THE WINNIPEG INTERNATIONAL AIRPORT SECURE ZONE:

AN ALTERNATE LANDSCAPE PLAN STUDY

BY

DAVID LAWRENCE STOYKO

29 August 2000

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

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture
University of Manitoba
Winnipeg, Manitoba

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

*****

COPYRIGHT PERMISSION PAGE

The Winnipeg International Airport Secure Zone:

An Alternate Landscape Plan Study

BY

David Lawrence Stoyko

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirements of the degree of

Master of Landscape Architecture

Abstract

This study examines an alternate landscape for the grounds of the secure zone at the Winnipeg International Airport. The objective is to achieve two main goals:

1. Reduce the negative impacts of operations at the airport on the local environment and community.
2. Design the landscape in a way that provides interest and meaning to those viewing the airport.

The primary challenge of the plan is maintaining full operational ability at the airport.

The research in this document provides a full analysis of the Winnipeg International Airport secure zone, including issues that are a concern to the community. A series of design recommendations are provided to achieve the two main goals through a new landscape plan proposal.

Acknowledgments

I would like to express my gratitude to all of the people who have helped in the creation of this document. This practicum would not have been possible without the support of others.

Special thanks to my wife Judy, who has proven insightful, helpful, and tolerant. Her support and encouragement has been the most important to allow me to complete this project.

My practicum committee, Cynthia Cohlmeyer, Ted McLachlan, Sheldon McLeod, and Richard Stevenson have all provided invaluable guidance.

From the Winnipeg Airports Authority, Bob Foster, former Director of Engineering and Environment, and Ray Rokosh, former Manager of Environmental Operations, were helpul in providing initial information and a private tour of the secure zone. Leanne Shewchuk, Environmental Coordinator for the airport, has been extremely helpful in providing additional information and answering questions.

Thanks to:

Drew Craig, Assistant Wing Environmental Officer, Canada National Defence for answering questions and loaning useful reference material.

Dr. Richard Baydack of the University of Manitoba for providing information.

Steve Clarke and Kim Willoughby for helping to review and clarify my work.

Amy Tsang for providing assistance in completing the final document.

Finally, thank you to the many other people who have been kind enough to provide help in my research, and provide support while I have struggled. This volume is not able to fully exhibit the total amount of information accumulated. Many sources have inspired and directed the ideas presented here.

Table of Contents

List of Figures

Chapter 1 - Introduction

Chapter 2 - Analysis

Chapter 3 - Synthesis

Chapter 4 - Conclusions

The Winnipeg International Airport Secure Zone: An Alternate Landscape Plan Study

CHAPTER ONE : INTRODUCTION

The Winnipeg International Airport was the first international airport in Canada. The airport has developed from its beginnings in 1928 as Stevenson Field into the 6th largest international airport in the country. Currently the airport is operated by the Winnipeg Airports Authority Incorporated, a not-for-profit organization. The airport provides full passenger and cargo service for Winnipeg and Manitoba. The Winnipeg International Airport serves an average of nearly three million travellers per year. The airport also promotes itself as a full cargo service facility (Winnipeg Airports Authority Inc., 1999), and has the capacity to receive the largest operating airplanes in service today.

While the airport was once outside of Winnipeg, the city has expanded right to its doorstep. The airport has been careful, but operations have negatively affected the local environment and neighbours. A number of concerns have been raised about pollutants being released into surrounding areas.

Addressing these issues also raises the opportunity to make the airport a more meaningful place to experience. The airport landscape can be designed to reflect the fact that it is seen from a variety of ground and aerial viewpoints.

Air travel provides an unique way to view the land. As planes move from ground level to a great height, the land is seen from a series of close and far viewpoints. Currently the landscape does not recognize this movement or the fact that it is viewed from a different perspective than most landscapes. The airport is a gateway to the city, and should be designed to reflect this important role. It is the first and last place people experience when visiting Winnipeg. Symbols and patterns of the region, applied to be seen from the air, would recognize the way the airport is viewed. This would create a direct connection to the observer, recognizing his or her importance to the site.

1 - **Airport operations. (FPG International, 1998)**

2 - **Natural, agricultural, and urban patterns as seen from the air. (Jellicoe and Jellicoe, 1995)**

This study examines an alternate landscape for the grounds of the secure zone at the Winnipeg International Airport. The objective is to achieve two main goals:

- Reduce the negative impacts of operations at the airport on the local environment and community.

- Design the landscape in a way that provides interest and meaning to those viewing the airport.

The primary challenge is maintaining full operational ability. The airport is a vital facility for the City of Winnipeg. Any proposals must not interfere with providing passenger and cargo services. The intention is to realize benefits that will improve the overall function of the airport and establish a strong sense of place. while at the same time balance the needs of people using and operating the airport.

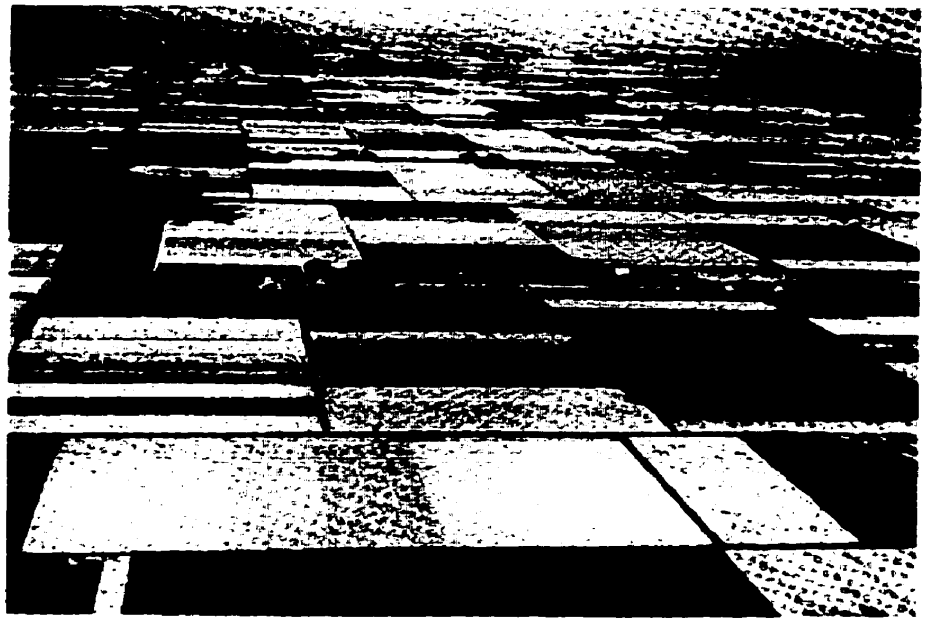
What are the negative impacts?

A facility such as the airport can negatively affect the environment and the local community. Operations at the airport have affected the quality of life for residents living nearby, and damaged the local ecosystem.

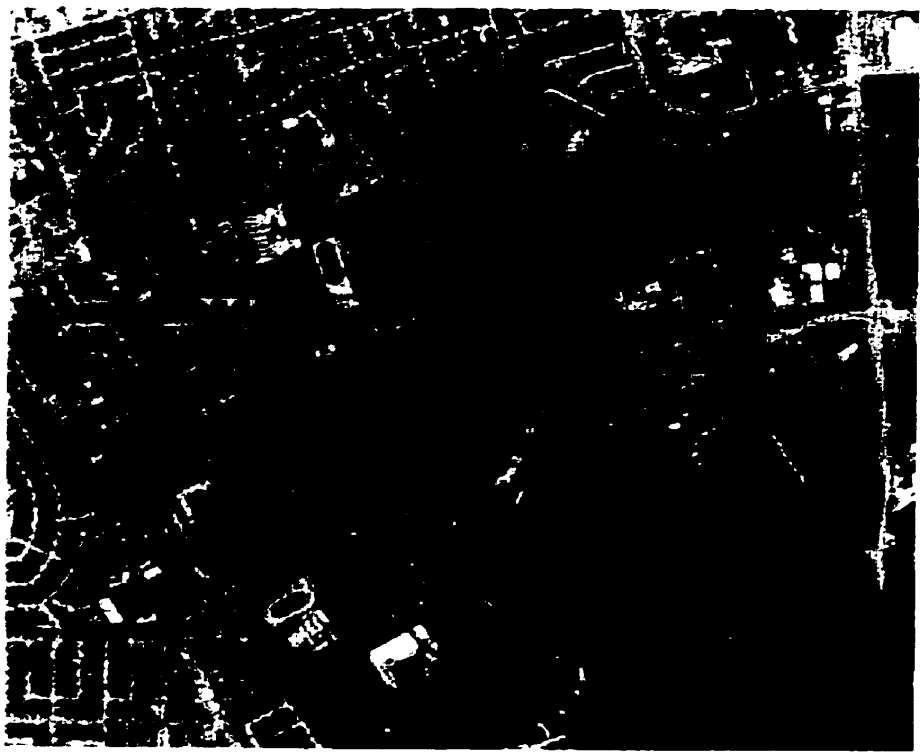
The public has voiced concerns over the effects of airport operations. Local residents are unhappy about pollution they have detected, and worry about chemicals they cannot detect. (Martens, 1998) Most international airports in North America have been making significant environmental improvements to operations due to strong public and government pressures. The Winnipeg Airports Authority has recognized their responsibility to insure the comfort and safety of the public, and have been working to improve environmental policies. (Winnipeg Airports Authority Inc., 1999)

Pollutants have occasionally been released accidentally through leaks or spills, but most contaminants are released as a result of normal airport operations. Some pollutants are unavoidable emissions from the operation of machinery. Oils, fuels, grease, and heavy metals are all released onto paved or vegetated surfaces. De-icing fluids are heavily used in Winnipeg as early as October and as late as May. Contaminants have been found entering in both Truro and Omand's Creeks. The types and levels of pollutants from the airport can be toxic to wildlife and vegetation and damage habitat.

The waterways in Winnipeg have important natural and social value worth protecting. People have a vital obligation toward the pres-



3 - Agricultural fields on the Prairies, part of the local vernacular. (Jellicoe and Jellicoe, 1995)



4 - Geometric and organic patterns of buildings and streets in an urban area. (Forman and Godron, 1986)

ervation of important natural features. While protecting Nature ultimately serves the interests of humans, nature has an intrinsic value not based on its use to people.

The airport has the capacity and the resources to use the landscape for environmental impact management. Operations should be modified to minimize the release and maximize the treatment of contaminants. Public concerns point to the most critical issues to deal with. Solutions to prevent pollution can be more effective and less costly than treating problems after the fact. Addressing pollution issues can also repair relations with the community.

Providing meaning to the landscape

The unintentional patterns of the landscape can be striking and attractive. Both natural and human landscapes can create visual patterns unique to a place. Some of these patterns are visible only from an aerial viewpoint. (Figure 2)

The landscape can be modified to create a meaningful place to observers. To provide meaning the landscape should relate to other aspects of life. Functional, natural, and social patterns can communicate the unique identity of the airport and the region. Symbols and patterns can tell a story about the features of the land and how it is used.

Functional patterns include the patterns of the airport operations. The features required for the primary function of the airport (service planes) form the structure of the secure zone. These patterns are created by the runways, taxiways, aprons, and buildings used by planes.

Vegetation and geography of the airport and the region display natural patterns. Existing features such as creeks and Prairie species tell a story about the natural history of the place.

Social patterns display the way people have modified the landscape to meet their needs. Agricultural fields and city blocks are both examples of patterns that tell how people have used the land. Simple agricultural fields create an enormous quilt of grasses and crops in a patchwork pattern. (Figure 3) City streets form geometric grids between buildings. (Figure 4) All of these patterns can relate current and historical conditions.

Aerial photography that displays landscape patterns has become very familiar. The aerial view of farm fields is an image that everyone from the Prairies recognizes. Images of the land are a part of our cultural persona. They talk about who we are and where we come from. All landscapes display cultural references and meaning. Adding meaning enriches the human experience of a place. Meaning creates a connection, or an association, between people and place.

5 - **Large airplane at the Winnipeg airport. August, 1997.**

Improvements to the secure zone landscape can reduce negative impacts of airport operations on the environment and local residents, and establish a strong sense of place. The airport can gain a unique identity through the landscape. The realization of the two main goals could allow the airport to function better environmentally, and as a service facility.

METHOD OF STUDY

The document is organized into two main sections: Analysis and Synthesis. Analysis describes aspects of the existing site. Synthesis details the proposed landscape plan. The approach to this study is as follows:

Analysis

The analysis is intended to form an understanding of the airport and how it functions. This analysis describes the history, site analysis, and functional requirements of the facility.

Site analysis describes the location of the site, context around the site, and the elements within the site. This provides a site inventory of existing features. Airport operations analysis outlines how the site is used and maintained. Airplanes have certain requirements for take-off and landing. Transport Canada has created numerous guidelines to insure maximum safety. Restrictions for the airport are outlined in terms of how they affect the landscape form and maintenance.

Research has identified issues from media and community sources. Analysis of the site reveals additional concerns. Each issue is studied to reveal a possible cause and who or what is being affected. These issues provide the opportunities for design.

A site view analysis of the airport displays the viewing opportunities. This includes both the ground based views and the views from airplanes. An analysis of the average passenger plane shows what range of view is available from within.

Synthesis

Synthesis tests ideas against the analysis. Recommendations will be described in terms of definition, benefits, implementation, possible

conflicts, and conflict remedies. Each of the identified issues can be addressed with specific recommendations. All potential causes for each issue are targeted. These recommendations are explained on a detailed and large-scale level.

Recommendations for the site are compared to the site view analysis. Site solutions are modified to enhance their visual appearance. Patterns are created to relate to the main site vantage points. Modifications to the plan achieve the desired design objectives.

CHAPTER TWO : ANALYSIS

The Winnipeg International Airport has a long history. Analysis of the secure zone details the existing site elements that have developed throughout the years. The functions, features, and issues of the airport will be explained before the new landscape plan is described.

Development of the Winnipeg International Airport

The original airfield in the location that is now the Winnipeg International Airport was Stevenson Field. Stevenson Field opened in May, 1928, and is named after Captain F.J. Stevenson, D.F.C., a noted Manitoba aviator. The air field was opened by the Aviation League of Winnipeg, which had formed the previous year. The Aviation League of Winnipeg sponsored the Winnipeg Flying Club, who leased the original sixty-four acres that made up Stevenson Field.

Stevenson Field consisted of three hard surfaced runways, each one 150 feet wide. The East-West runway was 3,650 feet long, the North-South runway was 3,400 feet long, and the Southeast-Northwest runway was 4,400 feet long.

In 1936 the City of Winnipeg joined with the Municipality of St. James to create the *St. James - Winnipeg Airport Commission*. The Airport Commission had the powers to deal with all matters pertaining to airports. In 1938 the operation and maintenance of Stevenson Field was turned over from the Winnipeg Flying Club to the Dominion Government.

In 1945 a document was published by the Airport Facilities Committee entitled Airport Facilities for Greater Winnipeg. This report summarized the history of the airfield until that point. The report called for airport expansion before the city growth made further development impossible. The city had grown to within three miles of the airport by that time. The report discussed the need for longer air strips and terminal facilities and buildings so that Winnipeg could provide passenger air service and cargo transport.

Between the years of 1958 and 1963 the titles of all airport properties were transferred to Transport Canada. Soon after 1963 the airport bound-

aries were expanded to 1720 hectares of land. (IDG Stanley, 1996) This is the present size of the lands owned and maintained by the Winnipeg International Airport. The current airport terminal building was constructed in 1963.

The airport is now operated by the Winnipeg Airports Authority. On January 1, 1997, Transport Canada transferred the Winnipeg International Airport to the Winnipeg Airports Authority Inc., a not-for-profit corporation.

When the Stevenson Field was first established, it laid relatively far from the residences of St. James. As the City of Winnipeg expanded, and joined with surrounding municipalities, development crept closer and closer to the airfields. The East side of the City has also expanded Northwards. Currently, residential and industrial areas border the Southern edge of the secure zone. The City has slowly expanded to the doorstep of the airport.

The mission statement of the Winnipeg Airports Authority declares that the airport will work in partnership with the community. The moto is "Community Character...Global Reach." (Winnipeg Airports Authority Inc., 1999) The airport's *Long Term Strategic Plan: 1999-2015* states a vision of being "recognized as safe, innovative and progressive". (Winnipeg Airports Authority Inc., 1999, p.1) This document states the importance of dealing with the impacts of various types of pollution.

The Winnipeg Airport Authority sees the airport as a potential North American transportation hub. The *Airport Area Plan: North and West of the Winnipeg International Airport* prepared by IDG Stanley details possible future expansion. Existing runways could be lengthened, or an additional runway added. Industrial park development can be accommodated to the North and West, both within and outside of the current airport secure zone boundaries. Such plans are intended to improve the financial and service strength of the facility.

Landscape Analysis

Covering 1720 acres, the secure zone of the Winnipeg International Airport encompasses the grounds reserved for the operation of aircraft. Because access is limited, the general public can only enter while in a plane or on a bus tour of the airport. Such restrictions ensure the safety and efficiency of air service.

The secure zone is comprised of a number of hard surface areas and vegetated areas. Most development of the site has occurred on the Southern half. The following is an inventory and description of the major features:

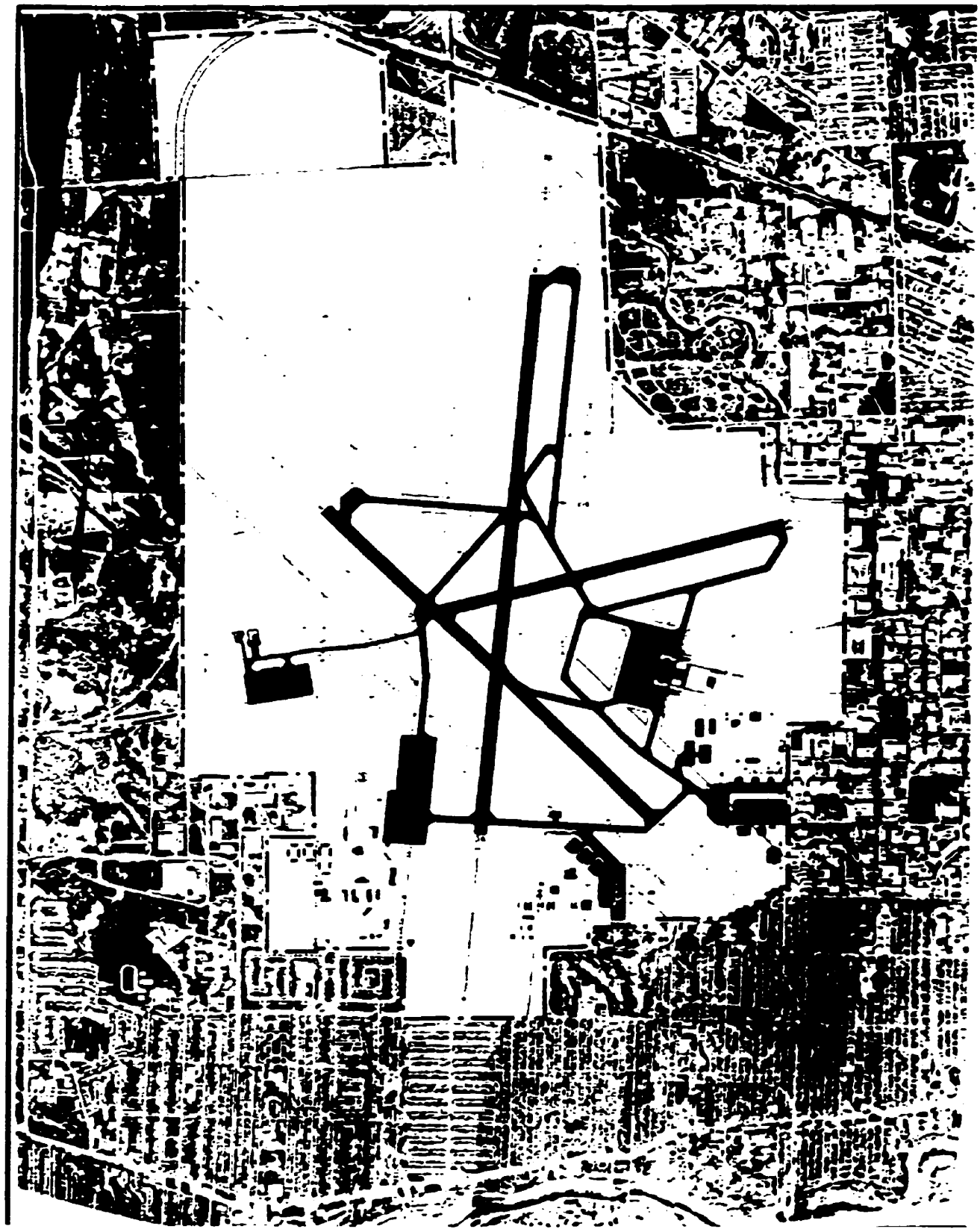
1. Context

The development around the airport is varied. Industrial, residential, agricultural, recreational, and other land uses border the secure zone. (Figure 6)

Along the East side of the airport is mainly industrial development. Many of the industries are directly related to the airport or air service. The highest density of development is closer to the terminal area. Near the North end of the East side is Brookside Cemetery. The cemetery is mainly green space, grass and trees. To the North of Brookside Cemetery is further industrial development. Farther North are residential areas.

Along the North side of the airport are agricultural fields. Farmed areas extend around the North-West and West sides. Patches of forested areas lie within the farm fields West of the airport. Truro Creek runs through the fields and enters the airport grounds at the centre of the West side. Agricultural fields generally extend right to the edge of the creek. In these areas, Truro creek is little more than a shallow swale that is dry much of the summer.

To the South-West of the Airport is industrial development. Beyond the industrial areas are residential homes. The residential areas continue along the South side of the airport. Pockets of industrial development also exist on the South side. The Assiniboine Golf Course is a nine-hole course



6 - Context Map - The Winnipeg International Airport.

South of the airport. The golf course extends to the edge of the secure zone. Truro Creek flows alongside of the golf course after exiting from the airport.

2. Climate

Winnipeg has a continental type climate with large variations in temperature and precipitation extremes.

Prevailing winds at the airport are mainly from the South and North-West. Temperatures can drop below -40 degrees Celsius in Winter months. Summer temperatures can rise above 40 degrees Celsius. Winnipeg receives an average of 535mm of precipitation annually, including rainfall and snowfall.

The highest daily rainfall recorded in Winnipeg was 152mm/24hours on June 26, 1901. July has the highest average monthly rainfall at 81mm total for the month. These rainfall levels are an indication of the typical Summer precipitation that the airport drainage system must be able to cope with.

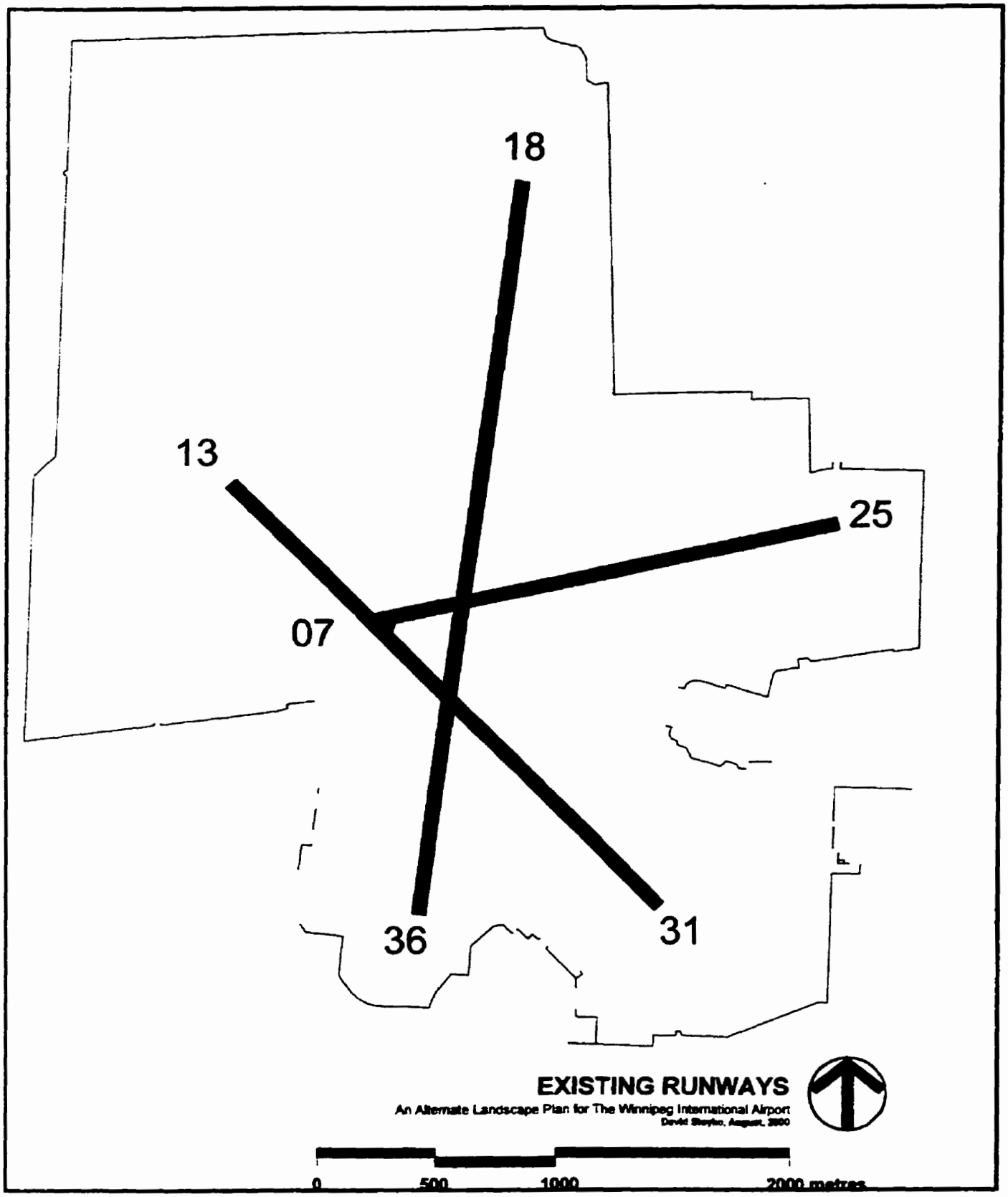
January has the highest average monthly snowfall at 24cm. The average snowfall for the winter is 130cm. This indicates the amount of snow which can be expected to melt off the secure zone each Spring.

