Cost of Poor Roads in Canada

Final Report

Prepared for:

Canadian Automobile Association

Prepared by:

CPCS

Solutions for growing economies

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Cost of Poor Roads in Canada

The purpose of this study is to evaluate the costs to motorists of driving on poor road infrastructure in Canada.

Acknowledgements

The CPCS team made use of Statistics Canada's Core Public Infrastructure Survey data, CAA's driving cost calculator data supplied by Vincentric, and a literature review of the impacts of pavement roughness on vehicle operating costs.

Opinions and Limitations

CPCS makes efforts to validate data obtained from third parties, but cannot warrant the accuracy of these data.

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Acronyms / Abbreviations

AAA	American Automobile Association
CAGR	Compound Annual Growth Rate
FHWA	Federal Highway
HDM	Highway Development and Management
IRI	International Roughness Index
km	Kilometres
NCHRP	National Cooperative Highway Research Program
SUV	Sports Utility Vehicle
TAC	Transportation Association of Canada
TRB	Transportation Research Board
VKT	Vehicle Kilometres Travelled
VOC	Vehicle Operating Costs

Executive Summary

Poor roads cost drivers money

Canada's 1.04 million kilometres of roads connect communities, sustain commerce and enable everyday travel for work and leisure. But when these roads are allowed to deteriorate, drivers pay the price. This study puts a dollar value on the incremental operating costs to Canadian motorists of driving on poor roads.

Using newly available data

The study uses new data from the Core Public Infrastructure Survey – a Statistics Canada survey based on self-reported data from provincial and municipal agencies – that provides the first comprehensive nationwide snapshot of the condition of Canada's roads. We then factored in vehicle operating costs, differences in fuel prices, vehicle types, vehicle kilometres travelled, and research on how poor roads affect vehicle operating costs. We define the "extra costs" due to poor roads as the incremental operating costs for motorists, relative to a hypothetical baseline where all roads are assumed to be in at least "good" condition (i.e. adequately maintained, but not necessarily brand new).

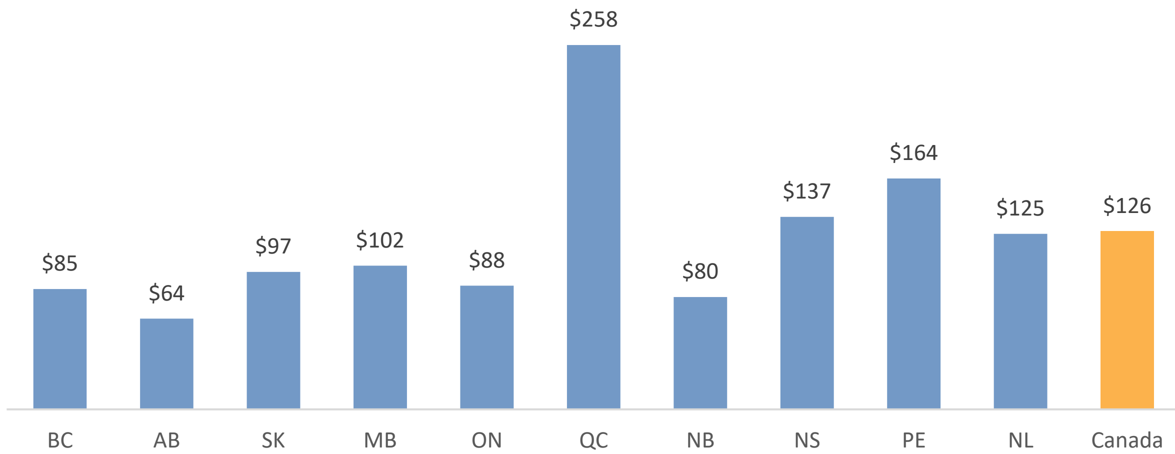
Drivers pay an extra $126 per year

Our study concludes that the average driver incurs an extra cost of $126 annually per vehicle due to poor-quality roads – equating to more than $1,250 over a 10-year lifespan of a car. This cost varies by province, and is highest in Quebec and Atlantic Canada. However, even in the provinces that report a low proportion of poor roads, drivers still pay more than $600 in extra operating costs over a 10-year vehicle lifespan – a significant sum. In aggregate, poor roads cost the nation's drivers a total of $3 billion per year in higher operating costs.

Although only 15% of the nation's roads are rated poor or very poor, these roads are responsible for most of the extra operating costs – especially on the arterial, collector and local road networks. Canadians who have the misfortune of having to rely on these roads for their daily commutes can be faced with costs well above the national average. The good news is that over half of Canadian roads are in good or very good condition – so fixing crumbling roads is not an unattainable task. By focusing on repairing the worst roads – or better yet prevent them from deteriorating in the first place – governments can save Canadians money.

Sound asset management benefits everyone. When roads deteriorate, Canadians pay twice: first through higher vehicle operating costs, and then through higher government spending on restoring roads. Spending one dollar on pavement preservation today may eliminate or delay spending $6-$10 dollars on costly rehabilitation or reconstruction in the future. While new road construction generates headlines, proper maintenance saves us all a lot of money.

Figure ES-1: Average Annual Extra Cost of Poor Roads per Vehicle, by Province (Dollars per Year)



Source: CPCS analysis

Limitations

COVID-19: This report calculates extra costs based on a typical or "normal" year using the most recently available data. Notably, we have assumed that vehicle kilometres travelled (VKT) per vehicle continue along a steady long-term trajectory, as opposed to estimating VKT based on the unusual drop in traffic volumes that has accompanied the COVID-19 pandemic. In the long run, the impacts of the pandemic on travel behaviour are unknown and speculative. This study does not make any assumptions or projections regarding such changes.

Self-reported data: This analysis relies heavily on Statistics Canada's Core Public Infrastructure Survey, which is based on self-reported data collected from thousands of asset-owning agencies nationwide. The extra costs calculated for each province are a function of the road quality measures as reported by the respective provincial ministries of transportation and municipal roads departments. Although StatsCan's survey has guidelines to promote consistency across agencies, the analysis is highly dependent on the reporting provided by these provincial and municipal agencies.

