



S. BURNETT
& ASSOCIATES LIMITED
ENGINEERING & ENVIRONMENTAL

Report for

Three Wildlife Culverts (Ecopassages) on the Long Point
Causeway between Lakeshore Rd and Erie Blvd, Long Point,
Norfolk County

Environmental Assessment Report



The Corporation of Norfolk County

Prepared by:

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October 2011



October 13, 2011

The Corporation of Norfolk County
183 Main Street of Delhi
Delhi, Ontario
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Attention: John Hamilton P.Eng, Manager of Engineering

Re: Long Point Causeway Ecopassages Environmental Assessment Report

Dear John,

S. Burnnett & Associates Limited was retained to complete an environmental assessment regarding the potential installation of three (3) ecopassages on the Long Point causeway for Norfolk County. The objective of the environmental assessment was to determine a solution to reduce the wildlife mortality and to ensure safe passage for the wildlife. Reconnection of the hydraulic connection between the bay and lake was also presented as an objective in the study and included in this report. This environmental assessment followed the Class EA process identifying potential solutions, analyzing the options and selecting the preferred environmentally sound solution. As discussed with you the next step in this process would be to move forward with the completion of the detailed design for this project.

Please find attached our final report. Thank you for this opportunity to work with Norfolk County. We look forward to assisting with the next steps in the process.

Yours truly,

A handwritten signature in blue ink, appearing to read 'Stephen Burnett', is written over a light blue circular stamp.

Stephen Burnett, P.Eng.

S. Burnnett & Associates Limited

Executive Summary

Background

The Corporation of Norfolk County retained a Consulting Team led by S. Burnett & Associates Ltd (SBA) for providing engineering and environmental services to complete the following document which reports a Class Environmental Assessment (Class EA) study for three (3) wildlife Culverts (Ecopassages) on the Long Point Causeway between Lakeshore Road and Erie Blvd., Long Point, Norfolk County. This report has been prepared in accordance with Municipal Class Environmental Assessment (Municipal Engineers Association, 2007), an approval under the Ontario Environmental Assessment Act for municipal infrastructure.

The project is funded by the efforts of Long Point World Biosphere Reserve Foundation, however due to the fact that the Longpoint Causeway is a County highway; Norfolk County is considered the proponent and is overseeing the project. SBA and the Consulting Team were retained on the basis of the proposal dated November 30, 2010.

Consultation

Opportunities were offered to the public, stakeholder and regulatory agencies to provide input on the development of the Problem Statement, development and evaluation of alternatives and on the selection of the components of the preferred alternative for the Strategy. The process included a Steering Committee Meeting, a Liaison Committee meeting and a Public Information Centre (PIC).

Placement and Density Assessment

AET Consultants and Eco-Kare International worked together to undertake an ecopassage assessment and provide biological, species at risk and geospatial road ecology expertise. As part of the ecopassages assessment, an analysis was completed to determine areas of wildlife-road mortality density (i.e. hotspots) along the Long Point Causeway. A Kernel Density algorithm created in Matlab 7.1 (Mountrakis and Gunson 2009) was used to assess where the highest intensity of herpetofaunal road mortality (hotspots) occurred along the Causeway. This information was utilized to determine the most appropriate location for the proposed ecopassages.

Hydraulic Connection Analysis

C.F. Crozier & Associates Inc. (Crozier) completed a Hydraulic Connection Assessment regarding the location suitability, hydraulic requirements and benefits to re-establish the water passage between the Big Creek Marsh and the Inner Bay. The hydraulic study confirmed the preferred location for the hydraulic ecopassage. This was based on the field observation of the existing road profile of the causeway, historical water depth data and information on both sides of the causeway, and the peak herpetofaunal movement patterns from spring to fall (target season). The study presented the water elevations vs. the duration percentage that it would be submerged or wet during the target season. The study also recommended that wetness and dryness of the hydraulic ecopassage throughout the year be further refined by its invert elevation during the detailed design stage of the project.

Proposed Alternatives

Alternative solutions to the problem/opportunity statement identified and comparatively evaluated were; 1) do nothing, 2) continue with the current silt fence, 3) install a concrete box culvert with funnel fencing, 4) install a steel culvert with funnel fencing, 5) install an open grate pour in place with funnel fencing and 6) head-starting and other turtle reproductive intervention measures.

For the purposes of evaluation, each alternative solution was subject to a systematic evaluation in terms of their advantages and disadvantages under the criteria of environmental impact, social impact, technical considerations and economic feasibility. This was completed to assist with quantifying each alternative for each of the criteria in the evaluation matrix.

Based on the results from the evaluation matrix it was determined that the concrete box culvert with funnel barrier fencing is the preferred solution. In order to verify this result a sensitivity analysis was performed on the evaluation matrix. The results from the sensitivity analysis verified that the concrete box culvert with funnel barrier fencing is the preferred alternative. Review of the alternatives revealed that the open grate culvert with barrier fencing was a close second under all conditions. Given the extensive scientific research currently being undertaken in this field of study it was recommended to install one open grate culvert as one of the terrestrial ecopassage for comparison and monitoring purposes. The other terrestrial passage and the aquatic ecopassage are both recommended as pre-cast concrete box culverts with barrier fencing.

Preliminary Design of Selected Alternative

The ecopassage locations were determined mainly based on the density analysis, however the findings from the hydraulic connection assessment (C.F. Crozier & Associates, 2011), the site investigations and the daily and seasonal movement distances of focal species groups were also used to select the suitable locations. The purpose of considering the site investigation in selecting the ecopassage locations was to avoid existing mature trees, dense stands of Phragmites, buildings and human-made structures, and artificial turtle nests. The purpose of considering the seasonal movement distances of focal species was to ensure that the distances between each ecopassage was not greater than the maximum and mean seasonal movement distance of 240m (rounded to 200m as a precautionary approach).

Three preferred locations for the ecopassages were identified. All three of SBA'S sub-consultant experts (Eco-Kare International, AET Group Inc. and Crozier and Associates) preferred that the wet ecopassage be installed immediately south of the Canadian Wildlife Service office. The ideal locations for the two dry ecopassages were selected by Eco-Kare International and AET Group Inc. The locations were selected based on the analysis described above and because they are adequately spaced so that wildlife will not have to travel more than 200 m to access a safe passage.

The consultant team established the precast concrete box culverts as the preferred ecopassage design for all two of the locations including the aquatic ecopassage. The third location was

recommended as an open grate culvert. It was also recommended that all three ecopassages be connected to each other by permanent barrier fencing placed on either side of the Long Point Causeway.

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1.0 Introduction and Background

1.1 Project Background

The Corporation of Norfolk County retained a Consulting Team led by S. Burnett & Associates Ltd (SBA) for providing engineering and environmental services to complete a Class Environmental Assessment (Class EA) study for three wildlife Culverts (Ecopassages) on the Long Point Causeway. Together with SBA, the Consulting Team includes Crozier & Associates Limited, AET Consultants and EcoKare International. The Consulting Team was retained on the basis of the proposal dated November 30, 2010.

The Long Point World Biosphere Reserve Foundation is dedicated to conserving biodiversity; promoting sustainable communities; and partnering in research, monitoring outreach and education within the Long Point World Biosphere Reserve.

In 2006/2007, the Foundation commissioned the Long Point Causeway Improvement Project Feasibility Study to develop practical short and long term solutions to address the objectives of reducing wildlife road mortality, providing for safe wildlife movement between Big Creek Marsh and Inner Bay, and restoring hydrological connections. The feasibility study was managed by a Steering Committee which included representatives from the Foundation, Bird Studies Canada, the Nature Conservancy of Canada, Parks Canada, the Ontario Ministry of Natural Resources, the Ontario Ministry of Transportation, Norfolk County, the Norfolk Land Stewardship Council, the Long Point Region Conservation Authority, the Upper Thames River Conservation Authority, the Norfolk Field Naturalists, the Long Point Country Chamber of Commerce, the Long Point Anglers Association, the Long Point Waterfowlers' Association, the Toronto Zoo, and the Ruffed Grouse Society as well as three individual citizen members.

Upon completion of this study it was determined that a Schedule "B" Class EA study would be required for the County of Norfolk, the responsible authority for the causeway, for the project to move forward.

1.2 Previous Studies

Studies were previously prepared for the Long Point Causeway Improvement project and have applicability to the issue of the reducing the herptile mortality on Long Point Causeway. The reports are:

- *Temporary Mitigation Plan for the Long Point Causeway Improvement Project: Literature Review*, prepared by Kate England in May, 2009.
- *Road Mortality Monitoring on the Long Point Causeway*, prepared by Bernie Solymar, EarthTramper Consultation Inc in 2008-2010.
- *Long Point Causeway Improvement Plan*, prepared by Ecoplans Limited, April 2008

The Temporary Mitigation Plan report summarizes the peak season of herptile-road mortality identifies at-risk herptile species occurring in the Long Point Causeway and provides literature summaries that recommend construction of roadway barriers to reduce herptile mortality.

The Road Mortality Monitoring report summarizes the number of road-kills per species before and after the implementation of the mitigation methods. These mitigation methods include

temporary silt fencing, escape hatches, artificial turtle nest –Monitoring has recorded a reduction of reptile road-kill of more than fifty percent over the past three years.

The Long Point Causeway Improvement Plan includes recommendations to create an Ecopassage system, restore hydraulic connectivity, wildlife habitat enhancement, enhance the recreational experience, signing for awareness, calm traffic, provide temporary measures and monitor. The Ecopassage system presented in the 2008 Plan included eleven (11) proposed wildlife culverts along the Long Point Causeway. These culverts will provide passages for terrestrial animals to cross the road, and re-establish hydraulic connection to Inner Bay. This EA document is only to establish three (3) potential ecopassages as determined in the Terms of Reference prepared by the County of Norfolk and the Long Point World Biosphere Reserve Foundation.

Other literature studies reviewed were provided in Appendix H.

1.3 History of Issues that Led to the Development of the Problem Statement

The Long Point Causeway (LPC) is a vital community and recreational link that connects Highway 59 (a Norfolk County road) and Port Rowan to the cottage community on Long Point at the head of Long Point Inner Bay on Lake Erie, in Norfolk County. It forms the east edge of the Big Creek Marsh, a 1,200 ha wetland located at the mouth of Big Creek at the head of Inner Bay. The LPC, as a section of Highway 59 has acted as the dividing border that isolates the Big Creek Marsh from the shoreline and nearshore habitat of Inner Bay.

The main effects of LPC on wildlife includes mortality from vehicles and subsequently, greater potential for extirpation (loss of species from a specific geographic area), the restoration of hydrological connectivity, removal and fragmentation of habitat, population isolation, reduced access to food, mating opportunities, nesting sites and hibernation sites. Turtle populations are particularly at risk of decline from road mortality. High rates of mortality can have detrimental and irreversible impacts on turtle populations due to late age of sexual maturity and naturally low annual recruitment due to high rates of egg and juvenile mortality. Although the importance of reptiles and amphibians in an ecosystem is commonly overlooked, they play an essential role as both predator and prey throughout their life cycles. The loss or depletion of reptile and amphibian populations can have far reaching, detrimental effects in both terrestrial and aquatic communities.

The impacts of the causeway on wildlife movement and resultant wildlife mortality are well documented. The Canadian Wildlife Service reports that traffic on the causeway between Port Rowan and Long Point was responsible for over 10,000 wildlife mortalities in 1979 and 1980, including federal and provincial Species at Risk (Ashley and Robinson, 1996). The LPC has been deemed the fifth deadliest road in the world for turtles (Ashley, 2006).

In April 2008, a Long Point Causeway Improvement Plan was completed and recommended eight ways to reduce the wildlife road-kill mortality:

- Create an Ecopassage System
- Restore Hydraulic Connectivity
- Wildlife Habitat Enhancement
- Enhance the Recreational Experience

- Sign for Awareness
- Calm Traffic
- Provide Temporary Measure
- Monitor

1.3.1 Ecopassage System

The Ecopassage System will include ecopassages as well as permanent funnel fencing which will serve to direct wildlife to the ecopassages.

Ecopassages are essentially culverts that provide animals with an alternative to accessing otherwise fragmented habitat. The habitat is fragmented due to the road and the barrier wall used to keep animals off the road. A total of eleven ecopassages were recommended as part of the original study to increase the likelihood of use by the target species and decrease out of way travel. As previously indicated, this EA study is being completed for three ecopassages. The spacing between culverts is based on the mean seasonal reptile movement of 240m, which is rounded to 200m as a precautionary approach. The purpose of the ecopassage is to provide connections between fragmented habitats.

Constructing a funnel fence in conjunction with an ecopassage connection is the most effective long term way to keep wildlife off the road and will therefore directly result in reduced wildlife road mortality.

The development of the passage system was based on detailed road mortality data gathered by the Canadian Wildlife Service over a period of 10 years. This data indicates high mortality rates along the entire length of the causeway which provides a challenge for identifying distinct “hotspots”. There is a slight spatial variation in species killed along the causeway, which has an influence on the proposed ecopassage placement was guided by the preference and behaviour of target species of amphibians and reptiles in different areas of the causeway.

A report completed by Bernie Solymar from 2008 to 2010, Road Mortality Monitoring on the Long Point Causeway, summarizes the wildlife road mortality as presented in Table 1-3.

Table 1: Summary of road-killed amphibians recorded in 2008, 2009 and 2010, compared to counts from 1979-1980 and 1992-1993 (Solymer, 2008-2010)

Common Name	Scientific Name	2010	2009	2008	1993	1992	1980	1979
Northern Leopard Frog	<i>Lithobates pipiens</i>	13	7	375	7,476	445	10,753	9,172
Bullfrog **	<i>Lithobates catesbeianus</i>	14	29	72	154	101	514	576
Green Frog	<i>Lithobates clamitans</i>	3	8	18	10	26	19	12
Gray Treefrog	<i>Hyla versicolor</i>	0	0	1	11	4	0	0
Western Chorus Frog	<i>Pseudacris triseriata</i>	0	0	0	0	0	12	0
American Toad	<i>Anaxyrus americanus</i>	0	0	151	131	83	55	164
SAR Toad		0	0	0	1	0	16	12
Unidentifiable Anuran		15	41	198	34	40	109	104
TOTAL AMPHIBIANS		45	85	815	7,817	699	11,478	10,040
*Species denoted in RED are designated species at risk by COSARO								
**Note that 2009 totals include specimens killed along the causeway prior to the drift fence being erected.								