3. Runways

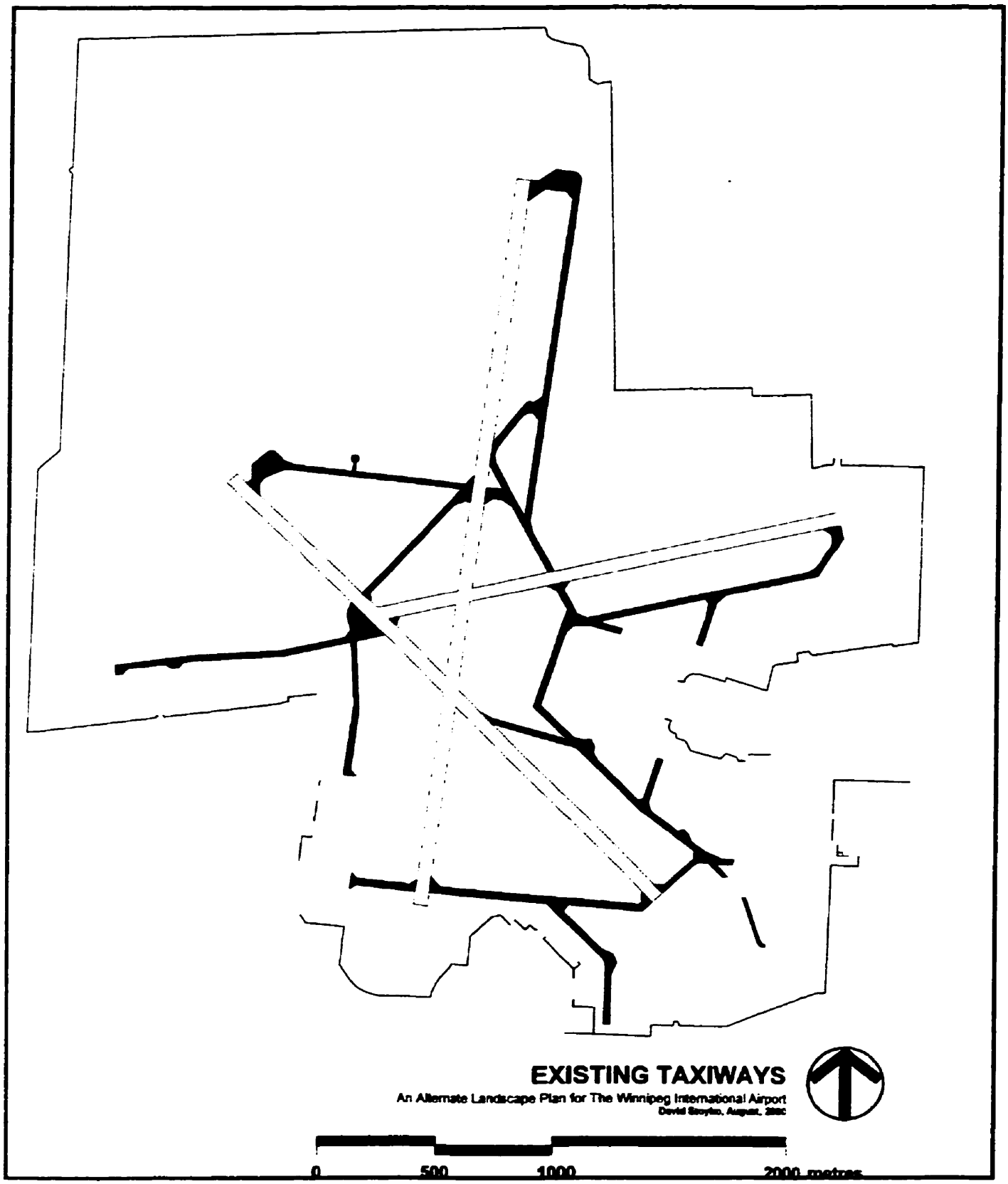
Runways are paved surfaces for planes to take-off and land on. The Winnipeg International Airport has three runways. Each runway points in a different direction so airplanes can take advantage of different wind directions. Runway 18/36 runs North / South and is the longest runway. Runway 13/31 runs North-West / South-East. Runway 07/31 runs East / West. Runway numbering is used to identify the ends of each runway. (figure 7)

All of the runways at the Winnipeg International Airport are 60 metres in width. This width includes the paved shoulders, which are part of the runway surface. Runways are precisely constructed to avoid any irregularities and are crowned in profile to provide good drainage to either side.

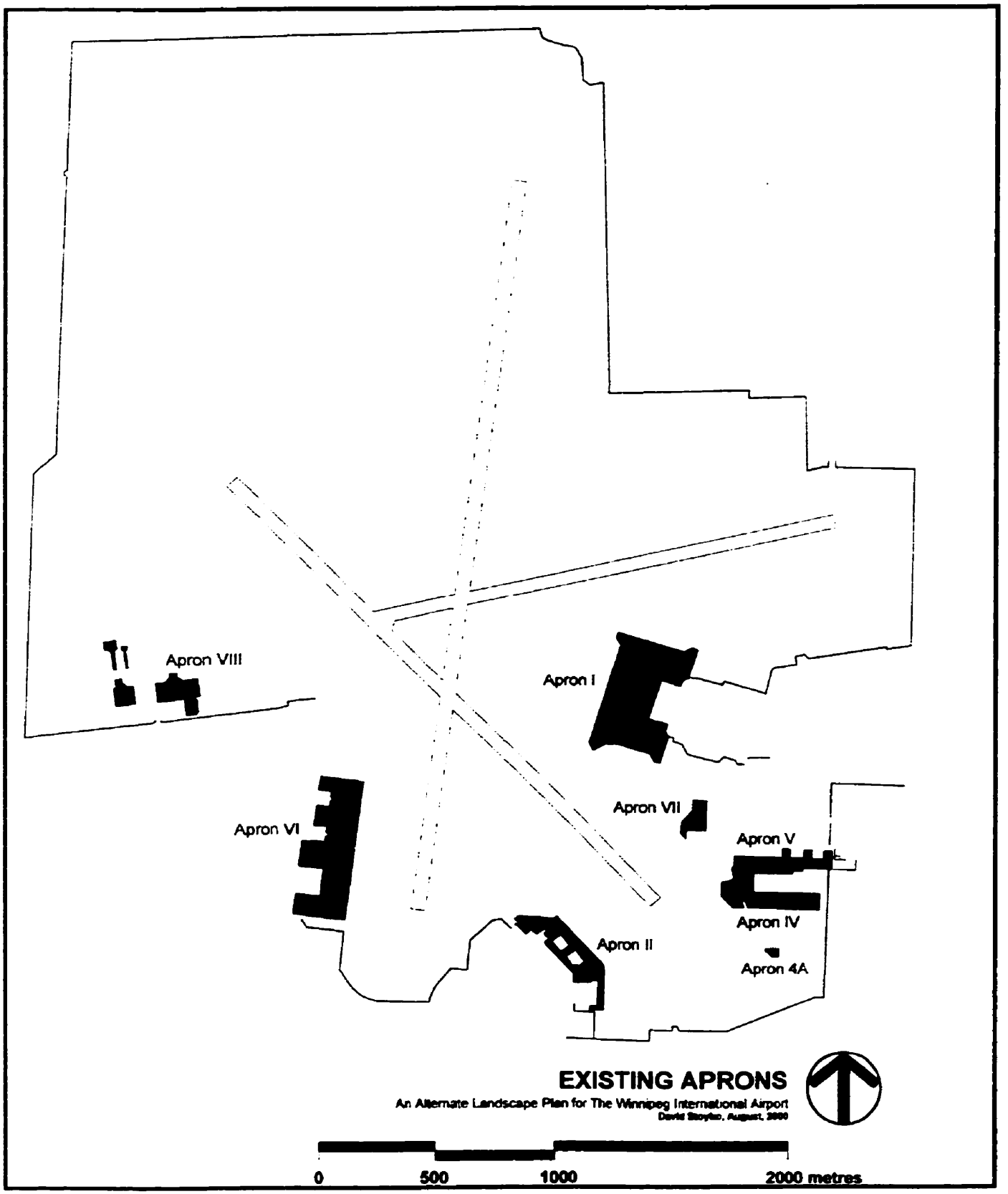
Evenly graded, extending 90 metres from the runway centre line, *graded areas* occupy each side of the runway. These prepared surfaces serve planes that accidentally leave the runway. Drainage ditches are not allowed within the graded area. Any object within the graded area must be frangible, and can not pose a hazard to planes.



7 - Runways at the Winnipeg International Airport.



8 - Taxiways at the Winnipeg International Airport.



9 - Aprons at the Winnipeg International Airport.

4. Lights

Aprons are well lit to allow aircraft to be serviced. The terminal building, hangers, and other buildings are well lit. The rest of the secure zone is not lighted, except for the runway landing lights. (figure 10)

The secure zone has full night-time lighting. Rows of bright lights are set on both sides of each runway. Approach lighting is situated at the end of runways. From the air at night, the lights trace out the pattern of the runways. Runway lights operate day and night, but are most evident at night. Snow is not allowed to cover runway lights in winter.

10 - Runway lights at night. (Winnipeg Airports Authority, 2000)

5. Stopways

A *stopway* is a paved area at the end of the runway. It is available so an aircraft can stop in event of an abandoned take-off. Stopways are the same width as the associated runway.

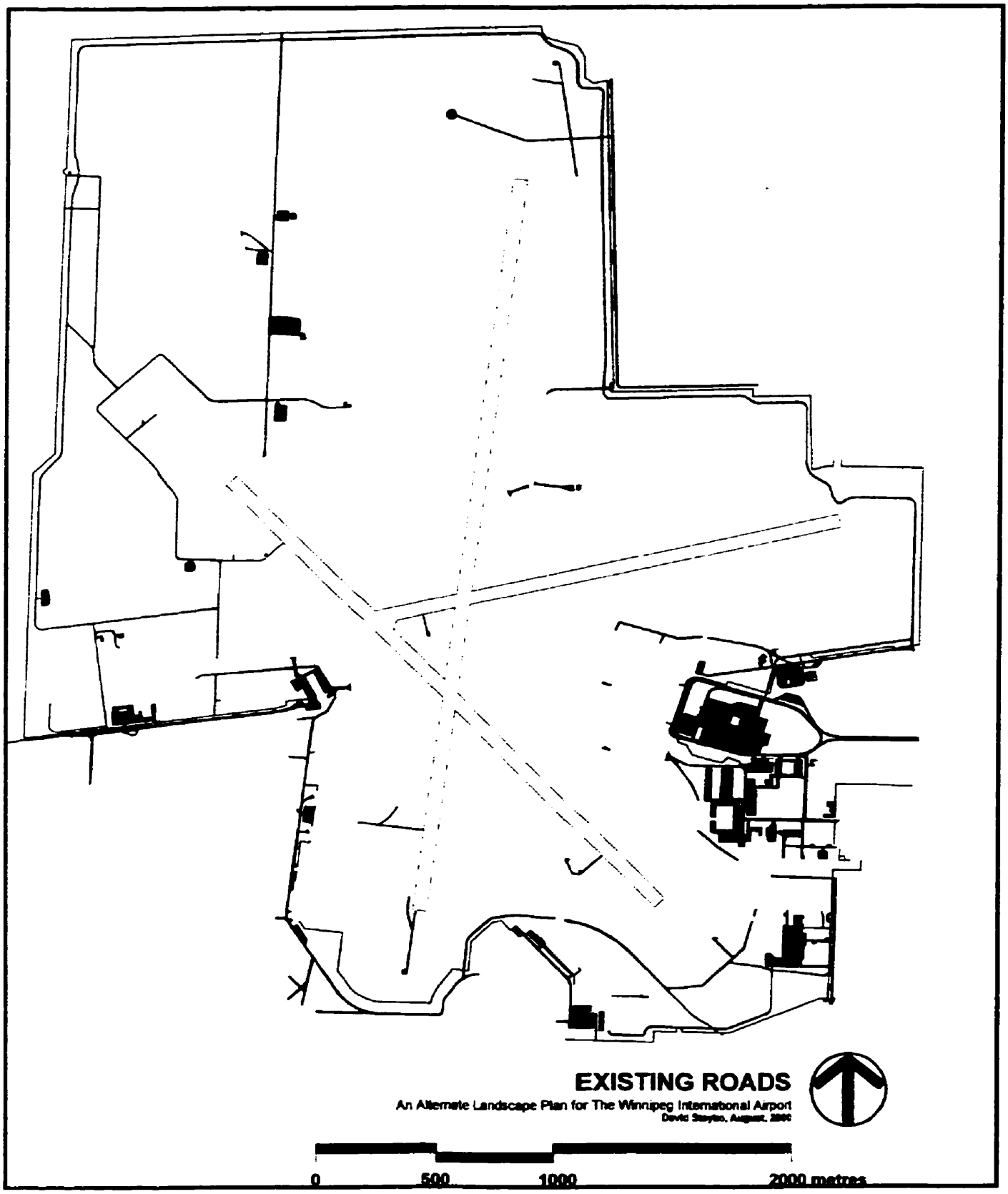
6. Taxiways

Taxiways are paved areas intended for ground movement of aircraft within the aerodrome. Taxiways provide links between the runways, to aprons, and to hanger areas. Taxiways are a minimum of 23 metres in width and are wider at curves and corners. (figure 8)

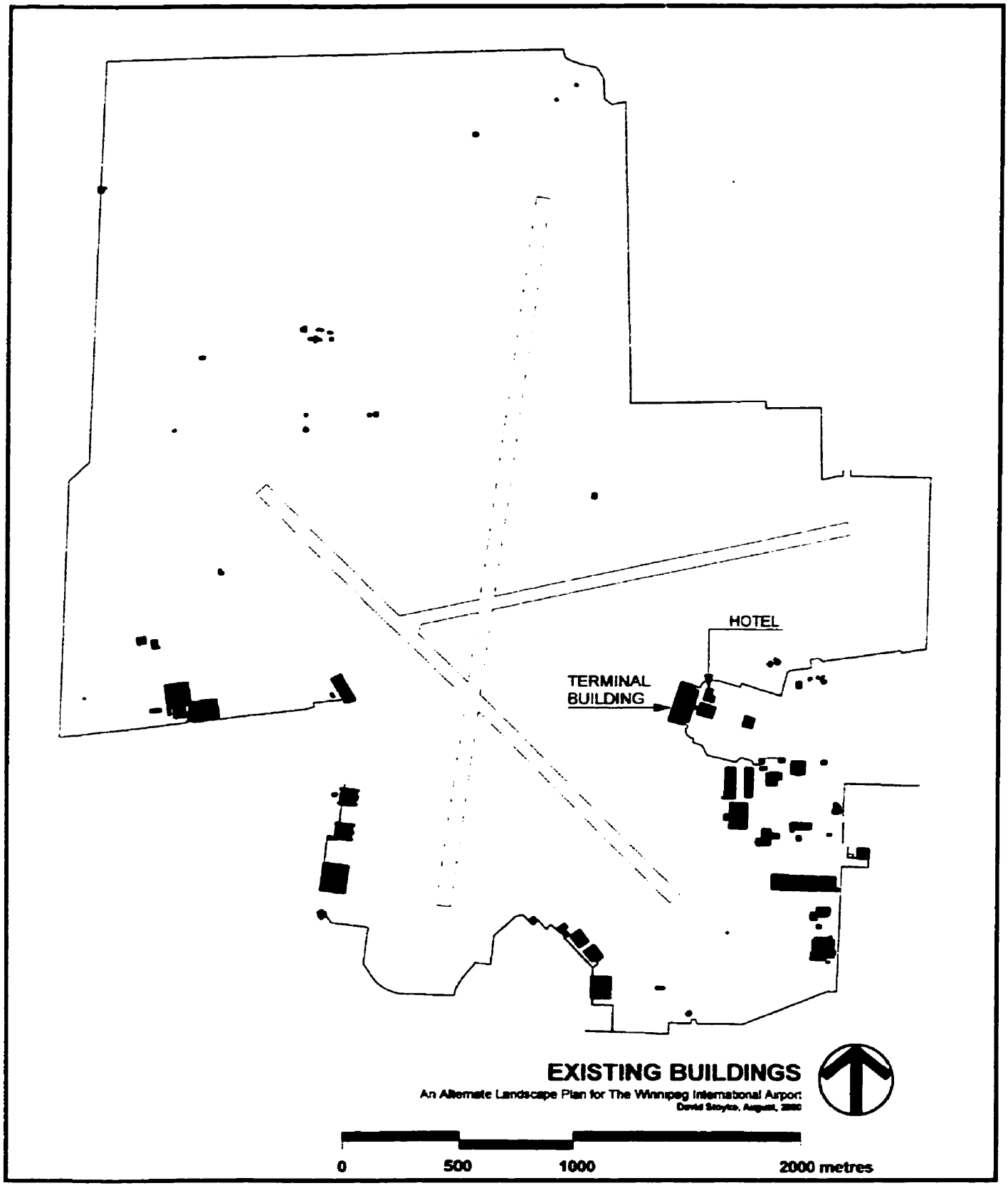
7. Aprons

Aircraft *aprons* are paved areas intended for loading and unloading of passengers and cargo, refueling, servicing, maintenance, and parking of aircraft. The apron also provides a surface for the movement of any aircraft, support vehicles, and pedestrians for these purposes. (figure 9)

Aprons come in various sizes to provide for the maximum anticipated density of aircraft traffic. Generally, they are located around the runways, servicing terminals and hangers. *Aircraft stands* are areas of an apron designated for parking aircraft.



11 - Roads at the Winnipeg International Airport.



12 - Buildings at the Winnipeg International Airport.

Apron I is the main apron around the terminal. It is approximately 140,000 sq.m. Other large aprons are located in the South half of the secure zone.

8. Roads

The secure zone includes many roads. Most roads are gravel, but some are paved with concrete or asphalt. Roads run to all corners of the site. Roads within secure zone are not for public use, they are service roads for airport operations. Most roads within the site average about six metres wide. (figure 11)

13 - The main Air Canada hanger building. August, 1997.

9. Buildings

Hangers and industrial buildings have been built in three main zones at the South side of the secure zone. (figure 12) Located in the South-East corner of the secure zone, Airport Business Park East has developed mainly around the South and East sides of the main terminal building. Airport Business Park South is located in the middle of the South edge of the airport. The Airport Business Park West is located in the South-West corner of the secure zone. The South-West corner is also where many of the large airplane hangers are located. (figure 13)

The main terminal building is located in the South-East quadrant of the airport. This is where the majority of the public experience the airport. All commercial flights are serviced through this terminal building. A new addition to the terminal building is the observation lounge. From this 3rd storey level the public is able to view into the secure zone. The observation lounge looks out onto Apron I and the surrounding landscape.

A new airport hotel has been constructed at the terminal building. This hotel building is taller than surrounding buildings at 7 storeys, and may afford good views of the airport grounds. A number of smaller support service buildings exist throughout the site.

Many buildings are large, with large roof surfaces. Roof surfaces collect water, which is drained into drainage system.

10. Site Drainage

The primary goal for site drainage is to keep areas where planes operate free of standing water. The secure zone has a complex network of drainage channels and sewers. (figures 14, 15, 16) The drainage network consists of a series of sewers that drain into ditches or into the city combined sewer system. Ditches feed run-off water directly into Truro or Omand's Creeks.

a. Sewers

A large sewer system has been built to service airport runways, taxiways, and aprons. (figure 20) Most hard surfaces for planes must be quickly drained. Catch basins are located along the edges of runways or in aprons. Sewers mainly empty into drainage ditches on the site, with a small amount draining into the City of Winnipeg sewer system. Two oil and pollution separators have been installed to filter some water that is drained from aprons into the sewers, but most surface run-off is not filtered.

b. Drainage Channels

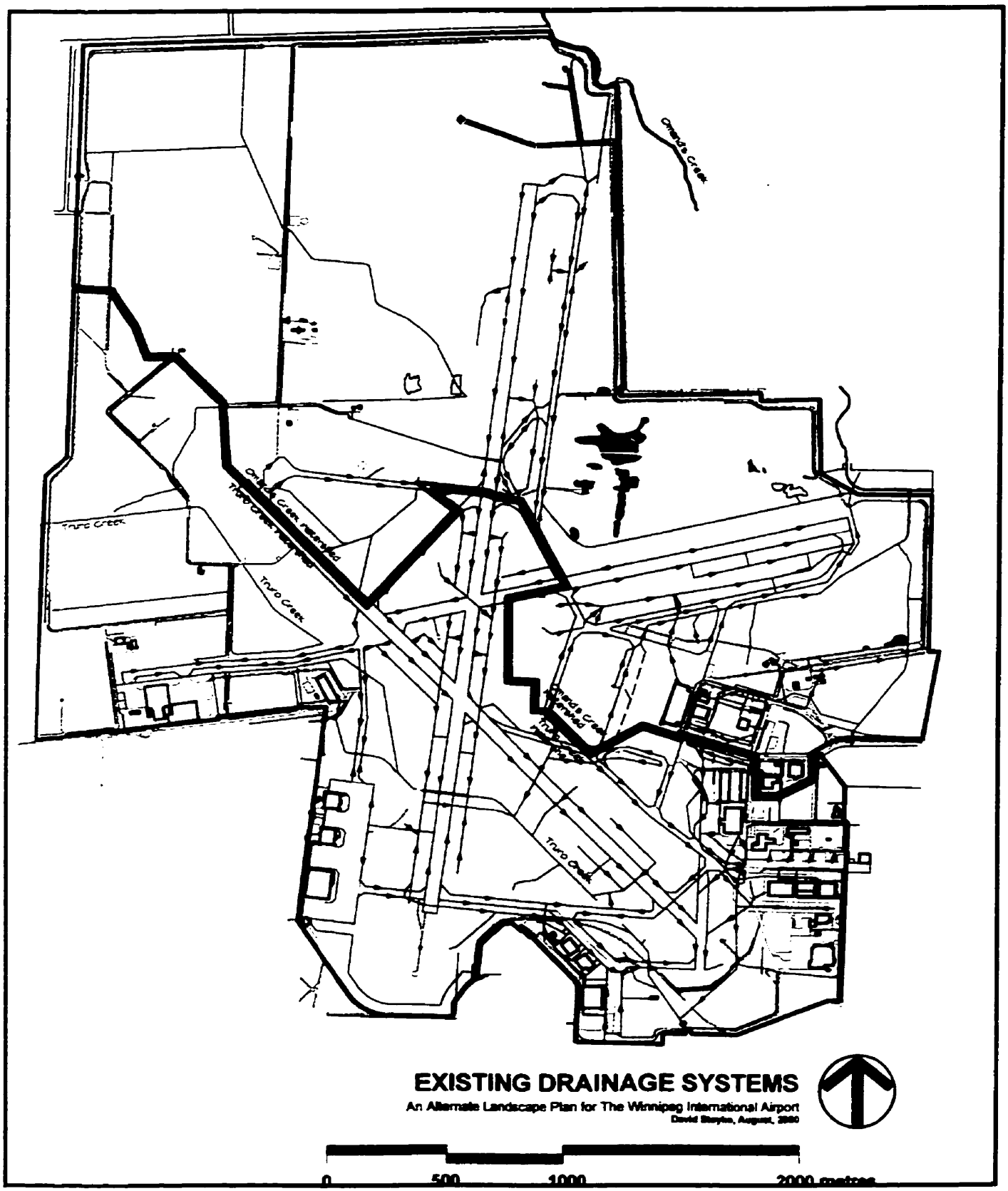
i) Creeks Two main creeks exist at the airport, Truro Creek and Omand's Creek. Both of these creeks existed prior to the airport development. Both creeks flow through agricultural land upstream, enter the city and flow through residential, commercial, and industrial areas downstream. The secure zone is split approximately in half by the drainage basins of these two creeks. (figure 19) Most of the run-off water from the airport drains into these two creeks.

Omand's Creek runs along the North-East side of the secure zone. (figure 15) This corner of the secure zone follows the edge of the creek. (figure 17) Omand's Creek is a large channel and flows into the Assiniboine River.

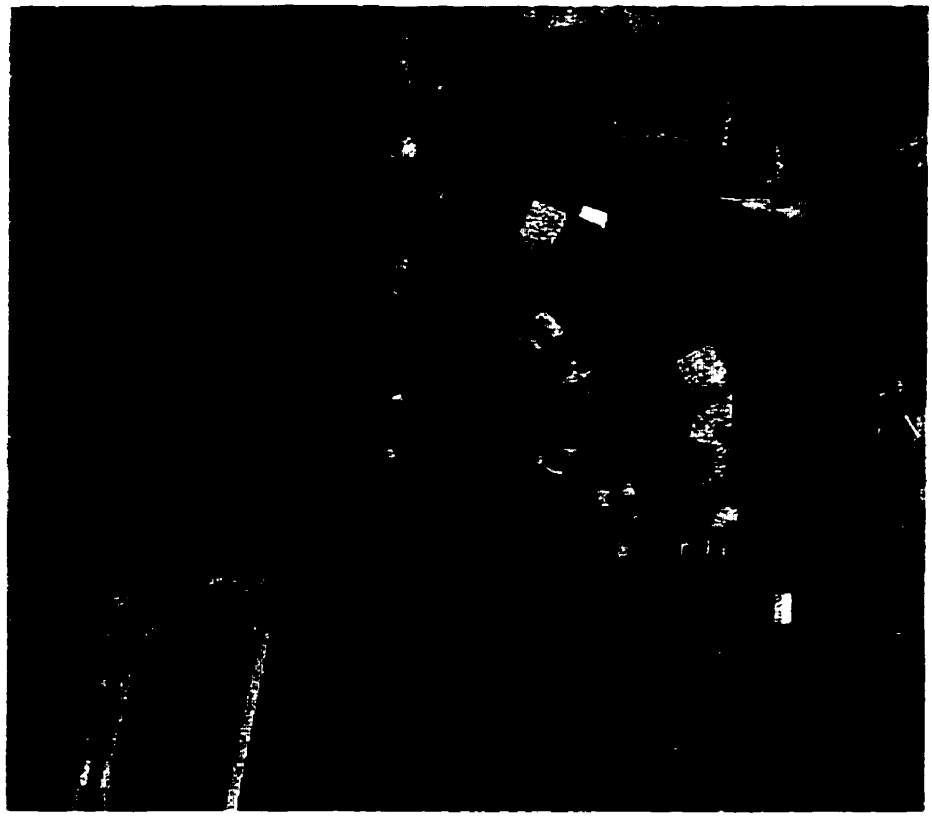
Omand's Creek has water all year at the airport. The Omand's Creek watershed area of the secure zone is only a small part of the creek drainage basin. The Omand's Creek watershed includes agricultural, residential, and industrial areas.

Truro Creek enters the West side of the secure zone and exits out the South side. (figure 16) Truro Creek has been graded into a wide, shallow ditch where it enters the airport. (figure 18) Upstream from the airport the creek runs through agricultural lands. Downstream from the airport the creek flows through residential areas and into the Assiniboine River.

Truro Creek is a seasonal creek and does not have water flow year round within or upstream of the airport. Historical Water Survey of Canada data has recorded flow rates since 1978. At the Western airport boundary



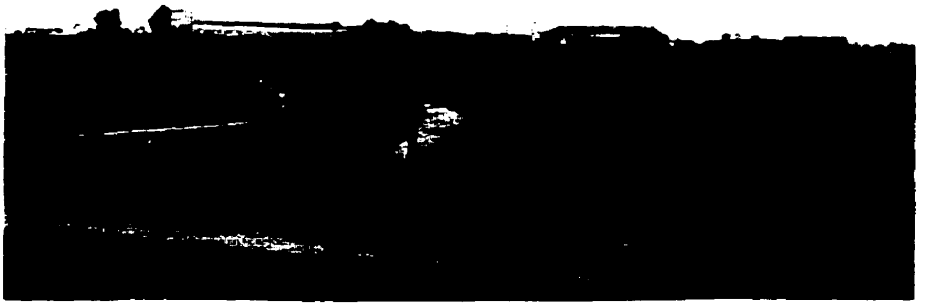
14 - Drainage systems at the Winnipeg International Airport.