Poor roads – the facts

Poor roads in Canada

According to new data, 15% of Canadian roads are in poor or very poor condition, and another 28% are rated fair. Only about 52% of roads are considered to be good or very good. Although this makes more good roads than bad, the poor roads still add up: Canada has 108,000 km of roads in poor condition and another 48,000 km in very poor condition (Figure 1).

Figure 1: Kilometres by Physical Condition

	Very Poor	Poor	Fair	Good	Very Good	Do Not Know	Total
Highways	4,243	8,952	40,841	67,848	12,450	11,191	145,524
Highway	2,045	4,155	10,449	26,541	3,649	4,248	51,087
Rural Highway	2,198	4,797	30,392	41,307	8,800	6,943	94,437
Non-Highways	44,166	99,512	251,278	315,681	149,510	37,846	897,993
Arterial	5,848	17,206	26,654	42,203	19,487	1,997	113,395
Collector	8,739	20,409	40,605	63,363	22,645	5,473	161,233
Local	29,580	61,897	184,019	210,115	107,378	30,376	623,365
Total	**48,409**	**108,464**	**292,119**	**383,529**	**161,959**	**46,878**	**1,041,267**
Pct.	**5%**	**10%**	**28%**	**37%**	**16%**	**4%**	**100%**

Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Measured in dual-direction lane-kilometres (i.e. one kilometre of a standard two-lane road is recorded as 1 km, four-lane road recorded as 2 km, etc.)

Our analysis of road condition is based on the Core Public Infrastructure Survey, a new survey developed jointly by Infrastructure Canada and Statistics Canada that provides the first nationwide snapshot of the stock, condition and performance of Canadian public infrastructure. The data for the second iteration of the survey (conducted in 2019, with 2018 data) was released in October 2020.

We analyzed the physical condition of Canadian highways and non-highway roads (arterials, collectors and local roads) as reported for all ten provinces. This data was assembled by Statistics Canada and Infrastructure Canada on the basis of comprehensive survey responses from over 2,500 asset-owning agencies across Canada, including provincial ministries of transportation and municipal roads departments. In each case, agencies self-reported the mileage of roads by functional classification corresponding to five condition categories, ranging from very good to very poor.

Road Condition – Defining Terms

Very poor: Immediate need to replace most or all of the asset. Major work or replacement is required urgently.

Poor: Failure likely and substantial work required in the short term. Asset barely serviceable.

Fair: Significant deterioration is evident; minor components or isolated sections of the asset need replacement or repair now, but the asset is still serviceable and functions safely at an adequate level of service.

Good: Acceptable physical condition; minimal short-term failure risk, but potential for deterioration in the long term. Only minor work required.

Very good: Sound physical condition. The asset is likely to perform adequately.

Source: Statistics Canada

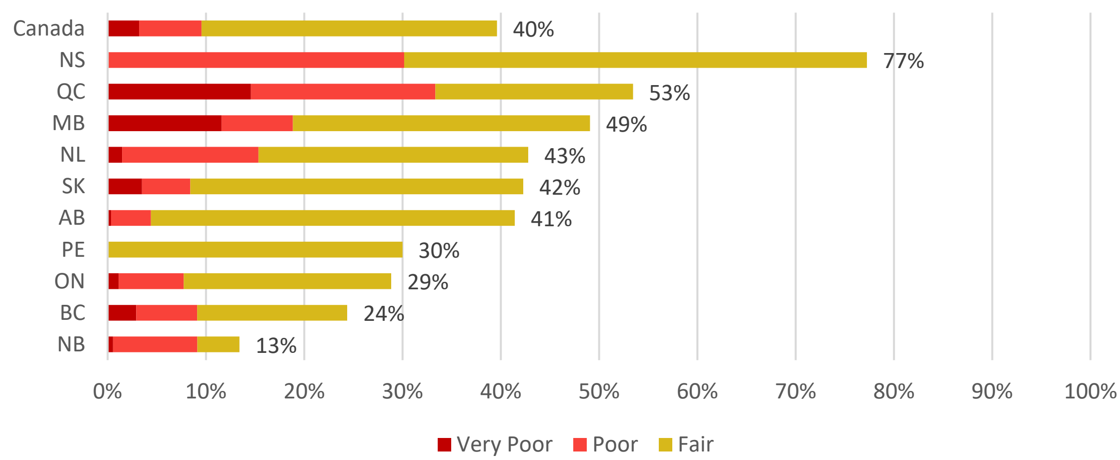
Poor roads by province

Figure 2 shows the distribution of highways by condition at a provincial level, for roads rated below good condition. The graphic demonstrates that there are fairly significant differences in road quality by province. Nova Scotia and Quebec surpass 50% – meaning more than half the highway-kilometres in these provinces are deteriorated or show signs of deterioration.

Figure 3 shows the same distribution for non-highway roads (arterial, collector and local roads). More than half of the non-highway road network is rated below good condition in Nova Scotia, Newfoundland, Prince Edward Island, New Brunswick, and Quebec. Among these provinces, PEI, Nova Scotia and Quebec stand out with more than 10% of their non-highway roads rated very poor.

