

# **A COMPARISON OF NIAGARA FRONTIER CROSS-BORDER TRAVEL PATTERS OVER TIME**

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## **ABSTRACT**

The Niagara River constitutes the most significant transportation crossing in Eastern North America. With four highway and two railway bridges, the Niagara Frontier is the second busiest commercial crossing along the Canada-US border, carrying approximately 19% of all bi-national trade. The highway bridges serve more than 72 million cross-border trips annually, more than any other crossing between Canada and the US.

In an attempt to better understand the travel behaviour of individuals traversing this important bi-national crossing and changes over time, the Ontario Ministry of Transportation (MTO) engaged Paradigm Transportation Solutions Limited to conduct roadside direct-interview travel surveys on the Canadian side of the Niagara Frontier highway bridges in summer 2007, fall 2012 and summer 2013. The purpose of the surveys was to determine the origin, destination and trip characteristics of cross-border passenger vehicles traveling between Ontario and New York at the four highway bridge crossings in Niagara Region.

A survey of this magnitude requires a multi-jurisdictional effort, including the support and participation of MTO, the New York State Department of Transportation, border agencies, bridge commissions and local police services. Several of these agencies have used the data for planning and monitoring initiatives, such as the Niagara to Greater Toronto Area (GTA) Corridor Planning Study and High Speed Rail and Corridor/Gateway studies linking New York City and Toronto.

The surveys provide a rich database of information that enable the agencies to monitor and adjust to travel trends over time. The results are considered statistically valid, as they sampled between 26% and 34% of all vehicles passing through the study area during the survey periods. In total, the three surveys captured travel information from over 60,000 vehicles crossing the bridges at all times of the day, and on both weekdays and weekends.

This paper outlines the differences in travel patterns observed between the three surveys and highlights changes in specific behaviour over time, including: vehicle characteristics, trip purpose, trip frequency, home country of travelers and overall travel patterns, and average trip distance by bridge and direction.

## **BACKGROUND**

The Ontario Ministry of Transportation (MTO) has broad policy and operational interests in ensuring international border crossings in the province operate effectively and support the safe and efficient movement of goods and people between Canada and the United States. Recognizing the importance of these crossings to the provincial and federal economies, the Ministry has invested significant resources into monitoring, studying and understanding the characteristics of bi-national travel over the past two decades.

One of the more significant initiatives carried out by MTO are the origin-destination surveys at the Province's border crossings. The surveys capture information on the origin, destination and trip characteristics of passenger vehicles traveling between Ontario and the bordering US state (and beyond). At the Niagara Frontier, the surveys gather data on vehicles entering New York State via the four international bridge crossings in Niagara Region: Peace Bridge in Fort Erie, ON; Queenston-Lewiston Bridge in Queenston, ON; Rainbow Bridge in Niagara Falls, ON; and Whirlpool Bridge in Niagara Falls, ON. **Figure 1** shows the general study area and location of each bridge.

The surveys sample between 10% and 20% of all passenger vehicles crossing the bridges during the peak survey hours. The data collected provides a comprehensive database of cross-border travel behaviour that can be easily queried by the respective agencies to provide not only trip-specific patterns but select tourism-related information that can be used in support of various initiatives and studies within Ontario and New York. The databases have historically been made available to the New York State transportation agencies, Niagara Falls Bridge Commission, Peace Bridge Authority, Canada Border Services Agency and tourism agencies to support project planning, economic analyses and program evaluation.

## **SURVEY METHODOLOGY AND OPERATION**

Several types of surveys can be conducted to collect origin-destination information including license plate trace studies, handout/mail back surveys and direct-interview surveys. The direct-interview methodology was determined to be the best option for conducting the 2007, 2012 and 2013 surveys given the volume of traffic at the bridges and the need to collect complete, accurate and random data within a safe, secure and controlled environment. Selection of this methodology also provided more control over the sample rate, especially during peak periods when higher sampling was required.

