Final MREM Report, Case B:

Investigating the Options for Twinning Highway 101 at the Windsor Causeway:

A Biophysical, Socio-political and Legal Perspective

Prepared for

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EXECUTIVE SUMMARY

Highway 101, extending from Bedford to Yarmouth, was once considered to be the most dangerous highway in Nova Scotia. As a result, a decision was made by Nova Scotia Transportation and Infrastructure Renewal (NSTIR) to twin the highway. Currently, progress to do so, has been made on the entire highway with the exception of a section between Three Miles Plain and Falmouth. Construction has been halted in this segment due to the presence of the Windsor causeway. This is primarily due to the fact that an Environmental Impact Assessment (EIA) for the expansion project that was initially slated to be completed by 2008 continues to be a work in progress. The purpose of this case study is to investigate the foreseeable options for expanding Highway 101 at the Windsor causeway.

Prior to the completion of the causeway in 1970, the Avon River was a tidal river that hosted a variety of diadromous fish. Although, reports on the health of fish populations in the river suggest that there had been historical declines in these populations as a result of upstream barriers preventing passage and anthropogenic activities degrading water quality. Agricultural land upstream of the current causeway was protected from river flooding due to the presence of dykes. Following the construction of the causeway the system endured drastic changes. Tides no longer flow upstream past the causeway and as a result, siltation on the seaward side of the causeway has created extensive mudflats that host one of the most productive salt marshes in the Bay of Fundy. A freshwater lake or headpond now exists upstream of the causeway which has significant recreational value to the community of Windsor. As well, dykes have been left in disrepair as the causeway prevents flooding of the agricultural lands.

Three foreseeable options for twinning the causeway have been identified and are discussed in detail in this report. The first option to expand the existing causeway on its seaward side is the current design proposed by NSTIR. Friends of the Avon River (FAR), a local environmental organization, have a primary goal to restore free tidal flow and to allow for successful upstream passage of diadromous fish in the Avon River. According to Dr. van Proosdij's interpretation of this term, free tidal flow could be accomplished by removing the tide gate which would be covered by a bridge. This would be in addition to the current expansion project, which is the second option considered in this report. The third and final option evaluated in this report is in regards to FAR's interpretation of free tidal flow. This would consist of the removal of a large portion of the causeway, which would be replaced with a 6 lane bridge. Many of the socio-political, biophysical and legal implications of these options are discussed in detail in this report.

Provided this information it can be concluded that the expansion project that is currently being considered is the most feasible option and should go ahead as planned. Public pressure to improve highway safety by expanding Highway 101 must be balanced with environmental concerns surrounding the impact such development would have on local ecosystems. Ecologically, socially, politically and economically, this is the best option. Following the conclusion are three recommendations that will aid in ensuring that the integrity of the current ecosystem is recognized and maintained while satisfying the societal need for improved highway safety over the Windsor causeway.

ACRONYMS

APWPS – Avon Peninsula Watershed Preservation Society

BoFEP – Bay of Fundy Ecosystem Partnership

CEAA – Canadian Environmental Assessment Agency

COSEWIC – Committee on the Status of Endangered Wildlife in Canada

DFO – Department of Fisheries and Oceans

EGSPA – Environmental Goals and Sustainable Prosperity Act

EIA – environmental impact assessment

FAR – Friends of the Avon River

HADD – harmful alteration, disruption or destruction

iBoF – Inner Bay of Fundy

MMRA – Maritime Marshland Reclamation Administration

NSE – Nova Scotia Environment

NSTIR – Nova Scotia Transportation and Infrastructure Renewal

NSWCP – Nova Scotia Wetlands Conservation Policy – draft for consultation

SARA – Species at Risk Act

TERMS AND DEFINITIONS

Aboiteau: a hinged gate built into a dyke to allow freshwater to run off but prevents salt water from moving upstream

Anadramous fish species: species of diadromous fish which spend part of their lives at sea and/or in estuaries but migrate to freshwater systems to spawn

Catadromous fish species: a type of diadromous fish species which spend most of their lives in freshwater systems but migrate to the sea to spawn

Causeway: A road raised above the natural level of the ground, serving as a dry passage over wet ground or a river

Diadromous fish species: migratory species in which all, or the vast majority of, individuals migrate between marine and freshwater habitats as a routine and essential component of their life cycle (Myers, 1965; McDowall, 1988 as cited in Isaaman, 2005).

Divided Highway: A highway with a barrier (land, or concrete barrier) to separate lanes of traffic going in opposite directions

Free Tidal Flow: for the purposes of this paper, free tidal flow is the mixing of fresh and salt waters during high tide cycles, and also the moving of salt water down river

Jersey Barrier: a concrete barrier that separates lanes of traffic (often opposing lanes of traffic) with a goal of minimizing vehicle crossover in the case of accidents. Normally put into place during the twinning process

Lake Pisiquid: freshwater lake formed by the construction of the Windsor causeway, also known as Pesaquid Lake, Lake Pesaquid, Pisiquid Lake or Lake Pezaquid

Tide Gate: A vertical structure in a tidal barrier allowing fresh water to run off the freshwater lake and prevents salt water from entering the lake at high tide

Twinning: The creation of a divided highway from a single highway

Investigating the Options for Twinning Highway 101 at the Windsor Causeway:

A Biophysical, Socio-political and Legal Perspective

About 45 minutes northwest of Halifax, Highway 101 goes over a causeway across the Avon River. Driving over a causeway is not unique, at least not in Nova Scotia. With over 7000 km of coastline (Natural Resources Canada, n.d.), and considering the general topography of the coastline, causeways are a common road feature. What is unique about the causeway at the Avon River is its size, and its importance to transportation to the region. It is almost one kilometer long, and on average has approximately 30 000 crossings per day (Dwayne Cross, personal communication, February 2 2010).

Despite its size and importance, it is not obvious when driving over it that it is anything other than a normal highway. The river is barely visible, and the adjacent mudflats are covered in grass. This allows drivers on the causeway to have a sort of "out of sight, out of mind" relationship with the river crossing. While they may drive the causeway on a daily basis, motorists do not have to pay its existence much mind.

This may be short-lived. Just to the east, Highway 101 at St. Croix is in the last stages of being twinned. After this, the final section to be completed runs right through Windsor and over the causeway, and environmental assessment documents will be filed with Nova Scotia Environment within a month (Bob Pett, personal communication, March 24 2010). If all goes according to plan, construction of the final section of the twinning process of Highway 101 should begin in Windsor within 2 years. Drivers' "out of sight, out of mind" relationship with the causeway may not last much longer.

INTRODUCTION

The purpose of the paper is to investigate the foreseeable options for expanding Highway 101 at the Windsor causeway. Public pressure to improve highway safety by expanding Highway 101 must be balanced with environmental concerns surrounding the impact such development would have on local ecosystems.

Paper outline

In order to properly accomplish the purpose discussed above, this paper will be laid out as a timeline of the construction of infrastructure at the Avon River estuary. It will begin with a brief description of the region to provide context to the issues. This will be followed by a description of the twinning of Highway 101, along with a discussion of how highway safety concerns informed the twinning decision-making process. Following the timeline format to the paper, the body of the paper will begin with a discussion of the pre-causeway ecosystem, both aquatically and terrestrially. This will be followed by an account of the construction of the causeway itself. Next, the paper will lay out the current, post-causeway ecosystem, and discuss some of how social pressures such as media, place identity and public perception influenced the decision-making process. This will be followed by a brief description of the environmental assessment process and the current status of the environmental assessment report. The next section of the paper will focus on the biophysical, social and legal implications of the three twinning options being discussed: causeway expansion, causeway expansion with tide gate removal, and expansion with causeway removal/replacement. This will be followed by a discussion of the potential for ecological restoration in the Avon River estuary. Finally, the paper will be brought to a close with a discussion of conclusions and recommendations for effective implementation of the twinning process.

Biophysical Methods and Limitations

The biophysical aspects of each of the three options discussed below are by no means all inclusive. These implications are limited in some cases to the literature available on the topic or to the changes that would be most physically apparent to the people of Windsor. In addition, for the purpose of this report, the ecological baseline is the current status of the ecosystem as this is generally, the baseline also used by the literature addressing issues pertaining to the Windsor causeway.

Background

The Windsor causeway was constructed between 1968 and 1970 (Isaacman, 2005). The causeway provides a major highway and railway crossing over the Avon Estuary, permitting relatively high-speed travel along Nova Scotia's Highway 101. The last tidal flow went down the Avon River in 1970, and since then two new ecosystems have been created: a freshwater lake and a salt marsh. The causeway maintains these ecosystems, acting as a barrier between one new ecosystem and the other. The causeway removed tidal oscillations from the region upstream, and therefore is responsible for protecting almost 1400 hectares of previously dyked land from seasonal flooding (Daborn et al., 2003a). In the four decades since the construction of the causeway, many changes observed in the river, estuary and watershed have been ascribed to its presence (Percy, 2008).

The construction of barriers across tidal rivers and estuaries has a long history of altering the sediment dynamics and ecosystem processes in the surrounding area (van Proosdij et al., 2009). The degree of alteration to the system depends in part on structure design, surrounding geology, sediment characteristics, tidal range, and basin morphology. Tidal barriers can cause changes in sedimentation patterns within the estuary that may, over time, decrease the cross sectional area of the channels and the overall capacity of the system to distribute tidal waters (van Proosdij et al., 2009).

The Avon River Watershed has been a primarily freshwater system since the construction of the causeway, which generally prevents tidal movements and saltwater intrusion into the river. Formerly, the tide extended several kilometres upstream; the original head of tide on the South Branch of the river was approximately 16 kilometres above Windsor (around the Windsor Forks area) and on the West Branch of the river was approximately 5 kilometres from the confluence with the South Branch (Isaacman, 2005). The tidal extent no longer reaches upstream, blocked by the causeway forty years ago.

As part of the twinning of Highway 101, Nova Scotia Transportation and Infrastructure Renewal (NSTIR) has proposed the expansion or modification of the causeway to accommodate extra traffic lanes; which has further intensified concerns and questions regarding the threats posed by this tidal barrier (Isaacman, 2005). The causeway is now taking on the role of protecting the Town of Windsor, the surrounding community and farmland from flooding. This role could be altered if the structure itself is changed significantly (Resource Stewardship, 2007).

The town is located immediately adjacent to Highway 101, and this enables quick access to other regions of the province. Windsor is within easy commuting distance of Halifax (66 kilometres) and a number of its residents are employed in the Halifax Regional Municipality. As well, traveling west on Highway 101 about 30 km will take you to Kentville. This is another economic hub, which many Windsor residents often visit for various reasons. The economy of the Town of Windsor and surrounding area is centred on agriculture, the mining and export of gypsum, stone monument manufacturing, and service industries. Windsor is 890.3 hectares (2,200 acres) in size, and has a population of 3,705 (Town of Windsor, 2009).

The natural mixing of freshwater and saltwater in an estuary creates an ecologically rich ecosystem that provides unique habitat for a wide diversity of marine life (Bergstrom et al., 2004). Human activities are affecting the natural balance of salt and other chemicals in estuaries, resulting in changes in ecosystem functions and services in coastal estuaries throughout the world (Bergstrom et al., 2004). The Avon Estuary is no exception as the construction of the causeway and the tide gate has significantly changed the original estuary that existed in the area. The salt content of estuaries is also sensitive to increases or decreases in freshwater inflow resulting from changes of inland river system management. Changes in the delicate balance of freshwater and saltwater in coastal estuaries may also impact the natural habitat function of estuaries, resulting in increases in some fish and wildlife species and decreases in others (Bergstrom et al., 2004).

History of the Area

The region encompassing present day Windsor was originally known as Pesaquid, a Mi'kmaq term meaning "Junction of Waters." This name referred to the confluence of the Avon and St. Croix rivers, which flow into the Bay of Fundy (Town of Windsor, 2009). They were not the only people previously in the area. Later, the European settlers who began settling the area in the early 1600s were the Acadians, a small band of French settlers (Percy, 1996).

There were more than 35,700 hectares (88,200 acres) of productive salt marshes scattered around the Bay of Fundy when the Acadians first arrived in the Windsor area. Most of these salt marshes have long since been wrested from the sea, with seemingly far-reaching consequences for the marine ecosystem of the Bay of Fundy (Percy, 1996). In the 1630s, the Acadians dyked and drained a few acres of salt marsh at Port Royal (present-day Annapolis Royal, Nova Scotia), and discovered that the new dykeland could produce abundant crops year after year without the help of fertilizer. Farmland that

could produce two tonnes of hay or 50 bushels of wheat in a season soon became the means of providing most of the colonists' food and clothing and allowed a distinct Acadian society to prosper and grow (Resource Stewardship, 2007).

Permanent settlement by the British began in 1749. Fort Edward was built in 1750 and is the last original standing blockhouse in Canada; it stands at the top of a hill in the middle of the town. It was a main assembly point in the Acadian Deportation of 1755. In 1764, the Township of Windsor was created (Town of Windsor, 2009).

Settlers around the Bay of Fundy (primarily the Acadians) constructed dykes and aboiteaux for over 350 years in order to farm the fertile tidal marshes of the Bay of Fundy. An aboiteau is a one way gate structure designed by the Acadians, allowing freshwater drainage while preventing the entry of tidal waters and coastal flooding (van Proosdij, 2009). The dykelands supplied the basic needs of the Acadians so well that they largely avoided clearing the upland. In fact, when all available marsh had been dyked along the Annapolis River, the colony expanded to other marsh areas around the Bay rather than using available upland nearby (Resource Stewardship, 2007). Marshland in the province was privately dyked until 1948 when the federal government set up the Maritime Marshland Reclamation Administration (MMRA) (established in 1948) to rebuild the dykes in the Maritimes (van Proosdij, D. et al, 2006).

During the 1950's and 1960's the MMRA embarked on a major program to control most of the large rivers around the Bay with tidal barrages. These served to protect upstream farmland from tidal flooding and did away with the need for frequent, costly repairs to miles of riverside dykes. At the time, little, if any, consideration appears to have been given to the possible environmental consequences of blocking all these tidal rivers (Percy, 1996).

Highway 101 Twinning Project Description

For NSTIR, the project represents the final stage of an overall project to twin Highway 101 from Bedford to Yarmouth. This final stage of construction is called “Highway 101 Phase 4 twinning 3 miles plains to Falmouth”, and in total is 9 km long (Bob Pett, personal communication, March 24 2010). This section of the highway includes 4 interchanges, at exits 5, 5A, 6 and 7 respectively. The plan is to expand from 2 to 4 lanes throughout most of this section, although between exits 6 and 7, it will be expanded to 6 lanes. This is due to NSTIR policy regarding the distance between two consecutive exits.

If this distance is less than 2 km, traffic entering at one of the exits must be able to travel to the next exit without actually merging into traffic. The distance in question, between exits 6 and 7, is less than 2 km, and therefore a third "merge" lane must be constructed in each direction (Bob Pett, personal communication, March 24, 2010).

Of particular concern is the 1 km section of highway over the Windsor causeway. As discussed above, the causeway was completed in 1970 as part of the creation of Highway 101. Since then, the macro-tidal environment of the Bay of Fundy has caused sedimentation on the downstream side of the causeway, creating an extensive system of mudflats. Beginning in the early 1990's, some parts of these mudflats have transitioned to become a very productive salt marsh. The expansion of the causeway will infringe on the salt marsh and the mudflats by 14 m. This infringement must be compensated for according to the new Wetlands Conservation Policy for Nova Scotia.

The total cost of the project is expected to be approximately $100 million. Although the design has not been finalized, and the contract has not been put to tender, this estimate is based on an average cost of $1-2 million per km of construction, plus $10-20 million for each structures. These structures include the 4 interchanges mentioned above, as well as a short bridge over the current channel (Bob Pett, personal communication, March 24 2010).

The current design includes a bridge approximately 100 m long. It will be a clear span bridge, which means that there will be no bridge piers in the channel itself. This length represents approximately the maximum length possible for such a bridge. The expected cost of the bridge is $20 million, but this estimate will not be confirmed until the design is finalized.

This project will be jointly funded by the provincial and federal governments, although the final funding has not been approved. These funding concerns, along with the compensation issue, have delayed the project. This project is a very high priority for NSTIR, but as of yet, the funding has not been fully secured.

Once funding is finalized and the project is approved by the various interested agencies, such as NSTIR, Department of Fisheries and Oceans, Department of Agriculture, and Nova Scotia Environment, the project will be tender ready. Assuming that a funding package is prepared, the project would be put out to bid sometime in 2012 (Bob Pett, personal communication, March 24 2010). This mean that since

the decision to twin the highway in 2002, it will have been a decade before any decision has been made about what to do at the Windsor causeway.

Highway safety

The official motivation for the twinning of Highway 101 is highway safety (Transport Canada, 2008). The separation of the two directions of traffic by a median has proven to virtually eliminate the potential for head-on collisions, greatly the reducing the frequency and severity of accidents (Transport Canada, n.d.). Obviously, from an analytical point of view, twinning a highway has merits. And while, in a court of law, a government may not be liable for any decisions it makes whether to twin highways or not (see *Just v. British Columbia* (1989) 2 SCR 1228), the court of public opinion may come to a different verdict. Often, to governments, the court of public opinion is more important than a court of law.

The court of public opinion in the town of Windsor is definitely sympathetic to the cause of highway safety. In a conversation with the Mayor of Windsor, Paul Beazley, he reiterated, over and over, how important the twinning project was for highway safety, and how important highway safety was to the people of the town of Windsor (Mayor Paul Beazley, personal communication, March 12 2010). In the opinion of Mayor Beazley, the people of Windsor are concerned with the environmental impacts of twinning the highway, but are unwilling to allow these to delay remedying the issue of highway safety in their town (Ibid).