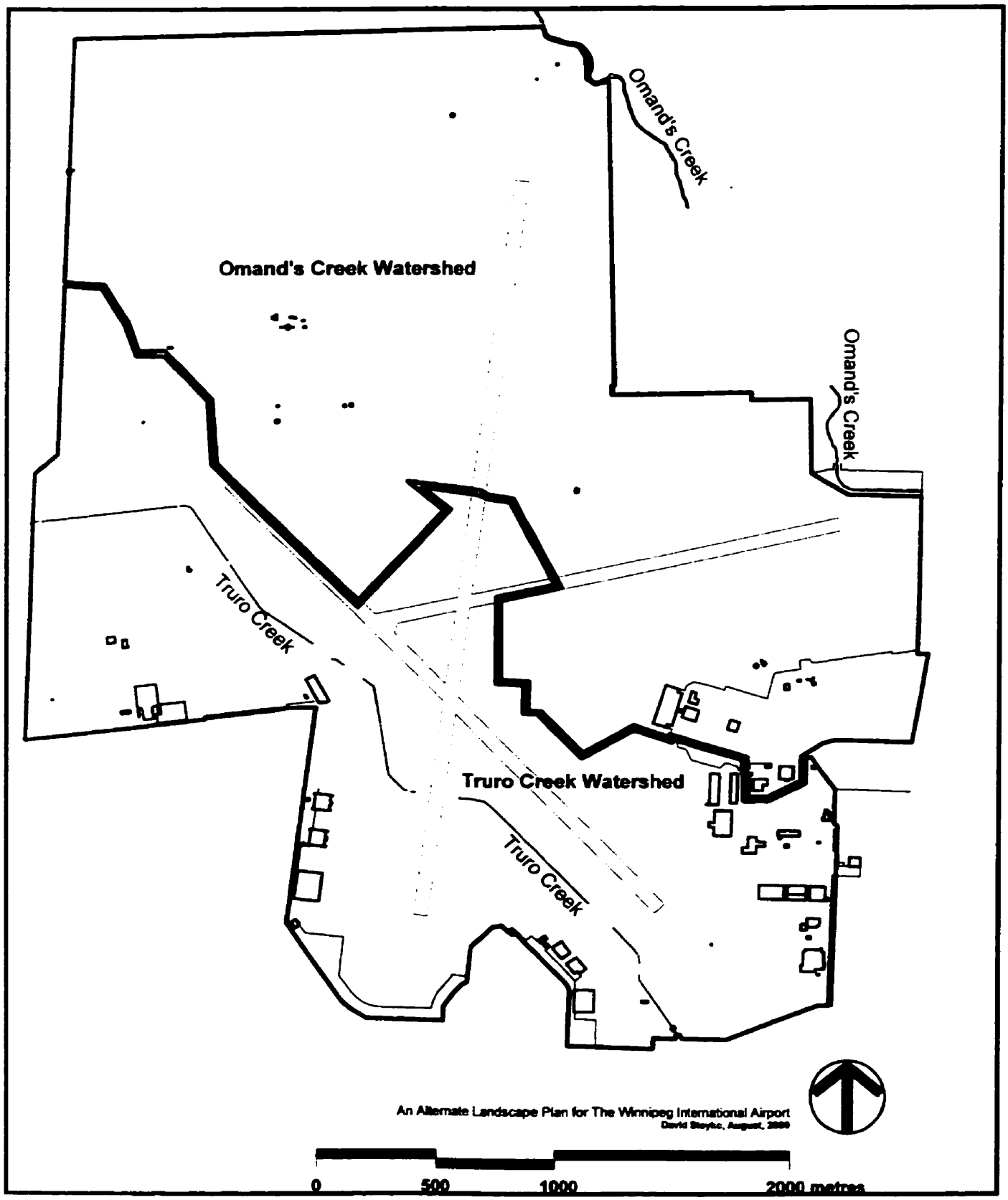
15 - Omand's Creek North-East of the airport. Survey Canada air photo.

16 - Truro Creek entering the secure zone at the West side. Survey Canada air photo.

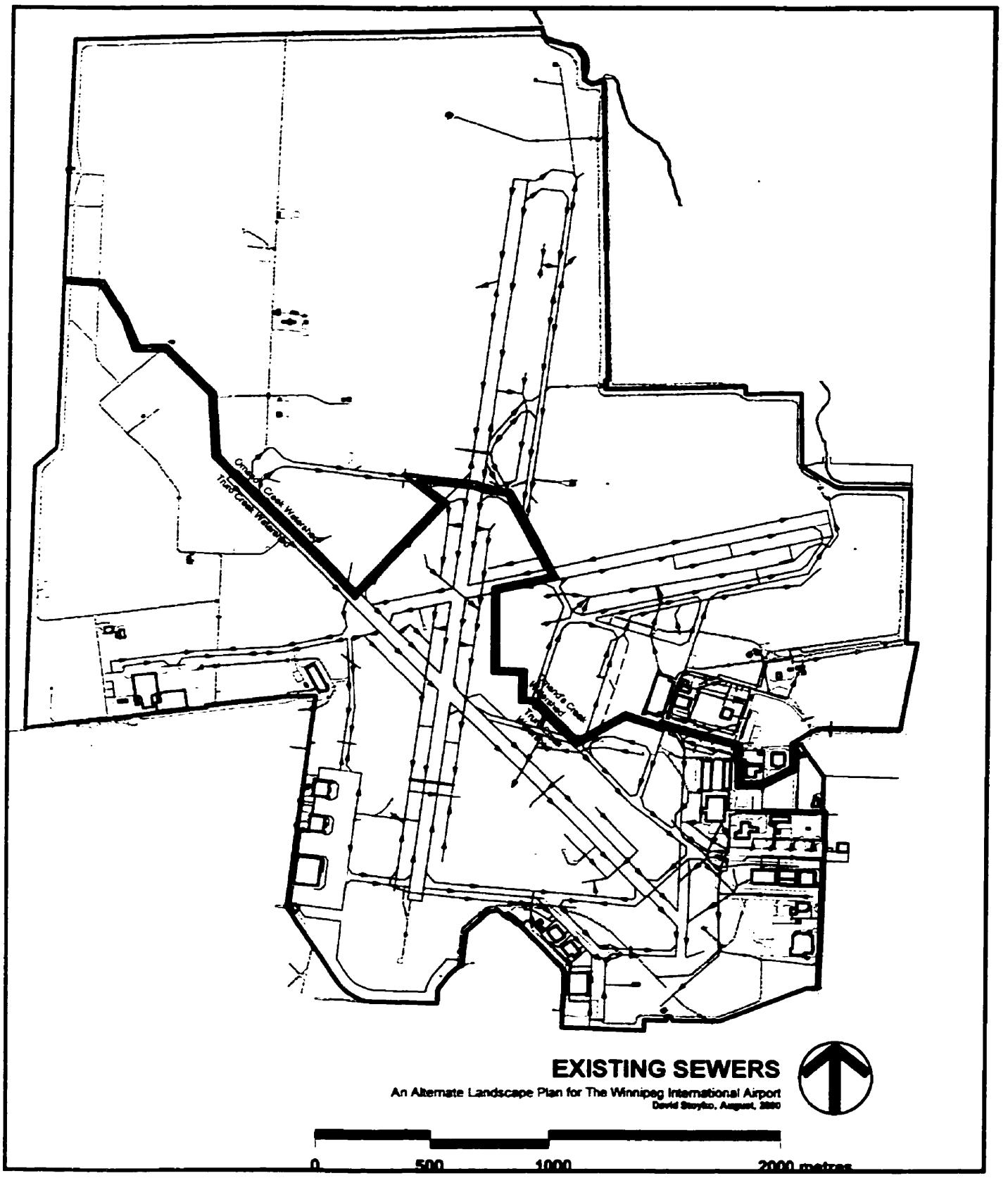
17 - Omand's Creek at the North-East corner of the airport. Photo taken from within the secure zone. August, 1997.



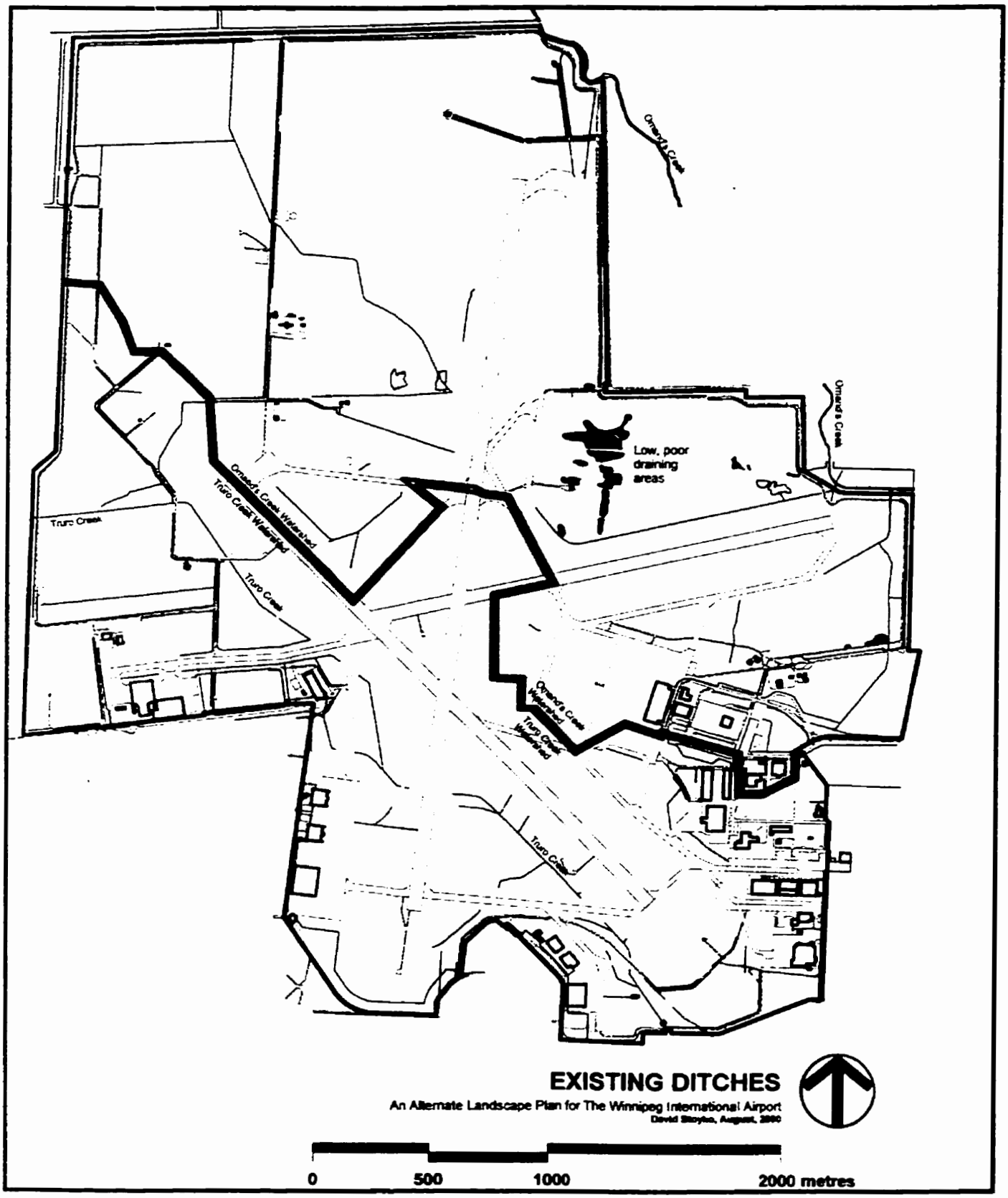
18 - Truro Creek at the inflow on the West side of the airport facing towards the East from within the secure zone. August, 1997.



19 - The Omand's Creek and Truro Creek watersheds within the secure zone.



20 - Sewer systems at the Winnipeg International Airport.



21 - Ditches and surface drainage at the Winnipeg International Airport.

Truro Creek consistently has flowing water in April and May. Other months have no flowing water except during and after rain storms. At the Southern airport boundary Truro Creek has recorded flowing water from March until November. Observation has revealed ponding water all year at this point.

Truro Creek has been partly channelized all along its length. Sections have been straightened to avoid paved surfaces and buildings. Downstream from the airport, the creek runs between blocks of residential development. The basic route of the creek is probably close to its original path, but sections have been straightened to work better with the geometric urban pattern of the city.

Channelization of a creek is very damaging to a watershed. Channelization of Truro Creek has caused increased erosion and siltation due to increased water flow and velocity. Sections of Truro Creek have been altered or damaged by high peak flows resulting in eroded banks which cannot support vegetation.

ii) Ditches A network of ditches exists to drain the secure zone into the two creeks. (figure 21) Ditches in the secure zone are mainly shallow and contoured with gentle banks. This allows ditches to be easily mown and does not create a hazard for planes that might run off the runways.

iii)Detention Ponds Several detention ponds exist within the secure zone for delaying the outflow of run-off water into Truro and Omand's Creeks. Located around the runways are three detention ponds that drain into Omand's Creek and six ponds which drain into Truro Creek. (figure 17)

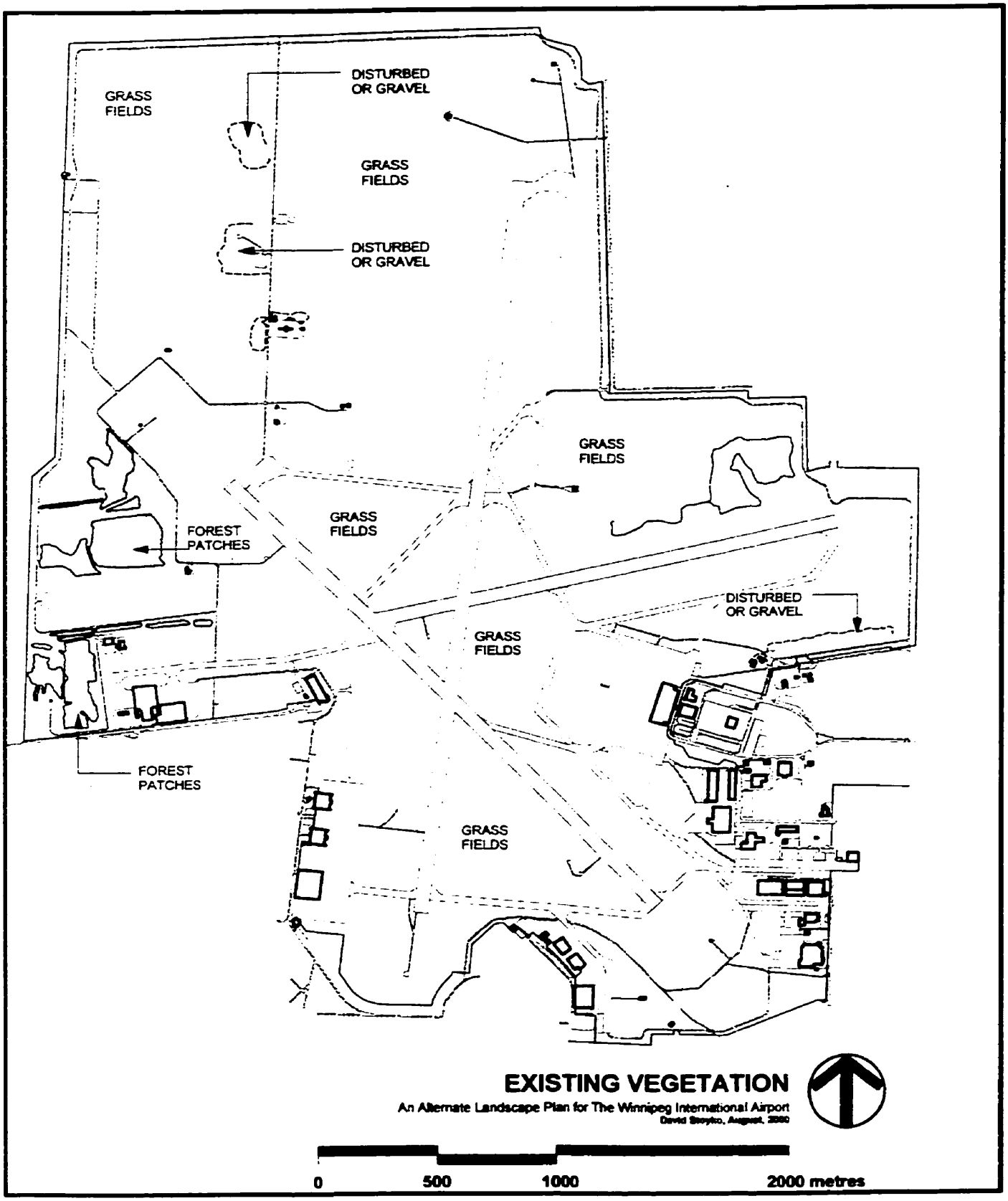
11. Vegetation

Current conditions at the Winnipeg International Airport consist of mainly mown fields, paved surfaces, and a few areas of disturbed ground. (figure 22)

The Winnipeg Airports Authority seeds fields with timothy grass. This grass species has been chosen because it does not offer any food value to wildlife. Some old reports and maps have discussed the existence of native prairie grass patches in the North-West quadrant of the secure zone. (Craig, 1997) These areas have been tilled over some time between 1990 and 1992. Many native plant species remain within the secure zone, but there are no pure native prairie grassland patches existing within the secure zone. (Shewchuck, 2000)

Native prairie species remain due to the existence of seeds in the soil. Tilling the fields has degraded the native grassland, but has also unearthed buried seeds. Restrictions required by the airport have provided some protection from complete destruction. Much of the secure zone cannot be developed, and will remain grassland.

The frequent mowing has caused some degradation of the native species. Some species may have disappeared from the area. Foreign and



22 - Existing vegetation at the Winnipeg International Airport.

weedy species have invaded the secure zone. There has not been a survey to identify the location and abundance of prairie grass species at the airport.

Shrub or tree species have not been allowed to establish within the majority of the site. Some forested areas exist in the South-Western corner where Truro Creek enters the secure zone. Forested areas are composed of mainly native oak trees with various shrub species. There are also some trees planted as windbreaks.

Along the larger creek and ditch sections some wetland species are present. Cattails, reeds, and other species have established where maintenance crews cannot mow. (figure 25) Mowing is generally taken as close to the water edge as possible, and many ditches are mown completely. (figures 23, 24) Standing water and steep banks prevent complete mowing of all ditch vegetation.

Some disturbed areas on the site have little or no vegetation. Constant use of these areas for airport maintenance practices has prevented plants from establishing.

More manicured vegetation exists in the industrial areas and the terminal area. These consist mainly of lawn and some ornamental tree and shrub plantings on the public side of buildings. Some roads in these areas have rows of trees along their edges.

23 - Ditches are completely mown where possible within the secure zone. August, 1997.

24 - Truro Creek at the outflow from the airport. Photo taken facing North from outside of the secure zone fence. July, 1996.

25 - Vegetation along Truro Creek within the airport. Mowing is as close to the water edge as possible. August, 1997.

12. Soils

Soils in the area are generally silty clays. The existing soil type is a result of the prairie grasslands that covered the area before human development. The soil within the secure zone has a fairly high clay content, although there are some occasional areas with only a thin clay layer. (IDG Stanley, 1996)

The soils of the airport are not fast draining. Infiltration estimates are 3.0 inches per hour for dry summer conditions and 0.1 inches per hour for saturated conditions. (M.M. Dillon, 1976) The amount of water which can infiltrate the ground before soil conditions become saturated was not determined in the research for this study. Air photos of the secure zone reveal several places where water is ponding on the ground surface. These ponds are normally dry in the summer but can fill up during heavy run-off.

Airport Operations Analysis

The airport is open 24 hours a day. Flights come and go during the entire period. Flights take-off and land on different runways depending on what type of plane and what the wind directions are.

The secure zone is a high security area. A multitude of federal and international regulations govern airport construction and operation. Restrictions affect development both within and outside of the airport. City zoning prevents certain types of development around the airport.

The Winnipeg International Airport meets certain national and international standards. According to Transport Canada designations the Winnipeg International Airport is a class 4E airport. This means that the runways and surrounding surfaces have the capacity to accommodate the largest passenger and cargo aircraft operating today. The standards are laid out in the Aerodrome Standards and Recommended Practices Manual, published by the Air Navigation System Requirements Branch of Transport Canada.

Basic restrictions insuring safe and efficient operation of the airport are outlined below. Only those constraints that affect the landscape are discussed. These restrictions determine how the landscape has been shaped and how it is maintained. Proposed plans must work within these limitations.

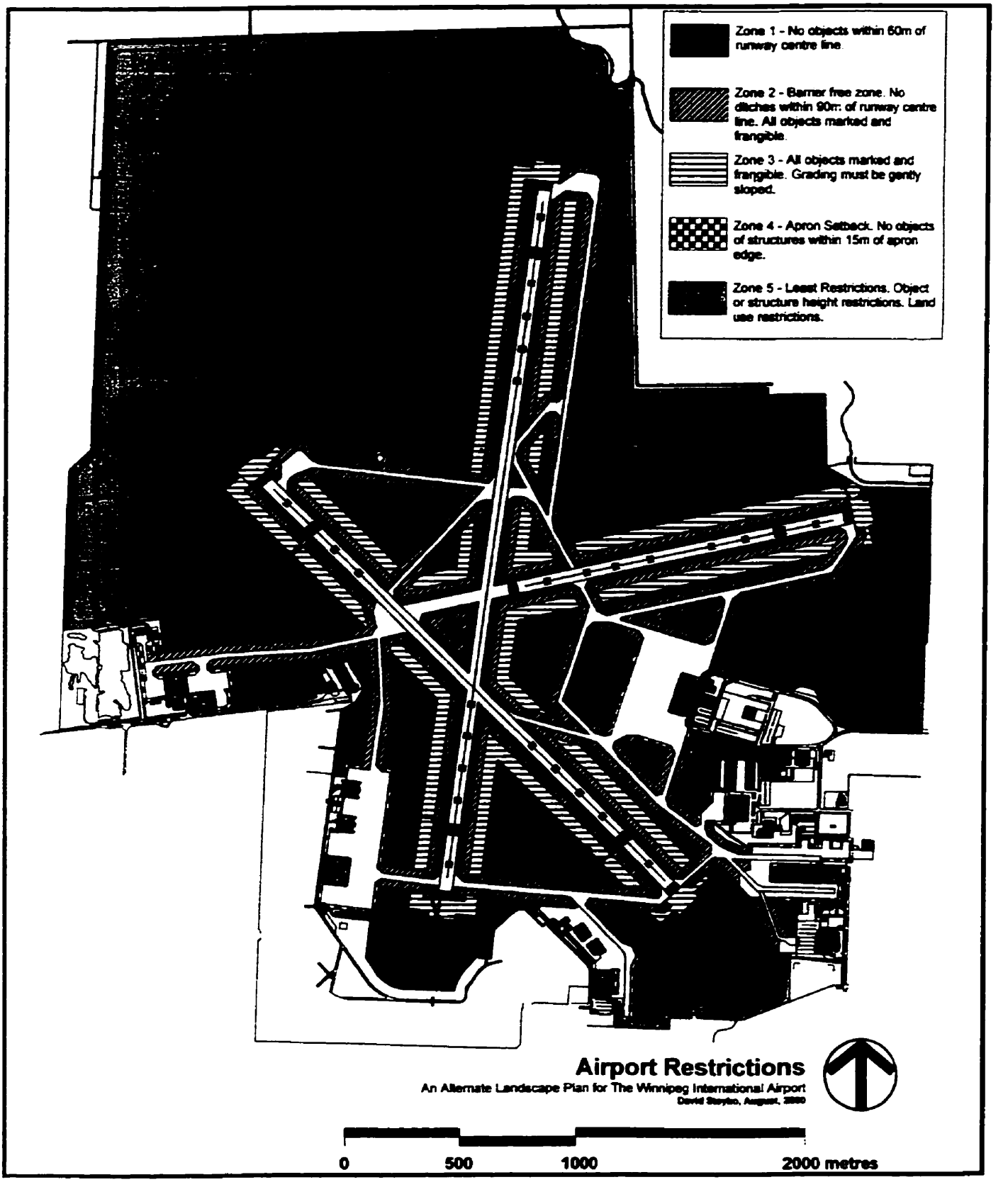
Restrictions revolve around hard surface features that are used for the movement of airplanes. Runways, taxiways, and aprons have setbacks to insure planes can operate safely.

Runways

1. The Runway

a) The minimum clearance distances for runways from storage levels in detention ponds is 500 feet (150m) from the runway centre line.

b) Any objects that are not required for air navigation are not permitted within 60 metres of a runway centre line.



26 - Restriction zone plan for the Winnipeg International Airport.

2. Runway Graded Area

The graded area extends out to 90 metres from the centre line of the runway.

a) Drainage ditches are not allowed within the graded area of the runway strip.

b) All restrictions for the runway strip apply to the runway graded area.

3. Runway Strip

The runway strip is a defined area that includes the runway and stopway. The strip extends beyond the end of the runway at least 60 metres. The width of the runway strip is 300 metres throughout the entire length of the runway strip.

a) Objects within the runway strip must be marked as an obstacle with lights, flags, or paint markings.

b) Objects that are allowed within the runway strip must be marked and meet frangibility requirements so they will not cause serious damage to aircraft that accidentally come in contact with the objects.

c) Ditches located at the edges of the runway strip should be contoured to reduce structural damage to any aircraft that overruns the ditch. Earth displaced from contouring the ditches should not significantly alter surrounding slopes. The recommended side slopes for open ditches are four units of horizontal measure for every one unit of vertical measure. Ditches should be graded and vegetated to control erosion.

4. Runway End Safety Areas

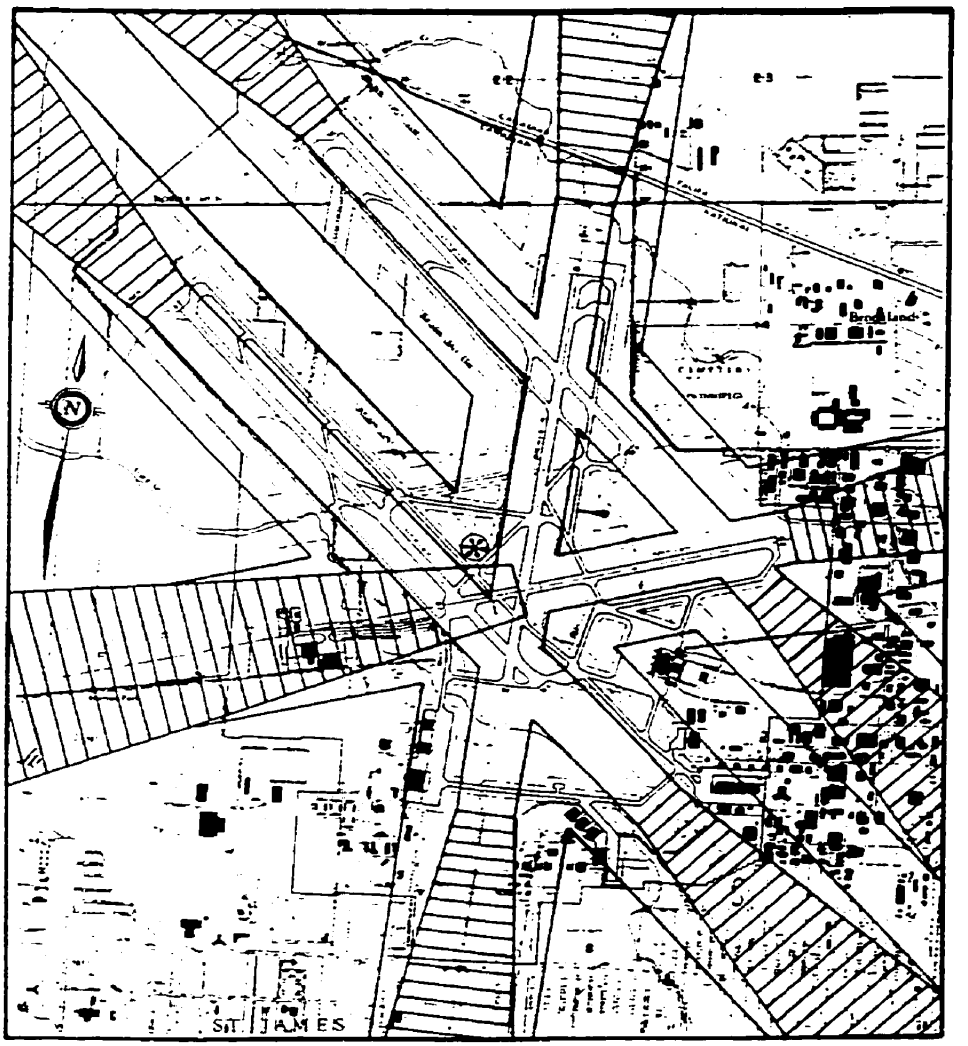
The runway end safety area is a zone provided at each end of the runways. The runway end safety area extends 90 metres from the end of the runway, and is twice the width of the runway. This area is provided to reduce the damage to any aircraft that overshoots or undershoots the runway.

a) Surfaces in the runway end safety area should be strong enough to support emergency vehicles and minimize damage to airplanes which overshoot or overrun runways.

b) All restrictions for the runway strip apply to the runway graded area.

