MAINLAND MOOSE

STATUS, POTENTIAL IMPACTS, AND MITIGATION CONSIDERATIONS OF PROPOSED HIGHWAY 113

FINAL REPORT

Submitted to:

Nova Scotia Transportation and Public Works
Environmental Services
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Dear Ms. Margueratt:

RE: Mainland Moose – Status, Potential Impacts, and Mitigation Considerations of Proposed Highway 113 - Final Report

AMEC Earth & Environmental (AMEC) is pleased to submit to you two hardcopies of the above-mentioned project.

If you have any questions, please do not hesitate to contact the undersigned.

Regards,

AMEC Earth & Environmental,
A Division of AMEC Americas Limited

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EXECUTIVE SUMMARY

Consultation with Nova Scotia Department of Environment and Labour (NSDEL), the Nova Scotia Department of Natural Resources (NSDNR) and the Nova Scotia Museum (NSM) was conducted to arrive at an appropriate scope of work that would satisfy the requirements of all of the parties involved, with direct regard for the Minister's requirement for additional information. The scope of work agreed upon by the concerned parties is provided below:

- Evaluate the potential impacts of the proposed Highway 113 on moose conservation and human safety concerns.
- Conduct a literature review and consult with adjacent jurisdictions to establish standards for mitigation of human/highway safety issues with moose in urban/suburban landscapes.
- Describe appropriate mitigative options and design options that accommodate wildlife movement and conservation within riparian corridors.

Development of the proposed Highway 113 has the potential to impact both the remnant moose population in the area and human safety to some degree. However, the potential occurrence and magnitude of these impacts will be related to the probability and frequency of interactions between moose, humans and the proposed highway alignment. Specifically, if there is little chance of interaction between motorists and moose in the area, then the human safety factor may not be significantly affected or impacted by the highway. It should be noted that the context of human safety within this report pertains solely to collisions or accidents cause by or involving moose. Likewise, if it is determined that the existing moose population has little chance of utilizing the existing habitat immediately within or adjacent to the proposed highway alignment, then the effect of the proposed highway on moose conservation may not be meaningfully impaired.

Potential impact of highway development on moose conservation may include:

- Direct loss of habitat associated with the footprint of the highway Right-of-Way (ROW);
- Direct moose mortality from vehicle collision;
- Indirect habitat degradation due to noise and habitat fragmentation; and
- Tertiary effects from increased development potential of adjacent lands due to highway access.

Potential impacts to human safety, due to development of the highway and moose interactions include:

- Human injury or mortality due to moose collisions or collision avoidance; and
- Cost of collisions in insurance claims.

Through discussions with several provincial and US state transportation departments, it was determined that standards for moose (animal) collision mitigation techniques are not commonly available. Although there is a growing core of data that is being used to determine minimum and optimum dimensions for animal crossing structures and fence design, the general opinion of the departments contacted was that the decisions of where, when and what type of collision counter measures to install was based on site-specific conditions and general common sense.

Given the complexity of the factors affecting wildlife collisions, we also feel that the development of a set of moose collision mitigation standards for Nova Scotia may not offer any additional benefit over the practice of site specific analysis used by other jurisdictions.

Due to the existing and planned future development of the areas east of the corridor, mitigation measures are likely to increase human / moose interactions and would be unfavourable.
Much of the west portion of the alignment between Stillwater Run and the Maple Lake / Fraser Lake corridor is crown owned and shows less immediate potential for development. Given the past reports of suspected moose presence in this aquatic corridor, and the westerly location of the identified core moose population from the NSDNR surveys, this location is the most promising area for moose crossing measures to be incorporated into the highway design. It is likely that a bridge type traffic structure would be recommended for this crossing, which would allow for the most unrestricted use of the opening by a wide variety of animals. Despite the fact that the chances of moose interactions with the proposed highway corridor are considered low based on existing records, it is also recommended that a public awareness program be considered.

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1.0 INTRODUCTION

The Nova Scotia Department of Transportation and Public Works (NSTPW) is proposing that Highway 113 will be a 4-lane, 100-series highway connecting Highway 102 (near Exit 3) and Highway 103 (just North of Exit 4) in Halifax Regional Municipality (HRM). Figure 1 shows the existing area and the proposed Highway 113 alignment.

On 2 May 2001, an environmental assessment registration document for the project, dated April 2000, was filed by NSTPW with the Nova Scotia Department of Environment and Labour (NSDEL). Additional information was issued by NSTPW to NSDEL in Addendum #1, dated April 2001.

Upon review of the registration document, the NSDEL Minister informed NSTPW by letter, dated 25 May 2001, that "*Specific information is required regarding the impacts and mitigation strategies for the publicly proposed Blue Mountain-Birch Cove Lake wilderness area in regards to Moose populations and other species with large home-ranges in the Blue Mountain-Birch Cove area …*". A copy of the Minister's letter is included in Appendix A.

Consultation with NSDEL, the Nova Scotia Department of Natural Resources (NSDNR) and the Nova Scotia Museum (NSM) was conducted to arrive at an appropriate scope of work that would satisfy the requirements of all of the parties involved, with direct regard for the Minister's requirement for additional information. The scope of work agreed upon by the concerned parties is provided below:

- *Evaluate the potential impacts of the proposed Highway 113 on moose conservation and human safety concerns.*
- *Conduct a literature review and consult with adjacent jurisdictions to establish standards for mitigation of human/highway safety issues with moose in urban/suburban landscapes.*
- *Describe appropriate mitigative options and design options that accommodate wildlife movement and conservation within riparian corridors.*

This report provides the results of the work described above.

1.1 BACKGROUND

Moose are the largest member of the deer family and can weigh up to approximately 600 kg (Schmidt and Gilbert, 1978). Primary moose habitat in Nova Scotia is often closely associated with near climax forests, with a good representation of shrubby vegetation (Davis and Browne, 1996). Moose tend to utilize coniferous and mixed coniferous/deciduous forests during winter for shelter and rely on buds and twigs of young trees and shrubs as diet. The quality of moose habitat has been shown to influence the fertility rate of female moose as well as the rate of occurrence of twins (Schmidt et. al. 1978).