Just v. BC

In *Just v. British Columbia* (1989) 2 SCR 1228, the Supreme Court of Canada ruled on the issue of government liability. It found that while British Columbia Department of Highways would in fact owe a duty of care to the motorists on the highway in question (or any highway for that matter), the question of whether it is liable for decisions would depend on whether the decision was one of policy or operations. In this case, the matter was one of inspections, and their relative quantity and quality. It was determined that this was a decision of policy, and therefore exempted the Department of liability. Applying this to the issue of highway expansion, it can be expected that a court would deal with such decisions in a similar fashion as in *Just v. British Columbia*. In all likelihood, the court would apply the test laid out in *Just*, and determine that the decision to twin a highway is one of policy and therefore exempt from liability.

The raw statistics would certainly seem to support the townspeople's concerns with highway safety on Highway 101 at Windsor. While it has recently been overtaken as Nova Scotia's deadliest highway by Highway 103, there is still a significant number of fatal accidents on Highway 101. Between 2006 and 2009, 14 people were killed on the 300 km-long highway (CBC, 2009).

Perhaps more impactful than the raw statistics, however, is a local perspective on the issue of fatal accidents. Fire Chief Scott Burgess has been with the Windsor Fire Department for 22 years, and has experienced the perils of the stretch of highway near Windsor first hand. As fire chief, he is responsible for a 31 km-long section of Highway 101, which he characterizes as "a deathtrap" (Scott Burgess, personal communication, March 26 2010). On a tour of the entire 31 km-long stretch, which includes the causeway, he pointed out the number of crosses on the side of the road memorializing the fatal accidents that occurred there. In total, over the course of the whole section, he pointed out between 25-30 fatal accidents that he can remember from 22 years with the fire department. In the past two and a half years, he can remember fatal accidents just on un-twinned section of Highway 101 alone.

He has also noticed a decrease in the number of serious accidents on the currently twinned section of highway within his jurisdiction. As mentioned above, the twinning of Highway 101 is completed up to St. Croix. Since this twinning was completed, Chief Burgess cannot remember needing to land the heli-vac in that area. On the other hand, he can remember doing so a number of times on the un-twinned section to the west (Scott Burgess, personal communication, March 26 2010). For a long time, the most dangerous section of his jurisdiction was the section to the east of St. Croix, but since the twinning, the number of accidents has decreased drastically.

This recollection of fatalities along the un-twinned highway has therefore been the motivation for twinning the highway. It is obvious that the twinning of the highway has been beneficial in reducing the number of accidents and deaths on the highway. Windsor wants to get rid of the "deathtrap" lingering on the outskirts of town. The Windsor causeway has presented itself as a difficult barrier to overcome in the design and timely implementation of twinning project.

WINDSOR BEFORE THE CAUSEWAY (PRE-1968)

Aquatic Ecosystems

Through research, conflicting information in relation to fish populations in the Avon River historically has been found. Isaacman (2005) describes the historical evidence of Inner Bay of Fundy (iBoF) Atlantic salmon, gaspereau (including blueback herring and alewife), rainbow smelt, American eel, sea-run brook trout (also known as sea-trout), white perch, three species of stickleback, American shad, striped bass, Atlantic sturgeon, and Atlantic tomcod species in the Avon River. Some species have been observed in the Avon Estuary much less than others, indicating that these species may not have used the Avon for spawning. The evidence presented seems to indicate that all of the species experienced declines in populations before 1970; however none of these declines were as drastic as the numbers observed since the construction of the causeway. By the late 1860s, observations were being made in the decline of anadromous[1] species, such as salmon, smelt, sea-trout and gaspereau, but it seems that there was a brief period of recovery for these species between the late 1800s and early 1900s. This is probably due to the introduction of fish stocking in the late 1800s.

Atlantic Salmon and First Nations

Historically, Atlantic salmon have played a vital role in many cultures around the world. For over 20,000 years nations across the globe have depended on these animals for food and as artistic inspiration to name a few. In particular, Atlantic salmon have been and continue to be significant First Nations of eastern Canada, including the Mi'kmaq People who called the fish *plamu*. For the Mi'kmaq this species of fish indicated the passing of seasons as a result of its migration patterns in addition to its integral role in their diet (Atlantic Salmon Federation, 2010). Today, as Atlantic salmon are listed as *Endangered* on the federal *Species At Risk Registry* First Nations communities are working with governments to help identify and mitigate threats to the survival of this species (Gespe'gewaq Mi'gmaq Resource Council, 2009).

Falling populations were observed once again, in particular in salmon populations, following the hydro-power development on the south and west branches of the watershed between the 1920s and 1930s. Contradicting sources make it difficult to ascertain the exact status of the fish populations prior to the construction of the causeway, but documents by the Department of Fisheries and Oceans (DFO) from the 1960s indicate that anadromous runs (salmon, sea-trout, smelt, gaspereau, and shad) had significantly declined by the mid-1960s. However, on the contrary, local

[1] Anadromous fishes are species which migrate from marine to freshwater habitats to spawn (Isaacman, 2005).

community members assert that fairly good anadromous runs, including salmon, continued up until the causeway's construction.

Terrestrial Environment

Mudflats and Wetlands

Extensive intertidal flats were evident at low tide on the Avon River near the Town of Windsor during the winter of 1963. Aerial photographs (Figure 1) demonstrate evidence of natural bar formation in the location of the future causeway (van Proosdij et al., 2006). According to Percy (2008), sedimentation historically occurred along the Avon River, creating riverside mudflats and salt marshes as far upriver as the tide could reach.

Figure 1 Picture of the Mouth of the Avon River showing natural bar formation, 1963 (van Proosdij & Bambrick, 2006)

Dykelands

Extensive habitat alteration and degradation of the original ecosystem began immediately upon European settlement in 1685 along the Avon River. The Acadians constructed dykes along much of the tidal portion of the lower Avon River and estuary to convert the fertile salt marshes into productive agricultural lands (Isaacman, 2005). This resulted in the disappearance of much of the salt marsh in the lower Avon River Watershed.

Industry

Before the causeway was constructed across the Avon River, there were other crossings over the river. The construction of the rail bridge began November 2nd, 1867, and the first through train from Annapolis to Halifax January 1st, 1872 (Percy, 2008). This was an important connection to make because it connected agriculture from the valley area to Halifax, and eased commuting.

In 1878, Windsor was incorporated as a town. Windsor's harbour created a favourable environment for shipping and shipbuilding during the age of sail and it became a major port. As more efficient land transportation became available, Windsor's importance as a seaport diminished (Town of Windsor, 2009).

Barriers on the Avon River

There are five barriers along the Avon River that were built between 1920 and 1954. These barriers were built to produce hydro- power, and are still in operation today. Some barriers have fish ladders built within them but others do not. There are also two waterfalls on the river, which impede fish passage upstream from the current causeway. Hydro-power development has significantly impacted the watershed's aquatic ecosystem and therefore has probably been one of the primary reasons for the contemporary declines in fish populations (Isaacman, 2005).

As Issacman (2005) discusses, in the early 1920s, the Avon River Watershed began to be developed for hydro-power generation (Shanks, 1994 as cited in Isaacman, 2005). The Avon River hydro power system is owned and operated by Nova Scotia Power Inc. and consists of a series of power dams, storage dams, and pipeline diversions. Two power dams were, as mentioned above, were installed on the lower South Branch, both without fish passage provisions. Storage dams were also built in the upper Avon River Watershed. In the mid-1930s, a dam was built diverting water flow into the Gaspereau River system (Smith, 1965 as cited in Isaacman, 2005).

The major detrimental effects of the hydro-power development on fish populations and other wildlife are likely to have been from the alteration of downstream hydrological conditions (e.g. water levels, flow rates and patterns), which subsequently affected water quality, disrupted habitat, and impeded fish migration (Isaacman, 2005).

CONSTRUCTION OF THE WINDSOR CAUSEWAY

The construction of the Windsor Causeway was conducted in phases. In September 1968, rock fill was extended from the western edge for a distance of 91.5 metres (300 feet) from the new tide gate structure. In November 1968, infilling began from the other side. By July 30, 1969, 33% of the project had been completed, with that number increasing to 54% by November 1969. By January 1970, a gap of only 305 metres (1000 feet) remained for water exchange. The causeway was closed completely in July 1970 and the tidal gates were opened for use (van Proosdij, et al., 2006). The first cars drove across the causeway later that autumn. The 700 meters (2,300 feet) long causeway required 1.65 million tonnes of rock fill (Percy, 2008).

Windsor Causeway Construction According to Mayor Paul Beazley

Every generation has an identifying moment; a moment where everyone knows where they were, and with whom. For many baby boomers, that moment was the moon landing. For younger generations, that moment was September 11, 2001. People generally remember these moments not out of some form of book learning or memorization, but rather simply by experiencing the event.

According to Mayor Paul Beazley, for many who grew up in Windsor and who lived there in 1970, that identifying event was the closing of the causeway. This is not to say the construction of the causeway; that event took too long to be truly identifiable and iconic. But rather, Mayor Beazley says that the day that the causeway was closed, when the flow of the river was stopped, that day was an iconic, identifiable event for the people of Windsor (Paul Beazley, personal communication, March 12 2010). Mayor Beazley remembers that the first two attempts to block the Avon River failed. Finally however, on the third try, in July 1970, the flow of the Avon River was stemmed.

The Windsor causeway replaced an existing train bridge upriver from the town and resulted in the rerouting of the Dominion Atlantic Railway's Halifax-Yarmouth main line. The rail line used to run through Windsor's downtown, crossing the river on a bridge parallel to the road bridge immediately upriver from the town. Interest in the construction of a causeway across the Avon River in the Town of Windsor was formally initiated sometime around 1966 in collaboration with the Nova Scotia Department of Highways and the Dominion Atlantic Railway (van Proosdij et al., 2006).

The construction of the Windsor causeway forty years ago did not include a fish passage. This is because DFO gave an approval for the causeway to be constructed following a study to assess diadromous fish (that is, fish that migrate between marine and freshwater environments as part of their life cycles)

populations in 1965, which found that the Avon River had little value to these species (Isaacman, 2005). Furthermore, it was thought that appropriate operation of tide control gates would allow sufficient migration of diadromous fish if any were present (Daborn et al., 2003a).

Issacman (2005) discusses why there is conflicting information regarding fish population estimates. The various interests (e.g. the Provincial Government and Town of Windsor) in favour of constructing a causeway and in a cost-effective manner may have influenced DFO's interpretation of the 1965 study results. This may have led to an overestimated perception of the insignificance of diadromous runs and thus threats to potential fisheries posed by a causeway. Conversely, the negative opinions of some local stakeholders towards the past and future impacts of the causeway may have led them to recollect larger fish abundances and smaller declines prior to, and therefore more significant declines following, its construction (Isaacman, 2005). Moreover, recreational fishers may have been unaware of the extent of declines due to advances in fishing gear technology (Post *et al*., 2002 as cited in Isaacman, 2005), lower water levels (e.g. from hydro power operations) or other factors, which may have enhanced the detection and capture of fish even as populations declined (Isaacman, 2005).

In addition to the lack of fish ladder in the causeway design, there was also no requirement for a formal environmental impact assessment at the time of construction. This is because the legislation that currently exists in Canada was not yet assented. There is now legislation in Canada, enacted in 1973, that requires a project such as the Windsor causeway to have a formal environmental assessment completed.

PRESENT ISSUES AT THE WINDSOR CAUSEWAY

The Windsor causeway has now been in place for forty years. This has resulted in major alterations to the ecosystem, causing a number of biophysical, social and legal consequences. Both the aquatic and terrestrial ecosystems in the region have changed significantly, which has altered the way local people interact with the environment. Furthermore, the creation and amendments of laws since the causeway was constructed has changed the way these ecosystems are protected, which sheds a new light on how they are valued.

The Aquatic Ecosystem

The once single estuary ecosystem at the mouth of the Avon River has since been divided into two separate marine and freshwater ecosystems by the Windsor causeway. These aquatic ecosystems will be referred to as the lower Avon River on the seaward side of the causeway, and Lake Pisiquid[2] on the upstream side. The differences in these ecosystems are attributed to the causeway preventing fish, sediment, nutrients, and saltwater or freshwater from breaching to the other side.

The most significant change to the aquatic ecosystem is the decline of diadromous fish populations in the Avon River Watershed (Isaacman, 2005). Recent studies and anecdotal experience show that major declines in these fish populations have occurred with many blaming the causeway, as significant changes in populations began to manifest within a few years after the causeway's completion (Isaacman, 2005).

Legally, flags should have been raised when the causeway was first designed in 1968 as the causeway has since contributed to the decline of fish populations. When the causeway was constructed, the *Fisheries Act* of 1952 was in force. Section 20(1) of the Act states that if the Minister determines it to be necessary for the public interest that a fish passage should exist, any obstruction across or in a stream must have an efficient fish-way. As previously mentioned, DFO did not consider the Avon River as a significant habitat for diadromous fish species, but it has since been determined through historical and current evidence that these species were and still are present in the region and that some fish cross through the tide gate (Daborn & Brylinsky, 2003; Isaacman, 2005). Based on this information, it is apparent that when the causeway was designed, DFO should have insisted that the causeway should have been built with a fish passage feature.

[2] Also known as Pisiquid Lake, Lake Pesaquid, Pesaquid Lake, or Lake Pezaquid

The Lower Avon River

According to Isaacman (2005) the most pronounced change has been observed in iBoF Atlantic salmon populations, which have not been reported in the Avon Watershed since the late 1980s. This is quite devastating considering that during the 17th and 18th centuries the Avon River was considered as one of the most important salmon rivers in Nova Scotia (Isaacman, 2005). It is true that salmon populations fell dramatically even before the causeway, but Isaacman (2005) reports that salmon runs were still fairly common prior to 1970. In a report produced by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2006), it is stated that in 2003 there were less than 100 wild anadramous (that is, fish that move from marine to fresh water as part of their life cycle) adult breeders of iBoF salmon spread across all the rivers of the inner Bay of Fundy, with 50-75 being the most likely estimate, and 200 being the maximum (Isaacman, 2005). The species has been listed as critically endangered by COSEWIC since 2001, and under the Species at Risk Act (SARA) since 2003. With such few numbers, it is unlikely that any of these individuals currently use the Avon River to spawn.

Daborn and Brylinsky (2003) conducted studies in the lower Avon River to determine the status of fish populations. Thirteen American eels, a catadromous[3] species, were caught on the seaward side of the causeway, but damage to bait indicates that eels were common in the area. American eel is an important species to consider because it is listed as a species of Special Concern by COSEWIC (DFO, 2009b). Gaspereau were quite abundant and represented almost half of the fish caught during this study. It is likely that the research was conducted too late in the season to catch smelt during spawning migration, resulting in no data on smelt. Striped bass was found below the causeway but it was difficult to determine if any spawn or feed in the Avon River. Lack of data on other species may have been due to limited sampling and relatively low abundance, as opposed to complete absence. Anecdotal reports suggest that spawning runs of alewife, blueback herring, and sea-trout still persist, and eels are still present, but all are much below their pre-causeway abundances (Isaacman, 2005). Table 1 summarizes the historic and current status of diadromous fishes in the Avon River.

[3] Catadromous fishes are species which migrate from freshwater to marine habitats to spawn (Isaacman, 2005).

Table 1: Historic and Current Status and Characteristics of Diadromous Fish Species in Avon River Watershed

Species	Historic Presence[1]	Evidence of Spawning Stock[2]	Current Status[3]
Atlantic Salmon	P	Y	N
Gaspereau	P	Y	D
Smelt	P	Y	SD
Sea-trout	P	Y	D
Shad	P	I	N
Striped bass	P	N	EP
Eel	P	N/A	EP
Sea lamprey	N	N	N
Atlantic Sturgeon	N	N	N
Tomcod	P	N	N

[1] *P*-present; *N*-no records of presence
[2] *Y*-spawning stock; *N*-no indication of spawning; *N/A*-not applicable; *I*-inconclusive
[3] *D*-declined from historic abundance; *SD*-significantly declined from historic abundance; *EP*-evidence of presence, but status unknown; *N*-no records of presence in recent years (Isaacman, 2005)

As previously mentioned, iBoF salmon and the American eel are designated as species of concern by COSEWIC. This is the main reason activist group, Friends of the Avon River (FAR), has petitioned local, provincial and federal governments to remove the causeway and replace it with a bridge (Eagles-Harvey, 2008; Sonja Wood, personal communication, March 12, 2010). FAR believes that the causeway is directly impeding the migration of these species to critical habitat, furthering contributing to their endangerment (Eagles-Harvey, 2008; Sonja Wood, personal communication, March 12, 2010). The designation by COSEWIC and FAR's concerns indicate that there is a social concern for fish species in the Avon River Watershed.

Comment [s1]: Mentioned later as well

Lake Pisiquid

South of the causeway lies Lake Pisiquid – a mostly freshwater impoundment that was formed when the causeway was constructed (Daborn et al., 2003a). Water flowing downstream, toward the sea, from the Avon River and its tributaries is stopped by the man-made barrier provided by the causeway (Figure 2) (Daborn et al., 2003a). The lake has a depth of approximately 2.75 metres (9 feet), which is maintained by the tide gate (Daborn et al., 2003a).

