 1968 it was placed under the jurisdiction of the Dept. of Natural Resources.

A split jurisdiction established in 1964 by the provincial government in order to standardize responsibility for the provinces waterways complicated matters. All natural and artificial water courses in southern Manitoba were classified according to the following system (Saunderson 1977).

- First Order Waterway: upper, single unbranched tributary having a drainage area of one square mile (2.6 sq km) or less
- Second Order Waterway: one which has a drainage area of more than one square mile (2.6 sq km) or has a tributary or tributaries of the first order
- Third Order Waterway: is formed at the confluence of two second order waterways and may have any number of first and second order tributaries; and
- Fourth, Fifth, Sixth, etc. Order Waterways: are defined similarly to the third with each order having any number of lower order tributaries and with an increase

in order occurring where two waterways of the next lower order meet.

Under the provincial waterways policy adopted in 1964, the province assumed responsibility for water courses of third order and higher, encompassing over 4800 km of man-made and partially altered natural waterways in the province. The maintenance and construction of first and second order waterways remained the responsibility of the municipal governments, which at that time accounted for over 12 000 km of drains (Carlyle 1983, p 286).

Section 5.3 Wilson Creek Experimental Watershed Project

During the 1960s, research on watershed dynamics was inaugurated east of Riding Mountain, on Wilson Creek. It emerged out of recommendations from a Federal-Provincial Committee on Headwater Flood and Erosion Control in 1957 under the auspices of the International Hydrological Decade program. The Terms of Reference for the committee included the following statement, which succinctly states the heart of the problem addressed in this current thesis: "Several streams originating on the western escarpment are interfering with agriculture in the plains by periodically overflowing their banks and by clogging natural and artificial drains through the deposition of shale and debris" (Newbury 1983, pg 1). **Figure 5.4** depicts the study area of the Wilson Creek Experimental Watershed.

5.3.1 Wilson Creek Research Projects

The experimental watershed project was continued for 25 years (1957-1982) and gathered data on all pertinent aspects of watershed management. Many of these studies were Masters' theses at the University of Brandon and the *University of Manitoba, and contributed greatly to the* body of knowledge on water resource management. *Hydrologic studies focused in on the causes of flood* frequency; it was determined that spring run-off and/or individual precipitation events were the primary factors, with the latter more serious in terms of damage. Rainfall events may alter the course of a channel, fill drainage ditches with sediment, and damage crops. The worst storm in Manitoba's meteorological record lasted from Sept. 17 to Sept. 20, 1975, and washed away the Packhorse Creek metering station and all of the bank protection works on Wilson Creek (Newbury 1983 p 3). In terms of the relationship between rainfall and runoff, it was found to

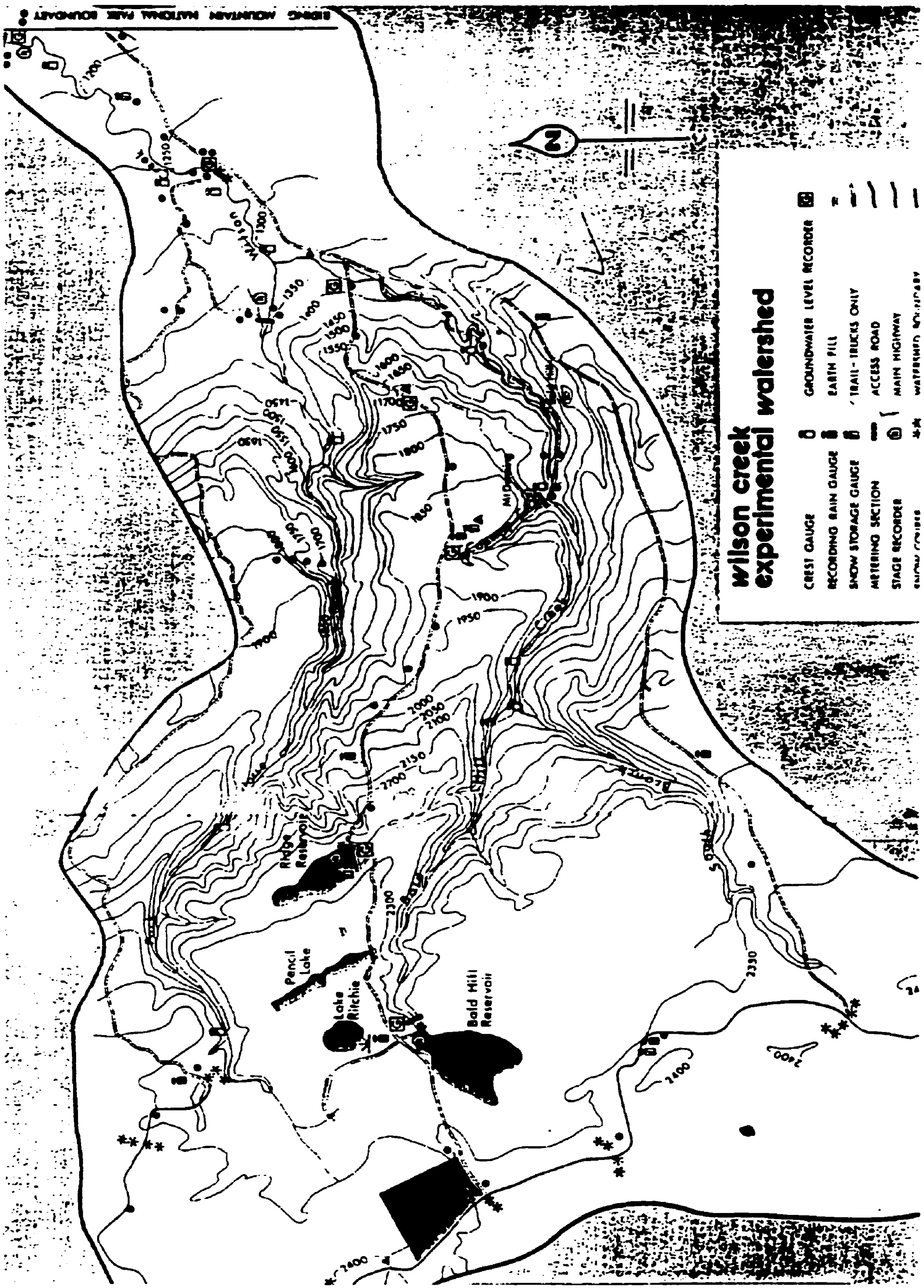


FIGURE 5.4 WILSON CREEK EXPERIMENTAL WATERSHED: 1957-1982

SOURCE: NEWBURY 1983

be highly variable, depending on the degree of saturation of the watershed. The Wilson Creek project also studied the groundwater of the subescarpment, with special attention given to the McCreary aquifer to help determine the nature of water movement within the water table. Sediment transport studies with respect to the rate and mechanism of shale movement on Wilson Creek provided evidence that the upper horizons of the agricultural land at the base of the escarpment were based upon post-glacial alluvium.

The Wilson Creek project also experimented with retention reservoirs above the escarpment. The Bald Head reservoir on Wilson Creek was used to reduce spring flooding downstream, but it was discovered that due to the slope and erosion factor further downstream, only the area above the escarpment could properly support the construction of reservoirs. The Wilson Creek project was the first in the District to use rock riprap and log crib stabilization to reduce lateral erosion. It was found that these works reduced downstream deposition by 30%. These techniques have become common practice on other escarpment streams. **Figure 5.5** is an example of one of the many shale traps used on the escarpment streams to

FIGURE 5.5 SHALE TRAP ON OCHRE RIVER SUMMER 1999

SOURCE: TREVOR LOCKHART

reduce the sediment load downstream. Even with the use of such traps, sedimentation remains as one of the biggest challenges in the District, as the photo in **Figure 5.6** illustrates.

One final aspect studied in the Wilson Creek project were alluvial fans. Approximately 6 km in radius, the alluvial fans formed at the base of the escarpment. According to the studies, it is the high water table that precludes agricultural success on the fans, and not a soil-type problem. Previous to interference, the alluvial fans were in a cycle of activity and inactivity, allowing layers of organic matter to develop on top of the fans during the inactive periods. The alluvial fan on Wilson Creek was studied in 1979 and an Equilibrium Model was developed that was able to successfully calculate the size of an alluvial fan based on the size of the basin and the discharge of the stream (McGinn 1979, pg 175).

Ever since Wilson Creek was connected to the drainage system of the District in 1916, erosion of the alluvial fans has caused deposition and sedimentation problems downstream. This statement is supported by research conducted with McGinn's Equilibrium Model (1979). It was found that the drainage projects

FIGURE 5.6 ESCARPMENT STREAM WITH VISIBLE SEDIMENT DEPOSITS SUMMER 1999

SOURCE: TREVOR LOCKHART

undertaken between the escarpment and Dauphin Lake "permit significant downstream migration of the loci of deposition" (McGinn 1979, pg 177). This disrupts the dynamic equilibrium of the alluvial fans and extends the fan sedimentation downstream, which results in more frequent floods, and "a significant increase in the magnitudes of sediment yield associated with the high discharge floods having a recurrence interval greater than 10 years" (McGinn 1979, pg 177). It is clear from McGinn's research that the drainage projects of the District have added to the frequency and magnitude of Spring flooding, as well as the increased erosion of the alluvial fans at the base of the escarpment and the streams which flow through them. The majority of the flooding and erosion in the downstream agricultural lands originates in the headwaters of the streams which flow off the escarpment, as well as sediment from the eroded alluvial fans (Newbury 1982, p. 11).

In addition to McGinn's 1979 thesis, a legacy of other projects and studies dealing with escarpment alluvial fans were made possible because of the Wilson Creek Experimental Watershed Project. In 1990, a comprehensive study of several escarpment alluvial fans was carried out by the Department of Natural Resources (Vitikin 1990). This report lists recommendations to help reduce erosion and downstream sedimentation. Broken down into three sections, the recommendations cover Educational Programs, District Planning Programs, and Engineering Works. These sections are detailed below.

5.3.2 Educational Programs

- Improved understanding of causes of erosion and sedimentation.
- Conservation of existing wooded areas. Even in the 1980s these areas were still subject to deforestation.
- Conservation Districts should appeal to the Province *for adoption of "no tax for wetlands" program.* An incentive to stop farmers from developing wetlands/alluvial *fans.*
- Ploughing of steep slopes should be discouraged. Steep slopes are marginal agricultural land to begin with, and are subject to severe sheet erosion from surface run-off and add to the siltation of drains and creeks.
- Buffer zones should be left between fields and the top of stream banks.

- Fencing along drains and creeks to reduce unrestricted grazing should be encouraged.
- Involve students to document stream erosion and sedimentation as a school activity. A riparian version of "Adopt a highway".

5.3.3 District Planning Programs

- No new drains in areas of more than 0.3% ground slope. (15 feet drop in a mile). Strongly discourage land owners from cutting drains on their land
- Give no further consideration to the altering, diverting, deepening or widening of the existing drainage systems. "The consequences of these works are unpredictable but always detrimental"(Vitikin 1990, pg 19). Maintain existing drainage system at its present cross section. By regular cleaning, a constant rate of erosion and deposition is maintained (provided that nothing is altered upstream). If the drain is upgraded by deepening, erosion will increase upstream. If the drain was allowed to be filled in, a new alluvial fan would begin to form.

- Channelization of natural streams should be avoided completely, as this will seriously alter the dynamics of the natural drainage system, or what is left of it.
- Buying back marginal land with severe erosion problems, siltation etc. and turning this land back to a natural state could be considered in the District's long range plan. In many cases, buying the land would be cheaper than dealing with the erosion and siltation problems on an annual basis.
- Prohibit the sale of Crown Land in the District and encourage leasing that reflects environmental concerns. (i.e. implement zoning restrictions).

5.3.4 Engineering Works

- Wilson Creek structures have proven effective during normal flows.
- Building of control structures will raise the creek bottom and disrupt the groundwater conditions, this would not be a problem in the deep channels of escarpment streams, but could cause water-logging of adjacent farmland adjacent to shallow drains.
- Headcutting on natural streams should be stopped by designing in-channel culverts and rip-rapping at

intervals downstream until velocities become non-erosive.

- Culverts could be used to inhibit erosion in deeper channels as well.
- Proper armouring and vegetative cover could reduce lateral erosion along valley walls.

Vitikin's study summarizes the major issues dealing with alluvial fans and sedimentation; the following list provides a good summary of alluvial fan research in the District.

Geomorpology:

- In geomorphologic terms, formation of alluvial fans has been a result of erosion of steep shale slopes of the Riding Mountain scarp-face. This erosion will continue indefinitely, at varying rates.
- Erosion rates of present alluvial fans are a result of induction of land into agricultural use and associated with the construction of an artificial drainage system.
- The goal is to reduce the rate of alluvial fan erosion in order to reduce the rate of land degradation and to reduce the frequency of clogging of agricultural drains.

- According to the Wilson Creek studies, 30% of shale gravel transportated as sediment is coming off the escarpment slopes and 70% is being eroded from the alluvial fans.

Conservation Practices:

- Reduction of fan erosion could be achieved largely through conservation-oriented land-use practices. The Conservation District should be advocating educational programs and demonstration projects to make these practices understood and attractive.
- Marginal agricultural land should be expropriated at fair market value from private owners and taken out of production. This land could then be used for pilot projects showcasing innovative management practices and conservation measures.

Engineering Works:

- Engineering works reducing erosion should be accorded only a secondary role in land-use management.
- The CD should plan no new drains or alterations on drains that have a slope greater than 0.3%.

- Engineering works should be limited to erosion-control structures, culvert structures, and to armouring of channel walls.
- Average annual cost of cleaning shale gravel from the drains was $50 000 in 1989.
- Average cost of one erosion-control structure in 1989 dollars was $45 000 The structures are suitable only for deep channels, since the inevitable raising of the stream bottom could stimulate flooding in adjacent fields.
- Culvert structures and armouring could cost from $3000 to $20 000 and up per site. The design standards should remain consistent throughout the area.