Table 2: Summary of road-killed reptiles recorded in 2008, 2009 and 2010, compared to data from 1979-1980 and 1992-1993 (Solymer, 2008-2010)

Common Name	Scientific Name	2010	2009**	2008	1993	1992	1980	1979
Painted Turtle	<i>Chrysemys picta marginata</i>	34	39	36	79	93	74	95
SAR Turtle 1		***1	4	0	9	7	0	1
SAR Turtle 2		27	31	96	78	45	74	75
SAR Turtle 3		8	3	3	18	17	7	19
SAR Turtle 4		9	8	11	6	2	5	12
Eastern Gartersnake	<i>Thamnophis sirtalis</i>	30	35	92	32	13	43	26
Northern Watersnake	<i>Nerodia sipedon</i>	0	1	0	2	0	2	4
SAR Snake 1		2	1	8	3	3	13	5
SAR Snake 2		0	0	0	0	0	1	0
SAR Snake 3		2	4	12	1	0	0	0
TOTAL REPTILES		113	126	258	228	180	219	237

*Species denoted in **RED** are designated species at risk by COSARO (endangered, threatened or special concern)

**Note that 2009 totals include specimens killed along the causeway prior to the drift fence being erected.

*** Turtle killed along the causeway prior to the drift fence being erected.

Table 3: Summary of road-killed mammals recorded in 2008, 2009 and 2010 (Solymer, 2008-2010)

Common Name	Scientific Name	2010	2009	2008
Virginia Opossum	<i>Didelphis marsupialis</i>	12	4	3
Star-nosed Mole	<i>Condylura cristata</i>	0	0	2
Little Brown Bat	<i>Myotis lucifugus</i>	1	1	5
Red Bat	<i>Lasiurus borealis</i>	2	0	2
Long-tailed Weasel	<i>Mustela frenata</i>	1	3	1
Short-tailed Weasel	<i>Mustela erminea</i>	0	0	1
American Mink	<i>Mustela vison</i>	2	1	3
Raccoon	<i>Procyon lotor</i>	10	4	11
Deer Mouse	<i>Peromyscus maniculatus</i>	0	0	10
House Mouse	<i>Mus musculus</i>	0	0	4
Unidentified mouse species		15	2	10
N. Short-tailed Shrew	<i>Blarina brevicauda</i>	2	0	0
Meadow Vole	<i>Microtus pennsylvanicus</i>	0	1	1
Eastern Cottontail	<i>Sylvilagus floridanus</i>	5	2	8
Striped Skunk	<i>Mephitis mephitis</i>	0	1	0
Muskrat	<i>Ondatra zibethicus</i>	1	2	0
House Cat	<i>Felis domestica</i>	0	2	0
Unidentifiable mammal		0	1	5
TOTAL MAMMALS**		50	24	66

**Note that 2009 totals include specimens killed along the causeway prior to the drift fence being erected.

1.3.2 Restore Hydraulic Connectivity

Two of the original eleven proposed ecopassages were to restore hydraulic connectivity between Big Creek Marsh and Inner Bay as described in the Long Point Causeway Improvement Plan completed in 2008.

The key ecopassage to re-establish the hydraulic connectivity is located immediately south of the Canadian Wildlife Service office where an existing small corrugated steel pipe culvert has been partially clogged for some time. A larger structure, for example, a larger culvert or bridge, combined with contouring to extend the existing channel and re-establish the open water link through the structure, would allow for a larger volume exchange with the bay, and would also provide for wildlife movement.

Another hydraulic ecopassage opening that could be considered is proposed further south, at the north end of the marina. Dredging would be required in this location to re-establish an open water connection with the bay. Implementation of this option depends on landowner agreement to the design. Maintenance, including possible sediment removal, would be a consideration during design.

This EA process reviewed the potential of re-establishing one hydraulic connection at the location immediately south of the Canadian Wildlife Service office.

1.4 Description of the Class Environmental Assessment Planning Process

The Three Wildlife Culverts (Ecopassages) project is subject to the Province of Ontario's Environmental Assessment (EA) Act. The Class Environmental Assessment process is an approved process under the EA Act for a specific "Class" of projects. Projects are approved subject to compliance with an approved Class EA process.

The County of Norfolk is the proponent for this study. As a municipality, the County is required to follow the process outlined under the Municipal Class Environmental Assessment document which was approved on October 4, 2000 and revised September 6, 2007.

1.4.1 Three Project Classifications / Class EA Schedules

The Class EA classifies the projects into three "schedules" according to their environmental significance:

- **Schedule 'A'** projects are limited in scale, have minimal adverse effects and include the majority of municipal maintenance and operational activities. These projects are approved and may proceed directly to implementation without following the other phases.
- **Schedule 'B'** projects have the potential for some adverse environmental effects. The municipality is required to undertake a screening process (Phases One and Two) involving mandatory contact with directly affected public and relevant review agencies to ensure that they are aware of the project and that their concerns are addressed. Schedule 'B' projects require that a report be prepared and submitted for review by the public and review agencies. If there are no outstanding concerns, then the municipality may proceed to implementation.

- **Schedule 'C'** projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Class EA Document (Phases One to Four). Schedule 'C' projects require that an Environmental Study Report (ESR) be prepared and submitted for review by the public and review agencies. If there are no outstanding concerns, then the municipality may proceed to implementation.

1.4.2 Schedule 'B' Classification

The proposed project was reviewed by the County of Norfolk and their consultant in the preparation of the EA Terms of Reference. The assessment was that the project was a Schedule "B" level project. The proposed project involves the construction of three proposed wildlife culverts ("ecopassages") on the Long Point Causeway (Highway 59 between Lakeshore Road and Erie Boulevard, Long Point, Norfolk County). This project is most similar to sample project 18, "construction of a new culvert or increase culvert size due to change in the drainage area". For this sample project it is designated as Schedule "B" project, with no financial limit. Therefore, no financial limit will be imposed on this project and it will remain designated as Schedule "B" project. This classification and the rationale was also reviewed and confirmed with the MOE EA branch during the initial stages of the EA process. Therefore, the following Planning and Design Phases were carried out for this study:

Phase One: Identify the Problem / Opportunity

This phase involves not only identifying the problem and/or opportunity, but also describing it in sufficient detail to lead to a clear problem / opportunity statement.

Phase Two: Identify and Evaluate Alternative Solutions to the Problem / Opportunity

This phase involves six steps: (1) identify reasonable alternative solutions to the problem/opportunity; (2) prepare a general inventory of the existing natural, social and economic environments in which the project is to occur; (3) identify the net positive and negative effects of each alternative solution including mitigating measures; (4) evaluate the alternative solutions; (5) consult with review agencies and the public to solicit comment and input; and (6) select or confirm the preferred solution.

Since the project was identified as a Schedule "B" project, Phases 3, 4 are not required for the completion of the EA study report. Once the EA is reviewed and considered complete, the project can move to Phase 5 which is the design and implementation phase. The following is a summary of the additional phases required for the completion of a Schedule "C" project.

Phase Three: Identification / Evaluation of the Design Alternatives for Implementing the Preferred Solution

This phase also involves six steps: (1) identify alternative design concepts for implementing the preferred solution; (2) prepare a detailed inventory of the existing natural, social and economic environments; (3) identify the net positive and negative effects of each alternative design concept including mitigating measures; (4) evaluate the alternative design concepts; (5) consult with review agencies and the public to solicit comment and input; and (6) select or confirm the preferred design concept.

Phase Four: Preparation of the Environmental Study Report (ESR)

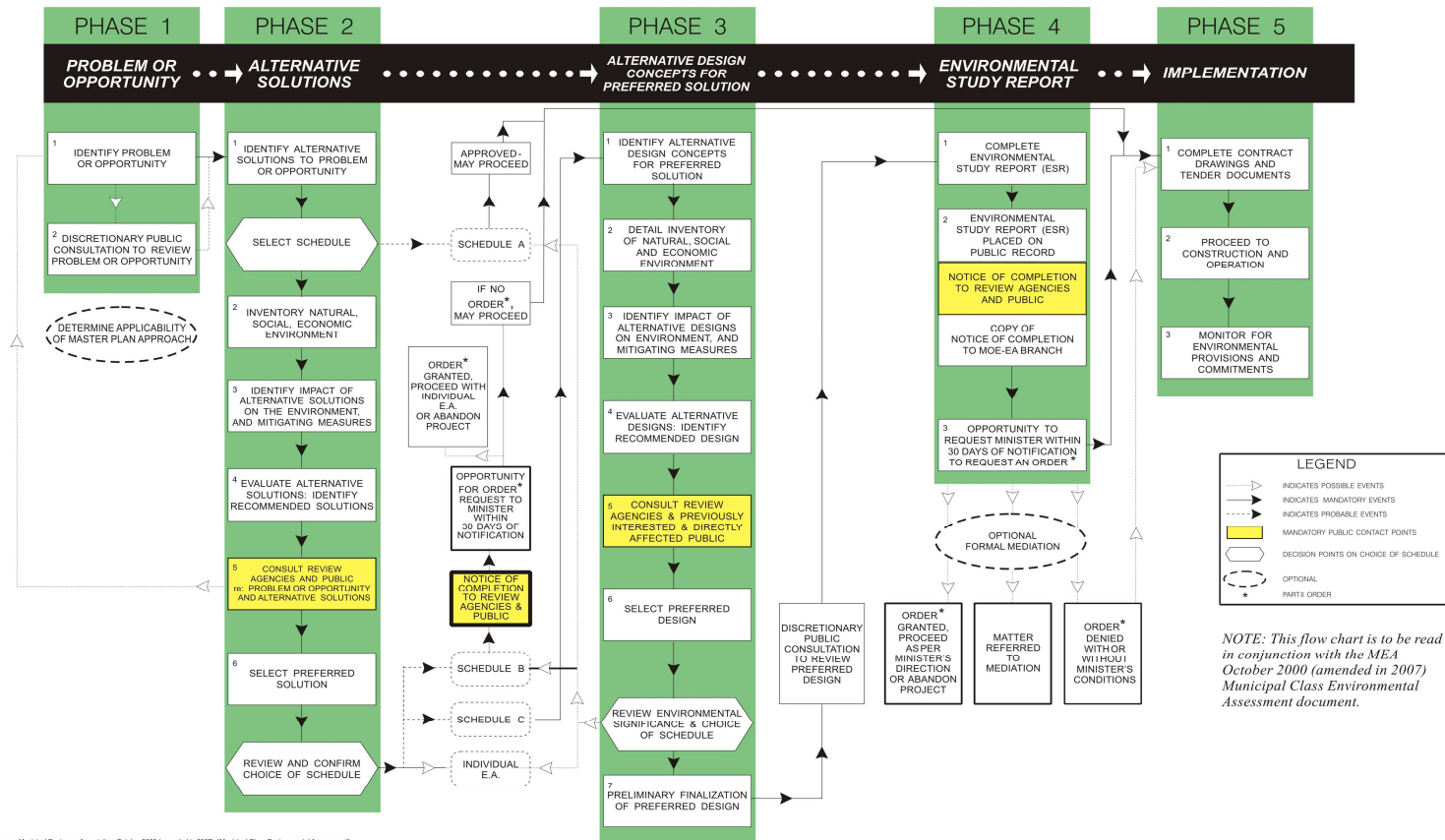
This phase involves the documentation of the three preceding phases in an ESR for review by review agencies and the public. Once completed, the ESR is placed on public record for a period of at least 30 calendar days to allow review agencies and the public an opportunity to review it.

Phase Five: Implementation

This Phase involves the implementation of the project which includes completing drawings and tender packages of the preferred solution and/or design concept and mitigating measures identified during the process. Any monitoring programs identified during the process shall be undertaken to ensure that the environmental provisions and commitments made during the process are fulfilled and effective.

Due to the interest in this study expressed by the residents during the initial public meetings for the three Ecopassages approval on the Long Point Causeway, the consultation program was an important component of the Environmental Assessment Study. In addition to the Notice of Study Commencement, one Steering Committee Meeting was held, one (1) Liaison Committee meeting was held and one formal Public Information Centre was held in the community to share progress and solicit feedback on study findings and recommendations. Figure 1 illustrates the five phases of the Municipal Class EA process which was followed for this project.

MUNICIPAL CLASS EA PLANNING PROCESS AND DESIGN PROCESS



Source: Municipal Engineers Association, October 2000 (amended in 2007), "Municipal Class Environmental Assessment"



Figure 1: Environmental Assessment Planning and Design Process

2.0 Problem Statement

2.1 Description of the Purpose of the Project

The Long Point Causeway (3.6 km roadway) is a vital community and recreational link that connects the mainland to the cottage community on Long Point. Constructed in 1927, the Causeway forms the east edge of the Big Creek Marsh, a 1,200 hectare wetland located at the mouth of Big Creek at the head of Inner Bay.

Long Point is one of the most significant regions for Species at Risk (SAR) in Canada, and in particular, herpetofauna. The wetland provides habitat for the Endangered Spotted Turtle (*Clemmys guttata*), the Threatened Blanding's Turtle (*Emydoidea blandingii*), the Endangered Eastern Fox Snake (*Elaphe vulpine gloydi*), and federally and provincially designated Species of Concern such as the Map Turtle (*Graptemys geographica*) and Eastern Milksnake (*Lampropeltis triangulum*).

There have been frequent road-kill mortalities along the Long Point Causeway (exceeded 10,000 animals in one year), which is rated as one of the highest turtle mortality zones in the world (Ashley and Robinson 1996). Therefore, in 2006/2007, a Long Point Causeway Improvement Project Feasibility Study was commissioned by the Long Point World Biosphere Reserve Foundation to develop practical short and long term solutions to address the objectives of reducing wildlife road mortality, providing for safe wildlife movement between Big Creek Marsh and Inner Bay, and restoring hydrological connections.

Since 2008, Foundation representatives have been securing funding for implementation of the Improvement Plan and follow-up experimental work along the Causeway. In 2010, the Foundation secured funding commitments to continue experimental work, including the installation of three ecopassages under the Causeway with associated wildlife funnel fencing near the south end of the Causeway.

This study will complete a Schedule B Municipal Class Environmental Assessment for the three Ecopassage installations to meet all requirements of the Municipal Class Environmental Assessment (Class EA) process (MEA, 2007).

2.2 Agency and Stakeholder Consultation

Opportunities have been offered to the public, stakeholder and regulatory agencies to provide input on the development of the Problem Statement, development and evaluation of alternatives and on the selection of the components of the preferred alternative for the Strategy. The process included a Steering Committee meeting, Liaison Committee meeting and a Public Information Centre (PIC).

2.2.1 Steering Committee Meeting

The Steering Committee Meeting took place on February 15, 2011 from 7:00 pm to 9:00 pm in the Bird Studies Canada Building. The meeting was attended by the Long Point Causeway Steering Committee, the proponent and SBA, the consultant. The purpose of the meeting was to review the background information collected and prepared on the Long Point Causeway project and to review the Class EA process.

2.2.2 Liaison Committee Meeting

The Liaison Committee Meeting took place on May 17, 2011 from 10:00am to 12:30pm in the Port Rowan Community Centre. The meeting was attended by 39 individuals, including SBA and the project team.

