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www.vtpi.org
Info@vtpi.org
250-360-1560

Rethinking Malahat Solutions

Or, Why Spend a Billion Dollars if a Five-Million Dollar Solution is Better Overall?

22 May 2019

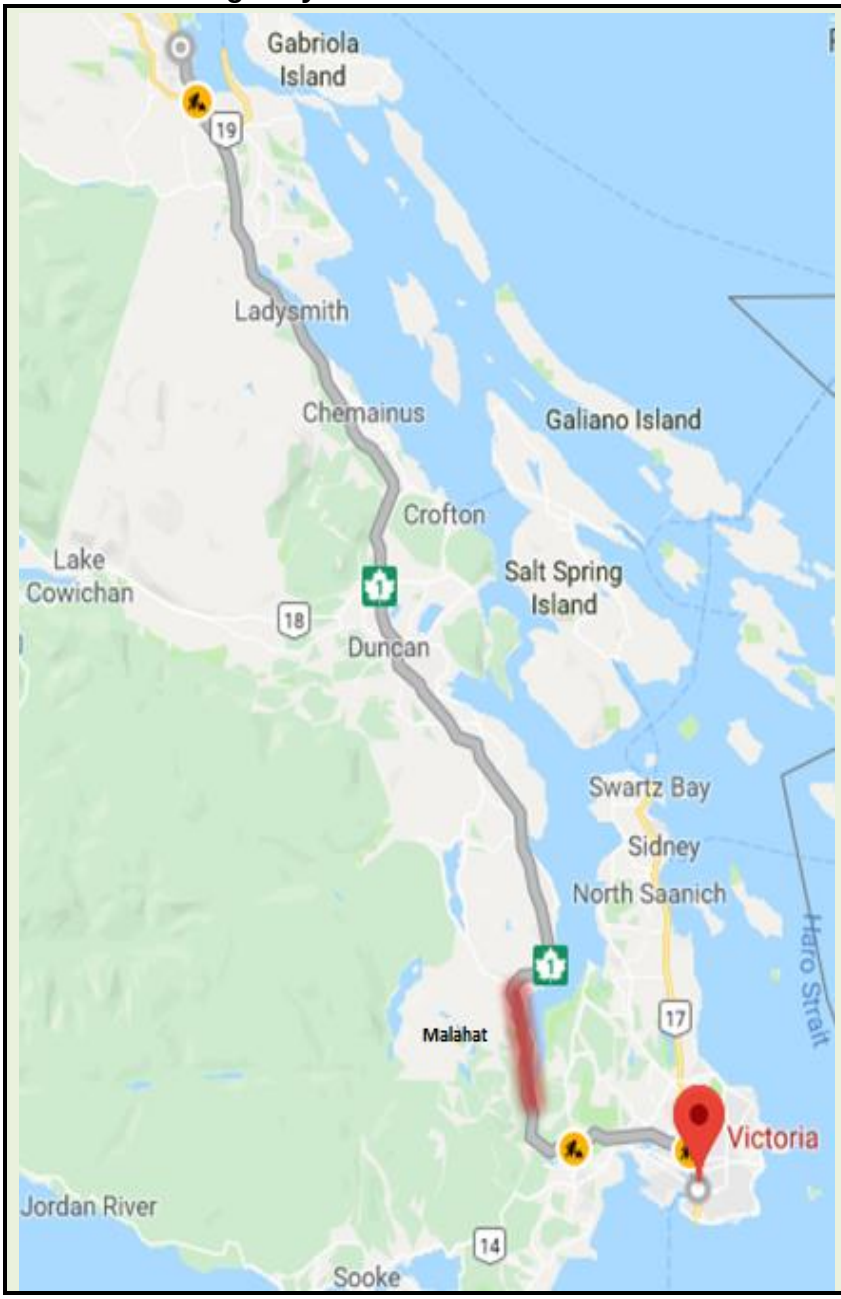
Todd Litman
Victoria Transport Policy Institute

(http://images.drivebc.ca/bchighwaycam/pub/html/www/8.html)

Abstract

This report evaluates various options for reducing Malahat Highway traffic problems. The analysis indicates that frequent and affordable bus service with Transportation Demand Management (TDM) incentives is the most cost effective and beneficial option. A basic program with hourly service between Nanaimo and Victoria would require an estimated $5 million annual subsidy, and shifting 10% of car trips to bus would require an $8-12 million annual subsidy, far less than other proposed solutions. In addition to these financial savings this provides additional benefits including increased traveller productivity, consumer savings and affordability, more independent mobility for non-drivers, reduced downstream traffic problems, parking cost savings, energy savings, emission reductions and habitat protection. Since higher cost and risk motorists are particularly likely to shift mode, it provides particularly large consumer savings, congestion reductions, safety and emission reduction benefits. A 10% mode shift should provide 12-15% fuel savings, 15-20% crash reductions, plus substantial congestion reductions on the entire corridor. Conventional planning tends to undervalue these benefits. This is an example of more comprehensive and multimodal planning.

The Malahat Highway



The Malahat Highway is a narrow, steep and windy 25-kilometer stretch of the Trans Canada Highway 1, along the west side of Saanich Inlet. It is a congested and dangerous bottleneck between Victoria and areas north on Vancouver Island. There are frequent calls to expand the roadway, create bypass routes, and apply targeted safety strategies.

Those solutions have limited benefits. At best, they can improve traffic conditions on that stretch of road, but do nothing to increase affordability or provide more independent mobility for non-drivers, and by inducing additional vehicle travel, they could increase traffic problems on other roads.

An alternative solution considered in this report is to provide frequent and affordable bus service between Victoria, Duncan and Nanaimo, with TDM incentives for motorists to shift to transit. This would provide more total benefits, including congestion reduction and safety benefits along the entire corridor between Victoria and Nanaimo.

Introduction

Transportation planning is undergoing a *paradigm shift*, that is, a fundamental change in the way transportation problems are defined and potential solutions evaluated (LaPlante 2010; Litman 2013). The old paradigm was automobile-oriented; it evaluated transportation system performance based primarily on motor vehicle travel conditions and so tended to favor automobile-oriented improvements. The new paradigm is more comprehensive and multi-modal, and so tends to favor more integrated solutions to transport problems. Table 1 summarizes the old and new paradigms.

