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*"THE USE OF NATIVE PLANT SPECIES IN ROADSIDE
VEGETATION MANAGEMENT FOR THE CANADIAN PRAIRIE
REGIONS: AN ECONOMIC, TECHNICAL,
AND ENVIRONMENTAL ASSESSMENT"*

*A practicum submitted to the Faculty of Graduate Studies of the University
of Manitoba in partial fulfilment of the requirements of the degree of
Master of Natural Resources Management.*

By

Ms. Jacqueline D. Durant

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Abstract

This study was undertaken to determine the feasibility of using native plant species in roadside vegetation management in the prairie regions of Canada. Traditional roadside vegetation management (RVM) practices of repeated mowing and chemical spraying have been costly to the taxpayer and to the environment and therefore alternative practices are being assessed.

The economic, technical, and environmental costs and benefits of using native species in roadside vegetation management practices were evaluated using a survey methodology. The survey, which was conducted between October 1992 and February 1993, was designed by the researcher to collect information from twelve Canadian and fifty American Departments of Transportation (DOTs). In order to identify and evaluate the programs of departments that were using native vegetation in their roadside rights-of-way (ROW) management practices, the survey was divided into three sections. The first section was answered by DOTs currently managing native vegetation. The second section was answered by departments that had been managing native vegetation but had discontinued this management practice. The last section was completed by DOTs that had never managed native vegetation in roadside ROW management.

Results of the survey indicated that thirty state and four provincial DOTs had incorporated native vegetation in roadside ROW management, and had determined that this practice was economically and environmentally feasible. In some jurisdictions initial costs for specialized equipment, native seed, and expertise were high, however, when all tangible and intangible costs were included, the long-term costs of managing native species were less than the costs of managing traditional practices and vegetation. The most appropriate sites for preserving, planting and restoring native vegetative species were rural areas, rest areas, and tourist routes. Urban areas with intensive development were identified as unsuitable locations. Using native vegetation in roadside ROW was found to reduce the need for intensive maintenance, inhibit the growth of weeds and non-native tree species, reduce soil erosion, increase water retention, preserve the natural integrity of the landscape, and beautify the roadside ROW.

The study results indicated that preserving, planting, restoring and maintaining native prairie vegetation in roadside ROW was an economically and environmentally sustainable method of vegetation management for the Canadian prairie regions. The recommendations made on the basis of this study will serve as a guide-line for decision makers considering the management of native prairie species in roadside ROW.

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TABLE OF CONTENTS

	Page
Abstract	i
Acknowledgements	ii
List of Figures	v
List of Tables	vi
List of Plates	vii
 Chapter I INTRODUCTION	 1
1.1 Background	1
1.2 Problem Statement	7
1.3 Purpose and Objectives	7
1.4 Methodology	8
1.5 Description of Study Area	11
1.6 Practicum Format	11
1.7 Definition of Terms and Acronyms	13
 Chapter II MANAGING VEGETATION IN ROADSIDE RIGHTS-OF- WAY	 15
2.1 Introduction	15
2.2 Manitoba Roadside Rights-of-way	15
2.3 Native Vegetation in the Prairie Regions	19
2.4 Ecological and Management Studies of Rights-of-way	 25
2.5 Financing Roads in Canada and the United States . .	28
2.6 Roadside Vegetation Management Programs in the United States	 29
2.7 Managing Native Prairie Vegetation	38
2.8 Summary	45
 Chapter III SURVEY RESULTS AND ANALYSIS	 46
3.1 Introduction	46
3.2 A Survey of the Use of Native Plant Species in Roadside Vegetation Management	 46
3.3 Using Native Vegetation in Roadside Vegetation Management: Section I	 52

3.4	Attempted Roadside Native Vegetation Use: Section II	76
3.5	Traditional Roadside Vegetation Management: Section III	78
3.6	Summary and Analysis of Survey Results	79
Chapter IV	SUMMARY, CONCLUSIONS AND RECOMMENDATIONS . .	95
4.1	Summary	95
4.2	Conclusions	97
4.3	Recommendations	103
BIBLIOGRAPHY		107
PERSONAL COMMUNICATIONS		114
APPENDICES		115
Appendix 1 - Survey Results and Survey Respondents . . .		115
Appendix 2 - Maintenance Performance Standard 300-1, Mowing		148
Appendix 3 - Estimated Preliminary Cost Schedule		153

LIST OF FIGURES

	Page
Figure 1. A North American roadside right-of-way	3
Figure 2. Roadside vegetation management study area	12
Figure 3. Historical distribution of major native prairie types	21
Figure 4. The prairies and aspen parkland in western Canada	21
Figure 5. Minnesota wildflower routes	34
Figure 6. Distribution of survey respondents	50

LIST OF TABLES

	Page
Table 1. Reasons for starting the roadside vegetation management programs that use native vegetation	53
Table 2. Suitable and unsuitable sites for native vegetation management in roadside rights-of-way	55
Table 3. Importance of using vegetation indigenous to the local area for restoring and planting	57
Table 4. Seed mixtures used when seeding native vegetation in roadside rights-of-way	59
Table 5. Techniques used when seeding native vegetation in roadside rights-of-way	61
Table 6. Iowa IRVM planting and maintenance equipment cost . . .	66
Table 7. Relative costs of native and traditional seed	68
Table 8. Relative costs of planting native and traditional vegetation	69
Table 9. Costs of planting native and traditional vegetation	70
Table 10. Relative costs of mowing and herbicide applications	71
Table 11. Maintenance cost of native vegetation in roadside rights-of-way	73
Table 12. Traditional vegetation cost and native vegetation costs . .	82

LIST OF PLATES

	Page
Plate 1. Mixed-grass prairie	22
Plate 2. Tall-grass prairie	22
Plate 3. Minnesota wildflower route	33
Plate 4. Minnesota wildflower route sign	33
Plate 5. Iowa roadside prairie restoration sign	37
Plate 6. Wisconsin roadside native planting	42
Plate 7. Truax native seed drill	67
Plate 8. Equipment for prescribed burning	67

Chapter I

INTRODUCTION

1.1 BACKGROUND

Canada's prairie regions are a mosaic of urban, agricultural and natural environments. These areas have been greatly modified in the last one hundred years by agricultural practices, urbanization, and industrialization. These modifications to the prairie regions have resulted in a continual alteration of the natural environment. The natural environment that still remains in the developed areas of the prairie regions includes linear landscape features such as farm fencerows, railway and roadside rights-of-way (ROW). Although roadside ROW are considered natural environments they are intensively managed by constant mowing and spraying with herbicides. These management activities are costly to the taxpayer and to the environment. Alternative roadside vegetation management (RVM) practices are therefore being evaluated to assess their potential for reducing costs and enhancing the natural environment.

The roadside right-of-way is the area that extends from the outer edge of the road shoulder to the limits of the highway property and generally consists of about 5 - 15 m (15 - 50 ft) of grassland (Albanese 1989) (Figure 1). Roadside ROW are unique components of the landscape which have technical and environmental importance. They are unique because while the right-of-way is constantly exposed to harsh climatic conditions and disturbed by human activities, they still provide habitat for a variety of flora and fauna that can tolerate the conditions. As well, movement corridors created by roadside ROW enable wildlife to move across potential ecological barriers such as agricultural fields.

Another characteristic of roadside ROW is that they provide motorists with safe distances from immovable objects on private and public land and allow for safe sight distances for curves ahead. Rights-of-way also serve as a drainage area for runoff from the road surface and adjacent land.

This study reviewed RVM practices used in the Canadian prairie regions, following which Manitoba was selected for a closer examination. The geography, climate and vegetation communities are similar in all prairie regions and the analysis of Manitoba was considered to be representative of the Canadian prairie region. The Province of Manitoba has an extensive system of roadside ROW with approximately 23,200 km (14,400 mi) of highway, and approximately 61,000 ha (150,700 acres) of mowable roadside ROW (MHT

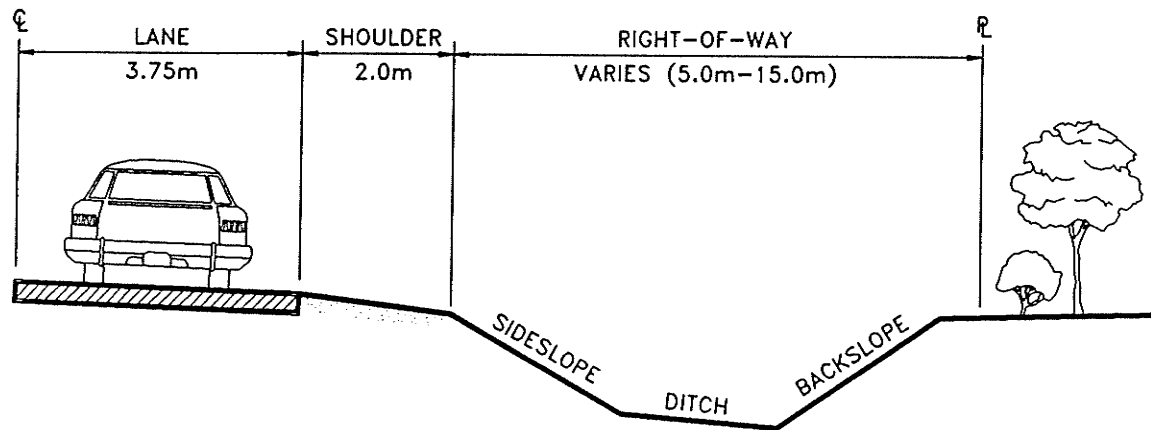


Figure 1. A North American roadside right-of-way



1992). Manitoba Highways and Transportation (MHT) is the provincial department responsible for the management of provincial highways and roads, while local municipal governments manage municipal roads within their jurisdiction.

Manitoba Highways and Transportation Operations and Maintenance Division provides for the construction and maintenance of the provincial highway system and assists municipal and local governments in developing and maintaining the local transportation infrastructure. The Division has a program that deals specifically with the maintenance of the roadways and ROW. The main objectives of the MHT maintenance program are to preserve highway facilities, accommodate highway users safely and with reasonable convenience, and to conserve the aesthetic values of the ROW (MHT 1991). Some of these objectives are achieved by employing a variety of traditional maintenance activities such as mowing, herbicide application, brush cutting, and litter removal. There are, however, considerable economic and environmental costs associated with these traditional vegetation management activities.

Public attitudes concerning the intensive management of roadside ROW such as that practiced in Manitoba have been changing in the last two decades. The earlier preference for a highly manicured ROW is shifting to a preference for a more natural ROW. In Vermont, for example, the public acceptance of reduced mowing and wildflower plantings has been high (Dusablon 1988). Local garden clubs in Michigan and Illinois showed a great deal of interest and

cooperation in their Departments' roadside wildflower planting programs (Stainton 1987, Saunders 1987).

In thirty-four Canadian and American jurisdictions, alternative management policies and practices have been initiated to address the economic and environmental costs associated with traditional RVM programs. These RVM programs involve the preservation, restoration, or planting of native vegetative species in roadside ROW.

Although management of roadside vegetation has been carried out since the early 1920s and 1930s, the management of native vegetative species in many American jurisdictions only began in the 1970s (Elmhirst and Cain 1990). During the 1970s the cost of fuel increased rapidly due to the marketing strategy of the Organization of Petroleum Exporting Countries (OPEC). The restricted availability and higher costs of fuel increased the costs of mowing and spraying in roadside ROW. The increasing costs of these activities led to the reduction of roadside vegetation maintenance, and the initiation of alternative management strategies. These alternative strategies included the incorporation of native vegetation in roadside management practices.

Another strategy initiated in the 1970s that encouraged the establishment of wildflowers in highway ROW was the "Operation Wildflower" campaign in the United States. The campaign was instituted in 1973 by the Federal Highway Administration in cooperation with the Federated Garden Clubs of America and is described more fully later in this document (Harper 1988).

Several states developed advanced RVM programs that managed native vegetative species in their roadside ROW. The Minnesota Department of Transportation (DOT) and Department of Natural Resources for example, have conducted vegetation inventories to identify roadside native prairie remnants. The inventories lead to the preservation of native prairie remnants in Minnesota's roadside ROW which are now part of the state "Wildflower Route" Program. Another example of an advanced RVM program is Iowa's "Integrated Roadside Vegetation Management" Program that establishes and maintains low maintenance roadsides. Native prairie vegetation is used whenever possible in new and regraded rural roadside ROW.

The preservation, restoration, and planting of native vegetation in ROW has been conducted in several American prairie states with successful results. Expanding the use of native vegetation in roadside ROW is a management option which could reduce economic and environmental costs associated with traditional roadside ROW management activities in the prairie regions of Canada.

1.2 PROBLEM STATEMENT

Throughout North America the annual establishment and maintenance of vegetation in roadside ROW is a very costly government activity. Increasing economic constraints have reduced the funds available to many government departments and as result, roadside vegetation managers are having to reconsider their RVM programs. Current RVM policies have to be reviewed and new policies are required in order to manage with dwindling resources. More economic techniques will have to be developed to manage roadside ROW, while maintaining a high level of safety and aesthetics. This situation is true also of Manitoba. No study has been conducted to date on the cost effectiveness and suitability of using native vegetation as a management alternative in Canadian ROW. Current traditional RVM practices have significant tangible and intangible economic and environmental costs, and therefore alternative roadside management practices will have to be developed to deal with these costs.

1.3 PURPOSE AND OBJECTIVES

The primary purpose of this study was to assess the economic, technical, and environmental feasibility of using native plant species in roadside vegetation management in the prairie regions of Canada.

The specific objectives were:

1. to identify, review and assess the economic, technical, and environmental factors associated with roadside vegetation management programs in Canadian and American jurisdictions that are presently using, or have in the past attempted to use, native plant species;
2. to conduct a case study of the Province of Manitoba's traditional roadside ROW vegetation management practices and to generalize the results of this study to the Canadian prairie regions;
3. to compare the benefits and costs of using native plant species in roadside vegetation management programs relative to the benefits and costs associated with traditional roadside vegetation management practices currently used in the Province of Manitoba; and
4. to provide recommendations regarding cost effective and environmentally sustainable alternatives for existing roadside vegetation management practices in the prairie regions of Canada .

1.4 METHODOLOGY

The methods used in this study included a literature review, data collection using a survey questionnaire, personal and telephone interviews and finally data evaluation.

1.4.1 Literature Review

In order to investigate RVM policies, practices, and programs a literature review was conducted. A broad range of source materials were reviewed to ensure that technological, ecological, economic, political, social and aesthetic components of RVM were considered.

Using Manitoba as an example of traditional RVM in the Canadian prairie regions, information pertaining to current practices was collected from MHT and Manitoba Agriculture. Carl Wiebe, Russ Farrell and Herb Mahood were contacted for sources of information on maintenance costs and techniques. Management programs and policies of MHT were reviewed to gain a better understanding of management practices used in Manitoba. Literature concerning native vegetation, roadside ecology and Canadian and American RVM programs were found in scientific journals, conference proceedings and government documents. Documents describing the use of surveys in collecting information were also reviewed.

1.4.2 Data Collection

Survey

The mail-out survey (Appendix 1) was designed by the researcher to identify those North American provinces or states which were using native vegetation in their roadside vegetation management programs. The survey was based on techniques described in the survey literature and suggestions from people with experience in ROW management. Analysis of the completed survey results were stratified into three groups: 1) those jurisdictions that were using native species of vegetation in roadside management program; 2) jurisdictions which have attempted to use native prairie species; and 3) those which have not yet tried this type of vegetation in their RVM program. The survey

collected information from the departments on native vegetation regarding current and past practices, the costs and benefits of these practices and public attitudes towards using native vegetation in RVM programs.

One hundred and ten surveys were sent out by mail on October 28, 1992, after being pre-tested in early November by three local individuals involved in ROW management.

Personal and Telephone Interviews

Preliminary information on RVM was obtained from provincial and state Departments by phone and by mail to determine which were the most developed programs that could be used for a focused interview. Kirk Henderson of the Iowa Integrated Roadside Vegetation Management Office was the subject of an informal interview on September 27, 1991. Iowa had one of the more advanced roadside vegetation management jurisdictions in North America.

1.4.3 Data Evaluation

The results of the survey were reviewed and evaluated in terms of the technical, environmental and economic factors associated with using native vegetation along roadside ROW and compared to the traditional vegetation management practices used in Manitoba.

1.5 DESCRIPTION OF STUDY AREA

The primary study area for this research included roadside ROW in Canada and the United States. The traditional roadside management practices of the prairie regions of Canada were studied in more detail. Finally, a closer study of Manitoba's RVM programs was conducted (Figure 2).

1.6 PRACTICUM FORMAT

The practicum document consists of four chapters. Chapter 1 describes the practicum proposal with general information about the study, and the methods used to conduct the research. Chapter 2 outlines in some detail the management of native prairie vegetation in roadside ROW based on a review of the literature and interviews with experts in the field. In Chapter 3 the results and analysis of the survey are presented. Chapter 4 provides conclusions and recommendations.

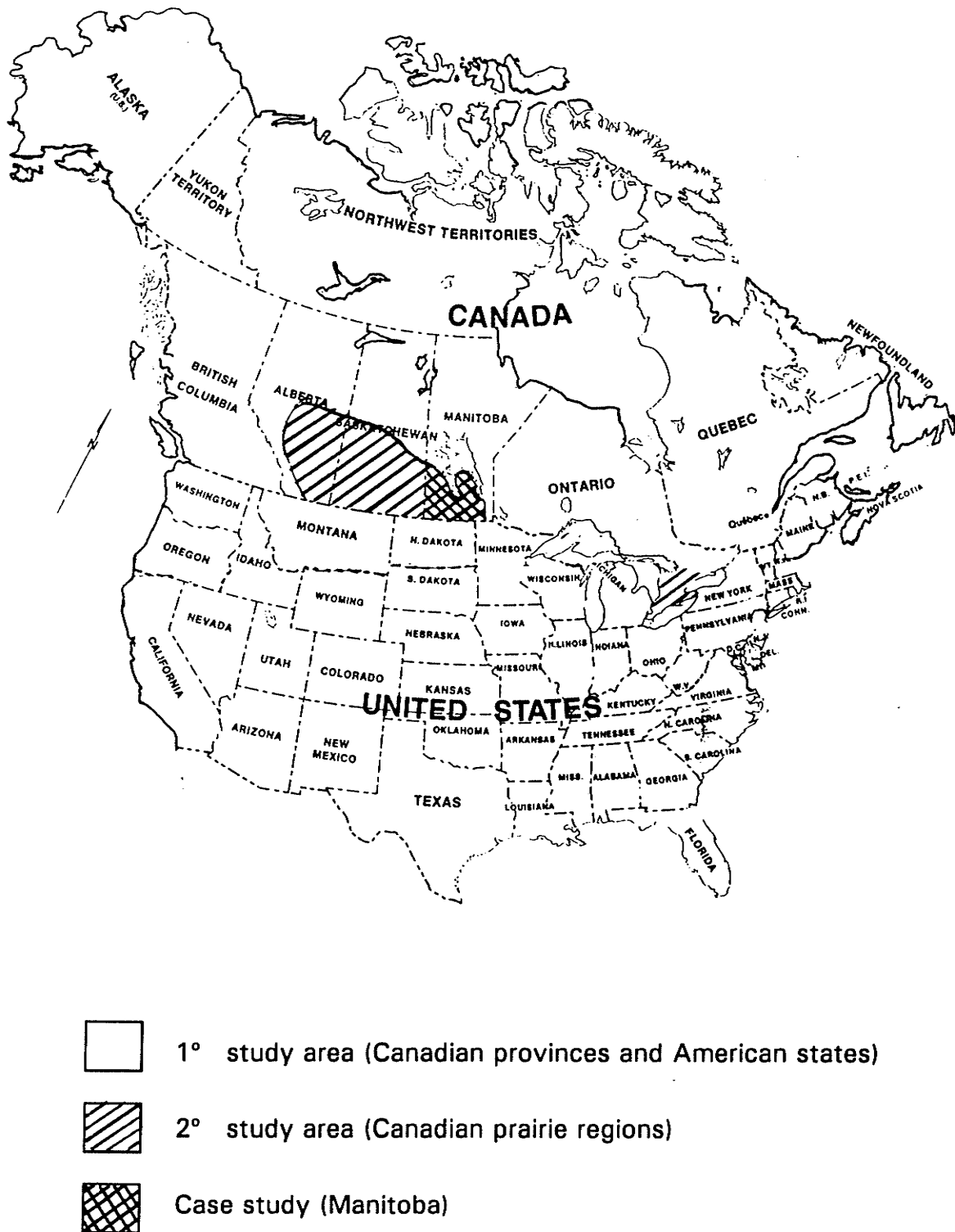


Figure 2 Roadside vegetation management study area

1.7 DEFINITIONS OF TERMS AND ACRONYMS

The following definitions will be used consistently throughout this document.

Grassland: A plant community dominated by perennial grasses, not representative of a prairie, whether deliberately established by humans or not.

Indigenous Species: Native plant species that occur naturally in a particular local area.

Linear Landscape Features: Landscape structures that have length but little width such as fencerows, railway and roadside rights-of-way.

Managing Native Vegetation: Preserving existing native remnants and planting and restoring native vegetation in roadside ROW.

Native Plant Species or Native Vegetation: Grasses and forbs that originated within a specific region.

Planting Native Vegetation: Seeding of native cultivars, ecovars or wild harvested seeds.

Prairie: An original, or authentic, plant community dominated by native perennial grasses and forbs with woody plants limited to low-growing shrubs.

Restoration: To re-create (or attempt to re-create) an authentic plant community using local native species on a site where that particular community no longer exists.

Revegetation: The establishment of a vegetative cover, not representative of an authentic plant community, on a non-vegetated site.

Rights-of-way (ROW): The area which extends from the outer edge of the road shoulder to the limits of the highway property. It generally consists of about 5-15 m (15-50 ft) of grassland and serves a variety of safety and technical purposes.

Traditional Vegetation: Vegetation routinely used as a ground cover along roadsides. It usually includes species not native to the area.

Using Native Vegetation: Preserving existing native remnants, planting and restoring native vegetation in ROW and the maintenance activities associated with these practices.

Weeds: Undesirable and unwanted plant species in a particular area.

ROW	Rights-of-way
MHT	Manitoba Highways and Transportation
RVM	Roadside Vegetation Management
DOTs	Departments of Transportation
DOT	Department of Transportation
WWF	World Wildlife Fund
WCED	World Commission on Environment and Development
VMS	Vegetation Management System
IRVM	Integrated Roadside Vegetation Management
NWRC	National Wildflower Research Centre

Chapter II

MANAGING VEGETATION IN ROADSIDE RIGHTS-OF-WAY

2.1 INTRODUCTION

This chapter examines roadside ROW in detail. The first section provides an overview of Manitoba's management of ROW. The second describes prairie grassland types of North America. Section three outlines ecological and management studies of ROW. Section four compares how roadside management is funded in Canada and the United States. The fifth section reviews literature describing vegetation management programs in the United States. The last section outlines four key aspects of managing native vegetation.

2.2 MANITOBA ROADSIDE RIGHTS-OF-WAY

This section undertakes a closer examination of Manitoba policies and procedures as they apply to roadside ROW. This province's RVM practices were used as an example of traditional RVM practices that are used in the Canadian prairie regions. Roadways in Manitoba are managed by two levels of

government: the provincial MHT and the local municipal governments. In Manitoba there are approximately 23,200 km (14,400 mi) of roadway, including gravel, concrete, and asphalt surface roads. This roadway accounts for approximately 61,000 ha (150,700 acres) of mowable ROW in the province (MHT 1992).

In 1993, approximately thirty-three percent of the MHT Operations and Maintenance budget was allocated to provincial highways for repair and preventative maintenance of road surface, gravel placement, drainage facilities and roadside care. This allocation represented approximately \$48,000,000 (\$37,000,000 US) (Wiebe, Personal Communication, 1994). In order to priorities the allocation and thus the level of maintenance, Manitoba roadways are grouped into one of five classes for summer maintenance (Class I - V), and one of three classes for winter. The factors used to classify a particular portion of roadway include travel characteristics, land use in the region, access control and most importantly, daily traffic counts. Roads within each classification receive approximately the same level of service (MHT 1991).