The surveys were conducted during the busy summer and fall seasons. The summer surveys involved 24 consecutive hours of sampling in each direction for one weekday and one weekend day at the Peace, Queenston-Lewiston and Rainbow Bridges. A total

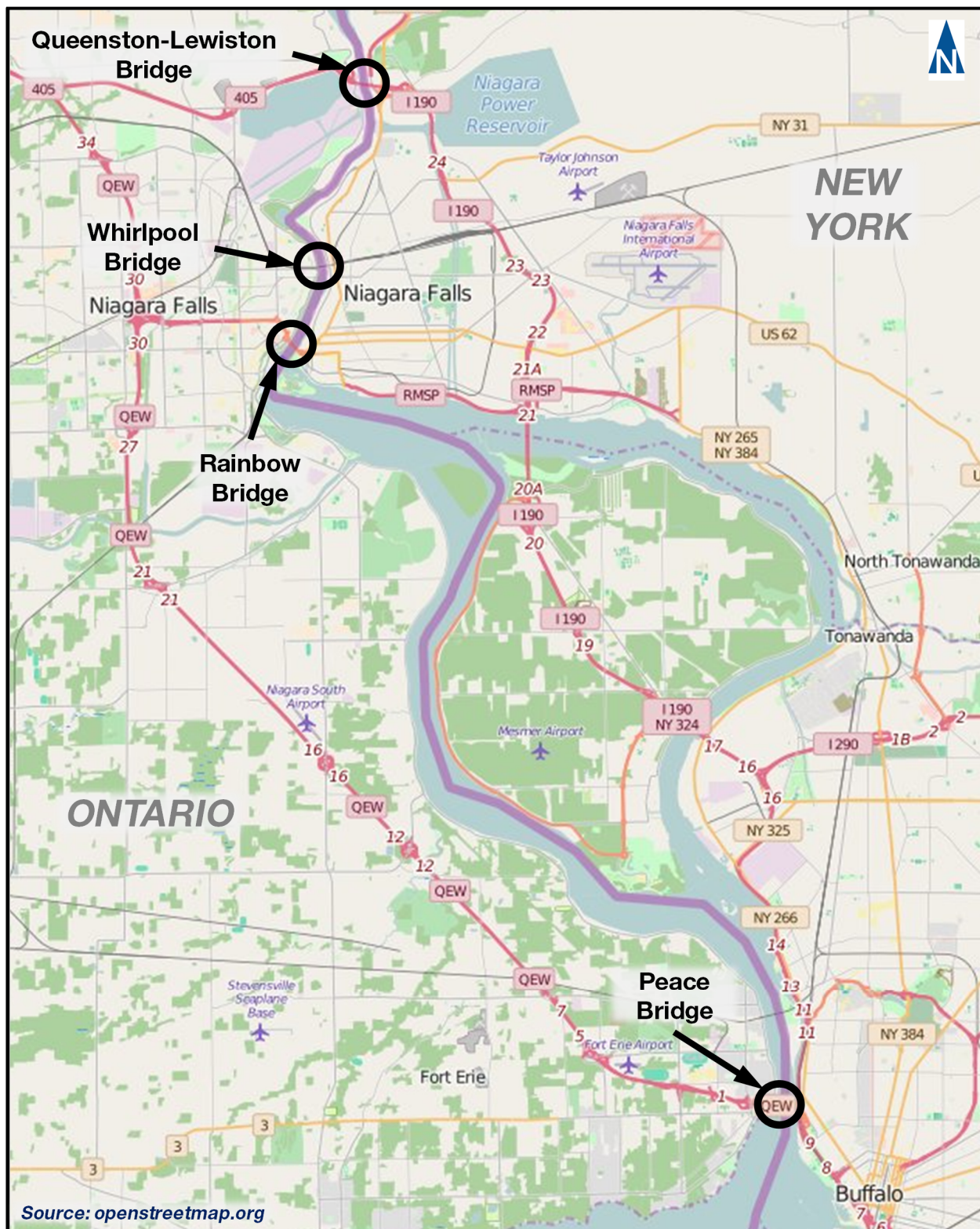


FIGURE 1 – General Study Area and Bridge Locations

of 16 consecutive hours of sampling was conducted in each direction for one weekday and one weekend day at the Whirlpool Bridge due to its limited operating hours (7AM to 11PM). The fall surveys involved eight (8) consecutive hours of sampling in each direction for one weekday and weekend day at all four bridges.