In 1999, the District purchased an alluvial fan along the Ochre River from private landowners (Anderson 1999). **Figure 5.7** is an aerial photograph which shows the transition from escarpment on the left to lowlands on the right. The alluvial fan purchased by the District can be seen as the dark patch in the top left corner of the photo. It is the hope of the District to keep sensitive alluvial areas out of active production and to help restore the natural cycle of alluvial fans without disruption through human interference. The same idea

FIGURE 5.7 ESCARPMENT/SUBESCARPMENT INTERFACE WITH ALLUVIAL FANS IN TOP LEFT CORNER (WITHIN WHITE CIRCLE)

SOURCE: MANITOBA REMOTE SENSING CENTRE

motivated the rerouting of Crawford Creek back into its original course. This is discussed elsewhere in this thesis (King 1999, pg 1).

In the spirit of the Wilson Creek Experimental Watershed, the Watershed Conservation Districts Act was passed in 1959 by the Province. This encouraged Rural Municipalities to form Districts based on the watershed model to help direct management efforts. Through this Act, the groundwork for Manitoba's Conservation Districts network was laid.

The watershed model gained support over the split jurisdiction approach advocated by the Michener Commission in 1964 for several reasons. The split jurisdiction resulted in no central authority to co-ordinate drainage initiatives. Although third and higher order drains were maintained by the province, the lower order drains were the sole responsibility of the individual rural municipalities, and municipalities upstream tended to not take responsibility for drainage and erosion problems occurring downstream beyond their jurisdiction.

The watershed model promised to solve many of these problems, although there was considerable opposition to this new approach to water management. Municipal governments would have to hand over control of their individual water rights to a District Board, and rate payers would pay a levy to the District rather than to their individual RMs. Municipalities which did not suffer from drainage problems balked at the idea of contribution to programs that were not immediately beneficial to them. Concern even arose over more prosaic matters such as in which town the District would establish its head office, and in which RM the utility and equipment yard would be located (Anderson 1999).

In 1972, the Resource Conservation Districts Act was passed, dealing primarily with land management. Both the Resource Conservation Districts Act and the original 1959 Act were replaced by the Conservation Districts Act in 1976 which dealt with both land and water management. Most recently, the Conservation Districts Act was revised in 1987.

Section 5.4 The Turtle River Watershed Conservation District

The formation of the Turtle River Watershed Conservation District was the next big step in managing water resources in the area between the escarpment and Dauphin Lake. The District was formed by a Provincial Order-In-Council in August of 1975. It was the second District to be created in Manitoba, after the Whitemud Watershed Conservation District.

Watershed Conservation Districts fall under the Department of Rural Development. The Conservation Districts Commission is a body of provincial representatives set up by the Minister of Rural Development. The purpose of the Commission is to advise the Minister in all matters relating to the Conservation Districts Act, including the administration and operation of the various Boards. The Commission is also available to provide advice and guidance to any Board that requests it. The Commission also annually reviews the resource management plans, budgets and operations of the Districts and makes recommendations to the Minister.

The Turtle River Watershed Conservation District is administered by a Board made up of representatives from the relevant RMs and local ratepayers. The day-to-day activity of the Board is overseen by a District manager who is hired by the Board. All major initiatives in the district must be approved by the Board before they can proceed. Each Conservation District appoints one Board member to the Manitoba Conservation Districts Association (MCDA), which acts as a unified voice for all Conservation Districts when dealing with the Department of Rural Development. The overall organizational structure of the Turtle River Watershed Conservation District program is shown in **Figure 5.8.**

The Turtle River Watershed Conservation District is divided into three Sub-Districts, which follow the boundaries of separate drainage sub-basins. The three Sub-Districts are #44 Upper Turtle River, #45 Lower Turtle River, and #46 Ochre River, illustrated in **Figure 5.9.** The number of people appointed from each Rural Municipality and sub-District committee to the District Board is summarized in **Figure 5.10**.

Section 5.5 Dauphin Lake Basin Advisory Board

5.5.1 Introduction

During the 1980s, another land and water stewardship organization in the area, the Dauphin Lake Basin Advisory Board, began to raise awareness and work towards more intensive conservation in the entire basin of Dauphin Lake, which covers an area of over 845 sq. km (325 sq.