5. Clearways

A clearway is used by aircraft to make a portion of its climb after take-off. The clearway extends beyond the edge of the Winnipeg International Airport secure zone, up to 300 metres from the end of the runway. The width of any clearway is at least 75 metres on each side of the extended runway centre line. a) Zoning restrictions to prevent obstacles from being erected within the clearway. (figure 23)



27 - Zoning restrictions for runway clearways. (IDG Stanley, 1996)

6. Obstacle Limitation Surfaces

Beyond the boundary of the airport are extended areas where the height of obstacles are limited, referred to as the outer surface. This area manifests itself as an imaginary plane above the ground which cannot be broken by physical structures. These surfaces are protected by the Registered Zoning Regulations of the Aeronautics Act. No new structures can be erected which will violate these surfaces. Any obstacles projecting into these surfaces may interfere with normal aircraft operations. (figure 27)

Within the airport secure zone there are specific restrictions revolving around the runways. Beginning at the outer edge of the runway strip are surface planes which extend up to the outer surface. These surfaces are the transitional surface and the take-off / approach surface. No obstacles can break these surfaces and interfere with the operations of the aircraft.

Transitional Surface

The transitional surface is a combination of three linear planes: a trapezoidal surface that rises from the edge of the runway strip and two joining triangular surfaces between the ends of the first surface and the take-off / approach surfaces. The transition surface rises from the edge of the runway strip at a slope of 14.3% (1:7), all the way until it meets the outer surface.

As buildings and objects come closer to the runway strip they must be lower in height to avoid breaking the plane of the transitional surface.

Take-off / Approach Surfaces

On either end of the runway are surfaces that dictate height limitation of objects in the path of airplanes on the runway. These surfaces begin at the corners of the runway strip and extend away from the ends of the runway strip at a slope of 2.0% (1:50). Take-off / approach surfaces continue all the way to the outer surface. As the surface extends away from the strip the edges of the surface diverge from each other to at least 15%. No structures may break this plane, and the type of structures or facilities constructed within the shadow of this plane are restricted.

Taxiways

1. The Taxiway

a) The minimum clearance distance from storage levels in detention ponds is 250 feet (75m) from the taxiway centre line.

2. Taxiway Strips

A *taxiway strip* is a defined restriction zone that includes the taxiway, and is intended to protect the aircraft as it travels along a taxiway. It stretches 47.5 metres from the centre line to the edge. Taxiway strips, as with runway strips, exist to provide a barrier free environment for airplanes to move around in.

a) Objects within the runway strip must be marked and meet frangibility requirements so they will not cause serious damage to aircraft that accidentally come in contact with the objects.

Aprons

1. Aprons

a) Clearances between the apron edge and any building or object should be 15 metres.

b) Aprons do not contain any objects that could damage aircraft.

2. Aircraft Stands

a) Clearances around an aircraft stand are 7 metres for any object or building that would provide a hazard or obstacle.

Restriction Zones

The existing landscape has been modified to meet these restrictions.(see figure 26) Current landscape management is meant to keep the landscape in compliance with transport regulations.

The airport restriction plan details the extent of restrictions on the site. Constraints for different airport components overlap. When setbacks are overlaid onto the site five basic restriction zones are apparent:

1. **Zone 1.** Immediately around the runways are the areas of maximum restriction. No objects are allowed within 60 metres of runway centre line unless required for navigation. (The runway is 60 metres wide, therefore no objects are allowed within 30 metres of the runway edge.)

2. **Zone 2.** The next level of restriction includes any area within 90 metres of the runway centre line. No drainage ditches are allowed within 90 metres of the runway centre line. A barrier free zone exists within 47.5 metres of a taxiway centre line. All objects within these areas must be marked and meet frangibility requirements. This restriction zone ends at the edges of the runway and taxiway graded areas.

3. **Zone 3.** The rest of the runway strip and the runway end safety areas encompass the next restriction zone. All objects must be marked and meet frangibility requirements. All grading within this area must be gently sloped to prevent damage to an aircraft that leaves the runway. These restrictions fall within a 300 metre width for the length of the runway to 60 metres beyond the runway end, and within a 90 metre by 120 metre area at the ends of runways.

4. **Zone 4.** All aprons have setback restrictions. No objects or structures are allowed within 15 metres of aprons.

5. **Zone 5.** The remainder of the site has the least restrictions. Structures cannot break the object limitation surfaces. Land uses cannot be overly attractive to wildlife. Any development that would create an obstacle hazard or a wildlife hazard to aircraft is not allowed.

These are the restrictions that govern the development of the airport. These same restrictions are common for all Canadian airports. Areas outside of the airport grounds only have to conform to the obstacle limitation surface requirements.✈

Current landscape maintenance practices

Landscape management has developed to maintain the Transport Canada regulations. Maintenance consists mainly of vegetation management and wildlife control.

Vegetation management

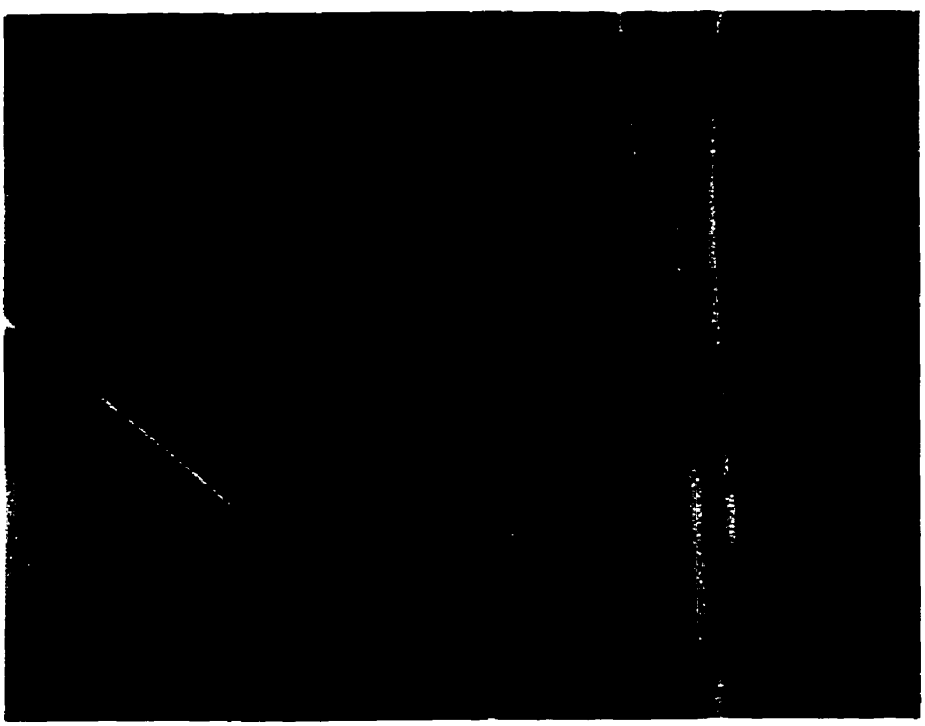
Most vegetation within the secure zone is grass. Mowing is the standard maintenance performed throughout the airport. Certain areas have a higher cutting priority than others. The secure zone covers a large area. Costs prevent the entire secure zone from being mown regularly.

The graded areas of runways and taxiways are frequently mown. Grass around the terminal building, and other buildings near aprons, is kept mown. These areas are given the highest level of maintenance due to their proximity to operating aircraft. Other areas are mown less frequently. Generally, the farther from the runways, the less the grass is mown. The areas in the North and West of the secure zone are mown occasionally. Grass clippings are not collected or taken off-site.

Vegetation within drainage channels is mown where possible. This is intended to insure positive drainage and prevent standing water. Plants within ditches remain only when standing water or steep banks prevents mowing. Wetland vegetation is occasionally cut down.

Some buildings, mainly those with public access, have manicured front areas. These front areas consist mainly of lawns with ornamental shrub and tree plantings. Side and rear areas around some buildings are only occasionally maintained.

Grass areas also contain other plants species. Some of these species are remnant prairie plants while others are weeds. The airport is overseeding grass areas with Timothy grass (*Phleum pratense L.*). This grass is seen to provide the least food or habitat value for wildlife. Timothy grass is an introduced species from Eurasia. It grows up to 3 feet tall, and has fibrous roots that extend to more than four feet deep. The seed head is a



28 - Small bird inhabiting tall grasses. (Taylor, 1999)

dense, spike-like cylinder. (Johnson, Kershaw, Pojar, and MacKinnon, 1995) Timothy seeds are very small. This grass is also drought resistant.

Wildlife control

Wildlife control is necessary to prevent animals from damaging aircraft. Even small animals can cause a large amount of damage in the event of a mid-air collision. Small animals also nest in inappropriate places, or attract larger predators. Collisions with birds are reported every year at the Winnipeg International Airport. Control measures are necessary to minimize wildlife strikes, and maximize safety.

Certain species that have proven to be a greater hazard and nuisance than others. These nuisance species, are usually targeted with control measures. (Vancouver International Airport Assessment Panel, 1991; Environmental Services, 1992) Nuisance species at the Winnipeg International Airport include ducks, geese, gulls, terns, raptors, red-winged blackbirds, rabbits, ground squirrels, and mice. (Environmental Services, 1992)

Birds are the most dangerous animals. (Figure 28) Striking a bird while in flight can seriously damage an aircraft. Some bird species are particularly dangerous due to their size and/or behaviour. A species is considered a nuisance if it consistently presents a threat, is difficult to scare off, or quickly adapts to control tactics.

Currently the Winnipeg International Airport has a four point program for wildlife control. These techniques are specifically tailored to the species which are the most problemic in Winnipeg.

1. Vegetation Control

Vegetation control is aimed at removing plants that provide food or habitat. (figure 24) The focus of control is to cut back plants which will attract wildlife, and encourage the growth of plants that do not provide food or shelter.

Modifying the environment to provide the fewest attractive features is a common and effective form of wildlife control.(Environmental Services, 1992) The Winnipeg International Airport has based its procedures on those outlined in the Transport Canada Wildlife Control Procedures Manual.

Mowing is the basis of vegetation control in the secure zone. Throughout the secure zone, the existing grasses are cut. Bull-rushes and other wetland plants in ditches and low points are cut down. This is intended to discourage birds from nesting in areas with heavy vegetation. Ducks and red-winged blackbirds are the main target for this practice.

2. Auditory Scare Tactics

Bangers and *screamers* (pyrotechnic noise makers) are the auditory deterrents used at the Winnipeg International Airport. Birds gathering near runways or aprons are scared away by the loud, sudden noise.

3. Eliminate Standing Water

Standing water is a major attraction to wildlife. The airport is most concerned about attracting ducks due to their size and behaviour. Winnipeg is within the main migratory flight path of many ducks and geese. Even the presence of three inches of water pooling in the secure zone seems to encourage ducks to nest. (Shewchuk, 2000)

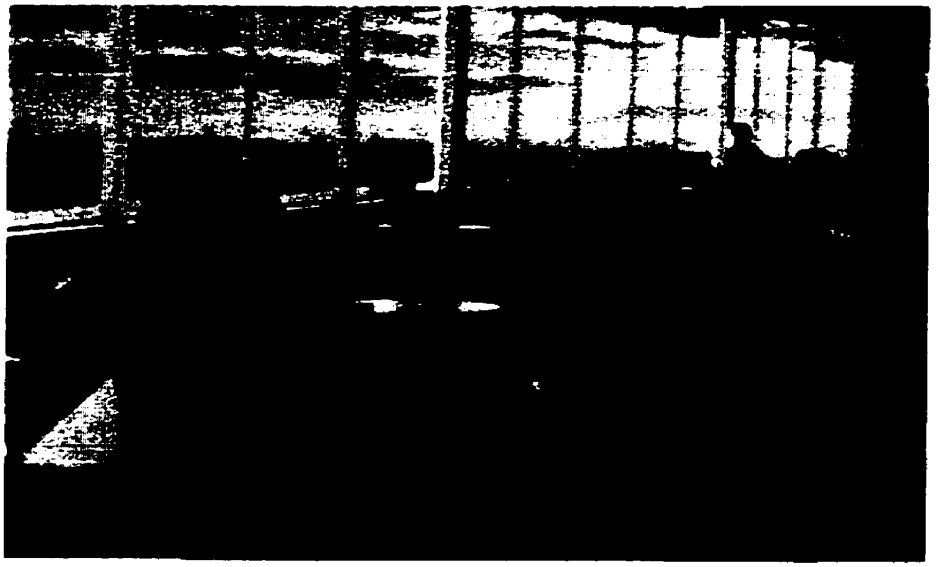
Water bodies in the secure zone have been contoured and maintained to provide maximum flow. Areas which temporarily form pools after rainstorms have been filled and eliminated as much as possible. Areas which collect water are drained quickly.

4. Removal of Problem Wildlife

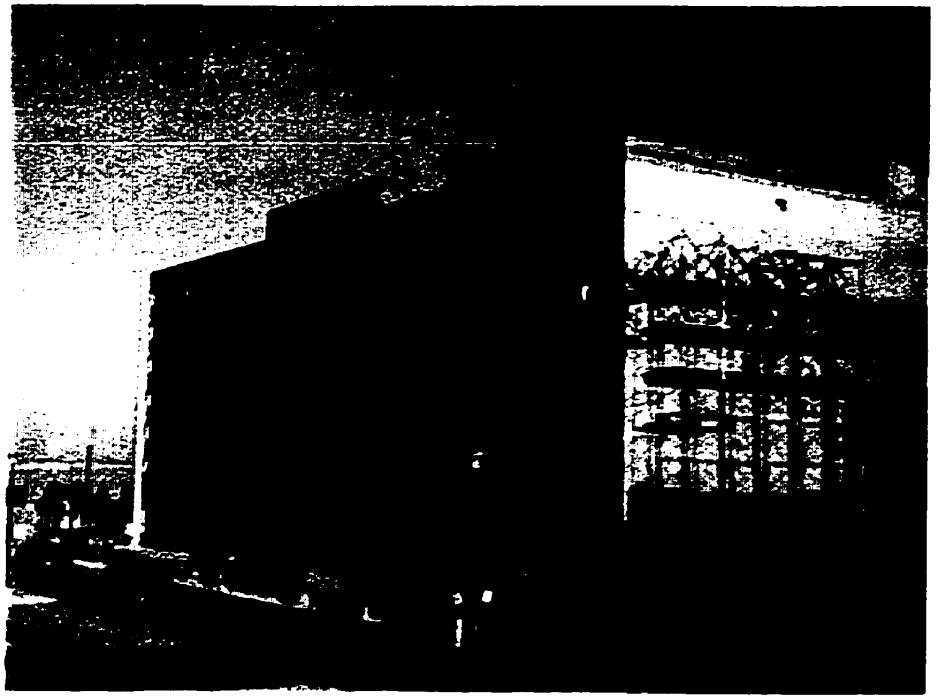
Any animals that insist on nesting at the airport are forcibly removed. Destroying animals is sometimes the only way of insuring aircraft safety. Geese have proven the least afraid of humans and have occasionally been removed.

Rabbits and ground squirrels create a nuisance at the airport. Rodents and other small wildlife can attract *raptors* (predator bird species). Raptors are large enough to cause significant damage to an aircraft.

Modifying the environment to provide the fewest attractive features is a common and effective form of wildlife control. Other measures commonly employed at airports include visual repellents (flags, streamers, scare crows), exclusion methods (netting, wires), and removing wildlife by force (poison, traps, shooting).



29 - The observation lounge at the terminal building . (The Winnipeg Airports Authority, 2000)



30 - The airport hotel at the terminal building. June, 1998

View analysis

Analysis of the airport shows where people can view the secure zone. Views can be gained from a number of ground and aerial locations. (figure 34)

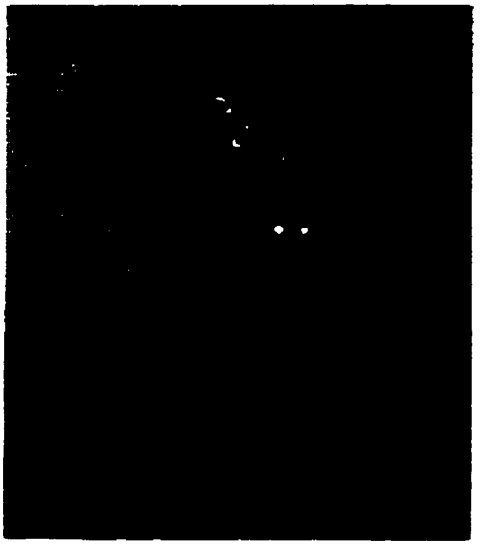
Views, and therefore the experience of the airport, change according to the observers perspective: from the ground or from the air. Ground views will be much different than aerial views. The higher the elevation of the viewer, the more of the secure zone can be seen at once.

Ground based views

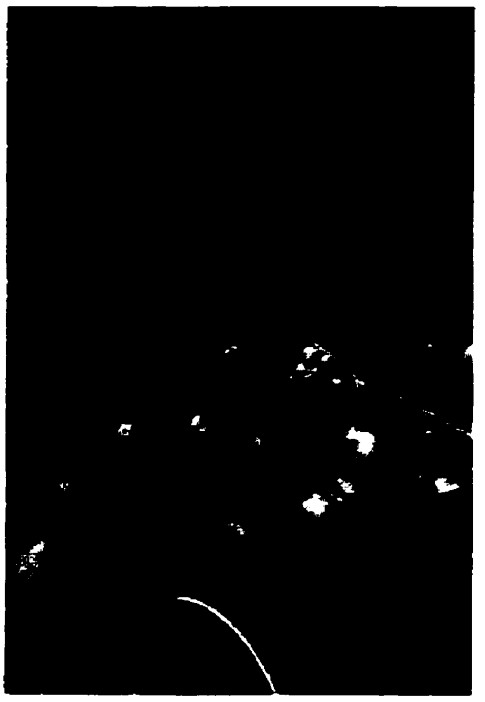
1. The Airport Terminal

- **Location:** The terminal building is located in the East side of the site. The building is on the East side of Apron 1, the main airport apron. (figure 31)
- **Description:** This is the main location from which the public can see the landscape. Travellers and visitors can see into the secure zone. Anyone at the airport can use the third storey observation lounge. (figure 29)
- **Views:** Almost the entire landscape of the secure zone is visible from the terminal. However most of the landscape is too far from the terminal to be clearly seen. Only the area between the terminal and the near edges of the runways is legible. Details within this area will be visible. Outside this area, details blend together.

31 - View out onto Apron I from the terminal building observation lounge. June, 1998.



32 - An airplane taking off. (not at the Winnipeg airport) (FPG International, 1998)



33 - Looking out the window of a plane. (FPG International, 1998)

2. The Airport Hotel

- **Location:** At the terminal area is a hotel facility built in 1999. (figure 30) The building is on the East side of the terminal building.
- **Description:** The hotel is seven storeys high. The top three or four levels of the hotel offer good views of the secure zone.
- **Views:** This is the tallest building close to the airport, and provides the highest elevation other than from in a plane. From the top floors one is able to see to the edges of the secure zone. Landscape patterns near the terminal will be clearly legible. Lower floors do not have many views into the secure zone because the terminal building is in the way. Lower floors will only be able to see into part of the secure zone to the North.

3. Public Entry Views

- **Location:** Along the public road leading to the terminal building, limited views to the North into the secure zone are available.
- **Description:** People can see into the secure zone from their cars while travelling to the terminal building. There is no formal viewing area from the roads and no significant views into the secure zone.
- **Views:** Views into this area are limited. Planes on the edge of Apron I are sometimes visible. Viewing height is too low to see very far into the secure zone. The East end of Runway 25-07 lies to the North of this vantage point, but is not easily seen.

4. South-East corner views

- **Location:** Community gardens occupy a small area of land at the South-East edge. This area is immediately East of where Truro Creek exits the secure zone.
- **Description:** This is a small area, but the public can easily walk up to the secure zone fence. The community gardens are on the edge of a residential area. This is the easiest point for the public to access the edge of the secure zone.
- **Views:** Limited views into the secure zone are available. The last length of Truro Creek before it exits the airport can be seen. Planes using runway 13-31 can be observed from outside the South-East corner of the secure zone. (figure 32)

5. North-East side views

- **Location:** Along the edge of the secure zone's North-East side. Directly East of the North end of runway 18-36.
- **Description:** A Road runs parallel to the secure zone fence along this edge. From this road people can look into the secure zone.
- **Views:** This area provides a close view to the North end of runway 18-36.

6. North side views

- **Location:** Along the edge of the secure zone's North end.
- **Description:** Roads run parallel to the North side of the secure zone and turn around the North-West corner.
- **Views:** Along the road, people can see into the North side of the airport. This provides views into mostly empty field areas at the North end. These viewpoints are not near runways.

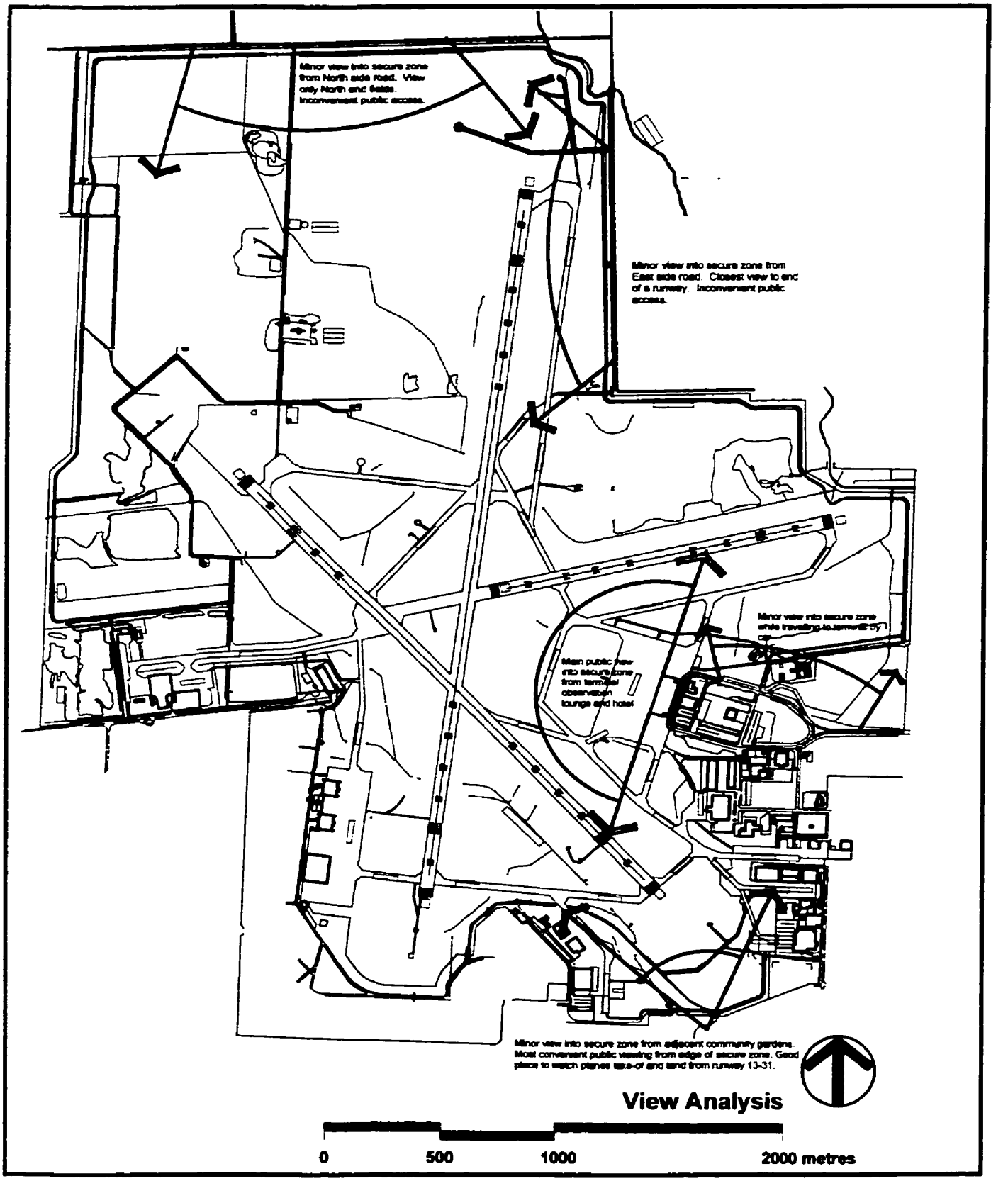
Aerial Views

As anyone who has traveled by air can attest, the landscape has a completely different appearance from above. From the air a person can see the larger patterns of the Earth. The land is seen with a new perspective that reveals the interconnection of systems. Only a small area is visible from the ground, but from the air a person understands the larger environment.

People have opportunities to view the landscape from a plane at several stages of air travel. At the airport the ground will rarely be seen from directly above. Views from a plane are limited (except for pilots) to seeing out the side of the plane. (figure 33) As aircraft take off or land, passengers can look out to the side and see the land. After lift-off, when a plane banks to one side, passengers can see the airport from the best viewpoint. The landscape will be seen from an oblique view. At certain times before landing and after take-off the airport landscape will not be visible.

The airport landscape has an advantage over other landscapes because people will see it from low airborne elevations. Aerial views of other landscapes are usually seen from a very high altitude. At 30,000 feet the landscape is beautiful, but individual sites are too small to offer much detail. The landscape within the secure zone will be seen by people who are flying at low altitudes.

The view of the ground changes as the progression from ground level view to airborne view changes. On the ground, the more detailed aspects of the vegetation are visible, and views across the site are limited. As a plane begins to rise from the air, the landscape transforms as patterns reveal themselves. The higher the view, the greater the ability to see and understand the larger patterns of the land.



34 - View analysis for the secure zone.

Issues at the airport

The airport interacts in many ways with the lives of city residents. People who live around the airport have raised issues with the way the airport operates. Issues arise out of concern for personal and environmental health.

Issues have been gathered from several sources. Media and community sources have identified some effects caused by airport operations.

The sources:

1. Neighbouring residents

To the East, South-East, South, and South-West of the airport are residential areas. Water from the airport secure zone flows through neighbourhoods downstream. People have reported foul smells effluence and visible pollutants in the water, especially in Truro Creek. (Martens, 1998) People in these areas have to live with the impacts of the airport. Due to their proximity to the airport, they are often first to detect pollution.

2. Local organizations

Organizations are often created to protect a local amenity, such as a park or creek. The Friends of Bruce Park and the Friends of Omand's Creek are the two main community organizations that raise environmental issues with the airport.

The Friends of Bruce Park is concerned about the health of Truro Creek along its entire length. Bruce Park is situated at the lowest reaches of the creek where it feeds into the Assiniboine River. Any contaminants entering Truro Creek eventually flow through Bruce Park.

The Friends of Omand's Creek are concerned about pollution entering the creek from any urban or agricultural source. The Friends of Omand's Creek beleive that the airport is allowing a number of pollutants into the water. De-icing chemicals are the main complaint.

These organizations would be very interested in measures that would treat run-off water, and control chemical spills.