The basic objectives of MHTs maintenance program are: "to preserve the investment in highway facilities, accommodate highway users with a safe, uniform level of service, and to conserve aesthetic values." (MHT 1991). To achieve some of these objectives, MHT has Maintenance Performance Standards applicable to mowing, gravel reclamation, snow fencing and sign maintenance. These standards are policy guidelines intended to help field personnel understand what level of service is desired on the various classes of

roads. Mowing standards are covered under Maintenance Performance Standard M-300-1, which is the mowing standard (hereafter referred to as Standard M-300-1) (Appendix 2). Mowing is the maintenance technique most often used for the management of roadside ROW vegetation and MHT spends more money on mowing in ROW than on any other vegetation management technique. This policy guideline provides details concerning the purpose of mowing, the responsibilities of mowing personnel, scheduling of the work and the required quality of mowing that should be carried out on Manitoba Highways. It also details required mowing procedures such as the time of year mowing should take place, the appropriate number of mowings, and the part of the ROW to be mowed for each class of highway.

The Standard M-300-1 also lists the following reasons for mowing:

1. to improve appearance;
2. to improve visibility;
3. to improve drainage;
4. to control weeds and brush; and
5. to minimize snow drifts.

As mentioned earlier, associated with M-300-1 are the following activities: 310 - mowing with a swather; 311 - mowing with a triplex mower; and 312 - mowing with a sickle bar or single rotary mower. Activities 310, 311, 312 and the mowers are used for specific types of vegetation from grasses to small brush.

The road classification determines the level of maintenance the roadside ROW receives. The ROW of a Class I highway for example, receives the most maintenance and when the grass reaches an average height of 30 cm (12 in), two swath-cuts are mowed adjacent to the edge of the road shoulder. This usually occurs in late June. Two swath-cuts encompass a width of approximately 3.66 m (12 ft). Once the required two swath-cuts are completed on all roads, the remainder of the roadside ROW is mowed. This cutting is usually completed by August 15th. Toward the end of the growing season another two swaths are mowed on the grade slope of the ROW.

Classes IV and V receive the lowest level of maintenance. Areas adjacent to the shoulders of roads in these classes are mowed once a year (two or less swaths), toward the end of the growing season. Their ROW are mowed when necessary every third year for brush control.

The estimated cost of mowing by government forces is \$34 per ha (\$11 US per acre), and by contract mowers \$32 per ha (\$10 US per acre). These estimated costs include the labour and the use of the equipment for mowing (Farrell, Personal Communication, 1993). In 1993, two and a half percent of the MHT maintenance budget, or approximately \$1,170,000 (\$866,000 US), was allocated to the mowing of highway ROW.

Maintenance Performance Standards have also been developed for other activities such as brush cutting and spraying brush with chemicals. Herbicide application techniques used in ROW include spot spraying and boom spraying.

The estimated cost of brush spraying was \$300 per ha (\$95 US per acre) in 1993. Approximately \$593,000 (\$460,000 US) was spent on activities such as spraying brush and weeds. Other activities included in the maintenance standards are the installation and maintenance of waste receptacles and rest areas, and cleaning roadsides of refuse.

Another roadside RVM practice carried out in Manitoba is haying. Manitoba Highways and Transportation maintenance foremen have working agreements with landowners in their district who wish to hay portions of the ROW for economic benefit. In Manitoba, there are no haying permits required to hay ROW. The maintenance foremen designate the areas to be mowed by government personnel and those areas to be hayed by local landowners (Mahood, Personal Communication, 1994).

2.3 NATIVE VEGETATION IN THE PRAIRIE REGIONS

The following section describes the three basic grassland types of North America: short-grass, tall-grass, and mixed-grass. Each type is characterized by a unique assemblage of flora and fauna that is dependent on the climate, topography, and mineral substrate of the region (Trottier 1992). The aspen parkland of western Canada is another plant community that will be discussed in this section because this community is a mixture of grassland and forest types (Bird 1961).

The short-grass prairie, consisting of short bunch grasses and

wildflowers, begins in the dry western regions of the United States and continues to the midwestern states. The tall-grass prairie is found on the moist central plains at the eastern boundary of the North American prairies. As the name suggests, the vegetation of this plant community includes taller species of grasses and wildflowers. The mixed-grass prairie is found between the short and tall-grass areas and extends from Alberta to Manitoba and southward to Oklahoma and Texas. The mixed-grass prairie is a mosaic of vegetative species from the two extreme grassland types. It is a transition zone that holds a diverse mixture of short and tall plants, as well as several species unique to the mixed-grass prairie (Joyce 1990). Figure 3 indicates the historic distribution of the three major prairie types in North America.

The two main grassland communities found in Canada are the mixed-grass and tall-grass prairies. Both have been greatly reduced in the last one hundred years (Plate 1, Plate 2). More than 80 percent of the native prairie in Canada has been modified with most of the native prairies having been converted to agriculture. The construction of residential and industrial areas and transportation corridors have also altered a significant portion of the native landscape (WWF 1988).

Canada's mixed-grass prairie is found in Manitoba, Saskatchewan and Alberta (Figure 4) (Joyce 1990). It has been estimated that only 24 percent of this native mixed-grass prairie remains, and that half of what remains is overgrazed (Trottier 1992). The mixed-grass prairie remnants that still exist are found in abandoned pastures, steep hillsides and roadside ROW.

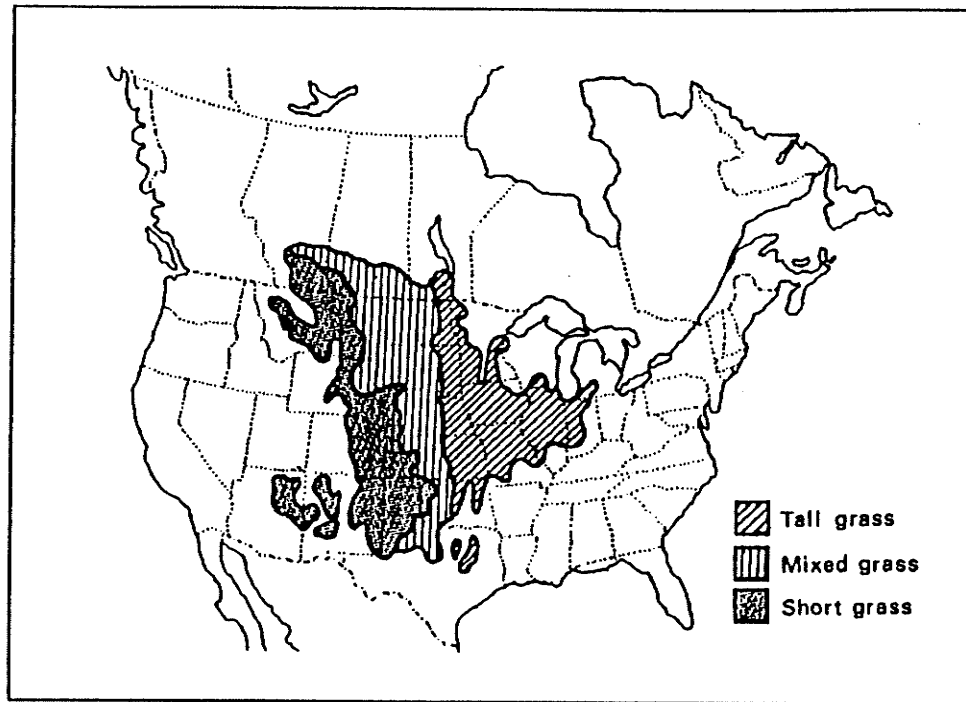


Figure 3 Historical Distribution of Major Prairie Types (Joyce 1990)

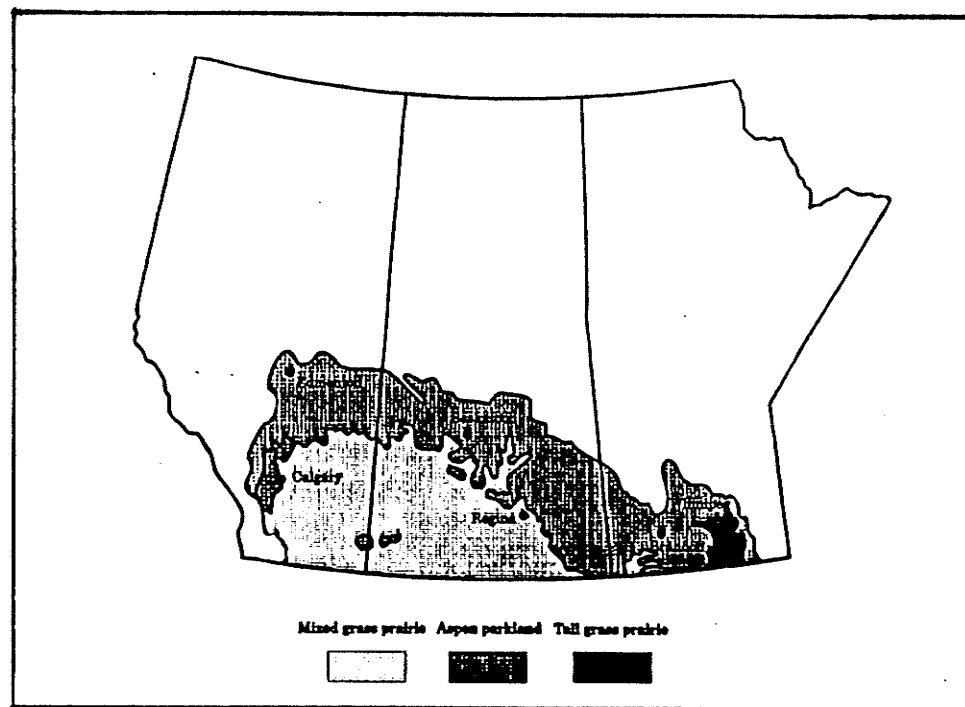


Figure 4 The prairies and aspen parkland in the western Canada (Trotter 1992)



Plate 1. Mixed-grass Prairie

(photo: J. Morgan)



Plate 2. Tall Grass Prairie

(photo: J. Morgan)

Tall-grass prairie is the rarest grassland type in Canada, with less than one percent of this community untouched by agricultural activities, urban development or industrial sites. The Red River Valley in southcentral Manitoba is the main range of tall-grass prairie in Canada. It is also the northernmost limit of this grassland type (Collicutt and Morgan 1990). The tall-grass prairie is also found in Ontario between Lakes Erie and St. Claire. Remnants of tall-grass prairie are typically found along railway ROW, historic cemeteries and abandoned pastures.

The aspen parkland is another significant plant community of the prairie regions of Canada that has been greatly affected by agricultural practices in the last 100 years. Prior to settlement, the aspen parkland contained aspen woods and wetlands intermingled with native prairies (Bird 1961). Presently, less than 20 percent of this ecosystem remains in Canada (WWF, 1988). Figure 4 shows the distribution of the prairie and aspen parkland of the Canadian prairie regions, excluding the tall-grass prairie in Ontario.

Native prairie remnants play an important role in the prairie ecosystem by supporting a variety of flora and fauna such as big bluestem, little bluestem, meadow blazingstar, prairie sage, Ferruginous Hawk and prairie long-tailed weasel. In addition to having a variety of flora and fauna, the preservation of Canada's native prairie communities is also an important ethical issue. Society has a moral obligation to preserve the diversity and richness of the prairie for future generations, and to ensure they have the opportunity to benefit from the

aesthetic, recreational and educational attributes of this unique plant community (WCED 1987). It is necessary to preserve the native prairie which is home to diverse populations of wildlife that are valued so highly in society today (WWF 1988). This includes several threatened and endangered species such as long-tailed weasel, loggerhead shrike, burrowing owl and the Baird's Sparrow. The prairies support large populations of migratory birds including waterfowl, shorebirds, and songbirds. The survival of many bird species hinges on the summer breeding season and on the preservation of the prairie ecosystem. The loss of native prairies has not only effected Canada but also the wildlife of many other North and South American countries.

Finally, it is important to preserve Canada's native prairie communities for economic reasons. Wildlife provides economic opportunities in the form of tourism, recreation, hunting and trapping. It has been shown that eighty-four percent of Canadians are involved in wildlife-related activities that result in significant expenditures on wildlife resources (WWF 1988).

The ecological role and economic value of many native species in the ecosystem is unknown. For example, native plant species may in the future provide many agricultural or pharmaceutical products. The prairie communities and their species must be preserved so that present and future generations may study each species and reap the potential benefits which are only possible from a wide diversity of species (WWF 1988).

2.4 ECOLOGICAL AND MANAGEMENT STUDIES OF RIGHTS-OF-WAY

Roadside ROW are continually exposed to harsh conditions through human activities such as trash disposal, automobile exhaust, salt and the application of chemicals. Alternatively, they are subjected to naturally occurring adverse climatic conditions such as drought, flooding, and extreme temperatures (Bolin *et al.* 1990). Although roadside ROW may appear to be rather hostile places, they have an ecological function in the region's natural environment. ROW provide habitat for a variety of flora and fauna, and are used as migration "corridors" by wildlife to move and cross potential ecological barriers such as agricultural fields or farm yards.

Several studies have examined the ecological importance of roadside ROW to plants and wildlife (Henderson *et al.* 1985, Wilson and McArthur 1967, Merriam 1984). The majority of these studies examined the significance of ROW and similar linear features to small mammals. Henderson *et al.* (1985) and Wilson and McArthur (1967) assessed the importance of interconnecting movement corridors such as fencerows, to the preservation of local species. The authors concluded that without interconnecting features such as roadside ROW and fencerows, negative ecological impacts might occur on many animals and plant species. A negative ecological impact is the extinction of local populations.

Studies have also shown that many bird species depend on interconnecting features for nesting and for movement in their territory.

Wegner and Merriam (1979) found "that birds seldom flew directly across open fields between woods" and concluded that they used the fencerows to move from one area to the next.

Vegetation studies have examined the secondary benefits of vegetation in ROW. Sanders (1986) studied the impacts of urban vegetation on hydrology and found that urban runoff could be reduced by 12 percent depending on the type of vegetation used. Benefits from reduced runoff included decreased soil erosion, reduced bridge and culvert repair costs and better groundwater recharge. Rowntree (1986) determined that urban vegetation was an important sink for carbon monoxide, carbon dioxide, and hydrogen sulphide. Walsh and Rideout (1990) found that native vegetation also had the potential to store large amounts of carbon dioxide from the atmosphere. This reduction of carbon dioxide levels could reduce the potential for global warming.

Several studies have been conducted on roadside ROW and how management ROW policies affect wildlife and their habitat. Getz *et al.* (1978) conducted an analysis of interstate highways as dispersal routes for small mammals with special consideration for the vole, *Microtus pennsylvanicus*. Following a change in policy to reduce mowing it was found that the frequency of voles had increased along the roadside. Getz *et al.* (1978) concluded that "the dispersal of the voles depended primarily upon the presence of continuous strips of grassy vegetation along roadsides, drainage ditches or railroads." The authors concluded that the dispersal of voles in the roadside ROW was affected

by the presence or lack of continuous strips of vegetation. Continuous strips of unmowed vegetation increased the amount of cover which allowed the voles to disperse to other areas along the roadside ROW.

Adams (1984) and Adams and Geis (1983) measured small mammal densities in mowed and unmowed areas of the ROW. They found there were 50 percent more species in the unmowed areas. These studies showed that wildlife benefit from roadside ROW because they can provide favourable habitat and can also serve as dispersal corridors. Roadside ROW can also be hazardous, however. One negative effect of roadside habitats was the potential for road mortalities. Garland and Bradley (1984) studied the positive and negative effects of highways on rodents. One conclusion they drew was that the width of the highway may influence the number of kills by cars. The greater the width of the crossing, the less likelihood there is an animal that will try to cross it.

Oxley et al (1974) studied the effects of roadways on the movements of small and medium-size mammals. This study found that the width of the ROW was the most important factor inhibiting the movements of mammals. The greater the width of the ROW, the lower the number of crossings by small and medium-sized mammals. The authors concluded that "the effects of roadways on the movements of animals should be considered by the planners and builders of roads and by biologists concerned with the impact of man on the environment".

2.5 FINANCING ROADS IN CANADA AND THE UNITED STATES

Under the Canadian Constitution, responsibility for the construction and maintenance of highways falls in the jurisdiction of the provincial governments. The provincial tax system is devised in such a way that provincial tax revenues are consolidated into one fund. The provincial government annually distributes departmental budgetary allocations from this fund. For example, MHT receives its budget funding from provincial tax revenues of the Manitoba provincial government. In addition, MHT also receives funding from the federal government on specific highway projects. The federal government enters into agreements with the provincial government to fund the construction and maintenance of inter-provincial and international routes. This involvement by the federal government in financing roads is due to the national importance of trade which is carried out on the inter-provincial and international routes (McMichael, Personal Communication, 1994).

In the United States the Federal Aid Road Act of 1916 was the first cooperative Federal-State program to establish a fund for the financing of highway construction and maintenance. The program has changed somewhat since 1916 and is now called the Federal-Aid Highway Act. The Federal Highway Administration is the agency that administers funds under this Act (FHWA 1976). These funds are for highway construction and maintenance, and are not from a consolidated tax fund. Instead, a specific tax is levied for this purpose and this tax revenue is strictly allocated to the construction and

maintenance of highways and roads. The federal government of the United States played a dominant role in the construction of the interstate systems using these funds from this program.

2.6 ROADSIDE VEGETATION MANAGEMENT PROGRAMS IN THE UNITED STATES

Roadside vegetation management has been changing over the last several decades. During the late 1960s and early 1970s many American DOTs were forced to reduce the amount of roadside vegetation maintenance along roadside ROW, due to the restricted availability and increased cost of fuel needed for mowing and spraying. In some jurisdictions vegetation along roadside ROW was left idle, and many native plants species that had been suppressed by intensive mowing and spraying emerged and prospered (Lamb 1989).

The public responded positively to the native grasses and forbs in the ROW. At the same time departmental staff realized that native species offered "stable natural vegetation cover which could be encouraged with little or no human effort and that the costs of maintaining these areas were much lower than for conventional landscape plantings" (Lamb 1989). Several jurisdictions subsequently began managing naturally occurring stands in the roadside ROW such as Texas and Minnesota.

Another important factor which also encouraged change in roadside vegetation management in the United States was the program "Operation Wildflower". This program was instituted in 1973 by the Federal Highway

Administration in cooperation with the Federated Garden Clubs of America. The purpose of the Program was to establish native wildflowers along American roadside ROW (Harper 1988). State transportation departments began seeding roadside ROW with seed donated by the state garden clubs. Several states, such as Michigan, Minnesota, Ohio and Virginia, had successful roadside plantings under this management program (Elmhirst and Cain 1990).

The increased support and success of using native wildflowers and grasses in roadside ROW led to the passage of the "Surface Transportation and Uniform Relocation Assistance Act, 1987." This Act required that wildflowers be used in landscaping highways on the Federal-Aid system (Lamb 1989). The Federal Highway Administration also added a stipulation that one quarter of one percent of federal highway landscaping funds must be used for the wildflower establishment (Elmhirst and Cain 1990). Another effect the legislation had was to increase the interest of several states which had not yet been involved in using native species along roadside landscaping. Today, over half of the states have begun incorporating the use of native species into their RVM programs. A number of states have developed extensive RVM programs including Texas, Minnesota, Iowa, Nebraska and Wisconsin. Some of the more advanced programs in Texas, Minnesota and Iowa are discussed below.

2.6.1 Texas

During the 1930s, staff at the Texas State Department of Highways and Public Transportation observed that the first vegetation to reappear in disturbed ROW following highway construction was wildflowers. The wildflowers not only increased the aesthetic beauty of the roadside, but were also beneficial in controlling erosion. A new management policy which led to the decision to delay mowing of ROW as a cost saving measure resulted in the healthy growth of wildflower cover. The first plantings of native wildflowers in Texas were done by spreading cut wildflower hay from established wildflower stands that contained the wildflower seeds (Elmhirst and Cain 1990). The preservation and planting of native vegetation gradually increased the extent of natural landscapes in Texas (McCully 1986).

In 1982, a new vegetation management system was introduced to reduce the cost of maintenance and labour by decreasing the number of times ROW were mowed and sprayed with herbicides. A 23% cost saving was achieved after one year of implementing the new management system (McCully 1986). This cost saving and the presence of wildflowers resulted in considerable media attention which led Texas roadside ROW wildflowers to become a major tourist attraction from April to June (Johnson 1988). Under the new roadside vegetation management system, stable native plant communities have proven to be cost effective and environmentally sustainable.

2.6.2 Minnesota

Minnesota's DOT changed its RVM policies in response to increasing energy costs during the 1970's. A reduction in mowing and spraying efforts led to a five-to ten-fold increase in the ROW native plant population (Ray 1987). With the introduction of "Operation Wildflower", the Minnesota DOT began seeding prairie wildflowers and grasses at rest areas along roadsides in 1974 (Harper 1988). A vegetation survey of highway and railroad ROW was initiated in 1978 by the Nature Conservancy and the Minnesota Department of Natural Resources. Twenty-five corridors of high-to fair-quality native prairie were identified and in 1987 the Roadside Wildflower Task Force was formed to develop native vegetation roadsides policies. This Task Force recommended that vegetation surveys be continued along state highways and adjacent railroad ROW. Analysis of the survey results identified high quality roadside prairies which were then designated and signed as "Wildflower Routes" (Plate 3 and Plate 4). The designated "Wildflower Routes" are composed of native plant communities. Presently there are six designated wildflower routes in Minnesota (Jacobson et al 1990) (Figure 5).

Minnesota's DOT has developed guidelines for the planting of native grass and wildflower seed along Minnesota roadsides. These guidelines specified that the native seed must originate from the same local area that is to be planted. The guidelines also outlined procedures to be followed concerning the native harvest, germination, installation, planting season,



Plate 3. Minnesota Wildflower Route (Truck Highway 56 in S.E. Minnesota)



Plate 4. Minnesota roadside Wildflower Route sign

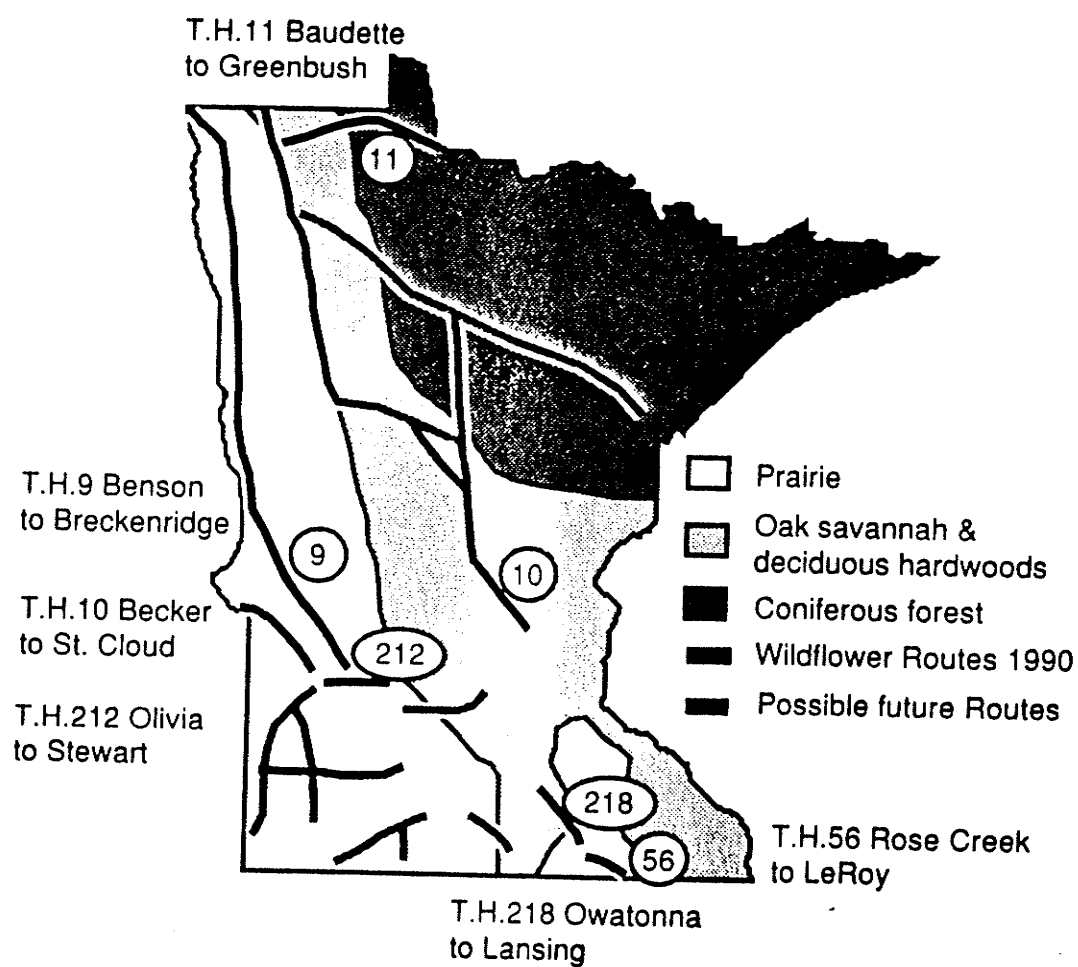


Figure 5 Minnesota wildflower routes (Jacobson et al. 1990)

seedlings, cover crops, and maintenance of the native grasses and wildflowers. This department became involved in the roadside "movement" in 1978 with the "Roadsides for Wildlife" program (Harper 1988). The goals of this program are to maintain and improve wildlife habitat on Minnesota's ROW by improving the quality of roadside habitat, and by informing the public of the vital importance of roadsides to wildlife (Roadside for Wildlife Program 1986). Mowing has been reduced to benefit nesting birds as well as many other wildlife and plant species (Varland 1985). Minnesota's DOT and DNR have both been involved in preserving and restoring native vegetation along ROW.