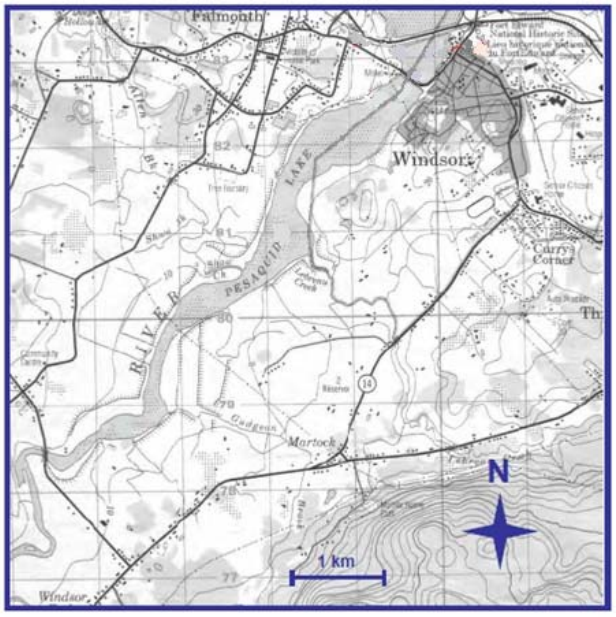

Figure 2. Map of Windsor, Nova Scotia displaying the location of Lake Pisiquid. Source: Daborn et al., 2003.

Daborn and Brylinsky (2003) studied fish populations in Lake Pisiquid and discovered there were eleven fish species in the lake: alewife, blueback herring, yellow perch, white perch, white sucker, small-mouth bass, lake chub, redbelly dace, banded killifish, threespine stickleback, fourspine stickleback and ninespine stickleback. The only anadromous species found on the Lake Pisiquid side of the causeway were gaspereau (blueback herring and alewife) and white perch. Nearly half of all the fish surveyed were gaspereau (Daborn & Brylinsky, 2003). Another interesting observation was eight of the eleven fish species in the lake were freshwater species and would only be found in Lake Pisiquid and the upstream arms of the Avon River (Daborn & Brylinsky, 2003). None of these eight species would typically be found

in the water of the downstream or seaward side of the causeway (Daborn & Brylinsky, 2003). Not only were the species of individual fish identified, but specimens were weighed and measured (Daborn & Brylinsky, 2003). These measurements allowed the researchers to draw conclusions on the quality of fish habitat being provided in Lake Pisiquid (Daborn & Brylinsky, 2003). Through the use of length to weight ratios, rates of growth were estimated for fish and found to be fairly reasonable (Daborn & Brylinsky, 2003). Being able to support reasonably normal, growing fish populations was used as an indicator for Lake Pisiquid being biologically productive (Daborn & Brylinsky, 2003).

Physiochemical conditions of Lake Pisiquid have been studied to determine the water quality. In the past there have been suspicions about farm run-off entering Lake Pisiquid since there is agriculture being conducted in fairly close proximity (Daborn et al., 2003a). Additionally, since the causeway prevents the lake from being flushed by tidal inflows, sediments and nutrients are expected to accumulate (Daborn et al., 2003a). Unexpectedly the first study on lake water quality, which took place in 2002, produced very positive results (Daborn et al., 2003a). Dissolved oxygen levels in the lake were high, there was no evidence of algal growth, and nitrate concentrations were low (Daborn et al., 2003a). Though the authors had found a separation of water quality, where higher salinity water would be found deeper in the lake and freshwater made up the surface water, this was primarily located in the water closer to the causeway (Daborn et al., 2003a). This suggested that some of the seawater was breaching the causeway and flowing into Lake Pisiquid (Daborn & Brylinsky, 2003). For the 2002 study the most significant finding was the absence of algae or excess nutrient content in Lake Pisiquid (Daborn et al., 2003a).

Only a year later, in 2003, another study was designed and conducted to further examine water quality in Lake Pisiquid (Daborn & Brylinsky, 2003). In this case the results were mostly the same (Daborn & Brylinsky, 2003). Oxygen saturation levels were high, greater than 70%, but not high enough to indicate the presence of algal blooms (Daborn & Brylinsky, 2003). There was still a discrepancy in higher salinity water sinking to the bottom of the lake and freshwater remaining in more shallow waters (Daborn & Brylinsky, 2003). But again it should be noted this phenomenon was most common in the water near the causeway, sometimes referred to as the Headpond of Lake Pisiquid. This 2003 study corresponded with the findings of the year before, namely that agricultural run-off and excessive nutrient loads were not a problem in Lake Pisiquid (Daborn & Brylinsky, 2003).

Lake Pisiquid is not only an important habitat for fish and other species, but it is also valued by the community of Windsor. The lake provides Windsor "with an attractive waterfront skirting a broad expanse of placid water," which contrasts with the seemingly barren mudflats and churning muddy waters that were the typical sight before the causeway (Percy, 2008, p. 9). It has also increased the value of waterfront property in the area (Percy, 2008). Further, the lake provides recreational opportunities, including canoeing, kayaking, and the Windsor-West Hants Pumpkin Regatta (Percy, 2008). The Pumpkin Regatta is part of the Giant Pumpkin Festival, a major annual tourist attraction that draws 8-10,000 visitors from around the world to the region (Lawrence, 2007). Lastly, water from the lake is used by Ski Martock, a skiing operation, to make snow for its seven runs on the nearby 185 m high Martock Mountain (Percy, 2008). This ski hill attracts visitors from across Atlantic Canada and is an important contributor to the local economy (Percy, 2008). According to Jim Boylan-Martock, the owner of Ski Martock, the operation would be out of business without the freshwater supply from Lake Pisiquid (Jim Boylan-Martock, personal communication, April 9, 2010). If any alteration is made to the causeway, the implications it may have on the lake will have to be considered as it is highly valued in the society.

The Terrestrial Environment

The construction of the causeway brought changes to terrestrial ecosystems and structures as well. As previously mentioned, tidal waters used to be able to deposit sediment to the upper reaches of the Avon River, causing the development of salt marshes and mudflats farther upstream. However, when the causeway was built the tidal waves were cut short at the mouth of the river, effectively starving the salt marshes and mudflats upstream of sediment and seawater, while at the same time causing the accumulation of sediment on the seaward side of the causeway (Percy, 2008). This accumulation of sediment has developed over the past forty years into an entirely new wetland ecosystem. Further, structures such as dykes and aboiteaux that once protected valuable agricultural land were no longer needed once the causeway was built. Over the years, dykes were removed or fell into disrepair and the aboiteau was replaced with a tide gate (Percy, 2008).

Wetlands

Since the closure of the causeway in June 1970, perhaps the most noticeable change is the increase of sedimentation along the seaward side banks of the causeway, which has resulted in the vast expanse of mudflats and salt marshes from Windsor to Hantsport (about 20km) along the Avon River

(Daborn et al., 2003a). Sediment of the Windsor causeway tidal flat is predominately clayey silts (~68% silt and ~23% clay), with mean grain size of 23-30 µm (Daborn et al., 2003a). A range of physical characteristics affects what happens to a mudflat ecosystem. These physical characteristics keep mudflats in constant flux, making them dynamic and fascinating systems (DFO, 2007). In 1975 and 1976, Carl Amos from Bedford Institute of Oceanography conducted a study to examine the dynamic forces operating in the upper Bay of Fundy, including Windsor Causeway. The rate of sediment accretion on Windsor mudflats during 1975 and 1976 ranged from 1.0 – 14.0 cm per month, averaging about 5.0 cm per month (Daborn et al., 2003a). This rapid rate of settlement produced a soft, muddy deposit, which has remained fluid to this day.

Previously, the mudflats were a desert, devoid of biota. However, since the 1980's, the lifeless mudflats have been brought to life in the form of a highly productive marsh downstream of the existing causeway below Windsor (van Proosdij, Bambrick & Baker, 2006). The salt marsh is one of the most productive ecosystems in the Bay of Fundy. The salt marsh has increased the biodiversity of the area with plants, insects, shorebirds and other animals. The characteristics of the mudflat-salt marsh system have visibly changed during the last three decades, becoming larger in size as the mudflats are colonized by salt marsh grasses, particularly *Spartina alterniflora* (Daborn et al., 2003a).

Another biophysical change to the flow of the Avon River is that it has become shallower and wider over the years. This is due to erosion from the aggressive tides at the mouth of the river, making it wider, and then the water carrying the sediment and depositing it up river making it shallower. Tidal barriers decrease turbulent energy in the tidal system causing sediments and other particles to drop from suspension and accumulate as deposits of mud, sand and silt (van Proosdij et al., 2006). This increased sedimentation has changed the channel of the river over the years.

There is anecdotal evidence of this from FAR member, Sonja Wood. During an interview, Wood told the story of how her land area has decreased since the time she bought it over two decades ago. She made particular mention of the fact that when she bought her property it was 16.6 hectares (41 acres), and as a result of erosion along the mouth of the Avon River, her property has diminished in size to about 11 hectares (28 acres) (Sonja Wood, personal communication, March 12 2010). It is difficult to determine, however, if this is a direct result of the causeway or if the erosion would have occurred naturally. Undoubtedly, a percentage of the erosion would be naturally occurring, but the causeway may have also been a factor.

Dykelands

It is important to remember that before the causeway was constructed, 26 kilometres of dykes and 36 associated aboiteaux, which were maintained by the MMRA, protected more than 1311 hectares (3240 acres) of agricultural land (Percy, 2008). The MMRA helped to partially fund the causeway construction because the causeway would prevent the need to maintain and repair the long stretch of dykes. Once the causeway was constructed, there was no longer a need for the dykes and aboiteaux, so some were removed or fell into disrepair (van Proosdij, 2009).

In addition to protecting dykelands, the causeway also prevents parts of downtown Windsor from periodic flooding (Percy, 2008; van Proosdij, 2009). Flooding is still possible, however, under storm conditions and/or at high tide, when the tide gate cannot adequately discharge water (van Proosdij, 2009). It is evident that the causeway plays a vital role in the protection of the local community's property, livelihood and economy.

Because of its function of protecting agricultural land, the causeway is now operated and maintained by the Nova Scotia Department of Agriculture. The province took over this responsibility from the MMRA between 1967 and 1970 (Nova Scotia Department of Agriculture, 2007). However, the responsibility over the causeway overlaps with NSTIR as the causeway is also an important highway and railway link. It is likely that these two departments would have to collaborate on any issue affecting the causeway.

Tide Gate Operation

The downstream flow of water of the Avon River, as well as the upstream tidal flow, is controlled by the tide gate located at the western end of the Windsor causeway. This is a vertical gate structure controlled automatically by computer, based on decisions made by an operator on a daily basis. These decisions are made based on the tide cycle, lake elevation and storm events. When the tide goes out and reaches the level of the lake, the gates are opened to allow for flow of water out of Lake Pisiquid. The exact amount the gates are opened, or how many gates are actually opened (one or two), is determined by the operator based on the level of the lake, as influenced by storm events, and the tide cycle. The lake has a set elevation, based on the time of year, and the operator attempts to keep this level as stable as possible by opening and closing the gates a certain amount. During large storm events, however, the level of the lake can rise by 2ft. per hour, creating a need to allow more fresh water out of Lake Pisiquid once the tide goes out (Ken Carroll, personal Communication, March 26 2010). See figure 3, a typical daily cycle of gate openings, tide cycles and lake elevations.

Figure 3. A typical daily cycle of gate openings, tide cycles and lake elevations. Source: Department of Agriculture, 2010

Environmental Impact Assessment

The Canadian Environmental Assessment Agency (CEAA) (2010) defines EIA as a process that "identifies possible environmental effects, proposes measures to mitigate adverse effects, and predicts whether there will be significant adverse environmental effects, even after the mitigation is implemented." EIA is designed to promote better project planning by informing decision-makers of possible environmental consequences of alternative development options, and using the information gained to reduce or avoid adverse effects (Duinker and Baskerville, 1986; CEAA, 2010; Nova Scotia Environment, 2009). EIA in Canada requires the consideration of biophysical consequences; social impacts on lifestyle, health, culture, historical resources and economic; and how these effects could relate to each other and change over time (Hanna, 2005). This information is collected during field surveys, modeling, background research, and consultation with governmental departments, non-government organizations, aboriginal communities, the general public, and various other stakeholders.

Though not usually a requirement for road and highway expansions, an EIA is required for the expansion of the Windsor causeway because the causeway was constructed before March 17, 1995, which was when provincial legislation for the exclusion of road expansions was created (Nova Scotia Environment, 2009). An EIA is required to assess the ecological and social impacts that the expansion may cause. This is legislated under the Canadian Environmental Assessment Act and the Nova Scotia Environmental Assessment Regulations. Both the federal and provincial governments will be involved in the EIA process for this project because the project affects a provincial highway, as well as involves federal departments – Transport Canada and the Department of Fisheries and Oceans – and uses federal funding. Federal EIA triggers can be found in the Canadian Environmental Assessment Act, s. 5(1). Because both governments are involved, a harmonized EIA must take place, which means that the two governments will collaborate to ensure that the EIA satisfies both of their requirements (NSE, 2009).

COMMUNITY FACTORS INFLUENCING MULTIPLE TWINNING OPTIONS

Why is there a need to consider multiple twinning options for the Windsor causeway? Public opinion surrounding the conservation of the salt marsh, the restoration of fish habitat, and community identity with both Lake Pisiquid and the historic Avon River, has resulted in pressures to rethink the current expansion plan. As a result, this report will highlight three foreseeable options for twinning the Windsor causeway. NSTIR's current proposal is to widen the existing causeway by 14 m on the seaward side. Based on expert opinion, a second hypothetical option could be that the tide gate is continuously open in the spring and summer. A final option for consideration could be the partial or full removal of the causeway and the replacement with a bridge. Since these options are a result of public influence, it is important to analyze several perspectives, such as the ones held by various stakeholders related to this case.

Stakeholders

For any project there will be stakeholders, and the project of twinning the Windsor causeway is no exception. There are government departments, such as Nova Scotia Transportation and Infrastructure Renewal (NSTIR), Nova Scotia Department of Agriculture, Nova Scotia Department of Environment (NSE), Department of Fisheries and Oceans (DFO), and Canadian Environmental Assessment Agency (CEAA). Another stakeholder group are the general community members, which include the Mayor, recreationalists, business and home owners, and motorists. Any development that has an environmental impact will likely have associated concerned environmental organizations. In the case of twinning Windsor causeway these groups are Friends of the Avon River (FAR) and the Avon Peninsula Watershed Preservation Society (APWPS). Other interest groups include Ski Martock, Hantsport Chamber of Commerce, Pisiquid Canoe Club, researchers and academics (Table 2). This is not an exhaustive list, but throughout our research, this is the list of stakeholders we deemed to be affiliated with the issue. A handful of stakeholders will be highlighted in this section to show the varied interests of each group to gain an understanding of the different perspectives.

Table 2: List of involved stakeholder groups for the twinning of Windsor causeway

Stakeholders
Nova Scotia Department of Agriculture
Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR)
Department of Fisheries and Oceans (DFO)
Friends of Avon River (FAR)
Avon Peninsula Watershed Protection Society (APWPS)
Windsor Citizens
Recreationalists
Ski Martock
Motorists
Mayor Paul Beazley
Pisiquid Canoe Club
Canadian Environmental Assessment Agency (CEAA)
Hantsport Chamber of Commerce
Business and residential owners
Researchers and Academics

Governmental Stakeholders

There are many stakeholders, several of which will be highlighted for special interest. First and perhaps most obviously, are NSTIR, DFO and Department of Agriculture. As mentioned earlier, NSTIR is the proponent because the highway is within their jurisdiction. They are primarily responsible for creating the expansion plans and providing funding for the project. Although NSTIR is responsible for the highway, the road itself is located on a dyke, which falls under the jurisdiction of the Department of Agriculture. As the dyke crosses through the mouth of the Avon River, it interrupts the flow of the river, which is under the jurisdiction of DFO. The result is the involvement of three government departments from both federal and provincial levels that need to collaborate in order to make decisions on the project. This can create confusion and consume time when it comes to decision-making and project advancement.

Department of Agriculture

The Department of Agriculture is responsible for the upkeep of the dykes that protect farmland around Windsor (and is also responsible for maintaining dykes throughout the province). However, they

are not responsible for any dykes that protect the town from flooding. These dykes protect about 3240 acres of agricultural land from flooding (Daborn et al., 2003). However, over the last few decades since the causeway was constructed, the majority of the upstream dykes have fallen into disrepair because the causeway has acted as a form of flood protection. If there were to be any alteration of the causeway, great consideration would have to be given to the upkeep of the dykels up river. Although the Department of Agriculture does not have power over the decision to twin the highway, or how it should be twinned, they could be greatly affected. They would have to rebuild dykes along the river to prevent flooding of the currently protected agricultural land, and they would lose control over the operation of the tide gate.

Ski Martock

Another interest group of special notice is Ski Martock. It may not be directly obvious why they are involved, but it should be realized that they are important to consider. Ski Martock is located about 3km south of the town of Windsor and is a popular vacation destination for many Nova Scotians. Ski Martock opened in 1965 and since 1980 has been drawing water from the fresh water Avon River to make snow for the ski hill. The ability for a ski hill in the Maritimes to make snow is an integral aspect to the success of their business. Without snow there is no skiing, and without the fresh water in the Avon River, there is no snow. In this way, Ski Martock is dependent on the causeway and the tide gate, which controls the fresh water in the river and lake.

If the causeway was removed or free tidal flow was restored in any way, it would result in the lost ability for Ski Martock to make snow. This is because restoring free tidal flow would create brackish water where there is current fresh water in the river and lake. In addition, the water would be inconsistent and muddy. This means that the water could not be used to make snow. In an interview with the owner of Ski Martock, Jim Boylan-Martock stated that there is no other location that they can retrieve water from that is close enough to their operations. If the causeway was removed and replaced with a bridge, Ski Martock would be out of business. Ski Martock also employs about 200 people and host about 100 000 people in the winter, whom would be out of a job or vacation destination if free tidal flow was restored. In an interview with Jim Boylan–Martock, the owner of Ski Martock, it is in their best interest to keep the causeway there in any twinning plans (Jim Boylan-Martock, personal communication, April 15 2010).