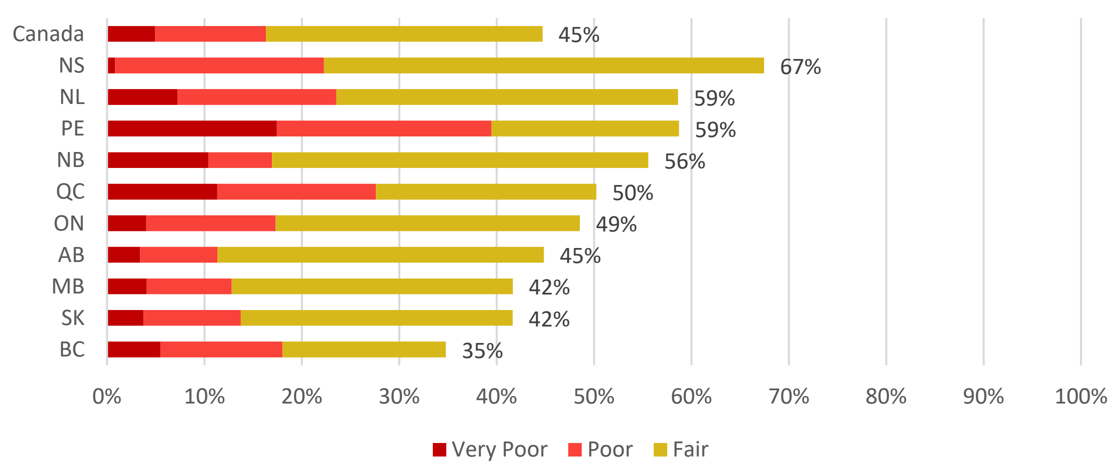
A full table showing the breakdown of road quality by province is included in the appendix.

Figure 2: Percentage of Highway Kilometres Rated Below Good Condition, by Province



Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Excludes "do not know." Note: Some highway data not available for 2018 for Quebec; 2016 data used to fill gaps.

Figure 3: Percentage of Non-Highway Kilometres Rated Below Good Condition, by Province



Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Excludes "do not know." Note: Some arterial and collector road data not available for 2018 for Quebec; 2016 data used to fill gaps.

How rough roads drive up costs

Roads deteriorate over time due to age, weather conditions, heavy traffic, and inadequate maintenance. In cold climates such as Canada, freeze-thaw cycles play a large role in creating potholes – a problem that is particularly acute where temperatures regularly fluctuate above and below the freezing point. As moisture from rain or snow seeps through cracks and openings in the pavement, it freezes and expands, causing the pavement to heave upward. Then as temperatures rise, the ground underneath the pavement returns to its normal level, leaving a cavity which breaks apart as a vehicles drive over the deformed pavement.

The high cost of potholes is obvious to any motorist who has faced sudden and expensive repair bills for a damaged vehicle – yet full-fledged potholes are not the only road quality issue that drives up operating costs. Moisture, traffic and poor drainage can also contribute to other pavement problems like cracking, rutting and foundation damage.

Engineers use standardized measures of pavement quality such as international roughness index (IRI) to consistently and systematically measure the quality of roadways. IRI works by tracking the vertical movement of the vehicle's suspension while the vehicle is in motion – the higher the accumulated vertical movement, the higher the IRI. In other words, a bumpy road will lead to more vertical movement than a smooth, even ride. This metric is reported as millimetres of displacement per metre of distance travelled (mm/m – also sometimes stated as m/km), or in imperial units as inches per mile. Scientists have decades of experience conducting research on how different pavement quality levels impact a typical vehicle's operating characteristics, such as fuel consumption and tire wear – and thereby vehicle operating costs.

Not all driving costs are impacted by road quality – some costs are set and do not change regardless of how or where the car is driven. Figure 4 shows the four categories of driving costs which we evaluated in this study in the left-hand column.

Figure 4: Costs Impacted and Not Impacted by Road Quality

Impacted by Road Quality	Not Impacted by Road Quality
Fuel Cost: Higher surface roughness reduces fuel efficiency and leads to increased fuel consumption.	**Insurance:** Theoretically there may be a connection, but we did not identify any studies quantifying a relationship between road quality and insurance cost.
Tires: Rougher roads cause increased tire wear.	**License and Registration:** These fixed costs are not impacted by the quality of roads.
Repair and Maintenance: Impact is minimal for moderate-quality roads, but costs rise quickly for poor and very poor roads as risks increase.	**Finance Expense:** These fixed costs depend on the terms of the loan – no impact from road roughness.
Depreciation: Poor roads can lead to damage reducing the value of the vehicle (depreciation is the reduction in the vehicle's resale value over time)	

Source: CPCS review of relevant literature

Impact of Rough Pavement on Operating Costs

We relied predominantly on research by the National Cooperative Highway Research Program (NCHRP), a well-regarded US research program under the Transportation Research Board which produces practically oriented, comprehensive best practice reports on a wide range of transportation topics. This report (NCHRP Report 720) summarizes the best available literature on pavement condition and operating costs and recommends values for integration into the Highway Development and Management (HDM) model, a tool widely used globally for roadway management (we are not aware of a similarly comprehensive study specific to Canada). The results are expressed as an adjustment factor relative to a baseline IRI of 1.0 – for example, a scale factor of 1.05 means that costs are 5% higher than under the baseline scenario. Figure 5 shows an illustrative example of these factors for a sedan operating on a highway. In our model, we performed this analysis separately for four classes of vehicles and three speed conditions.

Notably, at moderate IRI levels the biggest impact on costs is due to increased fuel usage. But, as roads degrade and IRI becomes very high, repairs and maintenance costs far outstrip the other categories.

Figure 5: Variation in Driving Costs as a Function of Pavement Roughness (Example for Sedan, Highway)

IRI (mm/m)	1	2	3	4	5	6
Fuel	1.00	1.02	1.05	1.07	1.09	1.12
Tires	1.00	1.01	1.03	1.04	1.06	1.08
Repair and Maintenance	1.0	1.0	1.0	1.1	1.4	1.7
Depreciation	1.00	1.00	1.00	1.01	1.05	1.13

Source: National Cooperative Highway Research Program (2012), NCHRP Report 720: "Estimating the Effects of Pavement Condition on Vehicle Operating Costs" (for fuel, tires, and repairs & maintenance). World Bank HDM-4 model for depreciation. Showing values for medium car at 112 kph.