2.6.3 Iowa

In 1985 a Roadside Vegetation Management Committee was established in Black Hawk County in Iowa to address weed invasion and soil erosion in roadside ROW. This committee proposed the integration of various vegetation management techniques and the establishment of native prairie vegetation to maintain roadside ROW to deal with these problems. This work marked the beginning of a state roadside management program called the Integrated Roadside Vegetation Management (IRVM) (Ehley 1990). Thirty-nine counties in Iowa have since adopted IRVM techniques, and the Iowa DOT and DOT's in Wisconsin, Minnesota, Nebraska, and Missouri are using similar programs in managing roadside ROW.

The primary goal of the IRVM program "is to establish and maintain a safe, stable, low maintenance roadside that is attractive and healthy for all life" (Ehley 1992). Native prairie vegetation is used whenever possible to fulfill this goal. Instead of planting traditional non-native vegetation, native prairie grasses and wildflowers are seeded on new or regraded rural roadsides (Plate 5). Many counties involved in IRVM have hired a County Roadside Manager to oversee the management of roadside ROW. This individual is usually a biologist or a professional roadside manager who uses various management techniques to maintain vigorous stands of both prairie and non-prairie rural roadsides. These techniques include burning every three to five years to increase the native plant diversity, recycling nutrients and retarding the growth of undesirable plant species. Spot spraying with herbicides is conducted on established perennial weeds two or three times to ensure complete eradication. Periodic mowing of road shoulders and dangerous intersections has proven necessary in some instances to maintain traffic safety, limit snow drifting, and allow adequate vehicular sight distances.

Iowa's IRVM emphasizes working with landowners adjacent to the roadside ROW. Many of these landowners own the ROW but responsibility for roadside maintenance remains with the county. Roadside managers spend time explaining the goals of the IRVM program to landowners to ensure that they will understand the program and its benefits.

The County Roadside Assistance Office of Iowa has developed an IRVM technical manual that is used during planning, budgeting and program development. The manual facilitates decision-making by providing information on alternatives, procedures, implementation requirements, costs and future maintenance needs. Sections in the manual describe the roadside inventory process, vegetation establishment, seeding, transplants, erosion control, burn management and herbicides. It is a very useful document which addresses important considerations when planning a vegetation management program for a specific site (Ehley 1992).



(photo: J. Morgan)

Plate 5. Iowa roadside prairie restoration sign

2.7 MANAGING NATIVE PRAIRIE VEGETATION

There are four key aspects of managing native prairie vegetation. They are: preservation; planting and restoration; the appropriate use of maintenance techniques; and public support. Each of these is described in the following sections.

2.7.1 Preservation of Native Prairie Remnants

The preservation of native vegetative communities is an important aspect of managing native vegetation in RVM. The identification of native remnants is the first step toward preservation (The Nature Conservancy, 1991). Conducting surveys, taking inventories, and contacting knowledgeable individuals are techniques used in many jurisdictions to locate native plant communities. Two examples of native vegetation inventories conducted in prairie regions of North America are described below. The first is the Tall-grass Prairie Conservation Project in Manitoba. The second discusses the Minnesota Roadside Inventory Project.

Tall-grass Prairie Conservation Project

A project to locate all tall-grass prairie remnants in Manitoba's Red River Valley was undertaken by the Manitoba Naturalists' Society. The objectives of undertaking this project were ultimately to take steps to protect and manage all the remaining tall-grass prairie that could be identified. Inventory collection

began in 1987 with an analysis of black and white aerial photographs of the Red River Valley. The purpose of this analysis was to locate potential tall-grass prairie remnants larger than 1 ha in size. Once identified, potential site locations were transferred to land-use maps for field use. These sites were then systematically ground-checked on a township-by-township basis, and ranked according to species dominance and diversity, cover/abundance and sociability, relative abundance and extent of physical disturbance on the site. Each site was given a letter rank between A and D, with sites ranked as A having high native species diversity and low numbers of exotic species, and sites ranked as D having low native species diversity and a high numbers of exotics. Sites ranked C or better were considered suitable for conservation. The study located 102 ha of tall-grass prairie. Some of these sites were purchased or leased by the landowners to the Manitoba Naturalists' Society to establish a tall-grass prairie preserve in southeastern Manitoba (Joyce 1989).

Minnesota Roadside Inventories

In 1988 and 1989 the Minnesota DOT surveyed native plant communities in roadside ROW along the state highway system. The survey was designed to locate remnant prairie as rapidly as possible. The roadside ROW were viewed from a moving vehicle for the presence of indicator species which included five or more prairie grasses and certain forb species. When indicator species were observed surveyors stopped their vehicles and conducted quality

assessments. Detailed inventories of the vegetation were taken at sites designated as high quality prairie vegetation. A one hundred foot long stretch of roadside, including the inslope, ditch bottom, backslope and railroad right-of-way, was surveyed. Using a simplified version of Braun-Blanquet's Floristic system, all blooming plants and any identifiable species still in the vegetative stage were documented, as were the relative cover/abundance and sociability (Bolin *et al.* 1990). Additional information recorded included the following: length and continuity of native vegetation stand, adjacent land use, indications of disturbances by maintenance activities, potential for extending the stand, and potential for harvesting seeds.

Surveyors found that approximately 50 percent of prairie identified in an earlier study in the late 1970's had been destroyed. They also identified additional high quality prairie (Bolin *et al.* 1990). As a result of these surveys, six wildflower routes were designated in 1989 and 1990 which are now cooperatively managed by the Minnesota DOT and the Minnesota Department of Natural Resources (Bolin *et al.* 1990).

2.7.2 The Establishment of Native Prairie Vegetation

The planting and restoring of native species is another important aspect of managing native vegetation in roadside ROW. In several mid-western regions of North America the establishment of native prairie species in roadside ROW has been successful. Establishment of native vegetation in roadside ROW

varies from stands of a single species seeded with native cultivars to native prairie restorations seeded with wild-type seed. Two important factors that must be considered when planting and restoring native prairie species are ensuring that the appropriate species for a specific project are selected and the origin of the seed.

The choice of species can range from a single species to many species. Some jurisdictions have established monoculture stands of a native grass, and other jurisdictions have used a mixture of native grasses and forbs. Restoration of a prairie with a diversity of species has also been undertaken in roadside ROW. The number of species used in roadside ROW is dependent on the desired outcome for the roadside vegetation. Plate 6 shows a three year old native roadside planting with a mixture of native forbs and grasses along a Wisconsin highway.

Seed origin is important because seed that originated locally is better adapted to the soil and climate conditions, and will be better able to survive. Local seed is preferred when restoring a native prairie. Good local seed is not always available however, and cultivars have been used as substitutes in the establishment of native vegetation. Native cultivars are registered plant varieties which have undergone genetic selection by plant breeders and have their origins in a specific ecotype. Many American native cultivars are readily available and currently nine native grass cultivars are registered for use in Canada (Joyce 1993). Cultivars originate from one specific ecotype, and

growing them too far from their place of origin can affect the success of establishment. While it is preferable to use locally grown native seed, its availability and cost are important factors in choosing vegetation for roadside ROW. In practice, the cost of local seed is usually greater than the cost of native cultivars (Morgan, Personal Communication, 1993).



Plate 6. Wisconsin three year old roadside native planting

The effort required for site preparation is location specific (Collicutt and Morgan 1990). Most sites require the control of unwanted species. Tillage has been the most widely used method of killing unwanted species, however, herbicides are being used increasingly because this procedure results in less soil

disturbance (Armstrong 1990). Once the site has been prepared native seed can be sown with different pieces of equipment such as a native seed drill, a hydroseeder, or a mechanical broadcaster. Native seed drills are considered to be the most effective method for sowing native vegetation (Morgan, Personal Communication, 1993).

Controlling unwanted vegetation is also important after seeding. Mowing of the sites may be required two or three times during the first two growing seasons. Spot spraying of noxious weeds is another method of weed control. Burning native vegetation can be an effective method of reducing the weed cover while allowing the native species to grow and establish, but is an option not widely used.

2.7.3 Long-term Management of Native Prairie Species

It has been recommended by a native prairie restorationist that an established prairie should be burned once every two to five years (Shramm 1990). Burning of the native prairie plantings has several advantages. It removes dead plant material, kills actively growing weeds, and stimulates the growth of the native prairie species. Mowing is another management tool that can be useful if burning is not possible. It has no detrimental effect on the native species (Hesse and Salac 1972). Hesse and Salac also concluded that certain mowing dates improve the aesthetic value of mowed plants over the unmowed sites. Appropriately timed mowings can delay and extend blooming

periods, and aesthetics are also improved because the plants are more compact and less susceptible to lodging.

Haying of native prairie vegetation is a management tool that is not widely used, though in some cases it is carried out to harvest seed for restoration sites. The plant material from established native prairie sites are hayed and the hayed vegetation is then spread over the prepared restoration site. The hay from established native prairies sites is also used as feed for cattle and horses, and certain native species are highly nutritious before they mature (Dodds and Jacobson 1983). For this reason the timing of haying is important to get the maximum nutritional benefit from it. Controlled grazing is another long-term management strategy that has been considered by native prairie managers. It is thought that prior to European settlement the native ungulates were important in influencing the prairie ecosystem (Berg 1990).

2.7.4 Native Vegetation Management and Public Participation

Public involvement has played an important role in preserving, planting and restoring native vegetation in several jurisdictions. Garden clubs, naturalist societies, 4H clubs and wildflower groups have been involved in seed collection, planting, site maintenance and fund raising. States such as Texas and Minnesota and the Province of Manitoba have an "Adopt-A-Highway" program through which corporations and other organization maintain a specific section

of highway. A sign, inscribed with the adopting organizations name is placed on the section of highway that it is maintaining (Lamb 1989).

Programs involving the public in roadside wildflower projects have been initiated in Texas (Elmhirst and Cain 1990). Under these programs responsible local groups are allowed to plant and maintain sections of the roadside ROW. Some of the disadvantages associated with involving the public in such an undertaking include the potential for injury to non-government personnel working in the ROW, the potentially high costs of planning and implementing the program, and the possibility that agencies' funding and interest may diminish after a few years. The advantages of public involvement are reduced costs for plant material and labour, and an improved public image of the DOT (Elmhirst and Cain).

2.8 SUMMARY

In summary, using native species in roadside ROW has been successfully implemented in Texas, Minnesota, and Iowa. The benefits of adopting this approach to ROW management include significantly reduced maintenance costs, better weed control, greater public awareness, improved appearance, wider species diversity, and more wildlife habitat. The use of native species on suitable ROW in the Canadian prairie regions could be expected to offer similar benefits.

Chapter III

SURVEY RESULTS AND ANALYSIS

3.1 INTRODUCTION

This chapter presents the results of the survey questionnaire sent to provincial and state levels of government in order to collect information on RVM practices in Canada and the United States. The first section outlines survey methods and the overall survey responses. The following three sections describe the survey results in three categories: responses from those DOTs using native vegetation in RVM; responses from those who had tried using these practices but had discontinued them and finally, responses from those who had never used native vegetation. The last section provides an analysis and evaluation of these results.

3.2 A SURVEY OF THE USE OF NATIVE PLANT SPECIES IN ROADSIDE VEGETATION MANAGEMENT

The use of a survey is an accepted means of gathering information for decisions and research and therefore a self-administered mail-out survey was used to acquire data concerning current roadside ROW vegetation management practices in Canada and United States (Hoinville and Jowell 1978). This type

of survey was used to produce a "photograph" of RVM practices in 1992. Surveys were mailed to individual involved in RVM in each DOT in Canada and the United States.

3.2.1 Survey Method

The survey method was chosen to collect information on RVM because of the low cost of mailing surveys and ease of administration of the survey. The mail-out survey also gave the respondents an opportunity to look up records, to consult with others and to provide thoughtful answers. The survey facilitated gathering information from across the Continent. In addition, using a survey ensured that the same question was asked of each individual, thereby reducing the potential for survey error.

The survey was sent to all individuals involved in RVM at the provincial and state government levels in Canada and in the United States. Provincial contacts were identified by contacting each provincial DOT and requested the name of the individual responsible for RVM. A list of representatives from state DOTs who were currently involved in roadside vegetation management was obtained from the National Wildflower Research Centre (NWRC), Austin, Texas (NWRC 1992). At least one survey was sent to each Canadian and American DOT. In some cases two or more individuals were sent the survey.

The survey was mailed to the targeted individuals for completion. The survey stratified respondents into three groups. The respondents who were

currently managing native vegetation in roadside ROW answered Section I. Those respondents who had attempted to use native vegetation but discontinued this practice answered Section II. The final group was comprised of those respondents who had never used native vegetation in RVM practices. A stratified sample method was used because this enabled the researcher to identify which DOT's were using native vegetation and to evaluate their RVM programs relative to those who were not.

The survey was a self-administered survey with closed questions and space for additional comments after most questions. Preliminary questions were designed following discussions with experts in RVM, and a review of pertinent literature concerning RVM and survey methods. Careful and complete wording was used in the survey to increase consistency in meaning to all respondents. The questions were typed, laid out clearly and uncluttered in order to be as easy to understand as possible.

A field pretest was conducted during the first two weeks in October 1992 on three local individuals involved in ROW management. The results of the pretest indicated that the survey was easy to read and understand and took approximately 45 minutes to complete.

On October 28, 1992 one hundred and ten surveys were mailed to the selected individuals. Respondents were given a month to return the surveys. Three weeks after the first mailing a reminder letter was sent to the individuals who had not yet returned the survey.

3.2.2 Survey Respondents

Respondents included agronomists, roadside specialists, landscape architects, engineers and maintenance managers. They held a variety of positions in their departments, ranging from that of maintenance director to field positions such as maintenance technicians. All of the respondents were knowledgeable concerning the subject matter and were able to answer most questions. Several respondents did not answer the questions regarding costs of roadside vegetation management. One respondent indicated it was "not within my job knowledge to answer", and another commented that the information requested did not fit the DOT's vegetation management program.

Of the 110 surveys mailed, 48 were returned for a 44% response rate. Nine of the responses received were from Canadian provinces and 39 were from American states. Seventy-seven percent of the respondents, or thirty seven respondents, represented jurisdictions which are currently using native vegetation in RVM, and they completed Section I of the survey. Two respondents had attempted to use native vegetation in RVM but discontinued this practice for a variety of reasons. These respondents answered Section II. Section III collected responses from traditional RVM practitioners and was answered by 11 respondents who are not currently using native vegetation in their RVM programs. Figure 6 shows the distribution and location of the respondents.

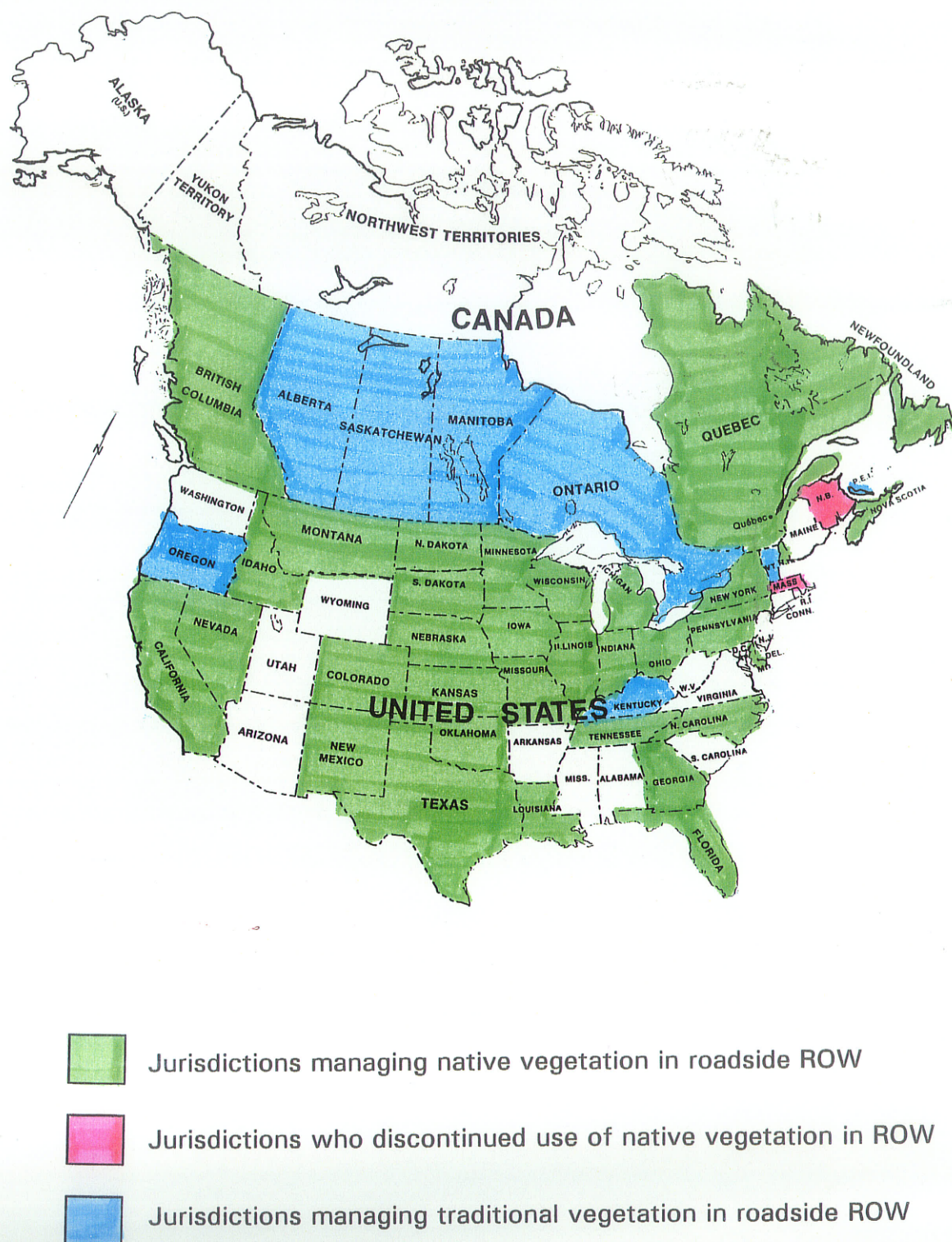


Figure 6. Distribution of survey respondents

3.2.3 Survey Responses

The majority of the questions were closed multiple choice due to the qualitative nature of the survey. For many of the questions several answers could have been chosen from the list of choices (Appendix 1, question 4) and for other questions only one answer could have been chosen (Appendix 1, question 11). For the multiple answer questions, the percentage of responses for each answer was calculated by dividing the number of people who chose that answer by the number people who responded to that particular Section. Table 1 on page 53 presents the results of a question for which respondents could choose a number of answers. Absolute percentages were calculated when the respondents could choose only one answer from the list of possible answers. Table 3 on page 57 lists the results of responses to a question for which the respondents could only choose one answer.

Dollar figures are in Canadian dollars with the equivalent United States (US) dollars shown in brackets. The 1993 average exchange rate of 1.2898 was used for conversion purposes (Tisdall, Personal communication 1993) .

3.3 USING NATIVE VEGETATION IN ROADSIDE VEGETATION MANAGEMENT: SECTION I

Seventy-seven percent of respondents were presently planting and/or managing native vegetation along highway ROW. The following results summarize the responses from the 37 respondents who answered Section I.

3.3.1 Roadside Vegetation Management Program

Thirty respondents were managing and planting native vegetation on ROW. Two DOT's, Newfoundland and New Hampshire were only managing native vegetation along roadsides. Two states, Ohio and Maryland, were conducting experimental research with native vegetation.

A few states such as Texas, New York and Kansas, began using native vegetation along roadsides in the early 1900s, but most of the respondents first considered using native species in the 1960s. Twenty-one percent of the provincial and state DOT's began using native species in that decade. Many respondents began their RVM programs using native vegetation in the 1970s and 1980s. Forty-eight percent of respondents began the project using native vegetation in their RVM programs the same year this idea was first considered.

Table 1 shows reasons why DOT's initiated programs that managed native vegetation. Half of the RVM programs were initiated as part of new departmental initiatives. Public interest and pressure from environmental groups were other factors which influenced the initiation of some RVM programs. Twenty-nine respondents commented that the tightening economic situation

was a significant reason for using native species along roadsides. Reduced mowing was emphasized in several programs as a cost-cutting opportunity which at the same time allowed for the growth of native species through regeneration. The South Dakota program was a response to state and federal game, fish and wildlife agencies' request for vegetation that would create good habitat for game species. Several respondents suggested that their programs were designed to use native vegetation for highway beautification and as a landscape feature to blend the highway ROW into the surrounding landscape. Michigan's DOT respondent simply stated it was the "best use of the land".

Table 1. Reasons for starting roadside vegetation management programs that use native vegetation.

<u>REASON</u>	<u>PERCENT OF RESPONDENTS</u>
New departmental initiatives	51 %
Public interest	46 %
Interest from environmental groups	32 %
Economic situation	29 %
Government legislation	27 %
Other	35 %

Source: Appendix 1, Section I, Qu. 5

To begin the new RVM programs, the DOT's collected background information on methods and techniques involved in the management of native vegetation from many sources. Fifty-nine percent of respondents, or 32 respondents stated that their preliminary source of information was internal sources within their departments. University research, journals and conferences were also considered valuable sources of information. Departments of natural resources and agriculture were contacted to gain further insight into the methods and techniques of native vegetation management. Local seed growers and several agencies, including the USDA Soil Conservation Service, the United States Forest Service, the Bureau of Land Management, and the Nature Conservancy were also mentioned as sources of information.

Using the knowledge gained from past studies and their own personal experiences, respondents suggested which areas would be suitable and which would be unsuitable for planting or managing native vegetative species along roadside ROW (Table 2). Many considered urban areas with intense development to be inappropriate for planting and managing native vegetation. Several of those who responded stated that it was not appropriate to use native species on the functional part of the road, that is, near the pavement or the shoulder edge since these areas required mowing for drainage and emergency parking for motorists.

Forty percent of respondents said that rest areas, tourist routes and high profile areas were considered to be appropriate places for planting native

vegetation. Some felt that ROW requiring little maintenance would also be suitable sites for using native vegetation. Rural areas were considered by many as being the most appropriate areas. Sites where yearly maintenance could be a problem were also considered suitable environments for native vegetation. Specific parts of the ROW such as ditch bottoms and backslopes were recommended as potential sites for native planting, while some considered all roads appropriate. The Tennessee DOT respondent stated that if RVM programs were properly planned, high visibility areas could be appropriate sites for native species.

Table 2. Suitable and unsuitable sites for native vegetation management in roadside ROW.

<u>SITE</u>	<u>SUITABLE</u>	<u>UNSUITABLE</u>
Rest areas	*	
Tourist routes	*	
Rural areas	*	
Backslopes	*	
Low maintenance areas	*	
High visibility areas	*	*
Steep slopes	*	*
Industrial areas		*
Urban areas		*
Heavily travelled areas		*

Source Appendix 1, Section I, Qu. 7 and 8

The introduction of new departmental initiatives using native vegetation along ROW were in response to shifting public attitudes towards favouring more naturalized ROW and in response to reduced budgets. Most respondents agreed that areas which required less maintenance such as rural areas were most suited to the management of native plant species. Urban areas were considered to be inappropriate areas. There were, however, some disagreements with respect to the appropriateness of using native vegetation at particular sites such as high profile areas and steep inclines.