Table 1 **Changing Transport Planning Paradigm** (Litman 2013)

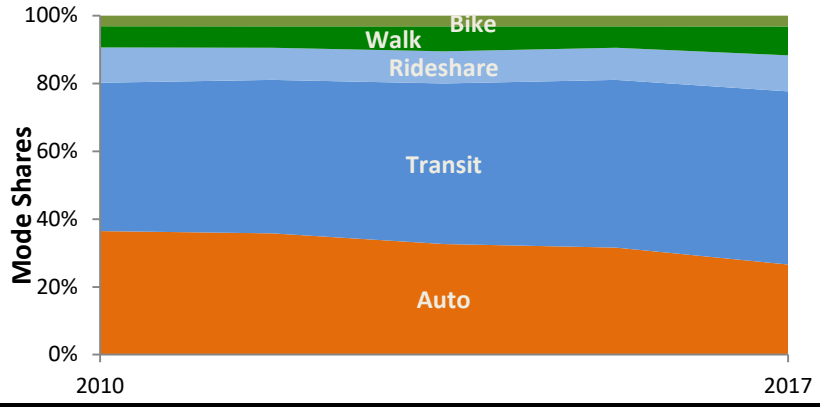
	Old Paradigm	New Paradigm
Definition of *Transportation*	*Mobility* (physical travel)	*Accessibility* (people's overall ability to reach services and activities).
Modes considered	Mainly automobile	Multi-modal: Walking, cycling, public transport, automobile, telework and delivery services.
Objectives	Congestion reduction; roadway cost savings; vehicle cost savings; and reduced crash and emission rates per vehicle-kilometer.	Congestion reduction; road and parking savings; consumer savings and affordability; accessibility for non-drivers; safety and security; energy conservation and emission reductions; public fitness and health; efficient land use (reduced sprawl).
Impacts considered	Travel speeds and congestion delays, vehicle operating costs and fares, crash and emission rates.	Various economic, social and environmental impacts, including indirect impacts.
Favored transport improvement options	Roadway capacity expansion.	Improve transport options (walking, cycling, public transit, etc.). Transportation demand management (TDM). More accessible land development.
Performance indicators	Vehicle traffic speeds, roadway Level-of-Service (LOS), distance-based crash and emission rates.	Quality of accessibility for various groups. Multi-modal LOS. Various economic, social and environmental impacts.

The old planning paradigm favored automobile-oriented transportation improvements. The new planning paradigm expands the range of objectives, impacts and options considered.

This report applies the new paradigm to evaluate potential ways to improve the Malahat, a narrow, steep and winding highway between Victoria and North Vancouver Island. It is difficult to drive, often congested, and has a relatively high crash casualty rate. Previous studies investigated potential improvements on that corridor. These studies reflected the old planning paradigm: they considered a limited scope of objectives, limited to traffic congestion and crash risks *on the Malahat* itself. The solutions they considered included various highway expansion and bypass routes, and plus re-establishing commuter rail service. These solutions are costly, and tend to increase other problems such as downstream congestion and habitat disruption.

An alternative solution is to provide convenient, frequent and affordable bus service and Transportation Demand Management Strategies (TDM) to encourage motorists to shift mode. This would give travellers better alternatives to driving, and by reducing vehicle travel would help reduce traffic problems on the Malahat and "down-stream," for example, reducing traffic congestion and accidents on local roads, and parking problems at destinations.

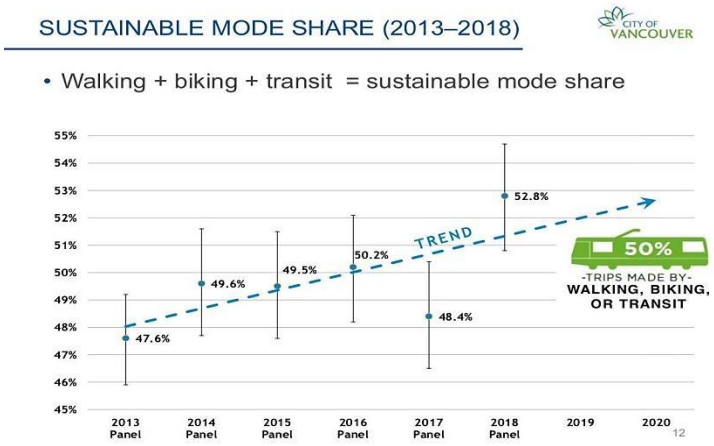
Figure 2 **Seattle Commute Mode Share Trends** (https://bit.ly/2u2FGDL)



By improving transport options and implementing TDM programs Seattle reduced its downtown auto commute mode shares from 35% to 25% in just seven years.

Current demographic and economic trends – aging population, declining youth drivers' licensure rates, changing consumer preferences, and increased health and environmental concerns – are increasing demands for non-auto travel options. Although few people want to give up driving altogether, surveys indicate that many people would prefer to drive less and rely more on alternatives, provided they are convenient, comfortable and affordable. In response, many jurisdictions are implementing multi-modal planning and TDM programs (Cross 2018; FHWA 2012; Sriraj, et al. 2017). For example, California has vehicle travel reduction targets (GOPR 2018), and by improving travel options and implementing TDM programs Bellevue (Johnson and Ingram 2015), Seattle (Peterson 2017) and Vancouver (McElhanney 2019) have reduced vehicle travel and auto mode shares, as illustrated in Figures 2 and 3.

Figure 3 **Vancouver, Canada Mode Share Trends** (https://lnkd.in/gJwu2in)



By improving walking, bicycling and public transit, and implementing TDM programs Vancouver increased non-auto mode share from 48% to 53%, over a six-year period.

These examples demonstrate that many travellers want new mobility options and will use alternatives to driving if they are convenient, comfortable and affordable to use.

The City of Victoria and the Capital Regional District also have multi-modal planning and vehicle travel reduction goals (CRD 2018). Similarly, provincial transport planning goals include increasing affordability and opportunity, sustainable economic development, improved rural and urban planning, sustainable public transit funding, and climate protection (Horgan 2017). In recent years, automobile mode shares have declined while walking, bicycling and public transit travel have increased. These shifts provide many benefits, as summarized in Table 2.

Table 2 **Public Transport Benefits and Costs**

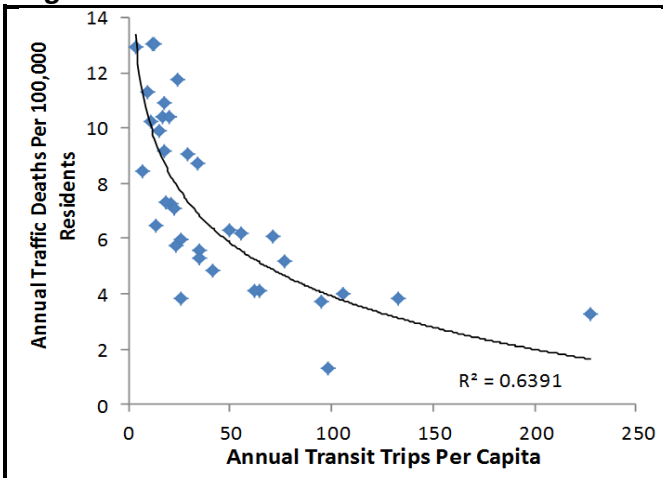
	Improved Transit Service	Increased Transit Travel	Reduced Automobile Travel	Transit-Oriented Development
Benefits	• Improved user convenience, comfort and productivity. • Equity benefits (benefits disadvantaged people). • Option value (the value of having an option for possible future use). • Improved operating efficiency (if service speed increases). • Improved security (reduced crime risk)	• Mobility benefits to new users. • Increased fare revenue. • Increased public fitness and health (by stimulating more walking or cycling trips). • Increased security as more non-criminals ride transit and wait at stops and stations.	• Reduced traffic congestion. • Road and parking facility cost savings. • Consumer savings. • Reduced chauffeuring burdens. • Increased traffic safety. • Energy conservation. • Air and noise pollution reductions.	• Additional vehicle travel reductions ("leverage effects"). • Improved accessibility, particularly for non-drivers. • Reduced crime risk. • More efficient development (lower infrastructure costs). • Farmland and habitat preservation.
Costs	• Capital and operating expenses. • Bus lane road space. • Bus congestion and crashes	• Transit vehicle crowding.	• Reduced automobile business activity.	• Various problems associated with more compact development.