Baseline Driving Costs

Our baseline costs for Canada come from Vincentric, a leading provider of cost-of-ownership data for the automotive industry which acts as the data supplier for CAA's Driving Costs Calculator. Vincentric measures costs for virtually all mass-produced passenger vehicles in Canada at a provincial level. The data we received cover four cost categories (fuel, depreciation, maintenance, and repairs) and over 1,100 passenger vehicle types aggregated to six categories (passenger car, SUV, pickup truck, van, luxury car, and luxury SUV). Figure 6 shows the average per-kilometre driving costs for Canada.

Figure 6: Average Driving Costs in Canada, per Kilometre

	Fuel	Depreciation	Maintenance & Repairs
Passenger Car	$0.10	$0.17	$0.08
SUV / Crossover	$0.11	$0.20	$0.08
Pickup Truck	$0.16	$0.23	$0.08
Van	$0.17	$0.24	$0.08
Luxury Car	$0.14	$0.41	$0.12
Luxury SUV / Crossover	$0.15	$0.37	$0.11
Average	$0.12	$0.22	$0.09

Source: CPCS analysis of data provided by Vincentric (2020).
Notes: Maintenance/Repairs includes tires. Non-impacted costs (e.g. insurance, financing) not shown. Estimate based on 25,000 km driven per year, fuel price assumed to be 122.8 cents per litre. Average calculated by CPCS based on modelled national vehicle mix.

Our calculations show that the typical Canadian motorist pays an average of 12¢ per kilometre for fuel, 9¢ for repairs and maintenance and 22¢ in depreciation. In total, the average motorist pays 43¢ per kilometre driven for cost categories that are impacted by road roughness. This value is higher for luxury vehicles and larger vehicles like pickup trucks and vans, and lower for sedans.

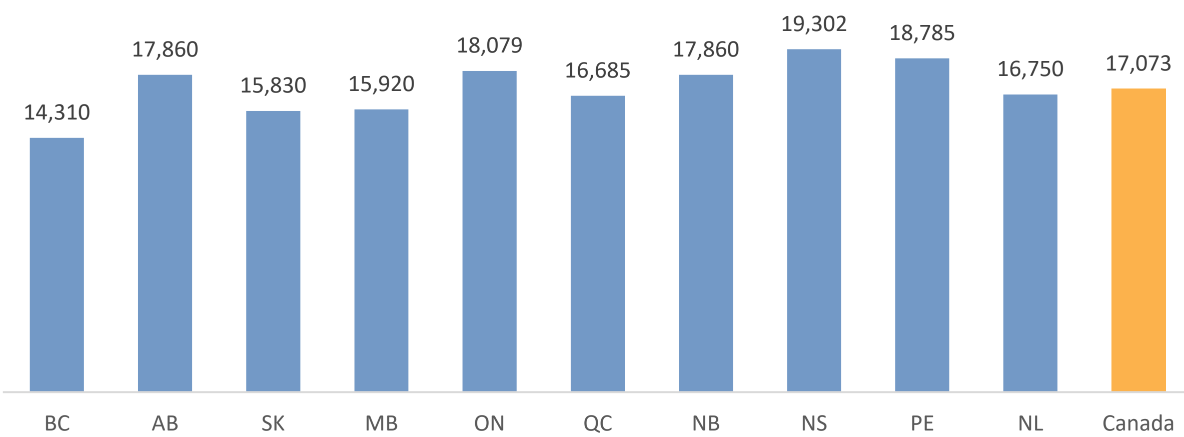
We extended this analysis to compute per-kilometre costs at a provincial level, considering factors such as variation in fuel prices and maintenance costs across the nation.[1] In order to match the categories from the pavement impact research, we took two additional steps: a) subsumed luxury cars and luxury SUVs within the sedan and SUV categories, and b) further subdivided maintenance into (i) tires and (ii) repairs & maintenance according to past cost of driving studies which provided for this distinction.[2]

Vehicle Kilometres Travelled (VKT)

We estimate that the average Canadian passenger vehicle is driven about 17,000 kilometres per year, based on data from Transport Canada (2018 Statistical Addendum). The most recent comprehensive data covering all provinces dates to 2009, when the Canadian Vehicle Survey was discontinued; but more recent data are available for about half of the provinces from 2015. We computed a national average growth rate and applied it to the most recent data available for each province to compute VKT equivalents for 2020 (Figure 7). We assumed these break down at a national level according to a ratio of 45% highway, 55% non-highway (city).

Note: The analysis in this report corresponds to a typical or "normal" year using the most recently available data. We have assumed VKT continue along a steady long-term trajectory, as opposed to estimating VKT based on the unusual drop in traffic volumes that has accompanied the COVID-19 pandemic.

Figure 7: Estimated Average Annual VKT by Province (kilometres)



Source: CPCS analysis using data from Transportation in Canada 2018 Statistical Addendum. Inflated to 2020 equivalent