3.3.2 Vegetation

Twenty-seven percent of respondents stated that their DOT had a mandate to seed a certain percentage of newly constructed highway ROW's with native vegetation. Some of the respondents were required to seed all newly constructed highway ROW with native vegetation and others were required to seed less than 2% of ROW with native grasses and wildflowers.

Sixty-seven percent of respondents stated that their department had no mandate to seed a certain percentage with natives species. Many were limited to seeding specific sites such as rest areas and high profile sites. It was also noted by several American respondents that the Federal Highway Administration had stipulated that .0025% of the landscaping costs of federal highway projects be used for wildflower plantings.

Seventy-three percent of respondents felt that it was important or very important to use native plants indigenous to the local area were the vegetation was to be planted. Twenty-seven percent felt it was not important to use indigenous plants (Table 3). The Tennessee DOT felt that using species indigenous to the physiographic area was more economical and provided an effective plant cover that also preserved the natural diversity of the area. The respondent from Minnesota stated that seeds should be purchased within a 160-320 km (100-200 mi) radius of their point of origin. Oklahoma's DOT wrote that native plants indigenous to the local area have a better chance of being established successfully. Although the use of local seed was considered by many to be important, respondents noted that the cost and availability of seed forced compromises between using local ecotypes or not using them for roadside projects.

Table 3. Importance of using native vegetation indigenous to the local area for restoring and planting.

<u>IMPORTANCE</u>	<u>FREQUENCY</u>	<u>ABSOLUTE PERCENT</u>
Not important	10	27
Important	17	46
Very important	<u>10</u>	<u>27</u>
	37	100 %

Source: Appendix 1, Section I, Qu. 11

Departments purchased the majority of their native seeds from either regional nurseries in their province or state. Several states purchased seed from suppliers in surrounding states, or from nurseries in similar climatic regions. Some respondents found that the local seed growers had seed readily available, while others found the supply for good local seed in their region was limited and costly. In some states, such as Illinois for example, the contractors obtained their seed from the "best available sources", with preference given to locally collected ecotypes. Other DOT's had little control over where the seed was purchased because their department used the low bid process for tendering projects. Ohio's DOT had its own native nursery, and the Wisconsin Department of Natural Resources had begun a state nursery for native plants and seeds which will be used for highway projects.

The seed mixtures used for seeding along highway ROW are shown in Table 4. Different seed mixtures were used at different sites. The choice of mixture depended on the site conditions and on the desired outcome. Roadside managers could choose to have a monoculture stand of grasses or they could have a mixture of grasses and forbs. Managers also had the option of restoring the roadside ROW to native vegetation and therefore the number of species planted in the ROW was dependent on what type of stand was desired.

Table 4. Seed mixtures used when seeding native vegetation in roadside rights-of-way.

<u>MIXTURE</u>	<u>PERCENT OF RESPONDENTS</u>
Non-native grasses, native grasses and native wildflowers	48 %
Non-native grasses and native grasses	45 %
Native grasses and native wildflowers	45 %
Native grasses	40 %
Non-native grasses and native wildflower	24 %
Other	16 %

Source: Appendix 1, Section I, Qu. 14

When planting vegetation in ROW, forty-eight percent of respondents used non-native grass, native grass and native wildflower mixture. Native grasses were used with either non-native grasses, native wildflowers or alone. The non-native grasses were used as a general soil stabilizer when used together with the native vegetation mixtures. Certain native species were not added to mixtures because of their potential to attract unwanted wildlife species to the roadside.

Using native species that were indigenous to the local area was important to many respondents. As evidence of this, 29 percent of respondents purchased seeds within the general region of their province or state. Some DOT's were forced to compromise and use cheaper and more readily available seed due to the higher cost and less available supply of native seed.

3.3.3 Site Preparation

Survey responses indicated that newly constructed highways which had no vegetation required RVM techniques different to those used on highways with existing vegetation when seeding native vegetation. Most seedings were done on newly constructed highway ROW. Seventy-three percent of respondents cultivated the soil to an approximate depth of one to three inches prior to seeding. The application of herbicides, used to kill existing vegetation or noxious weeds, was a preparation technique used by 48% of respondents. Some sites with existing vegetation were sprayed with herbicides and then a no-till seed drill was used.

Forty-three percent of DOTs added topsoil. This topsoil was usually added to newly constructed highway ROW where topsoil had been removed prior to construction. Once the soil had been spread over the site, it might have been cultivated, roller packed, or treated with herbicides.

Table 5 shows equipment used to seed native grasses and native wildflowers. Hydroseeding was the technique used by 70% of respondents for seeding grasses. Hand broadcasting was the method used most often for seeding native wildflowers. The use of native seed drills was also noted as being an effective method of seeding. Nebraska's DOT representative commented that while the native grass drill worked best, given time, all methods would work.

Table 5. Techniques used when seeding native vegetation in roadside rights-of-way.

<u>TECHNIQUE</u>	Native Grasses	Native Wildflowers
	<u>PERCENT OF RESPONDENTS</u>	<u>PERCENT OF RESPONDENTS</u>
Hydroseeder	70 %	48 %
Hand broadcast	51 %	70 %
Native seed drill	32 %	51 %
Agricultural drill	32 %	24 %
Mechanical broadcaster	29 %	34 %
Other techniques	10 %	2 %
No response	35 %	13 %

Source: Appendix 1, Section I, Qu. 16

Respondents indicated that specific measures should be taken when seeding for native vegetation. Many felt it was important that existing vegetation be eliminated, that the seed bed be firm, that seed placement be relatively shallow and less than one inch in depth, and that there be good seed to soil contact. It was noted that roller packing or cultipacking increased the seed to soil contact. Several commented that soil structure and soil type was important when seeding with native vegetation, and that special consideration be given to slopes, shallow soil and seeding during dry summers.

Once seeding was completed 78% of respondents covered the area with a mulch. A vegetative mulch of hay or a straw mixture was used most often. If a "no-till" seed drill was used, then the seeded area was mowed to provide

the mulch. In some cases a tackifier was used to hold down the mulch. Very few used fertilizer or irrigation.

The most common problems encountered during site preparation involved the soil conditions, including poor soil, a lack of topsoil or soil being too hard or too soft. Thirty-seven percent of respondents had soil preparation problems. The question of tilling or using a no-till drill was of concern. With tilling there was the potential for increased weed growth. The topography of the ROW or the surrounding area caused some problems. For example, the steepness of slopes made it difficult to use seeding equipment and left some areas inaccessible. Soil stability could be a problem as unstable slopes may erode.

Seed availability, the seed source and germination rates were problems associated with seeds. Twenty-seven percent of respondents had seeding technique problems. A common problem was that the seeds were planted too deep. In some cases this was due to the seeder not being calibrated to the proper depth. Another seeding problem encountered was difficulty in spreading seeds evenly when hydroseeding or broadcasting. Spreading the seeds evenly was important to ensure that the vegetation did not grow in patches on the site. The techniques used during site preparation were dependent on the site and the type of vegetation to be planted. Problems encountered during site preparation included site conditions, soil conditions and seed availability. Preparing a site to be seeded with native vegetation required planning to ensure that the efficient and effective techniques and equipment are used.

3.3.4 Site Establishment

Eighty-nine percent of respondents said that the sites planted with native vegetative species were monitored during the establishment phase. The level of monitoring ranged from daily to once a year, with the majority monitoring at least once a month. Once the sites were considered to be established respondents monitored their sites once or twice a year.

Weeds often became a problem during early establishment of the native vegetation, and continued to be problematic through to late establishment. A concern regarding weeds was that they could present problems of shading and nutrient depletion. Ten percent of the respondents had no problems with weeds.

Mowing was a technique used by the majority of respondents to control weeds. Sites were usually mowed one to four times in the first year. Forty-eight percent of respondents said they stopped mowing or reduced mowing to once or twice a year following establishment of the stand.

Sixty-four percent of the respondents used herbicide to control weeds, and the majority of them used it once a year. Herbicides were used most often prior to planting, in order to eliminate noxious weeds. For safety and aesthetic reasons selected areas near guiderails and fences were also sprayed with herbicides. The most common pieces of equipment used were spray booms with controlled nozzles and spot sprayers with backpack sprayers.

Burning was not used by many of the respondents, with only 21% of respondents using this maintenance technique. Those that did use it usually burned from March to May and did so once every two or three years or as soon as enough fuel had developed that would burn.

Forty-five of the respondents said they would not do anything if the vegetation did not grow vigorously during the first or second growing season. Many noted that most sites did not "look like anything" until the third year and might take a further five to ten years to develop into a stable ground cover. Twenty-nine percent stated that the site should be reseeded following the year of first seeding. Twenty-seven percent said the site should be reseeded the year after the second growing season. Many commented that a great deal of patience was required from both DOT personnel and the public when planting native vegetation due to the long period of time needed to establish this type of ground cover.

The main problems during the establishment phase were associated with maintenance techniques. Several respondents noted that the sites were accidentally mowed by maintenance personnel due to a lack of communication and knowledge of native vegetation growth. Many stated there was a need to inform all levels of personnel involved in maintenance and management of ROW to ensure that everyone understood the techniques and when they should be applied. Another major problem reported was weed infestation, which in turn caused problems with members of the public which reacted negatively to the

aesthetics of the ROW. Maintenance operations were noted as being particularly important during the site establishment phase when weeds might become a problem and need to be controlled by either mowing or herbicide application. A great deal of patience was required of both the public and DOT personnel because native vegetation was slow to become established. An understanding of the techniques unique to planting and restoring native vegetation and when to utilize them was also seen as critical to successful establishment.

3.3.5 Economics

Installation Costs

Of the respondents using native vegetation along ROW, 37% incurred start-up equipment costs. New equipment purchased included seed drills, hydroseeders, burn equipment (back pack sprayer, torches and flappers), skid units and all-terrain vehicles. The Iowa IRVM estimated some of the costs of equipment used in planting and maintaining native vegetation (Table 6). Examples of equipment used for planting and maintaining native vegetation in roadside vegetation management are shown in plates 7 and 8. The respondent from the Indiana DOT estimated average equipment operating costs at \$49.01 per hour (\$38.00 US) with the labour cost for two workers estimated at \$53.27 per hour (\$41.30 US).

Table 6. Iowa IRVM planting and maintenance equipment costs.

<u>EQUIPMENT</u>	<u>ESTIMATED COST</u>
Native seed drill	\$ 11,600 (\$9,000 US)
No-till seeder	\$ 11,500 (\$ 8,900 US)
Hydroseeder	\$ 10,300 (\$ 8,000 US)
Skid Unit	\$ 9000 (\$ 7,000 US)
All terrain vehicle	\$ 4700 (\$ 3,600 US)
Burn equipment (torches, backpack sprayers and flappers)	\$ 500 (\$ 400 US)

Source: Kirk Henderon, IRVM

In addition to capital costs, another initial cost was incurred for technical expertise through the hiring of roadside managers or native vegetation experts. The estimated salary budgeted for technical expertise was \$32,000 per year (\$25,000 US) in Iowa, and \$39,000 per year (\$30,000 US) in Tennessee.

The Wisconsin DOT began its programs gradually, buying equipment and planting in small increments over a period of years. This resulted in a reduction in initial costs. Other DOT's had no additional costs. The California DOT used the same equipment it used for native and non-native vegetation and therefore did not have increased costs. Staff from the Iowa DOT noted that although native seed drills are usually purchased, they can also be rented and this could have reduced costs. They further remarked that expenses incurred at the start of the program should be balanced against the savings which resulted from reduced mowing and herbicide use in the long-term.



Plate 7. Truax native seed drill (photo: J. Morgan)

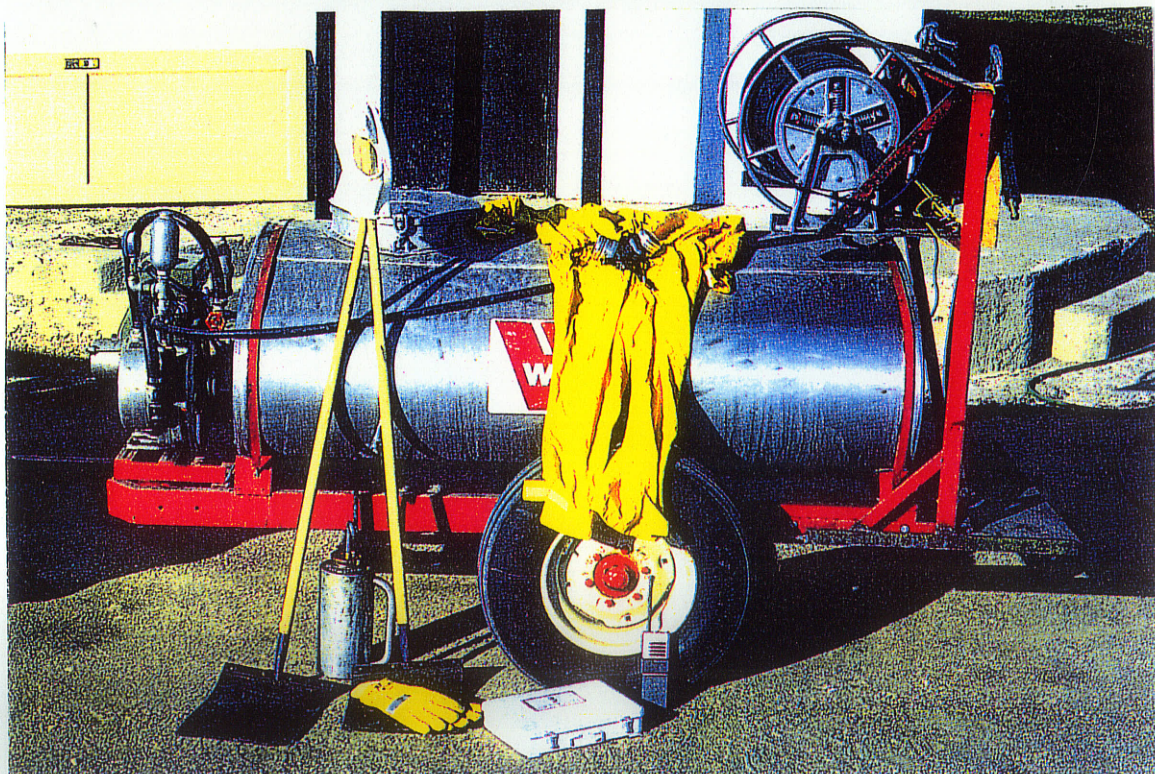


Plate 8. Equipment for prescribed burning (drip torch, rubber flappers, water tank) (photo: E. Driver, Trotter 1992)

Table 7 summarizes the responses of DOT's when asked to compare the relative costs of native seed to traditional seed. Approximately half of the respondents said that native grass seed cost more than traditional seed. A few respondents stated that these costs were comparable in their jurisdictions. Sixty percent indicated that native wildflower seed costs more than traditional forb seed.

Table 7. Relative costs of native seed and traditional seed.

	NATIVE GRASSES	NATIVE FORBS
	<u>ABSOLUTE PERCENT</u>	<u>ABSOLUTE PERCENT</u>
More than traditional	57	60
Same as traditional	16	13
Less than traditional	3	0
No response	<u>24</u>	<u>27</u>
	100 %	100 %

Source: Appendix 1, Section I, Qu. 31

Thirty-seven percent of respondents stated that it cost them more to plant native grasses and wildflowers than to plant traditional vegetative species along ROW, and 32% stated there was no difference in cost (Table 8). The reason given for the greater expense incurred in using natives in ROW plantings was that the seed was more expensive. The respondent from the Iowa DOT

suggested that even though costs were higher initially, if native species were managed properly, maintenance costs would be reduced. It was also noted by staff at the Nebraska DOT that although the costs associated with using natives were sometimes higher, the native species tended to last longer.

Table 8. Relative cost of planting native and traditional vegetation.

	<u>FREQUENCY</u>	<u>ABSOLUTE PERCENT</u>
More than traditional	14	27
Same as traditional	12	32
Less than traditional	1	3
No response	<u>10</u>	<u>27</u>
	37	100 %

Source: Appendix 1, Section I, Qu. 31

The cost of planting one hectare of traditional vegetation ranged from \$930 to \$7970 per ha (\$293 to \$2500 US per acre). The average cost of planting traditional vegetation in highway ROW was \$2820 per ha (\$884 US per acre) in 1992. The cost of planting native vegetation in highway ROW ranged from \$1050 to \$22300 per ha (\$329 to \$7000 US per acre). The average cost of planting native species was \$4050 per ha (\$1272 US per acre) (Table 9). The difference between the average cost of using traditional and

native species is approximately \$1230 per ha (\$388 US per acre). Some states for example, Kansas, Maryland and Illinois indicated that the cost of planting native vegetation was less than the cost of planting traditional vegetation. In Nebraska, Montana, Louisiana and California the costs associated with planting native vegetation and traditional vegetation were the same.

Table 9. Cost of planting native and traditional vegetation.

<u>VEGETATION TYPE</u>	<u>AVERAGE COST</u> per hectare (Canadian funds)	<u>AVERAGE COST</u> per acre (US funds)
Native	\$4050 / ha	\$1272 / acre
Traditional	\$2820 / ha	\$884 / acre
Difference	\$1230 / ha	\$388 /acre

Source: Appendix 1, Section I, Qu. 32

MAINTENANCE COSTS

Forty-five percent of respondent noted that the percentage share of their department's budget which was allocated for maintenance had remained the same since the introduction of native species management. Several respondents noted that their budgets had decreased. These reductions were primarily attributed to policy changes which reduced the mowing frequency and the number of applications of broadcast spraying with herbicides.

Since the inception of new RVM programs, the overall mowing costs had decreased for 35% of respondents, and remained the same for 30% (Table 10). Five percent stated that they had experienced increased costs due to increased mowing. The estimated cost of mowing a hectare was \$102 (\$32 US per acre). Although the amount of mowing had been reduced for some DOT's, the costs of fuel, equipment and labour had increased and therefore the total costs remained approximately the same. In Illinois the addition of new areas requiring mowing as a result highway construction, had offset the costs of reduced mowing in recent years. As a result the total costs remained the same. Those who stated that mowing costs were less attributed this savings to reduced mowing and to lower-priced contract mowing.

Table 10. Relative cost of mowing and herbicide application since the introduction of RVM programs that use native vegetation

	MOWING	HERBICIDES
	<u>ABSOLUTE</u>	<u>ABSOLUTE</u>
	<u>PERCENT</u>	<u>PERCENT</u>
Remained the same	30	32
Increased	5	22
Decreased	35	14
Not a method used	0	8
No response	<u>30</u>	<u>24</u>
	100 %	100 %

Source: Appendix I, Section I, Qu. #35 and 38

During the establishment phase herbicides were primarily used to eliminate noxious weeds and to maintain bare ground along guide rails and around posts. The estimated cost of herbicide application was \$166 per ha (\$49 US per acre). Table 10 shows the relative costs of mowing and herbicide use since the introduction of RVM programs using native vegetation. Most respondents commented that costs had remained the same or increased due to the continual expansion of noxious weed infestations and the use of more expensive chemicals. In Iowa the movement from broadcast spraying to spot spraying caused the average county expense for herbicides to drop significantly. The respondent from Tennessee stated that the use of native vegetation greatly reduced the requirement for herbicide application **after** establishment.

Seventy-eight percent of respondents did not use burning as a maintenance technique. The average estimated cost of burning was \$260 per hectare (\$82 US per acre). The high cost of burning was attributed to the need for safety precautions that can be expensive. In some cases fire departments are present or on stand by. Extra highway personnel were required when burning to assist and guide motorist moving through the burn area. A summary of burning, herbicide, and mowing cost are presented in Table 11.

Table 11. Maintenance costs of native vegetation in roadside rights-of-way

<u>MAINTENANCE TECHNIQUE</u>	<u>AVERAGE COST</u> per hectare (Canadian funds)	<u>AVERAGE COST</u> per acre (US funds)
Mowing	\$102 / ha	\$32 /acre
Herbicide	\$166 / ha	\$49 /acre
Burning	\$261 / ha	\$82 /acre

Source: Appendix 1, Section I, Qu. 37, 40, 43

Start-up costs varied. Some incurred high initial costs because of the need to purchase specialized equipment. Some respondents' start-up costs were negligible because they used existing equipment or rented the needed equipment. The cost of seeds was also an important part of these costs as more than half of the respondents found native seed costs to be more than the seed cost for traditional vegetation. The cost of planting native vegetation varied because it depended on seed availability, the techniques used, and need for RVM expertise.

3.3.6 Adjacent Landowners

A number of landowners had some problems with a roadside program which was using native vegetation. These landowners wanted to hay road ditches and would have preferred alfalfa growing in the ROW and, some landowners hayed natives as if they were alfalfa. State policy in Iowa does not permit landowners to mow roadsides in IRVM project areas, however, many landowners resent the policy and mow anyway. On most rural highways in Wisconsin landowners accept, support, or are unaware of native vegetation management. Unmowed vegetation tends to collect trash and provide hiding places for undesirable people and animals. This is a problem for landowners adjacent to roadside ROW. Increased wildfires may actually cause damage to property of landowners. Some adjacent landowners who mow their lawns would prefer the ROW to have a clipped fairway appearance as well.

Native vegetation in roadside ROW also provide benefits to landowners. Native vegetation could create wildlife habitat, eliminate noxious weed species, reduces disruption to drainage, enhances visual beauty that leads to higher property value due to greater aesthetic appeal, and results in cost savings through reduced mowing.

3.3.7 Public involvement

Sixty-two percent of respondents believed that overall public reaction to the use of native vegetation along ROW was positive and feedback was positive in most cases. In a survey carried out in Iowa, 70% of the 400 survey participants were in favour of native plantings. Together local governments and environmental agencies in Canada and the US supported DOT's in their use of native vegetation. Kansas was representative of several cases in which the number of positive and negative comments were about equal. In Illinois public reactions became more neutral as more and more seedings were installed.

Half of the survey respondents stated that there was some public involvement in the establishment and maintenance of native vegetation along ROW, and thirty-two percent said there was very little public involvement. Many different methods and mediums were used to promote and educate the public about the benefits of using native vegetation along roadsides. Forty-five percent of respondents used brochures to inform the public about the use of native species in ROW, and roadside signs were used by 37% to introduce the public to native species. Workshops were also used as a tool to inform the public. Other mediums used included television, newspaper and magazine advertisements, radio public service announcements, the distribution of free seed packets, videos, slide presentations, public lectures and meetings, seminars, workshops, demonstration plantings, news releases, conferences, and legislation.

3.3.8 General Assessment

Eighty-six percent of respondents to the survey stated that the use and management of native plants along highway ROW had been successful. Staff in Nebraska's DOT considered their use of native vegetation in RVM to be a success for a number of reasons. These reasons included positive public awareness, weed suppression, and the successful use of planned natives species. Indicators of technical success included: reduced mowing, erosion control and increased bird habitat. In Wisconsin staff wrote that they felt they had developed a sound program which stressed preservation and re-establishment of native vegetation. Louisiana DOT staff conducted an inventory of native vegetation and tried to preserve identified native vegetation. Many said patience was a key factor in the successful implementation of native vegetation programs. Iowa's DOT staff commented that given time and luck, RVM using native grasses would be viable.

3.4 ATTEMPTED NATIVE VEGETATION USE SECTION II

Section II of the survey was designed for those DOTs which had attempted to plant and/or manage native vegetation along highway ROW but which had discontinued this practice. The two departments which answered Section II were from Massachusetts and New Brunswick. Massachusetts began a program using native vegetation in roadside planting in 1983 and discontinued

constraints, but maintenance costs and equipment availability were other deciding factors. New Brunswick also stopped using wildflowers due to budget reductions. As well, germination and weed problems were other factors that lead to the discontinuance of this program which lasted only one year, from 1991 to 1992. Massachusetts had some successful planting at visibility sights such as verges and gateways. New Brunswick did not document any successful plantings.

Government employees in New Brunswick were responsible for 80% of the planting of vegetation on ROW, with the other 20% of the planting contracted out to landscape companies. Government employees and local contractors carried out highway maintenance along roadside ROW in both New Brunswick and Massachusetts. In Massachusetts there was an "Adopt-a-highway" program under which participating civic organizations were responsible for litter cleanup on two miles of selected roadway. At the time the survey was conducted mowing, in roadside ROW was a maintenance technique carried out once a year in New Brunswick, and four times a year in Massachusetts. Herbicide application and burning were not maintenance techniques used by either of the respondents.