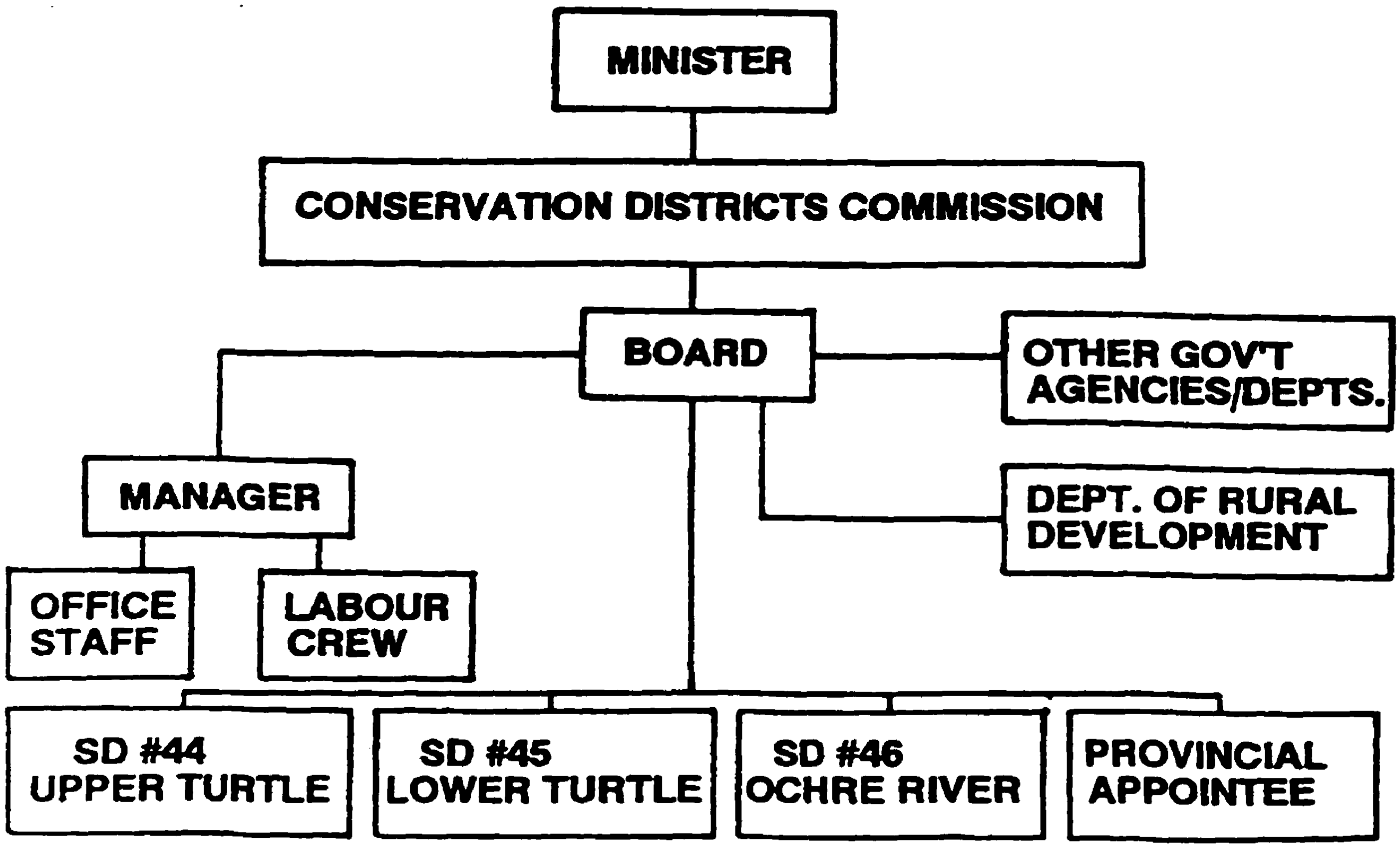


FIGURE 5.8 ORGANIZATIONAL HIERARCHY OF THE DISTRICT
SOURCE: TRWCD SUBDISTRICT MEMBERS' HANDBOOK

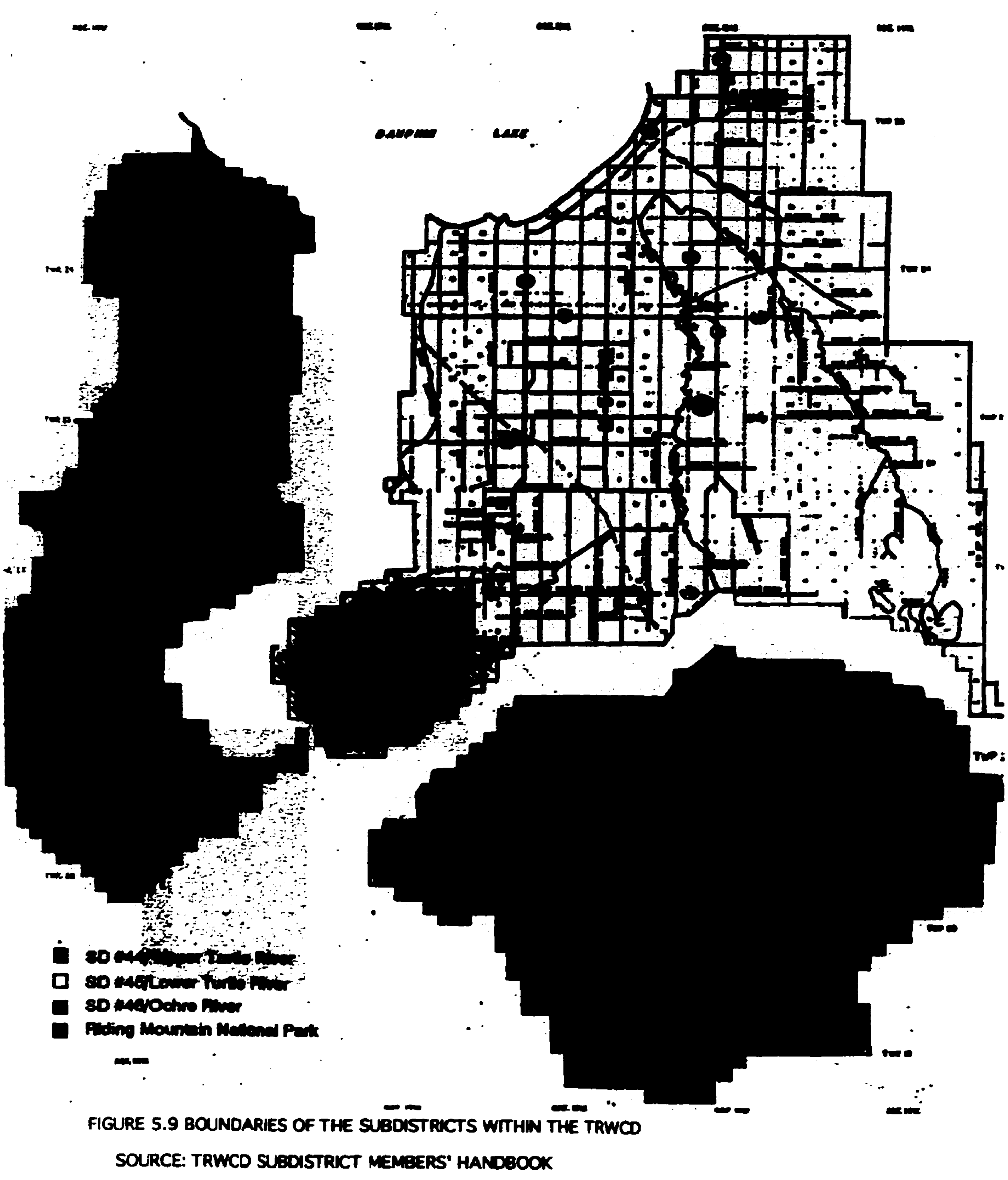


FIGURE 5.9 BOUNDARIES OF THE SUBDISTRICTS WITHIN THE TRWCD

SOURCE: TRWCD SUBDISTRICT MEMBERS' HANDBOOK

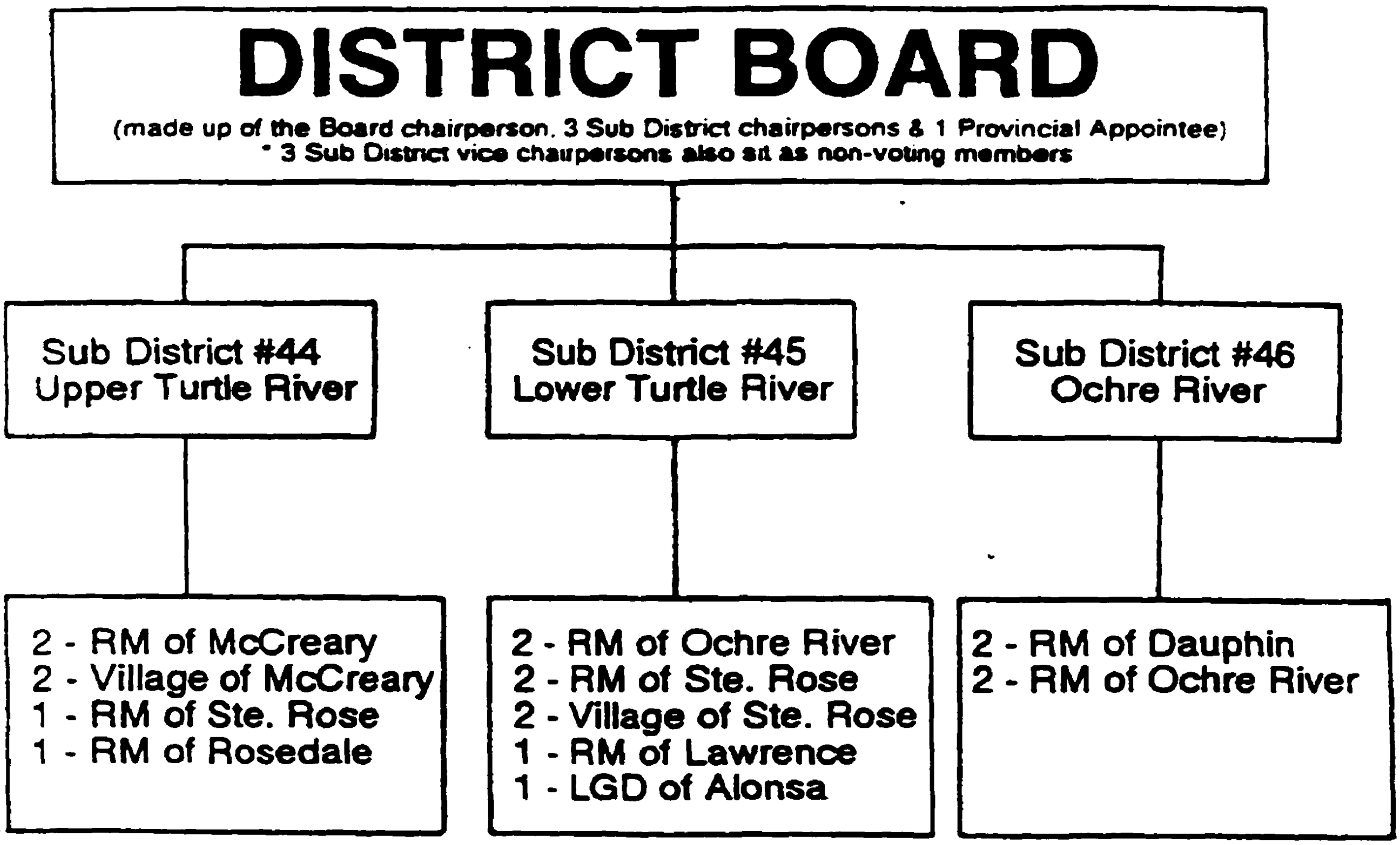


FIGURE 5.10 MEMBERSHIP REQUIREMENTS ON THE BOARD AND COMMITTEES OF THE TRWCD

SOURCE: TRWCD SUBDISTRICT MEMBERS' HANDBOOK

mi.) (DLBAB 1989, p 4). **Figure 5.11** shows the land area covered by the basin, and some of the jurisdictional boundaries within it, including the Turtle River Watershed Conservation District. **Figure 5.12** shows the extent of the artificial drainage system in the TRWCD alone, and gives some perspective as to the complexity of the drainage patterns in this complicated basin.

5.5.2 Objectives of DLBAB

The Dauphin Lake Basin Advisory Board (DLBAB) was created with two main objectives in mind. The first objective is to halt the deterioration of Dauphin Lake by dealing with the key problems throughout the basin, identified as erosion, siltation, and nutrient loading. The second objective is to enhance Dauphin Lake once some progress in halting the deterioration has been achieved (DLBAB 1989, p 3).

5.5.3 Challenges and Possible Solutions for the DLBAB

One of the main concerns of the DLBAB is the declining fishery of Dauphin Lake. In 1951, Dauphin Lake produced 200 000 pounds of Walleye. This dropped to less than 25 000 pounds in 1986 (DLBAB 1989, p 4). **Figure 5.13** reflects this trend. The current rate of sedimentation

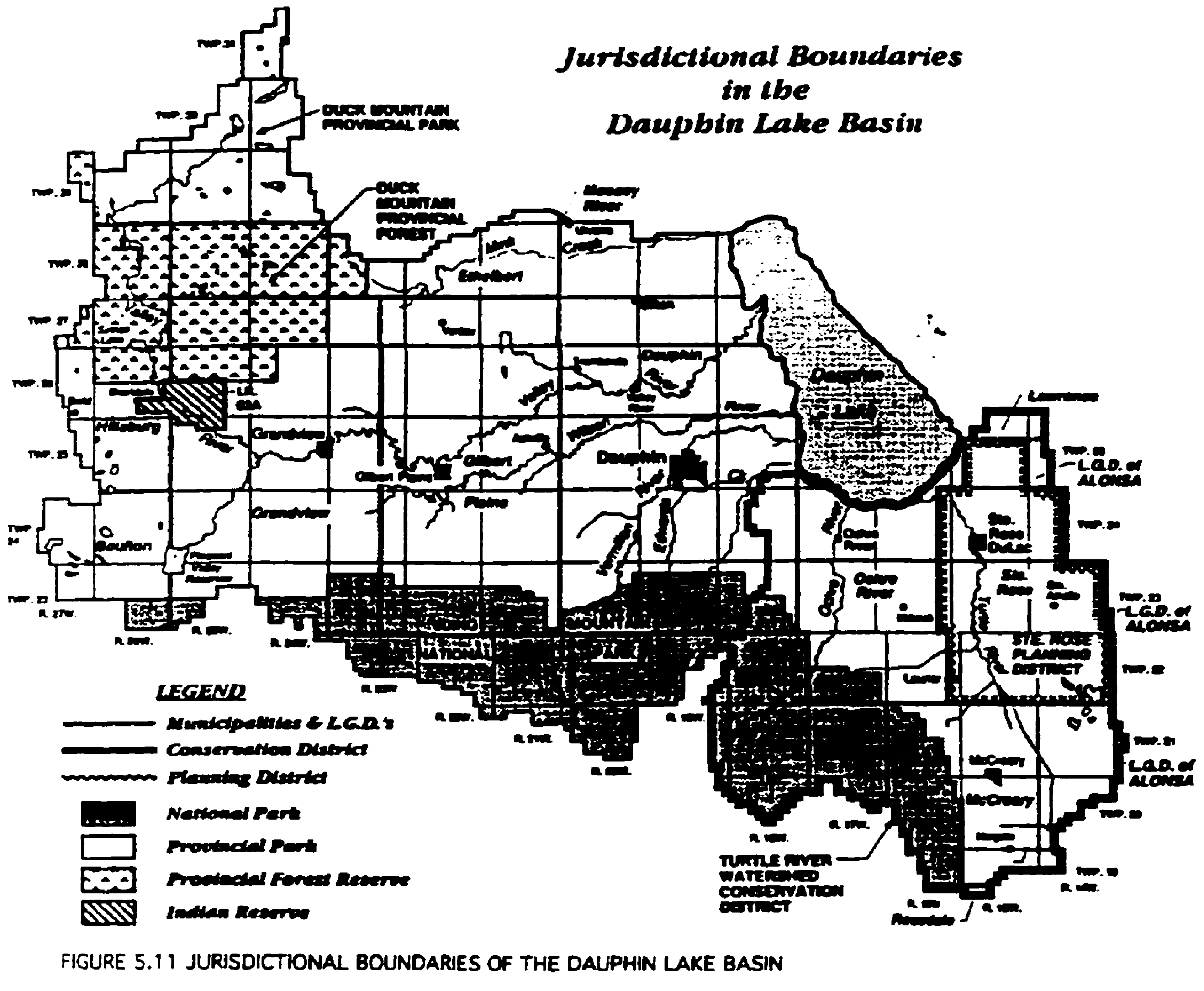


FIGURE 5.11 JURISDICTIONAL BOUNDARIES OF THE DAUPHIN LAKE BASIN

SOURCE: DAUPHIN LAKE BASIN ADVISORY BOARD 1989

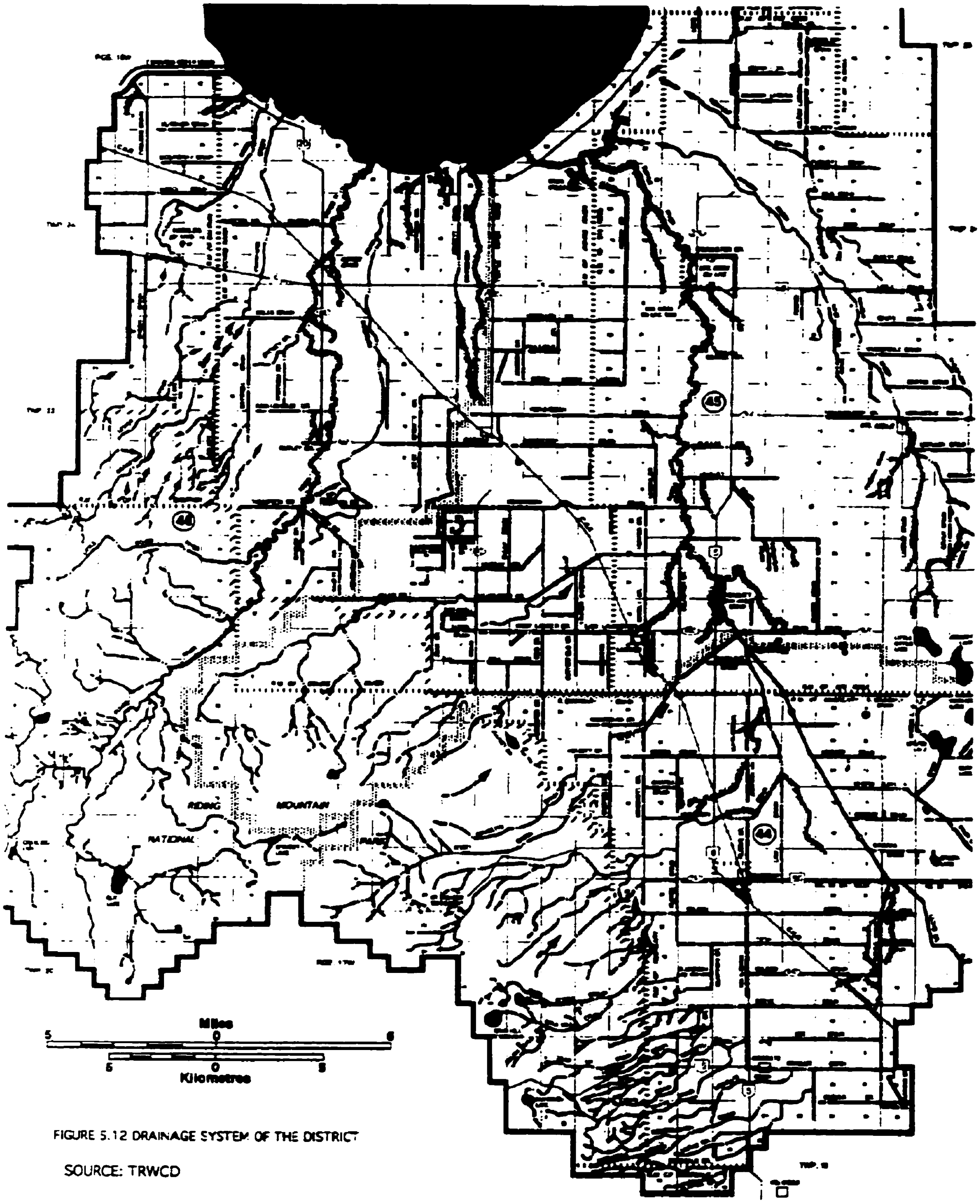


FIGURE 5.12 DRAINAGE SYSTEM OF THE DISTRICT

SOURCE: TRWCD

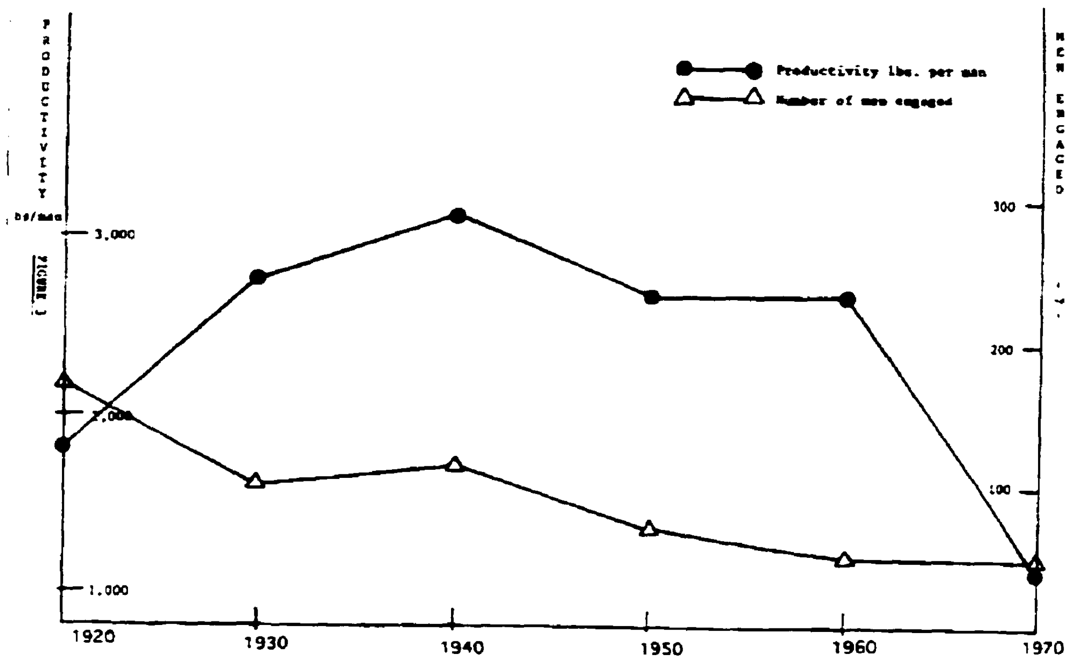


FIGURE 5.13 VOLUME OF FISH CAUGHT IN DAUPHIN LAKE FROM 1920 TO 1970

SOURCE: DAUPHIN LAKE BASIN ADVISORY BOARD 1989 reduces the volume of the lake by 4% every 100 years, meaning that in 2300 years the Lake would cease to exist and the surrounding area would become a marsh, frequently subjected to flooding (DLBAB 1989, p 6). Dauphin Lake receives more than 500 000 tons of sediment annually, and with the lake averaging a depth of only seven feet, siltation is seen as one of the main causes of the decline of the fishery (DLBAB 1989 p 4). Siltation can cover the fish-spawning substrates and can suffocate the incubating eggs. The high levels of phosphates entering the lake leads to algae production which ultimately reduces the fish population through deoxygenation. The phosphates enter the lake primarily through fertilizer run-off and human and animal wastes. Possible solutions to this problem include restricting livestock from having access to drains, to move feedlots away from streams, and to encourage the use of on-site watering methods for livestock (DLBAB 1989, p 10). **Figure 5.14** is a photograph of algae-covered rocks and sediment-rich water along the shore of Dauphin Lake.