The purpose of the meeting was to solicit options and expertise from all agencies and stakeholder groups prior to the public information centre. The meeting provided a common platform for open discussion to minimize disagreements from all parties. All technical matters would be addressed more appropriately at this venue prior to the public meeting.

The liaison committee meeting was attended by all interested parties as presented below:

- Norfolk County
- Long Point World Biosphere Reserve Foundation
- Bird Studies Canada
- Long Point Region Conservation Authority
- Long Point County Chamber of Commerce
- Long Point Waterfowlers' Association
- Norfolk Field Naturalists
- Norfolk Land Stewardship Council
- Ontario Ministry of Natural Resources – Aylmer District
- Ontario Ministry of Natural Resources – Lake Erie Management Unit
- Upper Thames River Conservation Authority
- Long Point Rate Payers Association
- Municipality of Kitchener – Waterloo
- Ducks Unlimited Canada
- Canadian Wildlife Service
- Friends of the Causeway Association (FOCAS)

The meeting included a presentation to introduce the problem/opportunity statement, the location and proposed alternatives for the project. The alternatives were also presented on a chart, which displayed the advantages and the disadvantages of each of the alternatives. Each of these alternatives was discussed as a group. The individuals who attended the meeting received a copy of the presentation and the advantages/disadvantages chart. The Liaison Committee Meeting Minutes were prepared and circulated to the meeting attendances along with a synopsis that was provided by FOCAS. Provided in appendix B are the list of individuals who were invited, the sign in sheets, the meeting minutes and the handouts from the Liaison meeting.

2.2.3 Public Information Centre

The Public Information Centre (PIC) took place on June 2, 2011 from 5:00pm to 7:00pm in the Port Rowan Community Centre. The PIC was advertised twice in the local newspaper and a formal letter of invitation was sent to all residence that would potentially be affected by construction on the Long Point Causeway, this included each mailing address residence on the causeway and in the Long Point Community.

The PIC was conducted in an open house format. SBA and the project team attended the meeting to answer any questions that were not answered by the 17 boards which were posted

on the walls of the Port Rowan Community Centre. The boards were 2'X3' in size and contained information on the project such as; background information, the EA process, the potential alternatives and the next steps. Specifically 2 of the 17 boards were an advantages and disadvantages chart of the proposed alternatives. In order to receive comments from individuals who did not get their questions answered there were comment sheets available.

Based on the sign in sheet the PIC meeting was attended by 47 individuals. We also obtained 20 comment sheets. Attached in appendix C is the sign in sheets from the PIC, the comment sheets from the PIC and the boards that were presented at the PIC.

2.3 *Development of Problem Statement as a Result of Consultation Process*

Through the consultation process, the Project Team, in collaboration with the Project Steering Committee, developed the following Problem Statement:

“The Long Point Causeway is a vital community and recreational link that connects the mainland to the cottage community on Long Point. The significance of Long Point, Big Creek Marsh and their associated habitat and wildlife is recognized worldwide. Based on monitoring conducted by the Canadian Wildlife Service, wildlife mortality on the Causeway has exceeded 10,000 animals in one year. To address this issue a project to implement three wildlife culverts on the causeway to reduce the wildlife mortality rates has been proposed.”

3.0 Description of Existing Environment

3.1 *Natural Environment*

3.1.1 Bedrock Geology

Long Point is located in the south-western part of St. Lawrence River Platform. A Platform is that part of a continent covered by flat-lying or gently tilted rock and underlain by very ancient rocks consolidated during deformations that preceded deposition of the overlying platform layer. The rocks of the platform layer are usually sedimentary in nature.

The bedrock geology of the area around Long Point Causeway is obtained from Bedrock Geology Map of The Atlas of Canada available at Natural Resources Canada's website. The map shows that bedrock in the local region is classified as Paleozoic Sedimentary and Volcanic rocks, which consist of shale, limestone, dolomite; conglomerate, sandstone; volcanic rocks; salt; oil and natural gas.

3.1.2 Physiography

The physiography of the Long Point area is described in the Physiography Regions of Southern Ontario of The Atlas of Canada available at Natural Resources Canada's website. Long Point Causeway is located in Long Point, and connects the point to the main land. The area is characterized by marshes and swamps. Long Point Causeway forms the east edge of the Big Creek Marsh, a 1,200 ha wetland located at the mouth of Big Creek at the head of Inner Bay.

Long Point is located on the north shore of Lake Erie, and is about 40km long and is about a kilometer across at its widest point. It is an outstanding example of sand dune and sand-spit formation in the Great Lakes region.

3.1.3 Topography and Drainage

Long Point Causeway is located on the northern shore of Lake Erie, at Great Lakes lowlands of St. Lawrence River. The land elevation is approximately 571 feet above sea level (amsl). The surrounding lands consist of watersheds of secondary river basins of St. Lawrence River.

Soils around this area are classified as grey brown podzolic soils with dark grey gleisolic soils, which contribute to approximately a total of 18,200 sq. miles of area coverage in the province of Ontario. The region is classified under Extinct Glacial Lakes (Maximum extent, not all contemporaneous) and consists of stratified deposits of clay, silt, sand and gravel.

3.1.4 Wetland

The region is an important location for bird migration in both spring and autumn, including half of the eastern North American Tundra Swan population. The region is a major staging area for many breeds of waterfowl.

"Long Point itself is one of the most important wetland complexes for migrating waterfowl in southern Canada, and is reported to receive the highest waterfowl use (based on numbers of waterfowl days during spring and fall migration) of any area on the Great Lakes (approximately 4 million days per year). Up to 30,000 Tundra Swans pass through the area in spring, and up to 8% of the world's Canvasbacks congregate in the area on any one day during spring and fall" according to a report by the Long Point World Biosphere Reserve.

In 1960, Long Point Bird Observatory was established to monitor migrant birds on the Point. It is North American's oldest bird observatory. In 1998, as a result of a growing national focus, the organization was renamed Bird Studies Canada. Its national headquarters overlooks Long Point Inner Bay on the western limits of Port Rowan.

3.1.5 Climate

Climate sculpts the landscape through heat, cold, humidity, light and wind. In Canada, the variety of landscapes shows the diversity of our climate. Around the Great lakes and alongside the St. Lawrence River, the climate is characterized by relatively warm summers and cool winters, moderated by surrounding water bodies. These conditions are suitable to the development of mixed wood and broadleaf forests. Some typical weather conditions are obtained from the Atlas of Canada Climate maps from Natural Resources Canada's website (www.nrcan.ca). Table 4 provides a summary of the typical local climate conditions.

Table 4: Long Point Causeway Climate Conditions (www.nrcan.ca)

Climate Parameters	Climate Conditions
Annual Precipitation	
Mean Annual Total Precipitation	34 Inches
Climate Regions	
Climate Region	Humid Continental, Cool Summer, No Dry Season
Frost	
Mean Annual Frost	160 Days
Growing Seasons	
Mean Annual Length of Growing Season	210 Days
Mean Annual Number of Degree Days Above 42°F	400 0 Degree Days
Precipitation Days and Precipitation Variability	
Mean Growing Season Precipitation	13.5 Inches
Variability of Growing Season Precipitation	25%
Seasonal Precipitation	
Mean Spring Precipitation (March to May)	8 Inches
Mean Summer Precipitation (June to August)	8 Inches
Mean Fall Precipitation (September to November)	8 Inches
Mean Winter Precipitation (December to February)	8 Inches
Seasonal Temperature	
January Mean Daily Temperature	25°F
April Mean Daily Temperature	45°F
July Mean Daily Temperature	70°F
October Mean Daily Temperature	50°F
Snow Cover	
Mean Date of First Snow Cover 1" or more	November 26 th
Mean Date of Last Snow Cover 1" or more	March 21 st
Mean Annual Number of Days with Snow Cover 1" or more	80 days
Mean Annual Maximum Depth of Snow	10 Inches
Temperature Range	
Mean Annual Minimum Temperature	-10°F
Extreme Lowest Recorded Temperature	-25°F
Mean Annual Maximum Temperature	95°F
Extreme Highest Recorded Temperature	100°F
Typical Weather Station	
Synoptic Weather Reporting Station	Located at Long Point Causeway
Sunshine	
Mean Annual Total Hours of Bright Sunshine	2000 hr
Mean Annual Percentage of Total Daylight Hours (Sunrise to Sunset)	45%

3.1.6 Aquatic Ecology

Aquatic Ecology is the study of the relationships among aquatic living organisms and between those organisms and their environment. There are two previous studies completed regarding the Aquatic Ecology nearby Long Point Causeway:

- Fish Community Sampling in National Wildlife Areas in Southwestern Ontario, 2002-2005, completed by N.E.Mandrak, J.Barnucz and D.Marson, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Central and Arctic Region, Department of Fisheries and Oceans;
- Targeted Surveys for Endangered and Threatened Fishes of the Essex-Erie Region, 2007, completed by M.R.Nelson and S.K.Staton, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Central and Arctic Region, Department of Fisheries and Oceans.

The Fish community paper or the National Wildlife areas does specifically list Big Creek and the species observed. A list of fish species detected is listed in the papers. The Essex-Erie study only sampled Turkey Point Marsh located in Essex County. However, this does provide Aquatic Ecology data on Inner Bay due to the connected coastal marsh systems (Turkey Point is located north of Inner Bay).

Existing data from Lake Erie Management Unit, Fish and Wildlife Services Branch of Natural Resources Provincial Services Division showed that a nearshore fish community assessment was conducted in 2007 for the entire Long Point Bay. A sampling station is setup at the mouth of Big Creek, 14 aquatic fish species were found through Electrofishing Methodology. These species include gizzard shad, grass pickerel, emerald shiner, spottail shiner, brown bullhead, white perch, rock bass, pumpkinseed, bluegill, largemouth bass, yellow perch, brook silverside, round goby and freshwater drum. In addition, according to the Lake Erie Management Unit, Lake Chubsucker, Warmouth, Grass Pickerel, Northern Pike, other Centrarcids, Lepomis and some cyprinid species as well would also benefit from the aquatic eco-passage installation, which re-establish the water flow between the Big Creek Marsh and Inner Bay of Lake Erie.

3.2 Economic Environment

Long Point is the location of an Ontario provincial park, Long Point Provincial Park, a popular destination for day visitors and campers. This destination is a tourism based economic environment.

3.3 Population and Land Use

The year-round population is about 450 people, but the population increases to about 5,000 in the summer months when cottagers and campers visit. Long Point is popular destination for boating, swimming, fishing, waterfowl hunting and canoeing, and more than 100,000 visitors each year. A large portion of Long Point is owned by The Long Point Company, a private organization that does not allow the public onto its property. Because of this, the bulk of homes, cottages and business are within the first few kilometers of the causeway that carries the road between Long Point and the mainland.

3.4 Social and Cultural Environment

The Long Point Causeway is a vital community and recreational link that connects Highway 59 (a Norfolk County road) and Port Rowan to the cottage community on Long Point at the head of Long point Inner Bay on Lake Erie, in Norfolk County. The causeway forms the east edge of the Big Creek Marsh, a 1200 ha wetland located at the mouth of Big Creek at the head of Inner Bay.

The significance of Long Point, Big Creek Marsh and their associated habitat and wildlife is recognized worldwide. Long Point is designated as a World Biosphere Reserve (designated by UNESCO in 1986) and is included in the International Ramsar Convention on Wetlands, a treaty developed to conserve globally significant wetlands. Long Point is also considered a Canadian Important Bird Area and the east half of Big Creek Marsh is a National Wildlife Area. The site is one of the most important areas for reptiles and birds in Canada, acting as a refuge for Species-At-Risk in an area of south-western Ontario otherwise fragmented by agriculture and development.

The causeway is a vital community and recreational link to Long Point. However, it has isolated the Big Creek Marsh habitat from the shoreline and nearshore habitat of Inner Bay, hindering wildlife movement opportunities, fish passage, causing significant wildlife road mortality and reducing open water connections and associated flow that provides nutrient circulation and exchange.

4.0 Identification and Description of the Alternative Solutions

Alternative solutions to the problem/opportunity statement were identified and comparatively evaluated. The following are the alternative solutions that were considered:

- 1) Do nothing
- 2) Continue with the current silt fence
- 3) Install a concrete box culvert with funnel fencing
- 4) Install a steel culvert with funnel fencing
- 5) Install an open grate pour in place with funnel fencing
- 6) Head-starting and other Turtle Reproductive Intervention Measures

4.1 Alternative 1: Do Nothing

The Class EA process requires that the 'do-nothing' alternative be considered. The Do Nothing alternative acts as a comparative benchmark for all of the other alternatives. To that end, no changes or improvements are considered under 'do-nothing' alternative, including the experimental work of installing ecopassages under the Causeway with the associated wildlife funnel fencing near the south end of the Causeway.

In order to mitigate the road mortalities, a silt fence was installed in 2008. However, the 'do-nothing' alternative will also require that the evaluation of the 'do-nothing' alternative be considered before the silt fencing was installed. The road mortalities associated with the 'do-nothing' alternative are presented in table 5.

Table 5: Total Wildlife road mortalities before silt fence was installed (Solymer, 2008-2010)

	1979	1980	1992	1993	2008
Total Mammals					66
Total Reptiles	237	219	180	228	258
Total Amphibians	10,040	11,478	699	7,817	815
Total Wildlife	10,277	11,697	879	8,045	1,239

Further information associated with the road mortalities of the 'do-nothing' alternative can be observed in tables 1 to 3 in sections 1.3.1 Ecopassages System.

4.2 Alternative 2: Continue with the Current Silt Fence

As a temporary mitigation effort to protect the wildlife from the road, silt fences were installed along the Long Point Causeway (The Causeway). The fencing was installed in stages, from

2008 to 2010. Installation of the silt fence started in 2008; however it was only installed on the west side of the Causeway. In 2009, the silt fence remained on the west side and in July was added to on the east side of the Causeway. In 2010, both sides were equipped with silt fence.

The fencing on the west side of the road begins north of The Causeway Restaurant and continues along the road until the bridge at Big Creek. The fencing on the east side of the road begins near the boundary of the Sandboy Marina and ends at the first cottage driving north towards Port Rowan. Figure 2 below illustrates the locations of the silt fence relative to the Long point community and the Causeway.



Figure 2: Locations of current (2010) silt fencing along the Causeway (Road Mortality Monitoring on the Long Point Causeway, 2008-2010)

Data was collect in order to determine the effectiveness of the silt fence. Data associated with the reduction of road mortalities after the silt fence was installed can be observed in tables 1 to 3 in sections 1.3.1 Ecopassages System.

It should be noted that the original fencing installed consisted of a light weight silt fence that was difficult to maintain. The silt fences are considered a temporary solution, due to the temporary nature of silt fencing and the large amount of maintenance required to keep them operational. This original light weight silt fence was subsequently replaced with the MTO approved silt fence specification for barrier fencing.