The reduction in budget monies and the cost of using natives in roadside ROW were factors that lead to the discontinuance of the Massachusetts and New Brunswick programs. The cost and limited availability of equipment and seeds, as well as weed infestation, were factors that influenced the termination of those programs.

3.5 TRADITIONAL ROADSIDE VEGETATION MANAGEMENT SECTION III

The seven DOT's which responded to this section gave several reasons for not currently using or managing native vegetation along ROW. Five respondents said that equipment and expertise were unavailable. A limited supply of seed coupled with high seed costs were other reasons given for not using native species. Saskatchewan had only recently become aware of the cost benefits of using native species. Staff at several DOT's showed interest in experimenting with natives.

Six respondents to Section III believed that their departments would probably incorporate native vegetation use in their future management plans. Many were interested in using native species in the future because of reduced mowing requirements and reduced maintenance expenditures. The public and environmental groups had also expressed growing interest in the use of native species.

The types of vegetation currently used by the respondents were grasses, wildflowers, shrubs and trees. The planting of vegetation on ROW was carried out mainly by contractors and/or some government employees. Many DOT's employees did the rehabilitation work of their roadside and the functional planting for screening, erosion control and beautification planting along highway ROW. The majority of newly constructed ROW were planted by contractors. All seven respondents stated that government employees were involved in the maintenance of ROW, and four respondents said local contractors were also

involved. Mowing was a maintenance technique used by all respondents, mowing being undertaken approximately three times a year. Herbicide application was a maintenance technique used by six respondents.

The reasons given for not using natives on ROW included the lack of equipment, expertise, and seed. Four respondents however, showed interest in incorporating native vegetation into their RVM programs in the future.

3.6 SUMMARY AND ANALYSIS OF SURVEY RESULTS

One of the main objectives of the survey was to identify those respondents who were using native vegetation in their RVM practices, those who attempted to use native vegetation and those who are using traditional vegetation in their RVM practices. Of the 48 who responded, 37 respondents are currently using native vegetation in RVM and believed that using native vegetation could be both economically and environmentally feasible if the proper native vegetation management systems were in place. The survey also yielded two respondents who had attempted to use native vegetation but stopped due to fiscal constraints. The additional cost of using native vegetation was also the reason given to explain why five of the seven respondents using traditional RVM practices had not started a program that used native vegetation.

The survey respondents also cited numerous economic, technical and environmental advantages and disadvantages of planting and/or managing

native vegetation along roadside ROW. There was, however, some disagreement on which techniques should be used, and the costs associated with using native vegetation. The following section summarizes and analyzes survey responses concerning the economic, technical and environmental benefits and costs of using native vegetation in roadside ROW management.

3.6.1 Economic Advantages and Disadvantages and Analysis

ECONOMIC ADVANTAGES

1. Reduced maintenance

Respondents noted that one of the advantages of using native vegetation included the reduced need for intense management. Once the native vegetation was established there was a reduction in mowing and chemical spraying in the ROW. The reductions in roadside vegetation maintenance resulted in lower maintenance costs.

ECONOMIC DISADVANTAGES

1. Increased start-up cost

Respondents found that the start-up costs, seed costs and establishment costs were economic disadvantages when starting a RVM program that used native vegetation. Some DOTs hired a roadside manager or received assistance from experts from outside their departments to design and run a program that incorporated native vegetation in ROW. These initial costs varied depending on the level of expertise already available in the department. Another start up cost

was for specialized equipment. Planting native species require specific types of equipment and techniques to ensure successful germination and growth. Specialized equipment such as native seed drills, hydroseeders or mechanical broadcasters were purchased for seeding the native vegetation.

2. Increased seed costs

Several respondents observed that the higher seed costs were a concern to their DOTs. In many cases the cost of seed for native vegetation was greater than the cost of traditional seed. These higher prices for seed increased planting costs of native vegetation.

3. Increased cost of establishing vegetation

Respondents for Pennsylvania and Ohio DOTs stated that the higher establishment costs of using natives were disadvantages to their departments. Many respondents indicated that the higher establishment costs were due in part to the slow establishment of the native vegetation. New plantings often needed intensive management during the first and second years, and this requirement increased the cost of managing the ROW.

ECONOMIC ANALYSIS

Table 12 shows a comparison between the economic costs associated with using native vegetation in RVM versus the costs of RVM practices.

Table 12. Traditional vegetation costs and native vegetation costs.

COSTS	TRADITIONAL VEGETATION		NATIVE VEGETATION	
	Canadian \$ (per hectare)	American \$ (per acre)	Canadian \$ (per hectare)	American \$ (per acre)
START-UP				
- Expertise	--	--	\$32000-\$39000	\$25000-30000
- Equipment	--	--	\$10600-\$11600	\$9000-\$8000
INSTALLATION				
- Planting	\$930-\$7970	\$293-\$2500	\$1050-\$22300	\$329 -\$7000
MAINTENANCE				
- Mowing	\$38 - \$258	\$12 - \$81	\$38 - \$258	\$12 - \$81
- Herbicide	\$25 - \$478	\$8 - \$150	\$25 - \$478	\$8 - \$150
- Burning	--	--	\$64 - \$522	\$20 - \$164

The cost of seed, equipment, installation and maintenance in the first few years of establishment are some of the economic costs associated with using native vegetation in roadside ROW. Many of these costs, however, can be reduced if equipment was rented or cost shared with other agencies in native vegetation management such as parks and utility companies. Another cost saving measure in the implementation of the program would be to spread the cost over a period of time by slowly phasing in the various components of native vegetation management. Also, as more organizations become involved in native vegetation management, the availability of seed and equipment will increase and the costs may decrease. The economic benefits of using native vegetation are reduced maintenance of the roadside ROW. The reduction of

maintenance activities such as mowing and spraying can reduce the costs involved in managing roadside ROW.

3.6.2 Technical Advantages, Disadvantages, and Analysis

TECHNICAL ADVANTAGES

1. Better adapted vegetation

Many respondents said that native vegetative species were better adapted to the roadside environment and had a higher survival rate than some of the traditional vegetation. Native species were found to be more resilient to the local climate and weather extremes. Most respondents believed that native vegetation was more drought and disease resistant, and hardier than introduced species.

2. Reduced weed growth

Respondents commented that the extensive root system of many native species could reduce weed growth by out-competing weeds for space and nutrients. Although native vegetation could preclude the growth of exotic vegetation, it was noted that natives were less likely to present infestation problems to surrounding rangelands or pastures.

3. Reduced soil erosion

Several respondents stated that native vegetation could be used as a long term source of erosion control. The deep root systems of native species held the soil better and, stabilized the roadways and fill areas. Native grassland

species provided stable plant communities that required less attention and reduced the need for costly vegetation management by physical or chemical means. Nova Scotia's DOT observed that roadside banks were more stable and did not slide when native vegetation was used. The respondent from Nova Scotia also noted that with natives there was less erosion and sediment in the waterways.

4. Reduced snow drifting

Responses indicated that native vegetation in ROW could become a living snow fence to reduce drifting across roads, if properly managed. Staff from Iowa's DOT stated that snow drifting may not be a problem if the plants that reduced drifting were planted in the appropriate spaces. It was also noted that native vegetation trapped snow evenly throughout the stand of vegetation in the ROW and resulted in an even snowmelt. Other respondents stated that native species held more snow in the ROW than did non-native vegetation.

TECHNICAL DISADVANTAGES

1. Limited availability of seed and equipment

Illinois and California encountered limited supplies of native seed and limited varieties. At the beginning of its program, the Tennessee DOTs also found it difficult to obtain native seed. Specialized equipment was difficult to purchase or rent due to the limited supply. The manufacturing of specialized

equipment for native vegetation management is a relatively new industry and the availability of the equipment is limited.

2. Slow to establish

Many respondents indicated that native vegetation was slow and difficult to establish. The respondent from Minnesota stated that there was a tendency for some native seed to lie dormant for a year or more and that this characteristic contributed to a slow establishment. Because of slow establishment, weeds tended to invade more easily in the early stages of planting. There were also some concerns regarding increased herbicide use to control weeds that grew during early establishment. From a technical standpoint, another disadvantage of the slow establishment of using native vegetation was the increased risk of erosion. Native species tended to grow more slowly, leaving the ground exposed for longer periods of time which increased the potential for soil erosion to occur in the ROW.

3. Potential for wildfires

In dry areas there was the possibility of wildfires occurring as a result of the increased native vegetation along roadsides that were allowed to grow undisturbed.

TECHNICAL ANALYSIS

The main technical benefits of using native vegetation is improved roadside conditions which arises from the reduction of weed growth, soil

erosion and snow drifting. Native species are also better adapted to local soil and climatic conditions and therefore, have a better chance of survival in the roadside environment.

Some of the technical problems associated with the use of native vegetation in RVM could be reduced or avoided with proper site preparation and the use of appropriate techniques for planting and maintenance. The proper site preparation which include the elimination of existing weeds is essential in avoiding weed infestation following seeding. One measure that can be taken to reduce soil erosion is to plant a cover crop that will hold the soil while the native vegetation is developing.

The limited supply of native seed and specialized equipment is currently a technical problem in many areas. However, as the concept of using native vegetation becomes more widely accepted, the availability of seed and equipment will improve. In the American and Canadian prairie regions, the supply of seed and equipment is steadily increasing. In the last ten years, for example several native prairie nurseries have been developing new seed sources and a number of companies have been designing and manufacturing specialized equipment. As more groups become involved in Canada, the techniques for seed harvesting, planting, establishing and maintaining native vegetation will improve and become more efficient. In the future, many of the technical problems associated with native vegetation management will be reduced and will make it more feasible to use native vegetative species in Canadian ROW.

3.6.3 Environmental Advantages, Disadvantages and Analysis

ENVIRONMENTAL ADVANTAGES

1. Reduced maintenance

The most significant advantage of using native vegetation in RVM practices was the reduced need for intensive management activities such as mowing and spraying. The decreased use of these activities not only has economic benefits but more importantly, environmental benefits.

The activities associated with traditional vegetation management have many significant effects on the environment. Water quality can be affected by traditional vegetation management activities because some of the herbicide, oil, gasoline, lead and sediment used in these activities could contaminate the surface runoff. The amount of contaminants in the water systems would be reduced by decreasing the amount of management activities in the ROW that cause these pollutants.

2. Reduced pollution

The native vegetation can reduce other types of pollutants in the roadside ROW. Native vegetation can trap and filter air borne pollutants on their leaves and stems, which gives them the potential to store large amounts of carbon dioxide, carbon monoxide, and hydrogen sulphide from the atmosphere. The efficiency of this pollutant trapping by the vegetation increases directly in proportion to a plants total surface area. The native species that grow from two to three feet when left unmowed, can essentially trap more pollutants than traditional turfgrasses that are usually six inches in height.

3. *Preservation of species diversity*

It was observed by respondents that managing native species in ROW preserved the genetic plant diversity of the local area. The Tennessee DOT representative stated that using native vegetation in ROW retained the natural integrity of the landscape and preserved the state's species diversity.

4. *Improved roadside aesthetics*

The majority of respondents stated that native vegetation was aesthetically more interesting than traditional vegetation throughout the year, and that it provided visual variety for regular commuters and tourists. The varied colours and interesting textures of native vegetation beautified the roadside ROW. Using native vegetation in ROW was also determined to be advantageous in terms of increasing tourist revenue because native vegetation has become a major tourist attraction in some states.

5. *Increased wildlife habitat*

Using native vegetation in ROW was seen by many respondents as an opportunity to increase wildlife habitat. Respondents felt that native vegetation offered wildlife a more diverse habitat and better cover. The respondent for the Montana DOT stated that the reported cases of deer collision kills have continued to decrease since the year mowing was reduced. Although the increased wildlife habitat may increase the extent of wildlife populations in ROW, Iowa's DOT survey respondent stated that there were no signs of increased wildlife collisions in the state. Wildlife collisions had been a serious problem in Wisconsin, specifically for the white tail deer. Staff at the DOT

problem in Wisconsin, specifically for the white tail deer. Staff at the DOT however, did not believe that natural roadsides had an effect on the behaviour of these animals nor had it concealed them from motorists.

4 . *Greater public awareness*

It was noted by several respondents that the public was beginning to understand the new idea of what constituted an attractive roadside. As a result, the public and environmental groups were shifting their attitudes toward favouring a more natural approach to roadside ROW, and the benefits of using native vegetation were attracting greater public interest than had previously been the case. Several states had received an overwhelming positive public response to the new RVM programs, and received a great deal of public support in the form of financial contribution and volunteer labour.

ENVIRONMENTAL DISADVANTAGES

1. *Increased wildlife*

The use of native vegetation in roadside ROW increase wildlife habitat and may also increase the activity of wildlife populations in the ROW. Small and medium-size animals might move into the native vegetation and cause problems by increasing the number of mortalities. Studies have shown however, that when ROW are wide, they may be effective barriers to wildlife dispersal (Oxley *et al* 1974). Studies have shown that when the width of the road was wider, small and medium-sized mammals (small mammals: less than 700 g and medium-sized mammals: 700 to 14000 g) were less likely to move

onto the roadway and be killed. When more large mammals (greater than 14000 g) moved and fed along ROW, there was the potential for an increased number of road mortalities. These large mammals were potential hazards and if struck by vehicles, could be detrimental to people and property.

2. Unwanted articles trapped

Once established, native vegetation sometimes collected litter. The respondent for Iowa's DOT said that native grasses could trap sediment and obstruct waterflow by remaining standing in areas where it was preferred that the grasses lie down and allow water to run unobstructed through the ditches.

3. Negative public response

A common problem encountered by respondents was the negative public reaction in response to plantings that were slow to establish. This weedy appearance in the early stages was not very appealing to many people. In Georgia the public argued that native vegetation was unsightly after bloom. Some members of the public viewed native vegetation as weeds and would rather have had the areas mowed. Many respondents observed that there was some negative public response to a natural roadside. This type of landscaping did not appeal to those who liked the neat look of a mowed area. Some people felt they were not getting their money's worth from their DOT when they saw the ROW left unmowed.

ENVIRONMENTAL ANALYSIS

Some of the more significant environmental benefits of using native vegetation in roadside ROW were reduced maintenance, the preservation of species diversity and improved aesthetics. These environmental benefits, on average far outweigh the environmental, technical and economic costs.

The use of native species in RVM reduces the need for intensive management and results in many environmental benefits. Less mowing reduces the amount of non-renewable energy resources used and also reduces the amount of pollutant to the air, water and soil. The reduction in herbicide use also has many environmental implications. The environmental costs associated with producing the chemicals, cleaning up after chemical production, managing chemical containers after use, and disposing of unused chemicals can be reduced. Using less herbicides also reduces the possibility of contaminating the soil or water.

The benefits of preserving the species diversity of native vegetation are also significant. There are many ethical, cultural, scientific and aesthetic reasons for preserving the native species. There is also a moral obligation to preserve the diversity and the cultural aspects of the native species for future generations. The role of many native species in the ecosystem and the potential value of native species are unknown. Preservation of native species gives the scientific community an opportunity to study their importance to the ecosystem and humans. The benefits of preserving native species may be

considered intangible and difficult to quantify in terms of dollars. They are, however, still significant to man and the environment .

Society also benefits from the improved roadside aesthetics when using native vegetation. The improved visual beauty of the native species in roadside add to the quality of life. Many DOTs in the prairie regions of the United States have received many environmental, technical and economic benefits from using native vegetation in their roadsides. Therefore, a potential exist for the DOT and the public in Canadian prairie regions to reap these benefits.

3.8 IMPLEMENTATION

The key factor for the successful implementation of native vegetation in RVM for the Canadian prairie is systematic planning. The development of a RVM program that incorporates native vegetation should be initiated in a progressive manner. The management of native vegetation should be slowly phased into current RVM program over a period time. This approach will ensure that not all costs are incurred at once but will be spread out over a number of years. An estimated preliminary cost schedule has been completed, which includes initial planting and maintenance for five years (Appendix 3).

The first step of implementing a RVM program that uses native vegetation is to inform all DOT staff of the benefits and costs and the objectives and processes involved this type of program. Raising the awareness levels of the public regarding the use of native prairie vegetation in roadside

ROW is also very important to the success of an RVM program. The public should be informed in regards to the economic, technical and environmental benefits associated with using native vegetation in ROW and what the DOT intends to do with native vegetation in roadside ROW.

A variety of techniques could be used to inform and educate the public on the processes involved in managing native vegetation. Techniques that could be used include brochures, public meetings, presentations, news releases, workshops, radio and television advertisements. The approach and the techniques used to inform the public can vary depending on the audience that is targeted. This is due to differing attitudes that exist within the public. For example, the residents of rural communities and residents of urban communities may have differing opinions regarding the use of native vegetation and therefore different approaches should be used.

The identification of native vegetation remnants present in roadside ROW is another important step during the early stages of this type of RVM program. Vegetation inventories should be conducted along the roadside ROW to locate native remnants. It is important to know where the prairie remnants are and the quality, so that these areas can be protected from disturbance or destruction. Once the areas are located and preserved, they can be managed using techniques that will enhance the native vegetation growth. The prairie remnant sites can also be used as an educational tool to gain a better understanding of what is involved in managing native vegetation in ROW.

Demonstration projects can also be used as a tool to aid DOTs and the public in understanding native vegetation and the processes involved in preserving, planting, and maintaining native vegetation in ROW. The experience gained from demonstrations should be used to initiate roadside projects on a greater scale.

The public's involvement in RVM programs is very important to the successful implementation of native RVM programs. Volunteer groups could help in the preservation of native prairie remnant sites and in the collection and development of seed sources. The involvement of volunteers in the programs can reduce some of the economic costs. Programs similar to "Adopt-a-highway", which have organizations cleaning up particular sections of highways, could be used to plant and maintain native vegetation along roadsides.

The approach which includes the implementation of native vegetation management in stages or steps has been used in Wisconsin with successful results. The use of native prairie vegetation management has also been used successfully in other states such as Minnesota, Iowa and North Dakota. Due to the similarity between these states and the prairie regions in Canada, the DOTs of the Canadian prairies also have the opportunity to successfully implement this environmentally sustainable method of RVM.

Chapter IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

4.1 SUMMARY

The vegetation in roadside ROW has been intensively managed in many regions of Canada. Existing techniques used to control vegetative growth in ROW include mowing, brush cutting and chemical spraying. These techniques incur considerable financial and environmental costs and may not be the optimum management strategy for RVM. For this reason, a study was undertaken to assess the benefits and costs of an alternative RVM method, that is, the preservation, planting, restoration and maintenance of native plant species along roadside ROW.

In order to assess the economic, technical and environmental feasibility of managing native plant species in roadside ROW an examination of traditional and native vegetation management programs was undertaken. A review was conducted of traditional roadside RVM practices and policies, using Manitoba as a case study. An extensive review of roadside management programs currently using native vegetative species was conducted using a mail-out survey and interviews. The data collected from across Canada and the United States was analyzed to compare the costs and benefits of using native plant species

in roadside vegetation management versus the costs and benefits of the traditional practices currently used in the Canadian prairie regions.

Following the comparison, many economic, technical and environmental advantages of using native vegetation in roadside ROW management were found. When all cost were included, the environmental and future economic benefits of using native vegetative species in roadside ROW exceed the benefits of using traditional vegetation.

Conclusions were drawn on the basis of the research conducted, and recommendations were formulated on the alternative of using native plant species in roadside ROW in the prairie regions of Canada.

4.2 CONCLUSIONS

The purpose of this practicum was to assess the economic, technical and environmental feasibility of using native plant species in roadside vegetation management in the prairie regions of Canada.

In recent years several government agencies and private companies have been taking innovative approaches to vegetation management. These approaches place equal emphasis on the economic and environmental factors associated with vegetation management practices and policies. Preserving, planting, restoring, and maintaining native vegetation in roadside ROW have been demonstrated to be economically and environmentally sustainable methods of vegetation management.

These sustainable methods of ROW management have many benefits that have made it feasible to use native prairie vegetative species in the Canadian prairie regions. The economic benefits of this management approach include the reduced need for intensive roadside ROW maintenance. Native prairie species provide a stable plant community that does not require constant and costly vegetation management by physical or chemical means.

There are, however, some economic costs associated with using native prairie species. These economic costs are usually incurred during the initiation of the program and during the early stages of native prairie establishment. It appears that the initial cost of planting native vegetation is greater than that of planting traditional species. These high initial costs are incurred in the

acquisition of technical expertise, specialized equipment, seed, and maintenance for the first few years.

The costs of not using native vegetation in roadside ROW, however, can also be high. Management activities such as mowing and chemical spraying are costly. Intangible costs resulting from the environmental effects of traditional management activities cannot always be measured but may well be significant. These intangible costs are not often acknowledged in the management costs, therefore, the cost of using traditional vegetation may be much greater than what it was thought to be. Tangible costs associated with traditional RVM include the cost of producing the chemicals, cleaning up after chemical production, managing chemical containers after use, and disposing of unused chemicals. These tangible cost may not always be incorporated into the costs of traditional vegetation roadside management. When all tangible and intangible costs associated with traditional vegetation management are included, the cost of using traditional vegetation is much greater than the cost of using native vegetation in roadside ROW.

The technical benefits of using native vegetation are numerous. Native species with their deep and extensive root systems, usually out-compete the non-native species for space and nutrients. Once established, this stable plant community can also inhibit the growth of slower growing, non-native tree species that may try to establish in the ROW. Establishment of a native vegetative ground cover reduces soil erosion and increases water retention.

Using vegetation that is indigenous to the area increases the chances of plant survival because of their adaptability to local climatic conditions, soil conditions and resistance to disease and pests. There are however a few technical disadvantages of using native vegetation such as the limited seed availability and slow establishment. These technical problems may be reduced when more people become involved in using native vegetation. The number of seed producers and equipment manufacturers will increase and these items will then be more readily available.

The most significant benefits of using native vegetation in roadside ROW are the environmental benefits to the ecosystem and society. The environmental benefits associated with native vegetation outweigh many of the economic and technical costs. Some of the more significant environmental benefits associated with using native vegetation are due to the reduced maintenance in ROW. The reduction of the maintenance activities can also reduce pollution and the use of non-renewable energy resources. These reductions allow for a healthier environment.

Careful management of existing native prairies and restored native prairies improves and enhances local ecosystems and preserves the natural integrity of this unique plant community for present and future generations. Restoring native prairie species increases the abundance of native vegetation. Native plant restoration in ROW increases the extent of natural habitat available to wildlife, and provides important travel corridors for many species.

Native grasses and wildflowers are aesthetically appealing and add beauty and colour to the highway environment. These aspects fit well with emerging public attitudes which are placing a greater value on natural landscapes and environmentally benign management techniques.

Many states in the prairie region of North America are currently involved in native plant preservation, restoration, and management on roadside ROW. The benefits of using native vegetation are being realized by many departments of transportation in Canada and the United States. The high response rate to the survey indicates a high level of interest in using native vegetative species in roadside vegetation management.

The survey found that rural areas, rest areas, and tourist routes are the most appropriate sites for preserving, planting, and managing native vegetation. Intensively developed urban areas are unsuitable sites. This information can be used to target potential sites for preserving, planting or restoring native vegetation.

When a suitable site has been chosen it is important to use native plants that are indigenous to the immediate area while recognizing that there are limiting factors in terms of the availability and costs of good local seed. These limiting factors may force a compromise toward the use of cheaper and more readily available seed. Alternatively native seed sources can be developed with the cooperation of other governments and private agencies.

Other important factors to consider when planting and restoring native vegetation is site preparation and the amount of time required for establishment. The preparation of a site for seeding with native vegetation requires proper planning to ensure that the most efficient and effective techniques and equipment are used. It was found that once the planting has been carried out the establishment of stable stands of native vegetation can take from two to ten years. The results of the survey indicated that the majority of those using native vegetation management in roadside ROW had been successful.

Following the review of traditional RVM practices, it was found that these practices were not always economically and environmentally sustainable. The comparative assessment indicated that using native vegetation could be successful in Manitoba and other prairie regions in Canada by following similar programs that are being carried out in the United State prairie regions.

It was recognized that in order for a RVM program that uses native vegetation to be successful in the Canadian prairie region, systematic planning is required. Systematic planning involves the "phasing in" of native vegetation management activities so that the costs of implementing the program are not incurred all at once. Department personnel and the public should be informed of the economic, technical and environmental benefits of using native vegetation. They should also be informed of the native vegetation mangement activities that will be carried out by the DOT.