The issues: Issue, cause, effect, and who or what is affected, seriousness.

1. Run-off volumes and velocity

a. Issue:

During storm events water is quickly drained. Surface drainage is promoted over infiltration. Large amounts of water are directed into Truro and Omand's Creeks over a short period of time.

Water volumes recorded immediately South of the airport for Truro creek (the Truro Creek outflow) are as high as 1.42 cubic metres of water per second during spring run-off, and as high as 1.98 cubic metres per second during a summer storm event. (Water Survey of Canada, 1989) Waterflow maximums recorded at the Truro Creek inflow into the airport are 0.917 cubic metres per second during Spring run-off, and 0.824 cubic metres per second during a Summer storm event. The storm event that saw 1.42 cubic metres per second of water flow at the Truro Creek outflow had only 0.194 cubic metres per second at the airport inflow. These statistics indicate that the volumes of water draining from the secure zone are greater than the much larger drainage area upstream from the airport. Additional development within the airport grounds will increase volumes and velocities beyond the capacity of existing downstream culvert structures.

b. Cause and Effect:

Creation of the airport has increased the volumes and velocity of run-off from the pre-development levels. The site has been engineered to drain quickly and prevent ponding. Good drainage keeps paved surfaces clear. Low points around runways and developed areas have been filled and sloped to promote run-off. Most water entering the airport storm sewer system is drained into Truro and Omand's Creeks. Truro Creek has been partly channelized to increase flow rates.

High peak flow levels can lead to erosion and flooding. Rapid drainage promotes high run-off velocities. High water velocity contributes to surface erosion and channel erosion. Summer storms can result in higher peak run-off levels, while snow melt combined with rainfall can produce higher run-off volumes.

The drainage area upstream from the airport is much larger than the airport grounds. The secure zone is a small part of the Omand's Creek watershed, but comprises approximately one-third of the Truro Creek watershed. Flows from upstream areas of Truro Creek have the most effect on the airport. Truro creek flows through agricultural fields upstream of the airport.

Future development at the airport will increase the amount of paved surfaces and increase the amount of run-off. Simulations for the airport have warned of the need to reduce run-off flows. (Radzius, 1981)

c. Who or What is Affected:

Channelized sections of the creek are the most at risk to erosion. The natural hydraulic action of water erodes the banks of straight channels.

Downstream sections of Omand's and Truro Creeks are affected by high water volumes and velocities. Several points of Truro Creek's downstream reaches have erosion undercutting the stream bank. Erosion damage degrades park areas along Truro Creek, and could affect several properties along Omand's Creek.

2. Run-off water quality

a. Issue:

The public is concerned about pollutants affecting their health and quality of life. (Martens, 1998) Fuels, oils, and chemicals are washed off the airport grounds by run-off water and have been detected in Truro and Omand's Creeks. (Bezte et al. 1998; Enviro-Test Laboratories, 1996) These pollutants can harm plant and animal life downstream from the airport. People who live and work near or downstream from the airport may be exposed to contaminants.

Keeping aircraft and runway surfaces clear of ice and snow is vital for safety. The Winnipeg International Airport will continue to use de-icing agents on runways and aircraft.

35 - De-icing an airplane in winter. (FPG International, 1998)

b. Cause and Effect:

i) De-icing chemicals

Potassium acetate and glycol based de-icing agents are used at the Winnipeg International Airport. Potassium acetate replaced urea as a runway de-icer in 1997. Glycol based fluids are used on aircraft to remove and prevent ice build-up. Glycol-based de-icers contain either ethylene glycol or propylene glycol.

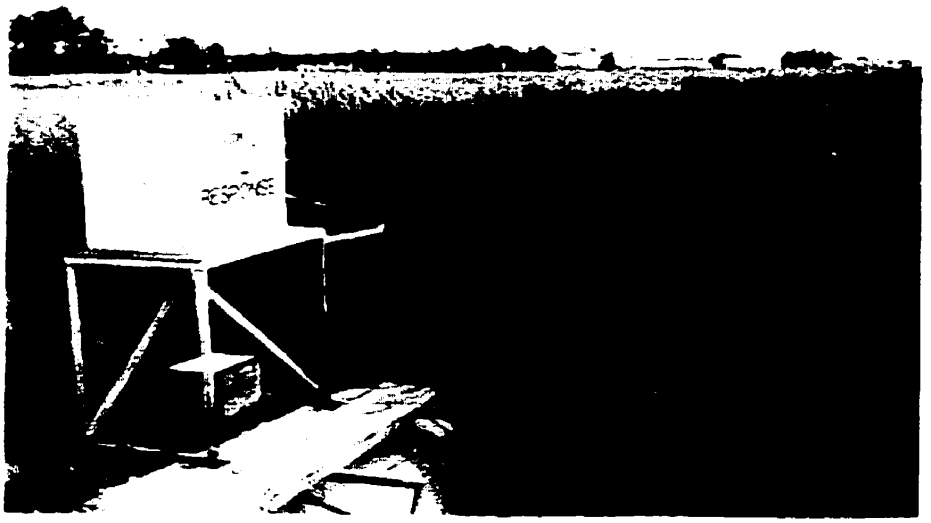
Tests have indicated that 35 percent of glycol used to de-ice planes is blown behind the aircraft and 49 percent falls to the ground around the aircraft. In the 1997/98 de-icing season only 16 percent of the 229,000 litres of glycol used at the airport were recovered for recycling or disposal. (Bezte and MacDonell, 1998) Most glycol used at the airport is not recovered.

All of the de-icing agents used at the airport decompose into non-toxic components. Glycol requires oxygenated water to quickly break down. It can take between several days to several weeks for glycol to fully decompose. The time required depends on oxygen availability, types of organisms present, initial concentration, temperature, and the presence of other limiting nutrients. Even after de-icing agents have decomposed the by-products created may still be present and continue to break down further.

Decomposition of de-icing agents requires the use of oxygen which is dissolved in water. This can create a biochemical oxygen demand (BOD) or a chemical oxygen demand (COD). High BOD levels found in creek water can indicate organic contamination. High levels of propylene glycol and its breakdown products are most likely responsible for the proliferation of aerobic bacteria and anaerobic, sulphur-reducing bacteria. (Bezte and MacDonell, 1998) These bacteria and the presence of glycol by-products are responsible for strong odours and murky water in Truro Creek. These water quality problems have been one of the main complaints by local residents.

Propylene glycol has been detected in Truro Creek as late as May 25th (in 1998), 34 days after the previous de-icing event. (Bezte et al, 1998) However, the concentrations found were below the federal guideline recommended maximum level of 100mg/L. High BOD levels and glycol products have been detected in Truro Creek as late as July. High BOD levels exceeding federal guideline limits were detected in an airport drainage ditch leading into Omand's Creek as late as June 23, 1999. High BOD levels have been detected in Omand's Creek in April and May, but glycol levels have been minimal or non-existent.

De-icing fluids are applied to aircraft or runways with spray systems. All companies using glycol based chemicals on their aircraft must submit a glycol mitigation plan which outlines de-icing locations, application methods, and containment, storage, recycling, and disposal measures. All catch



36 - Omand's Creek spill response structure. August, 1997

37 - Truro Creek spill response structure. June, 1996

basins and manholes are sealed in de-icing areas during the de-icing season. Measures are meant to minimize the spread of glycol de-icing fluids. During Spring melt periods, ponding has occurred on aprons with sealed drains. Drain seals are opened when ponding creates a problem, allowing glycol contaminated water to flow into the drainage system.

Truro Creek receives run-off from the majority of paved surfaces at the airport. Aprons II to X and approximately two-thirds of the paved runways and taxiways drain into Truro Creek. Apron I drains mainly into Omand's Creek. When snow is cleared from runways, taxiways, and aprons, it is deposited in a snow dump area on the West bank of Truro Creek. This dump area is very close to where the creek exits the airport. Snow that has been contaminated with de-icing chemicals, visually identified through a pink colouration, is taken to snow dump areas away from the creeks. The Truro Creek snow dump area may be receiving some contaminated snow, increasing the glycol levels detected downstream from the airport. (Bezte and et al. 1998)

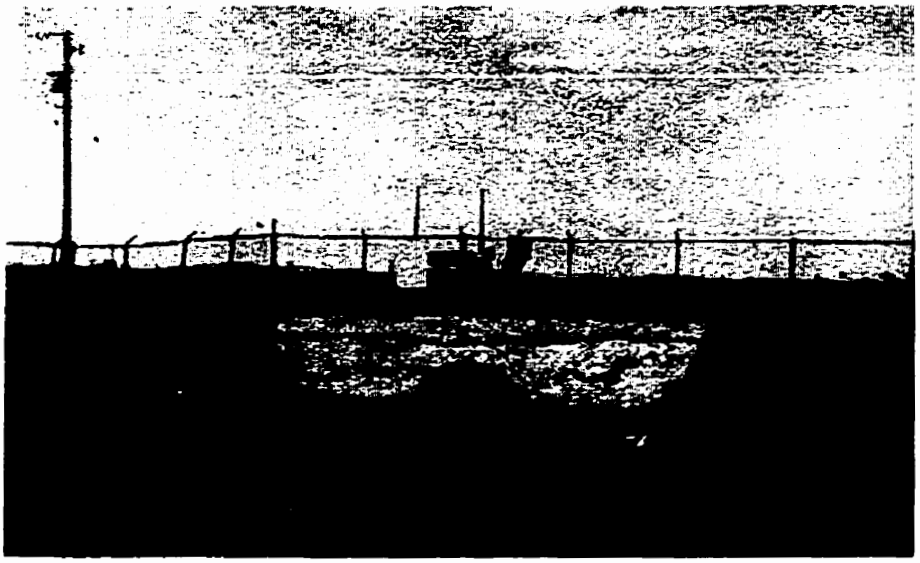
Approximately 75 percent of de-icing fluids used at the Winnipeg International Airport are ethylene glycol based and mainly applied on Apron I. This is the primary source of glycol contamination for Omand's Creek. Propylene glycol fluids comprise approximately 20 percent of de-icers used and were applied on or near Apron V. Remaining glycol de-icing chemicals were used on Aprons II, IV, and VI. These aprons drain into Truro Creek and are possible contamination sources. Glycol reaches creeks through the airport sewer system or from surface and subsurface drainage from snow dump areas with contaminated snow. The North/South Consultants Inc. report on Truro Creek water quality has also suggested that Apron V may have contaminated subsurface drainage. This contamination has resulted in glycol breakdown products released into Truro Creek until July. (Bezte and et al. 1998)

The Winnipeg International Airport has made attempts to mitigate water quality problems. Potassium acetate has replaced the more toxic urea for runway de-icing. Weirs have been constructed to temporarily detain contaminated water. Truro Creek has occasionally been flushed with city water to remove pollutants. These and other measures have had some positive results. The airport continues to monitor water quality to study the problem.

ii) Fuels, oils, salts, and heavy metals.

The operation of vehicles, machinery, and aircraft at the airport can emit pollutants. These are easily washed off the paved surfaces by precipitation. These types of contaminants are common in all urban areas. Oils, grease, sodium, iron, magnesium, and lead have all been detected in Truro Creek. A serious concern is the potential for a petro-chemical spill because large amounts of fuels and oils are used to operate aircraft.

Water testing between 1994 and 1998 revealed concentrations of oil and grease exceeding the federal guideline limit of 15 mg/L in 8 of 39 samples.



38 - Truro Creek airport outflow structure seen from outside of the airport. June, 1996

These two pollutants were higher in water leaving the airport than in water entering the airport. (Bezte and et al. 1998) These high concentrations may be attributed to insufficient maintenance by airport tenants on their oil/water separators.

Some measures are in place to deal with spills of different substances. Berms around some tanks have been built to contain leaks and spills. Spill control structures have been built at the main drain points into Truro and Omand's Creeks. Spill control structures have gates which block the outflow of water in the event of a spill or leak. (figures 36, 37) These gates must be closed manually to be effective.

Run-off from aprons is a potential source for many of these pollutants. Run-off from all paved surfaces may contribute to cumulative concentrations detected where drainage channels exit the airport.

iii) Other chemicals

Other chemicals that can be washed off-site include herbicides, pesticides, and fertilizers. Different chemicals have been used at the airport for vegetation and wildlife control. Other contaminants detected by water testing fin Truro Creek include nitrogen, ammonia, chloride, phosphate, sulphate, and potassium.

Pesticides have been used occasionally at the airport to provide wildlife control. Chemicals to kill worms and insects have been used around the runways. Worms and insects attract birds looking for food, which creates a potential mid-air collision hazard.

Agricultural fertilizers, pesticides, and herbicides may also be present in water flowing out of the secure zone. These chemicals can originate from farms upstream from the airport. There is no physical evidence from ground based or aerial observation that farmers are taking measures to control the leeching of agricultural chemicals.

c. Who or What is Affected:

The biological health of the local creeks is being affected. The by-products of glycol decomposition are creating an unnatural food source for bacteria. The high BOD levels can provide a toxic environment for aquatic plants and animals. Affects of the poor water quality is greatest at the outflows out of the secure zone. (figure 38) People and public areas downstream from the airport are most affected.

A *Winnipeg Free Press* article titled "Airport Blamed For River Stench: Residents say deicing chemicals make them ill" (Martens, 1998) has summarized the general attitude of neighbours. Homeowners have detected a variety of chemicals flowing out of the airport over the years. This article covers residents' negative feelings about the airport.

In Omand's Creek aquatic life including fish could be poisoned. Omand's Creek flows mainly through industrial areas before joining the

Assiniboine River, people are less directly affected. Contaminants in Truro Creek are affecting people who live along the creek.

3. Sedimentation

a. Issue:

Sedimentation has been observed in Truro Creek immediately South of the airport. Sedimentation is a concern for the Red and Assiniboine Rivers. Sedimentation can clog waterways, choke aquatic life, and degrade water quality.

b. Cause and Effect:

Sedimentation is a result of erosion. Soil particles that are carried away by run-off are eventually deposited when water velocity is reduced. This is a natural process, but land development can increase erosion and sedimentation rates.

Sediments have several negative affects on water quality. Sediments can trap and carry contaminants. High levels of suspended soil particles cause an increase in water temperatures. Deposition of sediments reduces channel flow capacity, and can increase the risk of localized flooding. All of these impacts affect aquatic plant and animal life.

Precipitation can erode soil in areas with disturbed ground. Removal of vegetation leaves soil surfaces exposed to impact erosion and sheet erosion. Aerial photography of the airport reveals several disturbed areas which may be point sources.

Sediments may originate from agricultural fields upstream of the secure zone. Agricultural practices such as tilling can expose soil to erosion from wind and rain. Soil particles washed off of fields flow through the airport in Truro Creek. Sediments from agricultural areas may also carry chemical fertilizers, herbicides, and pesticides. Sediments washed out of the secure zone may be blamed on the airport, even if they originate upstream. While sediments have been found entering the airport in Truro Creek, water quality testing has detected higher levels of suspended solids at the Truro Creek outlet. (Bezte et al. 1998)

Ditches within the secure zone are kept clear of heavy vegetation where possible. Storm events will flush them clean of sediments. This can increase the sediment loading outside of the airport as sediments are flushed into Omand's and Truro Creeks. Several areas of Truro Creek with very slow flows have sediment deposition.

c. Who or What is Affected:

Sedimentation can reduce the capacity of the drainage system of the airport. Sediments can also affect downstream areas of Truro and Omand's Creeks.

Sediments in the secure zone could restrict channels and cause ponding. Truro Creek South of the airport has several areas where sediments are being deposited. This could cause localized flooding and possibly damage adjacent properties.

Suspended particles also affect water quality. Soil particles can trap chemical pollutants. Sediments in the waters of Omand's Creek can harm aquatic wildlife. People who come in contact with the water in either creek could come into contact with contaminants attached to sediments.

Run-off volume and velocity, run-off water quality, and sedimentation are the primary issues of concern. These issues are directly related to the landscape of the secure zone. Other issues of public concern are less relevant to landscape form and management. Issues not examined include noise pollution and air pollution from aircraft.

CHAPTER THREE : SYNTHESIS

The proposed landscape plan for the secure zone has two main goals: i) Reduce the negative impacts of operations at the airport on the local environment and community; ii) Design the landscape in a way that provides interest and meaning to those viewing the airport.

The solutions provided here form the basis of the landscape plan for the secure zone. Recommendations will outline the forms and features that meet the primary goals.

Determining recommendations

To determine recommendations each issue has been examined to help define objectives. A list of actions required to accomplish the objectives has been proposed. The proposed design will provide a means to achieve the actions.

1. Issue: Run-off volumes and velocities

a. Objectives:

i) Reduce the amount of water entering the creeks. The time that storm water takes to reach the creeks (or the drainage exit points of the airport) should be increased. or the amount of run-off that is drained should be reduced.

ii) Reduce the velocity of run-off water. Both surface and channel run-off should be reduced.

b. Actions: (What is required to do this)

i) Increase friction to run-off waters.

ii) Increase detention of storm waters.

iii) Increase the amount of precipitation interception.

iv) Increase the amount of water infiltration.

c. Design solutions:

i) Increase the amount of vegetation cover in field areas and drainage channels.

ii) Increase the volume or number of detention ponds.

iii) Provide infiltration ditches or other infiltration structures.

iv) Provide drainage channel buffer zones.

2. Issue: Run-off water quality

a. Objectives:

i) Improve the water quality of run-off leaving the secure zone. Remove pollutants from water draining into Truro and Omand's Creeks, or prevent contaminants from entering run-off water.

b. Actions:

i) Increase the filtration of run-off water.

ii) Provide additional contaminant control and containment.

c. Design solutions:

i) Create filter strips and buffer zones.

ii) Provide increased vegetation levels to allow biological filtration.

iii) Create additional control structures around high risk areas.

iv) Filter water entering the secure zone.

v) Creation of contaminated snow storage areas.

vi) Convert drainage pipes into open ditches.

3. Issue: Sedimentation

a. Objectives:

i) Reduce the levels of sediments in the creeks.

ii) Reduce the levels of sediments in run-off water.

b. Actions:

i) Reduce the amount of on-site erosion.

ii) Filter sediments entering the secure zone from off-site locations.

c. Design solutions:

i) Increase the amount of vegetation cover, especially in erosion risk areas, to stabilize the soils and provide additional soil cover.

ii) Provide additional detention ponds for sediment settlement.

iii) Provide sediment filtration.

iv) Repair areas with erosion.

v) Vegetate disturbed areas and provide containment to control soil erosion.

4. Visual interest and landscape meaning

a. Objectives:

i) Increase the visual interest of the secure zone landscape.

ii) Communicate functional, natural, and social meaning of the airport and the region.

b. Actions:

i) Pattern areas that are uniform in appearance.

ii) Emphasize features that relate to the functional, natural, and social aspects of the airport and the region.

c. Design solutions:

i) Mow fields at different heights to provide contrast.

ii) Seed specific vegetation species in diferent areas to provide a colour and texture variance.

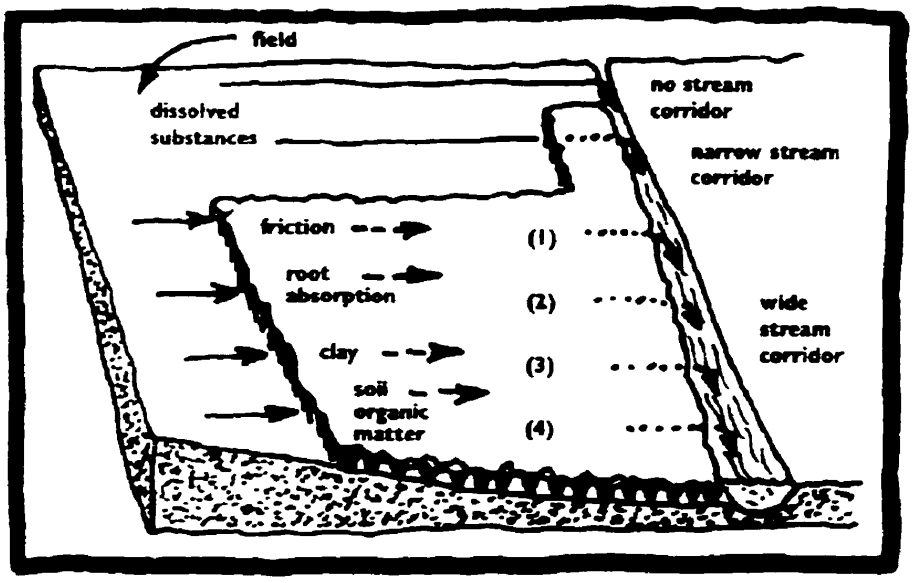
iii) Modify buffer zones and filter strips to be large enough to be seen from the air.

iv) Mow grass areas in patterns that relate to existing social patterns or to specific airport functions.

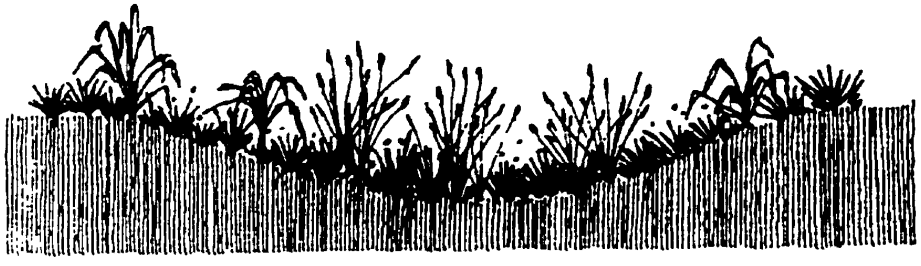
v) Arrange visible wildlife control measures in clear patterns.

These design solutions are the basis for making the primary recommendations of this report. Primary recommendations form the framework for the landscape plan to deal with the negative environmental and social impacts of the issues identified in the analysis.

Recommendations are outlined in two stages. The primary recommendations outline methods to meet the first goal of the landscape plan. Design recommendations provide additional ideas to meet the second goal of the landscape plan.



39 - The functioning of buffer zones. (Dramstad et al, 1996)



40- Bioswale, a filtration ditch using vegetation for run-off treatment. (Lyle, 1990)

41 - Buffer zone vegetation along the banks of Truro Creek South of the airport. (July, 1996)

Primary Recommendations

The following recommendations form the basis of the new landscape plan. Each recommendation is explained in terms of its definition, implementation, the benefits provided, foreseeable conflicts or costs, and options to remedy conflicts. These recommendations could be individually implemented to provide mitigation for the airport issues, but would be most effective working together as part of the site-wide plan.

1. Filter strips and buffer zones

- **Definition:**

Limited success in containing and recycling de-icing fluids, plus the potential for other chemical contamination in run-off, suggests the need for increased run-off filtration and infiltration measures. Vegetation can be used to reduce run-off velocity and provide filtration of pollutants. (figure 39) Buffer zones should be provided along roadsides, along aprons edges, and along drainage channel banks.

- **Implementation:**

Buffer zones should be visibly marked out and mowing within suspended. Along Truro Creek and other large drainage channels a minimum of 15 metres on each bank should be protected. Where space allows the width of drainage buffer zones should be increased. Vegetation should be allowed to grow along banks and within ditches. Smaller ditches can provide filtration and run-of velocity reduction before water can reach larger channels.

Apron edges should have filter zones to catch pollutants draining into grassed areas.(figure 40) Apron buffers can be a minimum of 15 metres wide, the same width as the Transport Canada apron setback.

Roadsides should also have vegetated strips to filter run-off. Fuels, oils, heavy metals, salts, and other toxins can be washed off paved roads. Filter strips along roads should be a minimum of 15 metres wide. Roadside ditches should have a continuous buffer zone between the pavement and the channel.

Buffer zones should be mainly comprised of existing vegetation. (figure 41) Some over-seeding of native or naturalized species within buffer zones will be required. Seeds can be collected from vegetation along the banks of local creeks or purchased from a native seed source. Collecting seeds directly from other local stream corridors may be the only source of native seeds. Continuation of the current practice of seeding Timothy Grass is recommended. This can be supplemented with other plant species that provide little or no food value to wildlife.

Occasional harvesting of vegetation within buffer zones helps to remove toxins stored in plant tissues. An annual or bi-annual harvest (mowing and removal of clippings) should be undertaken in all buffer zones. Removing excess plant material reduces litter build-up and prevents buffer zones from becoming fire hazards. Pollutants absorbed by vegetation will be removed and not allowed to leech back into the ground or run-off water. Harvested vegetation should be disposed of in a sanitary landfill to contain any contaminants present in plant tissues.

Buffer zones should not be mown lower than 10-12 inches in height to insure enough vegetative cover is left to provide filtration and run-off control. Mowing should not be attempted in areas that are saturated or have standing water. Compacting moist soils, stirring up weed species seeds, or releasing sediments should be avoided.

- **Benefits:**

i) Buffer zones provide filtration of suspended and dissolved pollutants. Soil, plants, and organic matter can trap suspended solids as well as absorb suspended and dissolved chemicals. Apron buffers can provide filtration as well as demarcating the area where no obstacles or structures are allowed. Filter strips can help to contain these pollutants before they enter drainage ditches.

ii) Heavy vegetation can reduce run-off velocity. Friction from plant stems, leaves, and leaf litter intercepts and slows surface run-off. High levels of water (during heavy storms or Spring melt) should be able to flow over vegetation unimpeded. Reduced run-off velocities extend the time required for water to drain into Truro and Omand's Creeks.

iii) Slower run-off velocities allow for increased water infiltration into the soil. This reduces the amount of water entering drainage channels. Infiltration provides recharging of sub-surface water tables.

iv) Increased infiltration and reduced run-off velocities reduce peak flow levels in creeks. Peak levels of channels within the site and downstream from the airport should be reduced.

v) More pollutants generated within the airport will remain within the secure zone. Filtering pollutants on-site reduces the amount of exposure for people and animals in surrounding areas. De-icing fluids and their decomposition by-products should be given more time to break

down before entering the creeks. Strong odours and murky water produced as a result of contaminants should be reduced and partially contained on site.

- **Conflicts:**

i) Buffer zones may provide an attraction to wildlife. Wildlife can pose safety hazard to aircraft.

ii) Weed species may appear within buffer zones. Weeds could spread to areas outside of airport, which may anger neighbours.

iii) Buffer zones will be less effective during Spring while plants are still dormant.

- **Conflict Remedies:**

i) Additional wildlife control measures as commonly used at airports can deter wildlife. Control tactics can be focussed in areas that develop attraction problems. Additional methods which have not been used at the airport can experimented with.

Managed areas that have been naturalized are only a moderate concern for safety. (Environmental services, 1992) These areas would attract mainly small birds that are not far-ranging, or birds that are present during limited times such as migration periods.

ii) Limited herbicide use, or selective mowing, can help to control large weed patches. Only bio-degradable herbicides should be used. Frequent mowing at a height of 10-12 inches can help control fast growing weedy species while allowing beneficial species to establish. Mowing at tall heights can significantly reduce the flowering and seed production of weeds.

iii) During the Spring, while plants are still dormant, buffer zones will be less effective but can still provide run-off control and filtration. Leaves, stems, and other plant litter should still slow run-off, and increase infiltration when the ground is thawed. Leaf litter can absorb and hold dissolved chemicals, providing time for pollutants to break down or be absorbed by vegetation later in the season.

Most of the de-icing contamination occurs during Winter or early Spring, when temperatures are low and vegetation has not begun to grow again. However, contamination from de-icing operations can still remain until as late as July. Buffer zones can provide treatment to lingering pollutants, and provide run-off control during heavy Summer storms.

2. Convert drainage pipes into open ditches

- **Definition:**

Water quality problems have been linked to contaminated water draining off the aprons. De-icing fluids used on aprons are recycled,

but accidental or intentional release of water into the airport sewer system has affected the creeks. Sewer pipes that empty into the creeks should be opened up to provide the best possible conditions for decomposition of de-icing chemicals. Day-lighting of pipes allows sunlight, air, soil, and vegetation to provide filtration.