The schedule was designed to limit the surveys to one direction (inbound or outbound) at two bridges per survey day, starting with the lower volume bridges. Scheduling the surveys in this manner provided staff the opportunity to acclimate to the working environment while focusing on the quality and speed of data collection. Limiting the surveys to one direction per day ensured that motorists would not be interviewed multiple times in the same period, thereby maintaining the randomness of sampling.

The surveys were scheduled to avoid holidays and holiday weekends, recognizing that travel patterns can vary significantly during these time periods. In the case of the summer surveys, all data was collected in either July or August to ensure peak summer trip-making was captured. The fall 2012 survey was scheduled for mid-October, but postponed one week to avoid a significant weather event that could have affected travel behaviour.

Safety was the most important factor in all surveys tasks, from the initial project meeting to final site take-down. The sites were designed with the safety of the survey staff and motorists at the forefront. This was achieved through the use of larger survey areas with more lanes, where space permitted, and effective traffic control, which helped to minimize congestion. All survey areas were designed to meet or exceed the requirements outlined in Ontario Traffic Manual Book 7 (Temporary Conditions) for short-duration work of less than 24 hours.

The interviews were conducted on the Canadian side at each bridge. Off-duty Niagara Regional Police and Niagara Parks Commission Police officers with cruisers were hired and stationed at each survey location to reinforce legitimacy and assist with initial traffic flagging duties. The cruisers, with rooftop lights illuminated, were positioned in highly visible locations in advance of the survey zones, which assisted in slowing approaching traffic. All bridge traffic, whether entering or exiting Canada, passed the police officer that was responsible for selecting vehicles for interview and directing them towards the survey zone when interview positions were available. Trained traffic control staff would take over and further direct the vehicles into an available position. When the survey zone was full, the police officers waved traffic past the survey area. This process was repeated throughout the survey day to ensure the target sample was met.

The traffic controllers “held” each survey line during the interviews, which were typically completed in under two minutes. When the interviews in the respective line were complete, the traffic controllers released the vehicles to continue their journey. At locations where vehicles were required to merge back into the general traffic stream,

the traffic control persons held the survey participant until there was a break in traffic at which point they were safely released into the traffic flow.

**Figure 2** shows an example of the survey zone setup for the Rainbow Bridge.



**FIGURE 2 – Sample Survey Zone Setup, Rainbow Bridge, Niagara Falls, ON**

## **SURVEY QUESTIONNAIRE**

The survey questionnaire was designed to capture the origin, destination and trip characteristics of each passenger vehicle selected for interview. The questionnaire was designed with input from the participating agencies prior to commencing each survey. Specific initiatives that were ongoing during each respective survey period helped to shape the overall questionnaire, resulting in a distinct form for each survey.

The proximity of the bridges to large retail commercial areas and duty free stores on both sides of the border presented a challenge to the collection of accurate origin and destination information. This is due to the large percentage of pass-by and diverted link trips that tend to occur prior to or immediately after crossing the border. To account for these trips and ensure the proper origin and destination data was collected, the survey questionnaire was designed to obtain extended trip information.

## **POST-SURVEY DATABASE DEVELOPMENT**

The survey data collected was manually entered into a database. After data entry, the records were cleaned and prepared for geocoding and expansion. Cleaning consisted of removing incomplete or illogical trips, correcting monument names, adding the address of monuments, correcting and completing intersections by city, checking

spelling of city names and correcting for state/province location, and completing logic and range checks to ensure responses were consistent and correct for each question. Once the data cleaning was completed the database was verified to ensure that all records contained an origin and destination at minimum.