The identification of native prairie remnants in roadside ROW is an important procedure in the early stages of the program. Once these areas are located, they can be designated and preserved as native vegetation sites. These sites can also be used as an education tool for the DOT personnel and the public to gain a better understanding of the management of native prairies. Demonstration projects can be initiated to study and develop efficient native vegetation management techniques for the region. These demonstration projects can be used as a basis for the development of projects of a larger scale. The public's participation in a RVM of this type can also be helpful. Public organizations can be involved in the development of seed sources, harvesting seed, planting and maintaining native vegetation in roadside ROW. The survey indicated that there was a great amount of support from the public for using native vegetation in roadside ROW.

The survey also indicated that there were several American prairie states involved in using native vegetation in their RVM programs but that there were no Canadian prairie provinces involved in this type of program on a large scale. It was found however, that there is a growing interest by the DOTs and the public in using native vegetation in the Canadian prairie regions. The benefits of using native vegetation in RVM as discussed in this study provide a strong rationale for incorporating these vegetative species into Canada's roadside policies and practices.

Many Canadian provinces, including Manitoba, have taken a leadership role and have made a commitment to sustainable development. From an economic and environmental standpoint, the approach to managing roadside rights-of-way proposed in this study constitutes a practical alternative to current practices. By moving forward in a systematic and carefully planned manner of change, the public will come to understand the interacting environmental and economic factors involved in using native plant species along roadside ROW.

4.3 RECOMMENDATIONS

Based on the conclusions drawn, it is recommended that:

1. Vegetation inventories be conducted.

Systematic vegetation inventories should be conducted on roadside ROW to identify native prairie remnants. Once native prairie sites have been located, steps should be taken to preserve these areas and designate them as native prairie sites. Management and maintenance techniques that enhance the growth of native species in roadside ROW should be then implemented. These sites should be clearly marked with signs identifying them as native prairie sites to ensure that the public and maintenance personnel understand its significance.

2. Public education programs concerning alternative roadside vegetation management practices be initiated.

A variety of programs should be initiated to inform the public regarding the advantages of using native prairie vegetation in ROW. News releases,

workshops, presentations, public meetings, conferences, radio and television advertisements and field trips are methods that can be used for this purpose.

Brochures describing the use of native species along ROW in terms of the economic, environmental and technical benefits should be prepared and distributed to the public. The brochures will emphasize the importance of preserving the native prairie species and the steps being taken by DOTS to preserve this important resource.

3. Demonstration projects be initiated and potential pilot projects be evaluated.

Demonstration projects at carefully chosen sites should be developed to test the concepts and techniques of preserving, planting, and managing native vegetation along roadside ROW. These projects will raise the awareness of departmental personnel and the public. The identification of the most suitable native prairie species and the most efficient techniques could be valuable results of these demonstration projects. These demonstration projects could provide a basis for the change toward native vegetation use on a more extensive level.

The results and experiences from the demonstration projects should be used to evaluate potential pilot project sites for planting and restoring native vegetation. The knowledge gained from the demonstration projects will be beneficial in choosing the most suitable seeds, techniques and management for the pilot projects.

4. The cost of preservation, planting, and managing native vegetation be documented.

All costs associated with the preservation, planting or managing of native prairie vegetation should be documented in the future. Documenting the demonstration project costs and pilot project costs will give other vegetation managers an opportunity to review the economics of managing native vegetation in roadside ROW.

A formal cost study should also be conducted comparing the traditional unit costs of managing roadside vegetation ROW versus the cost of managing native vegetation in ROW. Both tangible and intangible costs should be considered during the research.

5. Public participation in native vegetation roadside management be encouraged.

Garden clubs, horticultural and naturalist societies, 4H clubs and corporations, as well as other community groups should become involved and given an opportunity to preserve, plant, and restore native vegetation. These groups could participate in the dissemination of information to the public through workshops, presentations and field trips. Volunteer groups could aid in the collection and development of local sources of seed. With the DOT's approval and guidance, responsible local groups with the proper resources could be allowed to plant and maintain sections of the roadside ROW.

6. The results of this study be made available to those agencies involved in roadside vegetation management.

Government departments and other agencies in Canada who have or once had native prairie vegetation in their provinces should consider the distribution of this report to all staff involved in roadside vegetation management.

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APPENDICES

Appendix 1

SURVEY RESULTS AND SURVEY RESPONDENTS

**THE USE OF NATIVE GRASSES AND WILDFLOWERS
IN ROADSIDE VEGETATION MANAGEMENT**

A Survey of Canadian and American Jurisdictions

SECTION I: RVM USING NATIVE VEGETATION

RVM PROGRAM

1. Is the department currently:

Managing native vegetation on ROW's only	5 %
Planting native vegetation on ROW's only	3 %
Managing and planting vegetation on ROW's	81 %
Other	5 %
No Response	5 %

Other: "doing experimental work with native wildflowers"; "research"

Comments: "all planting is by contract"; "Limited mowing and some herbicide use are the only management tools"; "native first choice, not practical due to difficulty of establishment and non-availability"; 2/3 of all mixtures contain natives".

2. What year did the department begin to consider using and/or managing native vegetation along ROW?

Year:	<1950	16 %
	1950 - 1959	11 %
	1960 - 1969	22 %
	1970 - 1979	16 %
	1980 - 1989	22 %
	1990 - 1993	3 %
	No Response	8 %

Comments: "Support for this approach goes back to the 1930's"; "Some people in the department feel the ROW should have been managed that way all along.";

3. What year did the department actually begin using and/or managing native vegetation along ROW?

Year:	<1950	13 %
	1950 - 1959	12 %
	1960 - 1969	21 %
	1970 - 1979	19 %
	1980 - 1989	19 %
	1990 - 1992	8 %
	No Response	8 %

Comments: "Reduced mowing to encourage revegetation of native"; "Ministry has been managing, specifying retention of native species on newly constructed highways"; "Always used native vegetation along ROW"; "Used native vegetation along ROW since colonial times".

4. What sources were contacted to acquire the preliminary information to begin a RVM program which used native plants?

Internal sources within the department	59 %
Other departments of transportation	32 %
University research	49 %
Special interest groups	22 %
Conferences	38 %
Journals, Bulletins and Magazines	43 %
Other	22 %
No Response	3 %

Other: "United States Soil Conservation Service"; "The Nature Conservancy"; "United States Forest Service"; "Bureau of Land Management"; "Local seed growers, naturalists"; "Botanical gardens and arboretum"; "Plant Materials Centre"; "Department of Natural Resources"; "Department of Agriculture"; "Department of Wildlife and Parks"; "Consultant"; "Surveys and studies".

Comments: "Even though all these sources were contacted there was not much known about management of native species"; "... the idea from another county that was using switchgrass for conservation plantings".

5. Why was the planting and/or managing native vegetation along ROW initiated?

Public interest	46 %
Economic situation	29 %
Interest from environment groups	32 %
Government legislation	27 %
New departmental initiatives	51 %
Other	35 %

Other: "BEST USE OF THE LAND"; "Department's desire to improve aesthetics"; "Species are commercial grown and readily available"; "To blend the highway into the surrounding landscape"; "Highway beautification".

Comments: "State and federal Game/Fish/Wildlife agencies asked for vegetation that would benefit game reproduction and habitat"; "government legislation was the main impetus"; "State legislation provided funds ... to fund roadside program"; "Counties adopted the program to save money (low maintenance), beautify roadsides, and be eligible for Living Roadway Trust Fund money"; "Initially

planned as a landscape feature ... later utilized as a low management turf cover to reduce long term cost"; "Interest of the district land supervisor"; "Emphasis was placed on reduced mowing, promoting wildflowers and native grass, providing added cover for wildlife"; "Effort was made to permit disturbed areas to return to native"; "Native plants ... require less irrigation and were more adaptable to a wide range of site condition"; "Part of an ongoing cooperative research program .. to find plants which are better adapted ROW conditions and have a better chance of surviving and making the plantings a success".

6. What are the main benefits of using this strategy of planting and/or managing native vegetation along ROW's?

Landscape beautification	76 %
Wildlife habitat	57 %
Economic considerations	57 %
Reduced maintenance costs	76 %
No Response	3 %
Other	35 %

Other: "Improve water quality"; "Planting to control wind and water erosion"; "Erosion control"; "Weed suppression"; "Sod formers"; "Preservation of native vegetation and diversity integrity of species"; "water conservation"; "Living snow fence"; "Native grass tends to survive drought years better than Brome and Fescue cover"; "better resistant and survivability in local conditions"; "The use of native plant material offer more competition to invasive plants"; "Environmental reasons; to prevent erosion into water sources".

Comments: "Reduced maintenance costs ... should be a primary consideration"; "The intent has been for reduced maintenance costs, but this has not been proven or verified"; "Economics of establishment at this time higher than introduced eurasian species, however long term benefits may offset this initial cost difference. This would include increased tourism in wildflowers areas."; "The county program is motivated primarily by the desire to reduce herbicide use and control soil erosion, thereby reducing maintenance costs, beatification and habitat are additional incentives"; "Using native vegetation is less expensive than non-native vegetation, managing for native vegetation is less expensive than fence to fence mowing and herbicide application"; "less costly than imported plants"; "Wildlife habitat: negative aspect, we do not want to attract wildlife to the roadside"; "The reduced maintenance cost will not be reflected unless the standard operating procedures are changed, education of maintenance personnel at the highest levels in necessary to change procedures"; "Mostly a cost savings ... we have low cost "greened" up roadside, without having to introduce imported expensive nursery stock"; "Some believe mowed is more beautiful than unmowed, some believe increase in wildlife populations causes hazards"; "Blend in' with the existing surrounding vegetation types which compliments the roadside".

7. Are there areas of ROW's that you consider more appropriate for planting and/or management of native vegetation rather than the traditional plant species?

Rest areas	40 %
Tourist routes	40 %
High profile sites	40 %
No Response	5%
Other	59 %

Other: "Rural areas where low maintenance is acceptable"; " Rural undeveloped areas"; "Areas where yearly maintenance would be a problem"; "Hard to reach areas"; "Backslopes"; "Ditch bottoms"; "Steep slopes"; "Median areas of high visibility"; "Low areas that are wet"; "Wetland areas"; "Costal and mountain regions"; "Borrow areas away from the travelled way provide excellent opportunities"; "All areas you do not need to maintain regularly"; "Non-urban areas";

Comments: "Where natives ... provide better cover than traditional types"; "Planned low management areas outside the clear zone"; "Areas that need low maintenance"; "Management is more practical (long-term & economical) if natural areas(ie, where plants) were already growing"; "Do not consider any areas unappropriated"; "Areas of lower maintenance ... that mowers can't traverse without causing erosion"; "More flowers, trees and shrubs in urban and residential areas"; "They spend more money on wildflowers on the site that are most visible"; "Trying all areas - some seem to do better than others with native plants. High visibility areas are also appropriate and if properly planned can retain natural integrity of landscape"; "We are using native plants to keep mowing off slopes"; "They are more appropriate on rural highways"; "On tourist routes and rest areas, they can be viewed by the public and they educate the public about the native plant communities".

8. Are there areas of ROW's that you consider not appropriate for planting and/or management of native vegetation?

Heavily travelled areas	5 %
Steep inclines	24 %
Industrial areas	18 %
No Response	16 %
Other	59 %

Other: "Steep inclines with light soils"; "Near the pavement"; "All areas"; "sites with no topsoil and in dry areas"; "Urban areas with intense development"; "Near the pavement or shoulder edge"; "Residential/urban areas"; "Shoulders because of high maintenance needs of the shoulder areas (ie. grading , mowing, sight distance)"; "Areas where background and/or adjacent property is intensely managed along arterial system, and many areas that are intended to be mowed"; "Areas where there is not enough room to establish outside clear zone"; "Urban areas especially with slow moving traffic";

"safety clear zones"; "Areas where the natural soil drainage patterns and micro-climate have been altered to a degree which will not allow the establishment of native vegetation"; Older urban highways with narrow ROW, highly congested here maximum sight distance is required"; "Functional part of roadside, from shoulder across pitch. These areas need to be mowed for drainage and emergency parking for motorists".

Comments: "Non-native sites are rest areas, yards and highly urban ROW"; "Since the natives are usually slow to establish there may be some problems with erosion on steep inclines"; "Steep areas would be mostly grass"; "Natives are planted where they are suitable, wildflowers are planted where visible to travellers, accessible to care, beyond foreslope, suitable soil, low erosion risk and free of noxious weeds; shrubs are placed with grass seed on back slopes where suitable"; "Some bridge abutments and exit ramps are planted with burning bush for its dense growth habitat and brilliant fall colour"; "In all areas ... if properly selected and maintained the native vegetation will be more appropriate than horticultural exotic species"; "The department plants materials primarily on roadways that have recently or currently been under construction"; "Certain non-native species are particularly well suited to specific sites, especially in urban areas";

VEGETATION

9. Does your department have a mandate to seed a certain percentage of newly constructed highway ROW's with native vegetation?

Yes 27 %
 No 67 %
 No Response 5 %

If "Yes", what percent of ROW's are seeded with native vegetation?

less than 1 %, 2 %, 90 %, 100 %, 100 %, 100 %, 100 %, 1/4 to 1% of project landscape budget is to be planted to wildflowers.

Comments: "most new ROW, in rural areas must be seeded with a native species, this also a mitigation requirement when prairie is disturbed"; "1/4 of 1%; federal landscape funds are to be used for seeding wildflowers in the area of the construction"; "legislation says the DOT WILL implement IRVM and that the counties MAY";

If "No", is seeding of ROW's limited to specific sites?

Yes 40 %
 No 52 %
 No Response 8 %

Comments: "No, seeding is not limited, all areas disturbed by construction"; "Yes, we are mandated by FHWA to dedicate 1/4 of 1% of cost of landscaping to planting wildflowers"; "Yes, the federal highway administration has stipulated that .0025 % of money used for landscaping be used for wildflower planting"; "Yes, usually in rural areas; we find the soils that have been disturbed by construction do not support wildflowers; the better the soils the better the results"; "Almost all of our seeding is done on construction sites in rural undeveloped areas"; "We do not encourage eliminating an existing stand of ground cover to introduce native vegetation"; "EPA now has laws in place mandating a 70% cover on new construction; so, in essence all of the ROW is seeded with a specific seed mixture for that area";

10. Where are the native seeds purchased?

Government operated nurseries	16 %
Nurseries in the local area	29 %
Nurseries in the state or province	48 %
Nurseries of other states or provinces	54 %
Other	56 %

Comments: "Local seed supply houses can get the required seed pretty readily"; "Grass seed producers"; "Government nurseries"; "Supply is limited for good local seed and it is costly"; "Counties buy from both in state and out of state private seed dealers"; "We limit seed sources to four upper midwest states"; "We have begun a state nursery for native plants and seed with the Department of Natural Resources"; "best available source"; "with preference to locally collected ecotypes"; "Purchase seed grown only in the state or as close to state as possible"; "Seed suppliers from mid-west sources"; "Seed is not readily available so we purchase it where we can, in the future we hope to collect seed from our ROW"; "Collected locally and propagated in greenhouse"; "Department of Transportation has its own native nursery";

11. Do you feel it is important to use native plants that are indigenous to the immediate area where the vegetation will be planted?

Not important	27 %
Important	46 %
Very important	27 %

Comments:

Not important: "Not important but it is preferable"; "Not important for annuals and biennials used as cover crops"; "Not immediate area but a broader zone, the mix is selected according to site and growth characteristics";

Important: "Within 100-200 miles of genetic sources of variety"; "Prefer not to use improved varieties, though that is better in most cases than traditional turf mixes"; "Important for perennial species";

Very important: "It is obvious that the seed mix match the appropriate environmental regimes"; "Important for perennial species"; "Very important near native prairie areas"; "Very important and yet cost and availability force compromise"; "Important, but there is a range of miles ... that these grasses can be move and still be expected to do well"; "Our state nursery will concentrate on using local genotypes"; "In many cases, verifiably pure, local ecotypes are unavailable in sufficient quality"; "Using species indigenous to the physiographic area proves in the long run to be more economical and effective, and also preserves the natural diversity of the area"; "Species indigenous to an area are 'OK' to local environment"; "seed availability is the main factor"; "With certain species it is critical, I specify elevation ranges and a mile radius from the site on certain projects".

12. What types of vegetation do you plant and/or manage along the roadside rights-of-way?

grasses not native to the state or province	70 %
wildflowers not native to the state or province	59 %
grasses native to the state or province	78 %
wildflowers native to the state or province	97 %
trees	83 %
shrubs	78 %

Comments: "all of the above"; "try to plant specie in the are of state where they occurred naturally before settlement"; "Very little tree and shrub planting is done because of high maintenance cost to assure survival"; "We do not plant non-native herbaceous broad leaf plants as wildflowers; "Crownvetch, is sometime used for its flowers, we still use it for erosion control"; Different plants are utilized in different areas for landscape effect and management purposes"; "Combination of native and species that will complement natives"; "Species which have proved to be adapted to the highway environment"; "Will not use the "pre-packaged" wildflower mixes because they contain many aggressive non-native and annual species"; "Native grasses are only used for specific conservation/environmental circumstances";

14. What seed mixtures are used when seeding highway ROW's?

Non-native grasses and native grasses	45 %
Non-native grasses and native wildflowers	24 %
Non-native grasses, native grasses and native wildflowers	48 %
Native grasses and native wildflowers	45 %
Native grasses	40 %
Other	16 %

Other: "Non-natives mixed in to stabilize soil quicker"; "Non-native grasses and legumes make up our standard mix used to establish cover and prevent erosion"; "Combination"; "Wildflower mixtures no grass or non-native grass mixtures"; "Non-native grasses are used as a general soil stabilization"; "Non-native grass, non-native wildflowers, and native wildflowers"; "Non-native wildflowers"; "Some special locations also receive shrub and tree seed"; "Wetland woody shrub mix, wood shrub mix";

SITE PREPARATION

15. Prior to the sowing of the native vegetation how is the soil prepared?

Top soil is added	43 %
Cultivated	73 %
Roller packed	29 %
Treated with herbicides	48 %
Other	56 %

Other: "Topsoil is stripped, stockpiled and respread prior seeding; Seedbed in cultivated to a depth of about 3 inches, then roller packed for a firm bed"; "In some cases we till up and cover ... in other (cases) we use a no-till seeder"; "No till" is treated with herbicide and slit seeded"; "1. spray with Roundup 2. remove debris 3. scarify soil (one inch+) 4. hydro seed or hand seed 5. roll seed in or lightly drag chain link fence over surface 6. no mulch or fertilizer"; "A straw mulch blanket rated at .5 lbs/sqyd has worked very well on a trial basis"; "Water 2 weeks or until actively growing"; "Spray with Round Up then no-till drill into area 1/8 to 1/4 inch depth"; "Flail mower after herbicides"; Permanent seeding (native grass mixtures) is then drilled into established cover with a no-till drill, during spring season(March 1 to April 30)".

Comments: "Most seedings are done on new construction regrading of old roads or when ditches are cleaned out to restore drainage. Amount of working of soil depends on how steep and narrow the roadside is. Soil is packed as firm and smooth as possible."; "Can be roller packed, but we do not feel that it is necessary when a grass drill is used with packing wheels"; "We usually treat with herbicide to destroy existing vegetation"; "Round Up only when necessary to reduce competition"; "Topsoil is usually not used with natives"; "the department also uses a no till seed planter"; "Formal landscape

plans call for topsoil drill seeding where practical, hydroseeding and mulched on areas too steep to drill seed"; "Rarely treat with herbicides, topsoil is not always added"; "With tree and shrub planting, a plant pit mix of Loam, fertilizer, peatmoss is used"; "If hydroseeding, grading and scarification may be the only preparation at the roadsides"; "No preparation except it is level out";

16. a) How are the native grasses sown?

Native seed drill	32 %
Agricultural drill	32 %
Mechanical broadcaster	29 %
Hydroseeder	70 %
Hand broadcast	51 %
No Response	35 %
Other	10 %

Other: "Aerial methods (frost overseeding)"; "No till" or slit seed (inter seed hydroseed or hand seeding in inaccessible areas"; "Individually grass plants in peat pots hand planted in wetland";

Comments: "A grass drill equipped with individually mounted adjusted spring loaded double disk furrow openers fitted with depth hands and packer wheels"; "Drill furrow spacing can not exceed 8 inches"; "Agricultural drill beardless seed or hard seeds only"; "Six inch drill is favoured"; "Hydroseeding probably on the rise"; "Some sites permit broadcast only"; "The native grass drill works the best, but over time all methods will work"; "Hydroseeder only when slopes are too steep"; "Usually require or specify mechanical broadcast and hand rake into the soil".

b) How are the wildflowers sown?

Native seed drill	51 %
Agricultural seed drill	24 %
Mechanical broadcaster	34 %
Hydroseeder	48 %
Hand broadcast	70 %
No Response	13 %
Other	2 %

Other: "Areal methods (frost overseeding)"; "J. Thom 42 wild seeder";

Comments: "Smaller seeds agricultural drill"; "Usually hydroseeded to place seeds at ground surface or no till treatment"; "Not many native wildflowers used in planting yet, areas are small, so hand broadcast is best method"; "All"; "Depends on size of area to be seeded".

17. Are there any special measures that must be taken when seeding native plants?

"A good seed bed and plenty of patience"; "Seed bed must be firm, use cover crops on steep slope (4:1 or greater)"; "Try to have clean topsoil, firm bed, plant no deeper than 1/2 inch in depth, plant before June 15 and after September 1, mulch"; "Solid wildflowers planting probably best done with a wildflower drill"; "Very shallow seed placement, yet good seed to soil contact, prevent shading of new seedlings for first growing season and possibly second"; "Do not artificially water seeded areas unless frequent watering will be provided"; "Very important to pack soil after seeding; when hydroseeding some counties spray seed on first and then the mulchslurry, when broadcast seeding prevent bridging of fluffy seed by either debearding, or using more switchgrass or sideoats"; "Seed with no till seeder, sometimes we hand broadcast wild flowers, we use a nurse crop of seed grain and sometimes ryegrass"; "Grasses +/- one inch deep, wildflowers near surface, mulch if ground is cultivated, inoculate legumes, use properly stratified seed, seed at the proper time"; "Use of two application of Roundup to eliminate existing vegetation"; "we have the seed pressed into the soil either with roller or cultipacker; sometimes covered with chainlink fence dragged over surface then pressed in

18. What special measures are taken after the native seeds are sown?

Soil is packed	32 %
Soil is fertilized	16 %
Soil is irrigated	8 %
Tackifier applied to the mulch	45 %
Mulch applied	78 %

What type of mulch is applied?

Vegetative mulch	62 %
Paper mulch	10 %
Wood mulch	43 %
Other	16 %
Comments: "Hay\Straw"; "Excelsior Blanket"	
NV - straw	
Other	29 %
No Response	5 %

Others: "Apply a light coat of asphalt tack 6' out on shoulder following seeding fertilizing and mulching which reduces wind and water erosion at this location"; "Should be packed in most cases, mulch is applied only in steep or dry areas; straw mulch, seldom use wood mulch"; "Mowing to prevent shading by weeds just above seedling height"; "Straw mulch is used a fair amount, erosion blankets only in very erodible situations, fertilizer seldom used". "Paper and wood products used most with hydroseeding"; "Fertilized soil before seeding and worked into the seed bed"; "Vegetative mulch, native prairie hay (2 tons/acre) or threshed grain straw (2.25 Tons/Acre)"; "If a no till seeder was used,

seeing directly into existing cover previously treated with herbicide, the seeded area is mowed to provide a mulch"; "Excelsior Blanket"; "Burn planting where applicable, if burning isn't appropriate a late fall mowing is attempted";

19. What types of problems arise during the site preparation?

Soil types	51 %
Soil preparation techniques	37 %
Soil preparation equipment	18 %
Seeding techniques	27 %
Seeding equipment	27 %
Seeds	21 %
No Response	16 %
Others	27 %

Other: "Some contractors don't know how to adjust the drills to properly seed the natives"; "Often times they are planted too deep and failure to germinate results"; "Same problems as with conventional seeding, if right equipment is used and maintained these are not problems"; "Soil conditions, weather in general"; "Problems are mostly due to steepness of slopes. The industry has not yet caught up to the needs of roadside work. It is often difficult to get on steep slopes with equipment during any phase of projects. Narrower drill would help. ATVs help."; "Any of these problems may occur, but our contractors can be counted on to get the job done.";

20. Please expand on the indicated problems above that occurs at the site preparation stage?

"Wind and water erosion can be major problems erosion control should start in the 1st mile before 2nd mile is opened up"; "Drill can slide downhill so seed not deposited in furrow. Seed gets planted too deep. Drills can be tricky to calibrate."; "Soil tilling can increase weed problems. It can also cause safety problems such as distractions and perhaps blowing dust. Seeder must be properly calibrated set to the proper depth. Grist usually a nurse crop of seed grain is used."; "Soil preparation may be inadequate; specified seeds may be unavailable; portions of the site may be inaccessible; due to weather, topography, appearances or other barriers"; "Soil preparation problems deals with weather to till or use no till seeding; seeding problems are the depth of seed; seed problem deals with germination and source"; "The better soil support a higher quality final product"; "Several interchanges have a variety of soils, and rocks buried in them from the road construction period"; "Seed bed too soft, too hard, lack of topsoil, rocks backslope to smooth, hydroseeding, brown outs due to lack of moisture during germination/establishment period"; "Kansas soils range from clays, soils sand, to rocky or shaley soils; each requires a different level of performance from equipment to establish a viable seedbed";

SITE ESTABLISHMENT**22. During the establishment phase of the vegetation do you monitor the sites?**

Yes 89 %

No 5 %

No Response 3 %

If "Yes" how often are the sites monitored per year?