The Dauphin Lake Basin Advisory Board has also identified land-clearing and increased agricultural activity in the basin as a prime cause of decline in the

FIGURE 5.14 EVIDENCE OF SILT AND ALGAE ALONG THE SHORE OF DAUPHIN LAKE
SOURCE: TREVOR LOCKHART

fish population (DLBAB 1989, p 11). Deforestation leads to higher stream discharges and increased erosion. Rapid, large-volume run-off in the Spring results in low flows and temperature fluctuations later on during spawning. Another side-effect of agricultural activity in the basin is the channelization of natural streams, which also caused increased erosion downstream. From 1948 to 1984, 35 miles of natural channel were lost along Edwards Creek and the Wilson and Vermillion Rivers due to channelization (DLBAB 1989, p 4).

Possible solutions to these problems would be to replant riparian vegetation to reduce runoff, to prolong the Spring and Summer flows by building channel control structures, to encourage spawning success by constructing a series of riffles and pools throughout the stream network, and to reroute channelized streams back into their old courses (DLBAB 1989, p 11). This last objective was successfully achieved by the Turtle River Watershed Conservation District in 1998 on a section of Crawford Creek (King, 1999, p 1). **Figure 5.15** is an aerial photograph of Crawford Creek as the man-made drainage ditch gives way to the natural alluvial fan. The rerouting of Crawford Creek back into its original course

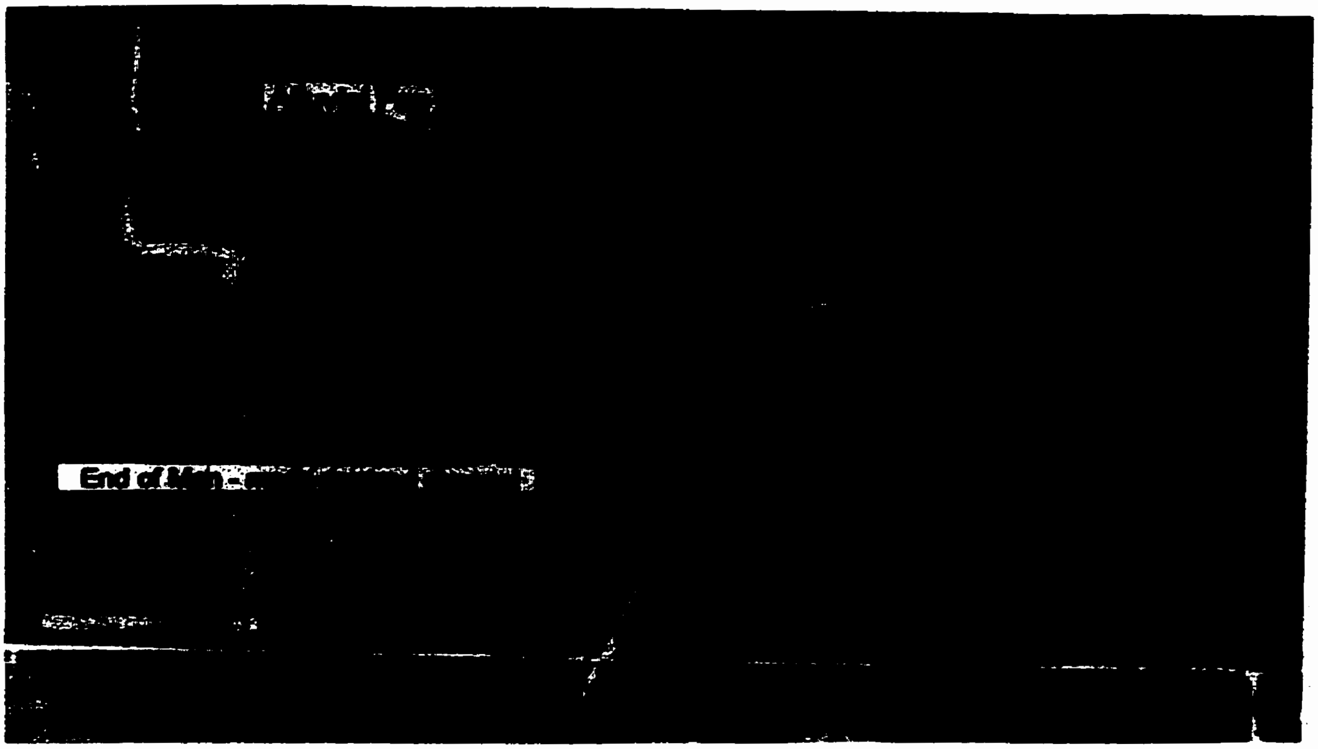


FIGURE 5.15 AERIAL PHOTO OF CRAWFORD CREEK ALLUVIAL FAN
SOURCE: KING 1999

was the only project of its kind in Canada when it was undertaken. The goals of this project were "to reopen a natural drainage channel in the area and one of the key fish habitats along the lake, to help alleviate problems that were developing with the diversion channel such as filling up with silt and sediment, and to stop the erosion the additional water from the creek was causing along the Ochre River" (King 1999, p 1). **Figure 5.16** shows the extent of some of the erosion along the Ochre River as it reaches Dauphin Lake near Highway 5. In order for other streams to be returned to their natural channels, a moratorium on Crown Land sales must be enforced in the basin, as well as a program to buy back, through expropriation if necessary, sensitive lands, such as alluvial fans, from private landowners (DLBAB 1989, p 14).

One final solution to the sedimentation problem of Dauphin Lake is to artificially raise the lake level by a third of a meter from 284.8 m asl to 285.1 m asl (DLBAB 1989, p 6). Such a step would significantly enhance recreational opportunities for boating and swimming, reduce algae growth because there would be less agitation of silt deposits and therefore less nutrient cycling, and

FIGURE 5.16 EROSION ALONG THE BANKS OF OCHRE RIVER SUMMER 1999

SOURCE: TREVOR LOCKHART

would promote waterfowl production within the adjacent marshes. The raising of the lake level would also cause increased flooding upstream, unless measures were taken to widen or improve the outlet channel and the first 13 km of the Mossy River as it flows into Lake Winnipegosis (DLBAB 1989 p 14).

5.5.4 Conclusion

The main hurdle blocking the effectiveness of the DLBAB is lack of public funding to implement the various recommendations developed by the Board. Until the sedimentation and declining fishery of Dauphin Lake is seen as a politically important problem, the fish will continue to decline in number and the Lake will continue to fill in with sediment. **Figure 5.17** is an aerial photograph showing the mouth of the Ochre River as it empties into Dauphin Lake in 1996. The sediment load spreading like a dark rippling cloud into the lake is unmistakable.

FIGURE 5.17 EVIDENCE OF SEDIMENTATION AT THE MOUTH OF THE OCHRE RIVER, 1996.

SOURCE: MANITOBA REMOTE SENSING CENTRE

Section 5.6. Riding Mountain National Park

5.6.1 Introduction

Riding Mountain National Park plays a crucial role in the management of the Turtle River Watershed Conservation District. Almost a third of the TRWCD is included in the escarpment portion of Riding Mountain National Park. The presence of this 3000 square kilometer forest island on the District's western border incorporates both benefits and shortcomings (Good Earth Productions 1997). The following section will provide a brief history of the Park as well as the positives and negatives of having a National Park adjacent to a Conservation District.

5.6.2 Park History

Riding Mountain National Park received official park status in 1929 after beginning as the Riding Mountain Forest Reserve in 1906 (Lothian 1987, pg 74). During the period of agricultural settlement, the forested uplands of Riding Mountain were a primary source of timber for buildings, railway ties, and fuel(Tarleton 1997, pg 17). The land which is now Riding Mountain National Park was withdrawn from settlement in 1895 to help reduce the exploitation of the area's bur oak, spruce, pine, oak and poplar stands. Shortly after receiving National Park Status in 1929, Riding Mountain was used as a location for relief camps during the Great Depression, holding as many as 1200 men during the winter. The work carried out in the park during this time included the clearing of vegetation for the campground and townsite, as well as extending and maintaining the highway through the park (Lothian 1987, 76). During World War II, the Park served as a "remote" location accommodating German Prisoners of War. Draft-age Canadian conscientious objectors and German soldiers performed much the same work that the relief workers did a decade earlier (Good Earth Productions 1997). Since the Park's original use was as a Forest Reserve, timber cutting continued until 1937, when a forest management plan was created (Lothian 1987, pg 78). Grazing and hay permits were issued until 1970, when they were finally phased out completely. The dichotomy between the Park's mandate and the implied mandate of the surrounding agricultural land speaks directly to the heart of this thesis and can be discerned as recently as the 1997 Riding Mountain National Park Ecosystem Conservation Management Plan. Even though grazing and hay permits within the Park were eliminated in 1970, the Park is still sensing an encroachment of crop and pasture land along the Park's boundaries. From 1976 to 1986, cropland in a 70 km radius beyond the Park increased by 27.3%, so that 80.2% of this zone was farmland. Within a 10 km radius 92.7% was farmland. Total pasture land increased from 23.7% to 28.6% of farmland between 1971 and 1986 in the 70 km zone (Tarleton 1997, p 66).

5.6.3 Riding Mountain Biosphere Reserve

Another project that falls under the control of Riding Mountain National Park is the Riding Mountain Biosphere Reserve (Whittaker 1999). Created in 1971 by the United Nations, the Biosphere Reserve program has 280 sites around the world. Each Reserve consists of a core area which promotes natural habitat and conservation, and a surrounding "area of cooperation" in which sustainable resource use is encouraged. Riding Mountain National Park consists of such a core area, and the area of cooperation includes 18 surrounding municipalities. Like the Turtle River Watershed Conservation District, the Biosphere Reserve is managed by a committee of area residents appointed by the municipalities and supported by Park and

Provincial Government staff. The main objectives of the Biosphere Reserve are: 1. To preserve Riding Mountain National Park; 2. to foster maintenance of quality-of-life and resources in the area of cooperation; and 3. to respond to present human needs in such a way that future needs can also be met. (Whittaker 1999). **Figure 5.18** is a map of the Biosphere Reserve.

5.6.4 Hope for the Future

One of the main objectives to emerge from the 1997 Ecosystem Conservation Management Plan was "to develop a regular liaison with Conservation Districts next to the Park and to share information on projects/programs of joint interest by the end of the fiscal year." (Tarleton 1997, pg 64). This is a positive step to overcoming the barriers between the management system inside the Park and the management characteristics of the agricultural community outside the Park. It remains to be seen, whether or not the good intentions of the management plan produce positive results.