Friends of the Avon River (FAR)

A third and important interest group is the active environmental organization called Friends of the Avon River (FAR). FAR is a small grassroots environmental organization based out of Windsor. Sonja Wood is the Chair of the group and has been actively involved with them since 2004. When FAR first formed, their focus was centered around a highway twinning issue. However, as a group they have educated themselves and realized they are more concerned about a fish issue. This is where a lot of the misconception has likely come from about what FAR wants. FAR's main concern is about fish, not the twinning of the highway. This does not mean they do not support the twinning project because that is not the case. They support the twinning of the causeway for improved safety, however, Wood is concerned with the lack of fish passage at the causeway and the now endangered Atlantic salmon and American eel. As a result, for any modifications to the causeway, FAR would like to see a comprehensive EIA of the watershed and would ideally like a twinning solution that includes a bridge or the allowance for free tidal flow to improve fish habitat.

As NSTIR seems to be turning away from the construction of a bridge, FAR still believes that free tidal flow of the Avon River by the construction of a bridge will be the end goal. If construction of a bridge is not the decision made now, FAR wants steps to be made towards restoring free tidal flow over the next ten to fifteen years, so "do [the EIA] right, right now" (based on the case of the Petitcodiac River causeway, which will be explained later in this report).

The Petitcodiac River causeway has set the precedent for causeway removal in the Maritimes and FAR would like to see the Avon River treated the same way. The Petitcodiac has been re-examined and corrected such that the tide gates are going to be opened full time in the spring and summer, and there are plans of a 280m bridge (AMEC, 2005). This would open the river to allow for fish passage and FAR wants to see the same thing happen for the Avon River. Wood thinks, "It should be fair! We expect nothing less" than the Avon River to be treated the same as the Petitcodiac River (Sonja Wood, personal communication, March 12 2010). They are using the Petitcodiac case to support their cause for the Avon River. As a small group they are working within their means trying to raise awareness by protesting and publicizing their concerns.

Effective Environmental Activism

The UN Climate Change Conference in Copenhagen December 2009 provides an example of largely ineffective international environmental activism. Despite a crowd of protesters estimated at 100 000 strong, the agreement reached on reducing greenhouse gas emissions set targets much lower than demanded (van der Zee & McKie, 2009; Vidal, Stratton, & Goldenberg, 2009). On a more local scale, the Ecology Action Centre, an environmental activism group located in Halifax, expressed concerns about biomass playing a central role in developing a renewable energy strategy for Nova Scotia (Benjamin, 2010). It is apparent activist groups play an integral and ubiquitous role in environmental issues of various scales, worldwide. Despite their prevalence, questions are routinely raised about their effectiveness.

The world of academia provides suggestions for environmental groups interested in becoming more effective at affecting change. *1) Know your issue* – Environmental activist groups need to have a strong grasp of accurate scientific facts that support their position (Chawla, 1999). *2) See the bigger picture* – To be effective at enacting change activists must understand both who the key players are, and how their decisions affect the economic or political situation surrounding a particular issue (Chawla, 1999). *3) Understand both sides* – Clearly an activist group will have a defined set of interests and beliefs surrounding an issue. However by approaching a topic with a "balanced bias" it sets the stage for a more open dialogue between opposing parties (Chawla, 1999). The Sea Shepherd marine conservation group presents a case of effective activism in its opposition to Japanese whaling (McCurry, 2010). After a high profile confrontation between groups, resulting in the sinking of one of their boats, Sea Shepherd was successful in preventing Japanese whaling vessels from catching their whale quota for 2010 (McCurry, 2010). While their use of hostile tactics, hurling bombs made of rancid-butter at whaling ships, is in direct opposition to the nature of the suggestions set forth by academia, the groups has been effective. This leaves questions as to if there is a one size fits all method to achieve effectiveness, whether the ends justify the means, and in regards to environmental activism, what does effective mean?

In a second interview with Sonja Wood several issues were clarified, mainly what free tidal flow would mean, and how FAR wanted this to happen. Wood described free tidal flow as, "when the salt water and the fresh water mix, like in the natural flow" at the mouth of a tidal river (Sonja Wood, personal communication, April 15 2010). There are several ways that this could happen at the Avon River. Wood said FAR is aware of the current expansion proposal that allows for a small bridge to be put in over the channel. Our research presented us with another possible option of ensuring 'free tidal flow'. During the interview this question was asked:

> "If NSTIR were to continue with the causeway expansion proposal as planned, but to accommodate your request of 'free tidal flow' by opening the two tide gates full time in the spring, summer and fall, would that be sufficient to meet your requests?"

Wood's response to this question was: "Well that would make us happy … and it would be a good start" (Sonja Wood, personal communication, April 15 2010). So restoring free tidal flow by simply opening the tide gates could potentially be a winning option.

Windsor Community

Perhaps one of the most important interest groups would be the Windsor community members. There were specific people targeted for interviews such as the Mayor, Sonja Wood, members from the specific government departments, and Ski Martock. Likewise, we thought it would be important to obtain local opinion and perception of the situation so in addition to the other stakeholders we interviewed a dozen Windsor citizens. These interviews are not all encompassing by any means, but the sample of opinions gathered does demonstrate different perspectives regarding our project. These citizens were selected randomly in the phone book as to avoid any bias.

The results of the community sample were interesting, and it can be noted from the sample that the majority do not really understand, nor are aware of the different expansion options. Most however, do know that highway 101 is being twinned for safety, but they are generally uncertain as to how it will be changed. Also from the sample of community opinion, when asked the question "what option (removal, free tidal flow, or expansion) would you like to see happen to the Windsor causeway", the responses were relatively evenly mixed. One woman said, "I just don't see how they are ever going to expand it to accommodate 6 lanes. There's just no way! If they did it on one side, they would remove the tracks and part of the lake… and good luck with the mudflats on the other side!" Some commented that it is such a big decision that NSTIR should just "leave it alone", while others were passionate about removing it by saying "get rid of the damn thing!"

At the same time there were responses such as "I guess expansion would be the best option." These responses demonstrate that for the most part, there is a great uncertainty of the real implications of any of the options. As well, the variability in responses demonstrates that some Windsor citizens do not have a strong opinion about what should be done, and others who care do not have any power.

Although this paper will not go into detail about all of the different stakeholders, it is necessary to highlight several key players in the Windsor causeway expansion project. Each of the different interest groups, from government to grassroots, have an important role in the decision making process. Even though not all groups have equal power and weight per se, appropriate social and political actions

can be done to address the imbalance. As mentioned earlier, if a community wide survey was distributed to allow the citizens to voice their opinions, then it would result in a better representation of what the community wants. In addition, it is important to have a series of community engagement and information sessions before and after the survey, where all interest groups are present. This would increase transparency and create a better understanding so that citizens can make more informed judgments, and the government can make more representative decisions. Ultimately, this would serve to manage any possible conflicts and confusion among interest groups.

Place Identity

For an individual, household, or community the simple act of being present in a location has the ability to create emotional attachments to that space (Larsen, 2004). These emotional connections account for the ability of an identical location to be experienced, understood, and valued differently by different individuals (Larsen, 2004). Such variation may be attributed to differing senses of *place* (Larsen, 2004). One interpretation explains sense of place as understanding a location not only through its physical setting, but also through the interactions between people and the natural environment that occur there (Cresswell, 2004). In this way Windsor, Nova Scotia is characterized by more than its causeway, the mudflats or Lake Pisiquid. The sum of these parts would not account for the local traditions, milestones or beliefs that make up Windsor's unique identity. As thoroughly detailed in the previous section, the installation of the Windsor causeway had many tangible effects on the landscape. Perhaps less tangible but no less striking are the variations in sense of place, pre and post causeway. From the dozen or so people interviewed, most had moved into the Windsor area after the causeway was built. This means that their experience of the area is with the causeway, rather than the free flowing tidal river. What they associate with Windsor is the causeway, not the river. These conflicting views are illustrated in the following excerpts from a random sampling of community members and causeway users, commenting on the pre-causeway Avon River or the causeway created Lake Pisiquid and mudflats.

Lake Pisiquid

For Fred Davis, a Windsor resident, Lake Pisiquid is representative of an annual family tradition, "The water there? Yeah when my grandsons visit, we walk the trails and go down to the little park there." Another resident, Ruth Fader, comments on the importance of the lake for the pumpkin regatta, "I don't swim there. I do see some boats there often, canoes and small boats. Of course in October,

when we do the pumpkin fest, you see pumpkins floating around in there." The importance of the lake for recreation is highlighted by Sally* who states, "My kids have all been involved in the paddling there... and my husband and I canoe. You can start on the lake and go down...almost to Martock. It's beautiful, so still, it's lovely. There's a place in Falmouth you can drive and put your canoe in." For these three community members Lake Pisiquid is an integral part of their sense of place.

Avon River Pre-Causeway

Contrastingly, some residents associate Windsor with the river as it existed pre-causeway. George* recalls the ecosystem before,

> "Well there was a straight flow-through, from the Minas Basin to upper Falmouth. There were tributaries into smaller rivers in upper Falmouth area. Years ago there was lots of boating at the Windsor wharf. They'd ship out, they'd fill the ships and send them out. It was quite an active port in fishing and exporting years ago."

Susan* also remembers the ship traffic on the Avon River, "Well it was a large river at high tide, with mudflats. And when it was full, it was beautiful. When I first saw it, it had lots of ships in it. Over a hundred ships in the winter."

Mudflats

Of the participant sample interviewed there were mixed opinions on the mudflats. Windsor resident Susan* remarked on the salt marsh development, "...the mudflats are growing into grass, soon they'll be into trees if they keep up." Francis* simply said, "I like [the mudflats]," and went on to mention bird watching in the area. Some less positive sentiments were vocalized by George*, "They're filling in, taking the river bank farther down the river and eroding the farmland farther down river. That's how I feel." One resident, Fred Davis, who has lived in Windsor for 6 years, doesn't want to lose the marshland and thinks which ever option does the least environmental damage would be the best option as it is "kind of a tricky area" (Fred Davis, personal communication, March 30, 2010). The mudflats while not universally liked by the sample group, seemed to be a part of their understanding of Windsor.

While by no means representative of the Windsor community in its entirety, the above statements provide snapshots into Windsor as a place. Consider Lake Pisiquid as an example. It would not be fully understood without recognizing its importance as a destination for recreational hikers, paddlers or the annual pumpkin regatta. Lake Pisiquid holds unique cultural value for some of the

* Pseudonym

participants interviewed. This cultural value is not diminished by the fact that it is not a naturally occurring lake, and only in existence as a direct result of the causeway's installation (Daborn et al., 2003b).

Social Constructionism and Landscape

Similarly the relationship between individuals and the natural environment can often be described in terms of *landscapes* (Greider & Garkovich, 1994). A landscape refers to an individual's (or community's) symbolic representation of an environmental reality, which is informed by their unique values and beliefs (Greider & Garkovich, 1994). As a result, landscapes are typically reflections of the culture and identity of their creators (Greider & Garkovich, 1994). This relationship implies any changes to the natural environment aspect of a landscape trigger an accompanying re-examination of self-identity in the landscape holder (Greider & Garkovich, 1994). In the forty years since the causeway's construction changing environmental conditions may have contributed to the perturbation of the landscapes held by Windsor residents. The following excerpts, again from a non-representative, random sampling of individuals, are comments on observed environmental changes as a result of the causeway.

One Windsor Resident, Arlene comments on the changes in the area, "Filling in a lot on Avon River side, mud, silt, don't know how tides can come in and go out. That's been, you really notice that over the years, notice it more and more just about every year. Oh I suppose it would have to do with the causeway." Fred Davis states, "[There's] a lot more mud." Sally* has also observed environmental changes, "It's filled with silt, which everyone can't help but notice." Other residents, such as Ruth Fader, have not noticed any environmental impacts since the causeway's construction, "... I don't use the causeway all that much... But no, I would say I haven't noticed it all that much." Another Windsor resident says, "I didn't pay attention, to tell you the truth." Even in the small number of participants interviewed there were broadly varying opinions on environmental changes and the causeway.

Opinions on Twinning Options

Once the two potential twinning scenarios were presented to participants, while some remained uncertain, the majority of residents in the sample expressed an opinion on which scenario they would prefer. Susan* a Windsor resident felt a bridge would be an ideal option, "Well they've got to do something haven't they, because it's a bottleneck. But I'm not an engineer. I don't know what they

* Pseudonym

could do. They could have a bridge, easily they could have bridged that." Another pro-bridge opinion was expressed by George*, who states, "Well personally I think the bridge going across it and eliminating the causeway altogether. If they build it wider then it's going to be further damage down river." There were also several preferences for widening the existing causeway. John*, a farmer in the area thought,

> "Well from a monetary view they should expand it. The running dykes that used to protect the riverbanks from flooding have all been let go, they'd have to be replaced and it wouldn't be cheap. Also building a bridge vs. expanding/filling would probably cost more money. The numbers are astounding if you compare the alternatives. Plus with the channel you have to be 100-200 feet back of the edge of the channel now. If they put those in along the river, well right now I farm right to the edge, I'd be losing 100-200 feet along the about 1.5km of waterfront. For me it probably wouldn't be profitable/economical to re-dyke for the smaller parts of my land. So I think it would be better to double it."

David Oulton, another Windsor resident, also expressed pro-widening sentiments,

> "Widening is the most economical. It would cost many millions to take it out. Like at the Petitcodiac, I think most people will be disappointed. I don't think people will have the river they remember. If they took it out they'd have to re-dyke downriver because of the change in the channel and current. Widening is most practical."

Interestingly, even in the small sample interviewed there was considerable variation in the individual preferences for a twinned bridge versus an expanded causeway.

Some of the participants interviewed felt there was not enough information to proceed with a decision either way, and that the causeway twinning project should effectively be abandoned. Ruth Fader felt this lack of information regarding the surrounding ecosystems, "I wouldn't be able to offer you a good opinion on that without having some understanding of what it would do to the river or pond or how it would affect people. I can't imagine a 6 lane bridge. That seems out of proportion to me. Without looking into that I couldn't give you a solid answer." Arlene is another citizen who voiced concerns about the impacts of twinning,

> "Like I said it's such a big debate. They should just leave it alone. I know they want to finish twinning it, but where there's such a debate and such an impact on everything, not just waterways but everything that's there now. I don't see how they could ever do it to

* Pseudonym

> accommodate what they want to do. Like I said they just should leave it the way it is. I know they don't want it like that."

One of the other participants interviewed, a resident of Kentville, suggested a compromise for the twinning project, "I might propose they put a partial causeway and a bridge. Put a partial bridge in the channel/flow that goes through there now. It would be a compromise, wouldn't it?" These opinions again suggested the participant group felt under-informed considering the causeway twinning project.

A unique dichotomy exists in that public pressures are the driving force for considering alternatives to widening the existing causeway; however the consensus from the small sample group indicated a majority of these participants were either unaware of the details of the twinning project or misinformed. While outside the feasibility of this case study, further public interviews need to be conducted to gain a representative sample of opinions of Windsor residents. Since the number of participants interviewed was not large enough to be representative of the population of Windsor, further investigation could help understand whether the public pressure to consider alternatives is limited to Friends of the Avon River or if these opinions are widely held town-wide.

The Role of Media

The issue of what to do about the Windsor causeway in terms of its twinning has confused and concerned many people, especially residents of the area, for many years now as illustrated in the previous sections. The media has been of little help to abate these feelings and interpretations. The issue of expanding Highway 101 at the Windsor causeway has been in the newspapers for years. However, it is hard to say whether the role media has played has been hindering or supportive to public perception and opinion of construction plans of the causeway. Throughout the years, media has lacked consistency in the messages it has portrayed to the citizens of Windsor around the decisions to alter the causeway for highway twinning.

The most influential medium for delivering information pertaining to the Windsor causeway would be via the local newspapers. Some of the most significant newspapers would be *The Hants Journal, The Wolfville Watch* and *The Advertiser*. Each of these community newspapers has presented articles about highway twinning at the causeway on several different occasions, highlighting various aspects and issues. For example, in 2007 the announcement was made that the Petitcodiac River in New Brunswick would be reclaimed by the river with the replacement of a bridge for the causeway. "New Brunswick has acknowledged problems posed as a result of a causeway there and have announced they

will build a bridge, remove the causeway at the place in question and free the river over the next 15 years" (The Wolfville Watch, 2008). This is a similar case to the Avon River and precisely what Friends of Avon River (FAR) are proposing for reclamation at the Windsor causeway. This could increase public awareness of the situation and arouse support for environmental groups, like FAR. However, it could also stir up conflict because FAR wants the same thing to happen to the Avon River, which to many, seems unrealistic.

Inconsistencies

Another example where media has had inconsistent representation of information is about what NSTIR has planned for the causeway twinning. There have been conflicting stories between 2007 and 2009 with regards to the plan of action for the causeway. For instance, in a 2007 article from *The Hants Journal*, entitled "Bridge to Span the Avon River?", NSTIR engineer, Phil Corkum, states that "DOT plans to install a barrier to divide the lanes on the causeway, but the big picture includes building a freestanding concrete bridge instead of adding more rock to the existing causeway." In this way, they are clearly stating that there will be a bridge the whole length of the causeway "from bank to bank". The article explained the bridge structure plans in greater detail and stated that "he wasn't certain how long the Environmental Impact Assessment will take, but we'll be moving ahead with (bridge) construction inside two to three years".

However, three years later, according to this article, there should be the construction of a bridge over the Avon River. This is clearly not the case, and in fact, NSTIR has changed the twinning plans from a bridge to the infilling of the mudflats on the seaward side to allow for widening the causeway to 6 lanes with a jersey barrier. One article from *The Hants Journal* describes the new plan as a "reconfiguration of interchanges, improved horizontal curve and a minimized highway footprint" (Armstrong, March 8 2009). In the same article, Senior Highway Planner, Dwayne Cross from NSTIR says the "causeway is here to stay". Their reasoning for the change in plans is because a bridge would cost millions more and delay construction even longer. As well, he mentioned that "widening the causeway would have no negative impacts on the environment. It's not going to change the flow pattern from what it has been over the past 30 years. We've conducted extensive environmental evaluation because that is a valuable salt marsh" (Armstrong, March 8 2009). From these two articles readers understand two completely different plans for the causeway. This is an example of the persuasive power of the

media and its ability to sway what the public hears and understands about the project, while also creating confusion.