"Daily, weekly, bi-weekly, monthly, once per year, twice per year, three times per year, four times a year"

23. When are weeds a problem?

Before germination of native vegetation 43 %

Early establishment of native vegetation 67 %

Later establishment of native vegetation 56 %

Not a problem 10 %

No Response 2 %

Comments: "if weeds are deep rooted perennial such as Canada thistle or leafy spurge. If these 2 plants are not under control before planting wildflowers the entire planting will probably be lost. If grasses only are used the planting should survive"; "this depends on sensitivity level. We tolerate many plants which some states treat as weeds"; "weeds can present problems of shading and nutrient depletion if not removed in early stages. Persistent bi-annual weeds can invade established plantings"; "weeds can be a problem and usually are! they can be a problem any time"; "annual weed not a problem except Kochia"; "weed can be a problem at any stage of growth, depending on the climatic conditions during the establishment year"; "if topsoil is spread and left over a period of time before planting weeds can become a problem before germination; weeds a problem later in establishment especially perennial, persistent species"

24. What techniques are used to control weeds?

Mowing 86 %

When is the area mowed for weeds?

"2 - 4 times during first year"; "in slopes and ditches in the fall, the early mowing is for safety and aesthetics and the fall mowing is to prevent snow lodging on roadway"; "once or twice first year"; "before and after seeding when necessary for annual and biennial weeds only; 1 or 2 times first year"; "twice during summer after planting possibly 2nd year the same"; "when weed cover gets to 12 inches"; "about a month after seeding, and if we get serious complaints"; "1 time in the fall"; "when native

species are young; for the purpose of allowing light to small plants"; "usually areas of excessive weed growth is mowed periodically to avoid blooming"; "early spring before wildflowers are up, when most of wildflowers have gone to seed (during early stages of wildflower establishment)"; "3-4 weeks after germination"; "as needed"; "prior to planting and at the end of the growing season"; "when weeds begin to take over site and after killing frost"; "once per month throughout growing season"; "never before June 1, but usually in normal rotation for mowing during the summer, some rural, low volume roads in the late fall"; "prior to seeding/planting"

How often is the area mowed to control weeds per year?

"Once"; "twice"; "three times"; "four times"; "1 time after first year"; "only when necessary for weed control"; "as necessary (usually not more than 3 times); "as often as necessary"; "depends on height of wanted material"; "as needed for planted trees and shrubs for 1 year".

Herbicide application 64 %

When is the area sprayed for weeds?

"prior to seeding, especially for perennial weeds then after planting if necessary"; "IRVM applies herbicide on a spot-spray basis only"; "herbicide generally not used on new stands of vegetation; Once established sites are spot sprayed if necessary"; "none for the first two years then spot spray for noxious weeds only"; "we only spot spray for noxious weeds. Usually in spring or early fall, regrowth after mowing"; "before soil preparation; spot spraying of weed in new growth"; "when required"; "before planting, during early stages of wildflower establishment and when grassy weeds are actively growing"; "in selected areas near guiderails, fences, etc. ; once per year"; "usually July 1 because this is when new money are available - not because it is the proper time for weed spraying this is a down right waste of time, effort and money"; spring and possibly fall"; "prior to planting, June 1 after planting"; wildflowers before seeding with Roundup"; "late spring to early summer"; "we do not use herbicide".

How often is the area sprayed to control weeds per year?

"1"; "2"; "1 to 2 times"; "1 to 3 times"

What techniques are used?

"back packs, directed sprays and only if necessary broadcast"; spot-spray with backpack sprayers or truck equiped with specifically controllable nozzle"; "spray booms and hand sprayers"; "broadcast"; "spray truck"; "boom spray, on moving vehicle"; "mechanical spray equipment".

Burning 21 %

When is the area burned for to control weeds?

"Usually spring April - May"; "burning is not used except in special situations"; "after the first years growth if there is adequate fuel then only if determined by inspection area"; "Mid-March to mid-April"; "Spring"; "fall or spring"; "Burning should take place as soon as enough fuel has developed that will burn; 2-3 years after planting"; "used only and very limited basis when another organization or group has expressed an interest"; "rarely".

How often is the area burned to control weeds?

"2 - 3 years in succession at first, then once every 3 to 5 years"; "3 year basis"; "every 2-3".

Other 29 %

No Response 8 %

25. If the native vegetation does not grow vigorously in the first growing season what is done?

Reseed the area that year	16 %
Reseed the area the following year	29 %
Nothing	45 %
No Response	13 %
Other	35 %

Other: "Depends on weather conditions, whether seeds germinated and amount of noxious weed component"; "Many do nothing or plant to reseed following year"; "Natives seeds usually take a couple years to really get going; root development occurs during the 1st growing season"; "investigate to determine why or if reseeding may be necessary"; "patience, most sites aren't going to look like much til the 3rd year"; "reseeding is sometimes done in 2nd year if these are no signs"; "Nothing - Be patient"; "we sometimes wait up to 5 years for results"; "I have seen native vegetation take 6 to 10 years to develop; the sooner a burn can be accomplished the sooner mature growth will happen"; "complete failures are reseeded; at times an additional application of fertilizer will boost growth; native grass mixtures generally take several years to mature"; "nothing if no serious erosion problems, may take 3 to 5 years for plants to establish themselves"; "seeded wildflowers are generally not reseeded; seeded grasses must be reseeded to provide a suitable erosion resistant stand; trees and shrubs are replaced"

26. If the native vegetation does not grow vigorously in the second growing season what is done?

Reseed the area that year	13 %
Reseed the area the following year	27 %
Nothing	45 %
No Response	13%
Other	37 %

Other: "usually burn the next spring and hold judgement until after third growing season";

"investigate, possibly fertilized, may inter-seed, into areas"; "nothing - Be patient; in one case we waited 4 years for a stand to develop"; "we sometimes wait up to 5 years for results"; "the area is over seeded"; "I have seen native vegetation take 6 to 10 years to develop; the sooner a burn can be accomplished the sooner mature growth will happen"; "reseed and fertilize"; "complete failures are reseeded; at times an additional application of fertilizer will boost growth; native grass mixtures generally take several years to mature"; "nothing if no serious erosion problems"; "area is sprayed and reseeded"; "abandon site"; "site evaluation and possible reseeding once corrective action is taken"; "fertilize".

27. Once the site is considered to be established do you monitor the sites

Yes 64 % No 29 % No Response 5%

If "Yes" how often are the sites monitored per year?

"1 - 2 times"; "1 or as often as possible"; "minimum once a year"; "as often as possible, usually monthly"; "monthly"; "2 times"; "periodically"; "2"; "1";

28. During the site establishment stage were there any problems with the following:

Maintenance techniques	29 %
Maintenance equipment	8 %
No Response	35 %
Other	51 %

Other: "public concerns and lack of knowledge"; "we do not count heavily on follow up maintenance"; "keeping mowers off developing plots"; "yellow sweet clover some years is a mowing problem"; "timing herbicide application with regular ROW maintenance, keeping mowers out, keeping people out"; "none"; "available personal";

29. Please expand on the problems indicated that occurred at the site establishment stage?

"It takes about 2 full growing seasons (sometimes 3 growing seasons) to establish a good grass stand. There are often many weeds the 1st year, less the 2nd year. by the 3rd growing season grasses are well established and weeds are pretty well gone"; "a large number of people still view 4 inch tall grass as the only way that a public ROW should look;" "that is changing with education and economics"; "you must have total control of maintenance and weed control people and have explained things to the engineers"; "we are on the side of having too much cover so that erosion does not become a problem. Maintenance is usually mowing and patience"; "site gets occasionally mowed by "accident" by maintenance forces. Expectations often are ahead of visible results. We use annuals and short-lived perennial to provide color the first 2 to 3 seasons while permeant cover develops"; "some erosion during the first year"; "Native grass mixtures tend to develop slowly, providing an environment for excessive weed growth. Several mowing during the first year kept weed growth suppressed to allow the native grass seedlings to develop"; "the main problem during establishment is manpower and scheduling of people to do maintenance. This would be alleviated by making native vegetation management part of regular ROW management";

ECONOMICS

INSTALLATION COST:

30. a) When the department started using and/or managing the native vegetation were there any new costs?

Equipment cost	37 %
Technical expertise	27 %
Labour cost	24 %
Administrative cost	16 %
No Response	16 %
Other	32 %

Other:

"None"; "normal"; "native seed cost"; "the primary increased cost is the seed cost"; "this is part of road construction projects and is "buried" within the contract estimate"; "as we have used "native plants" since colonial times, we have no data"; "extra contract cost";

b) Please specify these costs and estimate these costs [

"Equipment - \$100,000 (initial); \$11,000 annually thereafter; Labour =\$20,000/yr; Tech. expertise and administrative = \$50,000/yr"; "more should have been spent on education"; "native grass seed drills

were purchased at approx. \$10,000"; "purchase of native grass drills, however these could be rented"; "each county purchases - native grass drill \$9,000; burn equipment cost varies from a few hundred dollars for backpack sprayers torch and flappers to \$7000 for skid unit for pickup truck. A few counties bought hydroseeders - \$8000 and up; ATV's \$3600 if one is not currently available; Technical, labor and administrative cost in the form of hiring a Roadside Manager \$25,00 plus fringes, sometimes an assistant at least seasonal help; These expenses are balance against savings due to reduced herbicide use and contracting out seeding operations. Plus roadside managers take care of other duties counties pay for anyway."; "None";

31. a) Did the native grass seeds cost:

the same as the traditional seeds used?	16 %
more than the traditional seeds used?	56 %
less than the traditional seeds used?	2 %
no response	24 %

b) Did the native wildflowers cost:

the same as the traditional seeds used?	13 %
more than the traditional seeds used?	59 %
less than the traditional seeds used?	0 %
no response	27 %

c) Does planting of native grasses and wildflowers cost:

the same as traditional vegetative species planted?	32 %
more than traditional vegetative species planted?	27 %
less than traditional vegetative species planted?	2 %
no response	27 %

Comments: "the same: this is assuming fertilizer is used when planting non-natives. Natives are typically planted at half the rate of traditional vegetation;" " when CRP came into existence, native grass seed was expensive due to availability, now those prices have come down; wildflowers are not normally sown in all ROW projects. this may change in the future; even though costs are higher initially if native species are allowed to be managed properly, additional maintenance cost would cut"; "actual planting costs are the same"; " when rates of traditional per acre are factored the cost are much the same when using grass seed only. also if all seed is purchases vs. managing to ROW to enhance the growth of native already present the cost is less"

32. a) Please estimate the cost of planting traditional vegetation types on ROW's [59.5 %]

per unit mile \$4000; \$300

or per unit kilometreor per acre \$293; \$325; \$300-400; \$465-650, \$ 350; \$1380; \$265; \$1000; \$1200; \$800, \$500; \$450; \$400; \$800; \$1800, \$1821; \$532.00; \$450; \$2000**b) Please estimate the cost of planting native vegetation on ROW's [59.5%]**

per unit mile

or per unit kilometreor per acre \$350; \$329; \$425; \$575; \$150; 557, \$2500; \$7000; \$265; \$750; \$1400; \$900; \$1000; \$450, \$600, \$1200; \$1200; \$1000; \$2000; \$486.00; \$474.00; \$1000; \$2000or per hectare \$1200MAINTENANCE COST**33. For the last fiscal year please estimate the percentage of the department of transportation's budget allocated to maintenance of state or provincial highway ROW's?**

.64%, .002%, .2%, .5%, 2%, 2.5%, 4%, 3%, 8%, 9%, 10%, 10%, 11%, 13%, 16%, 20%, 20%, 20%, 22%, 30%, 50%, 60%

34. Since the use and/or management of native vegetation has this percentage :

Remained the same	45 %
Increased	8 %
Decreased	8 %
No Response	5 %

Comments: "Increased; again if allowed to be managed properly, these costs should not have to increase"; "decrease, when new policies of minimal mowing were followed (and spot spraying)"; "in this program other changes in vegetation management practices are made at the same time IRV counties start planting natives. Stop broadcast spraying herbicides, reduce mowing, etc. and it varies from county to county budgets decrease, increase and remain the same depending on the county."; "initially decreased because of savings associated with reduced mowing"; "no appropriate answer as we have always used some "native vegetation".

35. Since the introduction and/or management of native vegetation on ROW's has the overall mowing costs of all ROW's:

Remained the same	35.1 %
Increased	5.4 %
Decreased	29.7 %

Not a maintenance technique used 2.7 %
 No Response 13.5%

Comments: "increase due to spraying reduction due to legislation changes on non-native sites causing increased mowing of non-native"; "decreased; I would guess. Counties that previously only the immediate shoulder will not change mowing practices with introduction of natives. reduction in mowing is more the result of a change in philosophy rather than the result of the use of natives"; "We began reducing mowing in about 1960. Since then the total mowing has fluctuated for various reasons, but mowing is generally limited to shoulder cut with exceptions for safety, noxious weed control and woody plant control."; "Addition of mowed acres due to new construction etc. off set reduced mowing in recent years. Since the early 1970's mowing has been eliminated on about 1/2 the ROW acreage." "the amount of native vegetation is very small amount compared with traditional vegetation"; "Remained the same; increased due to fuel, equipment, and labour cost"; "initially decreased because of savings associated with reduced mowing"

36. Please estimate the percent of the last fiscal year's maintenance budget allocated to mowing for state or provincial highway ROW's?

.5%, 1.5%, 1.8%, 2.4%, 3%, 3.1%, 4%, 5%, 3.5%, 6.9%, 9%, 4%, 2%, 10%, 10%, 10%, 10%,
 17%, 19%, 20%

37. Please estimate the cost of mowing per unit mile (or unit kilometre or acre or hectare) of ROW's in the last fiscal year?

\$11.91, \$15, \$15, \$21, \$21, \$22, \$25, \$28, \$29, \$25, \$28.33, \$30.25, \$32, \$32.5, \$38.5, \$37.5,
 \$38, \$53, \$56, \$67, \$81, \$21.08, \$30.22, \$28.33

38. Since the introduction and or management of native vegetation on ROW's has the cost of herbicide application:

Remained the same	29.7 %
Increased	24.3 %
Decreased	21.9 %
Not a maintenance technique used	8.1 %
No response	10.8 %

Comments: "Increase, This is not due to native grasses but is caused by continual expansion of noxious weed infestation"; "it has increased in some years and decreased in other years"; "cost of application remained the same; amount used decreased."; "with IRVM Iowa counties go from broadcast

to spot-spray application. AN average county expense for herbicides would drop from \$70,000 to \$2000 per year."; "Increased because of use of more expensive chemicals to target noxious species"; "Herbicide expenditures are a fixed budget amount and do not reflect a greater or lesser need for this work.".

39. Please estimate the percentage of the last fiscal year's maintenance budget allocated to herbicide application of highway ROW's?

<1%, .5%, .9%, .6%, .5%, <1%, .33%, .2%, .05%, .5%, 1.4%, 1%, 2%, 1%, 10%, 16%, 20%, 28%

40. Please estimate the cost of herbicide application per unit mile (or unit kilometre or acre or hectare) of ROW in the last fiscal year?

\$8.46, \$8.5, \$15, \$17.93, \$19, \$16, \$20, \$28, \$37, \$37.87, \$74.32, \$88.63, \$101.17, \$142, \$150

41. Since the introduction and/or management of native vegetation on ROW's has the cost of burning:

Remained the same	2 %
Increased	5 %
Decreased	0 %
Not a maintenance technique used	70 %
No Response	18 %

Comments: "Not maintenance technique used; We use burning if we can, but because of liability, we do not count on it as standard practice"; "Burning increased, seldom used in the urban area. Was not used at all prior to native vegetation, however"; "this has been done gratis by our DNR";

42. Please estimate the percentage of the last fiscal year's maintenance budget allocated to burning of highway ROW's?

.05%, 1%, 2.9%, 10%

43. Please estimate the relative cost of burning per unit mile (or unit kilometre or acre or hectare) of ROW per year?

\$164.83, \$109.89, \$36.81, \$19.87 / acre

44. Does the maintenance of sites with an established native vegetation or with existing native vegetation cost:

the same as traditional vegetative species?	21 %
more than traditional vegetative species?	5 %
less than traditional vegetative species?	27 %
no response	40 %

GENERAL ASSESSMENT:**45. Please list some of the advantages of using and managing native vegetation on ROW's?**

"Lower long term cost maintenance costs, less herbicide use, long term for noxious weeds; increased wildlife habitat; increased water quality; less driver fatigue due to variety and colour view."; "Native grass matures later, therefore haying is done later giving game birds a chance to finish nesting. It keeps the wildlife, people happy"; "these plants should be more adapted to the area and be able to survive better; more extensive root systems provide better weed control, long term erosion control, habitat enhancement, aesthetically more interesting throughout the year"; "increased colour, weed suppression, snow control, reduced need for intense management, plant diversity to survive climate and weather extremes"; "out competes weeds, stands live longer - survive drought; hold the soil; enhance wildlife habitat; beautify roadsides."; "Deeper root system to better stabilize the roadway and fill areas; Better fall colour; better for wildlife as there is more diversity and better winter cover, less drifting snow for awhile; better able to keep weeds and noxious weeds out"; "The plant variety provides a cover which is much more likely to survive adverse conditions. Provides visual variety which is ever changing even for regular commuters. Public land becomes a resource of native species"; "- Reduction of management costs for the portion of the ROW involved; Good public relations; aesthetics; wildlife habitat; erosion control" reduces dollars spent on maintenance preserves native species"; "more natural, eliminates cross breeding problems, effective for erosion control once established, less attractive for wildlife"; "species are naturally adapted to area, they do not have to be replanted, retain the natural integrity of the landscaped and diversity of the state, can always be substituted for exotics, much less expensive to maintain"; "Native plants do a better job of withstanding the rigors of various climates, do not overtake areas or preclude other vegetation like exotics can. Natives work as a unit ecosystem rather than dominant single species. Are less likely to present problems to surrounding range/pasture. Costs over the long haul should be less to "maintain" native vegetation.; "

46. Please list some of the disadvantages of using and managing native vegetation on ROW's?

"Due to harsh conditions on roadsides, natives slow to establish; new planting need intensive management 1st year or two; Public perception that sites look weedy; erosion may occur due to slow establishment; Tendency of some seed to lay dormant for a year or more."; "additional cost."; "higher cost of seed initially, slow establishment"; "public knowledge or awareness, acceptance of a less than manicured area, possible wild fire" "establish more slowly risking erosion and weeds in early stages; does not appeal to those who like the tidy look."; "Some complaints about increase in road kills; some motorists prefer mowed roadsides"; " People like it "mowed and "neat"; Negative public reaction due to slow establishment and "weedy appearance"; Limited supply of material and variety available; catches litter"; "hard to find seed, hard to establish, some not affective for erosion control"; "some people view them as "weeds" and would rather have the area mowed; some people think there are more deer/auto collisions; reported cases of deer collisions kills actually peaked the year we reduced our mowing and has continued to decrease; the deer population relates directly to hunting" "at beginning of program seed is difficult to obtain"; "Does require some specialized equipment"; "higher establishment cost"; "sometimes natives (wildflowers) are in the way of noxious weed control; in this case they are sacrificed; native grasses have no effect"; "Some of the native grass species are harder to establish. Seed costs are more with native species.";

47. Were there any unexpected problems?

Increased wildlife collisions	0 %
Snow drifting	10 %
Over growth	5 %
Erosion problems	10 %
Drainage problems	5 %
Negative public opinion	16 %
None	2 %

Others	45 %
No response	16 %

Other:

"snow drifting may not if the correct plants are planted in the correct space in fact native vegetation. collects and holds more snow in the ROW than non-native"; "in hillier counties they prefer grasses that lie down when water runs thru ditches. Natives trap sediment and obstruct flow by remaining erect."; "all of the above were mentioned, but one has been shown to be a serious problem (increased wildlife collisions"; "crews not recognizing what is there and destroying what is there"; "employee resistance"

48. Please expand on these unexpected problems indicated?

"There are no signs of increased wildlife collision or snow drifting problems; Some people just do not think roadsides look civilized."; "The serious wildlife problem is white tail deer. We do not believe that natural roadsides has an effect on their behaviour or conceals them from motorists. Waterways with critical gradient are mowed. Public opinion is generally positive"; "None of the reactions was completely unexpected, some were countered through planting of annual and short lived perennial flowers, cover grass crops, fall mowing, "prairie planting" signs, etc.; Rate of establishment appears to be highly variable from year to year and job to job, this is especially true of wildflowers and annual wildflowers. This makes it hard to predict to the inquiring public just when they will see results."; "although not totally unexpected there is some resistance to reduced mowing by department employees. In the past, they were judged by how much and how fast they mowed their areas; many of our employees feel we should maintain our ROW like they do their yards: frequent and short"; "vegetation next to the pavement prevents the water from running off"; "Slower to establish grasses may contribute to erosion problems"; "Have not really noticed any unexpected"; "complaints on the reduction of mowing"

49. Were there any unexpected benefits?

Reduced maintenance cost	24 %
Increase erosion control	21 %
Roadside beautification	35 %
Wildlife habitat	18 %
Greater public awareness	45 %
Greater public participation	21 %
No response	24 %

50. Please expand on these unexpected benefits that have come from using and managing the native vegetation on ROW's?

"Increased interest in planting natives in ROW by public Garden clubs and schools wanting speakers and outdoor classrooms containing natives."; "a stand of natives (re-established) is very clean (wash free). People are catching on - slowly but surely"; "to this new idea of what constitutes an attractive roadside"; "They were not unexpected - we knew what would happen"; "All of the above can be realized. We have strong support for natural roadsides and roadsides as a public resource."; "All of the above were benefits that were no entirely unexpected. The degree of public awareness and acceptance was largely unexpected although opposition when it occurred was usually quite vocal."; "we have received many public comments on wildflower displays"; "although not unexpected it has been a great public relation tool; people expect the highway department to build roads but they do not expect the colourful wildflower plantings"; "overwhelming positive public response; public supports continued/expanded program"; "by managing native vegetation at ROW, i.e. retaining existing

vegetation when we build a new highway , we can lower project costs by avoiding expensive"add on" solutions at the end"; "roadside looks better for tourists, erosion is reduced greatly".

51. What benefits or problems does adjacent landowner have by the use and management of native vegetation along highway rights-of-ways?