All records in the database were geocoded, with georeferenced coordinates assigned to each trip end. Origin and destination points located within the Greater Golden Horseshoe Area of Ontario and Erie and Niagara Counties in Western New York were assigned to traffic analysis zone (TAZ) systems provided by MTO and New York State. The zone systems remained consistent across the 2007, 2012 and 2013 surveys. All trip ends, including those assigned to a TAZ, were then coded to a larger superzone system consisting of 32 zones: 15 internal study area superzones within Niagara Region and Western New York, and 17 external superzones.

Since the surveys did not sample every cross-border trip, hourly and daily expansion factors were developed to expand the results to represent 100% of the trips. The factors were calculated by dividing the total traffic per hour or day by the total number of surveys collected during that hour or day. Factors were established for both directions of travel at each bridge and then applied to the survey records based on bridge, direction and day.

## **SURVEY RESULTS**

As noted above, the questionnaire was modified for each survey to reflect and capture data for ongoing planning initiatives and tourism-related efforts underway at the time. That said, several questions remained consistent across all three surveys, allowing for direct comparison of the data. With the exception of the overall survey statistics, this section outlines the results of the entire expanded data set by survey year.

### **Overall Survey Statistics**

**Table 1** illustrates that nearly 200,000 vehicles passed through the survey zones during the three survey periods. The highest total survey traffic volume of 86,480 vehicles was observed during the summer 2007 survey. When the 24-hour survey was repeated in summer 2013, the traffic volume dropped by 7% to 80,900 vehicles. The drop in cross-border travel between 2007 and 2013 was initially thought to be tied to a weaker Canadian dollar, but this was not the case – the exchange rate was nearly the same in 2013 (\$0.96 US = \$1.00 Cdn) as it was in 2007 (\$0.95 US = \$1.00 Cdn) at the time of the surveys. Upon further investigation, it is believed that the requirement to present a passport to enter the U.S. by land, which began on June 1, 2009, affected the volume of cross-border trip making more significantly than the currency exchange rate. As expected, traffic volumes were significantly lower, 32,000 vehicles, during the shorter-duration fall 2012 survey.

A combined total of 61,567 surveys remained in the three databases after cleaning and final checks. The highest sample rate of 34.2% was achieved during the fall 2012 survey with the summer 2007 survey rate slightly lower at 33.8%. The summer 2013 survey had the lowest final sample rate of 26.5%. Although the traffic volumes were higher during this survey period, the lower sample rate can be attributed to the changes in the participant refusal policy instituted for this survey. These changes resulted in a higher percentage of incomplete questionnaires and ultimately a lower sample rate. However, all surveys exceeded the target sample rate by 6.5% or more.

**TABLE 1 – Summary of Survey Statistics**

Survey Statistic	Survey Year		
	2007	2012	2013
Length of Survey Day	24 hr	8 hr	24 hr
Total Survey Traffic Volume	86,480	32,000	80,900
Percent Change in Volume		n/a	-7%
Total Number of Completed Surveys	29,214	10,907	21,446
Target Sample Rate	10%	20%	20%
Final Sample Rate	33.8%	34.2%	26.5%

## Vehicle Characteristics

**Table 2** shows that the percentage of passenger vehicles (cars, vans, pickup trucks and sport utility vehicles) surveyed was consistently greater than 97% during the three surveys. A larger proportion of other vehicle types (car and trailer, motorcycle and taxi) was recorded during the 2007 survey, representing 2.4% of all vehicles interviewed. Other vehicle types constituted less than 2% of the total vehicles contacted during the 2012 and 2013 surveys. These lower percentages can likely be attributed to slight changes to the layout and design of the survey areas, which limited the size of vehicle that could be accommodated. Wherever possible, these vehicles were selected for interview.

**TABLE 2 – Vehicle Classification**

Vehicle Classification	Survey Year		
	2007	2012	2013
Passenger Vehicle (car, van, pickup, SUV)	97.6%	99.9%	98.5%
Car and Trailer	1.9%	0.1%	1.4%
Motorcycle	0.4%	0.0%	0.1%
Motorhome/RV	0.0%	0.0%	0.0%
Other	0.0%	0.0%	0.0%
Taxi	0.1%	0.0%	0.0%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

**Vehicle Occupancy**

As **Table 3** shows, vehicles with two occupants were most common. Between 37% and 47% of the vehicles crossing the border during the three surveys contained two people. Single-occupant vehicles were also relatively common, and represented a further 26% to 31% of all vehicles crossing the border during the surveys. Vehicles with three or more occupants were less frequent, and represented 33% of the total vehicles crossing the border in 2007 and 2013, but only 23% for the 2012 survey.