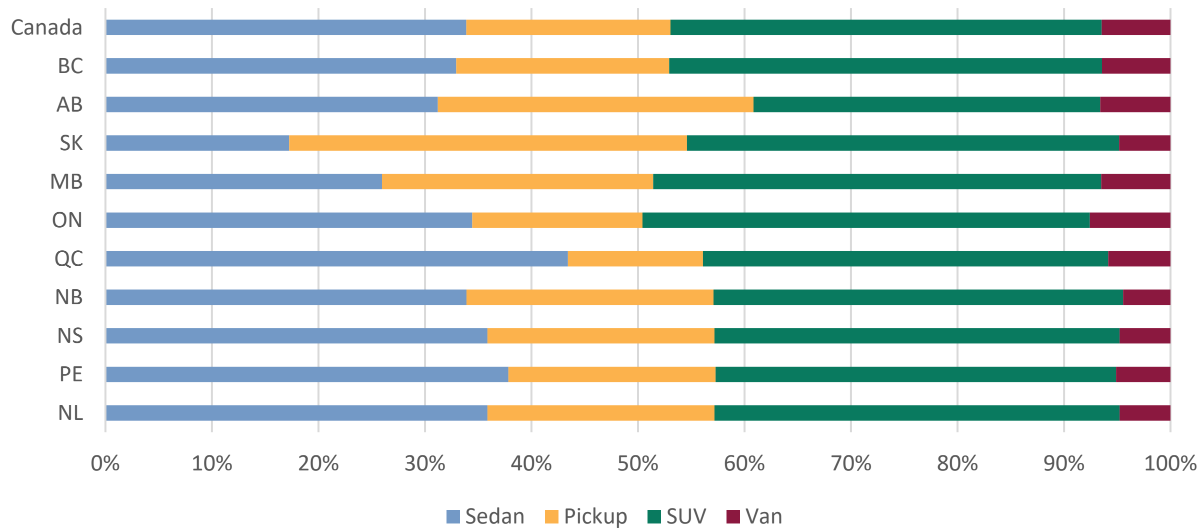
Type of Vehicle

To reflect the fact that the types of vehicles driven by Canadian motorists differ by province, we incorporated vehicle registration data from Statistics Canada on the breakdown of new vehicle sales by vehicle type, for each of the four vehicle categories, by province (Figure 8). This helps adjust for the fact that SUVs and pickup trucks constitute a larger proportion of the vehicle fleet in provinces such as Saskatchewan and Manitoba, whereas sedans are more commonly driven in Quebec.

[1] Based on the data obtained from Vincentric (2020)

[2] For luxury vehicles, we assumed these are roughly 12% of the nation's vehicle stock based on recent reports. For tires, we referred to AAA's 2015 "Your Driving Costs" study which showed this as being roughly 14-18% of repairs and maintenance costs depending on vehicle type.

Figure 8: Vehicle Type Breakdown by Province



Source: Statistic Canada New Vehicle Registration Data 2013-2019, Alberta Motorized Vehicle Registrations Data 2020. Note: no data available for Nova Scotia and Newfoundland (assumed similar to New Brunswick and PEI).

Modelling Assumptions

We set the target as a road condition of "good" or better. In other words, in our target scenario we assume that the good and very good roads stay as they are, while fair, poor and very poor roads are upgraded to good. This threshold reflects a situation where all roads are consistently reasonably well maintained, but not a perfectly ideal state where all roads are in brand new condition.

We assigned IRI thresholds using recommendations from a Transportation Association of Canada (TAC) 2012 study[3] (Figure 9) and validated these against disaggregate pavement quality data for Ontario and Alberta, provinces where IRI data were readily available from open data portals. We also applied an adjustment factor to non-highway thresholds to reflect that condition standards may typically be stricter for highways than for non-highways.[4]

Figure 9: Modelled IRI Thresholds for Highways (Typical)

	Very Poor	Poor	Fair	Good	Very Good
IRI (mm/m)	> 3.75	2.8 – 3.75	1.75 – 2.8	1.00 – 1.75	< 1.00

Source: Adapted from Transport Association of Canada (2012) Performance Measures for Highway Road Networks

In distributing VKT, we performed a series of adjustments at a provincial level. First, we added a modest adjustment to the 45%-55% highway-non-highway driving split to account for the fact that some provinces have a more extensive highway network while in others non-highway roads dominate. Second, we added a conservative adjustment to the distribution of VKT on the basis of municipal populations – a proxy intended to reflect greater usage of roads in more populous municipalities.[5] The intent of these adjustments is to reflect, as best as possible with the data available, pavement conditions *as actually experienced* by motorists.

[3] TAC (2012), "Performance Measures for Highway Road Networks"

[4] See for example Alberta Infrastructure (2000), "International Roughness Index (IRI)," which references different IRI standards for FHWA for interstate highways vs. other roads.

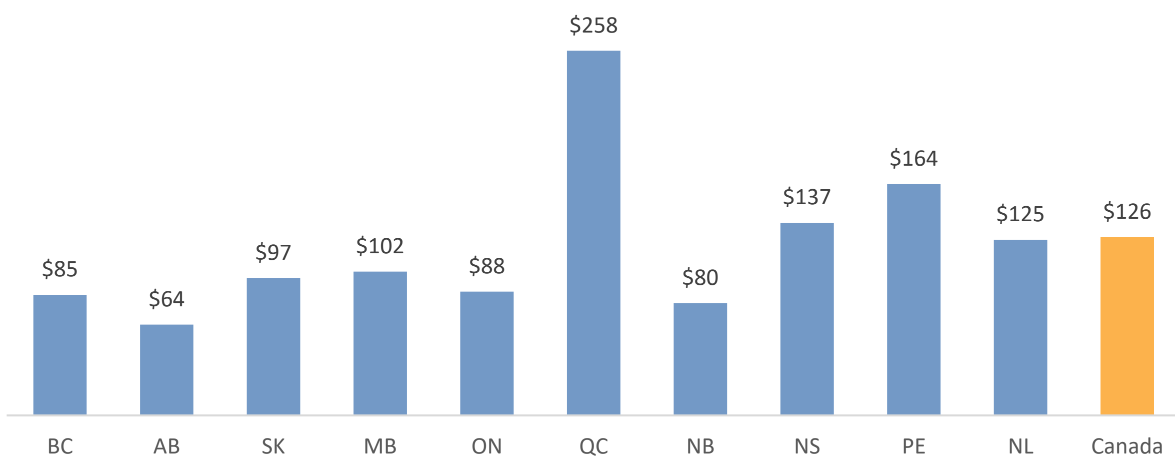
[5] This adjustment relied on microdata from the first iteration of this survey – scaled to the 2018 provincial totals

Rough roads cost drivers money

Canadian drivers pay an average of $126 per vehicle per year in higher vehicle operating costs as a result of driving on poor-quality roads. This adds up to more than $1,250 over a 10-year lifespan of a car.

The extra cost imposed by poor roads varies by province and is generally higher in Quebec and Atlantic Canada (Figure 10). Notably, in Quebec drivers pay more than $250 per year in increased operating costs, while in Alberta drivers pay an extra $64. The difference is attributable mostly to differences in road quality, especially "poor" or "very poor" arterial, collector and local roads. These secondary roads have different, lower pavement standards and are more likely to have unfixed potholes and other major deficiencies.