"Landowners want to hay road ditches so they think alfalfa is better; tend to hay natives as if they were alfalfa"; "others than beauty has not yet been determined however we are funding research on this question at this time"; "State law does not permit landowners to mow roadides where IRVM projects exist. Many landowner resent this, some mow anyway."; "Some have none and others look at the may potential and cry about not being able to cut the hay."; " This depends on the adjacent land use. On most rural highways land owners accept, support or are unaware. In built up areas, we attempt to be good neighbours.. If neighbours have mowed lawns and complain we do some mowing."; "Benefits: Screening, wildlife values, aesthetics, cost savings"; "Problems: Trash collection, hiding place for undesirable people or animals perception of weeds and not getting money's worth from the Department"; "increased wildlife habitat, increased aesthetics, higher property value, no noxious species were use so no disadvantage"; "adjacent landowners have more interest in assisting in ROW management"; "the benefit of natural screens from highway noise and pollution; problem could increase wildfire that many do damage to property"; "I am unaware of any problems, except that the cattlemen would like to have us eradicate big sage and rabbit brush and provide them with more grass. Since no grazing is allowed within the ROW this is of no consequence. In one case a consultant recommended a list of forbs that were down to present problems to live stock. In a protected environment (ei no grazing, burning or mowing seasonally) such as ROW the potential existed for future problems. Those species were removed from the list."; " they prefer the use of natives and the decreased use of exotics"; highway screening and visual beautification of plant material; some noxious weed seed"; "if we retain native buffers of vegetation along ROW land owners benefit by: increase screening and privacy, less disruption to drainage, wildlife habitat, some psychological benefit to noise attenuation";

52. What has been the overall public reaction to the use and management of native vegetation along ROW's?

Neutral	32 %
Positive	62 %
Negative	5%
No response	5 %

Comments: - We have had equal proportions of every type of response"; "an informal survey at our State fair showed 70% of 400 participants in favor of native plantings"; "positive; as they learn what its all about. Prior to that a few people think its all a bunch of weeds untidy looking"; " Most of the feedback we get is positive. We also get support from our state legislature."; " Reactions are becoming more neutral as more and more seedings are installed. Vocal pockets of pro and con opinions exist as in most issues."; "many call and newspaper articles in favour of wildflowers"; "good response form environmental agencies"; "positive comments and negative comments are about equal"; "public reaction have been very positive to the point of groups and organizations asking to participate"; "subject not brought to attention of public through media"; "our greatest benefits derive from our reliance on natural regeneration which progresses from grasses to wildflower/"weed" to shrubs then trees unless controlled by occasion mowing, brush cutting or integrated use of herbicides to control small brush"; "the public for the most part is supportive of native plants on highway ROW; BC has a large native plant palette to work with and the public realizes planting native is an environmentally good thing to do"

53. What amount of public involvement has there been in the establishment and maintenance of native vegetation along ROW's?

Very little public involvement 32 %

Some public involvement	51 %
A lot of public involvement	10 %
No response	2 %

54. What types public education strategy was used by the department to promote the use and management of native vegetation along ROW's?

Television advertisement	13 %
Brochures	45 %
Roadside signs	37 %
Regulatory signs	0 %
Workshops	27 %
Others	56 %
No response	13 %

Other:

"Radio PSA's; Newspaper"; "seed packets, public speaking;"; "videos, slide presentations seminars demonstration plantings, public meetings"; "News Releases to the media"; " We have been featured on television, but have done no advertizing. We passed out 30900 seed packets at the state fair."; "Most public education has been conducted directly through programs presented by employees to various groups and by the "Prairie Plants Do Not Mow" signs"; "interaction with environmental groups"; " Coordination with local civic leaders;" "wildflowers will be featured on the 1993-94 state map; display plots in rest areas; exhibits at workshops, conferences, etc.; "Roadside review newsletter" to adopt-a-highway groups; employees and other people involved with roadside management; giving away seed packets"; "some garden clubs assisted and got legislation passed"; "talks to civic and garden clubs"; "generally confined to project hearings/meetings and responses to correspondence; keep in mind our integrated uses of planted native and naturally occurring native plants is not new."; "we held workshops with Highway staff promoting retention of vegetation during clearing and grubbing for a new highway or widened species on display for public viewing"; "

55. Has the use and management of native plants along highway ROW's been successful overall?

Yes 86 %	No 0 %	No Response 10%
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Why?

"Yes, positive feed back and weed supression."; "They do establish, it takes time and some luck but it does work. One they are in place they are 100% better"; "Yes, because we planned that it would be a used species that would do the job."; "Yes, we feel we have a sound program. We stress preservation and re-establishment. we inventory what we have and try to protect it. We feature it in articles and publications. We try to be patient building and rebuilding slowly."; "Overall savings in maintenance costs accomplished by an aesthetic device that has high publicity value."; "the public response to the program has been positive"; " it takes a lang period of time for establishment wildflowers lid good soil not all sites we had chosen had good topsoil"; "all the sites are successful and met expectations"; " more attractive highways and pleased public"; "we have been able to demonstrate the success of multiple use vegetation"; "Long term better persistent ground cover, less erosion, more habitat visually appealing, less problems with pests/plants diseases"; "public relations"; " reduced mowing, erosion control, positive public awareness, increased bird habitat"; "as stated earlier, our use of natural regeneration is reliable and inexpensive; those native species we plant are generally reliable ; however naturally occurring vegetation can be difficult and expensive to control"; "it keeps the province looking better environment is helped due to less bank sliding and reduced sediment in river

56. What other agencies or levels of government in your state or province who are currently using or managing native vegetation on ROW's?

Municipal government	59 %	County government	48 %
Non-government groups	29 %	Contractors	18 %
Interest groups	29 %	Other	45 %

ADDITIONAL COMMENTS:

- Department has always used native grass mixtures, although brome and Fescue were also included in the mix. It has only been within the last couple of years that the KDOT has deleted brome and other introduced species from out mixtures. In conjunction with this modification we are altering our mowing policies to enhance the natural development of native grasses on the rights-of-ways.

- The TXDOT has always used native vegetation along with a few non-natives along the highways. IT has not proven to be feasible to use non-native only. We believe the ROW has too many niches to fill only to be using one spp.

- None of the three alternative survey sections accurately portray how we do business. As may be surmised, we rarely exclusively plant "native" vegetation in any particular situation except for very limited use of wildflowers. Our greatest use exclusive "use" of "native" plants is from planned or tolerated natural regeneration.

- A large portion of the information requested does no fit the Connecticut DOT's vegetation management program. The DOT plants red fescue, hard fescue, chewing fescue, perennial rye grass and birdsfoot trefoil at the time the highways are completed. Wildflowers are planted using plants, not seeds be use the success rate is much higher. Trees and shrubs used are generally species native to the area and are purchased from nurseries. Volunteer vegetation is selectively pruned and thinned as budgets allows.

SECTION II: ATTEMPTED NATIVE VEGETATION USE:**RVM PROGRAM**

1. What year was native vegetation first planted along highway rights-of-ways in your state or province?

1983, 1991

2. What year did the department discontinue planting native vegetation along highway rights-of-way?

1989, 1992

3. Why did the department discontinue the use native wildflowers and/or native grasses in their roadside planting?

Germination problems	50 %	Weed problems	50 %
Seed cost	0 %	Seed availability	0 %
Maintenance cost	50 %	Equipment availability	50 %
Negative public reaction	0 %	No response	50 %
Other	0 %		

Comments:

"Primary reason roadside planting discontinued was due to fiscal restraints"; "The Department discontinued the use of wildflowers due to budget reduction"

4. Were any of the sites that were planted with native vegetation successful?

Yes 50 % No 50 %

If "Yes", which ones?

"Visibility Sights (Rotaries and Gateways)"

CURRENT PRACTICES

5. What type of vegetation is presently being planted along newly constructed highway ROW's?

Grasses	0 %
Wildflowers	0 %
Shrubs	0 %
Trees	0 %
Other	50 %

Comments:

"mulch and hydroseeding of grasses."

6. Please list the predominant plant species planted on newly constructed highway rights of way?

"20% Canada Bluegrass, 10% Alsike Clover, 20% Hard Fescue, 10% Annual Rye Grass, 30% Creeping Red Fescue, 10% Timothy"

7. Who is responsible for the planting of vegetation on ROW's?

Government employees	50 %
Adjacent land owners	0 %
Non-government groups	0 %
Others (please specify)	50 %

Comments:

"about 20% is also contracted out to other companies"

8. Please estimate the cost of planting of vegetation on ROW's

per unit mile

or per unit kilometre

or per acre

or per hectare NB - \$1800

9. Please estimate the percent department of Transportation's budget that is spent on maintenance of state or provincial highway ROW's in the last complete fiscal year ?

< 1

10. Who carries out the maintenance of the highway rights-of-way?

Government employees 100 %

Local contractors 100 %

Adjacent land owners 0 %

Non-government groups 50 %

Others (please specify) 50 %

Comments: " Adopt-a-highway program (civic organizations responsible for 2 miles of selected roadway - Litter Control only)"

11. What RVM maintenance techniques are used on ROW's?

Mowing 100 %

How often are ROW's mowed per year?

4 times/year, 1 time/year

Please estimate the cost of mowing per unit mile (or unit kilometre or acre or hectare) of ROW's in the last complete fiscal year?

\$800/mile, \$100/hectare

Please estimate the percentage of the last fiscal year's maintenance budget that is allocated to mowing for state or provincial highway ROW's?

< 1

Herbicide application 0 %

What herbicide application technique is used?

☐ Spot spray ☐ Boom spray ☐ Other

Please estimate the cost of herbicide application per unit mile (or unit kilometre or acre or hectare) of ROW's in the last complete fiscal year?

Please estimate the percentage of the last fiscal year's maintenance budget that is allocated to herbicide application for state or provincial highway ROW's?

Burning 0 %

At what frequency are ROW's burned?

☐ Once a year ☐ Every two years ☐ Other

Please estimate the cost of burning per unit mile (or unit kilometre or acre or hectare) of ROW's in the last complete fiscal year?

Please estimate the percentage of the last fiscal year's maintenance budget that is allocated to burning for state or provincial highway ROW's?

Comment: "presently does not have a vegetation management plan. Vegetation is maintained mechanically"; "Brush Removal Program shared by 3 utilities ; Started in 1990 and has become an annual task due to its success. Approximately 350 km of ROW are cleared on both sides of the road throughout the province by contractors the total cost is equally shared by the 3 utilities."

12. Are there any other agencies or levels of government in your state or province who are currently using or managing native vegetation on ROW's?

Municipal government	0 %
County government	0 %
Non-government groups	0 %
Contractors	0 %
Interest groups	0 %
Other	0 %

Can you list these agencies and/or persons who can be contacted to participate in the study?

If you are interested in receiving a summary of the information gathered please check yes or no.

[2] Yes [] No

SECTION III: TRADITIONAL ROADSIDE VEGETATION MANAGEMENT

RVM PROGRAM

1. Please indicate the reasons for not using or managing native vegetation along ROW's?

Not the department management plan	28.6 %
Information on vegetation and techniques not available	14.3
Equipment unavailable	71.4 %
Equipment cost	0 %
Expertise unavailable	71.4 %
Seed unavailable	42.9 %
Seed cost	42.9 %
Negative public opinion	0 %
Other	28.9 %

Comments:

"seed unavailable in large quantities and use to supply is more expensive"; "the Department has never experimented with native vegetation as results have been favourable with seed mixture; that is not to say we are not interested in experimenting with it"; "the department is just starting to become aware of the benefits of using native vegetation; the cost is the main reason for not using"; "we have no definitive plan or direction; we would probably have the resources and public support; financial backing the key"; "planting criteria is based on plant hardiness, reliability, maintenance, material cost and availability; we use native shrubs that meet the above criteria for harsh highway environments when their use is appropriate"; "we do use and manage native vegetation, but it is not policy; the primary role for vegetation in ROW is functional use; we use conservation species that have been developed for a specific task"; "I am not totally sold on this type of program."

2. Do you foresee your department using native vegetation in the future as part of your roadside vegetation management programs?

Yes 85.7 % No 14.3 %

Why?

"low growing native varieties will reduce mowing requirements and reduce maintenance expenditures; some interest in wildflowers has been expressed by the general public"; "potential for reduced maintenance cost responding to public and environmental pressures; "possibly could use then in areas where grasses may reduce sight distances or on ground where grasses do not seem to catch"; "the main reason for not using native vegetation in the future is cost; "public opinion positive, top level management sympathetic to their opinions and desires"; "in areas designated for their scenic and historic value and for mitigation purposes"; " we use it when it is appropriate, based on need and site assessment"; "Lower Costs"; "To qualify for federal funding we have to include a given percent of planting wild flowers in the contract."

CURRENT PRACTICES

3. What type of vegetation is presently being planted along newly constructed highway ROW's?

Grasses	100 %
Wildflowers	42.9 %
Shrubs	57.1 %
Trees	57.1 %
Other	0.0 %

4. Please list the predominant plant species planted on newly constructed highway rights of way?

5. Who is responsible for the planting of vegetation on ROW's?

Government employees	57.1 %
Contractors	85.7 %
Non-government groups	0.0 %
Others	71.4 %

Comments:

"a few small isolated planting by local volunteer groups; variable success"; "most work carried out by government employees however in our larger project it will be included as a bid item."; "our crew does limited plantings of larger trees and shrubs; however, we are currently attempting to plant 15,000 seedlings annually"; "government employees design and specify all plantings is done by contract"; "new construction planted by contractors, rehabilitation work by maintenance division along with other functional planting such as screening, erosion control and beautification such as wildflowers and annual gardens."

6. Please estimate the cost of planting vegetation on ROW's

or per acre \$1000, \$150, \$800 grasses, \$200, \$150
or per hectare \$\$100

Comments:

"no recent costs estimate, depends very much on project; larger construction projects average about \$200,000 + ; there is no set percentage based on scope of project other than the mandatory 1/4 of 1% for natives"

7. Who carries out the maintenance of the highway rights-of-way?

Government employees	100 %
Local contractors	57.1 %
Land owners	14.3 %
Others	42.9 %

Comments:

"a few adjacent landowners on an unsolicited basis"; "both local and government employees cut grass; government employees also cut bushes along the ROW and at intersections"; "hired on contract for mowing"; "some maintenance contracts have been used in urban landscaped areas to compensate for manpower reductions".

8. Please estimate the percentage of the department's yearly budget that is allocated to maintenance of state or provincial highways?

10 %, 12% to 13%, 40 %, 2.4, unknown; 25 %, 29-30 %,

9. What RVM maintenance techniques are used on ROW's?

Mowing 100 %

How often on average are ROW's mowed per year?

"4 lane divided highways receive one complete cut and 2 shoulder cuts annually; 2 lane highways receive 2 shoulder cuts annually; depending on growth portions may receive a full cut"; "1 to 2 times; not mown in their entirety usually just 1 or 2 shoulder swaths"; "1 to 3 times"; "1 time (most ROW have the sideslope mowed once)"; "3 times; 1st and 3rd cycle limited mowing and 2nd cycle full width".

Please estimate the cost of mowing per unit mile (or unit kilometre or acre or hectare) of ROW's in the last fiscal year?

\$28.18/ha, \$58.00/ha, \$30.00/ha
 \$100.00/km
 \$20/A, \$36.77/A, \$77.00/A, \$20/acre, \$19

Please estimate the percentage of the last fiscal year's maintenance budget that is allocated to mowing for state or provincial highway ROW's?

1.5 %, 0.75 %, 2.0 %, 1.4 %, 40.0 %, 0.7 %, 2.6 %

Herbicide application 85.7 %

What herbicide application technique is used?

Spot spray 71.4 % Boom spray 71.4 Other 28.6%

"Broadcast using computer controlled herbicide injection system."

Please estimate the cost of herbicide application per unit mile (or unit kilometre or acre or hectare) of ROW's in the last fiscal year?

\$110/ha, \$65/ha, \$325/ha
 \$15/A, \$85.80/A, \$150.00/A, \$25.1/A

Please estimate the percentage of the last fiscal year's maintenance budget that is allocated to herbicide application for state or provincial highway ROW's?

0.75 %, 0.02 %, 10.0 %, 1.6 %, < 1.0 %,

Burning 0.0 %

At what frequency are ROW's burned?

☐ Once a year ☐ Every two years ☐ Never ☐ Other

Please estimate the cost of burning per unit mile (or unit kilometre or acre or hectare) of ROW's per year?

Please estimate what percent of the yearly maintenance budget that is allocated to burning for state provincial highway ROW's?

Other 28.6 %

Comments:

"limited mechanical and hand cutting of undesirable brush species"; "bushes cut along the ROW are mulched and left in ditches or where no chippers is available trucked to an old borrow pit where they are burned; need a permit from Department of Environment to burn bushes; bush cutting about 2 to 4 % of maintenance budget"; "never burn"

10. What other agencies or levels of government in your state or province who are currently using or managing native vegetation on ROW's?

Municipal government	57.1 %
County government	42.9 %
Non-government groups	28.6 %
Contractors	0.0 %
Interest groups	28.6 %
Other	100 %
No response	14.2 %

Can you list these agencies and/or persons who can be contacted to participate in the study.

"some conservation authorities";

If you are interested in receiving a summary of the information gathered please check yes or no.

[7] Yes 100% [0] No 0 %

Additional Comments:

"Due to lack of commercial quantities of native vegetation seed, and the subsequent high prices of that is available, DOT continues to specify cultivated varieties of grass for highway seeding projects."

"the province is responsible for all ROW maintenance in all communities streets and roads"; "we do allow native plants to naturalize to the roadside and protect them largely by maintenance practices; however, in planting, natives are used only if they fit the need of any given situation; plant materials are selected under a criteria based on site assessment and functional needs."

Appendix 2

MAINTENANCE PERFORMANCE STANDARD 300-1, MOWING

Manitoba Highways and Transportation
MAINTENANCE PERFORMANCE STANDARD



STANDARD M- 300-1 ACTIVITIES 310, 311, 312 PAGE 1 OF 4 DATE June 1985

MOWING

APPROVED _____

Purpose:

Mowing is done on Highways and Provincial Roads in order to:

Improve Appearance: A properly mowed right-of-way looks nicer.

Improve Visibility: Tall growth at intersections and along shoulderlines should be cut so that motorists can see intersecting traffic, signs and large animals emerging from the ditch.

Improve Drainage: Thick vegetation growth in roadside ditches slows drainage, especially where drainage gradients are minimum.

Control Weeds and Brush: Mowing to control the spread of weeds or brush is often more desirable (and practical) than spraying or hand cleaning.

Minimize Snow Drifts: Tall growth along the shoulder line is a snow trap and will cause drift build-up on the road.

Responsibility:

The Work Supervisor, in consultation with the Superintendent will determine when growth conditions are such that mowing should be done.

Scheduling:

Although mowing must not take priority over "on surface" work, it should be scheduled in an orderly manner so that quality standards are maintained. Keep the shoulder lines on Class 1 and 2 roads looking neat through summer. Mowing to reduce snow-drifting should not begin until after growth has ceased, usually in early September. Brush mowing can be done anytime, but is most effective during and immediately after the growth period of late spring and early summer.

Safety:

The operator must be continually aware of the hazards created by the mower both to himself and others nearby. All guards such as power take-off covers and chain curtains (rotaries) must be in place. Never dismount from the machine while the cutter is in operation. Do-not work on any part of the unit unless the engine is stopped. Particular care must be used with sickle mowers or serious hand injury can occur.

Although mowing is an off-surface activity, all amber warning lights are to be working when the machine is in operation. The operator must watch carefully for traffic when making shoulder line cuts, or turning on the road for any reason.

Working on slopes requires added caution. Dropping a wheel over a culvert end or into a hidden hole can easily cause the tractor to roll over.

When a rotary mower is used near the travel surface (on median or upper grade slope) caution is required to prevent the cutter from throwing stones or other debris. If possible, the unit should operate in a direction that has the front half of the rotary arc turning away from the travel surface. Do-not use a rotary in any manner that is dangerous for passing motorists.

It is desirable that two mowers be scheduled to work together (in the same vicinity). In the event that one operator needs help, the second one can assist.

Quality:

Quality standards (levels of service) have been established for each of the five road classes. Some points common to all classes are;

- * Newly grassed areas should not be mowed during the first year of growth.
- * Areas sprayed for weed control should not be cut for at least 10 days after spraying.
- * Make the first cut on shoulder line around to the right-of-way boundary on all intersecting public roads.
- * Spot mowing may be necessary anywhere on the right-of-way to control weeds or brush.
- * Medians in towns and villages are to be mowed to maintain growth height at not more than 15 cm.
- * Through towns and villages the right-of-way may be mowed full width to a maximum of three (3) times.

The following areas are not to be mowed unless weed or brush control, or visibility at an intersection is a factor.

- * High grade fills: where the grade slope is steeper than 3:1 and/or the fill is higher than three (3) metres (except for the shoulder line cut).
- * Cut slopes: Back-slopes that are steeper than 3:1 and/or higher than three (3) metres.

Note: A swath-cut is considered to be one pass with a small mower (maximum width - 2 metres). One pass with a swather or triplex is equal to two (2) swath cuts.

Class I (Red)

- Raised Medians: Mow when grass reaches an average height of 20 cm. up to four times each year.
- Interchanges: Mow when grass reaches an average height of 30 cm. up to three times each year.
- Depressed Medians: Mow the complete median when grass reaches an average height of 30 cm., up to two times per year (normally June and late August).
- Right-of-Way: Mow 2 swaths when the grass reaches an average height of 30 cm. - normally the last week in June. When the required top cut or cuts have been completed on all roads as per standard, the remainder of the right-of-way on Red roads should be mowed right out. This would mean that the remainder of the right-of-way on Class I roads would be mowed out completely by approximately August 15th. An additional 2 swath cuts will be mowed on the grade slope toward the end of the growing season.

Class II (Blue)

- Adjacent to Shoulders: Mow two swaths when grass reaches an average height of 30-40 cm. A second cutting shall be made toward the end of the growing season to reduce drifting snow. This will be to the toe of the grade slope, or a maximum of 5 swaths.
- Right-of-Way: Where required, the remainder of the right-of-way shall be mowed every third year for brush control purposes.

Class III (Yellow)

Adjacent to Shoulders: Mow one swath when grass reaches an average height of 30-40 cm. Make an additional cut, two swaths wide toward the end of the growing season to reduce drifting snow.

Right-of-Way: Where required, the remainder of the right-of-way shall be mowed every third year for brush control purposes.

Class IV (Green) and Class V (Orange)

Adjacent to Shoulders: Mow two or less swaths each year toward the end of the growing season to reduce drifting snow.

Right-of-Way: Where required, the remainder of the right-of-way shall be mowed every third year for brush control purposes.

Method:

Use mowing equipment where it is the most effective. Swathers and triplex mowers are designed for large, open right-of-way where terrain is level and reasonably smooth. Small mowers are used to clean up around obstacles and in confined areas. Sickle bars can reach down (or up) a slope that may be too steep to safely drive a tractor on.

Areas where small brush is beginning to grow should be mowed out. Do-not leave these until growth becomes too large for grass mowers to cut, and heavy duty machines are required.

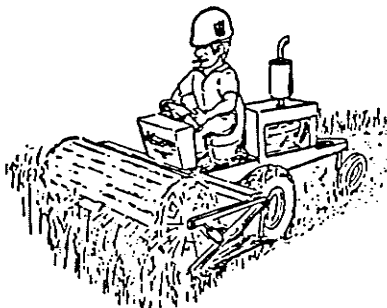
Areas that require close trimming (by hand around signs, guide posts, etc.) should be treated with soil sterilant or growth retardant. Consult the District Engineer before using such chemicals around drainage structures.

Productivity:

Sickle Bar or Single Rotary: 1.40 - 1.50 man-hours per hectare (approx. 2/3 hectare per hour)

Triplex: .65 - .70 man-hours per hectare (approx. 1 1/2 hectares per hour)

Swather: .75 - .80 man-hours per hectare (approx. 1 1/3 hectares per hour)



Appendix 3

ESTIMATED PRELIMINARY COST SCHEDULE

Estimated preliminary cost schedule (five years) for planting and maintenance for native vegetation in roadside ROW.

	<u>Canadian \$</u>	<u>American \$</u>
<u>Year 1</u>		
Installation		
- Planting	\$4050 / ha	\$1272 / acre
Maintenance		
- Mowing	\$ 306 / ha	\$96 / acre
(3 times per year)	(\$102/ha x 3 times/yr)	(\$32/ha x 3 times/yr)
<u>Year 2</u>		
Maintenance		
- Mowing	\$ 306 / ha	\$96 / acre
(3 times per year)	(\$102/ha x 3 times/yr)	(\$32/ha x 3 times/yr)
<u>Year 3</u>		
Maintenance		
- Mowing	\$ 204 / ha	\$64 / acre
(2 times per year)	(\$102/ha x 2 times/yr)	(\$32/ha x 2 times/yr)
- Burning	\$260 / ha	\$82 /ha
<u>Year 4</u>		
Maintenance		
- Mowing	\$ 204 / ha	\$64 / acre
(2 times per year)	(\$102/ha x 2 times/yr)	(\$32/ha x 2 times/yr)
<u>Year 5</u>		
Maintenance		
- Mowing	\$102 / ha	\$32 / acre
(1 time per year)		
	\$5,432 / ha	\$1,706 /acre

(Survey average costs, Appendix 1)