- **Implementation:**

Aprons I, II, IV, V, and VI are all potential sources for de-icing fluid pollution. (Bezte and MacDonell, 1998) Apron I drains into Omand's Creek, and Aprons II, IV, V, and VI drain into Truro Creek. Apron V has been found to be a definite source of contamination due to contamination of subsurface drains. Buried sewer pipes draining these areas provide day-lighting candidates.

Drain pipes that are converted into open ditches should not be adjacent to runways or taxiways. Day-lighting pipes must not attract wildlife close to operating aircraft. Most of the sewer systems follow along the edge of paved surfaces and should remain buried.

Drainage from Aprons IV and V are piped directly into Truro Creek where it leaves the airport. The airport has tried to prevent contaminated water from draining by sealing drains. This has not provided sufficient conditions for recycling or decomposition of chemicals. Ponding on the aprons has forced the airport to drain contaminated water.

The drainage pipe leading from Aprons IV and V runs through open areas of the secure zone and does not run alongside of a runway or taxiway. Except for crossing under roads this drain should be excavated. The new drainage channel should have vegetation within and along both banks as per buffer zone recommendations.

- **Benefits:**

i) An open channel should allow aeration and filtration of water drained off the aprons. The open ditch can provide a vegetated filter to treat de-icing chemicals. Strong odours and high biological oxygen demand levels should be reduced in areas outside of the airport.

ii) Vegetation can reduce run-off velocities of water before it enters Truro Creek. Pipes provide little resistance to water flow. A vegetated channel should allow a more gradual release of water into Truro Creek but will not prevent higher flows of water from moving through quickly.

iii) Increased drainage capacity. In the event of flooding an open ditch provides greater capacity than a buried pipe.

- **Conflicts:**

i) Vegetation may provide a wildlife attraction. The open channel with buffer zones may be more attractive to certain bird species than the current grass conditions. Some of this channel would cross to the South-East of the end of runway 13-31. Planes landing or taking off from

runway 13-31 may have to cross over this channel.

ii) Excavation of the sewer pipe would disturb the ground and possibly cause the release of sediments.

- **Conflict Remedies:**

Wildlife control measures should be concentrated in this channel. There would not be an extraordinary attraction to this ditch but additional control measures should help to insure safe operations. Tall vegetation could be cut down in late Summer or early Fall to reduce wildlife atttraction. Plants should not be completely cut down, only the top half should be removed. Vegetation must be allowed to provide continuous filtration functions.

Construction of the new ditch should be undertaken with great care. Sediments should be filtered as much as possible. Vegetation should be planted and seeded as soon as possible. Any conditions caused by the excavation of the sewer pipe should be rehabilitated as quickly as possible.

3. Additional detention ponds

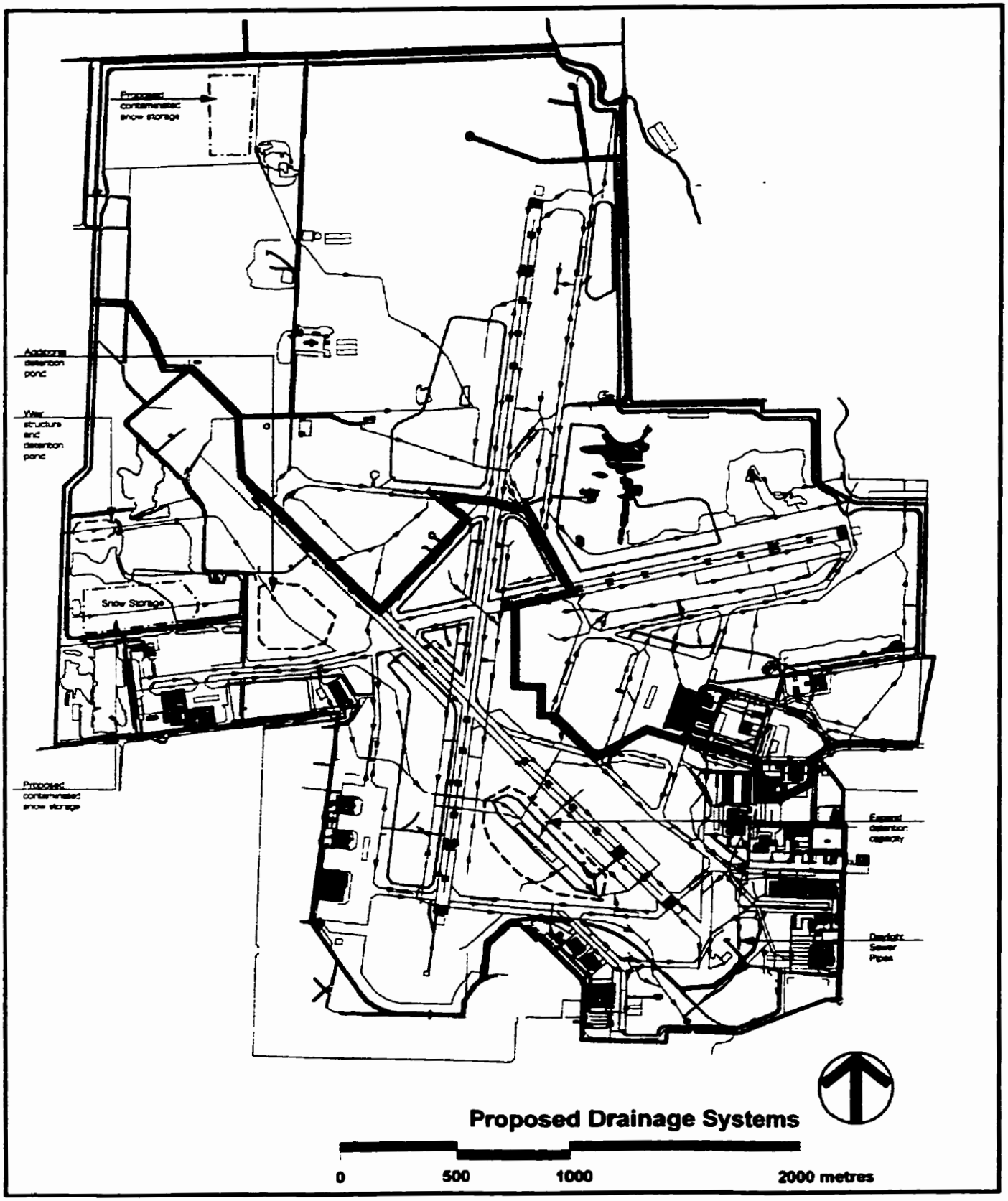
- **Definition:**

The detention ponds on site have been identified as inadequate to provide storage for the level of airport development. (IDG Stanley, 1996) Additional temporary water storage should be added. New storage ponds should work with the existing detention areas.

- **Implementation:**

Potential locations for additional ponds should first be identified. Several new ponds should be chosen where they would prove both useful and safe. (figure 42) Extra detention at the edges of the site would provide a chance to trap and filter site effluent before it exits the secure zone. Periphery locations are generally the farthest from plane operations and pose the least wildlife risk. Detention ponds located where water is entering from off-site areas can help filter pollutants before they move into and through the secure zone.

Providing detention for water entering the airport in Truro Creek can provide settlement and filtration functions. Chemicals and sediments entering from upstream land use are a serious concern. Providing additional filtration and infiltration opportunities should reduce the amount of contaminants that flow through the airport and into residential areas. The existing storm storage pond should have its storage capabilities increased. Small storm storage could be increased by creating a small depression within the existing storage area. During low flow periods water would travel normally. During precipitation inflows from upstream would fill the small detention area. The overflow depression should not have standing water for more than one day.



42 - Proposed drainage systems at the Winnipeg International Airport.

An area along Truro Creek South or Runway 13-31, East of Runway 18-36, and North of Taxiway C provides a large area which could provide additional detention. Flows from the newly day-lighted channel draining Aprons IV and V should have a small detention area provided. A small detention area should be created at the inflow of Truro Creek into the secure zone to trap pollutants entering from upstream sources.

- **Benefits:**

i) Temporary water storage reduces peak flow levels in creeks and ditches. This helps to reduce erosion and the risk of flooding.

ii) Infiltration and evaporation are increased by allowing water to pond. Less run-off is directed into creeks. Infiltration replenishes the water table and feeds creeks during dry periods. Lack of flowing water in Truro Creek has contributed to foul odours. Maintaining water table levels will allow continuous water flows in Truro Creek.

iii) Water filtration and sediment settlement can occur within detention ponds. Filtration is provided by vegetation and increased infiltration. Deposition of suspended solids reduces siltation in downstream areas. Contaminants trapped in sediments will remain on-site and not affect people downstream. Sediments should collect in specific areas such as detention ponds that can be occasionally cleaned out.

- **Conflicts:**

i) Standing water can attract some nuisance bird species, providing an aircraft hazard. Ducks are especially hazardous due to their size and attraction to water.

ii) Construction of new detention ponds can cause erosion and siltation.

- **Conflict Remedies:**

Additional wildlife control measures should be employed when standing water present. This can help prevent animals from becoming established within the secure zone. Areas that continually have ponding problems could be fitted with exclusion measures to prevent wildlife access. Netting or wires can be used to restrict access by large birds such as ducks, geese, and gulls. Monitoring areas which pond can determine the location of problem areas. Detention ponds should be prevented from holding water for too long. Outlets to detention ponds should allow for a continuous flow of water.

Erosion and siltation control measures should help to minimize problems when ponds are constructed. Promoting fast re-vegetation can stabilize new pond banks. Creation of new detention areas should be during May or June to provide maximum time for re-vegetation before winter.

4. Inflow Detention

- **Definition:**

A small weir structure in Truro Creek should be constructed near the inflow into the secure zone. This low structure should detain low flows into the airport to provide filtration and flow control. The weir should be designed so that high water flows pass over the weir and do not cause flooding.

- **Implementation:**

The weir can be constructed within the secure zone near the inflow of the creek into the airport. (figure 42) In the year 2000 this area is a wide grassed swale that is completely mown. Truro Creek enters the secure zone and flows through a grassed clearing and a stand of trees. The area directly upstream of the trees provides enough space for the weir structure and associated detention area.

Boulders can be used to construct the weir. The obstruction should be very low, enough to trap a small amount of water during low flow times. This small pond can provide a settlement area for suspended solids and filtration and infiltration for water. Vegetation within the pond can be allowed to grow without cutting or mowing.

Access to the detention area above the riffle structure should be provided. Sediments that collect in this area may need to be occasionally cleaned out.

- **Benefits:**

i) Dissolved chemicals in creek water can be filtered by vegetation in the detention area. Water that infiltrates into the soil will be further filtered.

ii) Sediments entering the airport from upstream areas can be filtered at this point. A small pond created by the weir structure can provide a settlement area for suspended solids.

- **Conflicts:**

i) Standing water can attract some nuisance species of wildlife, creating an aircraft hazard.

ii) Construction of a weir may cause small amount of erosion and siltation.

- **Conflict Remedies:**

Wildlife control measures can be employed where standing water is present. The riffle structure is located far from runways so there should be little wildlife risk.

Construction of the weir should be undertaken during dry weather. Sediment control measures can be employed. Similar riffle structures have been created downstream from the airport apparently without creating sediment or erosion problems.

5. Vegetation management changes

- **Definition**:

Certain vegetation management practices have been established to accomplish certain wildlife control and run-off drainage objectives. Vegetation is cut short as much as possible within the secure zone. Mowing practices should be modified to help meet environmental goals. Alternate mowing practices can provide inexpensive and effective solutions to several issues.

Cutting or burning vegetation in buffer zones should also be restricted. Over-seeding areas with beneficial plant species should be continued. Species other than Timothy Grass should be researched to provide additional vegetation types that do not attract wildlife.

- **Implementation**:

Areas that require higher maintenance levels, such as within runway and taxiway graded areas, should continue to be mown according to existing practices. Low cut grass in these areas provides a fast draining, easily maintained surface. Mowing vegetation in other areas of the secure zone should be reduced. Frequent mowing is an unnecessary energy and monetary expense.

One of the primary reasons behind frequent mowing is wildlife control. Mowing removes a food source and potential habitat. Unfortunately, mown fields actually provide an attraction to many nuisance bird species such as geese and gulls. Transport Canada recommends maintaining grass at a 6" height. (Environmental Services, 1992) Grasses at a 10" to 12" height provide an unattractive environment for larger species such as geese.

The birds that present the greatest threat to aircraft safety must be considered first in vegetation management. The birds that present the greatest threat are the large flocking species. Experimentation and observation can indicate what height of grass is the most effective at deterring wildlife in the Winnipeg area. Maintaining several areas at different grass heights should allow for direct observation and evaluation.

The current practice of over-seeding grass areas with species such as Timothy grass should be continued. (figures 43,44) Native prairie species that do not attract wildlife should also be over-seeded. Sheep Fescue grass (*Festuca ovina var. saximontana*) is one possibility for over-seeding into the secure zone. (figure 45) This grass has very narrow leaves, a small, single seed head, and grows in dense bunches. (Dawson Seeds, 2000) This species is available from seed suppliers.

Ongoing research should be undertaken to find additional species that do not provide a food or shelter value to animals. Vegetation should not provide foliage or seeds that are attractive food. Seeds, foliage, or

43 - Timothy Grass, Phleum pratense (left)
44- Timothy Grass seed heads (centre)
45- Sheep Fescue (Festuca ovina var. saximontana (right) (Johnson, Kershaw, MacKinnon, and Pojar, 1995)

flowers that are very attractive to insects should also be avoided. High insect populations will attract wildlife that feeds on insects.

Areas far from runways can be used as test areas for prairie restoration. Plants that provide an indue attraction to wildlife should be excluded from re-seeding. Maintaining a diverse vegetation community can prevent fast growing weed species from establishing.

Harvesting plant material reduces litter build-up and prevents creation of a fire hazard. Field areas can be mown and harvested more often than buffer zones.

- **Benefits**:

i) Taller vegetation reduces run-off velocities due to increased friction. Increased infiltration of precipitation is promoted. Plants are encouraged to develop deeper, stronger root systems. Surface erosion from precipitation impact or sheet flow is reduced.

ii) Precipitation interception is increased. Drainage channel loading and peak flow levels are reduced. Impact erosion is decreased.

iii) Reduced mowing translates into decreased maintenance costs. Fuel and machinery operation costs can be directly reduced. Labour can be shifted from routine mowing to other duties such as: landscape monitoring; gauging the effectiveness of recommendations; and undertaking research and experiments of additional beneficial management practices.

iv) Taller vegetation creates a less attractive resting area for nuisance wildlife such as geese and gulls. Geese, gulls, and some other birds seek mown areas that do not provide cover for predators. Many bird species avoid tall grass because it obstructs the view and restricts movement.

iv) Suppressed native species that exist in field areas should be allowed to re-establish. The airport could become an important prairie grassland sanctuary. In 1996 during work on the Truro Creek Naturalization Plan (Cohlmeyer, 1996) the author conducted vegetation species

sampling along Truro Creek. Sampling detected **XX#** of plant species between the airport and the Assiniboine River. Previously undetectable native prairie species were also observed in upland grass areas once mowing was reduced or stopped.The native species had spontaneous appeared and had not been previously observed.

During the Summer of 2000 native and naturalized species were observed in both wetland and upland areas of the secure zone. (Shewchuk. 2000) Very wet conditions during the Spring and Summer of 2000 prevented much of the normal mowing. A scientific sampling of vegetation species was not undertaken during this time.

v) Possibilities for patterning the landscape are created. Mowing different areas at different heights provides the opportunity for intentional ground patterning. The large, open areas of the secure zone provide enough room to create patterns visible from the air.

- **Conflicts**:

i) Weeds could be allowed to establish and spread. Some leafy weeds attract rodents. Noxious weeds can spread and contaminate airport and neighbouring land. Certain weeds provide food for wildlife.

ii) People may think airport grounds are no longer being maintained. Mowing grass provides a groomed aesthetic which is preferred by many people. Naturalized areas have sometimes been seen as neglected.

- **Conflict Remedies**:

Limited herbicide use and selective mowing can control weeds. Herbicides can provide a fast way to neutralize weed patches. Overseeding areas which have been weeded should help prevent weed species from re-establishing. New seeds should not be tilled into the ground or weed seeds will be unearthed. Seeds should be spread on the surface and seeded areas carefully monitored.

Public education should ease concerns and provide opportunity for airport promotion. Concerns about maintenance neglect can be relieved by simply explaining the objectives of the airport.

6. Creation of contaminated snow storage areas

- **Definition:**

Snow contaminated with de-icing fluids has traditionally been deposited in several areas. The Winnipeg International Airport has adapted the recommendation of storing all contaminated snow adjacent to Apron I. (Bezte and MacDonell, 1999) A specific snow storage area should be created farther away from creeks at the airport. Storage areas should be designed to hold contaminated snow and allow for proper decomposition of de-icers.

- **Implementation Strategy:**

The location for contaminated snow dump adjacent to Apron I allows de-icing fluids to drain directly to the creeks near where they exit from the airport. This will continue to cause the strong odours and murky water detected in the creeks. A new snow dump location should be found which can prevent or delay de-icing chemicals and their by-products from being quickly released into the creeks.

North of Aprons IX and X is an open area which might be very useful for contaminated snow storage. This area is immediately South of a forest patch and the inflow of Truro Creek into the secure zone. Snow piled here would not provide interference with airport operations and has existing road access. This land drains into Truro Creek. Water entering the creek in this area would still have to travel across the airport before entering neighbouring land. The area could be quickly drained if required or detention could be built to hold melt water longer.

Other areas which may provide snow storage exist in the North-West quadrant of the secure zone. Most of this land is not used. Some activities here include contaminated soil remediation and fire training. This land is farther from runways, aprons, and the creeks which reduces the likelihood of conflict. However, snow disposal is more expensive and less convenient because workers have to transport snow to a site that is farther away.

- **Benefits:**

i) Less de-icing chemicals and their by-products will be released from the airport. Chemicals should have more time to decompose. Contaminated water should have more time to infiltrate the ground and be filtered by soil and vegetation. Odour and murky water problems in the creeks can be reduced.

ii) Inconvenience to neighbours will be diminished if chemical and biological oxygen demand levels in the creeks are reduced.

- **Conflicts:**

i) Moving contaminated snow will be an additional expense. Storing the snow adjacent to where it is from is fast and easy. Moving the snow will require trucking snow to the alternate location.

- **Conflict Remedies:**

The costs of moving the snow cannot be remedied. However, costs of containing or treating contaminated melt water can be reduced. Costs of improving the water quality downstream should also be reduced. The airport has had to construct temporary weirs to contain contaminated melt water and flush Truro Creek with de-chlorinated city water to remove pollutants. These measures can be avoided or minimized through properly storing polluted snow in a safe area.

7. Provide additional spill and leak prevention around high risk areas

- **Definition**:

Areas with chemical or petroleum product storage should have berms or walls to prevent spills or leaks from spreading. Surfaces within the berms or walls should be impervious to keep substances from leeching into the ground. Drains should have spill control devices that allow precipitation to drain but hold back contaminants.

- **Implementation:**

These measures have already been undertaken for much of the airport. Storage tanks have been actively unearthed and raised above ground. Berms have been constructed around some storage tanks. Drain control devices are used on aprons when de-icing chemicals are being applied. These are positive measures that should continue.

Devices to insure spills are not allowed to escape should be used at all apron drains. The Department of Defence, 17th Wing, uses devices that block drains in the event of a petroleum product spill. (Craig, 1997) These devices expand when in contact with petro-chemicals but are unaffected by contact with water. Any spill is automatically blocked before large quantities of contaminants can escape. These types of devices should be installed anywhere that there is the risk of a spill or leak.

All facilities within the secure zone should be examined to determine situations which do not use these spill control measures. Every existing storage area should have both containment berms and drain control measures. Any situation which does not meet these standards should be updated immediately.

Spill control structures and practices should be updated to improve accident response. In the event of a contaminant spill the spill control structures should have automatic or remote activation. This would allow a faster response and prevent pollutants from leaving the secure zone.

New technologies should also be constantly monitored. Alternate or improved methods to provide pollution control should be adopted if they can provide a significant increase in protection.

- **Benefits**:

i) Spill control limits the area that needs clean-up of spills or leaks. Limiting a spill or leak to a small area minimizes the impact of the accident on the environment and people. This can also reduce the cost of decontamination because cleaning a small area is much easier and faster than a large region.

- **Conflicts:**

i) Drain control structures can create large ponds of water on aprons.

Drain control devices have been used at the airport to prevent glycol contaminated water from escaping into the sewers. These devices have caused water to collect, creating a poor work environment for de-icing and maintenance crews. (Bezte et al. 1998)

- **Conflict Remedies:**

ii) Contaminated water should be removed from apron surfaces with machinery that can recycle or treat chemicals. Companies are already under contract to recycle glycol used at the airport, and should be able to provide enough service to collect all contaminated water.

8. Conduct tests with alternate de-icing fluids

- **Definition**:

The Winnipeg International Airport uses bio-degradable de-icing fluids which are not toxic in small amounts. The agents used at the airport have been chosen due to their environmental properties. Undesired effects are still an issue at the airport, however. Alternative de-icing chemicals should be examined.

- **Implementation:**

A number of alternative de-icing chemicals have been developed to be environmentally friendly. These chemicals bio-degrade into neutral substances quickly. Many bio-degradable or non-toxic chemicals are in use at other major international airports. Other airport could provide performance data of de-icing chemicals which are not being used at the Winnipeg International Airport. Chemicals that could provide sufficient de-icing and reduced environmental impacts should be tested in Winnipeg.

Use of bio-degradable or non-toxic chemicals does not imply that spills of these chemicals should not be contained and cleaned up. All use of chemicals should be done with the highest standard of care. Even bio-degradable or non-toxic de-icing agents can be hazardous if concentrations are high.

- **Benefits**:

The use of different de-icing chemicals could help to reduce the murky water and strong odours caused by glycol decomposition. De-icing fluids that do not produce high BOD levels when decomposing

- **Conflicts:**

i) The de-icing fluids that are used at the airport are very effective at ice control. Other products may not provide the same level of performance. De-icing fluids that are less effective may not meet the required safety standards.

ii) Alternative de-icing fluids may be very expensive compared with the standard glycol-based de-icers.

- **Conflict Remedies:**

i) De-icing fluids that do not perform at least as well as the de-icers in use in the year 2000 should be avoided. Only chemicals that can meet both environmental and safety standards should be considered for use at the airport.

ii) De-icing fluids that are prohibitively expensive do not provide a viable option. The Winnipeg International Airport has a limited budget, and is required to operate in a financially responsible manner. Costs of repairing the negative environmental impacts of glycol based de-icing fluids should be considered in calculating the expense of alternate de-icing fluids.

9. Additional wildlife control

- **Definition**:

Some of the design recommendations may provide food or habitat for wildlife. Small birds and rodents might try to inhabit Buffer zones, filter strips, and native prairie grass patches. Standing water in depressions already provides attraction to birds, including ducks and geese. Measures should be taken to counteract wildlife attraction.

- **Implementation:**

The following are recommended additional wildlife control measures:

- Noisemakers should be installed where heavily vegetated drainage channels come close to the runway strips (150 metres of the runway centre line). Crackers, cannons, and recorded sounds could be used.
- Flags and streamers should be installed anywhere within the runway strip that there are drainage channels. These should also be installed along Truro Creek because the channel runs between the runways and aprons. Flags should be black plastic and approximately 60 centimetres by 90 centimetres in size. Other flag colours and sizes are not as effective. Streamers should be bright and reflective. Providing movement makes flags and streamers effective.

Anywhere that standing water for might collect such as detention ponds and natural depressions should have flags and streamers. Observation will reveal areas which regularly accumulate water. Four flags should be installed per hectare. Flags should be occasionally moved to prevent wildlife from being accustomed to their presence.

Additional wildlife control options should be experimented with. The use of chase dogs at the Vancouver International Airport, is an example of an alternate control method that could be used in Winnipeg. (Appelbe, 1999) Chase dogs provide a deterrent that animals do not become accustomed to.

Areas with extreme problems of wildlife attraction should have

physical barriers constructed to prevent access. Netting or wires can be used over small areas which constantly have standing water. Physical exclusion measures can be attached to structures that provide a perch for birds.

Monitoring by a control officer can determine areas that require additional wildlife control. The most effective form of wildlife control is human diligence. Wildlife control is an ongoing process. As new methods develop, the airport can shift their tactics to provide the most effective strategy.

- **Benefits**:

i) Any additional wildlife control measures will improve the safety of operating airplanes at the airport. Reducing the number of bird strikes at the airport would be a very valuable benefit.

- **Conflicts:**

There are no foreseeable conflicts with providing additional wildlife control at the airport. Any expenses would be made up through the increased safety levels.

10. Keep all storage tanks above ground

- **Definition:**

All fuels, oils, and chemicals should be stored above ground rather than buried. This can help to protect groundwater from contamination in the event of a leak.

- **Implementation:**

The airport soil conditions include areas with only a thin layer of clay. This clay layer provides protection for groundwater by blocking the leeching of pollutants. Excavation could strip away this natural protection layer, allowing polluted water to infiltrate quickly.

Existing storage tanks that have not already been raised above ground should be excavated and replaced. New tanks should be installed above ground. All tanks should have protective berms and drain control devices or other comparable measures to control spills and leaks. Reports do not identify the exact soil composition of specific areas. It should be assumed that any area could have only a thin clay layer.

- **Benefits**:

i) Reduced risk of groundwater contamination

ii) Increased ability to contain and quickly repair leaks in storage tanks.

iii) Any leak can be discovered quickly. Buried tanks do not allow for constant visual observation.

- **Conflicts:**

i) Buried tanks do not create a safety hazard in the event of an airplane

accident. Exposed tanks a subject to damage from any vehicle that comes into contact.

- **Conflict Remedies:**

i) All storage tanks should be located far from areas where planes are operating. Storage tanks should have protective measures such as fences and berms to minimize the risk of an accident.

11. Negotiate with upstream neighbours

- **Definition**:

Agricultural and industrial areas upstream add to the pollution of run-off and ground water. Pollutants which are found in Truro and Omand's Creeks are often associated with the airport even if they originate elsewhere. The Winnipeg International Airport has developed a public perception problem. The Winnipeg Airports Authority should develop relationships with neighbours to attempt to reduce local pollution.

- **Implementation:**

Measures proposed for within the secure zone may also be applicable for upstream areas. Buffer zones along Truro and Omand's Creeks can help to reduce run-off volumes, velocities, pollutants, and sediments. Settlement ponds for large sites can contain pollutants. Other land uses do not have the restrictions of an airport and can take advantage of additional pollution control measures.

The airport should take the lead by approaching neighbours and beginning a dialogue. Determining the interests of neighbours can help to inform landscape strategies. Effort by the Winnipeg Airports Authority will display concern for local residents and the environment and confirm intentions to involve the community.

The airport can become a community leader in impact mitigation by providing education and cooperation. Provincial and municipal governments may help to fund local environmental measures. The airport should not be responsible for upgrading the properties of others, but could provide information and assistance in attaining government funding.

- **Benefits**:

i) The airport can monitor and influence the practices of neighbouring property owners. Any land use decisions that might affect airport operations can be influenced to avoid a conflict.

ii) Pollutants from other sources is sometimes being attributed to the Winnipeg International Airport. (Shewchuck, 2000) Reduction in contaminant levels in run-off water entering the secure zone should reduce pollution associated with the airport.

iii) The Winnipeg Airports Authority can take advantage of public relations benefits. The airport can serve as an example of a good corporate citizen. Advertising the environmental and community initiatives can improve the profile of the facility.

iv) A minimum amount of airport resources would be required. Winnipeg Airports Authority staff would be providing mainly information and guidance. Some land owners may not have the facilities or ability to determine what would be effective methods to reduce operations impacts. The airport has a lot of experience and knowledge to share.