4.3 Alternative 3: Install a Pre-Cast Concrete Culvert Ecopassages with Barrier Fence

The feasibility study completed in in April 2008 recommended three (3) wildlife culverts to be constructed along the Long Point Causeway. These culverts are designed to provide not only

wildlife passages, but also to re-establish historic hydraulic connections between Inner Bay and wetland.

One potential type of culvert which could be installed for the three (3) ecopassages would be a concrete box culvert. This option would be installed by temporarily closing one lane of the road in the three (3) proposed locations for the ecopassages. Once the single lane of the road has been closed and excavated, a precast concrete box culvert would be placed and the road would be reconstructed over the culvert and reopened. Then the other side can be completed. In association with the culvert, funnel fencing will be strategically placed to guide the wildlife to enter the ecopassage.

The main issue associated with the concrete box culvert is that due to the fact that it is constructed of concrete, the ground surface remains cold. This does not suit the wildlife well because they are less likely to cross if there is a drastic temperature difference between the culvert ground and the outside ground. To alleviate this concern, other projects have introduced dirt and soil ground cover over the base of the pre-cast concrete culvert ecopassages with barrier fence. This has been relatively effective in minimizing the cold surface effects as the temperature of this soil generally matches the surrounding soil temperatures.

4.4 *Alternative 4: Install a Steel Culvert Ecopassages with Funnel Fencing*

Another potential type of culvert which could be installed for the three (3) ecopassages includes a steel culvert. As with the concrete box culvert, the steel culvert will be placed after the road has been temporarily closed and excavated. The steel culvert will also have guiding walls to assist the wildlife to enter the ecopassage. Although the steel culvert can be placed in sections similar to the box culvert they are generally done in a single crossing. This makes this alternative less appealing as compared to the box culvert based on maintaining an open traffic flow. They also have the issue with the interior surface being cold, as with the concrete box culvert.

4.5 *Alternative 5: Install an Open Grate Ecopassage with Funnel Fencing*

The open grate pre cast ecopassage is constructed the same as the pre-cast box culvert with the exception that it has an open grate or slats in the top portion of the culvert. This alternative also requires that one lane of the road be temporarily closed and excavated for the installation. The advantage to this alternative is that it allows the ground surface of the ecopassage to warm up and therefore there it will remain consistent with the rest of the surrounding ground. This consistency will increase the amount of wildlife that utilizes the ecopassage to cross the Long Point Causeway. These open grates can have maintenance issues associated with snow removal and road maintenance activities. However, newer designs are minimizing snow and debris accumulation and almost eliminating road maintenance issues.

4.6 *Alternative 6: Head-starting and other Turtle Reproductive Intervention Measures*

This alternative was proposed by the Friends of the Causeway Association (FOCAS). It was initially proposed as 3 individual alternatives, however due to their similarities, they were combined into one option by the consultant team. The 3 original alternatives were turtle nest protection, turtle artificial incubation and turtle head-start program.

Head-starting and other Turtle Reproductive Intervention Measures are intended to increase the population of turtle species through nest protection, artificial incubation or the head-start

program. Turtle nest protection increases population by replacing the lost adults by increasing the reproductive success of survivors, the hatchlings. This process required that nest locations be identified and a wire fence be installed around the nest, to reduce predation. Artificial incubation increases population size by removing the eggs from the nest and securing them in a safe location until the eggs hatch. Lastly, the Head-starting program increases the population size by taking hatchlings from an incubator or a nest enclosure and rearing them under simulated summer conditions for approximately one year. After this process the hatchlings are physically equivalent to a 3 year old because they do not hibernate.

The project team and the regulatory advisors are of the opinion that this is not a viable or stand alone alternative, because it is only an enhancement to the above alternatives. This alternative is viewed as an enhancement because it does not address the problem statement, of reducing wildlife mortalities on the Causeway. It should be noted that this alternative also requires permits for wildlife handling.

5.0 Placement and Density Assessment for Three Ecopassages

Eco-Kare International and AET Consultants worked together as part of the sub-consultant team to undertake an ecopassage assessment and provide biological, species at risk and geospatial road ecology expertise. The purpose of the ecopassage assessment was to provide recommendations on ecopassage placement and options in design parameters for consideration during the detailed design and construction phase of the Long Point Causeway Environmental Assessment. Figure 3 illustrates the project location. The complete analysis from AET Group Inc. and EcoKare International is attached in appendix E.

5.1 Background and Study Approach

The most recent and accurate mortality data, from Gillingwater 2003-2007, in combination with the existing site conditions, were used to assess the proposed locations of the ecopassages that were present in the LPCIP.

Based on wildlife-road mortality studies undertaken for the Causeway, anurans (frogs and toads) and reptiles (turtles and snakes) represent the majority of the road mortality species (Ashley and Robinson 1996; Gillingwater 2007, Solymer 2010). Therefore, the ecopassage assessment focused predominately on reptiles (particularly SAR) and amphibians.

5.2 Density Analysis

An analysis was completed by EcoKare International as part of the ecopassages assessment to determine areas of wildlife-road mortality density (i.e. hotspots) along the Long Point Causeway. Herpetofauna mortality data collected by Gillingwater (2007) from 2003 to 2007 was used for the analysis.

A Kernel Density algorithm created in Matlab 7.1 (Mountrakis and Gunson 2009) was used to assess where the highest intensity of herpetofaunal road mortality (hotspots) occurred along the causeway.

Figures 4 to 6 illustrates a relative comparison of the road mortality density (hotspots) for each group of turtles, snakes and bullfrogs separately for the entire length of the Long Point Causeway. Turtle and snake species groups included both common species and SAR, however only one anuran species (Bullfrog) was included in the data. This is due to the overlapping habitat use in the Big Creek Marsh; it is assumed that crossing points and road mortality locations on the Causeway for Green Frog, and to a lesser extent Leopard Frog and American Toad, coincides with Bullfrog.

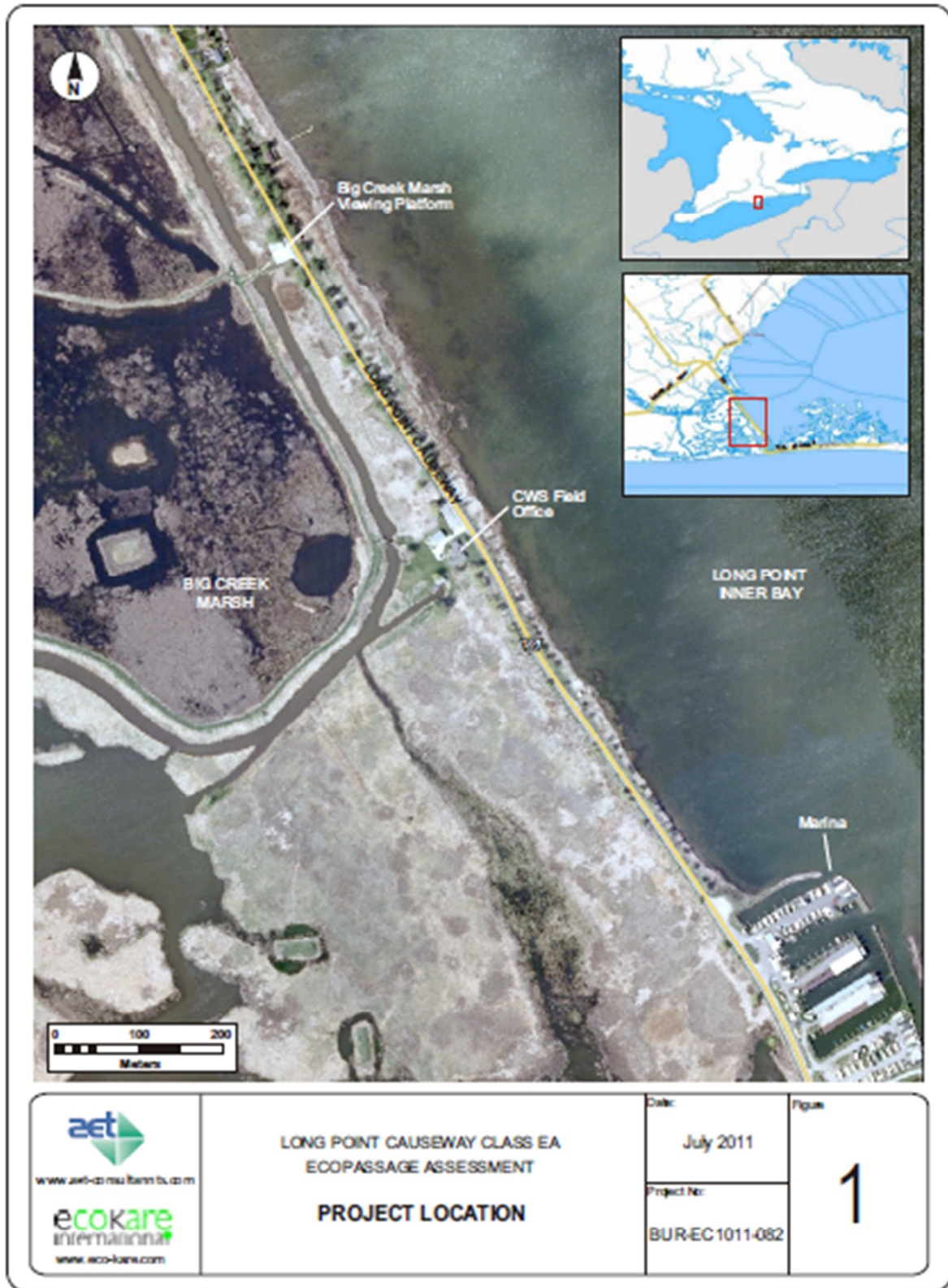


Figure 3: Project Location (AET and EcoKare International, 2011)

Road mortality density hotspots for all three species groups combined is presented in figure 7 (map scale was adjusted to focus on the south end of the causeway which was the area of interest for the Class EA). Hotspots are represented by the red line sections of the Causeway in each figure.

As expected, the hotspots in Figure 7 generally correspond with the hotspots for each species group (Figure 4 to 6) with only a slight variation. The hotspots in figure 7 were used to identify suitable locations for ecopassages that would effectively function for all three species groups.

5.3 Site Investigation

Three site investigations were performed in total. The investigations were conducted to determine potential constraints to ecopassage placement such as location of mature trees; buildings and structures; problematic vegetation community types (e.g. Phragmites); fish habitat; and SAR habitat. This information was used to assess and identify site specific location for the ecopassages within the hotspots identified from the road mortality density analysis.

The site investigations were also conducted to verify if any suitable or critical habitat associated with the SAR was present within the study area. The presence of any SAR plants within the study areas was also verified. A similar approach was taken to assess presence of suitable fish habitat.



Figure 4: Turtle Road Mortality Density Assessment (AET and EcoKare International, 2011)



Figure 5: Snake Road Mortality Density Assessment (AET and EcoKare International, 2011)



Figure 6: Bullfrog Road Mortality Density Assessment (AET and EcoKare International, 2011)



Figure 7: Combined Species Mortality Density Assessment (AET and EcoKare International, 2011)

6.0 Evaluation of the Proposed Hydraulic Connection

C.F. Crozier & Associates Inc. (Crozier) has completed a Hydraulic Connection Assessment regarding the location suitability, hydraulic requirements and benefits to re-establish the water passage between the Big Creek Marsh and the Inner Bay. The following summary has been developed from reviewing the background documents, interviewing with former Ducks Unlimited Canada staff and completed field visits:

- Big Creek, Big Creek Marsh and the Inner Bay of Lake Erie are indirectly hydraulically connected;
- Water levels in the Inner Bay of Lake Erie will be roughly equivalent to levels within lower reach of Big Creek, understanding that storm events, tides and seiches may cause lagging; and
- The “borrow” channel for the dykes surrounding the Canadian Wildlife Services (CWS) compartments is connected to Big Creek near mouth of Inner Bay, therefore water surface elevations in the “borrow” channel will be similar to those observed in Big Creek and the Inner Bay.

The above facts determine the scope of the hydraulic study, which were based on a differential evaluation in water surface levels between the marsh and Inner Bay.

Historic water levels of Lake Erie were analyzed for the average monthly elevation ranging from 1981 to 2010. The objective of the project is to re-establish a long-term hydraulic connection between the Inner Bay and the marsh, and to specify end treatment for erosion protection of the hydraulic structures as the ends will be subject to daily water level fluctuations, wave up-rush, seiches and wind erosion.

The proposed location of the hydraulic connection (or wet ecopassage), as outlined in the RFP and the Long Point Causeway Improvement Plan is adjacent to the CWS buildings. This location historically provided a connection between the Inner Bay and the marsh dating back to the 1930's. It's location in relation to Big Creek is preferable, since a closer location to Big Creek may promote short-circuiting of flows. Considering the flat nature of the causeway, there is no obvious low point where the hydraulic connection should be established. Since a channel is already present on the west side of the Causeway, adjacent to the CWS buildings, minimal earthworks would be required to complete the connection on the marsh side. Water levels observed on the east side of the Causeway in the inner Bay are generally quite close to the edge of the Causeway and therefore the location as proposed is suitable while minimizing requirements for dredging.

The hydraulic study confirmed that the preferred location for the hydraulic ecopassage is adjacent to the CWS buildings. Based on the field observation of the existing road profile of the causeway, water depth on both sides of the causeway, and the peak herpetofaunal movement patterns from spring to fall (target season), the study presented the water elevations vs. the duration percentage during target season. The wetness and dryness of the hydraulic ecopassage was estimated through this approach. This will be confirmed and utilized to determine the final invert elevation during the detailed design stage of the project. The complete analysis from Crozier is attached in appendix F.

7.0 Evaluation of Alternatives

7.1 *Description of the Evaluation Method*

Under the EA Process, municipalities are required to consider all aspects of the environment in their assessment and evaluation of infrastructure projects. The EA Act includes a broad definition of the “environment”, including the technical, natural, social, cultural, and economic environment. The EA Process requires a systematic evaluation of alternatives in terms of their advantages and disadvantages; and proponents are required to consider both positive and negative effects on the natural, social, cultural, and economic environments as part of their assessment and evaluation process.

For the purpose of evaluation, each alternative solution is subjected to a detailed comparative evaluation, using a “reasonable Argument Process”, which describes the advantages and disadvantages of each alternative in response to the evaluation criteria. Based on the descriptions provided, each alternative solution is ranked in terms of how well it responds to the criteria. Opportunities to incorporate mitigation to offset potential adverse impacts are considered within this ranking process. This is commonly referred to as a “Net Effects” evaluation.