The existing Cape Breton population is descendant from Alberta moose stock of the subspecies, *Alces alces andersoni*. The subspecies was introduced into Cape Breton following the near extirpation of the species following intense hunting pressure (Davis and Browne, 1996). The mainland populations are remnants of the original subspecies of moose native to Nova Scotia, *A.a. americana* (Davis and Browne, 1996). This subspecies is also representative amec

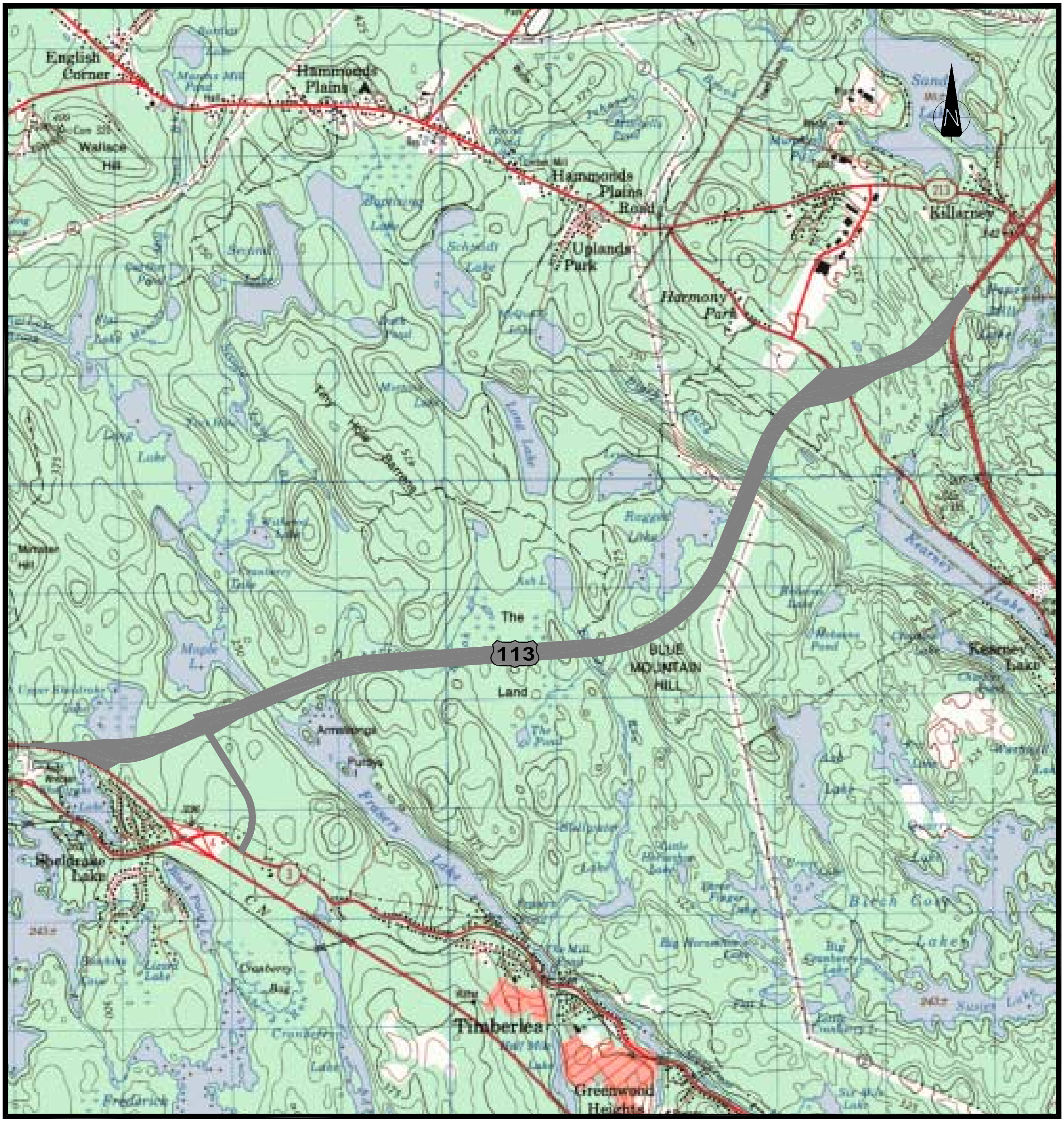

FIGURE 1
GENERAL SITE LOCATION
SCALE 1:50 000

MAINLAND MOOSE - STATUS, POTENTIAL IMPACTS
AND MITIGATION CONSIDERATIONS OF PROPOSED HIGHWAY 113
HALIFAX, NS

of the populations of moose found in the States of Maine and Minnesota, the provinces of New Brunswick and Newfoundland and most of the provinces of Quebec and Ontario. Adjacent areas such as New Brunswick, Newfoundland and Maine all have viable moose populations capable of supporting recreational sport hunting, suggesting that geographic constraints are not limiting factors to moose populations in mainland Nova Scotia.

1.2 NOVA SCOTIA MAINLAND MOOSE

The moose population in Nova Scotia fluctuated considerably following the arrival of European settlers and increased hunting pressure. Also, expansion of provincial deer herds resulted in increased interaction between deer and moose. This interaction exposed moose to a parasite (brain worm) carried by deer, which results in what is known as moose sickness and ultimately the death of the animal. Exposure of moose to this parasite may have had a significant effect on the populations except in the higher elevations where deer were less common (Pulsifer and Nette, 1997; and Davis and Browne, 1996).

Some mainland moose populations such as the Cobequid Hills and the Pictou-Antigonish Highlands, shown on Figure 2, supported a sport hunting season as recent as 1980, although reduced hunter success resulted in the annual hunt being discontinued by 1982 (Pulsifer and Nette, 1997; and Pulsifer, 1995). Despite this moratorium on harvest, it is thought that the population, at least over portions of the current range have continued to decline, (NSDNR, 2002a), leaving remnant pockets of animals scattered over the province, such as that found in the Halifax peninsula area.