The lower vehicle occupancy is likely related to the trip purpose, given that the majority of trips made during the three surveys were for discretionary purposes such as recreation and entertainment, casino and tourist attractions. These trip makers tend to return in the same day, as opposed to stay for longer durations.

**TABLE 3 – Vehicle Occupancy**

Vehicle Occupancy	Survey Year		
	2007	2012	2013
1 person	29.7%	30.7%	26.8%
2 people	37.4%	46.6%	40.5%
3 people	12.9%	11.3%	13.3%
4 people	13.1%	8.4%	13.2%
5 people	4.3%	2.0%	4.2%
6 or more people	2.6%	1.0%	2.0%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

## Trip Frequency

For the 2012 and 2013 surveys, motorists were asked how frequently they made the specific trip being surveyed. The question was phrased to ensure that the respondent answered for that exact trip purpose, not how frequently they cross the border.

**Table 4** shows that most surveyed trips, 35% in 2012 and 46% in 2013, are made once or twice per year. Regular daily or weekly trip-making represented 23% of the 2012 trips and 21% of the 2013 trips. The slightly higher rate of infrequent trip making in 2013 can be attributed to the survey period, which occurred during the peak summer travel season, as opposed to the fall for the 2012 survey.

**TABLE 4 – Trip Frequency**

Trip Frequency	Survey Year		
	2007	2012	2013
Every day	-	3.7%	4.8%
Every week	-	19.6%	16.5%
Every month	-	20.1%	15.9%
Every 3 or 4 months	-	19.4%	12.7%
Once or twice a year	-	35.0%	45.5%
Refused / don't know	-	2.2%	4.6%
<b>Total</b>	-	<b>100.0%</b>	<b>100.0%</b>

## Trip Purpose

After origin and destination, trip purpose was the most important question asked for the surveys. This information offers the respective agencies insight as to “why” trips are being made, which helps for different planning and development initiatives such as the Niagara to Greater Toronto Area corridor study.

**Table 5** indicates that tourism-related travel for recreation and entertainment, vacation, tourist attraction and casino purposes accounted for 26% or more of the cross-border trips during the three surveys. Shopping represented a larger percentage of trips in 2012 (39.3%) and 2013 (20.5%) than in 2007 (5.6%). The occurrence of cross-border shopping was believed to tie directly to the value of the Canadian dollar, but the exchange rate was relatively constant for the three surveys, as noted previously.

An increase in trips to visit friends and relatives was noted, growing from 8.8% in 2007 to 17.3% in 2013. “Other” trip purposes, including airport-related trips, grew considerably, increasing from 4.4% in 2007 to 12.9% in 2013, likely due to the proximity of Niagara Region to the Buffalo and Niagara Falls, New York airports. These airports offer attractive, lower cost flights to many US destinations, helping to spur the

growth in this travel market. Work, business and school trips represented less than 10% of the total cross-border travel during the three surveys, unlike typical metropolitan origin-destination surveys.

It should be noted that “home” was a valid trip purpose response for the 2007 survey. This resulted in an over-representation of trips made to and from “home”, as opposed to the actual trip purpose, such as “vacation” or “recreation”. To address this oversight in the 2012 and 2013 surveys, extended trip information was collected during the interviews that assisted with determining the actual trip purpose. Additional checks and cleaning were conducted on the subsequent data sets, which resulted in lower percentages of “home” trips and higher percentages of trips in the remaining purpose categories.

Overall, there is a high degree of discretionary cross-border trip making for purposes such as shopping, vacation and to visit friends and relatives. Trip purpose affects both vehicle occupancy and trip frequency, and as outlined previously, vehicles with two occupants and trips made once or twice per year represented the highest percentage of travel in their respective categories. This is consistent with expectations given the high percentage of discretionary trips recorded during each survey.