The evaluation criteria used to assess alternative solutions is largely based on qualitative measures that are used to describe the advantages and disadvantages for each criteria that are not easily measured or quantified or incorporate a number of different considerations. For some criteria, quantitative measures have been used to compare the advantages and disadvantages for criteria in numeric terms, where the higher (or lower) value indicates a better score.

7.2 *Evaluation Criteria*

The evaluation of the alternatives was carried out on the basis of determining the most appropriate option taking into consideration the following criteria:

- Environmental Impact
- Social Impact
- Technical Consideration
- Economic Feasibility

Detailed evaluation parameters of each criteria is summarized in Table 6 below, along with evaluation rational that will be applied to each alternative.

Table 6: Identified criteria and rationale with respect to the proposed project

Criteria	Rationale for Criteria & Method of Assessment
Environmental Impact	
Increases survival rates of adults by decreasing road mortality	The initiation of this EA is based on the objective to reduce the wildlife mortality rates on the Long Point Causeway. The selected alternative should best reduce the mortality rates.
Multi-species approach	The objective of the proposed project is to reduce wildlife mortality due to the Long Point Causeway. This includes not only providing safe passage for turtles but also for various other wildlife that are required to cross the Long Point Causeway. The selected alternative should provide safe crossing for multiple species.
Reinstatement of hydraulic and ecological connectivity	Many stakeholders (Conservation Authorities, Specialists, Governing agencies) have expressed concern that in the past 20 years, there has been no hydraulic connection between Lake Erie and Big Creek Marsh. Increased connectivity will increase the availability of resources for the wildlife on either side of the Causeway. The selected alternative should provide the best opportunity to reinstate the hydraulic connection.
Requires handling of wildlife	Handling wildlife requires an extensive number of permits. The selected alternative should require as little wildlife handling as possible.
Social Impact	
Access of cottagers to their cottages	Many residents, including an organized group (the FOCAS group), have express concern that the selected alternative may result in them having difficulty accessing their cottages. Due to the fact that the Long Point Causeway is the only access road that connects the mainland to where many individuals have cottages. The selected alternative should cause minimum disruption in the access to the cottages. Disruption of traffic flow
Jobs created	Depending on the degree of involvement and construction required for the selected alternative, jobs may be created. This would help to support the local economy and the families of the individual who is contracted to complete the required work. The selected alternative should provide job opportunities for the local residence.
Impact on the surrounding trees	Many residents have expressed concern that the selected alternative may impact the trees which are on either side of the Long Point Causeway. These trees may provide valuable habitat for the wildlife in the area. The selected alternative should result in a minimum impact detrimental effect on the trees along the Long Point Causeway.
International acceptance	The Long Point Causeway is recognized around the world as the 5 th highest road for causing wildlife mortalities. This does not put Long Point in a positive spotlight on the world stage. The selected alternative should be a world recognized and accepted solution that reduces wildlife mortalities due to the road. This would result in positive recognition from a negative issue.

Visual impact	The Long Point Causeway is the only road that connects Long Point to the main land. Based on the input from surrounding residents it has been recognized that this beautiful drive is an important aspect of the community. The selected alternative should not have a negative visual impact on the Long Point Causeway.
Loss of invested effort	Due to the recognized importance of this project, a group of Long Point residents, businesses, etc. have congregated to raise funding and a means to develop a solution to the wildlife mortalities. The selected alternative should meet the objectives that were set out by this EA in order to ensure that there is no loss of invested effort.
Increase road safety	The high volume of wildlife crossing the Long Point Causeway poses a safety risk to the drivers of the Causeway. This is due to the fact that it may result in increased swerving to avoid the crossing wildlife or the already killed wildlife. The selected alternative should reduce the number of wildlife crossing the Causeway in order to increase traffic safety.
Technical Consideration	
Proven Technology	Some residents have expressed concern as to whether the alternative will reduce the mortality rates of the wildlife. They are concerned that the technology being implemented has not been applied enough previously to ensure that it will reduce mortality rates. The selected alternative should have been applied in a similar situation to demonstrate that the technology will reduce the wildlife mortality rates.
How complicated the technology is to phase into the current infrastructure	There is a concern that during the implementation of the selected alternative access to the cottages, which are only accessible by the Long Point Causeway, will not be possible. The selected alternative should not entirely reduce access to the cottages.
Difficulty of coordinating schedules	Many stakeholders have expressed concern that the implementation of the selected alternative will have a negative impact on annual schedules for the wildlife and the residence of the area. Socially those impacts would include the disruption of the drive along the Long Point Causeway. Environmentally those impacts would include significant periods of time which are important to specific species. The selected alternative should be able to be coordinated around important social and environmental periods of time.
Measurability of success	In order to determine the effectiveness of the selected alternative, it is important that it is measurable. This will help to show that the capital invested into the alternative was good value for money. It will also promote the use of the selected alternative for other similar projects. The selected alternative should have the ability to be measured in order to determine its rate of success.
Reliability	Initially, silt fences were installed along the sides of the Long Point Causeway to prevent road mortalities. Many stakeholders have proposed that the silt fences remain as a permanent solution; however the issue with this is that the silt fences are not a reliable solution. They require constant maintenance because they are constantly collapsing. The selected alternative should be reliable and require as little maintenance as possible.
Seasonal interruptions	Depending on the season the effectiveness of the solution may change. The selected alternative should not be negatively affected by

	the change of seasons.
Permanent solution	As stated above the silt fences were temporarily installed to reduce wildlife mortalities. This temporary solution requires a large amount of maintenance in order to ensure that the fence remains erect. Also the silt fence is prone to ripping, which requires replacement. The fence is not considered a permanent solution due to its high rate of replacement that is required. The selected alternative should be a permanent solution.
Economic Feasibility	
Capital cost of the alternative	Concerns have been expressed that value for money will not be achieved by selecting certain alternatives. The concern is that a high capital cost will not result in better results than another alternative which has a lower capital cost. The higher the capital cost of the selected alternative the less desirable it is.
Operation and Maintenance Costs	Residences have expressed concern that a selected alternative will result in costly operation and maintenance. If a selected alternative has too high of an operation and maintenance cost, it may result that it would have been more efficient to choose an alternative with a higher capital cost but a lower operation and maintenance cost. The selected alternative should not have a high degree of operation and maintenance required in order to maintain its operation.
The degree to which funding will be required	This project is being supported through funding from various agencies, which are being provided by the Long Point World Biosphere Reserve Foundation. The selected alternative should not require more funding than is already available for the selected alternative.
Life Cycle Cost	In order to ensure that good value for money is being considered the life cycle cost of each alternative will be considered. The objective is to have an alternative with a low capital cost and operation and maintenance, which will last the longest period of time, before another major investment is required to extend time of utilization. The selected alternative should not have a high life cycle cost.

7.3 *Benefit Analysis Evaluation Matrix*

A benefit evaluation matrix was prepared in order to evaluate the advantages and disadvantages of the proposed alternatives against the evaluation parameters to determine a preferred solution.

Table 7 presents a summary of the evaluation results.

Table 7: Advantages and Disadvantages for Each of the Proposed Alternatives

Alternative Description		Environmental Impact		Social Impact		Technical Consideration		Economic Feasibility	
		Advantage	Disadvantage	Advantage	Disadvantage	Advantage	Disadvantage	Advantage	Disadvantage
Alternative 1	Do Nothing	<div>-No trees will be disturbed</div>	<div>-No crossing protection for wildlife -Road mortality rates will not decrease (remain the same before silt fence) -Hydraulic connection not re-established -Risk of local population extinction -Does not implement recovery efforts advised by the scientific committee for the Endangered Species Act - Biological connectivity to improve exchange of species and gene flow between Big Creek Marsh and Inner Bay remains impeded by causeway</div>	<div>-the Long Point Causeway will not require construction -No disruptions of traffic flow -No trees will be disturbed</div>	<div>-Time and effort of those who have invested both will be let down -will not show society importance of the environment and wildlife protection -Visual impact from road kill -Will not look good at an international scale where it is determined that the Long Point Causeway is the 5th highest road with wildlife mortality in the world -Potential traffic & safety problems as drivers brake/stop/swerve for crossing wildlife</div>	<div>-Nothing technical required -No construction or alterations will be required -Not complicated</div>	<div>-Other technologies will not be given the opportunity to see if they have successful solutions -No learning involved</div>	<div>-No Capital needed -No funding needed - No operation and maintenance needed</div>	<div>-Loss of economic support for the area due to negative environmental image.</div>
Alternative 2	Silt Fence	<div>-Decrease the mortality rates from do nothing approach -No trees will be disturbed -Multi-species strategy (except for high jumping frogs and snakes that easily get through the fence)</div>	<div>-Hydraulic connection not re-established - Wildlife still crosses road, therefore still the potential for road mortality -Temporary solution only. -Will not function properly unless regularly maintained -Does not allow wildlife free access to resources on both sides of the road - Significantly impedes seasonal movement of species between Big Creek Marsh and Inner Bay</div>	<div>-Long Point Causeway will not require construction -Not trees will be disturbed -No disruptions of traffic flow -Creates safer roads (e.g. motorists won't swerve to miss animals)</div>	<div>-Visual impact on the environment -Significant effort required to maintain and monitor fence</div>	<div>-Not complicated (a simple temporary solution) -No construction</div>	<div>-Not reliable -Annual and routine maintenance required -Without a cap or lip some species could climb the fence and access the Causeway - Not durable, may not with stand temperature extremes, erosion/water forces and winter maintenance</div>	<div>-Short-term capital not high in relation to concrete box culvert, steel culvert or open grate eco-passages -Funding may be required -High life cycle lost</div>	<div>-Requires a lot of operation and maintenance (long-term costs may exceed costs of ecopassages)</div>

Alternative 3	Pre-Cast Concrete Culvert With Barrier Fence	<ul style="list-style-type: none">-Significantly decreases wildlife mortality rates and vehicle collision potential, in relation to the “do nothing” option- Significantly improves biological connectivity (i.e. movement and exchange of species and gene flow between Big Creek Marsh and Inner Bay)-Hydraulic connection can be re-established-Facilitates movement of sediment between Big Creek Marsh and the inner bay-Locations have been modified to minimize tree removal-Wildlife can cross under road without threat from vehicle traffic-Wildlife can access resources on both sides of the road-0.3 m of substrate to minimize cold concrete floor condition-Accommodates a broader range of terrestrial and aquatic wildlife species between wet and dry conditions-Best proven method to solve both road mortality and fragmentation impacts caused by roads-Multi-species strategy	<ul style="list-style-type: none">-Not providing best crossing conditions (e.g. dark tunnel)-Dredging may be required to establish hydraulic connection- Flooding and ice formation may discourage use by some species during winter/spring period (however a bench will help)-Culverts may not match ambient temperature, moisture and light regimes preferred by some of the target species	<ul style="list-style-type: none">-Invested time and effort will not be wasted-Maintain better environment (remove/reduce wildlife carcass on the road)-Attract tourism-Job creation-Create safer roads, e.g. motorists won’t swerve to miss animals-More visually pleasing	<ul style="list-style-type: none">-Visual impact on the environment-Trees may be disturbed-Long Point Causeway will require construction- Some Disruption of traffic flow	<ul style="list-style-type: none">-Reliable-Periodic operation and maintenance required-Not a temporary solution-Simple Installation-Can keep one lane open during construction-Variety of available geometries improves ability to meet site constraints-Less earthworks required for footing- Proven technology- Multiple specs available	<ul style="list-style-type: none">-Requires construction-Will have to coordinate schedules of all stakeholders-May be noisy in passage depending on traffic	<ul style="list-style-type: none">-Low operation and maintenance in relation to silt fence-Low life cycle cost in relation to silt fence-Create construction jobs	<ul style="list-style-type: none">-Moderate Capital-Funding required
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Alternative 4	Steel Culvert with Barrier Fence	<ul style="list-style-type: none">-Significantly decreases wildlife mortality rates and vehicle collision potential in relation to the “do nothing” option- Significantly improves biological connectivity (i.e. movement and exchange of species and gene flow between Big Creek Marsh and Inner Bay)-Hydraulic connection can be re-established-Facilitates movement of sediment between Big Creek Marsh and the inner bay-Locations have been modified to minimize tree removal-Wildlife can cross under road without threat from vehicle traffic-Wildlife can access resources on both sides of the road-0.3 m of substrate to minimize cold floor condition-Accommodates a broader range of terrestrial and aquatic wildlife species between wet and dry conditions-Best proven method to solve both road mortality and fragmentation impacts caused by roads-Multi-species strategy	<ul style="list-style-type: none">-Not providing best crossing conditions (e.g. dark tunnel)-Dredging may be required to establish hydraulic connection- Flooding and ice formation may discourage use by some species during winter/spring period (however a bench will help)-Culverts may not match ambient temperature, moisture and light regimes preferred by some of the target species	<ul style="list-style-type: none">-Invested time and effort will not be wasted-Maintain better environment (remove/reduce wildlife carcass on the road)-Attract tourism-Job creation-Create safer roads, e.g. motorists won’t swerve to miss animals	<ul style="list-style-type: none">-Visual Impact on the environment-Trees maybe disturbed-Long Point Causeway will require construction-Disruption of traffic flow	<ul style="list-style-type: none">-Reliable-Minimal operation and maintenance required-Not a temporary solution	<ul style="list-style-type: none">-Requires construction-Will have to coordinate schedules of all stakeholders-May be noisy in passage depending on traffic	<ul style="list-style-type: none">-Low operation and maintenance in relation to silt fence-Low life cycle cost in relation to silt fence-Create construction jobs	<ul style="list-style-type: none">-Higher Capital-Funding required
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Alternative 5	Open Grate Culvert with Barrier Fence	<div><div>-Significantly decreases wildlife mortality rates and vehicle collision potential in relation to the “do nothing” option</div><div>- Significantly improves biological connectivity (i.e. movement and exchange of species and gene flow between Big Creek Marsh and Inner Bay)</div><div>-Hydraulic connection can be re-established</div><div>-Facilitates movement of sediment between Big Creek Marsh and the inner bay</div><div>-Locations have been modified to minimize tree removal</div><div>-Wildlife can cross under road without threat from vehicle traffic</div><div>-Wildlife can access resources on both sides of the road</div><div>-Accommodates a broader range of terrestrial and aquatic wildlife species between wet and dry conditions</div><div>-Best proven method to solve both road mortality and fragmentation impacts caused by roads</div><div>-Multi-species strategy</div><div>-Maintains light/moisture/temp.</div></div>	<div><div>-Dredging may be required to establish hydraulic connection</div><div>-Salt in the winter will enter the eco-passage through the grate</div><div>- Flooding and ice formation may discourage use by some species during winter/spring period (however a bench will help)</div></div>	<div><div>-Invested time and effort will not be wasted</div><div>-Maintain better environment (remove/reduce wildlife carcass on the road)</div><div>-Job Creation</div><div>-Create safer roads, e.g. motorists won't swerve to miss animals</div></div>	<div><div>-Visual Impact on the environment</div><div>-Trees maybe disturbed</div><div>-Long Point Causeway will require construction</div><div>-Temporary disruption of traffic flow</div></div>	<div><div>-Reliable</div><div>-Minimal operation and maintenance required</div><div>-Not a temporary solution</div></div>	<div><div>-Requires construction</div><div>-Will have to coordinate schedules of all stakeholders</div><div>-May be noisy in passage depending on traffic</div></div>	<div><div>-Low operation and maintenance in relation to silt fence</div><div>-Low life cycle cost in relation to silt fence</div><div>-Create construction jobs</div></div>	<div><div>-Highest Capital</div><div>-Funding required</div></div>
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Alternative 6	Head-starting and other Turtle Reproductive Intervention Measures	-Increase population size of species -Increases reproductive success	-Does not solve objective to decrease road mortality and increase connectivity for all wildlife (i.e. does not provide crossing protection for adult species) -Difficult to measure success -Delayed sexual maturity for turtles would have a lag effect to measure success -Large numbers of immature and mature reproductive adults will continue to be killed on the road -Not a multi-species strategy (only specific for turtles) -Not going to stop inbreeding from segregation due to road -Hydraulic connection not re-established -Will not help protect turtles, because they show late breeding maturity and need to be protected as adults -Requires artificial management of the population -Does not increase survival rate for adult species -Not a standalone alternative -Not a viable alternative	-No construction required, therefore no disruption of traffic flow -No trees will be disturbed -Job creation	-Visual Impact on the environment -Species At Risk sites will be known which may encourage poaching -A lot of work and a lot of effort -Requires handling Species at Risk therefore requires permits -Currently no group designated to complete activities	-Increase the population through artificial and conservation	-Does not stop current migration across the road -Does not physically reduce road mortality - Artificial Incubation must be completed before the head start program can be started -Use of this alternative on comparable projects has only been utilized as an addition to more traditional wildlife protection measures, success rates have been marginal	-Low capital for nest protection program -No construction -Creates jobs	-High operation and maintenance -Funding required - Potentially high capital for incubation and head-start facility
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7.4 Identification of Preferred Solution