Public transit can have various types of benefits and costs, some of which tend to be overlooked or undervalued in conventional transportation economic evaluation.

High quality transit can provide particularly large stress reduction, productivity, affordability, safety and congestion reduction benefits, because it tends to substitute for more stressful, expensive, risky and congested driving. For example, seniors who find highway driving difficult and stressful, travellers who want to work or relax, lower-income motorists who own inefficient and unreliable cars, and travellers who are impaired or fatigued are particularly likely to shift from driving to affordable and comfortable transit.

Many traffic safety strategies (graduated licenses, special tests for senior drivers, anti-impaired and distracted driving campaigns) are intended to reduce higher-risk driving; their effectiveness depends on travellers having viable alternatives to driving, such as convenient and affordable public transit (USDOT 2017). Traffic crash rates tend to decline as transit ridership increases (Litman 2016 and 2019; Stimpson, et al. 2014). Figure 4 illustrates this relationship: when transit mode share increases from less than 1.5% to more than 4%, per capita crash rates decline by about half. This occurs, in part, because convenient and affordable public transit helps reduce higher risk (youth, senior, impaired and fatigued) driving.

Figure 4 **Traffic Fatalities Versus Transit Trips** (FTA and NHTSA data)



This graph illustrates the relationship between per capita transit ridership and traffic fatalities for 35 large US cities. As transit travel increases, total traffic fatalities (including pedestrian, bicyclist, automobile occupant and transit passenger) tend to decline. Cities with more than 50 annual transit trips per capita average about half the traffic fatality rate as regions with less than 20 annual trips, indicating that relatively modest increases in transit travel are associated with large traffic safety gains.

Similar patterns are likely to occur on the Malahat corridor: peak-period, higher risk and lower-income travelers are most likely to shift from driving to bus, providing proportionately large congestion reduction, safety and affordability benefits. Because higher risk drivers tend to be most amenable to mode shifting, and because most casualty crashes involve multiple vehicles, each 1% reduction in automobile travel tends to reduce traffic casualties by more than 1% (Edlin and Karaca-Mandic 2006; Litman 2016 and 2019).

The old transportation planning paradigm undervalues many of these impacts. For example, the 2007 *Malahat Corridor Study* (MoTH 2007) gave no consideration to consumer savings, increased safety or parking cost savings from reduced automobile trips, and ignored generated traffic (additional vehicle trips caused by roadway expansions) and downstream impacts, and therefore increased congestion and accidents on local roads from highway expansions, and the parking cost savings from mode shifts (TE 2009).

The new transportation planning paradigm applies *Least Cost Planning* (LCP), which evaluates potential solutions according to their cost efficiency, considering all impacts, with demand management treated equally with capacity expansion, reflecting the principle, “a penny saved is a penny earned” (Sears 2015). In this case, LCP would mean that the cost efficiency of public transit and TDM programs would be compared with the cost efficiency of roadway expansions, considering all impacts. This is a significant change from conventional planning which has dedicated roadway funding that generally cannot be used for other modes or TDM programs, even if they are more cost-effective overall.

Least Cost Planning gives equal consideration to non-auto modes and TDM programs. For example, if adding an additional traffic lane to the Malahat Highway would cost one billion dollars and accommodate 1,000 additional peak-period vehicles, LCP would willingly invest up to a billion dollars for transit improvements and TDM strategies that reduce 1,000 peak period trips, and possibly more to account for consumer savings, parking cost savings, accident and emission reductions provided by improved mobility options and reduced vehicle traffic.

Analysis

The Malahat is a narrow, curvy length of highway between Victoria and North Vancouver Island which passes through Goldstream Park and involves a 356 m (1,156 ft.) assent. It is often congested and has a relatively high crash rate (about 30 reported annually), causing road closures several times each year. Many motorists consider it a difficult and stressful highway to drive. As a result, there is considerable interest in improving travel conditions on this corridor.

Figure 5 **Malahat Corridor Study Area** (https://bit.ly/2fx00oB)

The 2007 Malahat Corridor Study *evaluated various highway improvement options, with $200-$1,500 million estimated capital costs, plus additional operations and maintenance costs.*

That study gave little consideration to other impacts, including consumer costs, downstream traffic, parking costs and environmental impacts.

More comprehensive analysis tends to give more support for public transit improvements and Transportation Demand Management (TDM) strategies.

The 2007 *Malahat Corridor Study* evaluated various highway improvement options including widening the existing highway, building a new route or bridge, or establishing commuter rail service (MoTH 2017).[1] These projects' capital costs were estimated to range from $200-1,500 million, which represents $300-2,000 million in current dollars to account for inflation. This would require $20-120 million annual bond payments, depending on terms, plus additional maintenance and operating costs. As a result, their total additional annualized costs range from approximately $22 million to more than $100 million. Table 3 summarizes their estimated costs. Figure 6 compares their cost per trip.

[1] Appendix K (MoTH 2007b) predicted that commuter bus service would attract only 260 to 360 daily trips, but that assumed limited service, a $7 Victoria to Duncan fare, no bus priority lanes, and no TDM incentives. Improved service with improved incentives could increase this significantly.

Table 3 **Estimated Costs of Proposed Options** (MoTH 2007)

Option	Capital Cost ($2007 million)	Annualized Cost ($2007 million)	Cost Per Trip ($2007)
	A	B	C
Widen existing highway	$200 – 250	$31	$62
Improve existing highway	$300 – 400	$48	$96
Double deck existing highway	$400 – 500	$62	$123
Highway counterflow lanes	$250 – 300	$38	$75
Near West – new highway	$300 – 350	$45	$89
New highway on E&N RoW	$300 – 400	$48	$96
Niagara Main – new highway	$300 – 400	$48	$96
Couplet – new highway	$250 – 300	$38	$75
Shawnigan – new highway	$400 – 600	$69	$137
Far West – new highway	$1,200 – 1,500	$185	$370
North Peninsula bridge	$700 – 1,000	$117	$233
Highlands bridge	$900 – 1,200	$144	$288
Transit and TDM	**$5 – 15**	**$2**	**$7**
Passenger ferry	$30 – 50	$7	$30
Improved car ferry	$50 – 70	$11	$45
Adapt existing railroad	$30 – 50	$7	$30
Basic commuter railroad	$80 – 120	$19	$75
Enhanced commuter railroad	$150 – 250	$37	$150

