

ROAD ECOLOGY PROTOCOLS: PROCEDURES FOR INCORPORATING ROAD MITIGATION MEASURES INTO TORONTO'S INFRASTRUCTURE OPERATIONS

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FOREWORD

This paper demonstrates the role environmental planning plays in restoring the harmony between human societies and the natural world. The past three years have allowed me to delve into the individual components of my Area of Concentration through hands on experience as a graduate intern at the City of Toronto Environmental Planning Section. The position manifested the many gaps that exist within the jurisdictional divides of local government, but it also manifested the potential for collaborative planning. Efforts to protect wildlife populations and habitats in a rigid planning climate proved to be no small feat. The research project that I undertook has allowed me to become well versed in the processes of environmental and transportation planning through close interaction with planners, engineers, ecologists, and academics. These experiences have allowed me to accomplish learning objectives well beyond the ones that I began with in my Plan of Study. Through this project, I became familiar with ecological principles that pertain to the construction of road infrastructure. By the end, I was well equipped to challenge the institutional barriers, and to fill in the gaps that prevented coordinated collaboration between key stakeholders. These results have given rise to a shift in transportation planning culture to one that is inclusive and open to innovative and interdisciplinary dialogues relating to landscape connectivity and wildlife mitigation.

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1. INTRODUCTION

The document, *City of Toronto Wildlife Crossing Protocol: An Integrated Planning Approach to Amphibian and Reptile Ecopassages* (hereinafter referred to as the Protocol) presents a strategic planning framework for the City of Toronto to integrate wildlife mobility needs into its transportation operations. The Protocol also serves an underlying purpose of elucidating the role of environmental planning in challenging the limited rhetoric on human-focused land use and transportation planning at the municipal level. Since 2011, my culminating efforts to integrate transportation and wildlife conservation, in my capacity as graduate intern with the City of Toronto's Environmental Planning Section, have spawned a multitude of important outcomes such as the establishment of interdivisional and interagency collaborative partnerships, and the actualization of successful implementation of the Protocol in a road resurfacing project.

This report describes the process through which this Protocol was developed, as well as the influential outcomes of the effort. I also use this opportunity to share my own thoughts on how planning for wildlife mitigation fares beneath the weight of the City's Planning regime, and simultaneously offer my recommendations for implementing wildlife crossings in Toronto, based solely on personal observations and experiences acquired during my time at the City.

This report is divided into three distinct parts. Part one presents a short literature review that highlights some of the key discussions and opinions pertaining to roads and wildlife. Part two gives an account of the events that led me to the research project, and includes an overview of the innovative tools and methods that were developed to help realize the project's overall goals and objectives. And finally, my reflections and analysis piece is devoted to the third part of this report.

2. LITERATURE REVIEW

2.1 Introduction

There is no shortage of literature on the effects of roads on wildlife. A synthesis of published material that serves to provide current knowledge on the topic can be found in the Protocol. This literature review will not reiterate the information found in the document; rather, this review seeks to elaborate on the rationale for the research project, focusing on the importance of biodiversity and habitat connectivity and the role of wildlife crossings in restoring the human-nature relationship.

2.2 Research Context

Although roads play a vital role in the social and economic development of contemporary societies, they pose significant threats to the viability of wildlife populations by contributing to habitat loss and fragmentation. As dense transport networks divide natural habitats into small isolated fragments, there is a concomitant alteration of wildlife distribution and movement patterns (Beckmann & Hilty, 2010; Clevenger & Huijser, 2011). Roads can act as barriers to animal movement through mortality from collisions with vehicles or avoidance behaviours (Shepard, Kuhns, Dreslik, & Phillips, 2008), physically disrupt migratory routes, and limit genetic exchange (Hardy, Fuller, Huijser, Kociolek, & Evans, 2006). Optimal landscape

connectivity allows for the safe movement of wildlife across the road in order to access resources such as shelter, food, water, nesting areas. Connectivity therefore helps to promote genetic diversity, species adaptability to changing habitat conditions, and resiliency to natural disturbances—three key components to ensuring long-term population viability among wildlife species (Beckmann & Hilty, 2010).

The free movement of wildlife across habitats and landscapes also help boost ecosystem processes and enhance biodiversity by means of seed dispersal, predator-prey relationship, and pollination of plants (Bennett, 1998, 2003). Biodiversity is an expression of life that can be seen and felt through various ways. The natural ecosystem works hard in the background to provide the comfortable environmental in which we carry out our daily activities. For instance, biological communities play an essential role in the health of watersheds; buffering plants and their root systems help to prevent natural causalities such as flood and soil erosion, and regulate water quality and climate (Primack, 2008). Watersheds are also important feeding, and breeding grounds for wildlife like frogs that can, in turn, serve as indicators of habitat quality due to their acute sensitivity to anthropogenic stressors (Baldwick, et al., 2011; Grant, Middendorf, Colgan, Ahmad, & Vogel, 2011; Primack, 2008). In essence, ecosystems rely on species diversity in order to adapt to different conditions that result from increasing human activities. Identifying wildlife movement corridors and connecting remnants of significant habitat patches can help mitigate the negative ecological consequences of habitat fragmentation.

3. PROJECT HISTORY

3.1 Introduction

This section documents the history of my research project, the challenges it overcame and the many accomplishments that were achieved. I also include a case study of Toronto's first wildlife mitigation project that illustrates how influential the interagency and interdisciplinary cooperation was in shaping the planning and design process, and advancing toward new collaborative directions.

3.2 Genesis of the Project

The City of Toronto places a high priority on the protection and enhancement of its natural environment and biodiversity. Recognition of the intrinsic value of biodiversity to the overall health and integrity of ecosystems and their contribution to human well-being has prompted the City's Environmental Planning Section to undergo a review of the Official Plan, and to strengthen its mandate for urban biodiversity conservation (City of Toronto, 2014). Toronto roads pose a real threat on the viability of its wildlife, and although there are local measures put in place for overall biodiversity protection, the discovery of a complete absence of structural guidance for the planning and design of wildlife road mitigation generated a call for concern—prompting Environmental Planning to organize a new biodiversity initiative rooted in the foundations of science and road ecology.

The *City of Toronto Wildlife Crossing Protocol* initiative began in 2011 as a mapping project to locate hotspots within the city where amphibian and reptile species were most likely threatened by roads. Before I took over the project, a draft map had already been produced that

depicted nine target areas where roads bisected Provincially Significant Wetlands. During our introductory meeting, Kelly and I agreed that since one of the major goals of the project was to save cost, it would be wise for us to capitalize on the City's road reconstruction and resurfacing programs in order to create opportunities for us to install road crossing interventions while the road is already under repair. I began contacting the City's engineering departments in order to gather capital work program schedules. Pavement Analyst, Phil Pendleton provided me with a spreadsheet of the Transportation 5 year Capital Works program 2011-2016. This data revealed street segments that were scheduled to be reconstructed or resurfaced over the five-year period. With the help of our mapper, Lynne Harvey, we added this layer of information to our second draft map.

3.3 Early Challenges

Once our map began to take shape, we turned our attention to bridging partnerships between stakeholders, using our mapping tool as a platform for open dialogue on our vision for integrating wildlife mitigation and transportation planning. From June 2011 to August 2011, we managed to secure connections with three different agencies.

We first met with Kimmo Hamalainen, senior engineer of the City of Toronto's Transportation Services Department. At the time, Pottery Road was undergoing a series of improvement work including, road reconstruction, curb replacements, installation of guiderails and retaining walls, new sidewalks, watermain and storm water upgrades, and enhancements to the Lower Don bike trail crossing at Pottery Road. The road holds historical significance as an important corridor for human mobility within the central and lower stretches of the Don Valley; however, Pottery Road also bisects a critical habitat that is rich in biodiversity, in particular reptile and amphibian species. By the time we were made aware of the project—just two weeks before the scheduled construction date—it was already too late to submit any design recommendations for wildlife mitigation measures. Even if there was sufficient time for submissions, we were severely lacking in financial resources and other incentives conducive to, or that are likely to encourage conservation action. We approached the engineer with two main goals in mind: (1) to introduce the notion of integrating wildlife mitigation in transportation projects; and (2) to acquire a preliminary understanding of the City's transportation planning process. We came away from the meeting with a clear awareness and understanding of existing knowledge gaps that prevent the inclusion of any wildlife conservation measure in transportation planning.

Our second meeting was with Dave Ireland and Mandy Karch of the Ontario Road Ecology Group (OREG). OREG is a not-for-profit conservation program comprised of scientists, educators and transportation planners, all dedicated to protecting wildlife from the effects of roads. It had come to our attention, from our previous meeting with Kimmo that engineers are not well versed in wildlife conservation, and needed to be informed about the impacts of roads on wildlife and the natural habitat through technical information that can be communicated in a manner that is comprehensible and serviceable to them. Transportation planners rely heavily on maps and modeling data when planning for any project. Therefore, we needed to seek assistance from natural resource agencies that are well-equipped to conduct fieldwork that will yield the necessary technical information required of engineers. Given its perceived reputation as a society of researchers committed to the field of road ecology, OREG seemed best suited for the task. In

addition, there existed this wonderful opportunity to build on an already established movement that holds conceivable potential of becoming something revolutionary. Sadly, this connection was short-lived. Without a dedicated funding source, it was hard for this group to express any willingness to contribute in a collaborative way to our project. Furthermore, they appeared reserved and protective of their jurisdictional territory for reasons that remain an enigma to this day.

We then turned toward the TRCA as a prospective partner. TRCA and the City of Toronto have a rich history of collaboration that is supported by a common mandate to sustain and enhance the City's natural environment. TRCA has provided many services on behalf of the City on projects, for they possess specialized expertise and skills in the areas of biology, ecology, and geology that are required by the City. We met with TRCA in August 2011, with the chief intention of retaining their services to conduct baseline surveys that would determine amphibian and reptile species movement, patterns of habitat use, and hotspots of road mortality. Our goal was to use the data collected to validate and further enhance the mapping tool's utility, and better inform engineers about the technicalities on wildlife crossing design and implementation. We had a productive meeting and received lots of suggestions for additional layers that would help render our map more comprehensive. Despite their eagerness to see the project through, TRCA wanted assurance that funding would be provided to cover all operational costs. And once again, with nothing to offer, our alliance with the TRCA came to a stand-still.