1.2.1 Current Status of Moose and Conservation Strategies in Nova Scotia and Study Area

Recent estimates place a conservative estimate of between 24 and 50 animals as the total Halifax (Chebucto) Peninsula population, and less than 1000 moose in the whole Nova Scotia Mainland area (Snaith, 2001; and NSDNR, pers. comm., 2002, 2003). In comparison, the Cape Breton herd is estimated at >4000 animals (Snaith, 2001), while the New Brunswick moose population in 1999 was estimated at approximately 25,000 animals (Phillip, 1999) and the Maine population was estimated as 29,000 animals (MEDOT, 2001).

Due to the lack of existing habitat suitability models for Nova Scotia mainland moose, and the uncertain distribution of moose in the study area, NSDNR undertook the role of conducting winter aerial surveys to provide distribution and relative numbers of the local moose population. This work could not be completed during the winter of 2001-2002 due to poor weather and heavy snow conditions; however, NSDNR was confident that at least one set of moose tracks were observed in the study area near the Fraser Lake corridor, north of Highway 103, prior to the termination of the survey.

A recent (January 2003) aerial survey program was conducted by NSDNR to assess the numbers and distribution of moose in the Chebucto Peninsula and within the proposed highway alignment. A total of 24 moose were observed, with the majority (22) of the population being identified in the western portion of the peninsula, between Highway 333 and St. Margaret's Bay, in the vicinity of the Five Island Lake and the Terence Bay Wilderness Area. The locations of moose observations from this survey were provided to AMEC by NSDNR and are shown on Figure 2. Surveys of the proposed Highway 113 alignment and in particular the areas

immediately south of the alignment did not reveal any sign of moose in the area. However, there have been relatively recent reports (Fall 2002) of a single moose cow and calf observed in the Fraser Lake corridor, consistent with the winter track observation of NSDNR during the winter 2002 survey.

Additional efforts are being planned for the capture of three moose for fitting with GPS radio collars, to determine range and movements of individual moose in the area. NSDNR plans to monitor their habitat use and range, providing that animals can be located and captured in or near the study area. Despite the lack of a functional habitat suitability model for Nova Scotia mainland moose, it is felt that there may be sufficient habitat in the area defined as the Chebucto Peninsula to support a small moose population (project correspondence NSDNR, 2002). If in fact the areas to be crossed by the proposed highway are capable of supporting a portion of that moose population, NSDNR has expressed their concern that highway design should consider methods that could mitigate the risk of moose mortality, risk to human injury, and to help minimize the barrier effect of the new transit corridor.

There has been a noticeable decline in the mainland moose population since the 1960's (Pulsifer and Nette, 1997). Pulsifer (1995) and Pulsifer and Nette (1995) provided moose density estimates for the mainland herds of approximately 0.46 moose/km^2 in 1960 compared to 0.08 moose/km^2 in 1995. This decline in moose density can be fully appreciated when compared to 1995 densities of the Cape Breton herd, also provided by Pulsifer (1995), which ranged from 1.0 to 2.8 moose/km^2. The current Nova Scotia moose distribution and approximated numbers are shown on Figure 2, which presents data from Snaith (2001) and the recent aerial surveys for the Chebucto Peninsula conducted by NSDNR in January 2003.

As of October 27, 2003 the mainland moose population (A.a. Americana subspecies) is protected under the *Nova Scotia Endangered Species Act* and is designated as "Endangered" (NSDNR *ESA*, 2004) Currently, Nova Scotia considers the species to have a provincial Status Rank classification of "red" (at risk or potentially at risk). Red species are described as " Species for which a formal detailed risk assessment has been completed (COSEWIC assessment or a provincial equivalent) and that have been determined to be at risk of extirpation or extinction. Species that may be at risk of immediate extirpation or extinction and are therefore candidates for interim conservation action and detailed risk assessment by COSEWIC or the Province".

The moose populations in mainland Nova Scotia are considered low in numbers, and winter conditions are such that NSDNR has reported difficulty in monitoring the population status of moose on the mainland due to low densities, scattered distribution and the lack of consistent favourable winter snow conditions to permit proper aerial surveys (Pulsifer and Nette, 1997; and NSDNR, 2002a). An effort has been made to use pellet group inventory (PGI) methods to help determine relative moose numbers and distribution. The moose PGI efforts would correspond to every third year of the annual deer PGI surveys. NSDNR has recommended that the moose PGI efforts be conducted in areas of mainland Nova Scotia where it is feasible and logical to maintain a viable population of moose (NSDNR, 2002a).

2.0 POTENTIAL IMPACTS OF PROPOSED HIGHWAY 113

Development of the proposed Highway 113 has the potential to impact both the remnant moose population in the area and human safety to some degree. However, the potential occurrence and magnitude of these impacts will be related to the probability and frequency of interactions between moose, humans and the proposed highway alignment. Specifically, if there is little chance of interaction between motorists and moose in the area, then the human safety factor may not be significantly affected or impacted by the highway. It should be noted that the context of human safety within this report pertains solely to collisions or accidents cause by or involving moose. Likewise, if it is determined that the existing moose population has little chance of utilizing the existing habitat immediately within or adjacent to the proposed highway alignment, then the effect of the proposed highway on moose conservation may not be meaningfully impaired.

2.1 IMPACTS ON MOOSE CONSERVATION

As discussed in Section 1.2, the moose densities within the known mainland populations are very low. NSDNR records since 1989 indicate that there have been no moose collisions on the existing Highways 3 and 103 to the south of the proposed alignment, which currently separates the known core moose population from the study area. This suggests that there is little risk of moose collisions under current population conditions, based on the available 12 years of data. This condition should be considered during review of the following sections and potential moose mitigation strategies.

In addition to the low moose density, additional factors need to be assessed to determine the overall risk of a collision for a given area. It has been the experience of the BC Ministry of Transportation and the State of Maine, that the areas where wildlife crossings are likely to occur can be accurately predicted based on habitat conditions, habitat linkages and natural corridors (BCMOTH, pers. comm., 2002 and MEDOT, 2001). An interim report from Maine (MEDOT, 2001) found that most moose collision sites had wetland habitat at or near (i.e. within 50 m) the crash site. This finding is corroborated by the analysis of extensive Kootenay Park, Alberta, collision records where it was determined that almost all wildlife collisions coincided with areas where drainage corridors crossed or intersected the highway (Kerr, 1997).