Representation

Other examples of the role of media are how it portrays grassroots environmental groups such as FAR to the public. According to an article in *The Hants Journal* in 2008, FAR is best known for "raising awareness of the potential hazards they contend the Windsor causeway has placed on the Avon River" (Armstrong, May 25 2008). Wood, would like to see a bridge over the Avon River in order to gradually restore the River to its natural state. FAR has been lobbying for five years for the causeway to be opened to allow for free tidal flow of the river, and "to restore some of the fish habitat destroyed by the silting at the river's mouth" ("The River and the New Fisheries Bill", March 5 2007). According to Nadine Armstrong of the Hants Journal in 2008, they (FAR and other groups) "are calling for an 'emergency' comprehensive environmental assessment on the complete Avon River Watershed in order to protect the endangered Atlantic salmon, American eel and their critical habitat" (Armstrong, May 25 2008). FAR stands their ground that they are concerned with the fish passage at the river's mouth, and not the twinning of the highway.

Interviews with FAR and newspaper articles reveal two other primary concerns in addition to free tidal flow, which include the desire for "a comprehensive environmental study on the Avon River Causeway", whether a bridge is built or not, as well as the lack of community engagement around the decision making processes (Sonja Wood, personal communication, March 12 2010). FAR are portrayed as passionate and underrepresented, but also, perhaps misinformed. They are constantly appearing in the newspapers, on Facebook, and being active in the community to try and gain more support for their cause. FAR base their actions on the fact that "the Avon River causeway has altered the entire ecosystem of the upper river, resulting in decline and loss of critical fish habitats and rapid shoreline erosion and siltation along the Avon River Estuary" (Armstrong, January 19 2009). This is not entirely true as there were pre-causeway fluctuations in the fish populations as a result of other barriers on the river, as well as previous siltation in the area. Ideally, Wood would like to have more research conducted by CEAA. However, Council and Windsor CAO Louis Coutinho, said he was not convinced,

> "that the causeway is fully to blame for the current situation. Your literature suggests it's all due to the causeway. But prior to its construction in 1970, fish stocks were already at very low levels.

> It is clear to us that there are other implications that have played a role in this." (Armstrong, January 19 2009)

Perhaps this is the reason NSTIR has changed their plan for twinning and are now going with causeway expansion rather than a bridge. Currently, the plan is to widen the causeway by about 14 metres and infilling part of the mudflat and salt marsh on the seaward side.

In an interview with Sonja Wood, she mentioned that when she joined the group in 2004, their focus was on the issue of twinning the causeway. However, she stated that after they educated themselves on the issues, they realized that it was not a highway twinning problem, but rather a fish problem. "I'm not against the twinning of the highway. I am a huge advocate of it as I am a victim of an accident on it. I think the safety needs to be improved; for us, it's a fish issue" (Sonja Wood, personal communication, April 15 2010).

Bias

There is always a bias in media, whether it is intended or not. And often the tone or sensationalism of the article can portray a different message. For example, we can tell that Sonja Wood is passionate in her role because her messages clearly have a tone of urgency. This tone can affect the way readers react to the message. In addition, word choice by the author in a newspaper can have a great affect on the readers' opinion because they can downplay the role of FAR in the big picture. This can then affect how FAR is perceived by the public and thus have a negative effect on their support. It is important to consider who wrote the article, and who the article was written for. Anything written by FAR is going to have a bias on the side of removal of the causeway because that is what FAR is working for. On the other hand, any articles from NSTIR will feature the benefits of highway expansion, because that is what they want.

Citizen Awareness

Moreover, after conducting a dozen interviews the consensus from the sample was the group did not hear much about what is going on with regards to causeway twinning. There is minimal coverage on the television news, in the newspaper, or magazines and public consultations are virtually non-existent. There was a range of knowledge and interest of the issue. Some people interviewed knew very little of the details and of the causeway itself, and others were very knowledgeable and passionate about what should be done about it. One Windsor citizen, Arlene, who has lived in the area for 30 years

said, “Well I don’t see how they’re ever going to expand it to accommodate 6 lanes. There’s just no way. If they did it on one side they would remove the tracks and part of the lake” (Arlene, personal communication, March 30 2010). She was aware of the plans to twin the highway to improve safety, but she was unaware of the plans to do the twinning. She continued by saying,

> “…it’s such a big debate. They should just leave it alone. I know they want to finish twinning it but where there’s such a debate and such an impact on everything, not just waterways but everything that’s there now. I don’t see how they could ever do it to accommodate what they want to do” (Arlene, personal communication, April 8 2010).

There are other residents who were very concerned but still under-informed, such as Mrs. Ruth Fader, a resident of 10 years and an avid volunteer in the community. When asked her opinion about the mudflats, she responded,

> “I really don’t have an understanding of that. I know there’s a big environmental uproar about it. Lots of people don’t want the 101 going through because it’s going to disrupt that. I read about it in the Hants Journal, heard about it at Tim Hortons. People are talking about it. I don’t know how to answer in a concrete way if they are good or bad” (Ruth Fader, personal communication, April 8 2010).

In addition, when asked if she thought it was important to have her voice heard, as a community member, she had a strong opinion saying that of course it is important, and that if anything is going to affect the town she lives in and the environment around her then community consultation should absolutely be done. She thinks there should be group meetings and focus groups, but most importantly, there should be more coverage in the newspaper, because “that’s what they read” (Ruth Fader, personal communication, April 8 2010). This is true and there has been little newspaper coverage since the decision to twin the causeway was made.

On the other hand, we interviewed a man from Kentville who seemed well informed of the situation, and opinionated as to what should be done and how people think. When asked if he thought the causeway should be widened, he responded by saying,

> “It wouldn’t have much effect over what’s there now, wouldn’t change the amount of silting. Any reasonable person would say expansion would have no influence at all. It’ll be cheaper but it doesn’t address the problem of whether that should be in at all and it shouldn’t be. There should

> be a route around the town that goes through Falmouth. Any road that goes in now there's going to be a problem. You still have a reduced speed zone in that whole area. There's no change in motorists' perceptions at all if it's expanded. It's still slow. So morally, ethically and environmentally it shouldn't be there at all" (citizen of Kentville, personal communication, April 7 2010).

Although he doesn't believe that the causeway should even be there, he understands what is easy and what the government wants to do. He also considers the environmental impacts of removing the causeway at the same time as thinking about the ecosystem that was previously there. He acknowledges that it is a tough decision, but added that it would be a good idea to compromise by removing part of the causeway and putting in a partial bridge (citizen of Kentville, personal communication, April 7 2010).

Most of the community members interviewed in the small sample felt their opinion was important but not being considered in the decision making process. As well, most were under-informed as to the details of the causeway twinning project. Furthermore, the majority of the citizens interviewed did not seem to have a strong opinion of the situation as a whole. Mrs. Ruth Fader believes that "the majority of Windsor has no understanding whatsoever or even knows that there's more than one option. I'm just talking about the average guy, but I can pretty well tell you they don't [know]" (Ruth Fader, personal communication, April 8 2010). This is likely a result of limited media coverage, especially in the newspapers. For the most part, people were indifferent as to what should be done, and generally unaware of the details that were involved. About half of the respondents thought the causeway should be removed and replaced with a bridge, and the other half thought it should be expanded.

Technology

There are other forms of media, which contribute to the spread of knowledge about the causeway expansion at Windsor. Technology can further spread information about an issue. FAR's website "Save the Avon River" on Facebook allows people from all over the world, who have access to the internet, to learn about the Avon River who might otherwise not have known. Websites such as Facebook, Twitter, blogs and online news articles have all played a role in increasing the awareness of an issue that arise from the twinning of the causeway at the Avon River.

Language

Moreover, there are scientific reports and data that can be found but the language and information can be limited to those who understand the scientific jargon. In addition, the Facebook

group and some newspaper articles can have certain sensationalism to them where the emotion that is transferred from the writer can be inferred. This has an intended consequence to persuade the reader to feel more or less towards one option over another. Scientific data and results can be limiting to its readership, and often do not reach the Windsor public, so they are dependent on the newspapers, which might not fully inform or represent reality.

Cycle of interest

Over the years, there has been coverage of the issue to expand the causeway, but there have been times of greater and lowered interest and awareness. This is called the cycle of interest, and for the Windsor causeway interest has gone up and down over the last four decades. It refers to the intensity of interest and concern from the public regarding a particular topic. In this case it is the local public interest towards the twinning of the Windsor causeway. Perhaps more obvious examples of cycle of interest are following an earthquake or hurricane, the (global) community is immediately concerned and focused on helping, preventing and preparing for the next event. After time the interest dies down, such as with the Haiti earthquake, or after the Boxing Day tsunami. What to do with the Windsor causeway is a smaller scale example of the cycle of interest. After talking to the Mayor of Windsor, he suggested that once the construction actually begins at the causeway, people will see it every day and it will become more of an issue of concern and interest in the eyes of the Windsor community members. Therefore, the media coverage surrounding it will increase, thus increasing public awareness and communication about the topic. This will be short lived, and after the highway expansion is completed, interest will dwindle once more.

Media obviously has a role in distributing and portraying information on any public issue. Like most forms of information, there is usually a bias, whether there are attempts to mitigate it or not. There is also unequal representation of different interest groups and stakeholders involved. There needs to be more information of the different proposed options in the newspapers so that citizens can have a better understanding of the big picture. As we noticed from our interviews, the consensus from the small sample showed that there was misunderstanding among the group as to what is planned and should happen to the causeway. Furthermore, the language used in reporting the options and findings is important to consider. Overall, media has a significant role in informing the public opinion and perception about twinning the Windsor causeway.

Interview Methods and Limitations

The interview related research was conducted to gain an understanding of historical views of the Avon River, how the community of Windsor perceives the current causeway, and hear resident's opinions on the causeway twinning project. Two interview techniques were designed. In the first scenario, interviews were used to elicit general public opinion from Windsor residents. The second type of interviews targeted "experts" either as they were identified in the community of Windsor, or within academic literature.

For the public opinion sample approximately a dozen semi-structured, open-ended interviews were conducted, where participants were selected using a random sampling method. Individuals were randomly selected from a Windsor phonebook, and interviewed via telephone after informed consent was obtained. Participants had the option of using a pseudonym to ensure confidentiality and were offered a copy of the final report. Interview responses were then transcribed.

To conduct the interviews with community experts small-scale, snowball sampling was used, where after an interview the participant, e.g. the mayor, was asked who else they thought should be interviewed. Interviews with government officials and academic experts were arranged via email or telephone. Again for both types of expert interviews described above, informed consent was obtained and interview responses were transcribed.

The largest limitation in the public opinion interviews was the limited number of participants meant any results gathered were not statistically significant or representative of views held by all of Windsor. Additionally since there were only 12 community member interviews conducted any patterns in the results could merely be a result of chance and hold no indication of views held by the community of Windsor in its entirety. However acknowledging the time and scope constraints of the case study, it would have been very difficult to interview a statistically significant number of community members.

Ideally the randomly selected sample of Windsor residents would have included as broad a selection of participants as possible (e.g. homeowners, business owners, commuters, boaters, paddlers, farmers, anglers, birdwatchers, etc.). Again since only 12 community member interviews were conducted not all of these viewpoints were captured in the sample of participants.

A final limitation is the method in which the public opinion telephone interviews were conducted. Since the interviews were semi-structured and open-ended, each interview was not identical

and could not be reproduced in its entirety by following the sample interview guide. Also since participant responses were being transcribed by hand as the interview was being conducted, it is possible responses were not transcribed word for word.

FUTURE TWINNING OPTIONS

Three foreseeable options for twinning the causeway have been identified and are discussed in detail in this report. These options have been formulated as a result of discussions with various stakeholders. The first option to expand the existing causeway on its seaward side is the current design proposed by NSTIR. In conversation with FAR it was determined that their primary goal on the Avon River would be to restore free tidal flow and to allow for successful upstream passage of diadromous fish. According to Dr. van Proosdij's interpretation of this term, free tidal flow could be accomplished by removing the tide gate and replacing it with a bridge which is the second option considered. FAR's interpretation of free tidal flow would consist of the removal of a large portion of the causeway which would be replaced with a 6 lane bridge which is considered as the final option

EXPANSION

As previously introduced, Highway 101 is being twinned in the interest of highway safety. The total cost of twinning the entire 9 km stretch remaining is expected to be approximately $100 million (Bob Pett, personal communication, March 24 2010). Current designs for twinning the Windsor causeway involve leaving the existing causeway intact and simply widening it from two to six lanes (Bob Pett, personal communication, March 24 2010). Nova Scotia's Department of Transportation and Infrastructure Renewal's (NSTIR) proposed expansion design widens the causeway by approximately 14 metres on its seaward side to accommodate the extra lanes (Bob Pett, personal communication, March 24 2010). The expansion design would also include a clear span bridge over the existing tide gate channel approximately 100 m long (Bob Pett, personal communication, March 24 2010). The expected cost of the bridge is $20 million, but this estimate will not be confirmed until the design is finalized (Bob Pett, personal communication, March 24 2010). Additionally the design will decrease the curvature on the causeway's western side (Daborn, van Proosdij, & Brylinksky, 2003b). This will address the current need for drivers to slow to 90 km per hour to negotiate the curve, when a provincial highway should allow for travel at 110 km per hour (Bob Pett, personal communication, March 24 2010).

Terrestrial Ecosystem

Biophysical

For the purposes of this discussion the term terrestrial ecosystem will be used to refer to the salt marsh and mudflat system on the seaward side of the causeway. These salt marshes and mudflats on the seaward side of the causeway will likely suffer some of the most immediate effects as a result of

construction (Daborn et al., 2003b). Estimates for total salt marsh and mudflat area destroyed are 24 284 m^2 and 13 852 m^2, respectively (Daborn et al., 2003b). These figures suggest approximately 6% of the existing salt marsh and 4% of the existing mudflats will likely be buried as a direct impact of construction (Table 3) (Daborn et al., 2003b). Consequently 5% of the total ecosystem, including all of the salt marsh and mudflat area, would be destroyed due to construction (Daborn et al., 2003b). While all of the above figures refer to *direct* effects of construction, the *indirect* effects will potentially impact a much larger area of the ecosystem (Daborn et al., 2003b). Indirect effects would be similar to those listed previously in reference to Lake Pisiquid and include increased construction noise, vibrations, sediment deposition, and pollutants. The study conducted on the indirect effects associated with causeway expansion at Windsor examined indirect effects with a 30 m and 50 m buffer (Daborn et al., 2003b). A 30 m buffer resulted in 9% of the total salt marsh and mudflat area that would be indirectly affected by construction, while a 50 m buffer had 11% of the total area indirectly impacted (Table 3) (Daborn et al., 2003b). In summary, if the causeway is expanded 5% of the salt marsh and mudflat area will be destroyed directly as a result of construction, while approximately an additional 9-11% of the area will be impacted by indirect effects (Daborn et al., 2003b). Losing part of the ecosystem will likely also have a social impact, as some individuals use the area for bird watching or recreational exploration of the mudflats (Francis, personal communication, April 2010).

Table 3. Estimates of salt marsh and mudflat ecosystem area affected by proposed Windsor causeway expansion. (Source Daborn et al., 2003)

Existing Habitat within Study Area			Area (m^2)		Area (acres)
Saltmarsh Vegetation			397,515		98
Mudflat			327,717		81
Total Intertidal Habitat			725,232		179
Analysis of Habitat Impacts from Construction Process					
Habitat	**Direct (m^2)**	**30 m buffer (m^2)**	**50 m buffer (m^2)**	**Total (with 30 m buffer)**	**Total (with 50 m buffer)**
Vegetation	24,284	8,057	19,148	32,342	43,432
Mudflat	13,852	15.973	20,860	29,826	34,712
TOTAL (in m^2)	38,136	24,031	40,008	62,167	78,144
TOTAL (in acres)	9	6	10	15	19
% of existing vegetation.	6	2	5	8	11
% of existing mud	4	5	6	9	11
% of total intertidal	5	3	6	9	11

To determine possible construction effects on fish and bird populations the mudflat and salt marsh ecosystems were examined (Daborn et al., 2003b). Unexpectedly the salt marsh that has developed along the causeway has a very low abundance of benthic organisms, indicating it would likely not be productive foraging habitat for fish (Daborn et al., 2003b). Due to the presence of *Spartina alterniflora* and its seeds however, the salt marshes may be a feeding ground for waterfowl (Daborn et al., 2003b). Expanding the causeway on the seaward side would destroy salt marsh, the quantitative area approximations of which will be discussed subsequently (Daborn et al., 2003b). Waterfowl populations would lose part of their best foraging area, since the *Spartina* is most dense in the areas directly adjacent to the causeway, where it is most mature (Daborn et al., 2003b). While expansion would destroy some of this foraging area it is important to remember that salt marsh is continually being created as *Spartina* rapidly colonizes downstream mudflats (van Proosdij & Townsend, 2004). Because new foraging habitat is being created at an exponential rate, the loss of salt marsh caused by an expansion project would likely not be considered a significant impact on waterfowl.

The mudflats were found to support a large number of benthic organisms, most notably the mud shrimp *Corophium volutator* and the sandworm *Nereis diversicolor* (Daborn et al., 2003b). The mud shrimp is a particularly important species for the Bay of Fundy ecosystem since it is the major food source for most migratory shorebirds and fish species (Daborn et al., 2003b). With regards to foraging habitat, evidence suggests that the mudflat ecosystem primarily located downstream of the salt marsh at the causeway, is important for shorebird and fish species (Daborn et al., 2003b). Destruction of this foraging habitat is expected to be minimal as a result of the construction for the expansion project (Daborn et al., 2003b). Furthermore additional studies suggest the major feeding areas for shorebirds in the Bay of Fundy are actually located off of the St. Croix Estuary, not the Avon River (Daborn et al., 2003b).