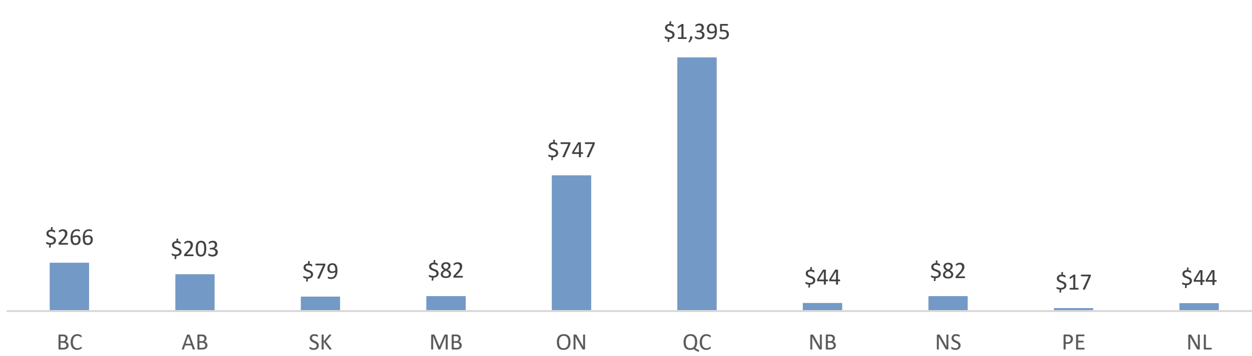
Figure 10: Average Annual Incremental Cost due to Poor Roads, per Vehicle, by Province (Dollars per Year)



Source: CPCS analysis

With around 23.5 million passenger cars on the roads nationwide, poor roads are costing the nation's drivers a total of $3 billion annually. Nearly half of that aggregate cost ($1.4 billion) is from the province of Quebec alone (Figure 11) – a number that reflects both the poor state of roads there as well as the large population (high number of motorists) compared to the Atlantic provinces. Ontario has the second highest aggregate cost at nearly $750 million, despite its roads being generally better than average.

Figure 11: Aggregate Annual Incremental Cost due to Poor Roads, by Province ($ Millions per Year)



Source: CPCS analysis

Case Study: Stuck driving on poor roads

Vehicle operating costs start to escalate rapidly as roads deteriorate into poor and very poor condition. Thus a driver who only occasionally drives on poor roads will experience far fewer added costs compared to drivers who are stuck driving on poor roads frequently.

Take as an example a one-kilometre stretch of arterial road in poor or very poor condition, and suppose that a driver must use this road daily. We estimate that this driver will incur an extra $25 in added costs annually just from this single one-kilometre stretch of road, compared to a generic road in average condition. This is primarily because of far higher repairs/maintenance and depreciation costs, reflecting the increased risk of damage to the vehicle. Fixing the worst roads – or keeping them from deteriorating in the first place – makes a big difference for those people whose daily commute gives them little choice but to rely on these roads.

Investing to save Canadians money

Although the majority of the Canadian road network is in good or very good shape, significant parts of the system are showing their age. According to StatsCan's Core Public Infrastructure Survey, 34% of Canadian highways were constructed between 1970 and 1999, and a further 26% between 1940 and 1969. This means that more than a quarter of Canadian highway infrastructure is over half a century old.

Good road infrastructure saves money. Pavement age alone does not necessarily imply poor quality – when paved roads are preserved as part of a sound asset management program they last longer and cost less for governments to maintain than pavements that are allowed to deteriorate to the point of requiring major rehabilitation or reconstruction. Spending one dollar on pavement preservation may eliminate or delay spending $6-$10 dollars on costly repairs later on.[6]

As our analysis shows, when it comes to poor-quality roads it is not just government and taxpayers that are footing the bill. The extra $126 that the average Canadian driver pays every year in the form of higher vehicle operating costs is cash out of their pockets – money they no longer have to spend on everyday wants and needs. These costs do not even account for the impact of poor roads on reducing ride quality, comfort, and in extreme cases safety. They also do not account for the increased operating costs for trucking companies and bus fleets.

While these costs are the average, the reality is that they are not predictable expenses that Canadian families can simply make room for in their budget. A motorist can luck out for a few years with no significant incidents, and then suddenly be hit with a major repair bill after hitting a sudden, unexpected pothole.

All of these extra out-of-pocket costs add up for Canadian families. A past study by CAA found that highway congestion costs hundreds of millions of hours in lost productivity every year.[7] Another past study found that households in the Toronto region alone pay an extra $125 annually in higher costs for goods and services due to congestion – these are costs passed through the supply chain due to trucked goods and supplies being delayed in traffic bottlenecks.[8] These impacts extend to other Canadian metropolitan areas as well. But unlike the costs of congestion, the costs of poor roads are not confined to busy urban areas and affect drivers across the nation, in communities big and small.

Our cost estimates appear to be somewhat on the conservative side, when compared to US studies conducted on this topic.[9] While the new Core Public Infrastructure Survey is a significant upgrade in terms of nationwide coverage compared to the data available previously, it does not provide quite the level of detail reported by the Federal Highway Administration in the US. The final chapter of this report provides recommendations on improving the nation's road infrastructure, and also the quality of data and reporting.

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[6] Canadian Infrastructure Report Card 2019, "Monitoring the State of Canada's Core Public Infrastructure"
[7] CAA (2017), "Grinding to a Halt: Evaluating Canada's Worst Bottlenecks"
[8] Toronto Region Board of Trade (2017), "Report #3: Toronto-Waterloo Corridor Movement of Goods Business & Consumer Impacts"
[9] TRIP (2018), "Bumpy Road Ahead: America's Roughest Rides and Strategies to Make Our Roads Smoother"

Action Items for Government

Making Smart Investments

Past versions of the Canadian Infrastructure Report Card have found the national aggregate replacement value for fair, poor and very poor roads to be on the order of $125 billion.[10] The replacement value is defined as the cost that would need to be incurred in order to replace the asset (including demolition).