Potential impact of highway development on moose conservation may include:

- Direct loss of habitat associated with the footprint of the highway Right-of-Way (ROW);
- Direct moose mortality from vehicle collision;
- Indirect habitat degradation due to noise and habitat fragmentation; and
- Tertiary effects from increased development potential of adjacent lands due to highway access.

The direct loss of habitat due to the highway “footprint” results from the clearing and filling of habitat, and is generally a small area in relation to total available habitat. However the effect of the operational highway in terms of habitat disruption is more significant, and has been termed by researchers as the “barrier” effect. Despite the physical ability of animals to cross most unfenced ROW, there can often be unwillingness for some species to do so, owing to factors such as noise, light, vibration, smell and the otherwise unnatural conditions. Also, direct mortality of animals due to vehicle impact can have a meaningful effect on local populations.

One case of European research has shown that depending on the species, Average Daily Traffic (ADT) of 10,000 vehicles can act as a complete barrier to animal movement (USDOT, 2001). According to records from the Trans Canada Highway (TCH), roughly half of the reported animal deaths in Banff National Park can be attributed to highways, and for some species, highway related deaths could equal or exceed the mortality rates of hunted populations (Clevenger, 1997).

2.2 IMPACTS ON HUMAN SAFETY

Human safety is also a primary concern when highways cross through moose habitats. Collisions of moose with vehicles tend to cause the greatest damage and human injury among animal collision due to their height and weight, which almost always result in the animal entering the passenger compartment of the vehicle during a collision (MEDOT, 2001). Furthermore, detection and avoidance of moose at night is difficult due to their dark, non-reflective coat (ONMTO, pers. comm., 2002), as well as their eyes typically being above headlight illumination, making detection and therefore avoidance difficult (MEDOT, 2001).

Potential impacts to human safety, due to development of the highway and moose interactions include:

- Human injury or mortality due to moose collisions or collision avoidance; and
- Cost of collisions in insurance claims.

3.0 REVIEW OF EXISTING MOOSE COLLISION REDUCTION METHODS

Moose collision mitigation methods were reviewed through literature searches and interviews/questionnaires conducted with adjacent provincial and state jurisdictions. Although several provinces and states were contacted and information was provided by personal communication, there was only limited response to the distributed questionnaire. Table 1 provides a summary of the jurisdictions contacted for information and their level of participation.

TABLE 1 Participation By Government Transportation Agencies

Geographic Region	Department	Number of Contacts	Verbal Information Provided	Written Questionnaire Returned
Newfoundland	Dept. of Works Services and Transportation	3	Yes	Yes (1)
New Brunswick	Dept. of Transportation	3	Yes	No
Quebec	Ministiere des Transports du Quebec	2	Yes	Yes (1)
Ontario	Ministry of Transportation	2	Yes	No
Alberta	Alberta Transportation	1	Yes	Yes
British Columbia	Ministry of Transportation and Highways	3	Yes	Yes (1)
Maine (USA)	Department of Transportation	1	Yes	Yes (1)
Minnesota (USA)	Dept of Transportation	3	Yes	Yes (2)

The results of the investigations revealed that there are two primary strategies used to reduce the frequency and severity of moose/vehicle interactions. These primary strategies are

- Driver orientated methods; and,
- Moose orientated methods.

Each primary strategy is discussed below along with the common individual techniques that fall into each category. Much of the most current and relevant data and case studies originate from the provinces of British Columbia and Alberta, where resource managers have been attempting to mitigate the conflicting uses between the Trans Canada Highway (TCH), and Canada's National Parks. Also, European countries provide extensive case history in the use of overpasses, underpasses, viaducts and other collision prevention technologies. Many of the cited studies have reported success or lack of success for wildlife in general, and do not specify individual species utilization. However, the potential for success of the method on moose can often be inferred based on the similar temporal behaviours and mobility of many ungulates such as elk and deer to those of moose. For example, success in reducing elk mortality in Alberta may be comparable to efforts of moose conservation in Nova Scotia, as both animals are large, widely dispersed, and are most active at night and during mating periods.

Other case studies such as those for bighorn sheep, which are mostly diurnal, may not be applicable due to the differences in their size, groupings and daily movement patterns. Only relevant case studies have been used; however, it should be recognized that all species have characteristics that may influence the success of any given method to that species. Table 2 summarizes the reviewed mitigation techniques that are described below and provides a rating of the suitability of the method to moose. This suitability is based on how well documented the method was in the existing literature, and the similarity of the case study species to moose.

TABLE 2 Relative Performance Assessment of Moose Collision Mitigation Methods

Mitigation Technique	Potential to Increase Barrier Effect of Highway	General effectiveness for Moose Collision Reduction	Level of Maintenance Required (L) Low, (M) Moderate, (H) High	Relative Cost Compared to other Cited Methods (L) Low, (M) Moderate, (H) High
Driver Orientated Strategy				
Passive Warning Signs	No Change	Not Effective	L	L
Active Warning Signs	No Change	Inconclusive	Not Available	M/H
Speed Limit Reduction	No Change	Effective	M	M (enforcement)
Brush/Vegetation Cutting	Increase	Effective/ Inconclusive	H	M
Overhead Lighting	No Change	Not Effective	M	M
Driver Education	No Change	Inconclusive	M	L/M
Moose Orientated Strategy				
Reflectors	Increase	Not Effective	H	M
Odours/Scents	Increase	Effective	H	M/H
Noise Emitters	Increase	Not Effective	L	L
Fencing	Increase	Effective	M	M/H
Under/Overpasses	Decrease	Effective	L	H

3.1 DRIVER ORIENTATED (ALERTNESS AND VISIBILITY ENHANCEMENT)

Driver orientated methods are directed at making vehicle operators more aware of the potential dangers, or making the highway conditions more favourable for the observation and avoidance of moose. Records consistently show that the occurrence of moose collisions is highest at night. Research also shows that the chances of hitting a moose can be greater on straight sections of road and when passengers are present in the car (Joyce and Mahoney, 2001) suggesting that driver alertness is a major factor in collision mitigation. Visibility and reaction time are key factors in preventing moose collisions by allowing the operator to comprehend and evade the obstacle. The following methods all use the enhancement of these factors to aid motorists in avoiding moose collisions.