Notes:

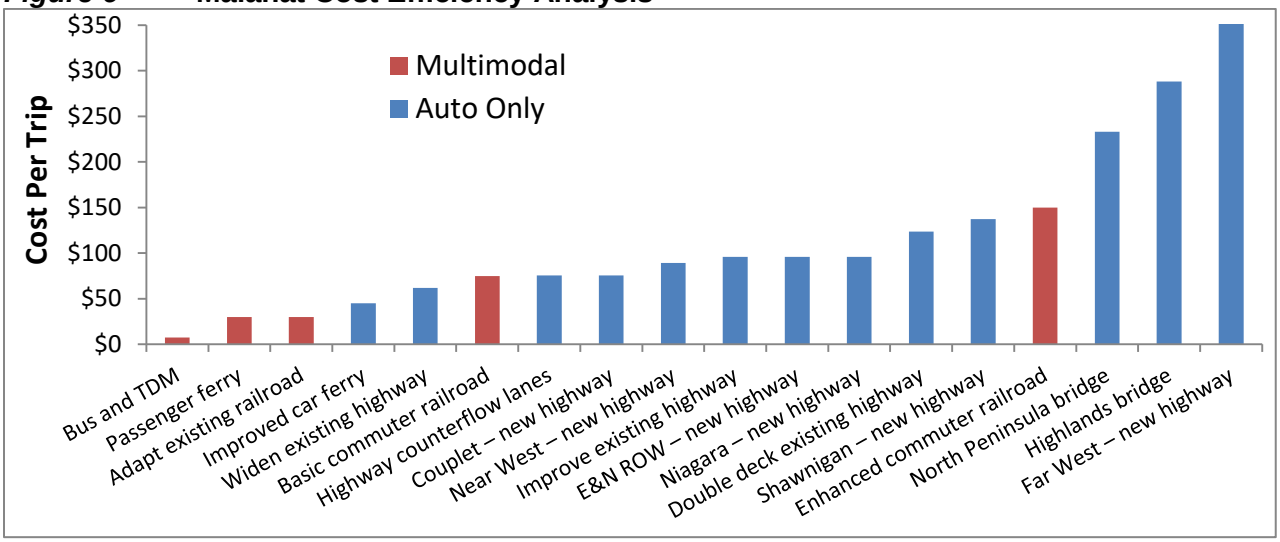
A. From *Malahat Corridor Study*.

B. Annualized at 6% over 20 years, with additional maintenance and operating expenses of 5% of capital costs for highway projects and 10% for other modes.

C. Annualized cost per additional peak-period trip, assuming 1,000 additional peak-period trips per highway lane, and 500 annual trips (two per day, 250 days per year).

This table calculates costs per additional peak-period trip for the various options.

Figure 6 **Malahat Cost Efficiency Analysis**



The Bus and TDM option costs far less per vehicle-trip than rail or roadway expansions. Multimodal solutions benefit people who cannot, should not, or prefer not to drive.

By far the most cost-effective of these Malahat transport improvement options is frequent bus service with TDM incentives. Hourly bus service from 6:00 am to 10:00 pm requires 32 daily round trips. Assuming 64 three-hour trips 365 days per year, this totals 35,040 total annual operating hours, costing approximately $6 million at $175 per hour bus operating expenses. These costs would be partly repaid by additional fare revenue, so this service would require approximately $5 million annual subsidy, as illustrated in Table 4. This could be reduced with less weekend and holiday services, or increased with more frequent peak service and later weekend service.

Table 4 **Hourly Bus Service**

Daily bus trips	32
Cost per bus-hour	$175
Bus-hours per year	35,040
Average bus occupancy	20
Average fare	$4.50
Total annual cost	$6,132,000
Fare revenue	$1,051,200
Subsidy required	$5,080,800

Hourly bus service between Victoria and Nanaimo would cost about $6 million and require about $5 million subsidy per year.

Larger shifts require more transit service. The highway currently carries approximately 23,000 daily vehicles, with 600-1,200 vehicles per hour during peak periods (MoTI 2018). Standard coach buses have about 45 seats, and double-deckers up to 80. Shifting 10% of peak-hour car[2] trips to transit, or 165 travellers assuming 1.1 passengers per car, requires between three double-decker buses averaging 55 passengers per trip, up to eight standard coach buses averaging 20 passengers per trips. Shifting 10% of off-peak car trips to transit, 66 travellers per hour, requires two to four buses averaging 20-30 passengers per trip. These service levels would need to double to displace 20% of car trips, and triple to displace 30% of car trips. The additional service would allow more routes providing direct service to more destinations, and greater service frequency, increasing user convenience.

Table 5 estimates the costs and subsidies required to provide bus service needed to carry 10%, 20% and 30% of Malahat private automobile users. In practice, bus service improvements are likely to generate new passenger trips that do not displace a car trip, and TDM incentives such as parking pricing and commute trip reduction programs are likely to shift some car trips to ridesharing and telework. This analysis assumes that these factors will offset each other so the additional transit trips will approximately equal the reduced car trips.

Table 5 **Cost and Subsidy Analysis**

Mode Shift	10%			20%			30%		
	Peak	Off-Peak	Total	Peak	Off-Peak	Total	Peak	Off-Peak	Total
Operating hours per day	8	8	16	8	8	16	8	8	16
Private car trips per hour	1,500	600		1,500	600		1,500	600	
Bus passengers per hour	165	66		330	132		495	198	
Average bus occupancy	40	25		40	25		40	25	
Buses per hour	4	3		8	5		12	8	
Total bus passengers	1,320	528	1,848	2,640	1,056	3,696	3,960	1,584	5,544
Annual cost (millions)	$6.3	$4.0	$10	$13	$8	$21	$19	$12	$31
Fare revenue (millions)	$2.4	$1.0	$3	$3.9	$1.5	$5	$4.3	$1.7	$6
Subsidy required (millions)	*$4*	*$3*	***$7***	*$9*	*$7*	***$15***	*$15*	*$10*	***$25***

This table summarizes estimated costs and subsidies required to serve 10%, 20% and 30% of Malahat private vehicle trips. A 10% mode shift would require about $7 million, and a 30% shift about $25 million, in subsidies.

[2] In this analysis, *car* refers to all private motor vehicles including car, van, light truck and motorcycles.

Transportation Demand Management (TDM) programs give travellers incentives to drive less and shift modes which increases transit cost efficiency, revenues and total benefits. Table 6 summarizes examples of these programs. Some strategies, such as efficient parking pricing and road tolls, provide revenues that offset program costs.