One of the main drawbacks of Riding Mountain National Park in terms of water and land management outside the park is the concentration of many wildlife

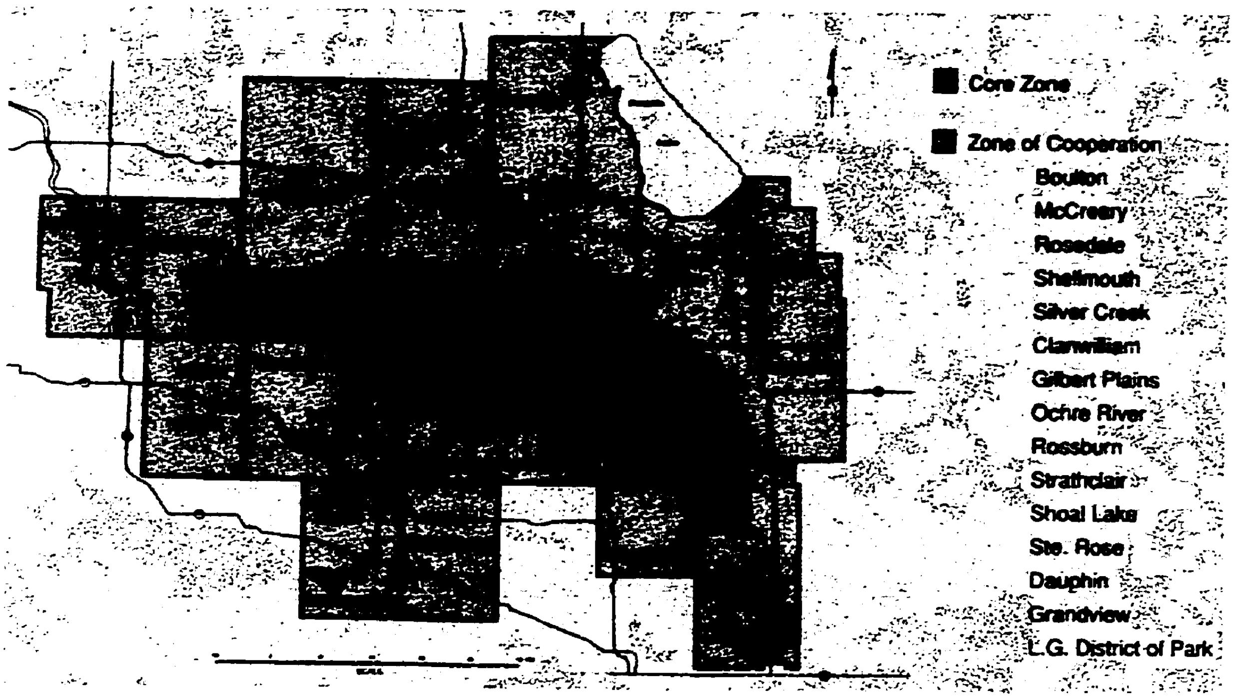


FIGURE 5.18 RIDING MOUNTAIN BIOSPHERE PROJECT
SOURCE: TARLETON 1997

species within the Park. During the Spring thaw, the problem becomes apparent when dozens of the Park's beaver population migrate downstream and end up building dams in the drains and conveyance channels in the District. It has been estimated that Riding Mountain National Park is home to 18 000 beavers, who construct 3500 dams in the park annually (Good Earth Productions 1997). The beaver situation has become so serious in recent years that as a result of their industry, an entire section of Highway 19 on the eastern edge of the Park was washed out in the Spring of 1999. Although beavers tend to initiate the most damage, by blocking drains and channels, the appearance of coyotes, wolves and elk on adjacent farmland have caused local problems (Rousseau 1999). The District has taken an "ad-hoc" approach to dealing with the beaver situation in the Spring. Demolishing dams and clearing blocked drains at landowners' request has become a regular procedure in the Spring. **Figure 5.19** is a photo of a "beaver proof" culvert. Designed with a deep basin on the upstream side of the crossing, the culvert is supposed to pass debris easily and reduce flooding and blockage. The effectiveness of these crossings remains to be seen as the District Manager and the Author spotted a

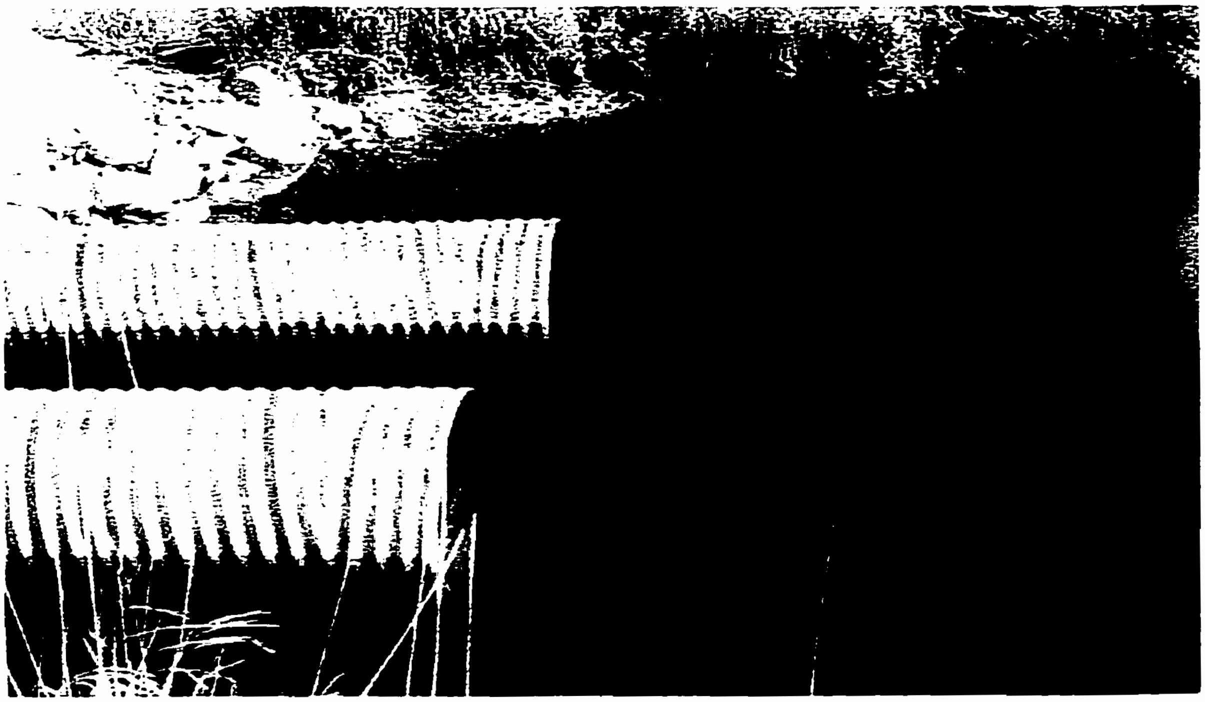


FIGURE 5.19 PHOTOGRAPH OF A CULVERT CROSSING DESIGNED TO DISCOURAGE BEAVER ACTIVITY

SOURCE: TREVOR LOCKHART

beaver swimming through the culvert and beginning to build a dam a short distance upstream!

Parks Canada's mandate is "to fulfill national and international responsibilities in mandated areas of heritage recognition and conservation; and to commemorate protect and present, both directly and indirectly, places which are significant examples of Canada's cultural and natural heritage in ways that encourage public understanding appreciation and enjoyment of this heritage, while ensuring long-term ecological and commemorative integrity" (Tarleton 1997, p 8). It is within this mandate that Riding Mountain National Park operates, and although no mention is made of the Park's relationship to its neighbours, the 1997 Ecosystem Conservation Management Plan addresses the role of the Park and its surrounding neighbours in addition to adhering to the Parks Canada mandate. "Key new components of this Plan include an ecosystem-based approach to park management and involvement by the public, by local stakeholders, by the scientific community and by surrounding jurisdictions in plan development and implementation...this plan uses the greater Riding Mountain ecosystem setting throughout while remaining focused on our own jurisdiction, i.e. within RMNP" (Tarleton 1997, p 10).

Section 5.7 Conclusion

This section has covered the history of the area between the Manitoba Escarpment and Dauphin Lake. Two separate jurisdictions have developed alongside each other over the last hundred years, and yet until recently there has been very little contact between the Federal jurisdiction *of Riding Mountain National Park and the* surrounding agricultural land now represented by the Provincially derived Turtle River Watershed Conservation District.

Chapter Six

Rationale for a Practical Water Management Plan

Section 6.1 Introduction

The Turtle River Watershed Conservation District is in need of a water management plan. It is the goal of this thesis that rational geographic principles are adopted and applied in order to maximize the benefits and clarity of the water management plan. The plan deals not only with the day-to-day work in the District, but also addresses the long term conservation concerns that plague the District from year to year. The combination approach of dealing with short term and long term challenges in an integrated manner has the synergistic advantage of lessening the short term problems in the long run.

The completed plan appears as "Part II" in the thesis and reference will be made to it throughout this chapter. It is the aim of this chapter to provide some rationale as to how the plan evolved over the last two years and why the plan ultimately ended up in the form which was presented to the Board.

Section 6.2 An Overview of the District

At the risk of repeating much of the information already covered by the chapter on the study area, the first step in developing a water management plan for the District was to become familiar with the topography. This includes an inventory of the surface water features and physiographic regions. It was decided that in order to deal effectively with such a geographically heterogeneous area, breaking the District down into four distinct regions based on similar soil type and texture, topography, drainage and land use would be useful. The four areas were identified as the Lowlands, the Subescarpment, the Escarpment, and the Uplands. Details of these four areas can be found in the chapter on the study area, as well as in Part II of the thesis.

Section 6.3 Water Management Zones

Once the four separate and distinct areas were identified within the District, suitable conservation measures and management techniques were developed for each area. It soon became clear that one homogeneous approach to managing the entire District was not only impractical, it would undermine the Board's effectiveness in coming to decisions on site-specific requests.

Although the hope at the outset was to come up with a broad, simple plan for the entire District, the reality was that the District's resources were so varied that for the plan to be anything more than a general guide, more research and development had to be completed.

Section 6.4 Agricultural Drainage Standards

With the help of the Board, four standards of service were developed and are used throughout the District in order to classify the level of attention required by the Board. "Value Added" is the highest level of service. Agricultural lands adjacent to the drains that conform to the "Value Added" standard would have excess summer precipitation drained within 1 to 2 days; "Cereal" standard land would been drained within 2 to 3 days; "Forage/Pioneer" land would be drained within 4 to 10 days; and the lowest standard of "No Drainage" would be applied to low wetland areas and receive the lowest priority by the Board. It is interesting to note that the Board would insist on using economically loaded terms such as "value added" to describe the quality of their drainage system and this relfects on their point of view that improving the land for agriculture remains a high priority.

As the Board adopts these standards, a few guidelines should also be understood. The drains that conform to these standards must be built to the agricultural standard of being below prairie level to allow for effective drainage. The drain standards are not set up to accommodate seasonal flood water. These standards apply only to existing District drains, as the Board will not generally approve the construction of new drains in the District. Even though the Board will not provide service to improve drains classified to the "No Drainage" standard, the Board will encourage conservation measures such as gully stabilization, grassed runways, shale traps and gradient controls to reduce bank erosion.

Section 6.5 Drain Maintenance

Once the agricultural drainage standards were developed, the Board needed to determine how much it would cost to restore drains to their maximum capacity within a given agricultural drainage standard. Out of the 780 km of drains within the District, it was determined that 610 km required normal maintenance; 91 km required heavy maintenance; and 78 km were non-maintainable.

Normal maintenance activities include mowing at \$56-\$65/hr or \$67/km; herbicide application at \$218/km; and spot cleanouts ranging from \$1800 to \$2400/km. A drain requiring normal maintenance would require work every one or two years, and ignoring normal maintenance work will ultimately result in costly heavy maintenance.

Heavy maintenance, determined essential on 91 km of the District's drain network, includes silt and shale removal ranging from \$3600 to \$5760/km; major brushing from \$1200 to \$4200/km; and resloping work costing \$3000/km. After receiving heavy maintenance for one season, it is hoped that the drain will be able to remain up to the agricultural standard it was designed for and in subsequent years receive only normal maintenance.

Drains considered to be non-maintainable tend to consist of steep bank slopes, suffer from severe erosion, and generally require reconstruction beyond that which is justifiable by the Board. These drains have been abandoned and do not receive any type of regular maintenance, although the percentage of drains classified as "non-maintainable" is reviewed annually by the Board.

Minor work, such as the removal of beaver dams, can still be carried out on "non-maintainable" drains.

Section 6.6 Policies of the Board

One of the most useful findings to come out of this research was that the Turtle River Watershed Conservation District consists of several distinct yet interconnected zones, and that each zone must be dealt with in a slightly different manner for maximum effectiveness to be achieved. As was mentioned in a previous section, segmenting the District's drains into different classes of service resulted in an overall more effective plan for the entire District. In virtually all cases, the most appropriate management practice will be dictated by the type of topography affected and its associated land use. Rather than develop one uniform plan which would act as a panacea for all water resource challenges, it was discovered that approaching each challenge without a preconceived notion opened up the possibilities for management. As the plan underlines, a variety of methods are possible throughout the District. Whether an area needs only to maintain its drainage channels, or whether it is decided a more aggressive management approach is required such as land expropriation to protect sensitive alluvial fans is left to the discretion of the Board.

This approach has been adopted for the Turtle River Watershed Conservation District's plan and will prove to be efficient and effective, as well as conforming to geographic principles such as examining the spatial relationships between the four zones of the District and linking these four zones in a watershed model.

Section 6.7 Recommendations

The condition of the drainage system in the Turtle River Watershed Conservation District is generally good, although the District lacks a formal long-term plan in which many of the ideas discussed throughout this thesis could be implemented effectively. A plan that respects the individual differences within the District, and yet at the same time gathers all of the various interests together under one unified vision for stewardship could go a long way in easing many of the issues addressed throughout this thesis.

It is recommended that the Board focus in on taking greater steps towards preventative conservation so that ultimately less time and money will be spent on day-to-day efforts such as dredging, beaver dam removal, and culvert reconstruction. The Board needs to focus in on the sensitive area along the escarpment where the streams flowing off the east side slow down into alluvial fans. It is along these areas that the erosion and sedimentation problems downstream originate. The uplands area is managed constantly by Riding Mountain National Park officials; flood control and stream flow is monitored regularly by the Park. The Park itself is officially out of the District's jurisdiction, so the first level of defense against erosion and sedimentation in the District is at the alluvial fans.

Expropriation of land which sits on alluvial fans, as well as the land immediately downstream of the fans, is the most effective management measure the Board can take at the outset. Removing those lands from production will result in a return to the natural vegetation which will reduce the amount of sediment being eroded from the fans downstream. A less intrusive measure is to provide tax credits for acres of land which remain privately owned but are under Board approved conservation management.

Long-term preventative management does not stop at the alluvial fans. Increased attention must be given to erosion control along the banks of not only the Ochre and Turtle Rivers, but also the various smaller streams and drains which contribute via tributaries to the larger channels. Projects such as grassed waterways, shelterbelts, buffer strips and forage crops all assist in reducing erosion and stream flow throughout the District.

Conservation can be practiced not only on the land adjacent to the drains and streams, but also within the streams and drains themselves. Shale traps, found along the escarpment streams, act as mini-dams which slow the stream-flow and allow the sediment to filter out before it reaches Dauphin Lake. The filtered sediment is then dredged and used as fill. Riffle and pool structures not only slow the flow of the escarpment streams as shale traps do, but also provide an oxygen enriched environment which is suitable for fish spawning. This can be enhanced by developing fish stocking programs along the Ochre and Turtle rivers, as well as Dauphin Lake itself. Developing the original marsh systems at the mouths of the Ochre and

Turtle rivers would act as a "last-stop" buffer for sediment to settle out before entering into Dauphin Lake.