3.1.1 Passive Warning Signs

Passive (standard) warning signs are generally yellow, diamond or triangular shaped signs that are placed in areas of frequent wildlife crossings, or areas where animals have been struck by vehicles in the past. Of all the jurisdictions interviewed during this study, only New Brunswick and Alberta had departmental standards for when a warning sign would be placed or removed and in the case of New Brunswick, these standards were still in draft form. Most provinces and states indicated that their departments relied on a common sense approach that involved placing signs where habitat or past records of crossings suggested the need. Areas where moose and other wildlife collisions are most likely to occur can be predicted based on habitat and drainage corridors (BCMOTH, pers. comm., 2002; MEDOT, 2001; and, Kerr, 1997). Maine DOT indicated that they follow the Manual of Uniform Traffic Control Devices (MUTCD) as standards for the placement of passive warning signs (MEDOT pers. Comm., 2003). A review of the MUTCD revealed that although there are standard sign dimensions and specifications for the installation, there are no specific criteria for determining when signs should be erected and it is assumed that this decision is left to the wildlife managers.

Generally, the passive warning signs appear to be most effective when first erected; however, transportation personnel felt that motorists quickly became accustomed to the warning signs and to not seeing wildlife, which desensitized the motorists to the warning signs. This was found to be the case in Europe where warning signs were considered to be ignored and largely ineffective (USDOT, 2002). It has been suggested that this technique may be more effective if the signs were posted only during the seasons when the risk of animal encounters are highest to inform the regular motorist using the roadway that the warning reflects current conditions. Studies are currently underway to test the desensitization of motorists to passive warning signs (BCMOTH, pers. comm., 2002).

European examples have also shown increased effectiveness of warning signs when used in conjunction with reduced speed limit zones (USDOT, 2002). A study of driver attitudes in British Columbia showed that although 83% of licensed drivers claimed to watch more closely for wildlife when in signed areas, only 53% of drivers indicated that they would reduce their speed in response to warning signs (Buckingham, 1997). Although still testing, MEDOT has found that the signs can be effective, although there is limited effectiveness observed for regular drivers on a given road (MEDOT, pers. Comm., 2003).

The main advantage of the passive warning sign is that the relative cost and maintenance requirements are small compared to other more elaborate methods, and there is no potential for the unobtrusive signs to increase the fragmentation and barrier effects of the highway.

3.1.2 Active Warning Signs

As discussed above, passive warning signs are generally considered to have limited effectiveness at preventing moose collisions. Active warning signs in this report refer to any type of warning sigh that has a dynamic component to it, such as blinking lights, flashing or scrolling text, or interactive measures that inform a motorist of a current or recent condition.

In Europe, simple flashing lights added to warning signs are believed to have increased the effectiveness of the signs (USDOT, 2002). However a study conducted in Colorado USA, using an animated warning sign for deer, failed to significantly change the wildlife crossing per kill ratio (Pojar et al., 1975). Active warning signs that rely on triggers, are a more recent concept that use flashing lights or dynamic text signs to inform motorist that an animal has entered the ROW recently and is likely still in the area. In Switzerland, solar powered (stored in batteries) infrared (heat) sensors are used to trigger reduced speed signs and have been shown to significantly reduce wildlife mortality on a two lane regional road, (USDOT, 2002).

The main advantage of the active signs is that motorists are informed of a current wildlife presence in the ROW, which is more likely to elicit a cautious approach by the driver. Research conducted by the Insurance Corporation of British Columbia showed that although motorists are generally unlikely to slow down due to passive warning signs, they are likely to slow down if they are warned that there is a current risk, (Vancouver Sun, 2002). Animal triggered active signs are relatively recent innovations in collision reduction, and as such there are still significant limitations to overcome. These limitations have been primarily identified as power shortfalls, vandalism and maintenance issues, (USDOT, 2002, MNDOT, pers. comm., 2002 and BCMOTH, pers. comm., 2002). Both British Columbia and Minnesota are currently experimenting with active warning systems.

Cost of the active systems is considerably more expensive than passive warning systems due to the newer technology, additional components and sensors, the need for power and required maintenance. The pilot study currently being conducted in Kootenay National Park, British Columbia was reported to cost 17 million dollars for the 2.5 km test site (Vancouver Sun, 2002). It is expected however that this cost would decrease considerably if the method became more widely employed.

3.1.3 Reduced Speed Zones

Reduced speed zones act on providing greater reaction time for motorists through areas known to experience frequent animal crossings or regular animal collisions. The specific reduced speed limit varies between programs and localities, which may affect the comparability of results and effectiveness of the method. Studies in Jasper National Park, Alberta, showed that speed zones reduced from 90 km/hr to 70km/hr resulted in a significant reduction in Elk collisions between 1983 and 1998 despite increased traffic volumes and a growing elk population during the study period, (Bertwistle 1999; and, Bertwistle 1997). Switzerland case studies, which used active warning signs to decrease speed limits to 40 km/hr, showed a significant reduction in wildlife mortality (USDOT, 2002). A night-time reduced speed limit of 90 km/hr (from 100 km/h) through a 5 km section of Alberta highway was inconclusive (Duckworth pers. Comm.., 2003).

This method was considered one of the most simple and effective actions by MEDOT, but it was also felt that there were considerable difficulties such as enforcement, legislating the speed reduction (required in Maine) and political resistance to slower speeds (MEDOT, pers. Comm.., 2003). There appears to be a trade-off between allowing a reasonable speed to permit efficient traffic flow, and the goal of increasing animal and driver safety. This is demonstrated in the above examples in that the Jasper National Park case study restricted speed 24 hours a day at 70 km/h, whereas the Swiss example used detection equipment to activate the reduced speed limit only when animals were present in the area, and were able to reduce speeds further without hindering traffic during periods when no animals were present. A review by Maine DOT

(2001) found that speed reduction was effective in reducing moose collisions, however there were concerns that the method had limitations with respect to the difficulty and cost of enforcing the speed limits. The Newfoundland Transportation Department found that the risk of human injury was 2 times more likely at highway speeds compared to slower speeds.