**TABLE 5 – Trip Purpose**

Trip Purpose	Survey Year		
	2007	2012	2013
Business	2.3%	3.5%	3.3%
Casino	3.1%	6.2%	4.0%
Home	44.1%	0.7%	2.2%
Other	4.4%	10.5%	12.9%
Recreation and entertainment	9.7%	8.1%	4.5%
School	1.0%	1.4%	0.5%
Shopping	5.6%	39.3%	20.5%
Sports/special event	0.0%	0.0%	4.1%
Tourist attraction	4.2%	2.5%	5.3%
Vacation	13.5%	9.5%	21.0%
Visit friends / relatives	8.8%	13.8%	17.3%
Work	3.3%	4.5%	4.4%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

## Home Country of Travelers

Drivers were asked their home country of residence to further understand tourism-related travel. **Table 6** shows that less than 1% of cross-border trips were made by international travelers during the three survey periods. This table also illustrates a decrease in trips made by residents of the United States between 2007 and 2013. This is likely due to the 2009 change in passport policy noted above.

**TABLE 6 – Home Country of Travelers**

Home Country	Survey Year		
	2007	2012	2013
Canada	38.2%	72.2%	54.0%
US	61.1%	27.3%	46.0%
International	0.7%	0.5%	0.0%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

## Average Trip Distance

The average Cartesian trip distances by bridge and direction were calculated using the geocoded X and Y coordinates of the origins and destinations collected through the surveys. All trip distances were calculated using the bridge as an intermediate point, since it was recognized that without this point, some straight line trip distances would be calculated going across the Great Lakes instead of around them.

The results of the analyses shown in **Table 7** indicate that the Queenston-Lewiston Bridge consistently serves as the primary crossing for long distance travel. It was found that many GPS devices directed the majority of cross-border trips to the Queenston-Lewiston Bridge, resulting in greater congestion and longer wait times at this crossing. The information collected during the surveys is being used by NITTEC to work with the various GPS manufacturers to address this issue and direct trips to the closest border crossing point instead.

The Peace and Rainbow Bridges consistently serve a large portion of intermediate to long distance travel with the average trip distances increasing with each successive survey. The Whirlpool Bridge accommodates the largest portion of shorter-distance trips. This is likely due to its status as a NEXUS-only, trusted traveler, crossing that typically has shorter wait times than other facilitates with this program. Upon further investigation, it was found that this bridge accommodates a large portion of shopping travel between Niagara Region and Western New York, which helps to explain the shorter trip distances.

**TABLE 7 – Average Cartesian Trip Distance by Bridge and Direction (in km)**

Location	Direction	Average Cartesian Distance		
		2007	2012	2013
Peace Bridge	Into Canada	147	166	243
Peace Bridge	Into U.S.	156	307	257
Queenston-Lewiston Bridge	Into Canada	260	237	282
Queenston-Lewiston Bridge	Into U.S.	242	218	324
Rainbow Bridge	Into Canada	171	114	197
Rainbow Bridge	Into U.S.	178	109	231
Whirlpool Bridge	Into Canada	40	40	64
Whirlpool Bridge	Into U.S.	53	78	62

## CONCLUSION

The four Niagara Frontier border crossing bridges provide vital links between Niagara Region and Western New York, and more importantly, serve as critical connections to Canada's largest economic trade partner, the United States. The crossings serve hundreds of thousands of vehicle trips per day, for a broad range of travel purposes. The vast majority of trips made by passenger vehicle are for discretionary reasons, which has remained relatively unchanged over time.

Although cross-border travel decreased between 2007 and 2013, the importance of collecting comprehensive cross-border travel information has not. The databases derived from this trip data provide fundamental information to be shared across jurisdictions and multiple agencies for a broad variety of transportation planning, marketing, tourism and economic development purposes. It assists the respective organizations in prioritizing initiatives and programs. Regular data collection also offers insights into how recent policy or infrastructure changes may have impacted cross-border travel.

## REFERENCES

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