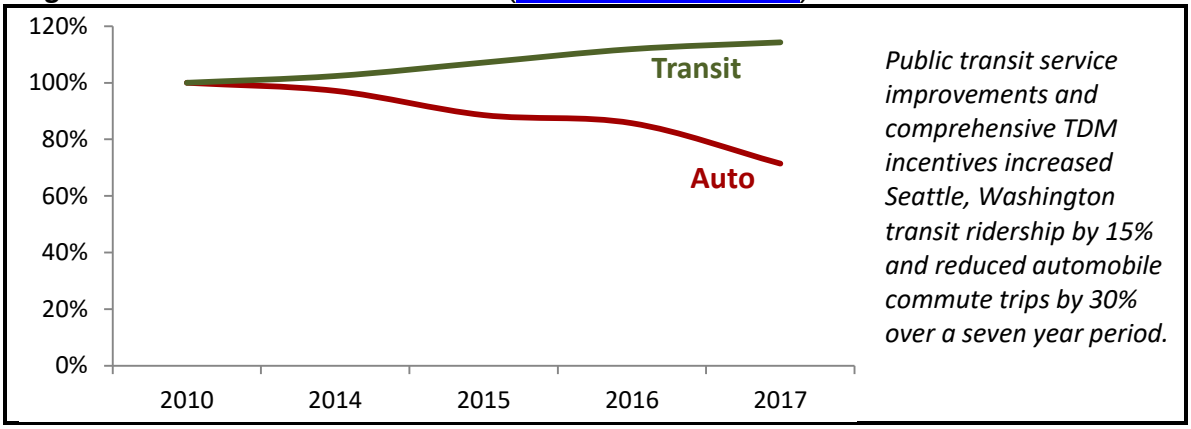
Table 6 **Transit Improvements and TDM Programs**

Basic Program	Moderate Program	Aggressive Program
• Improved user amenities (information and payment options). • Bus service: 60-minute headways. • Bus fares: $3 to Mill Bay, $5 to Duncan, $8 to Nanaimo (one way). • 20% vanpool subsidy: $80-100 monthly fees. • Commute Trip Reduction programs covering 20% of regional commuters. • Bus/HOV priority lanes save 5 minutes per trip.	• 30-minute headways. • Coach buses with wifi service and washrooms. • Bus fares: $2 to Mill Bay, $4 to Duncan, $6 to Nanaimo. • 40% vanpool subsidy: $60-80 monthly fees. • CTR programs covering 40% of regional commuters. • Encourage parking pricing and cash out. • Bus/HOV priority lanes save 10 minutes per trip. • Mobility management marketing along corridor.	• Full service bus stations. • 15-minute peak-period headways. • Premium coach buses with on-board refreshments. • Bus fares: $2 to Mill Bay, $3 to Duncan, $4 to Nanaimo. • 60% vanpool subsidy: $30-60/month. • Enhanced vanpool services. • CTR covering 60% of commuters. • HOV priority saves 10+ minutes per trip. • Comprehensive mobility management marketing for commuters and tourists. • Mandatory parking pricing and cash out. • Optional Pay-As-You-Drive insurance. • $2-3 per peak-period trip road toll.
Results: 5-15% shift	**Results:** 15-30% shift.	**Results**: 20-40% shift.
Annual cost: $8-12 million	**Annual cost:** $15-20 million	**Annual cost:** $25-30 million

This table lists various strategies that can increase mode shifting, and therefore total program benefits.

Are mode shifts of this magnitude feasible? Other jurisdictions that significantly improved transit services with comprehensive TDM incentives have experienced large automobile to transit mode shifts (EPOMM 2018; FHWA 2012, FBC 2009; Noxon Associates 2008; Sriraj, et al. 2017). For example, Seattle, Washington reduced auto mode share approximately 30% during a seven year period, as illustrated below. Some TDM strategies, such as local transit service improvements, highway bus lanes and commute trip reduction programs, are currently being implemented; they would support and be supported by high-quality Malahat bus service.

Figure 7 **Seattle Mode Shares** (https://bit.ly/2u2FGDL)



Public transit service improvements and comprehensive TDM incentives increased Seattle, Washington transit ridership by 15% and reduced automobile commute trips by 30% over a seven year period.

These solutions are even better considering *induced travel*: the additional vehicle travel caused by roadway expansions (Handy and Boarnet 2014). On congested roads, induced travel typically fills a majority of added capacity within few years (TE 2009). An additional lane that increased Malahat Highway capacity by 1,000 vehicles per hour is likely to *add* more than 500 peak-hour trips and more than 1,000 daily round trips compared with 1,800-5,500 vehicle trip *reduced* by 10-30% auto-to-transit mode shifts. Table 7 summarizes these impacts.

Table 7 **Potential Malahat Solution Compared**

Impacts	Roadway Expansion	Commuter Rail	Bus and TDM
Traffic Impacts (daily vehicle trips)	1,000 *more*	500 *fewer*	1,800 -5,500 *fewer*
Program costs annual	$22-100 million	$30-60 million	$8-30 million
User expenses	No change	No change	$1-10 savings per trip
Downstream congestion	Increased	Reduced	Reduced
Parking costs (annual)	$1 million increase	$0.5 million savings	$2.7 million savings
Total accidents	Increased	Reduced	Reduced
Total pollution emissions	Increased	Reduced	Reduced

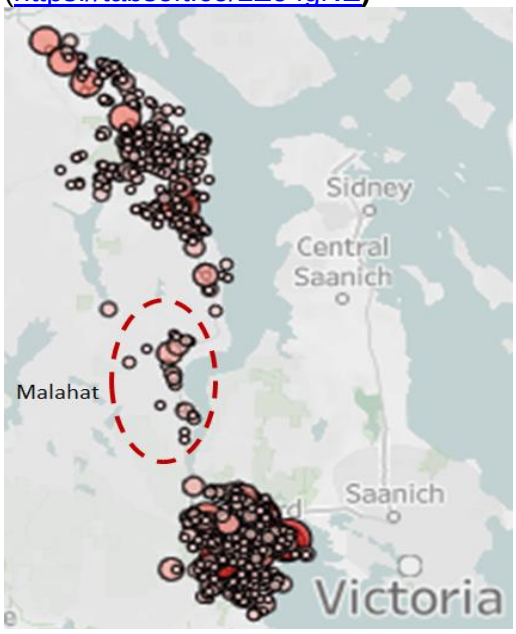
Roadway expansions tend to induce additional vehicle travel, which increases downstream congestion, parking, accident and pollution costs. Because buses are cheaper, more frequent and more direct than commuter rail services, they are likely to attract far more travellers who would otherwise drive, providing more total benefits.

How much could bus improvements and TDM incentives reduce ***congestion***? When traffic volumes approach a road's capacity, a 10-30% reduction significantly reduces congestion (TRB 2015). During peak periods the Malahat carries up to 1,200 vehicles per peak hour per direction. Under these conditions, shifting 100-200 trips per hour from automobile to bus could significantly reduce congestion and driver stress. However, traffic congestion tends to maintain equilibrium: it increases to the point that delays discourage some potential peak-period trips (Arnott 2013). As a result, shifting a portion of travellers from driving to public transit could fail to reduce long-run congestion because the additional capacity will fill with generated traffic. However, improving alternative modes, particularly high quality public transit, tends to reduce the point of congestion equilibrium by making mode shifting more attractive (Cervero 2003; Litman 2015). Traffic congestion does not disappear, but it is not as bad as it would be with less attractive alternatives. This indicates that bus improvements with TDM incentives targeting peak-period travellers could significantly reduce congestion costs, including reduced stress to travellers who shift from driving to public transit, and reduced delay and stress to those who continue to drive.