3.1.4 Vegetation Clearing

This method provides additional opportunity for motorists to observe the animals and take evasive actions. The Newfoundland Department of Works, Services and Transportation (NFDOT) use vegetation clearing in the ROW extensively, but as of yet, no testing has been done on the effectiveness of this method for moose collision reduction (NFDOT, pers comm., 2002). The Ontario Ministry of Transportation (MTO) has also used vegetation cutting and felt that it did help motorists by making it easier to spot the dark shapes of moose (ONMTO, pers. comm., 2002). MEDOT found vegetation clearing to be effective in reducing daylight collisions, but less effective during reduced light (MEDOT pers. Comm.., 2003). The use of vegetation clearing is currently being investigated by the Minnesota Department of Transportation, and although there is some opinion that it does help, their testing is incomplete and inconclusive as of yet (MNDOT, pers. comm., 2002). Alberta Transportation has vegetation management standards in place where all vegetation 25 mm or less is mowed to within 150 mm of the ground at least once a year (Alberta Transport pers comm.).

By maintaining a brush free zone adjacent to the roadway, there may be a greater chance that a moose will be spotted with sufficient time to avoid a collision. However, this technique needs to be further examined, as there is also the potential for the open areas to attract moose in an effort to avoid insects, or to feed on the new growth. Vegetation clearing has also been used in conjunction with habitat manipulation techniques such as plantings of undesirable species and leaving canopy cover at locations where crossings are encouraged. This technique, using 3-10 metre cut zones was found to be successful in Europe, (USDOT, 2002). The primary costs associated with this method are related to the continuous maintenance required to suppress vegetation encroachment during the growing season.

3.1.5 Overhead Lighting

European trials found that road lighting did not decrease the frequency of animal collisions, while negative impacts to nesting birds in the vicinity of the highway were observed (USDOT, 2002). A study in Colorado comparing deer activity and collision rates during alternating periods of highway lighting, showed that although lighting did significantly reduce deer crossing frequency, there was no significant reduction observed in collision per crossing ratios (Reed and Woodard, 1981). The use of lighting has limitations in that the areas of use must be within reasonable distance of an electricity source. MEDOT felt that lighting could be effective in reducing collisions, and are testing the method but it has received little support from the engineering community (MEDOT pers. Comm., 2003).

3.1.6 Driver Education

Driver education is focused on making motorists more aware of the potential for wildlife encounters and to better prepare them to avoid such encounters. A program called Watch out for Wildlife was proposed by the Department of Transportation in Florida that would encompass the education of school children as well as motorists, based on the belief that the increased awareness and appreciation of wildlife would result in less collisions (Evink, 1999). Maine DOT has strongly supported driver awareness and has made wildlife evasion a component of driver training and driver exams (MEDOT pers. Comm., 2003). Joyce and Mahoney (2001) demonstrated this with a case study from Sweden, where hunters were less likely to be involved in moose collisions than non-hunters. This difference was attributed to the hunters being better at spotting moose and understanding moose behaviour. It has also been shown that drivers are more likely to detect moose when they do not have passengers, (Aberg, 1981 as cited by Artemis Data Base; and Joyce and Mahoney, 2001), which suggests that the level of driver attention can significantly mitigate animal collisions.

Following an analysis of 5422 moose vehicle collisions in Newfoundland, it was suggested that the only viable way to reduce the number of moose related collisions was to implement a long-term driver education program (Joyce and Mahoney, 2001). The Minnesota Department of Transportation conducts annual driver education programs to decrease wildlife collisions but feel that the results are inconclusive (MNDOT, pers. comm., 2002).

3.2 MOOSE ORIENTATED STRATEGIES

Moose orientated strategies are designed to manipulate the behaviour of the animals such that they are less likely to enter the ROW where they would present a risk to motorists, and to their own health. It is a trade-off however, that most measures that decrease the likelihood of a moose to enter the ROW correspondingly increase the fragmentation effect of the highway.

3.2.1 Reflectors

Reflectors are manufactured poles with a reflective or mirrored face at the top, which directs red beams of light across the ROW, when struck by oncoming vehicle headlights. The motorists do not see the light beams created by the system, while it is believed that the ungulates do. The reflectors are aligned such that the reflected beams create a wall of light, which in theory causes the animal to stop its movement toward the road until the vehicle passes and the wall of light disappears. Some sources also suggest that the red light may simulate the eyes of a predator thereby frightening the animal. An advantage of reflector theory is that they would only create a barrier to movement when activated by vehicles, thereby minimizing the barrier effect of the method.

A review of reflector technologies on deer collisions by Danielson and Hubbards (1998), found that although some studies documented decreases in collisions with the use of reflectors, most studies were either inconclusive or showed no significant difference in collisions following installation. Their review also found that there was evidence that even in studies where the reflectors resulted in an initial decrease in collisions, the animals became desensitized to the devices over time with kill ratios returning to pre-installation levels. The state of Minnesota who tested over 53 miles of highway, found that the reflectors were ineffective on moose and deer and most of the devices have now been removed (MNDOT, pers. comm., 2002).

The amount of maintenance and repair required to keep reflectors operational has frequently been criticized. One study estimated that only 61% of reflectors were still in good shape following a three-year study (Reeve and Anderson, 1993 as cited by Danielson and Hubbards, 1998). The Minnesota DOT found that the reflectors required frequent cleaning and realignment to work properly (MNDOT, pers. comm., 2002). Similar findings were reported by a review conducted by the State of Maine where reflector maintenance was considered to approach installation cost over time, and results did not suggest a meaningful reduction in animal collisions (MEDOT, 2001; and MEDOT pers. comm., 2003.). European findings also found that the reflectors were either inconclusive or ineffective (USDOT, 2002). A study conducted by the BC Ministry of Transportation on four study reaches showed inconclusive results and suggested that reflectors did not perform as well in areas with lots of snow (Barlow, 1997).