One final area of effective management in which the Board can develop preventative conservation is through public education. Many farming techniques employed in the District contribute indirectly to the erosion of stream banks and sedimentation downstream. Adopting contour farming techniques, practicing zero till management, and utilizing plastic mulches are just some of the methods which reduce soil erosion and protect valuable top soil. The Board is encouraged to continue developing innovative agricultural methods which can be adopted by the individual farmer and enhance the entire District's resources. These new techniques can be demonstrated on designated plots so that farmers can see the benefits directly and in a practical setting.

Section 6.8 Conclusion

A unique experiment has been undertaken over the past two years in the Turtle River Watershed Conservation District. The experiment consisted of developing a water management plan which took into consideration the issues and concerns of the rate payers and the Board, as well as the other concerned parties adjacent to the District. The plan was to be practical in nature, yet based on sound geographic principles and existing research on the topic of water and land management. This chapter has summarized many of the ideas and reasoning that went into the water management plan, and answered many of the questions as to why certain issues were given priority over others in the final draft.

Chapter Seven

Summary and Conclusions

The role of the geographer has been examined in the context of the challenges faced by the Turtle River Watershed Conservation District. As mentioned in the introduction, the goals and priorities set out in the Brundtland report formed most of the theoretical framework for this thesis. In order for a problem to be properly met and dealt with, the entire scope of potential factors and variables must be considered. This may sound like a daunting task for those whose main priority is to solve a specific challenge, such as erosion. The view of any specifically defined discipline, such as hydrology, is too narrowly focused to adequately address the entire problem. This is not to suggest that the hydrologist's role is diminished. Rather, the narrow scope of each discipline has provided valuable results which would not be possible if specialization did not occur, as the Wilson Creek studies prove. Geography takes a different approach.

It is exactly for this reason that the influence of a geographer is essential for the tackling of any major problem which deals with varied interests. Rather than merely "thinking outside the box", the geographer rebuilds the box to include as big a picture as the problem allows. For the case of the Turtle River Watershed Conservation District and Riding Mountain National Park, it is the entire Dauphin Lake watershed of the Ochre and Turtle Rivers that must be considered when policy is developed.

The second part of focussing traditional thinking involves looking at the problem from the perspective of more than one specialty. The entire watershed must be assessed, not only in terms of area, but also in terms of all the physical and cultural influences and processes than occur in a daily, seasonal and/or annual cycle. The quality of the soil is linked to the quality of the water passing through the soil and the drainage patterns developed within it, as well as the land management techniques applied to the soil. The productivity of the land is heavily influenced by climate, and the microclimate can be altered and moderated with the intelligent use of shelterbelts and grassed runways. The type of land use, whether it is for field or forage crops, for grazing or left as fallow depends greatly on the soil quality as detailed in the Canadian Land

Inventory. Conversely, whatever land use technique is used will affect the structure and quality of the soil type as well. In order to see how these as well as other relationships affect each other in the District and Park, geographical perspective is required.

One final comment should be made as to the real possibility of adopting sustainable development practices within the District. It is clear that the main goal of the land owners in the District is to make money through agri-business. However, in the past few years, it has also become clear to the landowners that such a venture is becoming more and more difficult as a result of management decisions made by their ancestors a century before. The channelization of streams, although helpful in the short term by removing water from fields expediently, resulted in a much bigger long term problem of erosion and sedimentation. The attitude of the rate payers in the District is that something must be done to reverse this trend of erosion and sedimentation, or else there will not be any agri-business to protect in the near future. It is out of desperation rather than out of any dedication to sustainable development that the ideas in this thesis are given consideration by the Board.

Although resource management is challenged by the constant struggle for jurisdiction between Riding Mountain National Park and the Turtle River Watershed Conservation District, there are signs of hope that the water quality of Dauphin Lake and soil conditions below the escarpment will be managed with intelligence, rationality and foresight. There is no one right formula for sustainable development, but rather many options. The words of the Brundtland Report remind us that "Sustainable Development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future...No single blueprint of sustainability will be found as economic and social systems and ecological conditions differ widely among countries" (Brundtland 1987, pg 40). It is up to the managers of the Dauphin Lake basin, whether they are Park Rangers or District Board members, to develop together a plan that is sustainable for generations to come.

PART II

THE PRACTICE

A WATER MANAGEMENT PLAN

FOR THE

TURTLE RIVER WATERSHED CONSERVATION DISTRICT

JULY 2000

Trevor Lockhart
Turtle River Watershed Conservation District
Water Management Plan
May 2000

Executive Summary:

Ever since the Turtle River Watershed Conserveration District was inaugurated on August 30, 1975, water and land management and conservation has been a high priority for the land owners and managers of the area lying between the Manitoba Escarpment and Dauphin Lake.

This water management plan is a continuation and confirmation of all the hard work carried out by the Board and its rate-payers since inception. In order to give some direction and rationality to the decisions and work carried out by the Board, this plan should be seen as a guide and reference tool for those who have questions and concerns as to the work of the Board in the District.

The plan begins with a description of the District in terms of topography, resources and features. The first section of the plan classifies the District into topographic zones, water management zones, and "level of service" zones known as Agricultural Standards. It was determined that within the District's boundaries, four separate and distinct topographic areas exist. These are the Western Lowlands, the Subescarpment, the Escarpment and the Uplands. From these four natural physiographic zones, four water management zones were set up to reflect the areas that have similar water-and-land management issues and challenges. The four water management zones follow the physiography of the District closely. Using the Water Management Zones as a guide, the level of service devoted to each area was then determined by the Board. This is reflected on the Agricultural Drainage Standards Map accompanying the plan.

The second section of the plan deals with the artificial drainage system in detail. This section provides an inventory of the approximate number and type of drains throughout the District, as well as the cost of maintenance and repair on each type of drain in each zone type.

The third and final section of plan states the policies and priorities of the District. This section provides the rationale for project approvals and rejections. In addition to the policies and priorities, this section lists some of the recent accomplishments of the District, to provide a general idea as to what the Board believes is important in terms of land and water conservation and management.

Introduction:

This watershed management plan was mandated by the 1988 Management Plan for the Turtle River Watershed Conservation District. The management plan calls for research into a sub-plan which deals with land and water management issues. A detailed thesis on the history of water management in the escarpment and subescarpment and the relationship between the TRWCD and Riding Mountain National Park is being written at the same time as this water management plan, and can be used as a companion piece for further detail and information on the subject of water management.

The water management plan is broken down into three key sections:

PART 1: A broad picture of the Turtle River Watershed Conservation District including water problems and possible solutions.

PART 2: An inventory of the existing man-made drainage system and requirements for maintenance and reconstruction.

PART 3: A description of the District's policies and directions

PART 1
A BROAD PICTURE OF THE TURTLE RIVER WATERSHED CONSERVATION DISTRICT

IN THIS SECTION:

- Background;
- Surface water features and physiographic regions;
- Water Management Zones; and
- Agricultural Drainage Standards.

BACKGROUND

The Turtle River Watershed Conservation District encompasses an area of 2130 sq. km (824 sq. mi.). Historically, land drainage and runoff control were the two major concerns in the District. More recently, consideration has been given to the value of incorporating conservation measures, especially along the escarpment and subescarpment streams, to prevent further erosion and land degradation.

SURFACE WATER FEATURES AND PHYSIOGRAPHIC REGIONS

The Turtle River Watershed Conservation District can be subdivided into four unique areas based on physiography. Generally speaking, the four zones run East to West, with Area One covering the Easternmost portion of the District, and Area Four covering the Westernmost portion of the District.

Area One: Lowlands

This includes all of the area below the 300m contour. This area includes the greatest amount of land in the District, and stretches from its eastern border down to the southern border which runs between McCreary and Kelwood. The soil drainage is classified as from poor to good. The surface texture of the area varies from stone-free to extreme stoniness, and from clay to gravel. The parent material is made up of lake and alluvial deposits, as well as glacial till.

Area Two: Subescarpment

This zone occupies a narrow band between the 300 and 360m contours. It extends from the southeast to the northwest, following the contour of the escarpment. It is characterized by the presence of alluvial fans and beach ridges. The soil texture ranges from sandy loam to silty clay soils. This area also has well developed and defined stream channels with moderate to steep gradients. Soil drainage ranges from good to imperfect.

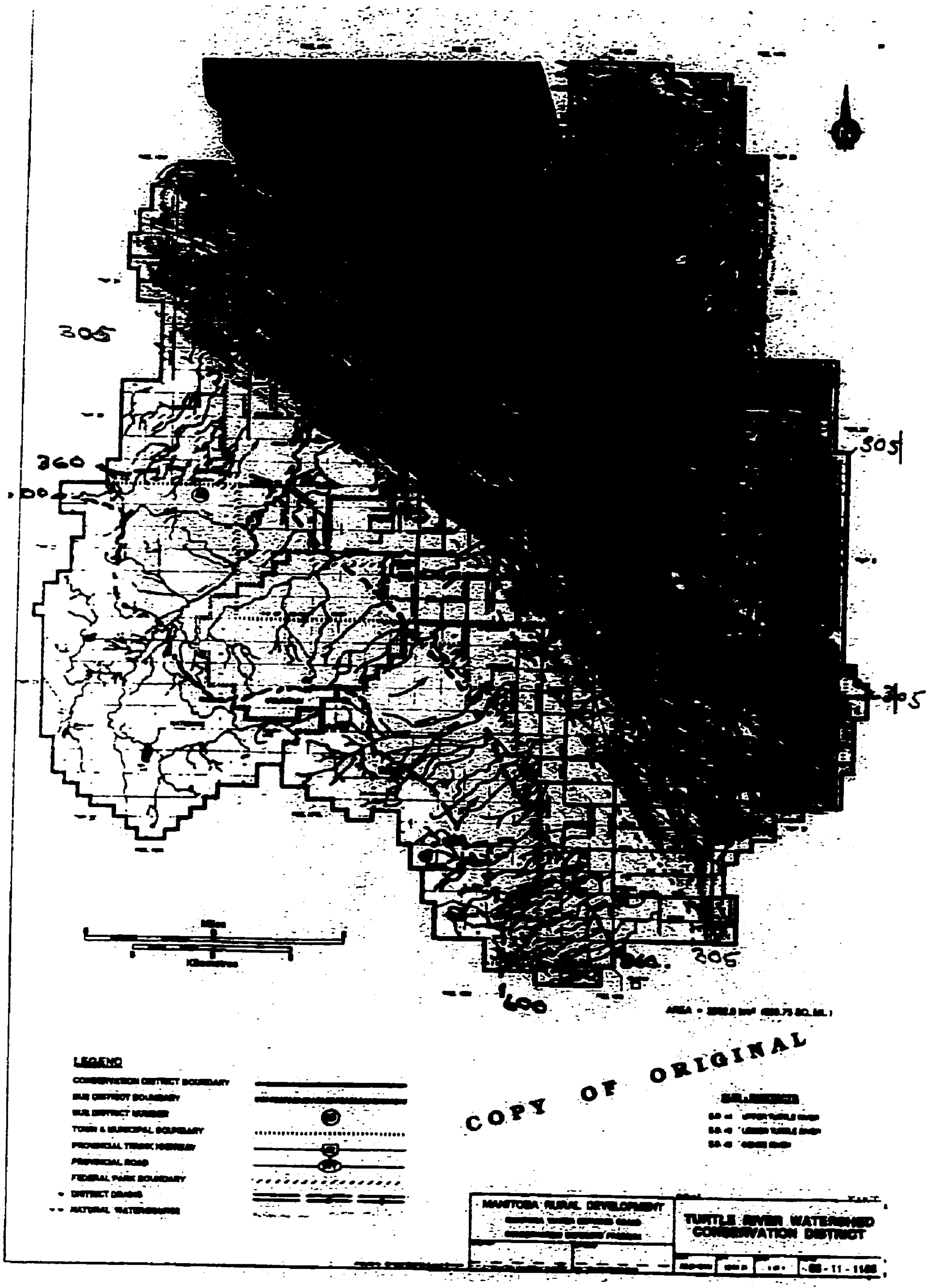


Figure 1

PHYSIOGEOGRAPHIC REGIONS

AREA #1
LOWLANDS

AREA #2
SUBESCARPMENT

AREA #3
ESCARPMENT

AREA #4
UPLANDS

SOURCE: TRWCD BOARD

Area Three: Escarpment

This is steep, sloping terrain between the Subescarpment and the Uplands areas. This area crosses over the Riding Mountain National Park boundary, and therefore is subjected to some jurisdictional overlay. The elevation ranges from 360 to 600 meters. The soil is the same as that of the Subescarpment region consisting of sandy loams and silty clays. Beach ridges and alluvial deposits occur at the base of this zone.

Area Four: Uplands

The Uplands area lies completely within Riding Mountain National Park, and is made up of a forested, rolling till plain. The elevation ranges from 600 to 675 meters. Since this area falls under Federal jurisdiction, the water management plan must respect the fact that any conservation practices undertaken within this zone must meet with approval from the Park administration.

WATER MANAGEMENT ZONES

It is recommended that the District be divided into 4 (four) water management zones, based on the natural physiography detailed in the previous section, as well as on the agricultural potential of the land. The agricultural potential of the land is based on the Canada Land Inventory Classification. Figure 2 outlines these four water management zones.