While this is a large and imposing figure, the reality is that governments can achieve a lot by rigorously focusing on a few key priorities (see recommendations box):

Recommendations for Improving the Nation's Roads

- **Pavement preservation and preventative maintenance:** Although directing scarce funds to fair and good roads may be counterintuitive, fixing roads before they deteriorate can save a lot of money over the long run. This means a focus on planned, proactive treatments to extend service life. The Transportation Association of Canada (TAC) and US Federal Highway Administration (FHWA) offer online resources to assist agencies with understanding pavement preservation treatments, including technology, timing, and implementation considerations.

- **Quick responsiveness:** Potholes and other major deformations can arise suddenly and result in significant damage to vehicles (and large repair bills for motorists). Public agencies need to be nimble in deploying crews to fix potholes, and also in gathering the facts on emerging potholes. This includes crowd-sourcing information from residents (the City of Toronto, for example, encourages residents to send tweets of potholes with pictures and location details to their 311 account, as part of a suite of reporting options that includes online forms, email, and phone).

- **Strategic prioritization:** Not all roads are equally important. Targeting investments in roads that are heavily travelled or otherwise strategically important ensures a maximum return on investment for agencies confronted with limited funding. In prioritizing funding for road repairs, agencies should apply a sound, data-driven methodology to ensure money is spent on roads where the benefit is highest.

- **Asset management plans:** An asset management plan is a strategic, regularly updated document that describes the existing condition of roads, performance against level-of-service targets, planned strategies and actions, and financing and implementation targets. According to StatsCan's Core Public Infrastructure Survey, 37% of large municipalities (pop. 30,000+) and 55% of small and medium-sized municipalities (pop. under 30,000) do not presently have an asset management plan. Developing these plans is an important first step towards a sound pavement management approach, and every agency no matter the size should have one.

Improving Data Collection

StatsCan's Core Public Infrastructure Survey is a significant and welcome improvement over the data sources that were previously available. Still, there is a lot that could be done to further improve the quality of Canadian

[10] Canadian Infrastructure Report Card, 2016. This report is a joint effort of a group of industry associations and advocacy groups to offer an objective look at the state of core public infrastructure in Canada. The 2019 update did not place a replacement value on roads due to data integrity issues, hence the 2016 value is cited.

road condition data – including incorporating some good practices from the US. The following text box outlines four recommendations for improving data collection and reporting:

Recommendations for Improving Data Collection and Reporting

- **Standardized Pavement Condition Thresholds:** StatsCan's Core Public Infrastructure Survey takes a step forward towards addressing data comparability issues, with a single questionnaire sent out to thousands of agencies across the country. However, this approach still has a limitation in that agencies have to self-report according to a set of guidelines. This could be improved by developing standardized quantitative nationwide thresholds for IRI classification, similar to what the US Highway Performance Management System uses. Doing so would further improve data quality and further improve comparisons between provinces and between municipalities.

- **Availability of Raw Data:** While most provinces regularly collect IRI data for highways, the data are often not available in the public domain in a disaggregate or geospatial format that indicates pavement condition by road segment. Provinces and municipalities making this data available through open data portals – as the Provinces of Ontario and Alberta do – would make future research more insightful, particularly if paired with annual average daily traffic (AADT) data.

- **Metropolitan-Level Reporting:** The Federal Highway Administration in the US reports pavement quality data not only by state, but also by metropolitan area (e.g. FHWA Table HM-73) – allowing for a deeper level of insight than what is currently available from Statistics Canada. Expanding the data collected from provincial agencies to account for metropolitan location – a step that would not be very difficult to implement – would facilitate comparisons not only between provinces, but between population centres across the country.

- **Provincial VKT Updates:** The latest data on vehicle kilometres travelled published by Transport Canada rely on a Statistics Canada Vehicle Use Study from 2015 – but for some provinces the most recent published data only date to 2009 – meaning that assumptions need to be made in projecting VKT to present-day levels. VKT is an extremely important statistic that is of use for all kinds of engineering, economic and environmental analyses. Officially updating these VKT measures is important for ensuring a high quality of research and analysis.

Conclusions

Repairing roads before they are allowed to deteriorate is a win-win proposition: it saves governments money and it saves drivers money. Even if some of the low-performing provinces simply improved to the national average, it could save drivers in their province around a hundred dollars per year in foregone costs.

While new road construction generates headlines and fanfare, it is the behind-the-scenes attention to maintenance and asset management that saves everyone money down the road. As this report shows, when agencies lose sight of that long-term focus it is Canadian commuters and travellers who pay up.

Appendix

Supplementary Tables

Figure 12: Highway Kilometres by Pavement Quality, by Province

	Very Poor	Poor	Fair	Good	Very Good	DNK	Total
BC	423	802	2,189	11,033	7	379	14,833
AB	137	1,578	14,399	18,500	4,280	2,134	41,027
SK	1,564	2,165	14,699	21,098	3,885	4,505	47,915
MB	909	570	2,368	3,025	965	76	7,912
ON	153	915	2,909	8,567	1,252	103	13,899
QC*	1,031	1,330	1,366	2,672	589	533	7,522
NB	17	267	134	743	259	1,726	3,146
NS	2	580	909	403	35	5	1,935
PE	0	0	3	6	0	0	9
NL	8	81	128	65	28	1,030	1,339
Canada	4,243	8,952	40,841	67,848	12,450	11,191	145,524

Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Notes: Based on self-reported data provided to StatsCan by provincial ministries of transportation and municipal roads departments. Measured in dual-direction lane-kilometres (i.e. one kilometre of a standard two-lane road is recorded as 1 km, four-lane road recorded as 2 km, etc.).
*StatsCan suppressed certain data for highways, arterial roads and collector roads in Quebec. Applying 2016 percentages where 2018 data suppressed.