Unable to make further headway, the project submitted to a one-year hiatus from 2012 to 2013. The concept of creating a protocol that would essentially describe a collaborative and iterative process for transportation engineers and planners to design and implement wildlife crossings, materialized midway into our partnership recruitment phase in the early stages of the project. It was our belief that our undertaking would help set in motion and lay the foundation for early considerations of wildlife mobility needs in the long-range transportation planning process.

Table 1: Project log summarizing key actions during 2011-2012

Completed To-Date	
July 2011	Met with Kimmo H., Engineer City of Toronto
July 2011	Met with Dave Ireland, Former curator of conservation and environment at Toronto Zoo, present managing director, Royal Ontario Museum & spoke with Mandy Karch, Ontario Road Ecology Group coordinator, Toronto Zoo Wanted to start a partnership with the Toronto Zoo, however, they are not willing to do work without secure funds
August 2011	Meeting with TRCA members including Kari Gunson, Namrata Shrestha, PhD Landscape Ecologist, TRCA
October 2011	Met with Waterloo students and Kari Gunson to discuss pilot study project. Mapping tool was instrumental in determine a study site for project.
June 2012	Spoke with Kimmo H. @ 416-397-4581...explained that DINs are now PINs and directed me to Planning and Programming who are now responsible for the PINs
	Spoke with Fulvio Naccarato, Project Manager, Planning and Programming dept. @ 416-397-0309... explained that P&P get notices from MCIC (Major Capital Infrastructure Coordination)
	Called Emily Chang, Project Manager, MCIC @ 416-397-7618... left message and called several times, but no reply... need to find email

July 2012	Touched base with Kari and Waterloo. Received report and scheduled tentative meeting on August 22 @ 1PM or after September 11 @ anytime
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3.4 First Application of Mapping Tool

Our mapping tool is the first advancement of road ecology in Ontario at a municipal level, and its success is evidenced in its application toward the determination of an appropriate study site for a pilot mitigation design. In October 2011, Environmental Planning met with three engineering students from the University of Waterloo, and their supervisor Kari Gunson of Eco-Kare International, who expressed interest in collaborating with the City in a pilot mitigation planning design study. The students were assigned the task of engineering an effective and cost-efficient design process to implement wildlife mitigation structures for amphibians and reptiles migrating across Sewells Road, which is situated in Rouge Park from Steeles Avenue East to Old Finch Avenue. Their results and recommendations were documented in a report titled, *Reducing Wildlife Mortality and Improving Hydraulic Connectivity on Sewells Road in Rouge Park, Toronto* in July 2012 and circulated amongst involved stakeholders.

3.5 Newfound Partnerships

Deliberations on development of new policy tools and integrative approaches to wildlife road mitigation remained stagnant until the fall of 2013 when I made a serendipitous contact with Evergreen and Ryerson, following a visit to the XING pilot exhibit on public display at the Evergreen Brick Works.

Prior to this, organizational shifts from within the Transportation Services Department had already taken place which meant that we had to re-establish our point of contact. **Appendix A** delineates the extensiveness of our exploration effort to locate a new inter-divisional relation.

Upon learning of the City's Wildlife Crossing Protocol Initiative, we were approached by Professor Nina-Marie Lister of Ryerson University who expressed great interest in exploring a strategic relationship with the City of Toronto. On October 1, 2013, a meeting was held between key representatives of Environmental Planning, Ryerson (XING), ARC-Solutions, and Evergreen. The purpose of the meeting was to foster dialogues and mutual understanding about the intersection of work in road ecology and landscape connectivity (see **Appendix B**). The conversation ended with a proposal by Professor Lister to engage the City of Toronto Environmental Planning team as a working partner in the SSHRC partnership development grant in the capacity of active contributor and participant in the Ecological Design Labs proposed for the generation of knowledge about road crossings in Toronto's political landscape (see **Appendix C**).

Finally, at the onset of the New Year, we succeeded in engaging the interest and support of a small team of engineers from the Transportation Services Department. In February 2014 we had a meeting with Kanchan Maharaj and Mark Berkowitz to discuss the feasibility of incorporating wildlife passages during planned road reconstruction projects. To our surprise, not only did the engineers actively immerse themselves into the topic during deliberation to bring forth enriching information relevant to the project, but proposed that we introduce up to 10 pilot studies to test the efficacy of wildlife crossing structures in the city's urban fabric.

3.6 Sewells Road Reconstruction

This case study draws from the experience of a team of experts in considering the implications of roads on wildlife in Toronto. In early May 2014, we received a notice from Rouge Park, of a promising opportunity to implement recommended design alternatives for below-grade wildlife crossings on Sewells Road which had been identified to undergo road reconstruction work scheduled to begin in the summer.¹ I attended a site visit to Sewells Road where I met with staff members of Rouge Park and Parks Canada (hereinafter referred to as the Parks), and the project's lead engineers of GHD Inc. (the company retained by the City to prepare detailed designs for tender). Central to the discussion during the site visit was the Parks' recommendation to capitalize on the proposed culvert replacements to install adequately sized wildlife tunnels. The Parks also stressed the importance of minimizing habitat fragmentation, degradation and wildlife mortality. Additional suggestions concerning culvert material and dimension, substrate, retrofitting, and fencing also emerged in the discussion as essential elements of effective crossing design.

What seemed like a promising breakthrough for road ecology in the City of Toronto was shattered by the City's unfortunate refusal to accede to the recommendations made during the site visit; the reason being that the project's allocated budget was not sufficient to cover costs beyond the existing scope of work. Displeased with how the situation turned out, and the outlook of yet another missed opportunity, immediate actions were taken to secure a meeting with Transportation Services. On May 30, 2014, a workshop assembled an interdisciplinary group of experts in ecology, planning, engineering, and academia to discuss ways to incorporate aspects of wildlife mitigation measures into the Sewells Road design. As expected, the meeting generated mixed responses among participants at the table, though by the end, a positive decision was made to include wildlife mitigation notes in the design, albeit subjugating them under provisional scope until funding was sorted out between Parks Canada and the City of Toronto. At the request of the engineers, a technical memorandum detailing alternative design specifications and realistic cost was developed and submitted to City and GDH Inc. engineers within a matter of days (see **Appendix D**).

4. DISCUSSION

Through the numerous trials and challenges that were confronted along the way, we can extract as many lessons learned from the overall experience.

4.1 Obstructions of Conservation Planning

Planning: A lost identity amid bureaucracy

Despite my momentary exposure to the normative underpinnings of local governance, I have seen, and borne witness to, the power struggles and internal political discord that have over the years succeeded to corrode the true nature and defining role of 'Planning'. There was a time

¹ The recommendations were informed through the report entitled, "Reducing Wildlife Mortality and Improving Hydraulic Connectivity on Sewells Road in Rouge Park, Toronto", a pre-engineering design study conducted by three Waterloo Engineer students under the supervision of Kari Gunson (see Section 3.4). Sewells Road was originally part of the 2013 Transportation Capital Works Program.

when planning was appreciated as an autonomous gateway to improving the welfare of people and the environments that they live in. When planning first emerged as a profession, new solutions to community issues were carried out with the notion of unity of effort in mind. But modern-day planning has evolved into a cluster of disconnected ideals about urban planning, natural environment, transportation, economy, etc. The current lack of alignment and integration between departments and agencies across multiple jurisdictions greatly impedes innovative solutions to complex problems, like wildlife road mitigation.

In Toronto, many missed opportunities for implementing wildlife crossings are a direct result of poor coordination and misplacement of ‘planning’ on the part of the city’s Transportation Services Department. Transportation planning is for the most part a multi-year venture; and while it sounds like plenty of time for conservationists and transportation agencies to partake in valuable discussions about wildlife and habitat connectivity, the reality is that conservationists typically are only given a two-week window to voice their concerns and offer their recommendations before construction workers break ground. Unfortunately, any form of mitigation that is hastily included within the short time-frame is often insignificant and ineffective in minimizing biodiversity loss in the long run.

As demonstrated through my research, it is possible for natural resource agencies and transportation planners to establish a firm partnership at the outset of planning, to align shared goals and objectives, address concerns, and prioritize efforts to integrate transportation planning with wildlife habitat conservation. Despite the earlier challenges that we encountered trying to recapture the identity of planning, we succeeded in gaining unlikely allies and developing a positive working relation with transportation engineers at the City. Now, with our assembled team consisting of Environmental Planning, Transportation Services, Ryerson and ARC-Solutions, TRCA, and Parks Canada, we are planning for the implementation of up to ten wildlife crossings to be constructed within Toronto over the next several years. This will be the first project of its kind to take flight at the municipal level in North America.

Conservation is undermined by limited fragments of data

Research by Vanlaar et al. (2012) uncovered that various data sets containing information on wildlife-vehicle collisions currently exist, but are scattered across multiple agencies. Presently in Toronto, available data is significantly lacking where it concerns the relationship between wildlife, roads and vehicles, one reason being that ecological values have tended to be underrated in face of compelling economic and social competitions. Ironically, such a gap in knowledge is what creates the biased risk perceptions among decision-makers, casting doubt on the need to invest in urban conservation research and action in the first place. Where it concerns wildlife and transportation, this gravely precludes the successful development and implementation of effective road mitigation measures. The magnitude of road impacts on wildlife populations is highly influenced by both road-related and species-specific factors (Santos, Lourenco, Mira, & Beja, 2013). These factors also dictate the locations with higher mortality rates, which is useful in indicating where wildlife crossings should likely be placed. Therefore, in order to accurately predict hotspot locations for effective planning and design of wildlife crossing structures, it is imperative to have accurate spatial and temporal wildlife distribution and vehicle collision data. The mapping tool presents a simple mechanism for gathering information essential to finding solutions that will address the issue at hand.