In order to determine a preferred solution, each of the identified criteria was assigned a weighting percentage. The weighting percentage for each of the criteria was determined based on the consultation, the advantages and disadvantages chart (Table 7) and the project teams' understanding of the project.

Table 8 presents a summary of the weighting percentages assigned to each evaluation criteria. Descriptions of weighting rational are also provided.

Each proposed alternative was then assessed and assigned a weighting score of 1-4 under each criteria category. A score of 4 represents that the alternative met the evaluation parameter entirely. A score of 0 represents that the alternative did not meet the evaluation parameter. Sum of the scores via criteria multiply the weighting percentage provides an overall score. The alternative with the highest score represents the preferred solution.

Table 9 presents a summary of the evaluation matrix with weighing percentage and weighting scores. A total score is assigned to each of the alternatives.

The identified preferred alternative was the pre-cast concrete culvert ecopassages with barrier fence. It should be noted that the open grate culvert with barrier fence was a very close second in the ranking. Given the ongoing scientific research that is currently happening in the field of ecopassage design and monitoring, it may be prudent to consider the installation of both pre-cast concrete box culverts and an open grate culvert. Both options would require the barrier fence component.

Table 8: Rational for the selected weightings

Criteria	Weighting	Rational
Environmental Impact	35%	The Environmental impact of the project is the most important criteria because purpose of the project and problem statement is to reduce the wildlife mortality rates on the Long Point Causeway. Therefore it is very important that the project has a greater positive impact on the environment then a negative impact. If the project has a greater negative impact on the project then it is not addressing the problem statement or the overall objective.
Social Impact	30%	Throughout the project the residences of Long Point Causeway have been heavily involved in the Environmental Assessment process. This is due to the fact that the Long Point Causeway is the only road connecting the Long Point community to the main land. There is concern that the installation of the ecopassages may affect the access the residences have to their homes on Long Point. Therefore the social impact of the project is the second most important criteria because there are many individuals who will be directly impacted by the outcome of the environmental assessment.
Technical Consideration	15%	It is important that the selected alternative is technically sound and will properly address the problem statement identified. Specifically for the ecopassages, it is important that it is designed to ensure its usage by the wildlife. However, it should be considered that the basic construction is that of a standard culvert, which is common practice.
Economic Feasibility	20%	It is important that the selected alternative is not unreasonable with respect to capital costs, operation and maintenance costs or lifecycle costs. In comparison to the environmental impact and social Impact the economic feasibility was not weighted quite as high but it has been stressed that the project remains within the budget.

Table 9: Evaluation matrix to evaluate preferred alternative

Total Weighting	35%				30%						15%						20%				100%
Criteria	Environmental Impact (%)				Social Impact (%)						Technical Consideration (%)						Economic Feasibility (%)				Score
Sub Categories	Increase Adult Survival	Reduces Wildlife Handling	Increases Connectivity	Multi-Species	No limit to Cottage Access	Limited Tree Disruption	Reduces Visual Impact	Increase Road Safety	International Acceptance	Creates Jobs	Proven Tech.	Permanent	Reliable	No Seasonal Issues	No Schedule Conflict	Not Complex	Low Capital	Low O&M	No Funding Required	Low Life Cycle Cost	
Weighting (%)	10.0%	5.0%	10.0%	10.0%	10.0%	2.5%	2.5%	5.0%	5.0%	5.0%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	5.0%	5.0%	5.0%	5.0%	100.0%
Do Nothing	0	0	0	0	4	4	0	0	0	0	0	0	0	4	4	4	4	4	4	4	40.0%
Silt Fence	2	2	0	3	4	4	2	2	1	2	1	0	0	0	4	4	4	0	3	0	49.4%
Pre-Cast Concrete Culvert with Barrier Fence	4	4	4	4	2	3	4	4	4	4	4	4	4	3	0	0	1	3	1	3	78.8%
Steel Culvert with Barrier Fence	4	4	4	4	1	3	4	4	4	4	2	4	4	3	0	0	1	3	1	2	73.8%.
Open Grate Culvert with Barrier Fence	4	4	4	4	2	3	4	4	4	4	4	4	4	2	0	0	1	2	1	2	75.6%
Head-starting and other Turtle Reproductive Intervention Measures	1	0	0	0	4	4	4	0	2	4	1	1	1	3	4	1	1	0	1	3	38.1%

4	Meets the criteria fully
3	
2	Only semi meets the criteria
1	
0	Does not meet the criteria

7.5 Sensitivity Analysis

The above evaluation matrix was selected because it best represents the problem statement and impacts that the project will have. The result of the evaluation matrix was that the box concrete ecopassage is the preferred alternative. In order to confirm that this is the preferred alternative, a sensitivity analysis was performed on the evaluation matrix. The sensitivity analysis was completed by altering the weighting of the criteria to determine if the box concrete ecopassage remains the preferred alternative.

Three sensitivity analyses were completed, in order to confirm that the preferred alternative is the box concrete ecopassage. The results of each of the 3 sensitivity analyses can be observed in appendix G.

The weightings for each of the sensitivity analysis were based upon the project team's understanding as to which may be considered as more important by the stakeholders. Therefore to mitigate potential conflicts the sensitivity analysis was performed.

The first sensitivity analysis was performed with equal weighting between environmental impact, social impact, technical consideration and economic feasibility (i.e. 25% weighting each). Equal weighting was investigated for the sensitivity analysis to account for any prejudice that could be in the weighting. The result of this sensitivity analysis was that the pre-cast concrete culvert with barrier fence remained as the preferred alternative.

The second sensitivity analysis was completed with a higher weighting for social impact (45%) and economic feasibility (35%). This analysis was considered because of the overwhelming concern from the public regarding how the project is going to impact the Long Point residence and how the project is going to be funded. The result of this sensitivity analysis was that the pre-cast concrete culvert with barrier fence is the preferred alternative.

The third sensitivity analysis was completed with a higher weighting for economic feasibility (45%). This analysis was performed to emphasize how the capital and cost of operation and maintenance could affect the selection of the preferred alternative. The result of this sensitivity analysis was that the pre-cast concrete culvert with barrier fence is the preferred alternative.

It should be noted that the open grate culvert with barrier fence also ranked very close to the pre-cast box culvert and was second on all three sensitivity analysis rankings.

8.0 Preliminary Design of Selected Alternative

An ecopassage system is used to achieve one or more of the following three main objectives (in no specific order): (1) allow safe passage of wildlife over or under roads and thereby conserve wildlife populations; (2) maintain or improve wildlife linkage and landscape connectivity between natural areas bisected by transportation corridors; and (3) reduce wildlife-vehicle collisions to increase traffic safety and minimize personal property damage and costs.

The permeability between Big Creek Marsh and Long Point Inner Bay would be significantly improved through implementation of properly installed ecopassage system to allow safe passage and help guide wildlife towards the crossing structures.

8.1 Ecopassage Locations

8.1.1 Location Considerations

As discussed above the density analysis served as the primary method for determining suitable locations for the placement of the proposed terrestrial and aquatic ecopassages. However the findings from the hydraulic connection assessment (C.F. Crozier & Associates, 2011), the site investigations and the daily and seasonal movement distances of focal species groups were also used to select suitable locations.

A number of site features that were potential constraints in ecopassage placement included; location of existing mature trees, dense stands of *Phragmites*, buildings and human-made structures, and artificial turtle nests. In consideration of tree loss concerns, ecopassage locations for this assessment were selected that avoided and would not require removal of any mature trees for installation of ecopassages. Resultantly, the placement of some of the ecopassages had to be slightly shifted in relation to the identified hotspots to avoid trees, particularly along road sections where the trees formed a continuous line on one or both sides of the Causeway.

Phragmites australis (Common Reed) is a non-native invasive wetland species that can rapidly spread and aggressively outcompete surrounding native wetland plants, displacing them, and altering wetland community and habitat structure. It has been shown that homogenous stands of exotic *Phragmites* can significantly reduce biodiversity and impede the movement of some wildlife species. This is a particularly a concern when considering animals such as turtles which are less likely to be able to manoeuvre through *Phragmites* stands due to their wider bodies and plastron and carapace (shell).

The maximum and mean daily movement distances and the minimum and mean seasonal movement distances within the home range of species were used to calculate an overall average daily/seasonal movement distance. This initially resulted in an overall average movement distance of 240m but it was rounded to 200m as a precautionary approach and to provide a more conservative overall mean distance. Therefore, a distance of 200m was used a general guide to determine spacing between proposed ecopassage locations.

8.1.2 Proposed Ecopassage Locations

The proposed locations for the three (3) ecopassages are presented in figure 8. As illustrated in figure 8, Ecopassage A falls just outside of the hotspot identified in the vicinity of the Big Creek Marsh viewing platform. It was positioned south of the hotspot to avoid mature trees and



Figure 8: Proposed Ecopassage Locations (AET and EcoKare International, 2011)

a stand of Phragmites. Adjusting the location slightly outside of the hotspot would not compromise the effectiveness of the ecopassage when barrier/guide walls are utilized to funnel animals to the crossing structure. Ecopassage B falls within a “high” road mortality area and was selected to provide a crossing point between Ecopassages A and C based on the 200m guideline for ecopassage spacing established for the assessment. It also falls within an area lacking in Phragmites and mature trees. Ecopassage C was selected because it falls within an area identified as having a “very high” road mortality, it is within 200m of Ecopassage B, and it was recommended as the most suitable location for an aquatic (“wet”) passage in the hydraulic connection assessment by C.F. Crozier.

Ecopassages A, B and C were identified as recommended locations for placement of the ecopassages for this Class EA. Ecopassages A and B would function as the terrestrial ecopassages and Ecopassage C would function as the proposed aquatic ecopassage. GPS coordinates for each of the identified ecopassages is provided in Table 10.

Table 10: GPS Coordinates for Proposed Ecopassage Locations

Ecopassage	UTM NAD 83
A (Terrestrial)	17 T 545301 4715759
B (Terrestrial)	17 T 545403 4715598
C (Aquatic)	17 T 545488 4715464

8.2 Ecopassage and Fencing Design Recommendations

As a result of the alternatives analysis the project team recommends the installation of two concrete box culverts and one open grate culvert, all with barrier fencing, as the preferred ecopassage options. It is proposed that the aquatic ecopassage be constructed as a concrete box culvert while the two terrestrial ecopassages will each use different types of culverts in order to provide valuable monitoring and a comparison of success for this and potentially other municipalities and community projects. Using two different types of ecopassages is feasible since they accumulated similar results when evaluated against all other options in Table 9. In order to maintain a warm enough temperature for the wildlife to use the ecopassages, soil is recommended to be layered on the bottom of the terrestrial culverts over the concrete base.

ACO wildlife fencing and/or the MTO approved membrane fencing will be used on the west side of the causeway to connect the ecopassages to the existing membrane fencing. It is recommended that steel sheet piling be utilized on the east (Bay) side of the causeway to connect the ecopassage to the existing membrane fencing. Depending on the distance and cost of this recommendation the membrane fencing may be extended towards the ecopassages to save on capital cost, however the sheet piling is recommended as barrier wings on the ecopassages on the east side for added erosion, high water and wave action protection. The fencing proposed to connect the ecopassages to the existing membrane fencing should be curved or angled so that it will act as a funnel to help guide the wildlife to the culverts. In fact the existing MTO approved membrane fence should be realigned to ensure this gradual guidance towards the ecopassages.

8.2.1 Ecopassage Invert Elevation

Crozier's report was used to determine the recommended invert elevations to install the terrestrial and aquatic ecopassages (concrete box culverts). The invert elevation recommendations were derived from 2 analysis completed by Crozier. The first was a statistical analysis of water levels in Lake Erie exceeding various elevations during the historical period of record, to estimate the effects various invert elevations would have on hydraulic connectivity. The other was that the historical average water level in Lake Erie from the period of 1918 to 2010 was 174.11m (CDG). From both these analysis it could be determined the percent (%) of time the ecopassages would be inundated with water.

As illustrated in figures 9 and 10, the proposed invert elevations of the box culvert for the terrestrial ecopassage is 174.0 or 173.75m (CDG). This means that the average monthly water levels in Lake Erie are (based on historic trends) expected to exceed 174.0 or 173.75m approximately 91% or 72% of the time respectively, from the start of April to the end of October (target period).