How much could bus improvements and TDM incentives reduce ***crashes***? As previously described, extensive research indicates that on busy roadways, traffic reductions tend to provide proportionately larger crash reductions, so each 1% vehicle travel reduction reduces crashes more than 1%. Two major factors contribute to this effect. First, higher risk drivers (youths, senior, people with disabilities, motorists with unreliable vehicles, and impaired travellers), are particularly likely shift mode. For example; a young man who drives an old fuel-inefficient truck, a senior with declining reflexes and night vision, and a celebrant travelling over the Malahat for an evening of dancing and drinking, are particularly likely to take the bus, provided the service is convenient, frequent and affordable.

Second, since about 70% of casualty crashes involve multiple vehicles, reducing vehicle travel reduces risks both to motorists who drives less and to other road users by reducing traffic density (Litman 2016). Even a driver who never violates traffic rules reduces total crashes by driving less because this reduces their exposure to other drivers' errors. Analyzing U.S. state-level traffic density and insurance costs, Edlin (1998) found that a 10% reduction in vehicle mileage reduces total crash costs 14% to 18%, with particularly large crash reductions in denser areas (Edlin and Karaca-Mandic 2006). Bus travel has much lower casualty rates than automobile travel and extensive research indicates that total per capita crash rates decline as transit travel increases in a community (Stimpson, et al. 2014).

Figure 8 **Malahat Corridor Crashes**
(https://tabsoft.co/2Zo4gNE)



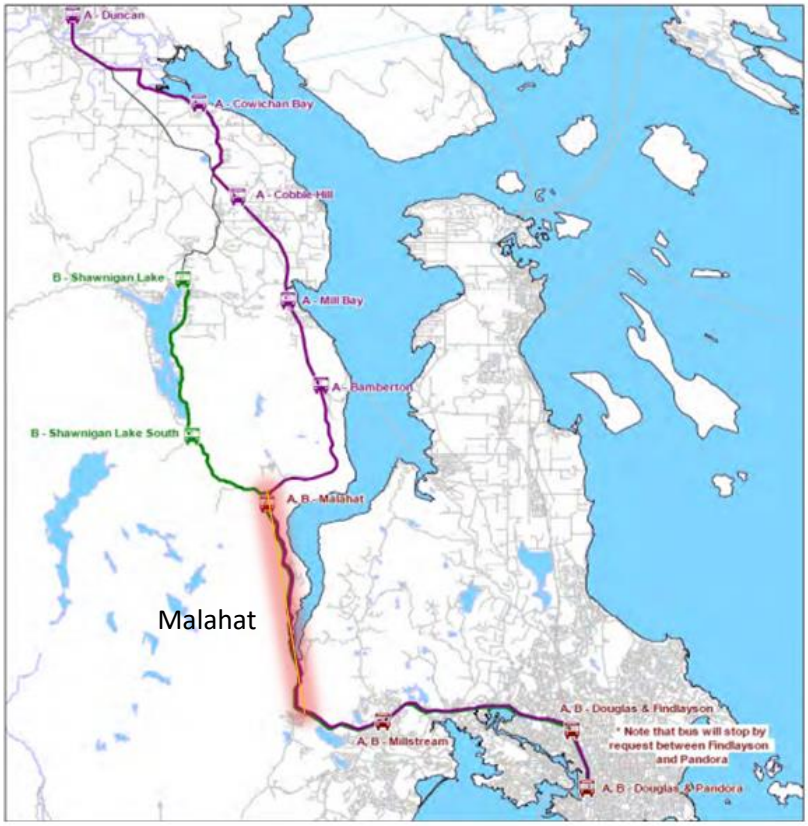
Only a small portion of crashes on the Victoria to Duncan corridor occur on the Malahat. (ICBC 2018)

Although the Malahat seems dangerous and occasionally has dramatic crashes, its crash rate is typical for busy highways, and only a small portion of total regional crashes occur there (map left). This suggests that a 10% automobile to bus shift would reduce crashes on the entire corridor by 15-20%, providing much larger crash reductions than safety strategies that only apply on the Malahat. For example, point-to-point speed cameras might reduce Malahat crashes 10-20% (assuming they cut speed-related crashes in half, which represent 25-30% of all casualty crashes), and grade-separation might reduce crashes on that stretch by 30-50%, but neither reduces risk on other roads, and by inducing additional vehicle travel they would increase total crashes.

What about **rail transit?** Some people consider rail more comfortable and prestigious than bus travel, and so argue it would attract more passengers, but rail has high costs and so would require higher fares, offer less frequent service (for example, the Fraser Valley West Coast Express has only five weekday runs, with no evening, weekend, or reverse commute service), and serve few destinations. With lower fares, greater frequency and operating hours, and direct service to more destinations, buses can offer more convenience and freedom, serve more trips, and attract more total passengers (Walker 2011).

Because it operates on separate right-of-way, rail can avoid some highway congestion and closures, but in practice these benefits are generally limited by train limited capacity. For example, after a highway closure is announced, travellers would need to access a train station and wait for a train with available seats. Transit agencies can easily deploy additional buses when necessary, and buses can sometimes operate when the Malahat is closed to general traffic, for example, if only one lane is open, or by transporting passengers to the Mill Bay Ferry.

Figure 9 **Malahat Corridor** (https://bit.ly/2UOSxJq)



Proposed Malahat Highway improvement projects only affect a small portion (20-25%) of the total travel corridor.

Bus and TDM improvements between Victoria and Nanaimo can provide far more crash and congestion reduction benefits.

Previous project evaluation studies overlooked these additional impacts, which undervalues multimodal solutions.

Some transit improvements and TDM strategies are currently being implemented. BC Transit has three commuter routes that cross the Malahat (8, 66, 99) although the service is very limited: it only operates weekdays, departing Duncan weekday morning at 5:32, 5:55, 6:10 and 6:25 AM, and return weekday evenings at 3:45, 4:10, 4:45 and 5:15 PM, with no evening, weekend or reverse commute service. This lacks the flexibility commuters often need to return home early, work late or stay in the city for post-work activities, and so is unsuitable for most travel.

BC Transit is improving user information and payment systems, highway bus lanes are under development, some employers have Commute Trip Reduction with efficient parking pricing, and local governments are improving bus stops. The Bus and TDM option helps achieve Provincial mandates to increase affordability and equitable economic opportunity, support sustainable economic development, address the needs of both rural and urban communities, improve public transit funding, and support climate protection goals (Horgan 2017).