Conservation, while based in science, is ultimately a social policy endeavour

Probably the most pervasive misconception among conservationists is that repetitive preaching will eventually invoke change. As important as empirical knowledge may be, science alone is not enough to induce policy reforms with positive implications for conservation biodiversity on a local scale. Within the context of road ecology research, attention is repeatedly given to documenting broad assessments of the effects of roads on animals; conducting different variations of the same studies; and synthesizing the results of those studies which are then added to the growing body of literature on road impacts on wildlife. This constant feedback loop is quite possibly born out of a false sense of security where studies with the highest inferential strength are most likely to appeal to decision-making principles. In practice, however, influencing decision-making requires an understanding of the complex interplay between science and the social processes that drive change. Therefore, the focus of the scientific community should be on providing ecological information that is relevant and complements the social system in which conservation policy decisions and action are made.

Biodiversity protection receives no dedicated funding

Toronto is currently under stress as it struggles to find the right balance between accommodating growing infrastructure needs and addressing aging transport networks with a combined value of \$9.890 billion (City of Toronto, 2014). As a result, Toronto City Council invests an enormous amount in our City's transportation services. In 2013, Council approved the Operating Budget of \$329.511 million gross which provided funds to services like road and sidewalk maintenance, permit and applications, and transportation, safety & operations (City of Toronto, 2013). City Council also establishes a discretionary reserve fund that is typically dedicated to specialized projects perceived to improve the overall road system. But no financial mechanism is available to properly coordinate biodiversity or habitat conservation activities. Consequently, initial engagement on such issues by transportation agencies is oftentimes resisted.

4.2 Lessons Learned

Successful conservation planning at the municipal level is an act of submission to the compelling forces of neo-conservative socio-political dogma. If I had to describe my three-year experience in one sentence, the above statement is what I would say. It is near impossible to break old traditions while trying to keep the peace, therefore one must find ways to instill new notions while keeping within the boundaries of old customs.

Dynamic partnerships are essential to effective wildlife mitigation planning and design.

The application of mitigation measures to reduce the negative effects of roads on wildlife is, by nature, an interdisciplinary endeavour—one that requires coordinated collaboration of key actors spanning across multiple jurisdictions. Partnerships have the ability to provoke social change through innovation and new thinking.

Patience and perseverance will lead to well-founded partnerships. If one searches hard enough, they are bound to come across allies who possess contributive knowledge and expertise. This journey is seldom an easy one, but the outcome is often well worth it.

Build on each other's ideas. The act of exchanging and developing ideas in groups has the potential of generating combinations of new ideas that may help to further realise a common vision shared among all groups, or simply allow members of one particular group to better understand the essence of their own ideas.

Be prepared to gather specific information for engineers. Design engineers deeply value the efficiency derived from context-specific information gathering. This approach limits the amount of time necessary to acquire information that is relevant to the problem at hand, and avoids information overload and often accompanies unnecessary complexity and ambiguity. Therefore, when communicating information to engineers, it is necessary to present the data in such a way that will ensure easy application upon receipt.

Never assume decision makers are well informed on topics pertaining to urban conservation planning. This might seem obvious and almost redundant, yet it amazes me how I continually show up to meetings ready to have a deeply-rooted discussion on a topic that is, as it turns out, completely novel to the other parties. Rather than feel discouraged, take this opportunity to strategically educate officials about the impacts of roads on wildlife and the wider landscapes, while exploring new educative tools and methods that could be easily applied to bring awareness to a broad range of conservation topics among stakeholders.

4.3 Tea Time with Jennifer Keesmat²

Bringing together both the research knowledge amassed over the years, and the practical experiences from working alongside key actors spanning different disciplines and sectors, I have come up with a list of recommendations for local authorities and natural resource agencies interested in bringing to light conservation objectives and public policy interventions that will influence local governments to be active stewards of wildlife conservation. These include:

Shift the engineering culture. First and foremost, it would be ideal to render the highly intricate transportation planning process more coherent and approachable to all stakeholders. Transportation planning has become profoundly systematic over the years due to growing social needs and pressures, resulting in a shift in engineering culture which now perceives the majority of projects as an engineering or technical endeavour, rather than a planning concern. Policies should be put in place to prohibit engineers from approaching stakeholders within a month of breaking ground. The process of seeking input from stakeholders like conservationists should occur as early as possible in the planning process.

Foster transparency and engagement across all sectors of planning. We cannot limit our efforts of wildlife road mitigation to transportation planning. Conservation in an urban fabric can only be further realised if collective engagement occurs across all departments of planning, including:

- Urban design – elements of conservation biology or habitat connectivity could be incorporated into several pieces of public art, for example. There are several great

² I owe credit to Professor Nina-Marie Lister for instilling the idea of envisioning having lunch with Toronto's Chief Planner Jennifer Keesmat as a method to express the many obstructions of conservation planning at the municipal level, and to offer my recommendations for implementing wildlife crossings, in the way I see fit.

opportunities to incorporate wildlife crossing structures into the Eglinton Crosstown LRT line;

- Toronto Water – wildlife crossings could be installed during planned watermain reconstruction projects; and
- Community Planning – this would be a great way to establish citizen science programs that record wildlife observations. Public support has been documented as a clear force to moving issues of conservation within communities.

Offer incentives for innovation in design for road crossings and habitat connectivity. Just as the Toronto Green Standards offer incentives to developers in the form of a development charge refund for voluntarily meeting higher level environmental performance measures, financial incentives can be offered to encourage planners and engineers to incorporate innovative thinking on road crossing designs and landscape connectivity. Multiple one-time funding programs could be created with a dedicated sum that is available over the life of the program. A cost-sharing option that uses those funds could be made out to eligible projects that have readily formed partnerships with external agencies.

Develop mandatory training courses to inform planners and engineers on urban conservation. With a broader knowledge base, planners and engineers will gain new insight into the needs of their city, and be better equipped to face the challenges surrounding urban conservation biology and habitat connectivity. Courses could be specially designed to include interactive training modules that instruct planners and engineers on how to properly identify potential habitat linkage points for wildlife crossing structures. The technology could be integrated with the capital works program database to forewarn of hot spots that offer high potential for crossing structures.

Create a wildlife-vehicle collision data clearinghouse where current and accurate information can be easily accessed and shared across agencies. The type of data collected should include two key pieces of information:

- A complete wildlife-vehicle collision report that includes information on location, time, and species (both small and large); and
- General and migratory species movement and patterns of habitat use.

The University of Wisconsin created an online Deer-Vehicle Crash Information Clearinghouse (DVCIC) that houses a mitigation measure toolbox, annual tallies of deer collisions for 11 states, data compilation reports and much more (see www.deercrash.org) (Vanlaar, Gunson, Brown, & Robertson, 2012).

5. CONCLUDING REMARKS

There is a growing concern about habitat fragmentation by roads; but as we have seen in the previous pages, protecting urban wildlife and habitat is no small feat as it requires considerable effort and investment from a diverse range of actors. While there is vast research on the topic, there continues to be limited knowledge and strategic guidance on how municipalities can bridge the gap between science and action to help restore landscape permeability for increased animal movements across roads. The process of developing the wildlife crossing protocol manifested an

array of existing planning tools and resources that are available to the municipality. This process also inspired engineers from the City's Transportation Services Department to propose a pilot study to test the efficacy of wildlife crossing structures in the city's urban fabric. This achievement has set a positive precedent for future road infrastructure development in Toronto and other municipalities across Canada.

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Appendix A

Project Log 2013 - 2014

Project Log

Priority	Date	Name	Organization	Email	Telephone	Action	Status
	8-15-13 2:45 PM	Phil Pendelton	Road construction & operations	ppendle@toronto.ca	416-338-5376	called. requested updated transportation 5 year CWP. referred to Alissa Park	confirmed
	8-15-13 4:27 PM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	emailed. Requested transportation 5-year CWP	confirmed
	8-15-13 4:46 PM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	emailed & called about updated herp data	confirmed
	8-16-13 10:29 AM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	called. Requested updated transportation 5 year CWP. Referred back to Phil Pendleton for information. Set up meeting on Aug. 27 to talk about project/map/next steps	confirmed
	8-16-13 11:59 AM	Jacqueline Waters	Royal Ontario Museum	jacquelinecwaters@gmail.com		emailed. Confirmed attendance at ROM's curators corner	confirmed
	8-16-13 12:56 PM	Phil Pendelton	Road construction & operations	ppendle@toronto.ca	416-338-5376	emailed. Requested updated transportation schedule. Cc'd Alissa and Kelly.	confirmed
	8-16-13 1:51 PM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	left voicemail. Requested updated herp data.	confirmed
	8-16-13 4:24 PM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	emailed map march 2012.	confirmed
	8-20-13 10:04 AM	Phil Pendelton	Road construction & operations	ppendle@toronto.ca	416-338-5376	left voicemail. Asked to return call.	confirmed
	8-20-13 10:05 AM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	she returned call. data will be provided by the GIS team at TRCA. She asked in return for most current map and Waterloo Sewells final report which I emailed.	confirmed
	8-22-13 9:42 AM	Renata Moraes	Transportation Infrastructure (Transportation Services)	rmoraes@toronto.ca	416-2392-6039	called. Asked if we could get road classification system from there division. suggested I contact Vesna Stevanovic-Briatico (416-392-8345) who is responsible for the information but is on holiday until next Monday	confirmed
	8-22-13 9:50 AM	Jim Thomas Smith	Traffic Management (Transportation Services)	jsmith8@toronto.ca	416-392-5210	called. Asked if we could get road traffic data from their division. suggested to email Giorgian Titichi (416-397-7589) to get access to traffic flow information. Make sure to sign a waiver b/c this info CANNOT be given out to outsiders otherwise license will be revoked.	confirmed
	8-22-13 10:35 AM	Giorgian Titichi	Traffic Management (Transportation Services)	gtitich@toronto.ca	416-397-7589	emailed. Requested access to traffic flow data.	confirmed
	8-22-13 11:57 AM	Vesna Stevanovic-Briatico	Coordinator Transportation Infra Mgmt	vstevan@toronto.ca	416-392-8345	emailed. Requested road classification information. Back in office Aug/26/13	confirmed
	8-22-13 1:04 PM	Jason Tam	TRCA GIS Specialist	jtam@trca.on.ca	416-661-6600 x5340	follow up DAYS. If no response by next week, email/call Jason to see if we can get data sets from TRCA.	confirmed
	8-23-13 9:56 AM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	emailed. Asked if data from GIS will include migration routes and spp. Composition.	confirmed