AGRICULTURAL DRAINAGE STANDARDS

The Board needs to identify the standard of agricultural drainage or the level of service that can be expected within the water management zones in the District. As a "Rule of Thumb", four drainage standards are proposed:

Drainage Standards:

- Value Added: High Level Service. Excess summer precipitation removed from adjacent agricultural land within 1 to 2 days.
- Cereal: Agricultural drainage within 2 to 3 days.
- Forage/ Pioneer: Agricultural drainage within 4 to 10 days.
- No Drainage

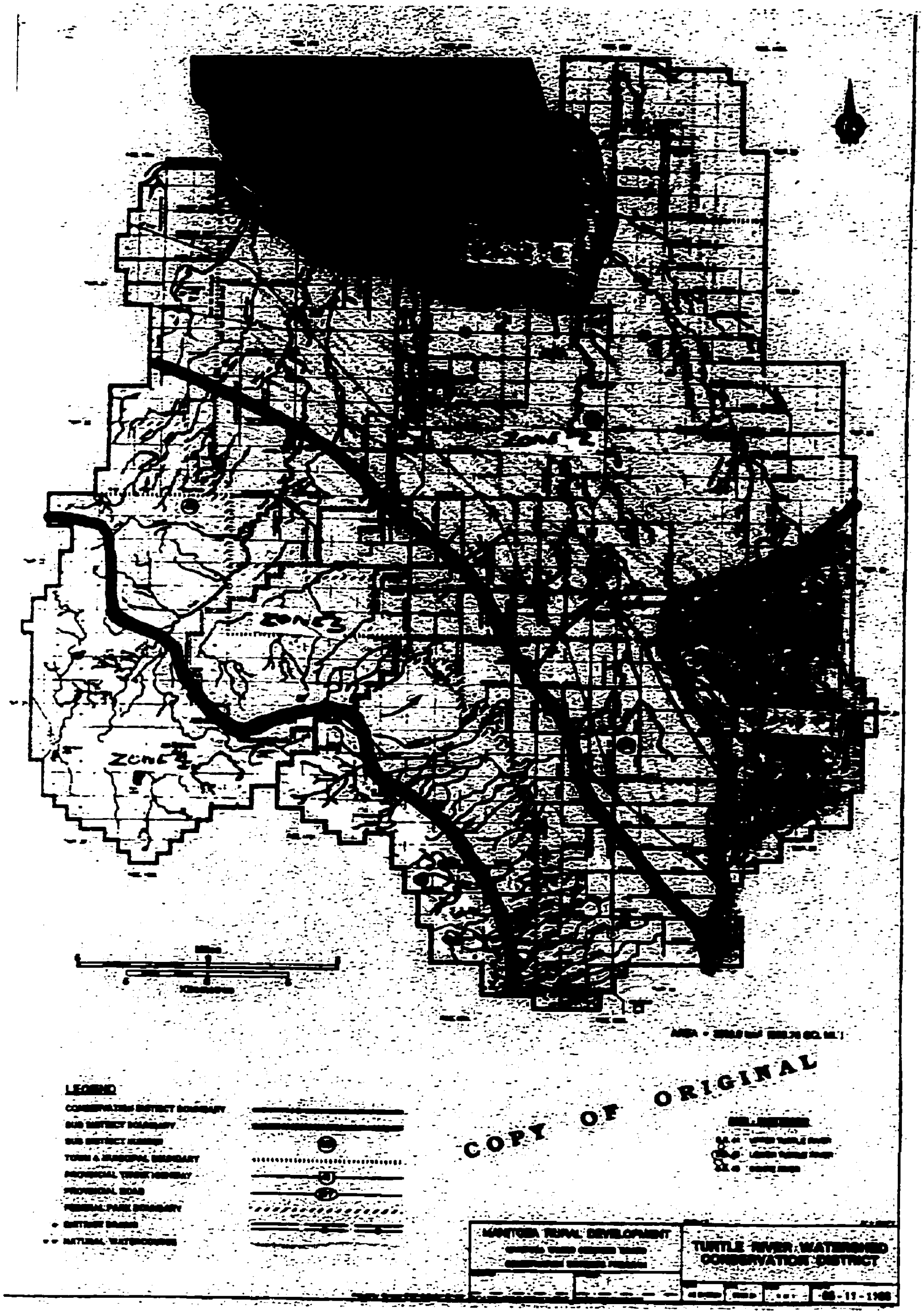


Figure 2

WATER MANAGEMENT ZONES

ZONE #1
EASTERN LOWLANDS

ZONE#2
SUBESCARPMENT

ZONE #3
ESCARPMENT
AND ALLUVIAL FAN

ZONE#4
WESTERN UPLANDS

The purpose of the agricultural drainage standards map is to assist the District in making decisions as to whether to maintain, reconstruct or upgrade the existing drainage system in given areas. (i.e. What level of drainage service can one expect in the various regions of the district?)

The following statements should be regarded as recommendations in any interpretation of the Agricultural Drainage Standards Map.

- The drains are built to an agricultural standard (they are built below prairie level to allow drainage from adjacent land).
- The drains are not designed to accommodate flood water.
- The drain standard applies only to existing District drains.
- The Board will not generally approve construction of new agricultural drains.
- In the area of "No Drainage" the Board will encourage conservation measures such as gully stabilization, grassed runways, shale traps and gradient controls to minimize erosion.

Conveyance Channels:

A separate design standard is required for conveyance channels which are constructed to transfer water from one area to another as opposed to draining adjacent agricultural land directly.

APPENDIX A

The following are definitions of key terms used in the Water Management Plan:

Conveyances: Channels constructed to transfer water from one area to another. The design flow may be contained within dykes above prairie elevation.

Drains: Channels constructed to remove water from adjacent agricultural land. The design flow will be below prairie level to allow drainage from the adjacent land.

Design Flow: This is the chosen level of service or standard chosen for a project. The standard is related to benefits: i.e. the greater the benefit, the higher the standard.

Agricultural Standard: This is the design flow required to protect or drain agricultural land in a reasonable amount of time. This is normally limited to events that would likely occur during the growing season. This standard does not provide sufficient capacity to handle large spring floods.

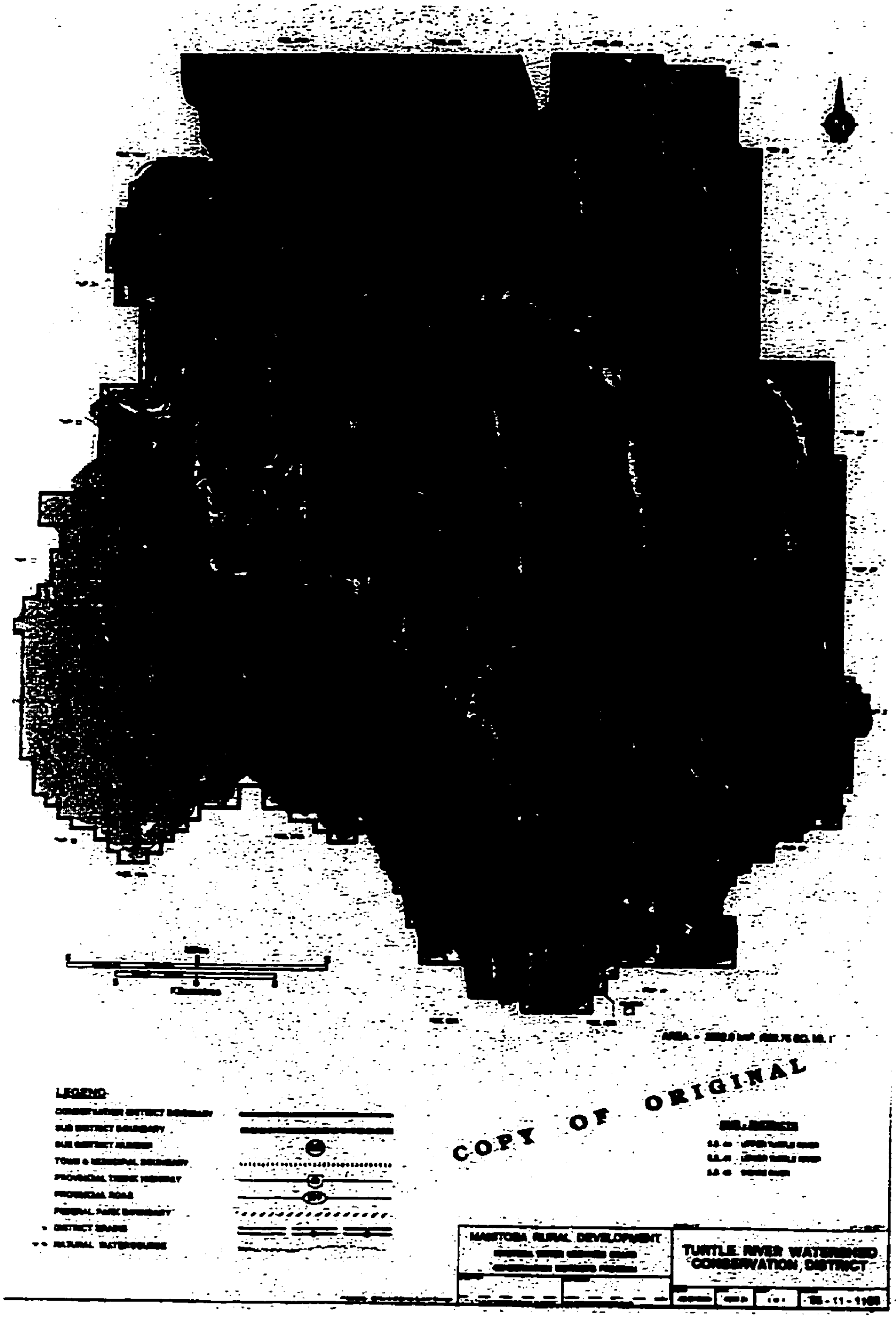


Figure 3

AGRICULTURAL DRAINAGE STANDARDS

VALUE ADDED CEREAL

PIONEER
FORAGE
PASTURE

NO DRAINAGE
NATURAL

SOURCE: TRWCD BOARD

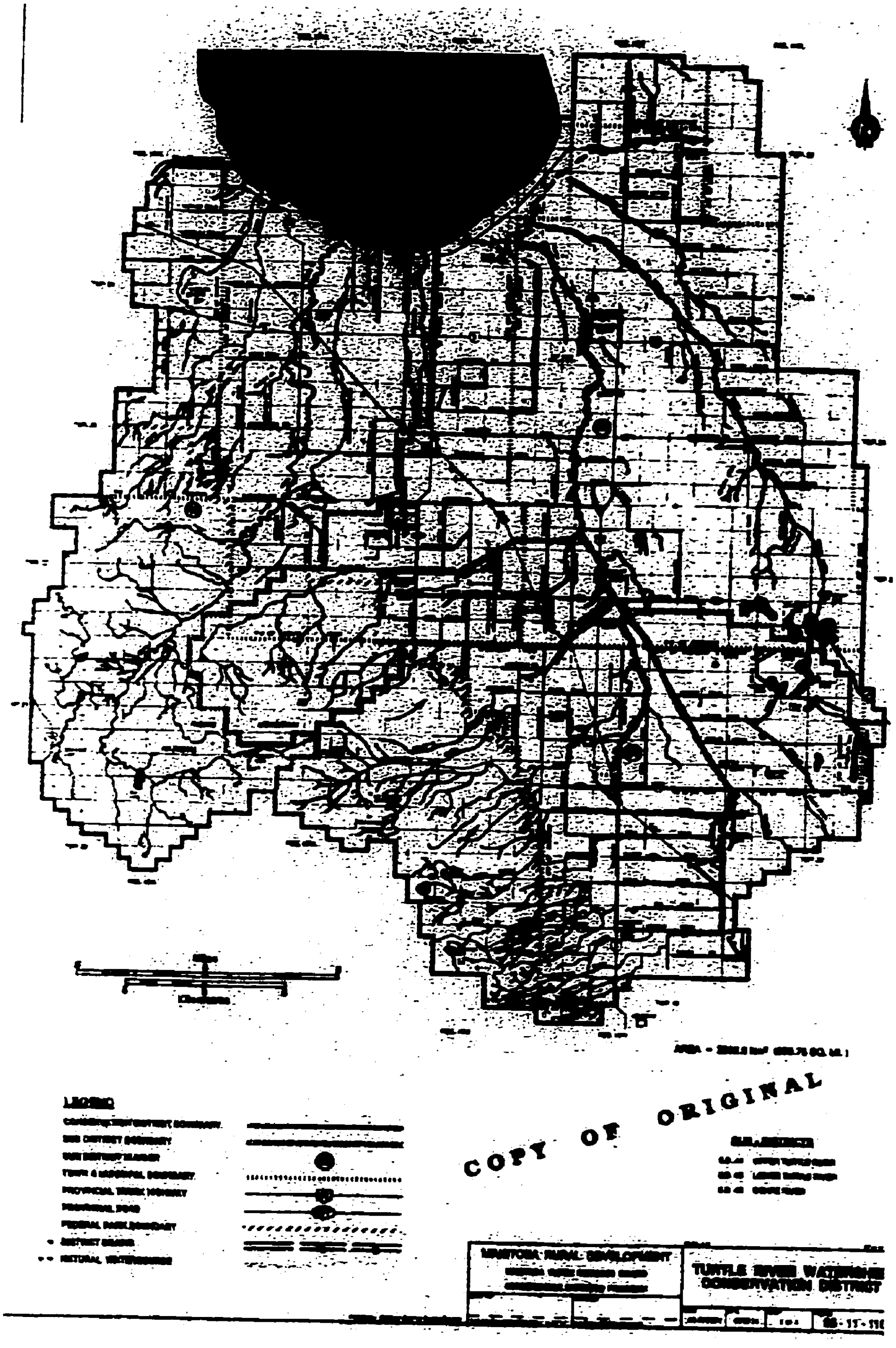


Figure 4
CONVEYANCE CHANNELS

LEGEND:
CONVEYANCE CHANNELS

SOURCE: TRWCD BOARD

Flood Frequency: An estimate of how often a particular event may be exceeded. This is based on available stream flow records.