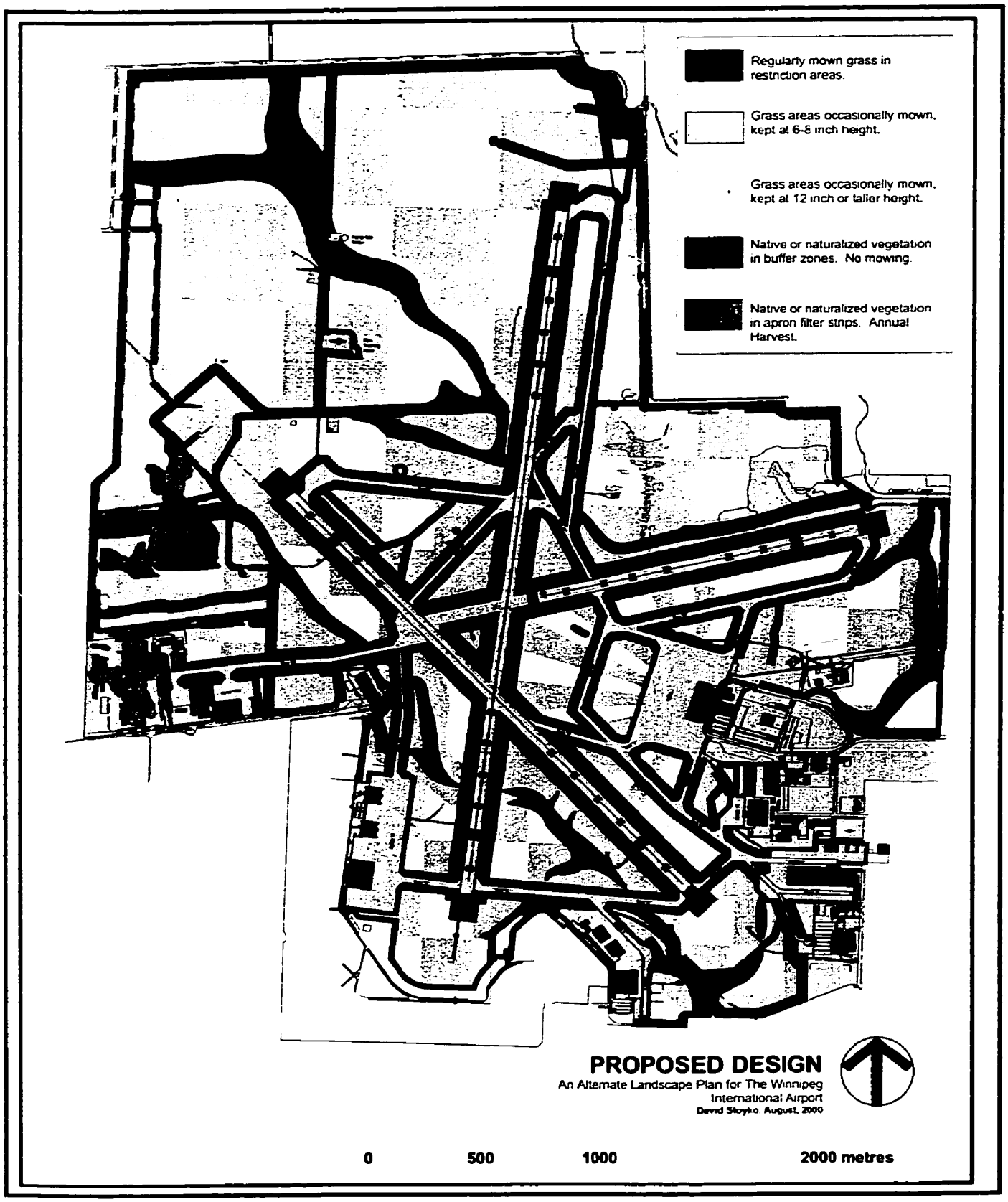
- **Conflicts:**

i) Some neighbours may not be cooperative in efforts to reduce pollution in the region. People may feel that a large corporation is attempting to deflect blame for local environmental issues.

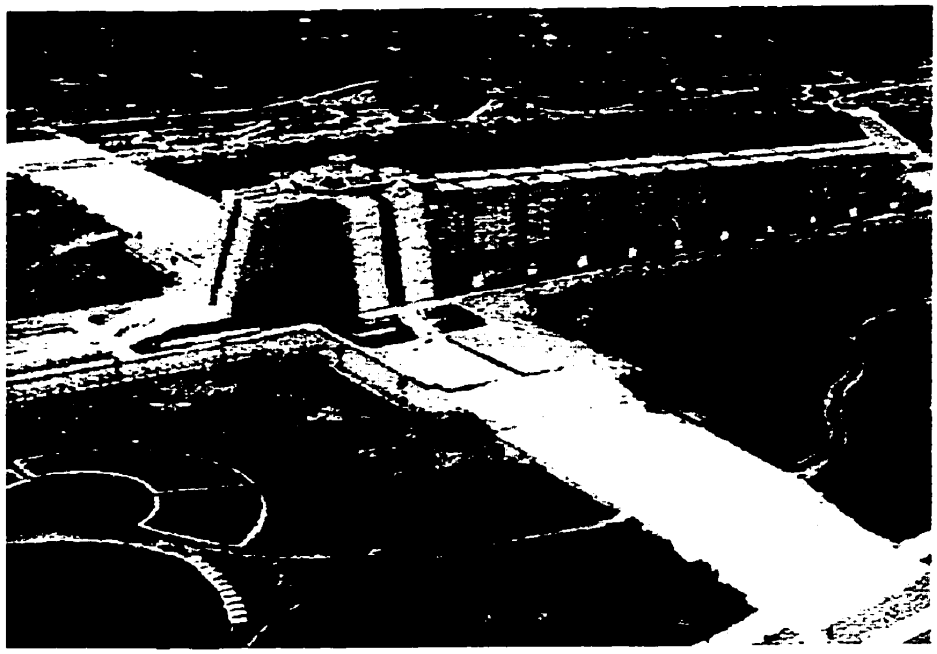
- **Conflict Remedies:**

i) The Winnipeg Airports Authority should be prepared for the possibility that some neighbours will not want to be involved in any discussions. Any attempt to involve the community and reduce regional pollution will be positive.

These recommendations provide the basic structure for the landscape. Designs are intended to reduce negative environmental impacts and add visual interest and meaning to the site. The design recommendations outline how the primary recommendations can be integrated into a cohesive landscape plan.



46 - Proposed landscape design for the secure zone.



47 - The lighthouse of Santo Domingo by Joseph Lea Gleave (Waldheim, 1999)

48 - Saskatchewan crop circle. (Bronskill, 2000)

Design Recommendations

The primary recommendations address environmental and social issues identified in the analysis. Design recommendations discuss how the landscape can be modified to be interesting and meaningful to view.

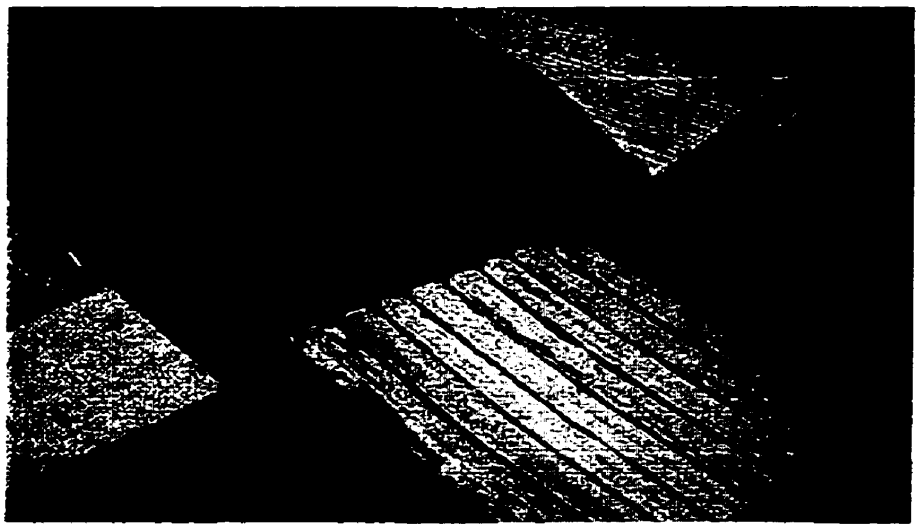
The design recommendations consist of inexpensive measures to add interest to the landscape. These are simple ways that the primary recommendations can be adjusted to add meaning. Slight changes to implementation and management of recommendations can create meaningful patterns, and still work within the desired environmental goals. Functional, natural, and social patterns provide visual meaning by communicating the unique identity of the airport and the region. Symbols and patterns can tell a story about the features of the land and how it is used.

Visual patterns created are meant to be seen from aerial views and from specific ground based views. Ground views that will be visible to the largest amount of viewers should get the most amount of attention.

Meaning and the aerial viewpoint

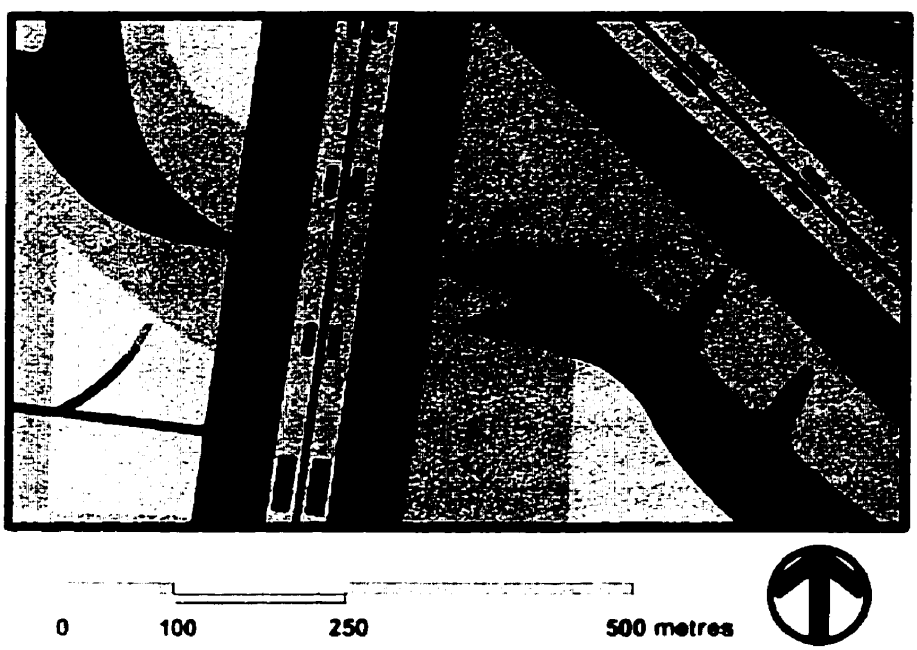
The opportunity to take advantage of the airborne view was realized early in the history of air travel. Structures and landscapes have been designed to be viewed from airplanes since the early part of the 20th century. The lighthouse at Santo Domingo, designed by Joseph Lea Greave in 1929, provides one example of an early monumental landscape sculpture. This building was intended to be seen by those flying into and out of Santo Domingo. The lighthouse is in the form of a massive cruciform, commemorating Columbus's 'discovery' of the Americas. (Waldheim, 1999) It is a representational marker of the colonization of the Americas, and designed to be seen from the air and the ground.

Crop circles provide a modern landscape example meant to be seen from the air. These large, and often complex patterns are swathed



49 - Planting rows in agricultural fields create patterns visible from the air. (Patterson, 1997)

50 - River lots on the bank of the Red River near Selkirk. (Taylor, 1999)



51 - Buffer zones diminish in size when they come close to the runways. (plan detail)

into agricultural fields. From the ground, crop circles are not much to look at. The larger patterns are not easily recognizable, only with an elevated view can they be understood.

Crop circles have provided great interest to the public, and attract a large amount of media attention. Crop circles are ephemeral, artistic expressions which display a simple way to use or alter vegetation to great effect. Their appearance sparks a great deal of imagination and discussion how they were created

Even the unintentional patterns of the landscape can be striking and attractive. Both natural and human processes can create patterns which are easily seen from the air. Natural features interrupt or influence human geometry. City streets form geometric grids between buildings. Agricultural fields in the prairies combine to create an enormous quilt of crops in a patchwork pattern. (figure 49)

Winnipeg's development has been based around the natural forms of the Red and Assiniboine Rivers. River lots were formed to provide water access to all land owners. (figure 50) Roads have to work along the curving river edges, with only a few places to cross.

The natural and human patterns are different in different parts of the world. They communicate the local geography and land use. Patterns reveal the story of how a place has been developed, and how the people relate to Nature. This is the meaning communicated by the landscape, and can be clearly seen from the air.

Designs for the secure zone

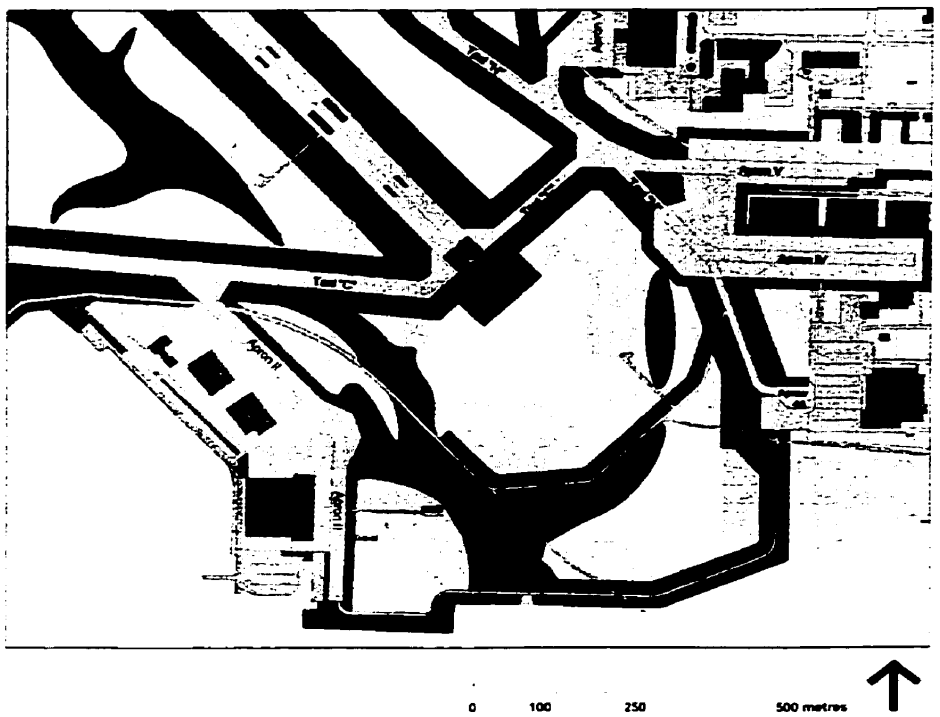
The design recommendations can help to communicate the local patterns of the airport, Winnipeg, and the Manitoba prairies. The airport patterns override all other features, providing an understanding of the site functions. This establishes a structure that social and natural patterns of the region can fit into. The following recommendations outline the design strategies:

1. Buffer zone modifications

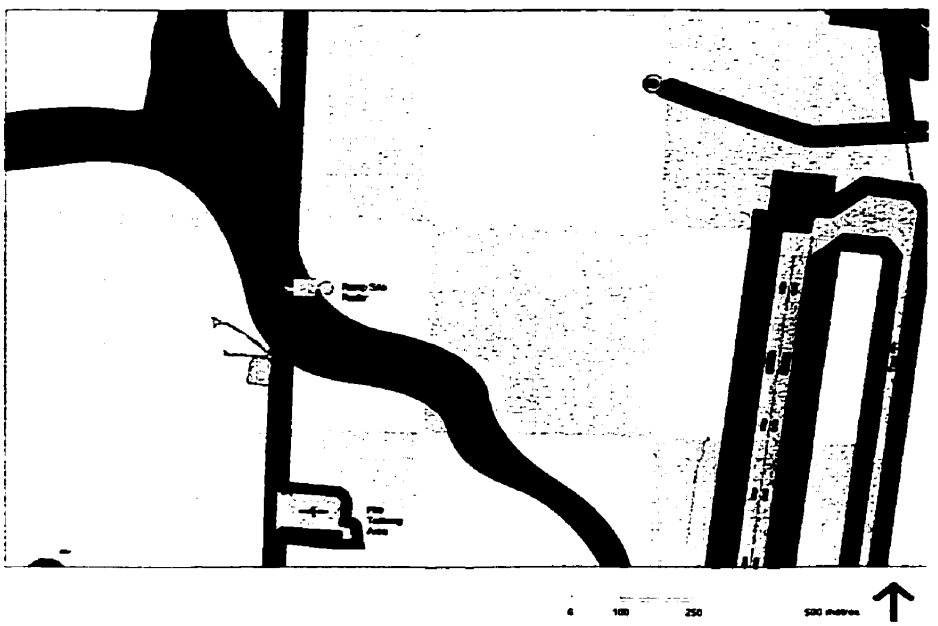
- **Definition**:

Buffer zones within the secure zone can be altered to increase their visual presence. Buffer zones should be a minimum size as outlined in the primary recommendations, but where possible should be expanded in width. This is simply an increase in the no mow zone along the channel. The larger the drainage channel, the larger the buffer zone should be. Small ditches can be expanded, but channels such as Truro Creek should have the widest buffer zones. The size of the buffer zones will correlate to the size of the channel.

Buffer zones should not come too close to runways due to wildlife attraction concerns. (figure 51) Truro Creek for example runs par-



52 - Buffer zones along the South end of Truro Creek in the secure zone. (plan detail)



53 - Drainage ditch meandering through the fields of the secure zone. (plan detail)

allel to runway 13-31. Buffer zone vegetation should be kept back from the runway as far as possible, while still maintaining water quality and visual pattern functions. Buffer zones along Truro Creek are reduced to nothing when they come to the edge of the runway strip, and expand out to as much as seventy-five metres. (figure 52)

This is a simple modification to highlight one of the main natural patterns within the secure zone. A stream channel breaking up the geometry of farmed fields is a common feature in the prairies. (figure This can display both the existing drainage system of the secure zone, and the speak about natural features and patterns of the airport and the region. (figure 53)

- **Benefits**:

i) The organic shapes of the secure zone will contrast with the geometric airport patterns. An intricate pattern of vegetation can tell a story about the natural and airport drainage systems.

ii) Wider buffer zones will provide additional run-off control. Velocity will be reduced and filtration and infiltration will be increased over narrow buffer zones.

iii) Most of the grassed field areas will require mowing several times during the year to maintain vegetation heights at six or twelve inches. Buffer zones will require only one harvesting every year as maintenance. Increasing buffer zone areas can slightly decrease mowing costs. This will not be a significant decrease in costs, but it will also decrease the amount of time required to mow grass fields.

- **Conflicts**:

i) Increasing the amount of buffer zone vegetation might create more areas to attract wildlife. The heavy vegetation areas could attract ducks or red winged black birds.

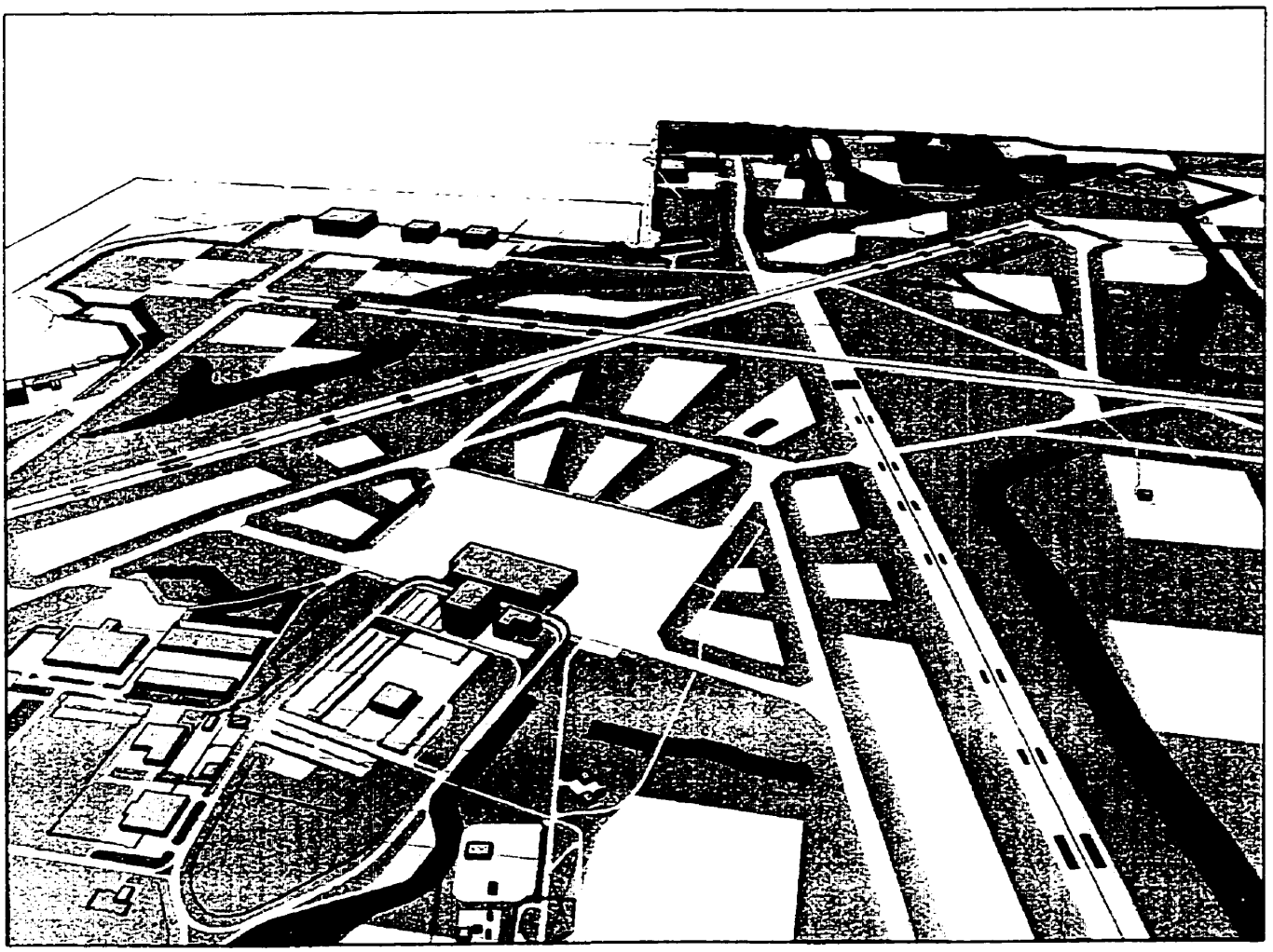
ii) Access to all areas that require mowing is required. Buffer zones should not block access by maintenance machinery to any area.

- **Conflict Remedies:**

i) Buffer zones will require additional wildlife control measures if it is revealed that they provide wildlife attraction. Channels near runways should be kept smaller, or at a minimum size, to prevent the creation of a hazard. Additional flags and streamers should be installed, which will also provide additional visual interest.

ii) Access paths can be created through buffer zones as long as they do not become source points for sediments or pollutants. Most areas are accessible by roads or other mown areas. Buffer zones do not block emergency access to any area.

54 - Perspective aerial view of the proposed plan showing the vegetation patterns. (plan detail)



2. Mowing at different heights

- **Definition**:

Field areas do not all need to be mown at the same height. Grass heights between 6 and 12 inches can provide hydraulic and wildlife control benefits. Some areas can be maintained at a lower height of six inches while others can be mown at 12 inches. The contrast between the two heights can create patterns on the land. Large landscape patterns create a rectilinear grid that relates to the regional land use. (figure 53) The historical river lot land division system is a pattern that has shaped the patterns of the agricultural fields and the city blocks surrounding the airport. (figure 50) A grid pattern of mown grass can relate this pattern, and make a connection to the surrounding context.

The size of the grid squares is based on the river lots. However, Southern areas of the secure zone have more paved surfaces and do not provide as much space as the fields in the North-West quadrant. Patterns must be made to fit within the available space to be legible. A smaller grid will allow the shapes to be seen in smaller field areas. This change in the grid size also relates to the finer patterns of the city blocks to the South, versus the larger agricultural field patterns to the North.

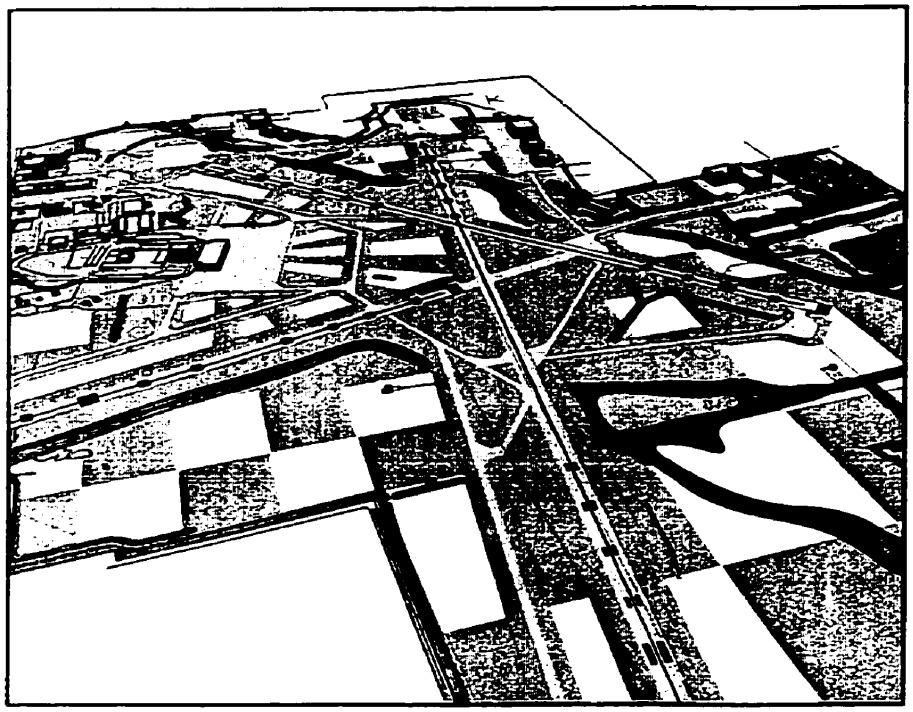
Mowing patterns around Truro Creek can serve to emphasize the connection between the sections of buffer zones. As the drainage channels move though the secure zone they are interrupted by the runway, taxiways, and other airport structures. Mowing grasses in a pattern that follows along the buffer zone edges, overriding the grid pattern, will help to visually connect the small stretches of creek. (figure 55)

Fixed ground based views offer the possibility of providing a composed scene. People will see certain areas from one view point, and the pattern can relate to that spot. The observation lounge at the terminal, for example, provides a fixed point from which people see apron I and the surrounding land. The grass should be mown specifically so that patterns are apparent from the terminal location.