Project Log

8-23-13 10:04 AM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	emailed. Asked if she could relay request to Phil Pendleton.	confirmed
8-23-13 12:57 PM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	emailed. Confirmed discussion about spp. Migration routes with Kelly and opened up date possibilities for a meeting.	confirmed
8-27-13 10:37 AM	Vesna Stevanoic-Briatico	Coordinaor Transportation Infra Mgmt	vstevan@toronto.ca	416-392-8345	called. Followed up on the email I sent on 08/22/13. She was interested and willing to help in any way she can. She would like to see a project summary so she can give her team a heads up on the project. She will also be providing the roads classification files. Follow up re: meeting in person.	confirmed
8-27-13 10:57 AM	Jason Tam	TRCA GIS Specialist	jtam@trca.on.ca	416-661-6600 x5340	called. Left message. Followed up on the email Namrata forwarded to him re: data sets.	confirmed
8-27-13 1:30 PM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	phone meeting. Refer to Document "meeting with Alissa Park" for more details on meeting.	confirmed
8-27-13 1:30 PM	Lara Tarlo	City Planning Urban Design City Hall 19E	ltarlo@toronto.ca	416-338-1132	contact to discuss process of submitting scope to planning and programming.	confirmed
8-27-13 1:30 PM	Mark Berkovitz	Transportation Services	mberkov@toronto.ca	416-338-5377	contact to ask about possible funding through transportation.	confirmed
8-27-13 4:44 PM	Lynne Harvey	City Planning	lharvey@toronto.ca	416-392-1829	emailed. Gave her map outline.	confirmed
9-3-13 3:28 PM	Tanya Pulfer	Ontario Nature	tanyap@ontarionature.org		emailed. Asked about the road mortality data.	confirmed
9-5-13 10:25 AM	Lara Tarlo	City Planning Urban Design City Hall 19E	ltarlo@toronto.ca	416-338-1132	called. Explained road ecology project and set up a meeting to meet in person with Kelly on Sept/13/2013 2PM.	confirmed
9-5-13 11:48 AM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	emailed. Asked about data discrepancy in transportation files.	confirmed
9-5-13 5:06 PM	Kelly Snow	City Planning	ksnow@toronto.ca	416-392-4787	emailed. Sent project summary draft to check over.	confirmed
9-6-13 1:32 PM	Phil Pendelton	Road construction & operations	ppendle@toronto.ca	416-398-5376	called. Asked about the CWP data discrepancy. Explained that it was normal and was showing only the confirmed 5 years rather than all.	confirmed
9-6-13 2:55 PM	Vesna Stevanoic-Briatico	Coordinator Transportation Infra Mgmt	vstevan@toronto.ca	416-392-8345	emailed. Sent copy of requested project summary.	confirmed
9-10-13 9:33 AM	Lara Tarlo	City Planning Urban Design City Hall 19E	ltarlo@toronto.ca	416-338-1132	emailed. Asked to reschedule Friday's meeting. Rescheduled for Friday September 20 from 10AM-10:30AM @ City Hall 19E	confirmed
9-10-13 12:37 PM	Tanya Pulfer	Ontario Nature	tanyap@ontarionature.org	416-444-8419 x243	emailed. Ontario Nature Data Sharing Agreement.	confirmed
9-19-13 10:42 AM	Ministry of Transportation - Road Talk	Ministry of Transportation	roadtalk@ontario.ca		emailed. Asked if I could get copy of turtle crossing project report done in Village of Caledon, and two-year monitoring report.	confirmed

Project Log

9-19-13 12:45 PM	Jim Schaffner	Engineering & Construction Services (ECS)	jschaff@toronto.ca	416-392-8598	emailed. Asked for (1) culvert intallation standards (2) GIS data on all Toronto culvert locations.	confirmed
9-20-13 7:47 AM	Jim Schaffner	Engineering & Construction Services (ECS)	jschaff@toronto.ca	416-392-8598	ret'd email. Said to contact	confirmed
9-20-13 11:51 AM	Tanya Pulfer	Ontario Nature	tanyap@ontarionature.org	416-444-8419 x243	called. Partner picked up. Tanya won't be back until next Tuesday. Wanted to ask about road mortality rate along the Don River by Pottery Road and the Brickworks	confirmed
9-20-13 2:23 PM	Melissa Yu	Project Manager Evergreen Brickworks	myu@evergreen.ca	416-596-1495 x 310	called & emailed. Talked about possible partnership with evergreen on road ecology pilot study. Sent her the project summary. Follow up to set meeting in near future.	confirmed
9-20-13 4:14 PM	Chris Loader	Engineer ECS	cloader@toronto.ca	416-392-8331	called. Asked for shp. File for culvert locations in Toronto and installation standards that are actually provided through MTO. Will send over info next week so follow-up if not received	confirmed
9-24-13 10:45 AM	Melissa Yu	Project Manager Evergreen Brickworks	myu@evergreen.ca	416-596-1495 x 310	emailed. Asked if she was available to meet tomorrow for a visit of the XING exhibit and to talk more about the details of their project with Ryerson and ARC	confirmed
9-26-13 12:33 PM	Nina-Marie Lister	Ryerson University	nm.lister@ryerson.ca	416-704-5736 416.979.5000 x6769	rec'd call. She called in response to Melissa's email and my project summary. Call to set up a meeting asap with her team and City. Working on a federal funding grant proposal. Would like Kelly and I to speak to her studio class in December. Waiting for word on meeting.	confirmed
10-1-13 9:34 AM	Melissa Yu	Project Manager Evergreen Brickworks	myu@evergreen.ca	416-596-1495 x 310	emailed. Asked for the Lower Don Consultation and Garth Armour PFR.	confirmed
10-1-13 2:44 PM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	called. Set up a tentative meeting for October 30, 2013 1:30 @ TRCA to discuss possiblity of TRCA doing continuous fieldwork in hotspots. She wants a brief description of the nature of the meeting and wants me to look into getting CWP data for TRCA.	confirmed
10-1-13 3:02 PM	Chris Loader	Engineer ECS	cloader@toronto.ca	416-392-8331	emailed. Followed up on the culvert data.	confirmed
10-1-13 3:51 PM	Alissa Park	MCIC City Hall	apark@toronto.ca	416-397-0787	emailed. Cc'd Namrata. Basically asking if TRCA has permission to access the transportation CWP 5-year data.	confirmed
10-4-13 9:18 AM	Mark Berkovitz	Transportation Services	mberkov@toronto.ca	416-338-5377	emailed. Asking if TRCA has permission to access the transportation CWP 5-year data.	confirmed
10-7-13 4:40 PM	Chris Loader	Engineer ECS	cloader@toronto.ca	416-392-8331	ret'd email. Sent over the culvert data and installation manual.	confirmed
10-8-13 11:40 AM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	Accepted meeting @ TRCA on October 30, 2013 1:30pm.	confirmed
10-8-13 11:40 AM	Kelly Snow	City Planning	ksnow@toronto.ca	416-392-4787	Accepted meeting @ TRCA on October 30, 2013 1:30pm.	confirmed

Project Log

	10-8-13 2:45 PM	Tanya Pulfer	Ontario Nature	tanyap@ontarionature.org	416-444-8419 x243	emailed. Asked if I could share road mortality data with Ryerson students.	confirmed
	10-9-13 1:05 PM	Tanya Pulfer	Ontario Nature	tanyap@ontarionature.org	416-444-8419 x243	returned email. Said it was fine to share as long as they are acknowledged as data source in pubs. And also share data with Ontario Nature to add to database.	confirmed
	10-9-13 9:00 AM	Donna Doyle	Oakville	ddoyle@oakville.ca	905-845-6601 x3898	Attended Oakville Road Ecology Symposium.	confirmed
	10-10-13 3:38 PM	Donna Doyle	Oakville	ddoyle@oakville.ca	905-845-6601 x3899	Emailed. Thanked for invitation to symposium. Asked for Oakville's Road Ecology Strategy	confirmed
	10-11-13 10:23 AM	Chris Loader	Engineer ECS	cloader@toronto.ca	416-392-8331	emailed. Asked for permission to share culvert data w/ Ryerson students.	confirmed
	10-15-13 9:34 AM	Donna Doyle	Oakville	ddoyle@oakville.ca	905-845-6601 x3898	returned email. Sent Oakville's Road ecology strategy and asked if I was attending the GTA-CAC Meeting on October 25, 2013 from 10-1 @ City Hall.	confirmed
	10-15-13 11:21 AM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	emailed. Asked her thoughts about inviting Vince D'Elia to the October 30 meeting.	confirmed
	10-15-13 12:42 PM	Sarah Merriam	MTO	sarah.merriam@ontario.ca	416-235-5272	rec'd email. Sent contract documents for highway 10 turtle crossing constructed by MTO.	confirmed
	10-15-13 1:58 PM	Matthew Kerry	Volunteer Communications Assistant, Evergreen	mattkerry81@google.com	none	rec'd email. Asked if he could interview me about City's Road Ecology project for an Evergreen blog.	confirmed
	10-15-13 2:40 PM	Carl Badow	Supervisor, Toronto Animal Services	cbadow@toronto.ca	416-338-1804	called/emailed. Asked for road mortality data in Toronto.	confirmed
	10-16-13 10:08 AM	Chris Loader	Engineer ECS	cloader@toronto.ca	416-392-8331	ret'd email. Asked that Ryerson provide more information for culvert data request. Forwarded email to Jenny Kluge.	confirmed
	10-16-13 10:48 AM	Namrata Shrestha	TRCA	nshrestha@trca.on.ca	416-661-6600 x5782	ret'd email. Said it was finet to invite Vince D'Elia and to also invite Sue Hayes. Proceeded to do so.	confirmed
	10-16-13 12:26 PM	Carl Badow	Supervisor, Toronto Animal Services	cbadow@toronto.ca	416-338-1804	emailed. Sent an excel file of all the animals reported dead in Toronto b/w January 2012 - October 16, 2013.	confirmed
	10-16-13 5:54 PM	Matthew Kerry	Volunteer Communications Assistant, Evergreen	mattkerry81@google.com	none	ret'd email. Said he will send questions.	confirmed
	10-17-13 3:42 PM	Mark Berkovitz	Transportation Services	mberkov@toronto.ca	416-338-5377	ret'd email. Said TRCA can have access to 5-year CWP program. Attached links to website and asked if GIS was needed. Forwarded email to Namrata who requested for GIS. Relayed info back to Mark.	confirmed
	10-18-13 9:44 AM	Nina-Marie Lister	Associate Professor, Ryerson University	nm.lister@ryerson.ca	416-979-5000 x6769	emailed. Asked when she needed City's SSHRC supporting letter by.	confirmed
	2-11-14 4:11 PM	Ted Bowering	Director, Toronto Water	tbowerin@toronto.ca	416-338-5473	emailed. Propsoed to meet with Toronto Water to discuss road ecology.	confirmed
	2-11-14 4:19 PM	Kanchan Maharaj / Mark Berkovitz	Transportation Services	kmaharaj@toronto.ca / mberkov@toronto.ca	416-338-5500 / 416-338-5377	emailed. Thanked for meeting and f/u re: Naz Capano from Operational Planning and Policy Unit. Kanchan discussed with him breifly and put on his radar, she will f/u tomorrow.	confirmed