3.2.2 Odours / Scents

The applications of predator or otherwise repugnant scents have been used to deter ungulates from using specific areas. This method, using a product that emulated wolf urine was tested with inconclusive results that did not encourage further testing by the Newfoundland DOT (NFDOT, pers. comm., 2002). Initial work in Europe using a foam spray application found that although there is some promise for this method, the cost associated with reapplication to maintain a scent barrier could become expensive (USDOT, 2002). Similar observations were made in Maine where labour cost for reapplication was seen as a major drawback. Also, it was felt that predator scents were less effective on moose in Maine as natural predators have been extirpated from the area for numerous generation (MEDOT pers. comm., 2003). An Ontario study found that a putrescent egg compound resulted in a sharp decrease in moose activity at mineral pools (Fraser and Hristienko, 1982). Alberta Transport found that the odour deterrents were effective with caribou in combination with other methods (Alberta Transport pers. comm., 2003).

3.2.3 Noise and Ultrasound Emitters

Devices such as vehicle mounted whistles, and other sonic devices have been advertised as effective methods to prevent animal collisions by either stopping animals from moving or by causing an evasive response. The literature and comments by authors and transportation agencies generally agree that there is no evidence to suggest that these devices are effective in reducing wildlife collisions (MEDOT, 2001; BCMOTH, pers. comm., 2002; MEDOT pers. comm., 2003; Alberta Transport pers. comm., 2003; USDOT, 2002 and Danielson and Hubbard, 1998). The Newfoundland DOT does not recommend the moose whistle due the possibility that they can give motorists a false sense of security.

3.2.4 Fencing

Animal fencing has been demonstrated to be an effective method to significantly decrease the occurrence of wildlife mortalities on highways. The technique relies on either preventing the animals from accessing the highway, or forcing them to cross the highway at a location more suitable for preventing collisions. Fencing is usually installed in conjunction with crossing structures to facilitate animal passage through the ROW.

Some of the best-documented case studies are associated with the Trans Canada Highway (TCH), and Canada's National Parks System. During the twinning of the first 26 km of the TCH in Banff, fences were incorporated into the upgrades, which resulted in a 96% reduction of road related mortalities, (Clevenger, 1997). Fences have also been used extensively in Europe to successfully prevent animals from accessing major highways. From the European experience, it is recommended that fence heights of 2.6 to 2.8 be maintained for ungulate species, and that this height be maintained through all terrain types and above winter snow conditions (USDOT, 2001). Also, for large animals, such as moose, the fence must be attached to the outside (away from the ROW) so that it cannot be pushed away from the poles (USDOT, 2001) by animals attempting to access the ROW.

A criticism of the fencing method is that animals can become trapped within the ROW if they do manage to enter the fenced area via the fence end, interchanges, or fence breaks. The New Brunswick DOT found that the one-way gates that allow trapped animals to escape required maintenance due to frost action and the tendency for the hinges to stick due to the cold (Phillips 1999). Some fence installations use earthen ramps to permit trapped animals to exit the ROW, as an alternative to the one-way gates (Bonds, 1999; and Danielson and Hubbard, 1998), however, there was no indication by the authors as to the effectiveness of the ramps, or if there was a concern for the animal's safety while jumping from the ramps. Increased wildlife collisions have been reported at fence ends (BCMOTH, pers. comm., 2002; Bonds, 1999; and Danielson and Hubbard, 1998) which emphasizes the need to provide crossing structures in conjunction with fencing. Also, it is recommended to use natural features to tie into fence ends to prevent animals from circumventing the protective measures.

Maintenance issues were identified with fences being cut where the ROW crosses ATV or Snowmobile trails (Philips, 1999). One major concern over the use of animal fencing is that it can act as a near complete barrier to movement if it is not constructed with functional animal crossings to allow relatively free movement of animals throughout their range.

The Wyoming DOT has effectively used fencing to reduce deer and elk collisions, and report that the cost of the wildlife fencing is approximately 30% more than typical fence installation, and that the fence has required little maintenance (Bonds, 1997). A more local case study of cost provided by the New Brunswick DOT presented costs ranging from $40,000 - $80,000 per kilometre for fencing alone (Phillips, 1999).

3.2.5 Underpasses and Overpasses

Underpasses and overpasses, referred to as structural animal crossings, can be installed structures specific to the purpose of creating animal movement opportunities, or they can be modified watercourse structures that incorporated animal use into the hydraulic design. Crossing structures have been shown to be very effective at reducing wildlife collisions when used in conjunction with animal fencing (MEDOT, 2002, USDOT, 2002; BCMOTH, pers. comm., 2002; Simonyi et al., 1999; and Phillips, 1999)

The size and characteristics of the crossings appear to greatly affect the use of the structures. Dimensions provided from European examples ranged from 5-12 m widths for small mammals to 25 m and greater for ungulates (USDOT, 2002). Additional European examples found that bridge structures with openings of 50 to 60 m showed significantly higher rates of normal behaviour by large mammals (Simonyi et. al., 1999). Mule deer in Colorado were observed to exhibit frightened behaviour while crossing through a fully enclosed underpass, specifically constructed for animal use, and did not appear to acclimate to the structure over a 10-year period (Reed, 1981 as cited by Danielson and Hubbard, 1998). Reed (1981, as cited by Danielson and Hubbard, 1998) also recommended using larger open bridge style underpasses as they resulted in less reluctant behaviour from deer.

One review found that overpasses were the most successful crossing structure for the largest spectrum of animals (USDOT, 2002). Equally important is the placement of such structures.

The locations where animals are likely to cross a highway has been accurately predicted by habitat linkages and natural corridors (BCMOTH, pers. comm., 2002)

The modification of watercourse crossings at the design and construction phase, to facilitate animal passage, is considerably less costly than the construction of overpasses specifically designed for wildlife (Danielson and Hubbard, 1998). It was presented by Phillips (1999), that the cost per crossing structure for corrugated steel pipe arches in New Brunswick was approximately $100,000 - $420,000 CND. Numbers reported by Danielson and Hubbard (1998), ranged from $92,000-$173, 000 USD for construction of underpasses on two and four lane highways respectively. A review of crossings in France showed that shaping overpasses like an hourglass with a narrow middle portion and wider ends could reduce costs, and that several smaller structures may be more beneficial than fewer larger structures (USDOT, 2002).