The often-overlooked impacts can be large. For example, Malahat highway improvements may reduce congestion and crash problems on that 25-kilometer stretch, but by reducing vehicle traffic on the entire corridor between Victoria and Nanaimo, frequent and affordable bus service with TDM incentives can provide several times the total congestion and crash reductions. Expanding Malahat Highway capacity is likely to induce additional vehicle travel that will increase congestion and accidents on other roads, and encourage sprawled development. Improving travel options and reducing total vehicle travel provides additional benefits.

Table 8 compares four Malahat improvement options. Although all improve Malahat traffic conditions, the Bus and TDM option provides additional but often overlooked benefits.

Table 8 **Comparing Malahat Improvement Options**

Impacts	Widen Highway	New Route	Rail Service	Bus and TDM
Malahat congestion	Large benefits that decline with generated traffic	Large benefits that decline with generated traffic	Small reduction	Small to moderate reduction
Downstream congestion	Large increase	Large increase	Small reduction	Moderate reduction
Parking costs	Large increase	Large increase	Small reduction	Moderate reduction
Consumer costs	May reduce operating costs	My reduce operating costs	None, due to high fares	Large savings due to low fares
Traveller productivity	No change. Drivers must focus on driving.	No change. Drivers must focus on driving.	Passengers can work or rest	Passengers can work or rest
Malahat crashes	Reduction offset by generated traffic	Reduction offset by generated traffic	Small reduction	Moderate to large reduction
Downstream crashes	Large increase due to induced travel	Large increase due to induced travel	Small reduction	Moderate to large reduction
Crash delays (unreliability)	Moderate reduction	Large reduction provided by additional route	Moderate reduction	Moderate to large reduction
Non-drivers' mobility	No benefit	No benefit.	Small benefit due to infrequent service and high fares	Large benefit due to frequent service and low fares
Pollution emissions	Increased by induced traffic	Increased by induced traffic	Small reductions due to small mode shifts	Moderate to large reductions
Land displacement	Increased	Increased	No impact	No direct impact. May reduce parking lots.

This table summarizes various impacts of the options being considered. Bus and rail benefits depend on the magnitude of auto-to-transit mode shifts. (Green = increases benefits, Red = increases costs)

The magnitude of benefits provided by public transit depends on the portion of private vehicle trips shifted and so depends on service quality and affordability, and TDM incentives. An aggressive program with convenient, frequent and affordable transit service that reduces vehicle trips 20-40% would provide large benefits, including reduced congestion, reduced chauffeuring burdens, and increased safety throughout the corridor. As a result, motorists have good reasons to support transit and TDM solutions.

How Planning Often Undervalues Transit and TDM

Underestimating Non-Auto Travel Demand

Modelling in 2007 assumed that transit and ridesharing could only attract about 5% of total travel demand. However, that assumed relatively poor service, high fares, and few TDM incentives. There are currently three daily bus trips between Duncan and Victoria with $10 one way fares, and four daily bus trips between Nanaimo and Victoria with $38-50 one way fares. Few employers have commute trip reduction programs that include incentives such as parking pricing or cash out. This poor service, high prices and lack of incentives gives most travellers little reason to shift mode. Given more support, much greater mode shifts are possible.

Transit is particularly appropriate on the Malahat corridor because driving this route is stressful and costly. Many travelers probably want alternatives to driving, provided they are convenient, comfortable and affordable. Experience elsewhere indicates that transit improvements and TDM incentives that include financial incentives such as parking pricing or cash out and Pay-As-You-Drive vehicle insurance (premiums based on annual vehicle mileage) can reduce 10-30% of affected personal vehicle trips (Boarnet, Hsu and Handy 2014; EPOMM 2018; Peterson 2017).

Limited Analysis Scope

The current analysis only considers three planning objectives: increased traffic capacity, reliability and safety on the corridor. These priorities favor highway expansions, including development of bypass routes that could be used when the Malahat highway is closed (Leyne 2019). However, these and other objectives can be achieved more quickly and more cheaply with transportation system improvements that reduce total vehicle traffic. Although bus services and TDM do not provide a bypass route, by reducing crashes they can reduce the need for a detour, and buses can carry many passengers through a single lane during a partial closure.

Underestimating Benefits

Conventional transport project evaluation tends to overlook or undervalue many benefits provided by transit improvements and TDM incentives, as indicated in Table 9. For example, it often overlooks the stress reduction and increased productivity if transit allows passengers to rest or work while travelling. Similarly, it ignores many vehicle cost savings, affordability benefits (cost savings to lower-income households), more independent mobility for non-drivers, and improved fitness and health (since most transit trips include walking links) provided by convenient, low-priced bus services. It ignores the additional downstream congestion, accident and parking costs causes if highway expansions induce more vehicle travel. It generally overlooks strategic development goals such as reducing habitat disruption and sprawl.

Table 9 **Impacts Generally Considered and Overlooked** (Litman 2018)

Generally Considered	Generally Overlooked	
• Malahat congestion • Malahat crashes • Vehicle operating expenses	• Traveller stress and productivity • Vehicle ownership costs • Affordability • Parking costs • Downstream congestion • Downstream crashes	• Independent mobility for non-drivers • Energy consumption and pollution emissions • Public fitness and health • Habitat disruption • Strategic development goals

Conventional planning tends to overlook many significant impacts.

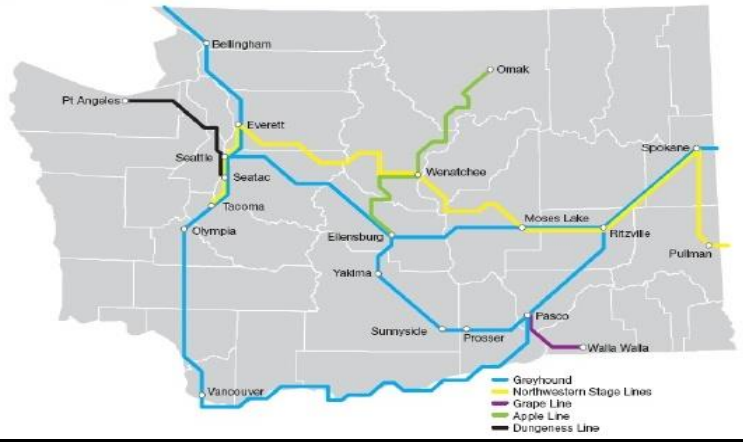
Rural Public Transit Programs

British Columbia currently lacks rural and intercity transit support programs. Below are examples of such programs (CRPD 2016; Litman 2017).

Travel Washington Intercity Bus Program (www.wsdot.wa.gov/transit/intercity)

The Travel Washington Intercity Bus Program provides intercity bus services to many communities (Figure 10). The State Department of Transportation works with communities to design the program and select service providers.