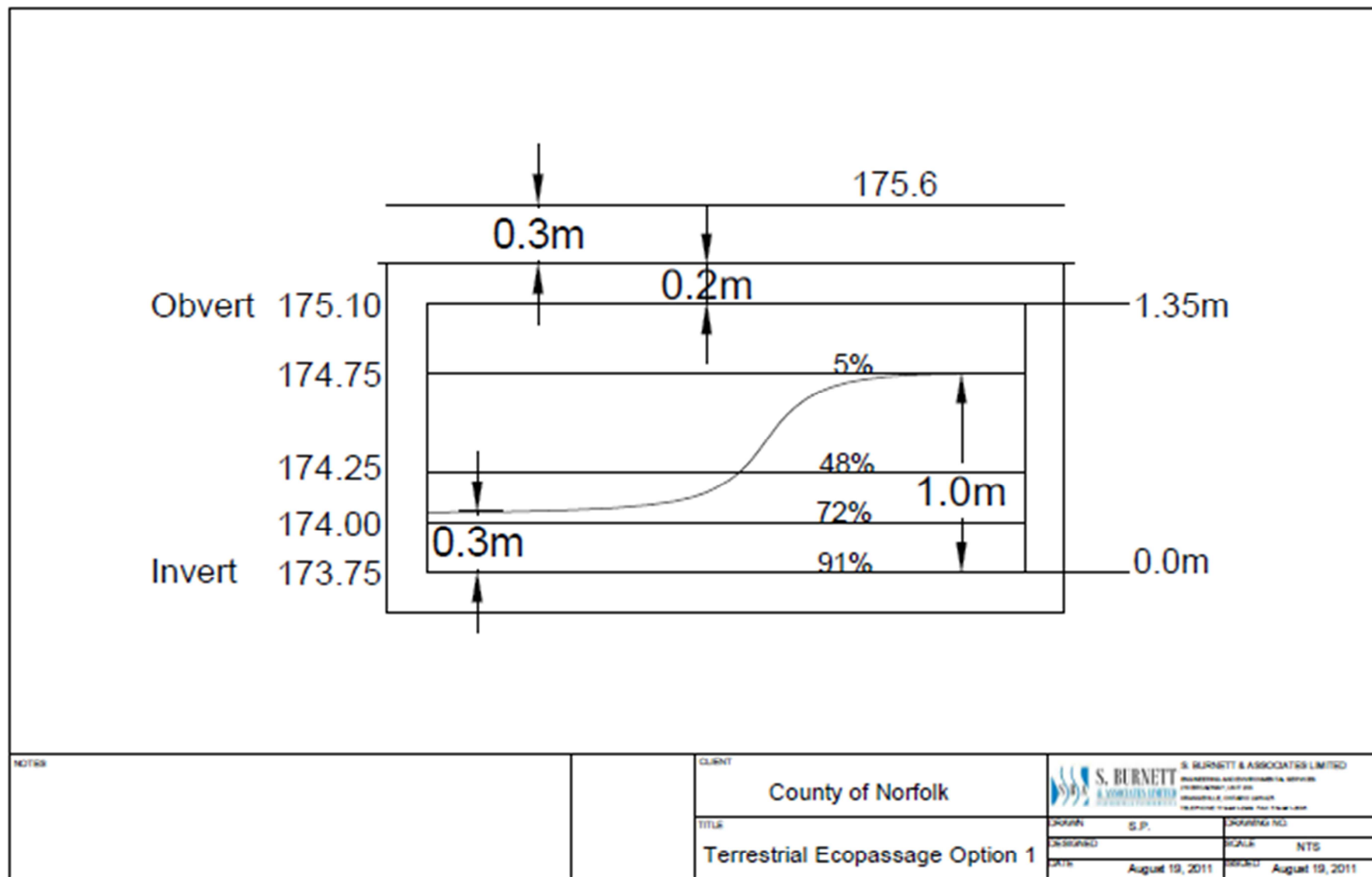


Figure 9: Option 1 for the Recommended Invert Elevation of the Terrestrial Ecopassage

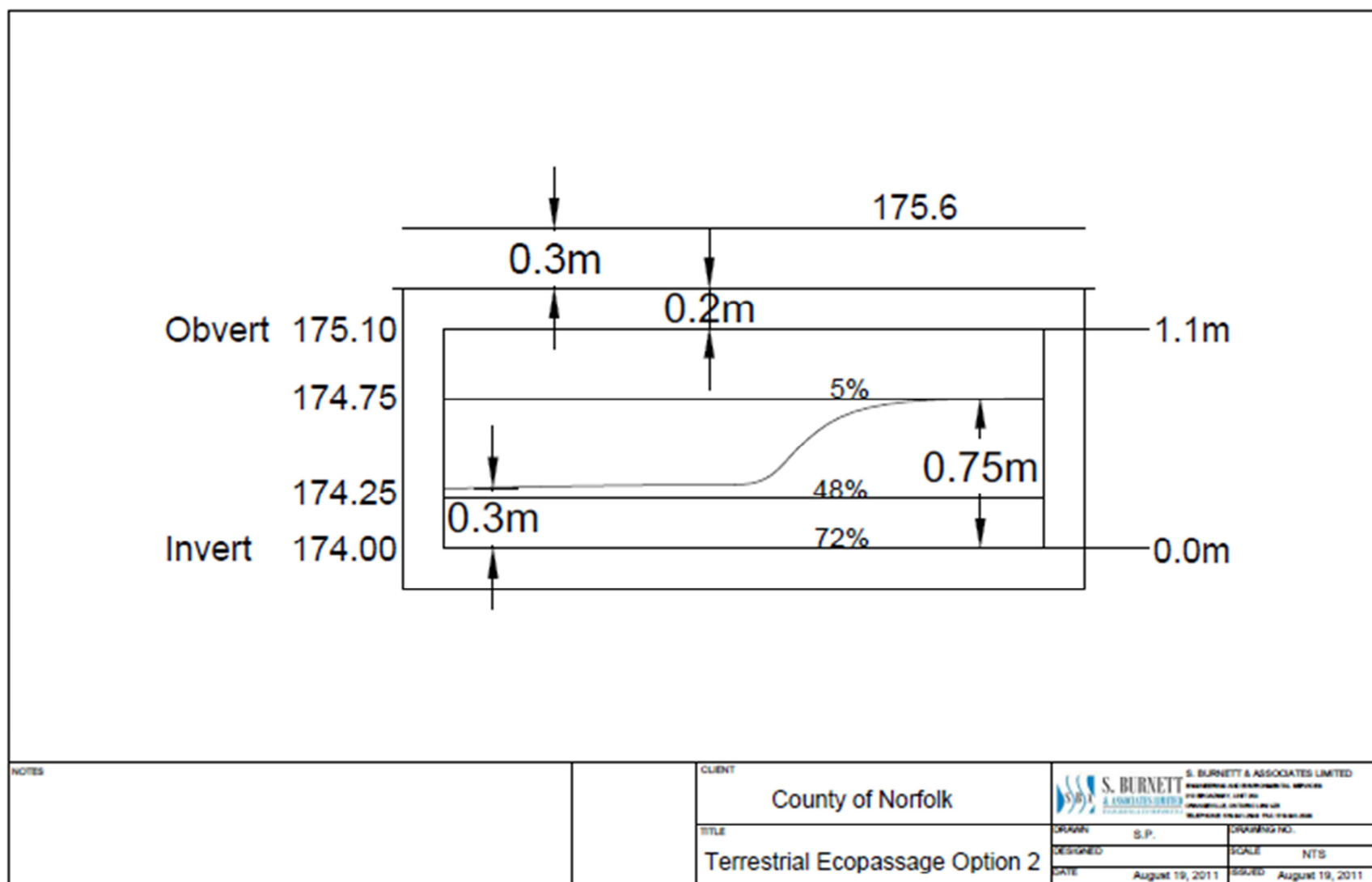


Figure 10: Option 2 for the Recommended Invert Elevation of the Terrestrial Ecopassage

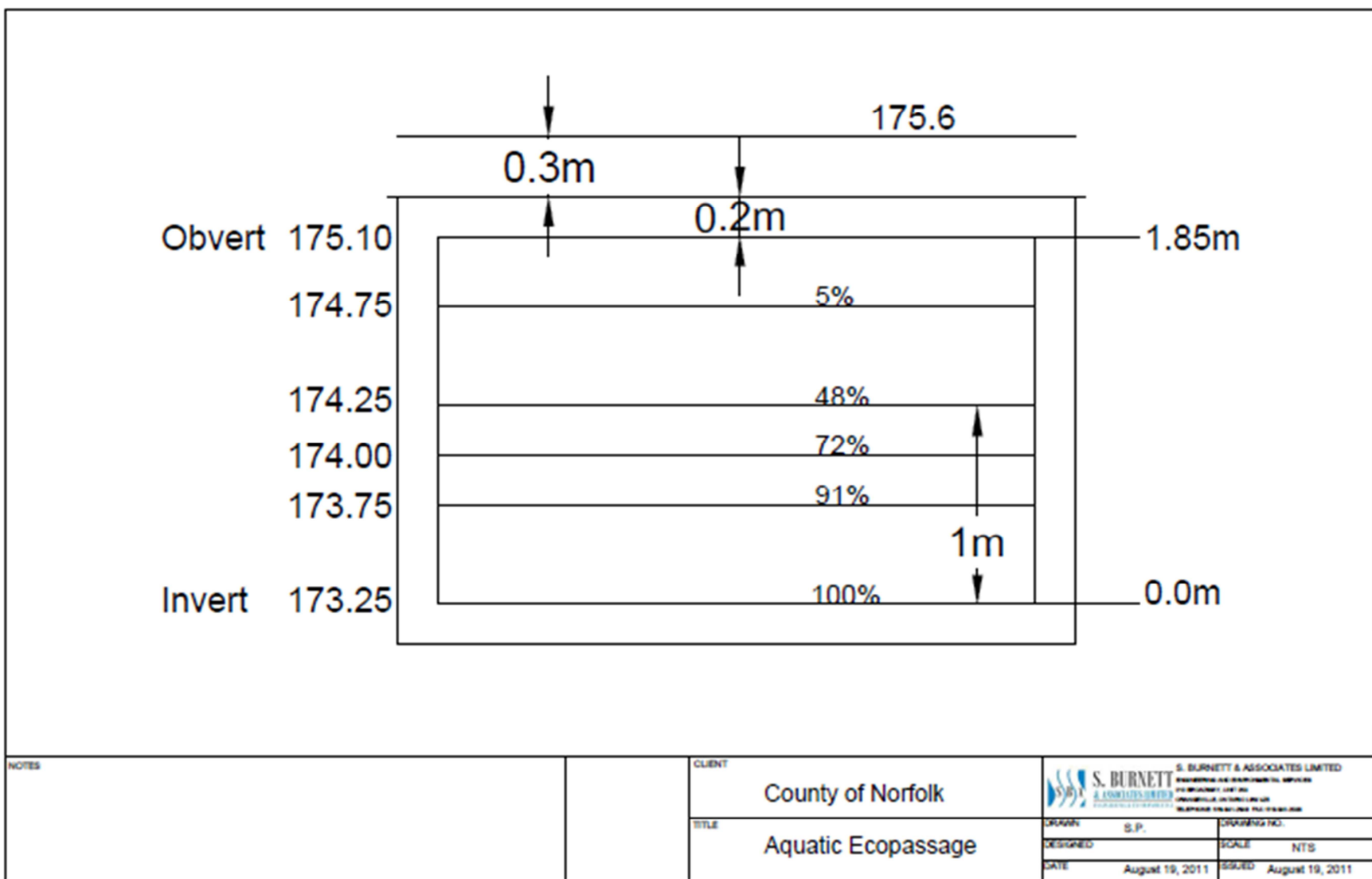


Figure 11: Recommended Invert Elevation for the Aquatic Ecopassage

As illustrated in figure 11, the proposed invert elevation for the aquatic ecopassage is 173.25m (CDG). This means that the average monthly water level in Lake Erie (based on historic trends) are expected to exceed 173.25m approximately 100% of the time from the start of April to the end of October (target period). At an invert elevation of 173.25m the aquatic ecopassage will be inundated with a water height of 0.5m approximately 91% of the time from the start of April to the end of October (target period). This is important because the aquatic culvert should allow passage of the largest bodied fish species likely to use the ecopassage (i.e. Northern Pike) at least 50% of the time. Based on calculations Northern Pike will require a minimum water depth of 20cm within the culvert, which an invert elevation of 173.25m accommodates. This invert elevation will also not require dredging if installed during the low water level.

8.2.2 Ecopassage Structure Design

A box culvert provides the greatest areas of opening with the least vertical profile which helps overcome the biological and physical parameters associated with the focal species and site conditions.

The paved width of the causeway is 7m with 1m gravel shoulders. The bottom of the road embankment is approximately 1.5m below the road profile (Ashley and Robinson, 1996). Based on these dimensions and taking into account the road embankment (approximately 45 degree slope), the length of the box culvert for the terrestrial and aquatic ecopassages will likely be in the range of 10-12 meters.

For the terrestrial ecopassage, a precast box culvert (closed bottom) with a span ranging from 600 to 1800mm and a rise ranging from 1250 to 1500mm is recommended. Similar specifications are recommended for the open grate culvert option. This dimension was determined while considering the biological traits of the focal wildlife species, height of the road profile, and the average monthly lake water elevations presented in the hydraulic connection assessment (C.F. Crozier, 2011). As well, native local surficial soils should be spread evenly across the entire inside bottom of each culvert section for the terrestrial ecopassages to create a natural substrate. Soils should be spread to a depth of approximately 10cm and then slightly compacted to stabilize.

For the aquatic ecopassage, a precast box culvert (closed-bottom) with a span ranging from 1800 to 2400mm and a rise of 2000mm is recommended. This size would allow the culvert to be embedded below existing grades at the bottom of the road embankment and permit “wet” crossing conditions.

8.2.3 Fencing Design

Wildlife fencing is used to prevent animals from accessing the road and to help guide wildlife towards the ecopassages. It has been found that ecopassages are utilized more frequently by wildlife when a fencing structure is installed.

For hepetofauna, permanent barrier/guide walls can be constructed of concrete, tin, vinyl or steel sheet piling. However, geotextile/fabric fencing and fine wire mesh (which have also been used); are less practical solutions. Fencing along the Long Point Causeway will have to endure, soft substrates, seasonal water levels, wave action and ice build-up on the east side of the

Causeway that faces Inner Bay. Therefore, it is important to ensure the fencing is durable and will not require immense amounts of maintenance.