It is estimated that the costs for overpasses built solely for wildlife will approximate those for a bridge of equal size (MEDOT, 2001). It is generally stated in the literature that underpasses and overpasses are one of the most expensive mitigation strategies to initiate, particularly if they are constructed solely for the movement of wildlife as opposed to modifying existing or planned watercourse structures. Also, fencing must be used to maximize the effectiveness of the crossing structures.

4.0 POTENTIAL MOOSE IMPACT MITIGATION ALTERNATIVES

4.1 MOOSE COLLISION MITIGATION AND POTENTIAL STANDARDS

Through discussions with several provincial and US state transportation departments, it was determined that standards for moose (animal) collision mitigation techniques are not commonly available. Although there is a growing core of data that is being used to determine minimum and optimum dimensions for animal crossing structures and fence design, the general opinion of the departments contacted was that the decisions of where, when and what type of collision counter measures to install was based on site-specific conditions and general common sense. Given the complexity of the factors affecting wildlife collisions, we also feel that the development of a set of moose collision mitigation standards for Nova Scotia may not offer any additional benefit over the practice of site specific analysis used by other jurisdictions.

The only agencies that indicated having a provincial / departmental standard for sign posting (by far the most generic mitigation measure) was New Brunswick and Alberta. The draft standard criteria for erecting a permanent moose warning sign on a reach of New Brunswick highway, was for a minimum of two moose collisions per year to have occurred for two years or for three moose collisions to have occurred in one year, within a 10 kilometre stretch of road. The Alberta standard for issuing an area as a “Special Monitoring Area” and posting warning signs is three similar collisions in five years.

A review of these standards and the moose collision records since 1989 provided by NSDNR, indicate that none of the highways or regional roads adjacent to the proposed highway alignment would qualify for a permanent moose warning sign. Although this suggests that public motorist safety is not likely to be meaningfully increased as a result of the proposed highway, this does not imply that there is a no potential impact for the existing moose population.

Given the low numbers of moose in adjacent areas, any decrease or mortality to the population can have a considerable effect to the overall surviving population. However, a review of moose sightings and moose collision records between the years 1989 and 1998 assessed in conjunction with recent surveys by NSDNR suggest that there is little use of the proposed ROW area by moose. This may in large part be due to the barrier effect exhibited by Highways 103 and 3, and by the community of Timberlea, which separate the study area from the main moose population in the Five Lakes area. The NSDNR has commented that several sightings of moose have occurred near Exit 4 of Highway 103 (NSDNR, pers. comm., 2002), which may suggest a natural corridor through the Fraser Lake and Nine Mile Creek system. If this is the case, the lack of sightings north of the highways support the thought that the existing developed corridor of Highway 103 largely prevents moose utilization of the proposed ROW areas.

4.2 POTENTIAL MITIGATION OF HABITAT DISRUPTION AND FRAGMENTATION

Given that moose generally use aquatic systems as corridors, the use of watercourse structures for animal passage may be a reasonable strategy to mitigate habitat fragmentation within the Highway 113 Corridor. However, consideration should be given to any adjacent areas, which that crossing structure may be connecting to, such as residential or otherwise developed areas. With exception of an approximately 500 m gap near Ragged Lake, approximately half of the proposed ROW, (east of Stillwater Run) is aligned through areas that are undergoing rapid residential development, or areas that are currently zoned as private, developable lands. This land configuration is shown on Figure 3.

These areas to the east may not be suitable, now or in the near future for moose utilization given the potential for development and the fact that with few exceptions the alignment is within one kilometre of existing residential communities. As these land areas are currently zoned for further development and road and residential density is expected to increase, it is unlikely that these areas will provide continuous and functional habitat for moose. Furthermore, it may be undesirable to provide mitigation measures such as structures that encourage moose to access these areas if it is anticipated that human and moose interaction is likely to be increased, in the event that moose utilize adjacent areas more frequently in the future.

Much of the west portion of the alignment between Stilwater Run and the Maple Lake / Fraser Lake corridor is crown owned and shows less immediate potential for development. An animal friendly spanning structure was recommended for the crossing of the narrows connecting the Fraser and Maple lake basins (Washburn & Gillis Associates Ltd. 2000). Given the past reports of suspected moose presence in this aquatic corridor, and the westerly location of the identified core moose population from the NSDNR surveys, this location is the most promising area for moose crossing measures to be incorporated into the highway design. It is likely that a bridge type traffic structure would be recommended for this crossing, which would allow for the most unrestricted use of the opening by a wide variety of animals.

Care should also be taken during the design to incorporate the most recent findings of animal passage criteria such as creating as wide of a walkway as possible, filling voids in rip rap armouring or covering stone treatment with soil, and vegetation and cover placement to shield approach and exit points. Other complementing structures such as wildlife fencing adjacent to the structure could be considered to help direct moose to the structure opening; if it is determined that moose usage of the corridor is increasing. The ultimate decision to incorporate these mitigation measures should be made in conjunction with NSDNR following the completion

Figure 3 – Existing / Future Habitat and Movement Constraints

of the planned moose telemetry study. These moose mitigation measures would only be reasonable from a cost benefit perspective if the ongoing NSDNR studies determine regular or increasing use of the corridor by multiple animals. Likewise, if the ongoing research indicated regular moose usage of other corridors such as the Fisher Brook area, then consideration could be given to a corrugated steel arch opening at one of the crossings of Fisher Brook to provide additional permeability to the corridor.

Despite the fact that the chances of moose interactions with the proposed highway corridor are considered low based on existing records, it is also recommended that a public awareness program be considered. The awareness campaign could explain the status and habits of moose, collision prevention tips, and encourage motorists to report any moose sightings. This reporting component of the awareness program would also serve as a monitoring program to assess whether additional measures are warranted if moose populations and distributions increase.

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APPENDIX A

NSDEL Minister's Letter