Figure 10 **Washington Intercity Bus Network** (www.wsdot.wa.gov/transit/intercity)

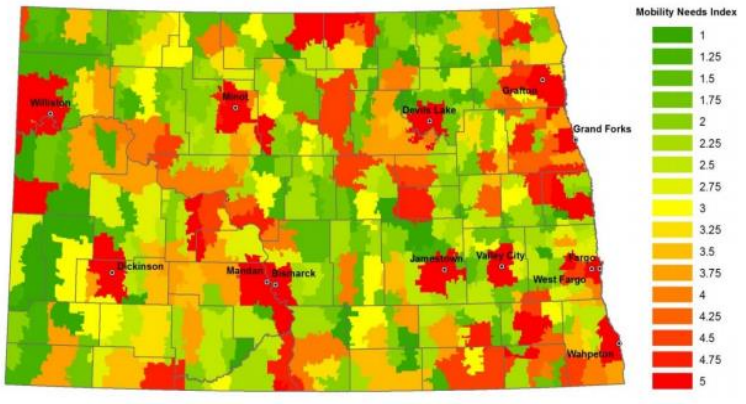


The Travel Washington Intercity Bus Program supports an intercity bus network that serves rural areas and smaller towns.

North Dakota (www.ugpti.org/resources/reports/downloads/dp-280.pdf)

Identifying and Satisfying the Mobility Needs of North Dakota's Transit System, by the Upper Great Plains Transportation Institute (Mattson and Hough 2015), analyzed demographic and economic trends that affect transit demands, and surveyed various service providers to identify existing and future transit service needs, gaps and funding requirements. It calculated a *Mobility Need Index* rating for each county, based on projected growth in total population, residents aged 65 or older, people with disabilities and low incomes, workers without access to a vehicle, and population densities (Figure 11).

Figure 11 **Mobility Needs Index Map** (Mattson and Hough 2015)



The Mobility Needs Index indicates where transit demand is projected to increase due to growth in population groups that rely on public transportation. Each number represents a quintile (20% of total areas). Higher ratings indicate greater projected future transit demands.

Conclusions

The Malahat highway is a significant bottleneck on a major travel corridor. There are frequent calls to improve it. Most proposed solutions would cost hundreds of millions of dollars and exacerbate problems such as habitat disruption and downstream congestion. A more cost effective approach is to provide convenient and affordable bus service and Transportation Demand Management (TDM) incentives to encourage mode shifting. A basic program with hourly service between Nanaimo and Victoria from 6:00 am and 10:00 pm would require an estimated $5 million annual subsidy. If successful this could be expanded. Shifting 10% of private vehicle trips to bus would require an estimated $8-12 million annual subsidy, far less than other solutions.

Examples of TDM Incentives

- Bus and station amenities
- Bus/HOV priority lanes
- Mobility management marketing
- Rideshare encouragement
- Efficient parking pricing
- More affordable housing in transit-oriented neighborhoods
- Commute trip reduction programs
- Walking and bicycling improvements
- PAYD insurance pricing

In addition to government savings this would provide additional benefits including reduced traveller stress and increased productivity (they can work or rest while travelling), consumer savings and affordability, reduced downstream traffic congestion, parking cost savings, energy conservation, emission reduction, and more independent mobility for non-drivers (Table 10). This reflects government mandates (affordability, economic opportunity, fairness, supporting rural and First Nation's development, and reducing climate change emissions) better than other solutions (Horgan 2017).

Table 10 **Comparing Strategies**

Planning Objectives	Roadway Expansion	Commuter Rail	Bus and TDM
More traveller productivity (work or rest)		✓	✓
Reduced congestion	✓	✓	✓
Infrastructure savings			✓
Parking cost savings		✓	✓
Consumer savings and affordability			✓
Traffic safety	✓	✓	✓
More independent mobility for non-drivers		✓	✓
Energy conservation		✓	✓
Pollution reduction		✓	✓
Physical fitness and health		✓	✓
Reduce habitat displacement and sprawl		✓	✓

Roadway expansions provide few benefits. At best they reduce traffic congestion and accident risk, but these tend to decline in a few years as induced traffic fills the additional capacity, increasing downstream traffic problems. Transit improvements and TDM programs provide a much larger set of benefits.

This could provide large total benefits. Experience indicates that bus improvements with TDM incentives can reduce 10-30% of peak period trips, and since higher cost and higher-risk drivers are particularly likely to shift mode, this tends to provide proportionately larger consumer savings, safety, emission reduction and congestion reduction benefits. Convenient and affordable bus service should be particularly attractive to young, impaired, fatigued drivers, and motorists with inefficient and unreliable vehicles. Because 70% of casualty crashes involve

multiple vehicles, vehicle travel reductions increase safety for all travellers. As a result, shifting 10% of automobile travel to buses should provide 12-15% fuel savings, 15-20% crash reductions, plus substantial congestion reductions on the Malahat and on other roadways. Total benefits are likely to be much greater than Malahat Highway improvements, particularly if they induce additional vehicle traffic which increases downstream congestion and accidents.

Some people favor rail over bus transit because they expect it to be more comfortable, prestigious and reliable, but bus service is likely to be cheaper, more frequent, and directly serve more destinations. As a result, bus service is likely to attract far more passengers, providing greater total savings and benefits. Achieving large benefits with rail would take decades to build a large network with transit-oriented development around each station. Regardless of whether or not a rail network is planned, frequent bus service is needed.

Conventional planning tends to undervalue multimodal solutions. The 2007 Malahat study only considered three planning objectives (increased traffic capacity, reliability and safety on the corridor) and so overlooked many benefits of improving travel options and reducing vehicle traffic. Valuing these solutions requires *least cost planning*, which considers demand management equally with supply expansions, and accounting for all benefits and costs.

This approach faces various obstacles. Motorists may consider this solution unfair because it invests in transit rather than roads, although motorists have good reasons to support bus services and TDM incentives that reduce their congestion, parking, accident and chauffeuring problems, and as an option they may use in the future. Critics may also argue that, unlike a new highway or rail service, bus improvements fail to provide a bypass route when the Malahat is closed, but by reducing crashes it reduces closure frequency, and by carrying large numbers of passenger on a single lane or to the Mill Bay Ferry, bus service can operate when the Malahat is closed to general traffic.

Malahat corridor bus ridership is currently small due to inconvenient and unaffordable service. Three commuter-oriented bus routes between Duncan and Victoria can only serve a small portion of total trips. Buses currently lack amenities such as onboard wifi and real-time bus arrival information that is proven to attract passengers. Few employers have commute trip reduction programs or efficient parking pricing. Better options and incentives could significantly increase ridership. Since major highway projects take years to implement, cause construction delays, exacerbate downstream traffic problems, and do nothing to increase affordability or independent mobility for non-drivers, bus service improvements and TDM incentives make sense regardless of what other strategies are implemented.

This is an important and timely issue. Although the BC Ministry of Transportation is, ostensibly responsible for all modes, the majority of its resources are devoted to highway projects. It is time for British Columbia to develop intercity and rural bus service programs to ensure that people who cannot, should not or prefer not to drive receive a fair share of investments.

This is a specific example of new paradigm planning. The old paradigm focused on automobile travel and so favored highway improvements. The new paradigm considers other objectives, impacts and options, which leads to more cost effective and beneficial solutions. The Malahat is an excellent place to apply more comprehensive and multimodal transport planning.

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