Drain Maintenance: Work done to maintain or improve the drain capacity without significantly altering the size of the channel. Examples of this include mowing, haying, minor silt removal, brushing and herbicide application.

Drain Reconstruction: Work done to upgrade the channel so as to provide a higher standard of drainage service for an area.

Natural Water Channel: A channel which exists in its natural location with no improvements to increase its drainage capacity. A channel does not lose its "natural" status because of the clearing of vegetation or construction of minor works affecting a minor portion of the channel.

Man-made Drain: A channel constructed to direct water along an artificial route (i.e. not natural). The Board has responsibility for the maintenance and repair of all the manmade drains outlined in the Drain Maintenance Policy section of this plan.

APPENDIX B

Water Management Zones: Problems and Solutions

It is recommended that the Turtle River Watershed Conservation District be divided into 4 (four) water management zones. Each zone is identified by key soil and topographic features and by similar water problems, both externally and internally imposed:

ZONE 1 Eastern Lowlands;

ZONE 2 Subescarpment;

ZONE 3 Escarpment; and

ZONE 4 Western Uplands.

PART 2
MANAGEMENT PLAN FOR MAN-MADE DRAINS IN THE TURTLE RIVER WATERSHED CONSERVATION DISTRICT

In this Section:
- Background;
- Drain Capacity;
- Drain Maintenance;
- Drain Reconstruction; and
- Summary of Drain Maintenance and Reconstruction Strategy.

BACKGROUND

The man-made drains in the Turtle River Watershed Conservation District fall under the responsibility of the Turtle River Watershed Conservation District Board. This report outlines the current condition and possible strategies for maintaining and rehabilitating these drains.

The key goals of this strategy are to:
- ensure that the drainage system does not deteriorate;
- develop a system that can be maintained through normal maintenance;
- eventually reconstruct low capacity drains to a standard compatible with land use and soil types;
- encourage projects which are ecologically friendly and sensitive to environmental concerns; and
- ensure that projects which involve maintenance and reconstruction are implemented with a minimum impact on aquatic and wildlife habitat.

This section is strictly concerned with channels. There is no consideration given to the costs of replacing bridges and culvert crossings. The data is based on the current condition of the system. The evaluation is not based on an intensive engineering study but is based on the knowledge and experience of field staff and the Board. No attempt has been made to anticipate damages as a result of floods, erosion etc. Since drain capacity requirements can change from one runoff event to another, a rigid, objective system for determining drain capacity could not be developed. As a result, the following descriptions of drain types are meant to be used as general guidelines only.

DRAIN CAPACITY

First, the condition of the drainage system was evaluated. Each drain was rated as good, fair, poor, very poor or non-maintainable depending on its current maintenance status. For example, a "good" drain would have adequate capacity to convey water, i.e. it has been maintained so that vegetation or silt would not cause a major reduction in capacity. Although maintenance work can improve a drain to its full capacity, this does not mean that the drain was built to a sufficient design in the first place. In fact, several of the drains in the District have inadequate hydraulic capacity.

DRAIN MAINTENANCE

Maintenance is defined as work done to restore the drains to full capacity without significantly altering the size of the channel. This is usually limited to vegetation control and silt removal. The drains were divided into three categories:

- normal maintenance channels: 610 km (381 miles);
- heavy maintenance channels: 91 km (57 miles); and
- non-maintainable channels: 78 km (49 miles).

The number of miles of drain in each category was tabulated and multiplied by an average cost per mile to determine overall maintenance costs. Repair costs due to unpredictable events such as flooding were not included.

Normal Maintenance (381 miles):

- mowing \$56 to \$65/hr or \$112/mile;
- spraying \$363.24/mile; and
- spot cleanouts \$3000 to \$4000/mile.

The annual allowance for normal maintenance must be determined by the Board.

Important factors regarding normal maintenance are that:

- work is carried out every one or two years;
- hay permits on well-constructed large drains reduce costs;
- ignoring normal maintenance results in expensive drain reconstruction; and
- it is reasonable to expect projected costs will increase 3-6% annually due to inflation.

Heavy Maintenance (57 miles):

- silt removal \$6000 to \$9600/mile;
- major brushing \$2000 to \$7000/mile; and
- resloping \$5000/mile.

The annual allowance for heavy maintenance must be determined by the Board.
Important factors regarding heavy maintenance are:

- usually it is a one time expenditure assuming follow up normal maintenance

Non-Maintainable Drains (49 miles):

- maintenance is not possible;
- steep side slopes, severe erosion; and

- requires reconstruction.

The percentage of Drains which are non-maintainable will vary from year to year and is subject to the discretion of the Board.

Important factors regarding non-maintainable drains are:

- virtually all these drains have been abandoned because either they have far more capacity than required (on eroded steep slopes) or reconstruction costs are beyond the means of the District and are likely not justifiable; and
- maintenance is limited to minor work such as removing beaver dams.

SUMMARY OF DRAIN MAINTENANCE AND RECONSTRUCTION STRATEGY

Overall, the drainage system in the Turtle River Watershed Conservation District is in good shape. The adoption of a workable 10-year management plan will ensure that the drainage system does not deteriorate. By using this water management plan as a benchmark, future Board decisions can be measured against the state of the District in the year 2000 as presented in this plan.

PART 3
WATER MANAGEMENT POLICIES

In this section:

- District's Vision;
- Goals;
- Ongoing Priorities;
- Recent Accomplishments;
- Proposed Actions;
- Channel Maintenance policy;
- Drain Reconstruction policy; and
- Drain Design and Construction Guidelines.

VISION

Managing the natural resources of the district for the benefit, enjoyment, and economic well-being of residents, now and in the future.

GOALS

- To encourage wise use and integrated management and development of district resources;
- To provide a leadership role in soil and water management;
- To plan, develop, and maintain land drainage and other water control works necessary to maximize agricultural productivity and minimize effects from flooding and erosion;
- To ensure that quality and quantity of surface and ground water are protected such that present and future users are not adversely affected;
- To protect and preserve key parcels of marginal land to serve as multi-purpose natural areas, including reclaimed wetlands and biological and ecological filters;
- To rehabilitate critically eroded escarpment creeks; and
- To ensure that aquatic and wildlife habitat are not damaged by any development.

ONGOING PRIORITIES

- Maintain and upgrade drainage channels;
- Maintain and upgrade transportation crossings;
- Stabilize and rehabilitate stream banks;
- Water quality monitoring;
- Establishment of shelterbelts;
- Using plastic mulches;
- Grassed waterways;
- Buffer strip program;
- Erosion control;

- Forage seed assistance on eroding lands;
- Fish and wildlife enhancement and preservation;
- Demonstration sites for new programs; and
- Public education.

RECENT ACCOMPLISHMENTS

- Co-operative recreational development with the Ste Amelie Ridge Trail Riders;
- Erosion control along eastern slopes of the Escarpment;
- Hanson Creek Rehabilitation;
- Installed Field Shelterbelts using plastic mulches;
- Fisheries enhancement initiatives;
- Crawford Creek Drain restoration;
- Acquired the last intact alluvial fan at the base of the Manitoba Escarpment;
- Innovative recycling of rail and tank cars as bridge crossings;
- Skene's Crossing day-use area;
- Ochre Beach Conservation Project; and
- Turtle River Boat Launch.

PROPOSED ACTIONS

- Riparian area management actions;
- Further erosion control on critical creeks along the Escarpment;
- Continued assistance in conversion to forage crops;
- Expand tree planting and shelterbelt establishment projects;
- Maintain agricultural drainage channels and transportation crossings;
- Fish stocking projects along the Ochre and Turtle Rivers, as well as in Lake Dauphin;
- Buffer strip and forage strip encouragement; and
- Tax credit incentives for land under conservation management.

CHANNEL MAINTENANCE POLICY

The District's drain maintenance program shall be guided by the following policies.

Mowing and Brushing:

- Mowing and brushing will be undertaken on an as-needed basis; and
- Heavy brush mowing may be limited to one-mile stretches, to prevent excess debris buildup.

Silt Cleanout:

- Will be undertaken on an as-needed basis;
- Cleanouts will improve the drain to a maintainable condition;
- Cleanouts resulting from adjacent land wind erosion will only be completed with a landowner agreement to leave a minimum 10 foot grass buffer strip. Drain

cleanouts from adjacent land erosion may not be completed if erosion is recurrent; and

- Silt Cleanouts will be initiated during seasonal periods during which a minimum of impact on local aquatic and wildlife species will be caused.

Hay Permits:

- Will be encouraged and available to the adjacent landowner;
- Release forms will be signed if adjacent landowner does not want to maintain a permit; and
- Hay permits are renewable 3-year contracts.

Snow and Ice Removal:

- The Board will not remove snow and ice from drains unless buildings or other real property are threatened;
- Any individual or agency may be liable for damages and costs that result from works they undertake to remove snow or ice from District drains; and
- Strategic placement of shelterbelts is encouraged to prevent snow blockage.

Seeding:

- Drains will be seeded as soon as possible after a cleanout, to establish a protective cover and reduce erosion. This will also minimize adverse impacts on terrestrial. aquatic and wildlife species who rely on covered riparian zones as habitat.

Spoil Material:

- Certain drains must have their spoil material removed from the District. The shale material has no value on adjacent land below the escarpment, and there is no extra room for the material in berms, roadwork, and dykes.

Beaver Dams:

- The Board will only remove beaver dams from the District drains where the dam is causing serious damage such as flooding of crop land; and
- The landowner must take the initiative to have the dam and/or beaver removed. The District will not act unless all other efforts have been exhausted.

Herbicide Weed Control:

- The Board will only use provincially recommended and registered herbicides;
- All rules and safety practices for herbicide use recommended by the province will be followed;
- The chemical drain maintenance program will be supervised by a licensed applicator;
- Proper environmental licensing will be required; and

- No spraying will occur where there is a risk to fish, wildlife habitat or water quality.

Natural Water Channels:

- The Board will not assume maintenance responsibilities for natural water channels, although rehabilitative measures for erosion control or riparian enhancement may be considered. This is especially true for problems that are affecting landowners, homesteads and operations.

DRAIN RECONSTRUCTION POLICY

The District's drain reconstruction program shall be guided by the following policies.

Reconstruction Policy:

- As a general rule the board will reconstruct a drain to a standard that matches the area's agricultural capability, i.e. the higher the agricultural capability, the higher the drainage standard; and
- The Board will consider maximizing the return on its investment dollars when planning reconstruction projects as well as minimizing the impact on aquatic and terrestrial resources.

Buffer Strips and Spoil Banks:

- The Board will consider acquisition of additional land along drains, where feasible, to provide for buffer strips or to place spoil banks;
- The District will seed the berm or spoil bank to grass; and
- The District will maintain the berm or spoil bank. However, landowners are encouraged to maintain the grass cover.

Fence Removal:

- The District will not remove landowners' fences, unless the situation falls under a specific conditional written agreement.

DRAIN DESIGN GUIDELINES

General Design Guidelines:

- Works will be designed to provincial standards;
- Three agricultural drainage standards are suggested: value added, cereal, and forage/pioneer. The highest drain standard will be applied to lands of highest agricultural capability;
- The system will be designed to provide agricultural drainage only and not to accommodate flood flows; and

- Conveyance channel design will vary depending on the location, drainage area, gradient, soil type etc.

Channel Design:
- Drains will be designed, where feasible, for low maintenance with gentle 4:1 side slopes to allow mowing;
- Minimum 3 metre bottom width, 3:1 side slopes;
- Maximum water velocity of 3 feet/second, with consideration of soil type and susceptibility to erosion;
- Gradient control structures to be installed to reduce water velocities where required;
- Design criteria will include consideration of downstream impacts, groundwater impacts, and fish and wildlife impacts; and
- Grassed runways will follow the natural direction of water flow.

Erosion Control Design:
- Rock chutes, drop structures and other gradient controls will be installed to minimize erosion along drains;
- Shale traps will be installed to reduce downstream sedimentation of drains and consequent costly cleanouts;
- Rock drops will be constructed where required on grassed runways and gully stabilization projects; and
- Buffer strips along drains will be promoted. The District will seed the buffer strips while the day-to-day maintenance of the strips will be the landowner's responsibility, unless specifically stated otherwise.

System Design:
- No upstream drainage improvements will be completed without provision of an adequate outlet;
- All drainage projects will be designed in the context of the entire drainage system;
- Projects will avoid connection of the groundwater table to surface drainage.

Environmental Design:
- There must be no net loss of fish and wildlife habitat as a result of drainage works;
- The Board will incorporate fish and wildlife habitat enhancement features where feasible, i.e. pool and riffle designs;
- There must be no loss or degradation of wetlands;
- Crossings should adhere to stream crossing guidelines for fish, where required;
- Drainage development that degrades a natural undisturbed environment will not be recommended;

- Projects such as the Crawford Creek rehabilitation and the alluvial fan preservation will be encouraged to promote conservation and reduce erosion along the escarpment streams; and
- The Board will encourage drainage schemes that restrict runoff from livestock operations from emptying directly into the drainage system.

Water Storage Design:
- The District will consider small dams within existing drains for water storage;
- Gated culverts or drop inlet structures will be considered to promote water conservation and discourage beaver dam construction and activity; and
- Backflood projects to slow down the runoff rate will be promoted.

CONCLUSION

This water management plan for the Turtle River Watershed Conservation District is intended to be a working document that may aid the Board in making decisions in allocating funds for the various projects and services that the Board is responsible for. It is based on the rational, objective notion that the District is made up of various physiographic regions and land suitability types, and that these different areas and their drainage systems must be prioritized in order for the District to operate in an effective and healthy manner. Final authority rests with the Board in determining the status of drains and the priority of service, and this document should aid the Board in arriving at those decisions.

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