Legal

An additional challenge to expanding the causeway is a potential legal implication under the *Agricultural Marshlands Conservation Act*. The salt marsh on the downstream side of the causeway would certainly qualify as a "marshland" under the *Agricultural Marshlands Conservation Act*, as it is "subject to periodic tidal flooding" (S. 2 [d] [i]). As a result of this, the expansion project may be subject to permitting issued by the Minister under S. 41 (1) (a), which requires a permit for variance authorizing

development on a marshland. That said, under S. 41 (2), the Minister also has the power to exempt the development from the permitting process if the development is viewed to be in the public interest.

The expansion project would face another legal challenge because of likely wetland destruction. In 2007, Nova Scotia implemented the *Environmental Goals and Sustainable Prosperity Act* (EGSPA) which is a series of 21 goals to be accomplished by 2020. "The long-term environmental and economic objectives of the Province is to fully integrate environmental sustainability and economic prosperity" for the province of Nova Scotia (EGSPA, s. 4 (1), 2007). One of the long term goals in s. 4 (2)(n) stated there needs to be a policy to conserve and protect Nova Scotia's wetlands by the end of 2009. As a result, wetlands specialist, John Brazner from the Nova Scotia Department of Environment, drafted the Nova Scotia Wetlands Conservation Policy (NSWCP). After rigorous community consultation and revision, the policy will be in effect this year.

The most important aspect of the new wetlands conservation policy is s. 2(e) the "No Net Loss" of wetland function, habitat or area. In addition, all 'ecologically significant' wetlands (i.e. salt marshes) will be protected (NSWCP, 2009). This requires that any wetlands that fall under specific parameters be compensated. Moreover, according to the NSWCP, any wetland developed as a result of a construction project prior to 1990 is included in the compensation policy. Because the causeway was built in 1970 and the salt marsh formed as a result of the construction, these wetlands need to be compensated for in accordance to the NSWCP. During the widening of the causeway, a 14m section of the adjacent salt marsh will be filled in along the causeway. According to the new wetlands compensation Policy for NS, the causeway and salt marshes do not fall under any exceptions. The causeway was built before 1970 and the salt marsh is a result of construction, therefore it is not exempt from compensation according to the new wetlands conservation policy.

The new 'no-net-loss' of wetlands policy will apply, and the proponents will be responsible for compensating any loss to wetlands that may be incurred. NSTIR's plan to incorporate this must be demonstrated in the EIA before approval will be granted. NSTIR does plan to compensate for the entire amount of salt marshes affected during construction, which includes the 14m buffer along the seaward side of the causeway. NSTIR has planned a 1:1 compensation ratio, if not more. The location and details of compensation have not yet been confirmed. Details will be in the EIA which as previously mentioned is still in negotiation, and scheduled to be finalized and released this spring.

Social

Another significant benefit to expanding the existing causeway stems from the causeway's role as a flood barrier (van Proosdij, 2009). If the existing causeway remains in place and is simply widened it will continue to act as a flood barrier, protecting both the town of Windsor and agricultural dykelands (van Proosdij, 2009).

Aquatic Ecosystem

Biophysical

Associated with the expansion method of twinning the causeway are some definite benefits. The largest of which is that expanding the causeway will resolve the issue of highway safety most quickly and with the least effects on the surrounding natural environment (Daborn et al., 2003b). Since causeway expansion would occur on the seaward side there would be very limited impacts on the Lake Pisiquid ecosystem (Daborn et al., 2003b). Effects such as increased sedimentation deposited in the lake, greater probability of localized spills of construction related substances, and increased levels of noise and vibration are some of the possible direct effects of widening the causeway on Lake Pisiquid (Daborn et al., 2003b). Specifically in the case of sedimentation, it is unlikely that unintended sediments deposited into the lake over the course of construction would be in large enough quantities to affect the depth of Lake Pisiquid (Daborn et al., 2003b).

Legal

The terms aquatic ecosystem will be used in this discussion to describe the fish populations in the lower Avon River. As described previously, the Avon River Estuary is home to many fish species. The two that are most significant to a potential causeway expansion plan are the American eel and Atlantic salmon. It should be noted that American eel are currently identified as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), while Atlantic salmon have been identified as endangered (Government of Canada, 2009a; Government of Canada, 2009b). Legislation is in place, *Species at Risk Act*, which prohibits the destruction of any critical habitat of an endangered or threatened species.[4] However given the fact that Atlantic salmon populations have historically fluctuated, and that the species has not been reported in the Avon River Estuary since the 1980s, it is unlikely any expansion directly adjacent to the causeway will destruct *critical* salmon habitat (Isaacman, 2005).

[4] *Species at Risk Act*, S.C. 2002, c. 29, s. 58

Impacts on fish habitat as a result of causeway expansion will need to be addressed as stated in the *Fisheries Act*.[5] The *Fisheries Act* contains a general prohibition of any Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat.[6] However in cases where HADD cannot be avoided, permission for it to occur must be granted by the Minister.[7] This will likely be necessary if the causeway is expanded since fish habitat is broadly defined as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes".[8] Filling will likely be part of the construction process, causing harmful alteration, disruption or destruction to any fish habitat that exists along the seaward side of the causeway. Additionally the Department of Fisheries and Oceans has developed a Fish Habitat Management Program, which includes a guide to habitat compensation for any unavoidable HADD as a result of a project (Department of Fisheries and Oceans, 2009a). The hierarchy of compensation options contains the following four alternatives, as outlined by the Department of Fisheries and Oceans (2007):

1. Create or increase the productive capacity of like-for-like habitat in the same ecological unit;
2. Create or increase the productive capacity of unlike habitat in the same ecological unit;
3. Create or increase the productive capacity of habitat in a different ecological unit;
4. As a last resort, use artificial production techniques to maintain a stock of fish, deferred compensation or restoration of chemically contaminated sites.

Since they are outlined in a hierarchy, a proponent's first choice is creating like-for-like habitat in the same ecological unit, with the use of artificial production techniques as a last resort (DFO, 2007). In the causeway expansion project any HADD of fish habitat may be required to be compensated for through the use of one of the above options.

Social

The final challenges in the expansion of Windsor causeway are community based. In the small sample of community members that were interviewed the general consensus of the group was a lack of information and misconceptions on how an expansion project would proceed. The second community based challenge relates to Friends of the Avon River (FAR). As outlined earlier (in the stakeholder section) FAR is a local environmental non-governmental organization whose members would like to see free tidal flow and unrestricted fish passage restored to the Avon River (Sonja Wood, personal

[5] *Fisheries Act* R.S.C. 1985, c. F-14
[6] *Fisheries Act* R.S.C. 1985, c. F-14 s. 35(1)
[7] *Fisheries Act* R.S.C. 1985, c. F-14 s. 35(2)
[8] *Fisheries Act* R.S.C. 1985, s.34(1e)

communication, March 12). Since the expansion project is not designed to allow for either of these, there is a potential for future conflict between FAR and NSTIR if FAR believes their requests are not being taken into consideration. Additionally while not representative of the community's feelings on a whole, some participants in the interview sample group expressed a preference for the causeway's removal and replacement with a twinned bridge (participants, personal communications, March-April 2010).

Conclusion

Ultimately some of the largest challenges facing the entire Windsor causeway expansion project are the concerns surrounding HADD of fish habitat, the potential need for wetland compensation, and possible lack of information in the community. An Environmental Impact Assessment (EIA), aside from being necessary for the expansion project, would likely include and address each of these issues. Currently, an EIA detailing plans to twin the final section of Highway 101, between 3 Mile Plains and Falmouth, has not been registered with Nova Scotia Environment (Steve Stanford, personal communication, March 22, 2010). That said, the plans to complete this final section of twinning are well underway. Sometime this spring, NSTIR plans to file a draft of the "Highway 101 Phase 4 Twinning 3 Miles Plains to Falmouth" Environmental Assessment Report. They commissioned Stantec Consulting of Dartmouth with the completion of this report, and at present, it is approximately 99% finished (Bob Pett, personal communication, March 24, 2010). All that is left to determine is fish habitat compensation due the harmful alteration, disruption or destruction (HADD) of fish habitat due to the limited infilling of the current channel (Bob Pett, personal communication, March 24, 2010).

REMOVAL OF TIDE GATE TO RESTORE FREE TIDAL FLOW

Another option for the expansion of the Windsor causeway would be to alter the existing infrastructure so as to allow for free tidal flow upriver from the tidal impediment. This is not an option that was considered early on in this study, but was revealed later in discussions with Dr. van Proosdij when discussing the definition of free tidal flow (Danika van Proosdij, personal communication, March 26, 2010). This could be accomplished by expanding the causeway to include a 6 lane bridge over the 100 m (Bob Pett, personal communication, March 24, 2010) tide gate, which would be removed (Danika van Proosdij, personal communication, March 26, 2010). This option is largely understudied and the implications of such a project, particularly from a biophysical perspective, are generally unknown. However, there is significance in considering this project as an option for causeway expansion, as this would allow for free tidal flow and the return of fish passage upstream of the causeway. Ultimately, this option would satisfy the desires of Friends of the Avon River, who would like for the expansion project to restore free tidal flow and fish passage (Sonja Wood, personal communication, March 12, 2010).

The known biophysical, socio-political and legal implications of this expansion option are examined below. Given the limited resources available on this topic, it should be noted that the implications presented are by no means exhaustive.

BIOPHYSICAL

Aquatic Ecosystem

This expansion option would obviously have many impacts on the aquatic ecosystem. In particular, this scenario would restore free tidal flow into the system and allow for fish passage however, it can be presumed that there would also be alterations to the existing mudflats and Lake Pisiquid. These implications would be in addition to those created by the expansion option mentioned above as a majority of the causeway would be expanded, and only the short segment consistent of the tide gate would be removed and replaced by a bridge.

Fish

One of the main purposes of removing the tide gate would be to allow for fish passage upstream. Historically, the Avon River has been populated by several species of diadromous fish including gaspereau, Atlantic salmon and American eel. Although species of fish have been vulnerable to anthropogenic activities on the Avon River dating back to the late 1600s, significant declines in fish

populations were observed following the construction of the causeway (Isaacman, 2005). Of particular interest is the decline, and in some cases, complete disappearance, of diadromous species given their ecological importance as previously mentioned. Researchers have attributed the complete loss of Atlantic salmon to the causeway as these fish no longer have access to breeding grounds upstream (Isaacman, 2005). As a result, the restoration of free tidal flow could in theory contribute to the restoration of diadromous fish species in the Avon River.

However, there are other factors that could affect the successful restoration of diadromous fish species in the river including capacity and opportunity (Tanner *et al*, 2002), anthropogenic activities on river (Isaacman, 2005), existence of, and access to, appropriate spawning grounds upstream, the presence of barriers upstream and existence of proper salinity (Haverstock, 2004). The least obvious of these factors is the capacity and opportunity for fish. This was explored in a case of ecosystem restoration as a result of the removal of a tidal barrier on the Snohomish River in Washington. The restoration of juvenile salmon in the system was of great importance to project partners. Two restoration assessment criteria were used in regards to juvenile salmon in the system; they were *capacity and opportunity*. Capacity can be measured by the presence of prey, which in the case of juvenile salmon is the availability and quantity of invertebrates in the estuary. A survey in 1999 at three reference points displayed positive presence of invertebrates and the stomach contents of juvenile salmon collected at the same time included many of the invertebrates present. Furthermore, refuge areas provide juvenile salmon with the *opportunity* to exist in this system as they can hide from predators in these areas. As a result, refuge areas would have to be made available to these fish in order to satisfy the opportunity criteria. Project partners were satisfied with the presence of plant communities within the estuary that could provide refuge for juvenile salmon (Tanner *et al*, 2002). Given this research, it would be of value to ensure that both capacity and opportunity exist in order for juvenile salmon to return to the Avon River.

Lake Pisiquid

Although the restoration of free tidal flow could potentially have a positive impact on diadromous fish populations, its effect on the fish population in Lake Pisiquid would likely be negative. Through sampling Daborn and Brylinsky (2004) discovered there were eleven fish species in Lake Pisiquid: alewife, blueback herring, yellow perch, white perch, white sucker, small-mouth bass, lake chub, redbelly dace, banded killifish, threespine stickleback, fourspine stickleback and ninespine stickleback.

Another interesting observation was that eight of the eleven fish species in the lake were freshwater species (Daborn & Brylinsky, 2004). Not only were the species of individual fish identified but specimens were weighed and measured (Daborn & Brylinsky, 2004). These measurements allowed the researchers to draw conclusions on the quality of fish habitat in Lake Pisiquid (Daborn & Brylinsky, 2004). Through the use of length to weight ratios, rates of growth were estimated for fish and found to be fairly normal (Daborn & Brylinsky, 2004). Being able to support reasonably normal, growing fish populations was used as an indicator for Lake Pisiquid being biologically productive (Daborn & Brylinsky, 2004). Therefore, the introduction of free tidal flow, and water with a higher salinity, into Lake Pisiquid may have detrimental effects on existing fish habitat upstream from the causeway.

While the introduction of tidal cycles to the upstream ecosystem may have a harmful effect on fish populations, the overall effect on water quality would likely be beneficial. Although recent studies suggest that there is no eutrophication occurring within Lake Pisiquid (Daborn & Brylinsky, 2004), the restoration of free tidal flow in the river would furthermore reduce any risk of this taking place. Similar case studies suggest that removing tidal barriers improves upstream water quality and tackle upstream sedimentation as the river is flushed twice daily (Patrick et al, 2006; McAlice & Jaeger, 1983).

Terrestrial Ecosystem

Mudflats/Salt marsh

Again, there is no apparent literature available on the effects that restoring free tidal flow may have on the accumulated mudflats and salt marsh below. However, given that the removal of the tide gate would allow for water to move freely up and down stream, it can be presumed that there would be a decrease in sedimentation downstream of the causeway. Currently, tides carrying sediment from the Bay of Fundy are forced to deposit their load at the causeway. This has led to the creation of remarkable mudflats, and consequently a biologically significant salt marsh over the past 40 years, discussed above (van Proosdij, 2009). The continual sedimentation that is currently occurring (Percy, 2008) would likely decrease significantly or end altogether if free tidal flow were restored. This would also expose the current mudflats and salt marsh to erosion (Percy, 2008) which could affect the integrity of the ecosystem that is important to foraging shorebirds (Daborn et al., 2003b). Furthermore, Daborn (2003b) also suggests that if flow were restricted to a narrow permanent opening in the causeway, significant erosion would occur both upstream and downstream (Percy, 2008).

SOCIOPOLITICAL

The social and political implications of restoring free tidal flow on the Avon River by means of removing the tide gate and replacing it with a short bridge are largely related to the biophysical impacts and are discussed in detail below.

Fish

One of the main purposes for restoring free tidal flow to that Avon River estuary would be to allow for the return of diadromous fish populations to the system (Sonja Wood, personal communication, March 12, 2010). If the fish, particularly the Atlantic salmon were to return to the river, certain members of society, including Friends of the Avon River, would be pleased. Uncertainties arise as to whether the return of such fish would benefit the people from a social perspective which is discussed in more detail in the legal section of this option below.

Flooding

There is only one known study that addresses the flooding hazard as a result of removing the causeway. Dr. van Proosdij suggests that the town of Windsor would be subjected to significant flooding if the barrier were removed (van Proosdij, 2009). This is in line with public perception on the issue (Paul Beazley, personal communication, March 12, 2010). Certainly, this would have significant social and financial ramifications on the Town of Windsor. Daborn (2008) also suggests that ice jamming at the narrow opening would likely occur, which would result in major flooding upstream (Percy, 2008).

Moreover, given that dykes upstream of the causeway have not been maintained over the last 40 years (Percy, 2008), it can be presumed that the restoration of free tidal flow would also lead to the flooding of agricultural lands upstream of the causeway.

Lake Pisiquid

The potential loss or alteration of Lake Pisiquid as a result of removing the tide gate and replacing it with a bridge would likely affect the recreational quality of the lake. Currently, the lake hosts the Pisiquid Canoe Club which offers canoe and kayak programs on the lake (Pisiquid Canoe Club, n.d.). Furthermore, an annual Pumpkin Race is also held on the lake as part of the Pumpkin Regatta (West Hants Pumpkin Festival Committee, 2009). Although the actual physical changes that may occur on the lake if the tide gate were removed are currently unknown, if there were to be significant changes, Lake Pisiquid recreationalists would be affected.

LEGAL

Given the nature of the significant biophysical changes that would likely occur as a result of expanding the causeway to allow for free tidal flow, there are also many legal implications. These implications will be highlighted below.

Fish Habitat (HADD)

The *Fisheries Act* defines two terms that are significant to the legal implications of removing the tide gate and replacing it with a bridge. They are as follows: *Fish habitat* is defined in section 34 as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes". *Deleterious substance* is also defined in section 34 as "any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water."

As previously mentioned, Lake Pisiquid provides sufficient habitat for many species of fish (Daborn & Brylinsky, 2004). The actual effect of restoring free tidal flow in the estuary on existing fish habitat is unknown. However, it can be presumed that an increase in salinity and flow within Lake Pisiquid may have negative implications on existing habitat. Given the definition of a deleterious substance in the *Fisheries Act* (above) it can be argued that the introduction of saline water into a primarily freshwater environment could be considered as the introduction of a deleterious substance. As such, the restoration of free tidal flow could be argued to be in violation of the *Fisheries Act* section 36 (3) which states that no person shall deposit or permit the deposition of deleterious substance into a river where fish are present.