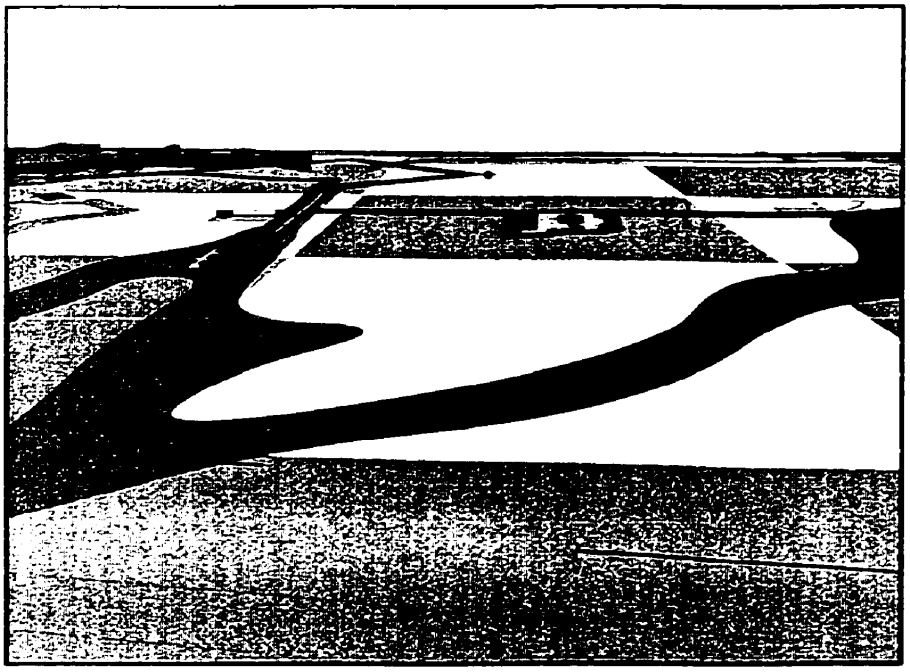
Grass around the terminal building should be mown in directions that are most effectively seen from the observation lounge. (figure 54) Due to the elevation of the observation lounge the grassed areas beyond Apron I will be seen from a low angle. Complex patterns will not be clear.

The pattern of mowing has been designed to radiate away from the terminal building. Lines that are parallel to the direction of view will be visible, while lines running perpendicular to the sight lines will be hard to see.

The radiating pattern represents the movement of people from the airport out into the world. The terminal is the focal point of airport operations, the starting location for travellers. From the air, the radiat-



55 - Aerial perspective of the proposed plan looking towards the South. (plan detail)



56 - Aerial perspective of the proposed plan representing the view out the side of a plane while taking-off or landing. (plan detail)

ing pattern also points to the terminal building. This highlights the activity centre to people landing at the airport.

- **Benefits**:

i) This is an easy an inexpensive way to add visual meaning to the landscape that relates to the airport and its context.

ii) Cost savings could be realized with a reduced amount of area requiring frequent mowing. Low mowing should be restricted to the runway and taxiway strips. The majority of the secure zone will require only occasional mowing.

- **Conflicts**:

i) It will require some attention to maintain the patterns on the ground. Areas with different heights need to be marked out to insure they are consistently mown.

Conflict Remedies:

i) Patterns should not be so complex that they are difficult and time consuming to maintain. Large, bold patterns would not only be the most clearly seen from the air, they are easier to create and maintain.

3. Seeding different species in separate areas

- **Definition**:

Currently Timothy Grass is over-seeded in most of the field areas as a plant that does not provide a food or shelter attraction. Other grass species can be seeded into some areas to provide a colour and texture contrast. Any chosen species also cannot provide an attraction to wildlife.

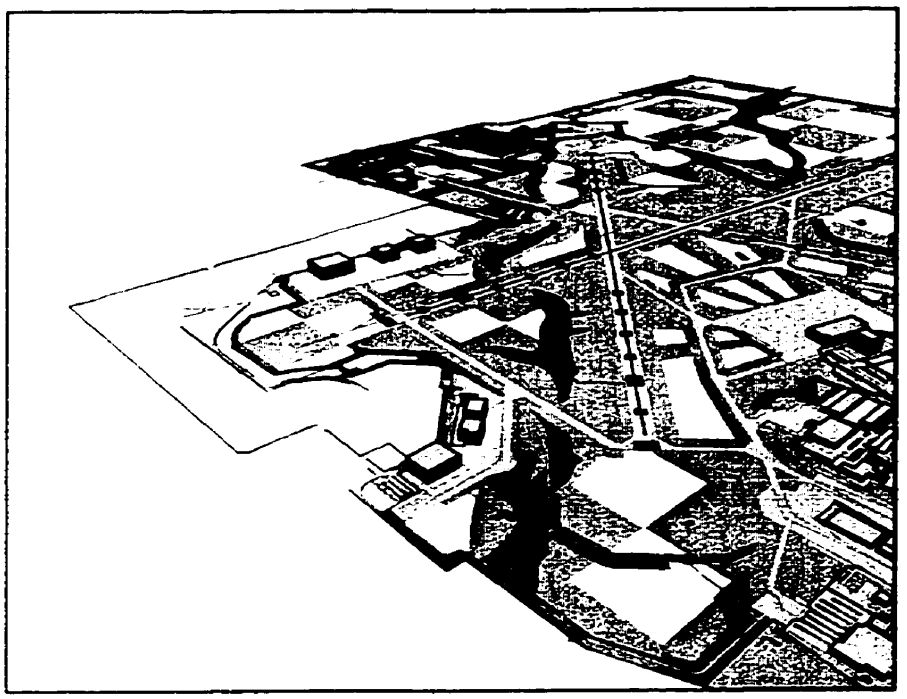
Sheep Fescue (*Festuca ovina*) is the recommended grass for overseeding in addition to the Timothy Grass. The two grasses have slightly different textures and colours. Areas that are maintained at 12 inches height should be seeded with Timothy Grass, which is a taller growing species. Areas which are maintained at 6 inches in height should be seeded with Sheep Fescue, a much shorter grass. This will prevent mowing from decreasing the abundance of the different species. Timothy grass can disappear from an area if it is constantly mown, while fescue is more likely to survive close cropping. (Johnson et al. 1995)

- **Benefits**:

i) Seeding areas with alternate vegetation should enhance the contrast between different areas. This can increase the clarity of landscape patterns.

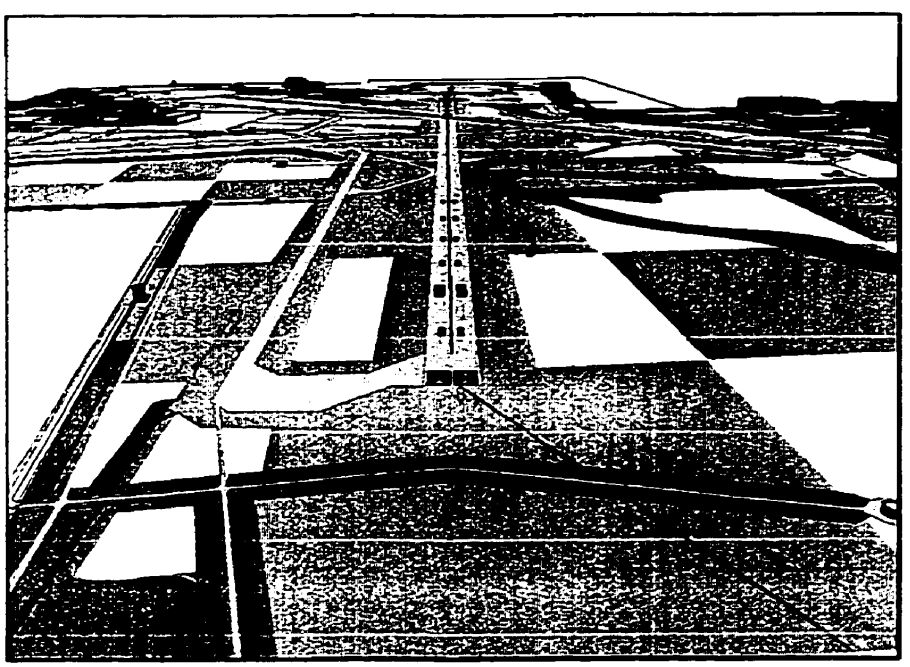
- **Conflicts**:

i) There is little difference in costs or effort for adding a different species to the seeding regime. This practice will only require some additional attention to apply certain seeds in specific areas. There are no foreseeable conflicts.



57 - Aerial perspective of the proposed plan looking towards the North-West. (plan detail)

58 - Aerial perspective of the proposed plan looking South along the line of runway 18-36. (plan detail)



4. Patterning the wildlife control measures

- **Definition**:

Wildlife control measures such as flags and streamers are useful to provide control. The placement of these measures provides another possibility for landscape interest.

While flags will be too small to be easily seen from the air, they can provide additional patterning to the area around the terminal building. Flags and streamers can be set along the lines of the radiating patterns to enhance the contrast between the different heights of grass.

Black flags are the most effective at scaring wildlife, but other colours can be used as well. The Canadian flag, the provincial flag, the Winnipeg coat of arms, and flags with the airport logo all relate information about the airport and region. These will be especially visible to people in planes taxiing towards and away from the runways, providing a gesture of welcome to this place.

- **Benefits**:

i) Wildlife control measures are necessary. Measures such as flags and streamers provide a visual dimension that adds to the landscape image. Highly visible measures can be located so that they are seen from aircraft on the runways, or from the terminal building. These will mainly scare birds but will also provide visual interest for free.

- **Conflicts**:

i) Wildlife can become *habituated* (accustomed) to flags and streamers.

- **Conflict Remedies:**

i) Re-positioning of flags and streamers, or variations in colour or shape, can help to prevent habituation. Other control measures should be used in combination with flags and streamers. Any wildlife that becomes habituated should be relocated or forceably removed.

Existing features form patterns that inform observers about the character of the airport. They relate a mainly functional facility, but do not tell much about the local regional identity of the airport. The design recommendations can provide additional layers of meaning that communicate social and natural patterns which are unique to Winnipeg and Manitoba.

CHAPTER FOUR: CONCLUSIONS

The Winnipeg International Airport provides an excellent example for studying nature-based solutions to issues created by technology. The heavy restrictions required by such a facility limit the types of solutions available. The revised plan displays how the landscape can play a role in difficult conditions.

This research meets the two main objectives stated in the beginning:

1) Reduce the negative impacts of operations at the airport on the local environment and community.

2) Design the landscape in a way that provides interest and meaning to those viewing the airport.

These objectives are met through recommendations to modify the landscape of the secure zone at the airport.

Objective 1 - Reducing negative impacts

To reduce negative impacts of airport operations, the following recommendations are proposed:

1. Addition of filter strips and buffer zones

Vegetated buffer zones can provide filtration to suspended and dissolved contaminants, and reduce run-off volumes and velocities. They also help to display the natural and functional patterns of the airport.

2. Convert drainage pipes into open ditches

Exposing the drainage water to air and vegetation will help filter and break down pollutants. The most important pipes to convert are those draining Aprons IV and V.

3. Additional detention ponds

Additional detention ponds should be added to provide temporary storm water storage and control run-off quantities and velocities. Detention ponds can also help filter contaminants.

4. Provide inflow detention for Truro Creek

A small weir should be constructed within the secure zone near the inflow of Truro Creek, providing filtration and water flow regulation.

5. Vegetation management changes

i) Mowing practices should be modified to support environmental goals.

ii) The practice of over-seeding grass areas with species such as Timothy grass (*Phleum pratense L.*) should be continued.

iii) Sheep Fescue (*Festuca ovina var. saximontana*) should also be overseeded into field areas. Ongoing research should be undertaken to find additional species that do not provide food or shelter value to animals.

6. Creation of contaminated snow storage areas

A specific snow storage area should be created far from the creeks at the airport. Storage areas will hold contaminated snow and allow for decomposition of de-icing fluids.

7. Provide additional spill and leak prevention for high risk areas

Areas with chemical or petroleum product storage should feature berms or walls to prevent spills or leaks from spreading.

8. Conduct tests with alternate de-icing fluids

A number of alternative de-icing chemicals have been developed to be environmentally friendly. The Winnipeg International Airport should research and experiment with de-icing fluids that could reduce the current impacts.

9. Additional wildlife control

Some of the proposals may attract wildlife. Measures should be taken to counteract that attraction.

i) Noisemakers should be added.

ii) Flags and streamers should be installed.

iii) Monitoring by a control officer can determine areas that require additional wildlife control.

iv) Additional wildlife control options should be explored.

v) Physical barriers should be established to prevent wildlife from gathering in problem areas.

10. Keep all storage tanks above ground

All fuels, oils, and chemicals should be stored above ground.

11. Negotiate with upstream neighbours

The Winnipeg Airports Authority should dialogue with neighbours to help reduce local pollution.

Objective 2: Designing the landscape

The primary recommendations address identified environmental and social issues. Design recommendations discuss how the landscape can be modified to be interesting and meaningful to view.

Functional, natural, and social patterns provide visual meaning by communicating the unique identity of the airport and the region. Symbols and patterns can tell a story about the features of the land and how it is used.

1. Buffer zone modifications

Buffer zones within the secure zone should be altered to increase their visual presence. The vegetation can tell a story about the natural and airport drainage systems, and provide additional run-off control and filtration.

2. Mowing at different heights

Grass fields should be mown at heights of six or twelve inches. The contrast between the two heights can be used to create patterns on the land.

3. Seeding different species in separate areas

Sheep Fescue and Timothy Grass can be seeded into separate areas to provide a colour and texture contrast.

4. Patterning the wildlife control measures

Wildlife control measures such as flags and streamers can be placed around the terminal building to enhance the radiating patterns created by mowing.

Maintaining airport operations

Allowing the airport to operate normally is absolutely essential. Proposals that do not provide for airplanes will interfere with the primary reason for the airport's existence. Ideas that hamper airport operations will be automatically rejected.

Full airport operations are necessary to provide the level of service the public requires and to allow the airport to generate revenue to function. As the population of the region increases, the need for air travel will increase. The Winnipeg Airports Authority is actively promoting the airport as a strategic hub for cargo and courier services. Maintaining fiscal health will allow the airport to provide the necessary services to the city. Generating revenue will insure that the airport is able to maintain safety standards and implement improvements.

Goals and benefits

Strategies that can achieve the desired environmental goals, and also provide operational or economic benefits, present the most value. The Winnipeg Airports Authority is under pressure to provide a vital public service as efficiently and economically as possible. Ideas that provide environmental benefits to the detriment of the airport's functions will not be acceptable.

The airport has also recognized the importance of working together with the communities of the City of Winnipeg. Environmental improvements display a willingness to listen to and address public issues. The exchange of ideas among all stakeholders should benefit the Winnipeg International Airport, the environment, airport neighbours, and the City of Winnipeg.

Improvements to the secure zone landscape can reduce negative impacts of airport operations on the environment and local residents, and establish a strong sense of place. The airport can gain a unique identity through the landscape. The realization of the two main goals could allow the airport to function better environmentally, and as a service facility.

A revised landscape plan can provide valuable benefits as well as challenges. Outlining all of the benefits and potential conflicts allows for the best judgement of the merits of the proposed plan. Realizing the challenges inherent in each idea defines how they should be used within the existing airport framework. Advantages will be gained from individual ideas, and the combination of ideas into the larger strategy.

Undertaking environmentally and socially conscious measures is a noble endeavour. The Winnipeg Airports Authority has issued a vision statement to be: "recognized as safe, innovative and progressive; financially strong; a leader in pursuit of globally emerging opportunities; and a source of pride to all." (Winnipeg Airports Authority Inc., 1999) The Airports Authority can confirm their intentions with this revised landscape plan.

Bibliography

Air Navigation System Requirements Branch. Aerodrome Standards and Recommended Practices: Fourth Edition. Ottawa: Transport Canada Aviation. March 1993.

Airport Facilities Committee. Airport Facilities for Greater Winnipeg. Winnipeg: The Winnipeg Board of Trade. January 8, 1945.

Appelbe, Alison. "Airport opts for dog days to control the birds." The Vancouver Courier. Vol. 90. No. 93. November 21, 1999. p.14.

Bezte, C. and D.S. MacDonell. An Investigation of Water Quality in Truro Creek 1998. Winnipeg: North/South Consultants Inc. August, 1998.

Bezte, C. and D.S. MacDonell. Water Quality Monitoring in Truro and Omand's Creeks 1999. Winnipeg: North/South Consultants Inc. December, 1999.

Boorstin, Daniel J. The Republic of Technology: Reflections on our future community. New York: Harper and Row, Publishers. 1978.

Bronskill, Jim. "A bumper year for crop circles fails to reap answers" The Vancouver Sun. Vancouver: Southam News. February 5, 2000.

de Blij, H.J. and Peter O. Muller. Physical Geography of the Global Environment. Toronto: John Wiley & Sons, Inc. 1996.

Callicott, J. Baird. Intrinsic Value in Nature: a Metaethical Analysis. Bloomington: Indiana University. 1995.

Craig, Drew A., B.Sc. Assistant Wing Environmental Officer, Wing Construction Engineering Squadron, 17 Wing, Department of National Defence. Personal communication. June, 1997.

de la Croix, Horst, Richard G. Tansey, and Diane Kirkpatrick. Art Through The Ages: Ninth Edition. Toronto: Harcourt Brace Jovanovich, Publishers. 1991.

Dramstad, Wenche E., James D. Olson, and Richard T.T. Forman. Landscape Ecology Principles in Landscape Architecture and Land-Use Planning. Washington, DC: Harvard University Graduate School of Design, Island Press, and the American Society of Landscape Architects. 1996.

Emery, Malcolm, for the Ecological Parks Trust. Promoting Nature in Cities and Towns: A Practical Guide. Dover: Croom Helm Ltd. 1986.

Environmental Services - Safety and Technical Services - Airports Group. Wildlife Control Procedures Manual. Transport Canada. November, 1992.

Fleming, William. Arts And Ideas: Seventh Edition. Toronto and Montreal: Holt, Rinehart and Winston, Inc. 1986.

Forman, R. T., and M. Godron. Landscape Ecology. Toronto: John Wiley & Sons. 1986.

FPG International LLC. Stock Directory Science + Industry. Hong Kong: FPG International LLC. 1998

FPG International LLC. Selects Volume 8. Hong Kong: FPG International LLC. 1998

Gray, D.M., and D.H. Male. (Eds). Handbook Of Snow: Principles, Processes, Management, And Use. Willowdale, Ontario: Pergamon Press Canada. 1981.

Hodges, Jef. Prairiesource.com: The Native Grass Manager. "Beating Weeds In Native Grass Planting". World Wide Web Site *http://prairiesource.com/pages/newsletter/* . 1999.

IDG Stanley. Airport Area Plan: North and West of the Winnipeg International Airport. Winnipeg: Airport Area Plan Planning Committee. 1996.

Jellicoe, Geoffrey, and Susan Jellicoe. The Landscape of Man: Shaping The Environment From Prehistory To The Present Day. London: Thames And Hudson Ltd. Third Edition. 1995.

Jeung. Rodney A. Urban Stormwater Pollution: An Investigation Of The Problem And Its Control. Ithaca: Cornwall University Program in Urban and Regional Studies. January. 1978.

Johnson. Derek. Linda Kershaw. Andy MacKinnon. and Jim Pojar. Plants of the Western Boreal Forest and Aspen Parkland. Edmonton: Lone Pine Publishing. 1995.

Lanarc Consultants Ltd. Cf. Colophon. Community Greenways: Linking Communities To Country. And People To Nature. British Columbia: Ministry of Environment. Lands and Parks: Canada: Department of Fisheries and Oceans. 1995.

Lanarc Consultants Ltd. Cf. Colophon. Stream Stewardship: A Guide For Planners and Developers. British Columbia: Ministry of Environment. Lands and Parks: Ministry of Municipal Affairs: Canada: Department of Fisheries and Oceans. 1994.

Lyle. John Tillman. Regenerative Design for Sustainable Development. Toronto: John Wiley & Sons. Inc. 1990.

Martens. Kathleen. "Airport Blamed For River Stench: Residents say deicing chemicals make them ill." The Winnipeg Sun. Winnipeg: The Winnipeg Sun. June 22. 1998.

McClain. William E. Prairie Establishment and Landscaping: Natural Heritage Technical Publication #2. Springfield. IL: Division of Natural Heritage. Illinois Department of Natural Resources. 1997.

McLachlan. Ted. and Alf Simon. Nature In Parks. Parks In Nature. Winnipeg: University of Manitoba. Department of Landscape Architecture. Report for the City of Winnipeg Parks and Recreation Department. June. 1996.

M. M. Dillon Limited. Winnipeg Area Airports System Study: Storm Drainage Study. Winnipeg: Transport Canada. September. 1976.

Newbury. Robert W.. and Marc N. Gaboury. Stream Analysis and Fish Habitat Design - A Field Manual. Winnipeg: Newbury Hydraulics Ltd.. The Manitoba Habitat Heritage Corporation. and Manitoba Natural Resources. 1993.

Parham. George. Edge Of The Prairie. www.bigeastern.com/eotp/ep_home.htm. August. 1999.

Patterson. Freeman. Portraits of Earth. Toronto. Ontario: Key Porter Books Limited. 1997.

Radzius. V.A. Winnipeg International Airport Truro Creek Drainage: Snowmelt and Spring Runoff Simulation. Winnipeg: Transport Canada. Airport Professional Services Branch. Surface Structures Division. October. 1981.

Riley. Ann L. Restoring Streams In Cities: A Guide For Planners. Policymakers. and Citizens. Washington. D.C.: Island Press. 1998.

Shewchuk. Leanne. Winnipeg Airports Authority Environmental Coordinator. Personal communication. July. 2000.

Stein. Achva Benzinberg. "The Urban Landscape and Technology." On Architecture. The City. and Technology. Washington. DC: Association of Collegiate Schools of Architecture. 1990.

Switzer. Maurice H. Catch Manitoba's Great Spirit. Winnipeg: The Winnipeg Free Press. 1994 Edition.

Taylor. Robert R. The Manitoba Landscape: A Visual Symphony. Winnipeg: Windermere House Publishing. 1990.

Thayer. Robert L. Gray World. Green Heart: Technology. Nature. and Sustainable Landscape. New York: John Wiley & Sons. 1994.

Thompson. J. William. "The Poetics of Stormwater." Landscape Architecture. Vol. 89. No. 1. January. 1999. pp.58.63. 86-88.

Transport Canada. Winnipeg International Airport: Airport Master Plan. Winnipeg. September. 1984.

Vancouver International Airport Environmental Assessment Panel. Vancouver International Airport Parallel Runway Project: Report of the Environmental Assessment Panel. Ottawa: Federal Environmental Assessment Review Office. August. 1991.

Waldheim. Charles. "Aerial Representation and the Recovery of Landscape." Recovering Landscape: Essays in Contemporary Landscape Architecture. New York: Princeton Architectural Press. 1999.

Water Survey of Canada. Omand's Creek and Truro Creek Water Survey of Canada Published Data: 1978-1989. Winnipeg: Water Survey of Canada. 1989.

Webster's Ninth New Collegiate Dictionary. Markham, Ontario: Thomas Allen & Son Limited. 1983.

Whyte, William H. The Last Landscape. Garden City, New York: Doubleday & Company, Inc. 1968.

Winnipeg Airports Authority Inc. Community Character...Global Reach. Winnipeg: Winnipeg Airports Authority Inc. 2000.

Winnipeg Airports Authority Inc. Long Term Strategic Plan: 1999-2015. Winnipeg: Winnipeg Airports Authority Inc. April, 1999.

Appendix

Glossary Of Terms

Aerodrome: Any area of land, water, or other supporting surface used or designed, prepared, equipped, or set apart for the arrival and departure, movement, or servicing of aircraft. This includes any structures connected with these functions.

Bioswale: A drainage swale planted or designed to slow the flow of runoff water in order to allow increased infiltration, evaporation, and evapotranspiration. A bioswale is used to help mitigate the problems associated with fast runoff rates and filter some pollutants and sediments from runoff water. (Thompson, 1999)

BOD: (Biological Oxygen Demand)

Chernozem: A dark-coloured zonal soil with a deep rich humus horizon found in regions of temperate to cool climate, such as the Great Plains of North America. (Webster's, 1983)

Cultural: Human made. Human built machines and systems. Through creating what is not natural, or modifying nature, humans create a cultural objects, systems, or environments.

Development: The construction of human systems or buildings on a piece of land. The alteration of a natural environment for the use of people.

Erosion: The detachment and transport of soil particles. (Jeung, 1978) Erosion can be caused by water or wind scouring the soil surface. The higher the wind or water velocity, the larger the size of sediments that can be carried.

Frangibility: The ability of an object to break, distort, or yield to impact as a part of that object's design. Frangible objects are designed to present a minimum hazard in case of impact.

Habituate: To become accustomed to a place or thing.

Icon: A pictorial representation. An image that represents another meaning or object, or that has embedded meaning.

Infiltration: Infiltration is the process of water percolating into the soil. Infiltration provides the recharge of groundwater, which feeds creeks and streams between rainfalls; moisture around the roots of vegetation; and supports life beneath the ground. In addition, infiltration of run-off provides filtration of suspended and dissolved particles and chemicals. Soil, plants, and organic matter all provide filtration.

Leave zone: A leave zone is an area which is excluded from active maintenance. Leave zones are completely removed from maintenance regimes or given only a minimal amount of maintenance. Natural succession is allowed to re-establish and determine the vegetation communities for an area. (Lanarc Consultants Ltd., 1994)

Mollisol: A soil with a thick, dark surface layer high in alkaline content and at least 50 percent saturated with basic cations (calcium, magnesium, potassium, sodium). Most often associated with tall or short grassland regions. This is the dominant soil of the Great Plains of North America. (de Blij et al. 1996)

Natural: growing without human care - not cultivated - having a form or appearance found in nature

Naturalistic: Created or designed to be as that of nature; Human-made to be like true natural conditions. Not truly the work of Nature, but to resemble the work of Nature or include Nature and natural systems.

Naturalization: Landscaping in a way that mimics, resembles, or restores natural forms and systems. To become established as if native. A form of landscape design where the intent is to use the laws of nature to create a more

sustainable system.

Nature: The nonhuman world. Aspects of the earth which are not created by humans. What is not human or human-made. Natural. All that is devoid of the properties we associate with humans. Humans are part of Nature as well, but humans and their creations are classified as culture and cultural for definition's sake.

Off-site pollutants: Pollutants that originate from sources outside the boundaries of a site, but might be found within a site. Wile they originate from without, they affect the area in question.

On-site pollutants: Pollutants that originate from sources within a site. These pollutants will affect various conditions of the site, and could affect adjacent, or even distant, areas.

Over-seeding: The process of spreading additional seeds over a vegetated area. Over-seeding can be used to add new species of plants into an existing plant community, or to increase the density of specific existing species.

Pest: Any creature, animal or insect, that could pose a hazard to the safety of operating aeroplanes. Pest control is one of the priorities of any airport, due to the risk to human life and the extreme expense of collision repair. A variety of methods to control pests are employed by airports.

Pre-development: The condition or state of an area or thing before humans altered it for their purposes.

Restoration: Rebuilding to a previous form. Re-creation of previously existing conditions. A representation or reconstruction of the original form.

Runoff: Overland flow of precipitation or melt water. Run-off occurs when precipitation exceeds the infiltration rate. As precipitation continues, and infiltration rates decrease, run-off rates increase. (De Blij et al, 1996)

Safety zones: (Runway strips, taxiway strips, setbacks, clearways, etc)

Sedimentation: The deposition of sediments. Sediments are suspended in flowing water. Deposition occurs when water velocity slows and no longer has the energy to carry sediments.

Sustainable: Not requiring outside assistance or inputs to continue operation. An ecological theory where a natural system operates as a closed system, not requiring input from human sources.

Tributary ditch: A small ditch that feeds (drains) into a larger channel.

Urban watershed: The land within an urbanized area that empties into a water body such as a lake or river.

Watercourse: A creek, stream, river, or other channel, natural or human made, through which water flows.

Watershed: A watershed is a basic collection unit of the water that falls as precipitation. Heights of land cause rain or snow to be collected by systems of creeks, streams, to be deposited into ponds, lakes, rivers, and eventually the ocean.