Project Log

	2-11-14 4:41 PM	Mike Popik	Engineering & Construction Services (ECS)	mpopik@toronto.ca	416-392-8487	emailed. Proposed meeting to discuss short list of 10 candidate locations for pilot study.	confirmed
	3-3-14 10:15 AM	Renata Moraes	Operational Planning and Policy	rmoraes@toronto.ca	416-392-6039	left voicemail. She wanted to talk about GIS data - what's available and what's not.	confirmed
Low	3-3-14 10:49 AM	William Snodgrass	Toronto Water	wsnodgr@toronto.ca	416-392-9746	emailed. F/U: road ecology initiative that was first sent to Ted Bowering and later forwarded to Bill by David Kellershohn	waiting for response
	3-3-14 10:57 AM	Mike Popik	Engineering & Construction Services (ECS)	mpopik@toronto.ca	416-392-8487	emailed. F/U: road ecology initiative pilot project refining 10 strategic locations.	confirmed
	4-17-14 9:18 AM	Vesna Stevanoic-Briatico	Coordinato Transportation Infra Mgmt	vstevan@toronto.ca	416-392-8345	ret'd email. Provided more info on the type of project I am undertaking and what the req'd info will be used for.	confirmed
	4-30-14 1:31 PM	Sue Hayes	Project Manager TRCA	shayes@trca.on.ca	416-661-6600 x.5356	ret'd email. Thanked for the message and called for a meeting either before or after Namrata's return.	confirmed
	4-30-14 2:48 PM	Nina-Marie Lister	Ryerson University	nm.lister@ryerson.ca	416-979-5000 x6769	emailed. Asked if she had students that would be willing to conduct fieldwork for us this year.	confirmed
High	4-30-14 2:53 PM	Kanchan Maharaj	Transportation Services	kmaharaj@toronto.ca	416-338-5500	called. Gave her an update of or situation and aksed her about the rough timeline for MCIC deadlines. She said that June 27/14 deadline is already set, but dates for 2015 will come out at the end of 2014. So F/U then.	follow-up WEEKS
	4-30-14 3:11 PM	Nina-Marie Lister	Ryerson University	nm.lister@ryerson.ca	416-979-5000 x6769	rec'd response. Said that she has 1 or 2 students for fieldwork in mind. Call her on Monday after site visist to arrange in-person meeting to discuss scope of work and logistics.	confirmed

Appendix B

Meeting Notes

Date: October 1st, 2013

Time: 13:00 - 14:00

Location: Metro Hall Chief Planner's Board Room

Attendees: Nina-Marie Lister, Jessica Yuan, Kelly Snow, Melissa K. Yu, David Stonehouse, Marta Brocki, Jeremy Guth, Stewart Chisholm

Re: XING, Road Ecology - Partnership meeting

MEETING AGENDA/OBJECTIVES

- Discuss shared interest in road ecology and landscape connectivity work:
 - o Share our research and work to-date
 - o Discuss potential to partner for a pilot project or other initiative together
- XING exhibit: part of a bi-national effort through ARC Solutions/Evergreen/US partners to educate, innovate and advocate for road ecology and wildlife crossing infrastructure
- City of Toronto: bringing awareness and policy tools into Transportation and Planning initiatives at the City
- Proposition: City of T.O. Environmental Planning team become a partner in the SSHRC grant application for \$300K to build a cross-country network in this context (Submission November 2013)

CITY'S BRIEF PRESENTATION ON PROJECT

1. Introductions
2. Present the meeting package
3. When project started
4. Goal's that still stand today (read obj. from Alissa's notes)
5. Accomplishments to-date
 - a. Mapping tool
 - b. Engineering students
 - c. Since August collecting more data to update the map
6. Barriers we are facing:
 - a. **Budget.** (it's hard to be taken seriously when dealing with a topic that's so foreign to most dept. but even harder to be taken seriously when we tell them that we have no money)...but obviously we're not letting that stop us from doing what we think should be done
 - b. **Time.** (Mention the timeline that was included in the package). Included timeline because this impacts 3 big things: timeframe, design, budget
 - c. **Fieldwork Expertise.** We have been set back a bit b/c we don't have the resources and knowledge to go out and conduct fieldwork

QUESTIONS

Q: Cross country network? What does this entail?

Q: In terms of the SSHRC grant what opportunities does this partnership open up?

CONTACTS

Nina-Marie Lister, Associate Professor Ryerson University nm.lister@ryerson.ca

Jessica Yuan, Graduate City of Toronto, jyuan@toronto.ca 416-392-4766

Kelly Snow, Planner City of Toronto, ksnow@toronto.ca 416-392-4787

Melissa K. Yu, Project Manager Evergreen Brickworks myu@evergreen.ca 416-596-1495 x310

David Stonehouse, General Manager Evergreen Brickworks dstonehouse@evergreen.ca

Marta Brocki, Undergrad Ryerson University mbrocki@ryerson.ca

Jeremy Guth, ARC Solutions jeremyguth@me.com

Stewart Chisholm, Director Evergreen Brickworks stewartc@evergreen.ca

----- End of meeting notes -----

Date: September 25, 2013

Time: 13:00 - 13:30

Location: Evergreen Brickworks "XING Exhibit"

Attendees: Jessica Yuan, Melissa Yu

Re: XING Exhibit & Partnership Opportunities with T.O.

MEETING AGENDA/OBJECTIVES

1. Explore XING Exhibit

- When did the project begin
- What was the impetus for the project
- Goal of the project
- Project partners and roles
- Focus location

NOTES

Main Partners

- Evergreen
- ARC (Animal Road Crossing)
- Ryerson University
- Calgary Creative City Collaboration (C4)
 - o C4-yyc.tumblr.com
 - o Will be presenting similar exhibit in Calgary 2014

Precedents on Display

- Highway 69 (2011)
 - o MTO built 3 crossings and 10 km of continuous fencing
 - o Eco Kare (Kari Gunson) monitoring effectiveness on behalf of MTO
- Long Point Causeway (citizen-led project)
 - o Target species: Amphibians and Reptiles
 - o 3 ecopassages
 - o 4 km of fencing

Funding

- **ARC** - most of the funding provided through ARC
- **Evergreen** - through donation of viewing space, projectors and other resources for exhibit

Partnership possibility

- Evergreen would gladly partner with City of Toronto as long as the project pertains to the Lower Don River
 - o So, there is potential for a Pottery Road Pilot study
- Melissa suggested to contact [Parks and Forestry](#) because they are currently working on a proposal to install a Pottery Road Biking Bridge that will connect the Don Trail and Pottery Road across the railway tracks
- Melissa suggested to contact [Nina-Marie Lister @ Ryerson](#) about more information on the XING / ARC project and possible partnership opportunities

Next Steps:

- Contact [Nina-Marie](#)
- Melissa will provide: (1) Lower Don Community Consultation & (2) Garth Armour PFR

CONTACTS

Jessica Yuan, Environmental Planning jyuan@toronto.ca 2-4766

Melissa Yu, Project Manager Evergreen Brickworks myu@evergreen.ca 416-596-1495 x310

----- End of meeting notes -----

Date: September 20, 2013

Time: 10:00 - 10:30

Location: City Hall 19 East Tower

Attendees: Jessica Yuan, Lara Tarlo

Re: Road Ecology Meeting: Preparing Scope for workshop October 16, 2013 and MCIC

MEETING AGENDA/OBJECTIVES

1. RE Project

- When - 2011 to Present
- Where - City of Toronto (urban setting)
- What - Accomplishments to-date
- Why - Reasons for meeting

2. Goal of Project

- Increase awareness of biodiversity conservation in the City
- Mitigate the number of wildlife casualties (amphibians and reptiles) due to roads
- Improve hydraulic and wildlife connections
- Develop permanent policy/protocol to be integrated into major infrastructure operations
 - o To be considered throughout the development process

3. Questions

Q: How to get onto PINs circulation

Q: Approx. timeline from before pins are circulated → submission of scope from city planning → approval of submissions → final decisions before construction → breaking ground