Three options are available for the fencing; steel sheet piling, ACO Wildlife fencing and the existing MTO approved membrane/geotextile fencing. Steel sheet piling is more durable of the three options; however it does not appear to be cost effective. Steel sheet piling are able to withstand the elements for approximately 40 year, with very little maintenance, at an estimated cost of approximately \$920 to \$1,230/m. The steel sheet piling should be installed such that no less than 1.0m will remain above the existing ground surface and a minimum of 1.2m below the existing ground surface. A steel sheet piling fence will require a lip be welded to it, which will increase the costs associated with this option. The ACO fencing has been estimated to withstand the elements for approximately 15-20 years, at a cost of approximately \$100/m for materials and installation. The ACO fencing should be installed such that the posts remain 0.4m above the existing ground surface. The ACO wildlife fencing is equipped with a built in lip. The existing MTO membrane/geotextile fencing has had some maintenance issues but has worked relatively well as a guidance tool. Although it has not been effective stand alone option, it has merit as the barrier fence for the ecopassage options. Therefore, it is recommended that the existing membrane/geotextile fencing be maintained for the majority of the barrier fencing. It is recommended that the ACO wildlife fencing be utilized to connect west side of the terrestrial and aquatic ecopassages to the existing membrane fencing. However, if budget permits it is recommended that sheet piling be installed at the mouth of the east side of the culverts, to ensure durability on the bay side.

The placement and alignment of the proposed barrier/guide wall should ideally have an angle or curvature to it that would guide wildlife to the ecopassages. This may match that of the barrier fencing currently installed along the Causeway to the most extent possible but may also require the relocation of this fencing in some areas to be an effective guiding tool.

8.3 Construction Timing

From an environmental viewpoint and regulatory window of work, the spring season is not an appropriate time for construction. Similarly winter's cold weather and snow accumulation prevents it from being a good time for construction of this nature. Since the Causeway and surrounding area is heavily used in the spring and summer months by cottagers, the summer is also not ideal for construction due to social and economic constraints. Therefore, it is recommended that the most appropriate timing for construction of the ecopassages would be in the early fall season. Appropriate discussions and approval from the regulatory agencies will need to be established to ensure that construction in the fall is still completed within the appropriate timing and permitting windows.

During construction, at least one lane of the road will always be available for drivers at any given time. Installation of each of the three culverts will be done in two parts, the east half of the culvert, and the west half of the culvert begin completed in stages to allow the opposite lane to remain open to traffic. Temporary signals or flagging operation will be set up to direct traffic from both directions during the time period when using one lane only. It is estimated that each side of the culvert will take approximately one to two days to complete.

8.4 Other Recommendations

The fencing should abut the front edges of the ecopassage structures, in order to prevent wildlife from passing through the cracks onto the road.

To help minimize wildlife from getting around the outer ends of the barrier/guide wall and moving into the road right-of-way, the ends of the barrier fencing should be angled inwards (approximately 45 degrees) away from the road for several meters (e.g. 10m) to redirect wildlife back towards the ecopassages (see figure 12).

Due to the minimal distance between the road surface and the low water level, it is recommended to install a soil bench within the terrestrial ecopassage. The purpose of this benching would be to ensure a dry passage for a longer period of time from April to October. Otherwise the terrestrial ecopassages will be under water for a significant portion of the travel period due to the relatively high water levels and the low road profile.

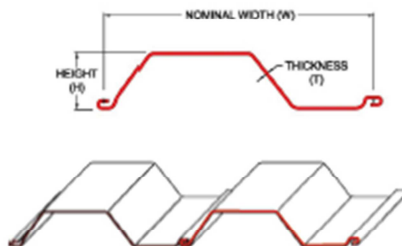
Some wildlife may find their way on the other side of the barrier/guide between the road and the barrier/guide wall. To prevent wildlife from being trapped in the road right-of-way, earthen escape ramps should be constructed against the barrier/guide wall (between the wall and road) to allow wildlife to get back over the wall (see figure 12). An earth ramp should be placed approximately halfway between each of the ecopassages and on both sides of the road where there is sufficient width between the fence and the road profile.

The entrance of the ecopassages should contain low stature cover. This can include such things as large rocks (15-25cm diameter), drift wood or stumps and low stature vegetation (<20cm). Although some natural plant cover is appropriate, tall emergent vegetation should be removed at the ecopassage openings to permit a clear line of sight from one end of the ecopassage to the other and to avoid impeding wildlife movement. An entrance pad made from concrete, geosynthetically-reinforced soil or other suitable material could be installed at each entrance to reduce vegetation growth.

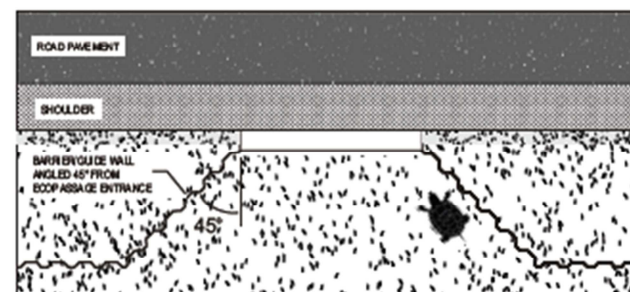
**PHOTO SHOWING EXAMPLE OF INSTALLED
STEEL SHEET PILING**



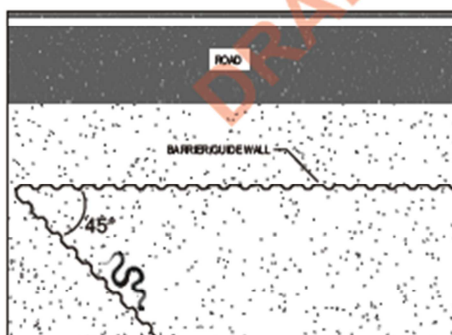
**SECTION OF STEEL SHEET PILING WITH
CROSS-SECTION DIMENSIONS**



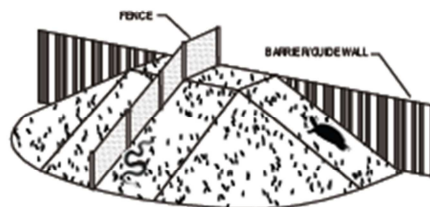
PLAN VIEW OF ECOPASSAGE ENTRANCE AND BARRIER/GUIDE WALL



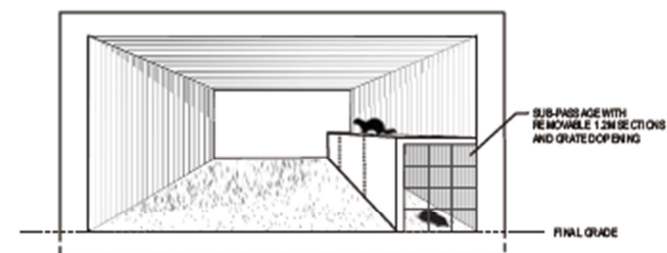
**PLAN VIEW OF BARRIER/GUIDE WALL END
ANGLED BACK 45° FROM ROAD**



WILDLIFE ESCAPE RAMP



FRONT VIEW OF ECOPASSAGE ENTRANCE WITH SUB-PASSAGE



NOTES:

Drawings not to scale (N.T.S.)

LONG POINT CAUSEWAY CLASS EA
ECOPASSAGE ASSESSMENT

DESIGN CONCEPTS

Project No:
BUR-EC1011-082

Date:
July 2011

Scale:
N.T.S.



Figure

8

Figure 12: Recommended Design Concepts (AET and EcoKare International, 2011)

9.0 Monitoring

The primary outcome of the LPCIP is to establish an ecopassage system that reduces wildlife-road mortality and improves aquatic and terrestrial habitat connectivity between Big Creek Marsh and Long Point Inner Bay. Post-construction monitoring is recommended to evaluate the performance and effectiveness of the proposed ecopassage system.

In order to determine if there is a reduction in road mortality it is recommended that road mortality surveys are conducted on road sections with and without crossing structures. Surveys must be extensive in length (3-5 years) and systematically conducted on an annual basis. Further details for timing, survey frequency, and survey techniques will be provided during the detailed design phase in a Post-Construction Monitoring Plan.

In order to determine the effectiveness of the ecopassage design, passive non-invasive detection methods to quantify species-specific use (e.g. track plates, remote infrared cameras, pit-tag and passive detection system, underwater or overhead videography).

9.1 Inspection and Maintenance of the Ecopassages

Regular inspections and maintenance should be conducted throughout the life of the ecopassage system. This will assure that structural integrity of the ecopassage system is upheld and that it is functioning as intended. The inspection should address;

- Removal of sediment build-up and other blockages in ecopassages.
- Ecopassage entrances need to be maintained to remove tall vegetation so that entrances are not blocked
- Removal of tall vegetation and shrubs along the fence (on the side opposite the road).

Timing of inspections and maintenance activities should occur in July/August to coincide with the growing season and to minimize potential disturbances to the focal species during their reproductive periods. Inspection and maintenance can occur without effecting traffic flow or use as the activities are on the sides of the Causeway. These activities could also be completed during the fall season.

10.0 Recommendations

It is recommended that this Schedule 'B' EA report be submitted on the public record as complete and that a Notice of Project Completion be issued publically. Pending the 30 day public review period it is recommended that the project proceed to Phase 5 of the Municipal Class EA process, specifically implementation. This will include a detailed design of the recommended ecopassages and barrier fencing including the necessary geotechnical and topographical surveys. The detailed design phase will also include applying for and securing the necessary permits from the regulatory agencies required for the designing, construction and implementation of the three proposed ecopassages and barrier fencing.

11.0 References

- Arsenault L., & Mockford, S. A Summary and Discussion of Headstarting of Blanding's Turtles in Nova Scotia.
- Aresco M.J. (2005) The Effect of Sex-specific Terrestrial Movements and Roads on the Sex Ratio of Freshwater Turtles. *Biological Conservation*, V.123: 37-44.
- Brooks R. J., Brown G. P., & Galbraith D. A. (1991). Effects of a Sudden Increase in Natural Mortality of Adults on a Population of the Common Snapping Turtle (*Chelydra serpentina*), *Can. J. Zool.*, V.69: 1314-1320.
- Clark R. W., Brown W. S. (2009). Roads, Interrupted Dispersal, and Genetic Diversity in Timber Rattlesnakes. *Conservation Biology*.
- Congdon J. D., Dunham A. E., & Van Loben Sels R. C. (December 1993). Delayed Sexual Maturity and Demographics of Blanding's Turtles (*Emydoidea blandingii*): Implications for Conservation and Management of Long-Lived Organisms. *Conservation Biology*, Vol 7, No. 4.
- Congdon J.D., Dunham A.E., & Van Loben Sels R.C. (1994) Demographics of Common Snapping Turtles (*Chelydra serpentina*) Implications for Conservation and Management of Long-lived Organisms. *Amer. Zool.*, V.34: 397-408.
- England K. (2009). Temporary Mitigation Plan for the Long Point Causeway Improvement Project: Literature Review. The Long Point World Biosphere Reserve Foundation.
- Ecoplans Limited, MRC. (April 2008). Long Point Causeway Improvement Plan
- Fahrig L., Pedlar J.H., Pope S.E., Taylor P.D., & Wegner J.F. (1995). Effect of Road Traffic on Amphibian Density, V13: 177-182.
- Ford A.T., & Clevenger A.P. (2010). Validity of the Prey-Trap Hypothesis for Carnivore-Ungulate Interactions at Wildlife-Crossing Structures. *Conservation Biology*, V. 24, No.6: 1679-1685.
- Gibbs J. P., & Shriver W. G. (2005). Can Road Mortality Limit Populations of Pool-breeding Amphibians. *Wetlands Ecology and Management*, V.13: 281-289.
- Gibbs J. P., & Shriver W. G. (December 2002). Estimating the Effects of Road Mortality on Turtle Populations. *Conservation Biology*, V.16(6): 1647-1652.
- Gibbs J. P., & Steen D. A. (April 2005). Trends in Sex Ratios of Turtles in the United States: Implications of Road Mortality. *Conservation Biology*, V. 19(2): 552-556.
- Harrison K. E., & Archer R. W. (February 2008) Natural Sciences Research Gap Analysis and Annotated Bibliography for Long Point Bay and the Greater Long Point Area. Bird Studies Canada.

Hels T., & Buchwald E. (2001). The Effect of Road Kills on Amphibian Populations. Road Ecology Center, John Muir Institute of the Environment, UC Davis.

Jackson S. D. (2000). Overview of Transportation Impacts on Wildlife Movement and Populations. Department of Natural Resources Conservation University of Massachusetts, Amherst.

Jaeger J.A.G., & Fahrig L. (December 2004). Effects of Road Fencing on Population Persistence. *Conservation Biology*, V18, No.6: 1651-1657.

Lake Erie Management Unit. (2007). LPBEA Summary Site and Fish Species Data.

L. W., & Fahrig L. (August 2001). Effect of Road Traffic on Two Amphibian Species of Differing Vagility. *Conservation Biology*, V. 15(4): 1071-1078.

Little S.J., Harcourt R.G., & Clevenger A.P. (2002). Do Wildlife Passages Act as Prey-traps?. *Biological Conservation*, V107: 135-145.

Kilborn Limited Consulting Engineers. (October 1978). Preliminary Engineering Study – Big Creek Marsh, Long Point.

Mader H.-J. (1984). Animal Habitat Isolation by Roads and Agricultural Fields. *Biological Conservation*, V.29: 81-96.

Mandrak N. E., Barnucz J., & Marson D. (2002-2005). Fish Community Sampling in International Wildlife Areas in Southwestern Ontario, 2002-2005,.Great Lakes Laboratory for Fisheries and Aquatic Sciences, Central and Arctic Region, Department of Fisheries and Oceans.

Municipal Engineers Association. (2000). Municipal Class Environmental Assessment.

Nelson M. R. & Staton S. K. (2007). Targeted Surveys for Endangered and Threatened Fishes of the Essex-Erie Region, 2007. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Central and Arctic Region, Department of Fisheries and Oceans.

Row J.R., Blouin-Demers G., & Weatherhead P. J. (2007). Demographic Effects of Road Mortality in Black Ratsnakes (*Elaphe obsoleta*), *Biological Conservation*, V. 137: 117-124.

Solyman B. (2008-2010). Road Mortality Monitoring on the Long Point Causeway, Earth Trampler Consulting Inc, Report Submitted to Environmental Canada Habitat Stewardship Fund for Species at Risk, Ontario Ministry of Natural Resources, Species at Risk Stewardship Fund.

Steen D. A., & Gibbs J. P. (2004). Effects of Roads on the Structure of Freshwater Turtle Populations. *Conservation Biology*, V.18(4): 1143-1148.

Steen D.A., Aresco M. J., etc. (2006). Relative Vulnerability of Female Turtles to Road Mortality. *Animal Conservation*, V.9: 269-273

The Atlas of Canada. (2003). List of Environmental Maps – Climate, Ecology, Land and Water, Natural Resources Canada

Wood R. C. and Herlands R. (1997). Turtles and Tires: The Impact of Roadkills on Northern Diamondback Terrapin, *Malaclemys terrapin terrapin*, Populations on the Cape May Peninsula, Southern New Jersey, USA. Conservation, Restoration, and Management of Tortoises and Turtles – An International Conference, P: 46-53.