As a result, this project may have the potential to create harmful alteration, disruption or destruction of fish habitat (HADD) which would be in violation of the *Fisheries Act*. Provided the definition of fish habitat (above), it can be argued that any alteration to the existing upstream and downstream river may affect existing fish habitat as a result of erosion and the introduction of salt water into a freshwater environment. According to section 35 (1) of the Act there is a general prohibition of HADD of fish habitat by any undertaking or work. However, section 35(2) offers relief from this prohibition if Authorization is given by the Minister. It is important to note that this Authorization applies to the HADD of habitat itself and not to a project resulting in HADD of habitat. Section 37(1) of the Act gives authority to the Minister to request plans for projects that may result in

HADD of habitat. Under this section, the minister may also make recommendations for modifications, additions to the work or restrict the work entirely. Occasionally the Minister may be confronted with a work or undertaking that will result in HADD of habitat where such avoidance is impractical or impossible. In this situation the proponent will be referred to the *Policy for Management of Fish Habitat* regulated by the Department of Fisheries and Oceans (DFO). Essentially, this policy exists to ensure that there is No Net Loss of fish habitat which can be achieved through a Hierarchy of Compensation Options. Four options exist under this hierarchy and consist of,

1) Creating/increase like habitat on site of the project,
2) Creating/increasing unlike habitat on site,
3) Creating/increasing the productive capacity of a different ecological unit, or
4) Use artificial techniques to maintain fish stock, defer compensation or restoration of chemically contaminated sites

(Department of Fisheries and Oceans Canada, 2007).

Given these options, in this case, it is likely that the proponent would have to compensate for lost habitat.

Environmental Impact Assessment (EIA)

Removing the tide gate at the Windsor causeway so as to allow for free tidal would require an EIA according to federal regulations (*Canadian Environmental Assessment Act S.C., 1992, c. 37*), and these legal issues would be dealt with in the EIA.

Wetlands Compensation

With regards to free tidal flow and wetlands compensation there is a significant amount of salt marsh that will need to be compensated for. With the restoration of free tidal flow, increased erosion on the seaward side of the causeway will greatly decrease the area of salt marsh, at a rate that is currently undetermined (Daborn et al., 2003b; Percy, 2008). The direct impact on the salt marsh and mudflats will be much more than widening the causeway, and thus a greater amount of wetlands will need to be compensated for. Compensation can occur in the form of a 'like habitat' in the same location (which will not be an option), or like-habitat in a different location (could be an option), unlike-habitat in the same location (not likely an option), or unlike habitat in a different location (unlikely an option). In any case, the proponents, NSTIR, will be responsible for compensating any area and productivity loss to

wetlands and their plan for compensation must be incorporated into the EIA before approval will be granted.

REMOVAL OF CAUSEWAY AND REPLACEMENT WITH A BRIDGE

A final option for the expansion of the Windsor causeway would be to remove the causeway entirely or nearly entirely and replace it with a 6 lane bridge. This option has been favoured by a few members of the community, most notably the Friends of the Avon River. This organization has advocated for restoring free tidal flow by removing both the entire causeway and also only a section of the causeway. There appear to be some misconceptions in regards to the wants of this group within the community. Regardless, public documents do state that FAR and other members of the community of Windsor favour this option (Wood, n.d.; Percy, 2008). As a result, it is an important option to explore. Furthermore, a similar case is currently occurring on the Petitcodiac River, NB which according to FAR, sets a precedent for the fate of the Windsor causeway (Sonja Wood, personal communication, March 12, 2010).

`The Petitcodiac causeway was built in 1968 primarily as a means to create a cost effective automobile connection between Moncton and Riverview, to protect upstream agricultural lands from flooding and to create a freshwater headpond for recreational purposes. The biophysical implications of building this tidal barrier were also experienced on the Avon River (Daborn et al., 2003b), and included: infilling of sediment, prevention of fish passage upstream and creation of a freshwater headpond (Government of New Brunswick, n.d.). The causeway on the Petitcodiac River is being removed as a result of an EIA that stated the necessity of such action in order to restore fish passage upstream (Amec, 2005). Unlike the Windsor causeway, the Petitcodiac River causeway was built to allow for fish passage upstream, however, despite many attempts to rectify the existing infrastructure fish passage upstream has proven to be unsuccessful (Amec, 2005). The 5 gates of the causeway opened on April 14th, 2010, for the spring and fall seasons. They will then be closed for the fall and winter in order to avoid ice jamming. This process will occur for two years which will be accompanied by rigorous monitoring of the area. The proponent anticipates that by 2013, 280 m of the causeway will be replaced by a bridge (Government of New Brunswick, n.d.).

The implications associated with the option of removing the causeway, and in particular, the biophysical impacts would be colossal. Other similar cases, including the Petitcodiac River causeway, have been documented which prove to be useful when attempting to determine what would happen if the Windsor causeway were removed. The most significant biophysical, socio-political and legal

implications of removing the causeway are highlighted below. It is important to note that many of these implications are similar to those of removing the tide gate. They have been repeated in this section for the purpose of consistency.

BIOPHYSICAL

Aquatic Ecosystem

The removal of the causeway would likely lead to the restoration of the Avon River estuary to pre-causeway conditions. This would lead to significant alterations to the aquatic ecosystem, most would be similar to those resulting from the removal of the tide gate, however, there is considerably more information available from a removal perspective.

Fish

Removal of the causeway would have effects similar to those of removing the tide gate on fish populations in the Avon River including the restoration of fish passage. Again, uncertainties arise as to whether species of special interest including the Atlantic salmon would return to the system (Percy, 2008), as is the case on the Petitcodiac River (Amec, 2005). In order to facilitate this process, appropriate habitat conditions should be available to fish. Moreover, special consideration should be given to other factors that could affect the successful restoration of diadromous fish species in the River including capacity and opportunity (Tanner et al., 2002), anthropogenic activities on river (Isaacman, 2005), existence of and access to appropriate spawning grounds upstream, the presence of barriers upstream and existence of proper salinity (Haverstock, 2004).

Fish Habitat

As mentioned in the study of the effects of removing the tide gate on fish habitat, this option would likely also pose a threat on existing fish habitat. Given Daborn and Brylinsky's (2004) study which indicated that 8 of the 11 fish species found in Lake Pisiquid were freshwater tolerant, the introduction of salt water upstream of the current causeway would affect existing fish habitat. As discussed in the legal implications of removing the tide gate and replacing it with a bridge, it can be argued that the removal of the causeway option may also degrade fish habitat downstream of the causeway as a result of erosive forces. This is further discussed in the legal implications below.

Lake Pisiquid

Removal of the causeway would simply result in the loss of Lake Pisiquid (Percy, 2008). This would have considerable social implications which are discussed below. Removal of the causeway and the loss of Lake Pisiquid would result in improved water quality on the Avon River. Diurnal macrotides historically experienced in the Avon River estuary would flush contaminants in the system occurring as a result of anthropogenic activities on the river banks (Daborn et al., 2003b). However, it should be noted, that a 2003 study indicated that there appeared to be no threat of eutrophication in Lake Pisiquid (Daborn & Brylinsky, 2004). In the case of the Petitcodiac River, researchers anticipate that removing the causeway would have positive impacts on water quality in the river (Amec, 2005).

Terrestrial Ecosystem

Similarly to the effects of removing the causeway on the aquatic ecosystem, the terrestrial ecosystem would also undergo significant change as is discussed below.

Mudflats/Salt marsh

Although sediment accumulation had created some mudflat on the Avon River prior to the construction of the causeway, the majority of this mudflat was located upstream of its current location. The mudflat exists now below the causeway as a result of forced sedimentation occurring as the tidal waters are stopped at the causeway (van Proosdij et al, 2009). A salt marsh has developed on these mudflats which are now considered to be one of the most ecologically productive of its kind in the Bay of Fundy (Daborn et al., 2003b). Limited information exists in regards to what causeway removal would mean for the mudflats and hence the salt marsh, however, it is thought that the effects would result in significant loss of the mudflats (Daborn et al., 2003b). Carl Amos, a sedimentologist formerly at the Bedford Institute of Oceanography, suggests that erosion of the mudflats would occur quite rapidly following the removal of the causeway (Percy, 2008). Interestingly, Daborn et al. (2003b) suggests that this process would occur slowly as it may take years for enough erosion to occur in the channel that the tidal flow could begin eroding the mudflats. The erosion of the mudflats would also result in substantial loss of the *Spartina alterniflora* and the shorebirds that rely on the salt marsh (Daborn et al., 2003b). Over time, mudflats may develop upstream of the current causeway as the sediment that would be eroded could be deposited upstream. However it should be noted that an intertidal bar existed at the location of the current mudflats prior to the construction of the causeway (although no salt marsh existed) which may continue to exist even if the causeway were removed (Percy, 2008). The variety of

opinions of what could potentially happen to the mudflats and salt marsh demonstrates the level of uncertainty associated with the implications of removing the causeway.

Physical changes to the channel

Anticipated physical changes to the channel itself are solely based on what is expected to occur on the Petitcodiac River following the removal of that causeway. It is important to note that substantial differences exist between both systems. However, given the macrotidal nature of both river systems, it is the most relevant comparison. Infilling of sediment would likely be reversed and this is expected to occur on the Petitcodiac in the amount of 77 mm^3 over 20 years. Upper estuary tides are expected to increase on the Petitcodiac, however not to pre-causeway heights (Government of New Brunswick, n.d.). Also to be noted, following the removal of a causeway on the Sheepscot River in Maine, tidal flow increased by 50% and researchers suspected that it would eventually reach pre-causeway conditions (McAlice & Jaeger, 1983). Unfortunately, no further research appears to have been conducted on this system.

SOCIO-POLITICAL

Similarly to the socio-political effects of removing the tide gate, the effects of removing the causeway on the people of Windsor would be large. This process would involve altering a system on which many townspeople have been dependent upon for flood control and recreational purposes for 40 years. These issues will be addressed below.

Fish

As is the case in regards to fish passage if the tide gate were removed, it is expected that removing the causeway would also allow for fish migration upstream of the current causeway (Percy, 2008). Nevertheless, there are concerns as to whether certain fisheries would be restored in the Avon River following removal. Furthermore, the question that arises is whether or not the people of Windsor would benefit from the return of the Atlantic salmon fishery. It should be noted that this species is listed as an *Endangered Species* under the federal Species At Risk Act and as *At Risk* under the provincial Endangered Species Act. The implication of these designations will be discussed in detail in the legal section of this option. Furthermore, the introduction of salt water into Lake Pisiquid could result in the loss of freshwater tolerant fish species including the yellow perch found in Lake Pisiquid (Daborn and Brylinsky, 2004). This fish holds some recreational value in Canada (Government of Nova Scotia, 2008) which would be lost if brackish water were introduced to the river.

Flooding

The removal of the causeway would lead to widespread flooding of a portion of the Windsor waterfront (van Proosdij, 2009) including properties that have been developed since the construction of the barrier (Paul Beazley, personal communication, March 12, 2010). Flooding would occur primarily due to the lack of upkeep on 27 km dykes upstream of the causeway and as a result, nearly 1,400 hectares of agricultural land would be subject to tidal surge (Percy, 2008). Flooding would lead to the displacement of people and businesses which would have inevitable financial implications. Interestingly, FAR recognizes this hazard but suggests that it is a necessity and that those affected could be compensated (Sonja Wood, personal communication, April 9, 2010).

Despite Ms. Wood's assertions, the economic effects of causeway removal would not be insignificant. According to estimates from Ken Carroll, Aboiteau Superintendent for the Department of Agriculture, the total construction costs of replacing the dykes necessary to protect the 3240 acres of agricultural land that the causeway currently protects would be an estimated $ 2 960 000, in 2003 dollars (Ken Carroll, personal communication, March 26 2010). In 2010 dollars, this works out to $3 328 520, based on a 2010 CPI of 112.45 and base year of 2003 (Bank of Canada, 2010). This includes estimated costs of $1 416 870 (2010 dollars) for reconstruction of the 84 000 ft of dykes that protect the surrounding agricultural land, $1 686 750 for reconstruction of 33 aboiteaux in the system, and $224 900 for rocking of certain areas (Ken Carroll, personal communication, March 26 2010).

While this represents a significant investment, it is important to note costs which are not included. These estimates only represent construction costs, without any consideration for engineering or design. This does not include the relocation of 4 houses which would displaced by the reconstruction of the dykes. Nor does this estimate include any work required to protect the town itself from the flooding that would inevitably occur, as mentioned above. The above estimates deal only with the protection of agricultural land, and estimates of other costs were not available. This estimate also does not include the increased project costs associated with deconstruction of the current causeway and the longer bridge over the newly opened channel, should the causeway be removed. Estimates of these costs were unavailable as well.

Lake Pisiquid

The removal of the causeway would result in the loss of Lake Pisiquid which currently serves several recreational purposes for the people of Windsor. Most significantly, Windsor and West Hants

host an annual Pumpkin Regatta which includes a race of giant pumpkins across Lake Pisiquid (West Hants Pumpkin Festival Committee, 2009). With the loss of Lake Pisiquid this event would have to find a new home. Lake Pisiquid is also used by the Canoe Club (Pisiquid Canoe Club, n.d.) which would too have to relocate and find another lake on which to recreate.

Property Value

In the case of the Petitcodiac River causeway removal, concerns arise over decreased property value as a result of the lack of flood protection. Despite the fact that if the causeway were removed many properties would be lost, there may also be cause for concern over general loss in value of water front properties. Interestingly, the value of properties downstream of the Petitcodiac River causeway decreased following the construction of the barrier as a result of sedimentation (Amec, 2005). Property value upstream of the Windsor causeway increased as Lake Pisiquid formed, and created attractive lakefront property (Percy, 2008), this is likely to change if the causeway were removed as the waterfront property could be subjected to flooding (Percy, 2008).

Public apathy on the subject of causeway could come back to haunt the residents of Windsor. As discussed above, for the most part, the citizens of Windsor are uninformed on the proposed expansion project. While the planned design would have little effect on their lives, restoration of free tidal flow, either through removal of the tide gates or removal of the causeway in general (to be replaced by a bridge) would have a far greater effect. If the experience of the citizens of Moncton is any indication, the potential removal of the causeway might be something with which the citizens of Windsor may wish to become involved.

Ken Carroll, of the Department of Agriculture was contacted recently by members of the Petitcodiac causeway association to obtain contact information for community members in Windsor. The landowners upstream of the Petitcodiac causeway are concerned that their land may be affected, and wanted to warn the landowners near the Windsor causeway. The apathy apparent in Windsor is similar to that which existed with regard to the Petitcodiac causeway, and by the time the citizens became well-informed enough to understand the implications, it was too late – the decisions had already been made (Ken Carroll, personal communication, March 26, 2010).

LEGAL

There are several legal implications associated with the removal of the causeway all of which are consistent with those determined for the removal of the tide gate.

Harmful Alteration, Disruption or Destruction of Fish Habitat (HADD)

As mentioned above, Lake Pisiquid provides sufficient habitat for many species of fish (Daborn & Brylinsky, 2004). Furthermore, given the definition of fish habitat in the *Fisheries Act* it can be argued that the river downstream of the causeway may too serve as fish habitat as many species of fish have been found in the estuary (Daborn & Brylinsky, 2004). The actual effect of restoring free tidal flow in the estuary on existing fish habitat is unknown. However, it can be presumed that an increase in salinity and flow within Lake Pisiquid may have negative implications on existing habitat. It is presumed that the river downstream of the causeway would also be subject to erosion if the causeway were removed. As a result, this project may have the potential of creating harmful alteration, disruption or destruction of fish habitat (HADD) which would be in violation of the *Fisheries Act*. According to section 35 (1) of the Act there is a general prohibition of HADD of fish habitat by any undertaking or work. As is the case in the option above, it is likely that lost habitat would have to be compensated for.

Species At Risk

One of the main motivations for removing the causeway would be to allow for fish passage upstream. In particular, FAR is interested in the fate of the Atlantic salmon and American eel (Sonja Wood, personal communication, March 12, 2010). The Atlantic salmon is listed as a federal *Endangered Species* according to the Species At Risk Act (SARA). Provincially, this species is considered to be *At Risk* in the Endangered Species Act. According to section 32. (1) of SARA there are several prohibitions as to what one can do to an endangered species including harm, kill or capture the animal. As a result, Atlantic salmon could not be fished. The benefits of restoring this fish to the system would be based solely on spiritual significance of the presence of this species, if such exists in the area. Also, there are some biological benefits associated with diadromous fish species in aquatic ecosystems as previously mentioned.

Environmental Impact Assessment

Friends of the Avon River hope that the result of an EIA would be similar to that of the Petitcodiac River causeway EIA. The causeway on the Petitcodiac is being removed as a result of an EIA that stated that the causeway impeded the upstream migration of the Atlantic salmon which is in

violation of the *Fisheries Act*. However, it is important to bring to light that sampling of fish species in the Petitcodiac River have resulted in the presence of juvenile salmon (although potentially as a result of stocking) and no such species have been found on the Avon River (DFO, 2006).

Expanding the Windsor causeway so as to allow for free tidal by removing the tide gate and replacing it with a bridge would require an EIA according to both provincial and federal regulations (*Canadian Environmental Assessment Act S.C., 1992, c. 37*).

Wetlands Compensation

As mentioned in the free tidal flow option above, the implications on wetlands will be nearly identical. Therefore, the requirement and procedure for wetland compensation will be similar. That means any salt marsh destroyed will need to be compensated for in one of the aforementioned methods. Again, in the case of causeway removal and replacement with a bridge, NSTIR will be responsible for compensating for any loss of wetland area, habitat or function. Furthermore, this will need to be addressed in the formal EIA.