Q: Funding

NOTES

(+) News:

- Chance to squeeze our project into urban design budget in 2014
- Work towards submitting scope and mapping in new year 2014 January

(-) News:

- Go back and work on the "Pitch", "Details", "Justification"
- Leave technical mapping until you have dept. attention

Plan of Action:

- Work on presentation focusing on:
 - o Justification/rationale/hard facts & #s/Case studies/Precedents/Other examples from different countries
 - o Background analysis
 - o Cost for materials & Labour → talk to Kimmo and other dept. to get samples
 - o Scope of Work, Design of the project
- Try to partner with Evergreen to cultivate knowledge among public and agencies, maybe initiate a funding project through the pilot study
- Convince and get comments from Toronto Water b/c the culverts will most likely affect underground pipes. Contact: **Katherine Crowther (Sr. Engineer)** kcrowth@toronto.ca 2-7695 and **Patrick Cheung (Sr. Engineer)** pcheung2@toronto.ca 2-7702

- If the project is utility based, then we need to go through Toronto Public Capital Utility Coordination to get approval
- Look into human-vehicle collisions to see their process of implementing mitigation measures
- Try to find locations from 2016-2019 CWP in line with Urban Design
- Mapping Def'n: Linear (street or section of a road) / Point (Usually intersection, focal spot)
- Alissa has submission dates for scope of work and mapping

CONTACTS

Jessica Yuan, Environmental Planning jyuan@toronto.ca 2-4766
Lara Tarlo, Urban Design ltarlo@toronto.ca 8-1132

----- End of meeting notes -----

Date: August 27, 2013

Time: 13:30 - 14:30

Location: Telephone Meeting

Attendees: Alissa Park, Jessica Yuan

Re: "Road Ecology Protocols" & Next Steps

MEETING AGENDA/OBJECTIVES

1. Talk about the project

- When it began
- The goals
- What has been done
- Why we need her help

2. Objectives

- Increase awareness of biodiversity conservation in the City
- Mitigate the number of wildlife casualties (amphibians and reptiles) due to roads
- Improve hydraulic and wildlife connections
- Develop permanent policy/protocol to be integrated into major infrastructure operations
- To be considered throughout the development process
- Ex. Toronto Green Standard (TGS) where new planning applications are required to comply with the measures

QUESTIONS

Q: How to get onto PINs circulation?

- Work is now being done for 2013-2018 programs...too late for 2013/2014 programs
- Intake 2015 programs as of March 2013. Scope...Technical reviews.
- shp. file → **Constr_con TS** (technical services/linear infra)
- **TR-RO** ("Transportation Road operations") - these don't require design b/c replacing curb, resurface roadway
- **ECS** ("Engineering and Construction Services") part of "**PP**" Planning and Programming
- PP - There are different project managers in charge of each district
- Funding*** \$10,000

Q: Approx. timeline from before pins are circulated → submission of scope from city planning → approval of submissions → final decisions before construction → breaking ground.

- PINs are ready & circulated in Spring (March or May each year)

1. Agencies receive Transportation CWP 5-year File-Assessment. They assess constructions projects they are interested in. Ex// Steeles from Markham to Nelson can

2. Scope of Work-Prepare. They prepare detailed scope of work to be added to the CWP.
Format. All details are maintained in shp. file format throughout process. (MCIC in process of transitioning to Automated processes). **Follow** Toronto line information.
Meet the standard template

3. Assign delivery group. **Engineering team**.

4. Delivery date

5. MCIC enters info into PTP ("Project Tracking Portal")

6. Work assigned to appropriate engineering services

Key Terms

Bundling project (adding additional scope)

Program owner (agency wishing to add scope to the CWP)

ECS (Engineering and Construction Services)

PP (Planning and Programming)

Rough Timeline

Working Group Meetings are scheduled 5 times a year

Meet with Lara Tarlo (8-1132) for PINs and how to prepare scope of work reports

October 16, 2013 the next working group meeting

FOR 2015 PROGRAMS

May 2013 - PP circulate PINs in May 2013 PINs for 2015 programs

September/October 2013 - Closing dates for comments

Early 2014 to end of year - PP provides all planning programming to delivery groups.
Start designing.

Early 2015 to end of year - Construction begins and ends.

Q: How much wiggle space does Transportation have in terms of budget for constructions?

- None. City council to get policy change to get funding

Q: If she says that protocols can be implemented ONLY if there is money flow through other means, than ask how much it would cost for labour if the materials and installation process are already provided.

CONTACTS

Alissa Park, MCIC apark@toronto.ca 7-0787

Jessica Yuan, City Planning jyuan@toronto.ca 2-4766

----- End of meeting notes -----

Appendix C

SSHRC Letter of Engagement
& Ryerson Award Letter of Support

November 26, 2013

Prof. Nina-Marie Lister,
Associate Professor
School of Urban + Regional Planning
Ryerson University
350 Victoria Street, SBB432
Toronto, Ontario M5B 2K3
416.979.5000 ext. 6769
nm.lister@ryerson.ca

**SSHRC Partnership Grant – Letter of Engagement
City of Toronto Partnership Agreement**

Dear Professor Lister,

On behalf of the City of Toronto's Environmental Planning Section, I would like to express my commitment to our newly established partnership in support of the advancement of the *ARC – Animal Road Crossings for a Linked Landscape* collaborative project. The objectives and methodologies that you propose in your partnership grant application to the Social Sciences and Humanities Research Council of Canada, are clearly delivered and prove to be in alignment with our current initiative. On a broader level, your proposal strongly promotes the visions of City Planning as captured in the City of Toronto's Official Plan. I am therefore in full support of your research endeavours and look forward to building on our working relationship throughout the course of the project.

The City of Toronto's Environmental Planning team is responsible for building a liveable, sustainable and inclusive city through excellence in planning and influential policy. Since issues of environmental sustainability are inherently interdisciplinary, we work collaboratively with Council, other City Agencies and Divisions, and members of the public in formulating and implementing environmental policies in light of development in Toronto. This collaborative spirit is further captured in our City Planning Division call to action statement: *Planning a Great City Together!*

Environmental Planning is actively engaged in a wide-range of environmental projects at a variety of scales. Our current project: *The City of Toronto Road Ecology Initiative* began in 2011. The primary goal of this project is to develop road ecology protocols that can be used for the planning and design of wildlife crossing structures and their associated measures (e.g. fencing) that facilitate the safe movement of amphibians and reptiles across roads with the Toronto area. The final outcome of our work is intended to be used by Technical services Transportation, Engineering, and City Planning departments responsible for planning, designing,

and implementing major road re-construction/re-surfacing projects. This document will also help other stakeholders and advocacy groups foster discussions with agencies in regards to reducing vehicle-wildlife fatalities and improving habitat connectivity within urban settings. To date, the team's main accomplishment has been the development of a mapping tool that locates hot spots within the City of Toronto where species are most likely threatened by roads.

We are thrilled by the shared interest we have in road ecology and landscape connectivity and look forward to the resulting conceptual designs for wildlife passageways that will emerge from ARC's "Ecological Design Labs". We are confident that the collection of data, infrastructural design concepts and municipal implementation strategies will contribute to the design phases of our project and overall framework of our final protocol document. Furthermore, we look forward to the longer-term goal in which our combined research will develop into a pilot mitigation planning design study in a set of carefully chosen locations in the City of Toronto. We anticipate that as our partnership matures, we will realise a pilot study that will serve as a testing site for long-term field work, design implementation, construction and monitoring strategies, leading to broad-scale planning and policy changes to support landscape connectivity. It will also fulfill our secondary goal of raising awareness of the impact roads and vehicles have on the natural environment and wildlife mobility, while engaging the public and decision makers to be part of both the dialogue and the solution of landscape connectivity at a municipal level.

In support of ARC's Ecological Design Labs, we are prepared to provide in-kind contributions which will take the form of:

- Access to proprietary spatial data—including access to new data to contribute to the road ecology mapping tool—from various City of Toronto Divisions (\$100/data request; with an estimate of 5 requests per year or 10 requests over the life of the project);
- Meeting room use (\$1,000/year or \$2,000 over the life of the project);
- Program staffing, including project-specific management and coordination assistance (\$2,000 of in-house staff time over the life of the project)
- **Total value of our in-kind contribution = \$5000.**

I look forward to the years ahead of work with you and your team in moving this project forward.

Sincerely,



Kelly Snow
Environmental Planner
Zoning Bylaw and Environmental Planning
City Planning Division

January 30, 2014

To Whom It May Concern,

I am writing today to endorse Professor Nina-Marie Lister's nomination for Ryerson's Knowledge Mobilization & Social Engagement Award based on her outstanding work in furthering the discourse of sustainability through means of creative collaboration that radiates beyond the University and contributes to shaping evidence-based policy and practice.

The City of Toronto's Environmental Planning team is responsible for building a liveable, sustainable and inclusive city through excellence in planning and influential policy. Since issues of environmental sustainability are inherently interdisciplinary, we work collaboratively with Council, other City Agencies and Divisions, and members of the public in formulating and implementing environmental policies in light of development in Toronto. This collaborative spirit is further captured in our City Planning Division call to action statement: *Planning a Great City TOgether!*

Environmental Planning is actively engaged in a wide-range of environmental projects at a variety of scales. Our current project: *The City of Toronto Road Ecology Initiative* began in 2011 as a mapping project to locate hotspots within the city where amphibian and reptile species were most likely threatened by roads. Our mapping tool is the first advancement of road ecology in Ontario at a municipal level, and its success is evidenced in its application towards determination of an appropriate study site for a pilot mitigation design, conducted by engineering students from the University of Waterloo under the supervision of Kari Gunson of Eco-Kare International.