Figure 13: Non-Highway Kilometres by Pavement Quality, by Province

	Very Poor	Poor	Fair	Good	Very Good	DNK	Total
BC	3,559	8,140	10,817	35,838	6,820	1,784	66,958
AB	5,564	13,043	55,041	70,422	20,182	6,225	170,478
SK	6,993	18,468	51,810	64,117	44,280	13,119	198,787
MB	3,251	7,033	23,258	32,887	14,152	1,352	81,931
ON	7,280	24,086	56,604	59,930	33,465	5,023	186,388
QC*	12,323	17,540	23,892	33,064	19,659	7,113	113,592
NB	3,075	1,930	11,414	6,077	7,037	83	29,616
NS	216	5,582	11,772	7,271	1,199	0	26,040
PE	721	987	878	1,299	579	1,469	5,933
NL	1,141	2,572	5,534	4,438	2,090	40	15,816
Canada	44,166	99,512	251,278	315,681	149,510	37,846	897,993

Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Notes: Based on self-reported data provided to StatsCan by provincial ministries of transportation and municipal roads departments. Measured in dual-direction lane-kilometres (i.e. one kilometre of a standard two-lane road is recorded as 1 km, four-lane road recorded as 2 km, etc.)
*StatsCan suppressed certain data for highways, arterial roads and collector roads in Quebec. Applying 2016 percentages where 2018 data suppressed.

Figure 14: Highway Kilometres by Pavement Quality, by Province

	Very Poor	Poor	Fair	Good	Very Good	Total
BC	3%	6%	15%	76%	0%	100%
AB	0%	4%	37%	48%	11%	100%
SK	4%	5%	34%	49%	9%	100%
MB	12%	7%	30%	39%	12%	100%
ON	1%	7%	21%	62%	9%	100%
QC*	15%	19%	20%	38%	8%	100%
NB	1%	19%	9%	52%	18%	100%
NS	0%	30%	47%	21%	2%	100%
PE	0%	0%	30%	70%	0%	100%
NL	3%	26%	41%	21%	9%	100%
Canada	3%	7%	30%	51%	9%	100%

Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Percentage breakdown excludes “do not know.”
*StatsCan suppressed certain data for highways, arterial roads and collector roads in Quebec. Applying 2016 percentages where 2018 data suppressed.

Figure 15: Non-Highway Kilometres by Pavement Quality, by Province

	Very Poor	Poor	Fair	Good	Very Good	Total
BC	5%	12%	17%	55%	10%	100%
AB	3%	8%	34%	43%	12%	100%
SK	4%	10%	28%	35%	24%	100%
MB	4%	9%	29%	41%	18%	100%
ON	4%	13%	31%	33%	18%	100%
QC*	12%	16%	22%	31%	18%	100%
NB	10%	7%	39%	21%	24%	100%
NS	1%	21%	45%	28%	5%	100%
PE	16%	22%	20%	29%	13%	100%
NL	7%	16%	35%	28%	13%	100%
Canada	5%	12%	29%	37%	17%	100%

Source: CPCS analysis of Core Public Infrastructure Survey data (2018). Percentage breakdown excludes “do not know.”
*StatsCan suppressed certain data for highways, arterial roads and collector roads in Quebec. Applying 2016 percentages where 2018 data suppressed.

Assumptions and Technical Notes

Item	Description
Number of vehicles by province	Number of vehicles registered by province is taken from Statistics Canada Vehicle Registrations (Table 23-10-0067-01) for most recent year (2019)
Vehicle types by province	Vehicle types are inferred from new vehicle registration data for 2013-19 from Statistics Canada (Table 20-10-0021-01). Statistics Canada does not have data for AB, NL and NS. Data for Alberta is taken from Alberta Vehicle Registration Data 2019; NL and NS are assumed to be similar to NB and PE.
Estimation of vehicle kilometres travelled (VKT)	Based on VKT data reported in Transport Canada's 2018 Transportation in Canada Statistical Addendum. Calculated national average CAGR and applied this rate to the latest value for each province.
VKT on highway vs. non-highway	Total VKT has been split into highway and non-highway using a 45-55% split – a typical proportion used by Natural Resource Canada (NRCan). We slightly adjusted this percentage in proportion to each province's highway vs. non-highway road stock (adjustments generally up to +/- 5%), calibrated so that the national totals align with the 45-55 ratio.
VKT by road quality	Taken from StatsCan's Core Public Infrastructure Survey, 2018. We remove the "do not know" category and proportionally distribute the remaining kilometres for each province. For non-highways, we used seed values from the 2016 microdata (first version of the survey) to create a series of scale factors intended to provide greater weight to populous municipalities and reduced weight to expansive, sparsely-populated ones. This approach is intended as a "second best" proxy for weighting roads by their actual use, given that we do not have traffic (AADT) data tied to pavement quality.
IRI thresholds and values	IRI thresholds are taken from a Transportation Association of Canada (2012) study. We apply these to highways and use raw data where available (Alberta, Ontario) to interpolate average IRI values within threshold categories for modelling. For non-highways, we apply a ratio of 1.3-1.4 assuming stricter standards for highways vs. non-highways (ratio based on example targets for FHWA). This is also intended to roughly reflect that some municipalities may use other metrics such as present serviceability rating.
Baseline driving costs	Based on CAA's Driving Costs calculator, using data supplied directly from Vincentric (2020). We compute costs separately for all provinces and for six vehicle categories. We then subsume luxury cars and luxury SUVs within the remaining four categories assuming luxury vehicle constitute 12% of all vehicles. Maintenance cost distributed roughly 1:5 between repairs & maintenance and tires based on past AAA studies which supported this breakdown.
Impact of pavement condition on vehicle operating costs	Fuel, tires and maintenance taken from NCHRP 720 for three speed conditions and four types of vehicles. Depreciation estimated using HDM-4 model.