Economics

While certainly not equivalent, the economics of the removal of the Petitcodiac River causeway can certainly help to inform decision-making with regard to the Windsor causeway. In 1992, the Department of Transportation of the Province of New Brunswick commissioned a report called “Analysis of the Options for the Future of the Petitcodiac River Dam and Causeway”. Included in this analysis was a cost-benefit analysis of each of the 7 options proposed. Some of the options proposed have not been investigated in any way, in this paper or elsewhere, for the Windsor causeway. But for the common options proposed, it is interesting to look at the cost-benefit analysis.

The analysis examined the costs of the gates being opened, as well as replacement of the causeway with a bridge (the eventual option chosen), among others. Neither of these options was determined to be feasible economically. The analysis examined the net present value (NPV) of costs as well as benefits and found that the NPV of opening the gates (benefits-costs) was -$ 1 951 972, meaning that the costs outweighed the benefits (ADI Limited, 1992, p. 113). For replacement of the causeway with a bridge, the NPV (benefits-costs) was -$ 13 923 154, with costs again drastically outweighing the benefits (Ibid, p. 114).

There are two caveats to think about, however. First, the report, although acknowledging and accounting for intangible benefits and disbenefits, does nothing to quantify these, and there these are not included in the cost-benefit analysis. Second, this report was written in 1992, so the actual numbers involved are relatively insignificant. What is of interest is the relationship between the costs and the benefits of each option. For the two options foreseeable for the Windsor causeway, the NPV is negative, meaning that neither option made economic sense. Interestingly, however, the same can be said about each of the options analyzed – they all had negative NPVs. Despite this fact, as mentioned above, on April 14th 2010 the gates were opened to allow water to flow freely, and by 2013 the causeway will be replaced with a bridge. There is no guarantee that this cost-benefit analysis was used to help decide the fate of the Petitcodiac causeway, but if it was, it is clear that the intangible benefits that went unquantified must have been given great value in the decision-making process.

Ecological Restoration

If the causeway on the Avon River were removed, the current ecosystem would endure significant changes. Advocates for this option would like to see the return of Atlantic salmon in the river and the restoration of free tidal flow. Ultimately the ecosystem may restore itself to pre causeway conditions. Research has been conducted to examine the motivation around social support for ecological restoration and the willingness to pay (WTP). Connelly et al (2002) suggest that there are many criteria that may influence one's willingness to pay for restoration including; past experience with restoration, use of ecosystem in question, income and social status. Ultimately, users of the particular ecosystem have some vested interest into its fate, and generally, those who earn higher incomes are more willing to pay. However, it should be noted that public support for restoration tends to decrease once the cost of action is defined. Generally, what appears at first to be a novel idea to local residents may soon become a burden when the costs, not only financial, are introduced into the restoration plan. The researchers suggest that in order to maintain some level of interest, those advocating for change should continue to partake in public outreach and involvement despite loss of support (Connelly et al, 2002).

> "I would suggest to you, just from being a resident and very active in the community, I am a lion and do a lot of volunteer work. The majority of Windsor has no understanding whatsoever or even knows that there's more than one option. I can pretty well tell you they don't. Now I'm just talking the average person. But for the average guy, I can tell you they don't know."
>
> -Ruth Fader, Town of Windsor Resident

Friends of the Avon River are the primary advocates for the restoration of free tidal flow and fish passage on the Avon River. Essentially, the group would like the *Endangered* Atlantic salmon and *Species of Special Concern*, the American eel, to have access to suitable habitat upstream of the causeway (Sonja Wood, personal communication, April 9, 2010). Ultimately, the removal of the either the tide gate or the causeway would encourage ecological restoration to the former ecosystem. Despite efforts by members of FAR to advocate for the restoration of free tidal flow and fish passage, generally, the people of Windsor have either grown complacent on the issue as a whole or are not aware as suggested to in the quotation to the right (Ruth Fader, personal communication, April 8 2010). Despite this, FAR should continue with a public outreach campaign in order to maintain the support that they have.

Generally, ecological restoration occurs to restore a system to a healthier level of functioning (Kent, 1999, as cited in Connelly et al, 2002). More specifically, The Society for Ecological Restoration defines this process as,

> "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. Frequently, the ecosystem that requires restoration has been degraded, damaged, transformed or entirely destroyed as the direct or indirect result of human activities…Restoration attempts to return an ecosystem to its historic trajectory" (SER, 2004, pp 3).

When considering ecological restoration of an ecosystem questions arise in regards to the historic trajectory of the system. To what date does an ecological restorer restore a system (Allison, 2004)? According to the SER definition, that date is prior to when humans had direct or indirect impacts on the system. Without historical records how can we know specifics about the ecosystem at that date? In North America, Aboriginal people had direct and/or indirect impacts on the environment prior to European settlers. So, does our historic trajectory date back to pre Aboriginal influence (Allison, 2004)? It is apparent that defining historic trajectory in regards to ecological restoration is highly contentious. As such, humans and human activities must be separate, and unnatural human activities must be clearly defined. In the case of the Avon River, if the causeway was removed and efforts were established to

restore the ecosystem to its pre-causeway condition, what would the historic trajectory be for this restoration project? Human influence on the Avon River predates the construction of the causeway and as a result, there have been historic declines in fish populations. Furthermore, other barriers exist upstream of the causeway which have been on the river system for decades longer than the causeway, should they be removed as well (Percy, 2008)? Should agricultural activity that has altered the water quality in the river for over a century cease? There are many uncertainties as to whether or not diadromous fish populations, in particular the Atlantic salmon and the American eel would recover in the Avon River given the changes that have arisen as a result of more than just the construction of the causeway (Percy, 2008).

Another point of interest concerning ecological restoration is the value of the new ecosystem in comparison to the "old" ecosystem. Allison (2004) addresses this issue when considering a restoration project in Illinois where agricultural land is restored to tallgrass prairie. Allison (2004) states that although agricultural land is not native to the area, it is of great value to American society for food production. Furthermore, the researcher is uncertain as to how successful the tallgrass prairie system would be at hosting important keystone species fauna. The restoration itself would require a great amount of human influence and Allison states that if the agricultural land were left to restore naturally, it is unlikely that the end result would be tallgrass prairie (Allison, 2004).

In the case of the Avon River estuary, questions arise as to whether the pre causeway tidal river was indeed healthier than the current freshwater lake and salt marsh. Friends of the Avon River state that the current system is a mud desert devoid of life (Wood, n.d.). However, scientists argue that the existing salt marsh is one of the most productive in the Bay of Fundy and possibly in North America (Daborn et al, 2003b). Given the uncertainties surrounding the ability of the Atlantic salmon and American eel populations to recover in the Avon River, it is possible that the biophysical and social benefits of the current ecosystem outweigh those of recorded accounts of the pre-causeway system.

CONCLUSIONS

Responding to concerns surrounding safety on Highway 101, plans to twin the highway were announced in 2002 and it quickly became apparent that this project would also include adjustments to the existing Windsor causeway. The tidal barrier has been in place for 40 years, and as a result, has altered a tidal river hosting a variety of populations of diadromous fish into a limited access for diadromous fish, freshwater river and an ecologically significant salt marsh. Members of the community, in particular the activist organization Friends of the Avon River, view this highway safety project as an opportunity to restore free tidal flow and to allow for fish passage upstream of the causeway. Restoring free tidal flow on the Avon River would have significant biophysical, socio-political and legal ramifications. Through a series of interviews with members of the community and experts, and an extensive literature review, many of these ramifications have been identified and summarized in this report. The restoration of free tidal flow would almost certainly destroy the current ecosystem, including the productive salt marsh, without any guarantee that the previous ecosystem would be restored or that the lost diadromous fish populations would return. Provided this information, it can be concluded that the expansion project that is currently being considered is the most feasible option and should go ahead as planned. Public pressure to improve highway safety by expanding Highway 101 must be balanced with environmental concerns surrounding the impact such development would have on local ecosystems. Ecologically, socially, politically and economically, this is the best option. However, this conclusion comes with recommendations, and they are as follows:

First, NSTIR is presented with a very informative case study to help with the decision-making process. On Wednesday, April 14th, 2010 the gates of the Petitcodiac causeway were permanently opened with about 500 people watching. Within the next three years, the causeway itself will be removed, replaced with a bridge. From a biophysical perspective, this case will provide a good indication as to whether ecosystem restoration is possible in a macrotidal environment. From a social perspective, it will also provide an opportunity to gauge public reaction to the removal of a causeway. The lessons learned on the Petitcodiac River can be easily applied to the Avon River, and as such the removal of the Petitcodiac causeway should be closely monitored.

Second, in the meantime, further research should be conducted on the effectiveness of different types of fish passages in macrotidal environments such as the Avon River estuary. A number of fish passage options were explored on the Petitcodiac prior to deciding to remove it, but none were

successful. If an effective means of incorporating fish passage could be included in the current expansion plans, this would be a cost effective way to satisfy highway safety needs while attempting to restore healthy levels of diadromous fish populations in the Avon River. This would also allow for the maintenance one of the most productive salt marshes in the Bay of Fundy.

Third, the creation of a community-based stewardship group that could monitor the ecosystem and construction progress would present an opportunity for further community engagement. This could be partially incorporated into the elementary school curriculum which would foster an appreciation for the local ecosystem in grade school children. The community stewardship group could also aid in the facilitation of more effective community consultations by presenting the twinning process from a local perspective. Ultimately, a stewardship group would give voice to the community members, as well as act as a quality control device for the twinning project.

In addition to the recommendations laid out above, there is one overarching issue to be considered. While climate change is certainly a factor in the planning of developments, the exact effects are generally unknown. Even the IPCC 4th Assessment Report, perhaps the most comprehensive study of the global effects of climate change, couches all of its predictions of these effects in probability-related terms such as "likely" and "very likely" (IPCC, 2007).

This fact may be the proverbial red herring in the entire decision making process in the in the twinning of Highway 101. It is a variable that can be considered, but can't be accurately accounted for, due to many unknowns. For instance, how do we deal with question such as the following: How will climate change affect fish populations? How will it affect tide cycles? How will it affect river flow? What about siltation? And what about the unknown effects that don't have names, and certainly haven't been considered? These recommendations will aid in ensuring that the integrity of the current ecosystem is recognized and maintained while satisfying the societal need for improved highway safety over the Windsor causeway.

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Canadian Environmental Assessment Act, S.C. 1992, c. 37 (CanLII).

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Fisheries Act R.S.C. 1985, c. F-14

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Nova Scotia Wetlands Conservation Policy - Draft for consultation (2009)

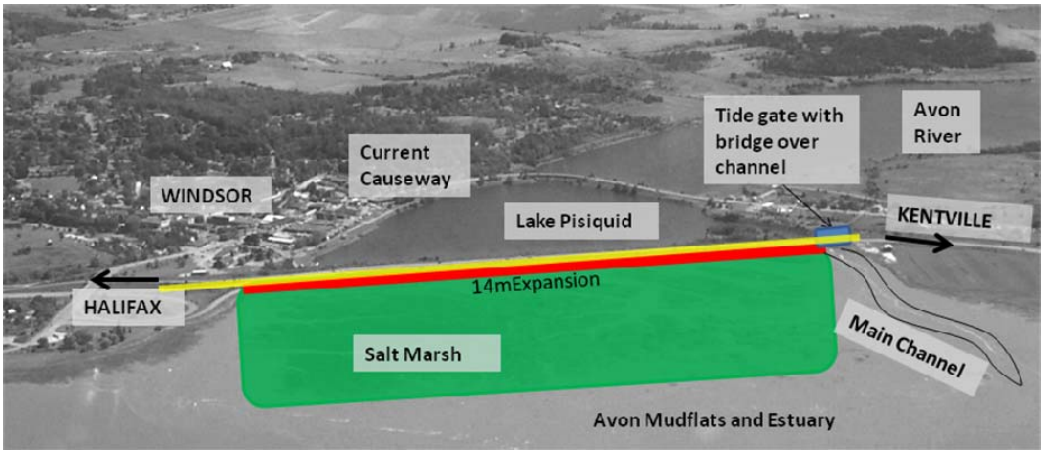
Species At Risk Act, (2002, c.29)

APPENDIX A: SCENARIO DRAWINGS

Pre-Causeway (Pre-1968)

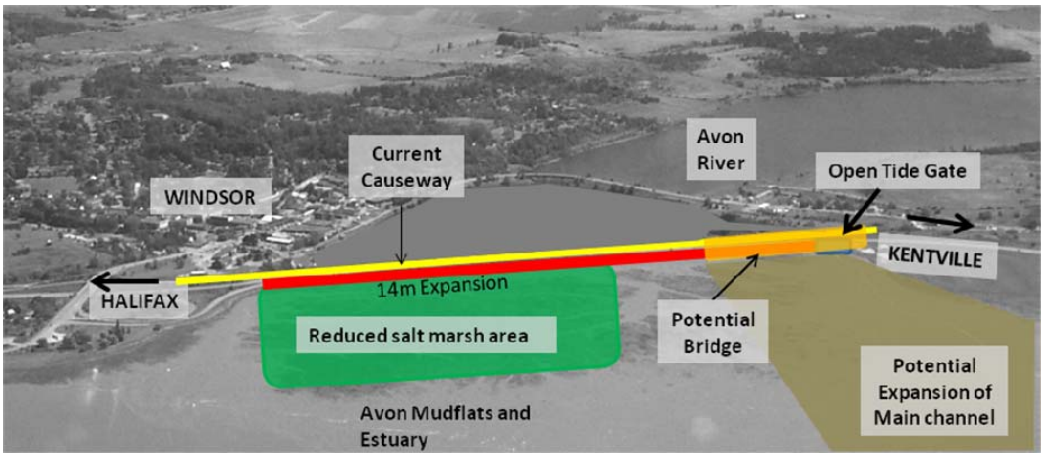
Adapted from:
http://www.facebook.com/home.php?#!/photo.php?pid=281769&op=2&o=global&view=global&subj=12202985330&id=634404984

Future: Expansion



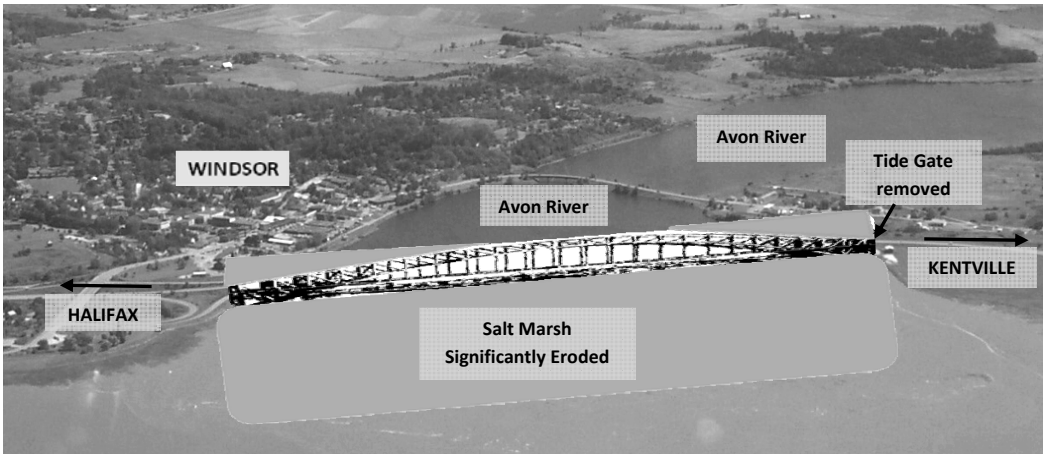
Adapted from: http://www.bofep.org/PDFfiles/fundy_issue_28.pdf

Future: Tide Gate Removal



Adapted from: http://www.bofep.org/PDFfiles/fundy_issue_28.pdf

Future: Partial or Complete Causeway Removal and Replacement with Bridge



Adapted from: http://www.bofep.org/PDFfiles/fundy_issue_28.pdf

APPENDIX B: SAMPLE CONSENT FORM

Implications of the Removal or Expansion of the Windsor Causeway

Student Researchers: Erica Fisher, Ashley Graham, Laura Johnstone, Elaine Mailman, Todd McBride, Michelle Wong Ken

Supervised by: Faculty in the School for Resource and Environmental Studies, Dalhousie University, Contact: Dr. Heather Castleden (heather.castleden@dal.ca or 902-494-2966)

Research Question: What is the social context surrounding the removal or expansion of the Windsor Causeway?

Purpose of Research: To gain an understanding of multiple stakeholder perspectives of the potential expansion or removal of the Windsor Causeway.

Participation and Withdrawal
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. If you feel uncomfortable with the content of the discussion during the interview you are free to terminate participation.

Confidentiality and Anonymity
Confidentiality will be maintained because the recordings and transcripts will only been seen by the Student Researchers and their supervising professors. The recordings and transcripts will be securely stored on a password protected website and computers. Pseudonyms will be used if you wish to be quoted but remain anonymous.

How the Research will be used

Direct quotes of what you say may be used in our final report and/or presentation in April 2010. This presentation is open to the public and the final report will be posted on the School's website. Any direct quotes from your participation will be available for your review up until April 9th, and anonymity, if requested, will be maintained by using a pseudonym (fake name). As a participant in our research, a copy of our final report will be available to you if you request one.

Rights of Research Participants
You may withdraw your consent at any time and discontinue participation. This study has been reviewed by the Faculty of Management Ethics Review Board at Dalhousie University. If you have questions regarding your rights as a research participant, please contact Dr. Peter Duinker, Associate Dean (Research) of the Faculty of Management, Dalhousie University, at peter.duinker@dal.ca.

Consent:

☐ **I AGREE to participate in this study.**

☐ I give permission to tape record the meeting.

☐ I give permission to be identified as a participant and quoted by name.

☐ I give permission to attribute my name, in the form of a pseudonym, to any quotes.

☐ I would like a copy of the final report. Provide electronic or postal mailing address below.

Participant Signature: _____ Date:

___ Verbal Consent over phone

Name: _____

Affiliation: _____

Mailing Address: _____

_____

_____

Email: _____