Since then, our commitment over the years has evoked an overarching goal of developing road ecology protocols that can be used for the planning and design of wildlife crossing structures and their associated measures (e.g. fencing) that facilitate the safe movement of amphibians and reptiles across roads with the Toronto area. The final outcome of our work is intended to be used by Technical services, Transportation, Engineering, and City Planning departments responsible for planning, designing, and implementing major road re-construction/re-surfacing projects. This document will also help other stakeholders and advocacy groups foster discussions with agencies in regards to reducing vehicle-wildlife fatalities and improving habitat connectivity within urban settings.

We are thrilled by the shared interest we have in road ecology and landscape connectivity and look forward to the resulting conceptual designs for wildlife passageways that will emerge from Professor Lister's research through ARC Solutions. We are confident that the collection of data, infrastructural design concepts and municipal implementation strategies resulting from our partnership will aid in the improvement and validation of our mapping tool through the identification of road mortality hotspots and form the basis for the development, implementation and evaluation of direct mitigation measures for amphibians and reptiles. Collectively, these

goals and objectives are instrumental to the design phases of our project and overall framework of our final protocol document. Furthermore, we look forward to the longer-term goal in which our combined research will develop into a pilot mitigation planning design study in a set of carefully chosen locations in the City of Toronto. We anticipate that as our partnership matures, we will realise a pilot study that will serve as a testing site for long-term field work, design implementation, construction and monitoring strategies, leading to broad-scale planning and policy changes to support landscape connectivity. It will also fulfill our secondary goal of delivering communication and education programs to raise awareness of the impact roads and vehicles have on the natural environment and wildlife mobility, while engaging the public and decision makers to be part of both the dialogue and the solution of landscape connectivity at a municipal level.

The work being conducted by the nominee unquestionably merits recognition. In many ways, the value of their contribution to both academic and professional practice, and their continued commitment to the expansion and transfer of knowledge through creative collaboration, complements and far exceeds the Award's objectives. There is no doubt in my mind that Professor Lister is highly deserving of the honour and opportunity bestowed by the Knowledge Mobilization & Social Engagement Award.

Thank you for your time and consideration.

Sincerely,

A handwritten signature in blue ink, consisting of a stylized 'J' and 'A' followed by a horizontal line.

Joe D'Abramo
Acting Director
Zoning Bylaw and Environmental Planning
City Planning Division

Appendix D
Technical Memorandum

Ecopassages Design Options

Sewells Rd.

Prepared for

Transportation Services
City of Toronto

– and –

GHD Inc.

Prepared by

Jessica Yuan
Environmental Planning
City of Toronto

– and –

Marta Brocki
Ryerson University

June 4, 2014

Via E-mail: kmaharaj@toronto.ca

Kanchan Maharaj, P. Eng.
Transportation Services
Asset Management & Programming
Toronto City Hall
100 Queen Street West, Floor 22E
Toronto, ON M5H 2N2

Dear Ms. Maharaj,

Re: Ecopassages Design Options: Sewells Road Road Resurfacing

Further to our meeting on May 30th, 2014, we are pleased to submit design options for wildlife passages to be installed at "hot spots" within the boundaries of the Sewells Road road resurfacing project.

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned.

Sincerely,

Marta Brocki
mbrocki@ryerson.ca
416-556-6129 (C)

Jessica Yuan
jyuan@toronto.ca
416-397-5616 (O)
416-568-5377 (C)

Encls.

cc: GHD, Jeff Dunlop, P. Eng. Project Manager - Roads & Bridges
City of Toronto, Thomas Yeung, P. Eng. Project Engineer
Rouge Park, Maria Papoulias, Manager
Parks Canada, Richard Scott, Sr. Planner
TRCA, Namrata Shrestha, Landscape Ecologist
Ryerson University, Nina-Marie Lister, Associate Professor
ARC Solutions, Jeremy Guth, ARC Steering Committee - Founding Sponsor

Executive Summary

Background

At the May 30, 2014 meeting, Transportation Services and GHD Inc. requested that staff prepare an Ecopassage Design Options Report detailing alternative design specifications for up to three (3) additional road crossing interventions—targeted at amphibians, reptiles and small mammals—to be installed at “hot spots” within the bounds of the Sewells Road project. Interventions were to be presented in order of feasibility and efficacy for the improvement of wildlife mobility across this roadway, while observing the City of Toronto’s objectives of addressing the area’s poor drainage conditions.

Alternative Design Considerations

A number of site-scale factors were identified and discussed at the May 30, 2014 meeting that pose constraints and limitations to the design and placement of safe wildlife passages (or “ecopassages”). These factors, which include, but are not limited to: existing gas pipelines; hydro corridors; load-bearing capacity; and archaeologically sensitive areas, have been taken into account when locating recommended sites for the installation of crossings.

For the purposes of this particular report, the following alternative ecopassages were considered:

1. Corrugated Steel Pipe-Arch or Circular (CSP) culvert ecopassage
2. ACO Climate Tunnel (solid top) KT 500 under road
3. Concrete box culvert ecopassage

The following alternatives were given consideration, but deemed unfeasible after extensive deliberation among decision-makers:

1. Bottomless CSP culvert ecopassage
2. ACO Climate Slit Tunnel (installed flush with road surface)

The primary objectives of this document include:

- Evaluate and rank the priority of road segments, for up to three additional tunnel structures aimed at reducing wildlife-vehicle collisions (WVC);
- Make recommendations for mitigation measures (i.e., materials and dimensions) based on secondary literature review and accessible primary sources;
- Provide a feasibility cost estimate – an accurate forecast of completion cost for provisional work being requested; and

- Provide detailed precedent design drawings of wildlife tunnels.

Ecopassage Recommendations Summary

	Option 1	Option 2	Option 3
Type	Circular Culvert	Pre-cast Solid Top Tunnel	Precast Concrete Culvert
Shape	Circular or Arch	Rectangular	Rectangular
Material	metal corrugated, steel (lined with sandy substrate)	Polymer Concrete ACO Climate Tunnel KT500	Prefabricated concrete
Suggested Contact Person	David J Penny Executive Director Corrugated Steel Pipe Institute 652 Bishop St. N Unit 2A Cambridge ON N3H 4V6 Direct: 519-212-1252 Tel: 519-650-8080 Fax: 519 650-8081 djpenny@cspi.ca www.cspi.ca	Jonathan Donaldson Sales Representative, ACO	
Cost Estimate	IDEAL: ~\$10,505 INTERMEDIATE: \$5112 MINIMUM: \$978 – 1,757	\$9,495.68	\$15,114
Estimate Source	CSPI & Armtec	ACO	Hanson Pipe and Precast
Number of Passages Proposed	3	1	1
Notes		Delivery time: 8 - 10 weeks (from time of order to on-site delivery)	

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1.0 Amphibian Ecopassage Design Specifications

1.1 Option 1: Corrugated Steel Piping (CSP)

Corrugated steel piping has been identified as a cost effective option for underpass construction. The wide range of standardized sizes available allows for the adjustment of culvert size based on site specifications as well as engineering and financial constraints.

In contrast to other mitigation options outlined in this report, the comparatively low cost of corrugated steel piping could allow for the installation of more than one culvert within the study area. Research on road crossing solutions for amphibians and reptiles is still in its early stages and the installation of multiple culvert types (ie. both circular and arch culverts) would allow for a broadened understanding of target species use of crossings during post-implementation monitoring.

1.1.1 Recommended Culvert Dimensions

Three options for culvert size have been provided:

IDEAL: 1880 x 1260mm Arch Pipe Culvert **OR** 1500mm - 1800mm Circular Culvert

INTERMEDIATE: 1390 x 970mm Arch Pipe Culvert **OR** 1000-1200mm Circular Culvert

MINIMUM: 300mm - 600mm Circular Culvert

Recommendation Priority	Description	Unit Length (cm)	\$/unit	# of units	Total Cost (CAD\$) 13% HST not incl.
Ideal	1880 x 1260mm Arch Pipe Culvert *Preferred	100	350.16	30	10,505
	1500mm - 1800mm Circular Culvert	100	196.39 -- 226.45	30	5891 -- 6794
Intermediate	1390mm x 970mm Arch Pipe Culvert *Preferred	100	\$170.40	30	5112
	1000mm - 1200mm Circular Culvert	100	99.65 -- 138.57	30	2,990 -- 4,157
Minimum	300mm - 600mm Circular Culvert	100	32.59 -- 58.59	30	977 -- 1,757

(# of units is estimated based on 3 culverts installed with up to 10m of pipe/tunnel needed to span width of roadway.)

Given that incorporating a slotted upper surface in the culvert design to mediate climate within the ecopassage will not be possible, due to concerns around road salt and the resulting runoff, a large diameter culvert would provide greatest opportunity for light, heat, and moisture to enter thereby increasing efficacy of the ecopassage.

A pipe arch culvert provides a wide base for the insertion of substrate necessary to provide a continuous travel surface between the outside and inside of the culvert and is preferable to a circular culvert with similar cross-section area (see below). Circular culverts should be considered only if the installation of arch pipe culverts is not possible.

Depending on engineering constraints, culvert sizes that fall between those listed above (for example, 1630 x 1130mm arch-pipe) should be pursued to maximize culvert size.

1.1.2 Rationale for Proposed Culvert Size

Openness ratio (OR) is a measure of culvert length in relation to culvert cross-section area (see figure below). A sufficient OR is necessary to provide for light permeability and to ensure climate regulation within the culvert. The optimal OR for mitigation targeted at amphibians and reptiles is ≥ 0.25 (Ecoplans Limited, 2008). However, this recommendation has been difficult to adhere to in past cases due to feasibility and landscape constraints. In the case of a 7m tunnel a minimum of 1500mm diameter circular culvert would be recommended to achieve this target and a larger diameter would maintain ideal OR following the addition of substrate necessary to mitigate climate within the culvert (see section 2.1). More conservative recommendations suggest a minimum culvert diameter of 975mm for tunnels less than 20m long (Table 1).

Several local precedents suggest that smaller culverts (200mm - 600mm) have exhibited some efficacy in mitigating amphibian and/or reptile road crossings. For instance, Glista, DeVault and DeWoody (2009), concluded in their study that while large diameter ecopassages were frequented by mammals, the rate of usage was not extended to amphibians. Should a larger culvert be impossible to install a smaller scale replacement of existing culverts and installation of additional circular culverts should be pursued.

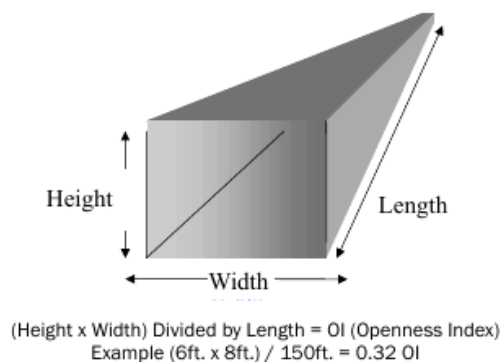


Figure 1. Illustrated description of Openness Ratio (OR) (Brudin, Carl O. III., 2003)

Table 1: Minimum Culvert Dimensions for Effective Amphibian & Reptile Mitigation

Tunnel length (ft)	< 65	65-100	100-130	130-165	165-200
Rectangular Culvert Dimensions	3.2 x 2.5 (ft) 975 x 762 (mm)	5.0 x 3.2	5.75 x 4.0	6.5 x 5.0	7.5 x 5.75
Circular Culvert Diameter	3.2 (ft) 975 (mm)	4.5	5.25	6.5	8.0

Source: WTI, 2011, pg. 161

1.2 Option 2: Pre-Case Solid Top Tunnel

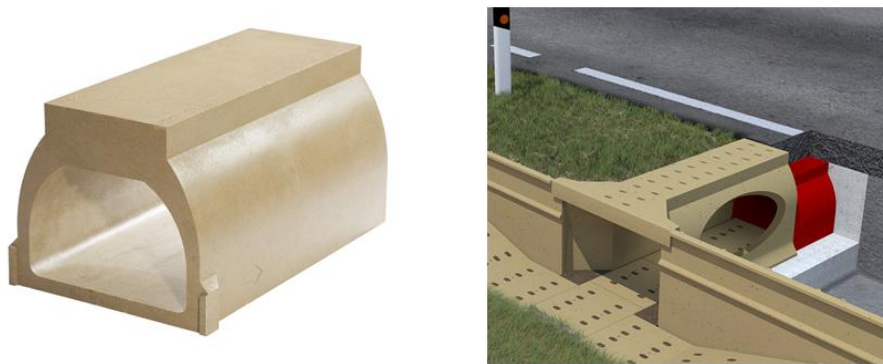


Figure 2: ACO Climate Tunnel (solid top) KT 500 (ACO Systems Ltd., n.d.)

1.2.1 Cost

Table 2: ACO Climate Tunnel (Solid top) KT 500

Description	Length (cm)	Width overall (cm)	Height overall (cm)	List price (CAD\$)
Wildlife Climate Tunnel (solid top)	100	63	52	750.00
Wildlife one-way fence panel (optional) - \$44 (each) • Including fence post (chisel point) • Nails	105	52.5	44	51.00
Fence post (chisel point) • 45cm of post driven into ground • 40cm of post above ground	40	40	85	5.00
Fence nails (20 nails per bag)				12.00
Climate tunnel entrance KP 1000-700 (optional)	100	100	72	622.84

Source: ACO Systems Ltd

Table 3:¹ Cost estimate for 11 m Wildlife Climate Tunnel + 2 tunnel entrances (2 m) = 13 m

Description	Unit Length (cm)	\$/unit	# of units	Total Cost (CAD\$)
Wildlife Climate Tunnel (solid top) KT 500	100	750	11	8,250.00
Climate tunnel entrance KP 1000-700 (optional)	100	622.84	2	1,245.68
			Total	\$9,495.68 + Applicable Taxes

Source: ACO Systems Ltd.

1.2.2 ACO Products in Canadian Projects

Long point causeway, Norfolk County, Ontario (2012)

Environmental Assessment Report Prepared by:

S. Burnett & Associates Limited

Engineering & Environmental

<http://www.norfolkcounty.ca/download/government/enviro-reports/longpointcauseway/PW%2011-103%20Report%201.pdf>

Waterton Lakes National Park, Alberta (2008)

Barb Johnston, Ecosystem Scientist, Waterton Lakes National Park

Tel: 403-859-5182

Email: barb.johnston@pc.gc.ca

<http://naturevancouver.ca/sites/naturevancouver.ca/VNHS%20files/Amphibian%20Tunnel%20Project.pdf>

Cyprus Lake Road (2012)

Bruce Peninsula National Park

John Haselmayer, Manager of Resource Conservation

Tel: 519-596-2444 x310

<http://www.pc.gc.ca/amnc-nmca/on/fathomfive/ne/news4.aspx>

Recommendation / Proposal Stage:

The Gore Road, Region of Peel

Peel Urban Road Ecology Study

Toronto and Region Conservation Authority (TRCA)

Sue Hayes shayes@trca.on.ca & Namrata Shrestha nshrestha@trca.on.ca

<http://www.peelregion.ca/pw/transportation/environ-assess/pdf-gore-road/6-Appendix-E.pdf>

¹ For official cost quotation, please see Appendix E, *ACO Systems Ltd.*

1.3 Option 3: Concrete Box Culvert

For this application a concrete box culvert 1800 x 900mm in size is recommended.

Table 4: Concrete Box Culvert

Description	Unit Length (cm)	\$/unit	# of units	Total Cost (CAD\$)
Concrete Box Culvert Unit	100	\$1374	11	\$15,114 + Applicable Taxes

2.0 Additional Design Considerations

2.1 Substrate

In order to encourage amphibian movement through culverts, entrances and passageways should be lined with a sandy loam substrate composed of fine crushed stone and sand collected from within the study area. A 0.3m substrate layer is recommended to mediate the effects of culvert material on temperature, moisture, and alkalinity inside.

2.2 Distance between Culverts

A maximum distance of 45 - 107m between tunnels is generally recommended -- guiding walls or fences are funnel-shaped and used to guide amphibians to culvert. Passages

2.3 Guiding Fence Specifications

A guiding wall, or exclusionary fencing, with a minimum height of guiding wall/fence: 0.4 m (0.6 m for some jumping species), is to be used in combination with the ecopassage in order to guide amphibians to culvert openings. Fencing can be permanent or temporary and will be discussed by project partners following the installation of culverts. It should be noted that ACO wildlife fencing (0.5 m high, 1m long), made out of recycled composite, is designed to be a permanent guidance fence, despite its easy install feature (see Appendix E for images of installed fence).

References

- ACO Systems Ltd. (n.d.) *ACO Wildlife*. Retrieved from http://www.aco.co.uk/product_search_results.php?cat_4=&cat_1=30&cat_8=&cat_2=&cat_7=
- Ecoplans Canada. (2008). *Long Point Causeway Improvement Plan*. Prepared for Long Point World Biosphere Foundation. Retrieved from: <http://longpointcauseway.com/library/Long%20Point%20Causeway%20Improvement%20Plan%20April%202008.pdf>
- Brudin, Carl O. III. (2003). Wildlife use of existing culverts and bridges in North Central Pennsylvania. *Road Ecology Center*. UC Davis: Road Ecology Center. Retrieved from: <http://escholarship.org/uc/item/67f406zv>
- Gartner Lee Ltd. (n.d.). *Case Study for a Wildlife Crossing in Muskoka: recommendation to the changes of implementation*. Retrieved from: <http://www.torontozoo.com/pdfs/janas.pdf>
- Koeth, L., Acovski, A., Schimana, M. & Gunson, K. (2012). *Reducing Wildlife Mortality and Improving Hydraulic Connectivity on Sewells Road in Rouge Park, Toronto*.
- Western Transportation Institute (WTI). (2011). *Wildlife Crossing Structure Handbook: Design and Evaluation in North America*. Retrieved from: http://www.westerntransportationinstitute.org/documents/reports/425259_Final_Report_Updated.pdf
- Woltz, H. Gibbs, J., & Ducey, P. (2008). Road crossing structures for amphibians and reptiles: informing design through behavioural analysis. *Biological Conservation*, 141, 2745-2750

Appendices

Appendix A - Bayview Extension - Town of Richmond Hill

5 dedicated amphibian tunnels were installed under the Bayview Avenue extension between Bethesda Side Road and Stouffville Road. Appendix A details the design specifications of crossings implemented in this intervention and includes technical drawings.

Appendix B - Highway 24 - Brantford, Ontario

In 2010 permanent exclusionary fencing was installed along a stretch of Highway 24 at the Mount Pleasant Creek crossing near Brantford, Ontario to direct turtles to an existing culvert along this stretch of roadway. Appendix B provides road cross-sections showing culvert installation as well as formulas used to calculate optimal culvert size for amphibian and reptile mitigation.

Appendix C - Muskoka - Georgian Bay

Appendix C details various design options considered in the implementation of a wildlife crossing in Muskoka. Includes technical drawings and design specifications for four proposed mitigation options as well as the engineering and feasibility constraints associated with each.

Appendix D - Long Point Causeway - Norfolk County, Ontario

Appendix D includes mitigation design and siting plans for the Long Point Causeway which implemented both terrestrial and aquatic passages for amphibians and reptiles. Minimum, typical, and enhanced strategies for road improvement were included, altering the size of culvert required to span the roadway. This source was used as a reference for determining optimal design specifications for spacing and size of culverts.

Appendix E - ACO Systems Ltd.

Attached are design specifications and pricing for an ACO Systems Climate Tunnel mitigation system. Images of installed tunnels and exclusionary fencing are also include

Appendix F – Armtec Ltd.

Attached is pricing for Armtec Ltd. pipe arches and circular culverts as per recommendations described in option one. The numbers are based on typical manufacturing lengths of 6m, but depending on the culvert run lengths required, they can be customized to suit. Prices are based on the minimum CSP wall gauge / thickness as per OPSD 805.010 and 805.020, and are available in larger gauges / thicknesses once specified by the engineers calculations.