An Exploration of the Past, Present, and Future of British Columbia's Highways

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Abstract
The British Columbia road network connects communities and facilitates the movement of goods across the province and the rest of Canada. The road network forms a vital part of the pacific gateway, providing one of the primary connections between Asia and North America from docks located in Vancouver and Prince Rupert. With a booming economy growing in Asia and increasing export traffic, the importance of maintaining and upgrading BC's highway network infrastructure has never been higher. Several factors from past to present have driven the development of BC's diverse road infrastructure, including:

- The fur trade
- The gold rush
- Logging
- Tourism
- Oil and Gas Development
- Urban and Rural development,
- Agriculture
- National Defense
- Container movement
- And most recently, the potential for Liquefied Natural Gas

The BC highway network has developed steadily over the past century. In more recent times, several major highway infrastructure projects have been undertaken. Projects such as the Sea-to-Sky Highway, the Coquihalla Highway, Port Mann Highway 1 project, the Cariboo Connector program, and the Kicking Horse Canyon make up just a portion of the billions of dollars of infrastructure improvements constructed within BC.

Transportation design in BC faces several unique challenges owing to the diverse natural terrain within the province. Thousands of kilometres of infrastructure wind through steep mountainous terrain, cross large river valleys, and navigate through or around environmentally sensitive and fragile ecosystems. Past designers have had to devise innovative solutions to handle the unique situations found in BC to maintain the movement of goods and people through the country. Designers are now faced with upgrading this existing infrastructure and adapting to the new challenges facing the 21st century such as alternative project delivery models, rising sea levels, coastal erosion, soil stability, and ever increasing environmental awareness all within the context of sustainability, increasing safety, reliability, and mobility.

This paper will draw attention to some of the innovative solutions and construction methods used by engineers of the past to cope with the terrain and environment of BC. As a comparison, current modern day projects will also be featured, illustrating how

current technologies and methods tackle some of these same issues and constraints. Feats of engineering that were not possible in the past will be highlighted. Finally, the future of transportation projects and design in BC will be discussed, highlighting the fundamental and evolving objectives and issues designers will be faced with moving forward into the future.

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1 .0 Introduction

The British Columbia (BC) Highway Network has a rich and diverse history. It originates from foot paths and hunting trails developed by the First Nations people, which were followed by wagon trails developed during the fur trade and the gold rush in the 1800s. Engineered paved roadways and multi-lane highways became the norm during the 20th century and beyond. The many and diverse factors driving the development of BC's highways are evolving over time, with economic drivers being the dominant force behind development and engineering of highways throughout the province dating back to the fur trade.

Fur traders in the early 1800s were the original trailblazers of BC's highway network. Companies such as the Hudson's Bay Company and the North West Fur Trading Company dispatched explorers and fur traders throughout British Columbia to establish fur trading networks and pathways to economic resources. These pathways required engineering and ingenuity to allow for larger mule trains and wagons to pass through British Columbia's challenging topography, and were built upon the original footpaths and hunting trails developed by the First Nations people. The onset of the gold rush created an urgency in the mid 1800s to develop these roads even faster and to more remote areas, driving road designers and builders to overcome adverse challenges when dealing with British Columbia's remote and mountainous terrain.

The development of the automobile at the turn of the 20th century presented new challenges to road designers and builders. Roads constructed in the early and mid 1800s served as the backbone of British Columbia's future highway network. Bigger and faster modes of transportation were now capable of increasing the accessibility to remote areas within the province. They were also capable of increasing the speed and capacity of goods and people movement. With limited space and/or alignment opportunities, road designers were faced with the challenge of rehabilitating, improving, and widening existing roads and highways to acceptable standards. These widened roads needed to accommodate the increasing speed, number, and size of vehicles.

As BC moves into the future, the province has established itself as the Pacific Gateway, providing a connection between Asia and the rest of Canada. With two large ports (Vancouver and Prince Rupert), BC acts as one of the main points of entry for goods and people coming from across the Pacific Ocean. The growing economic strength of Asia Pacific countries has facilitated an increase in import/export and other trade activities. This has caused an increase in the demand and necessity for multi-lane highway corridors to Canada and the United States. According to the 2005 British Columbia Ports Strategy [(1)], the expected combined increase in port traffic for the Vancouver, Fraser, and Prince Rupert ports from 2003 to 2020 is between 200% to

300% for container cargo, 10% to 55% for resource exports, and 50% to 150% for cruise passengers. This equates to upwards of 7 million containers, 96 million tonnes of resource exports, and 2.4 million cruise passengers. BC's ports are also closer to Asia than the American ports in Los Angeles and Long Beach, offering up to 58 fewer travel hours for vessels [2].

New economic development opportunities within BC such as Liquefied Natural Gas require road designers to accommodate newer and larger transport vehicles to construct infrastructure, pushing the envelope of existing design guidelines and parameters. BC will continue the process of widening and multi-laning existing highways to keep up with capacity demands created by the increasing economic opportunities and population growth. Population growth estimates calculate that BC's population will grow by 1.5 million people by 2036, bringing the total population of BC to 6 million people [3].

Today's designers are faced with the challenge of designing and upgrading roadways through BC's diverse and challenging terrain while accommodating future use and capacity requirements. Highway design in BC requires innovation, ingenuity, and forward thinking to overcome the mountainous terrain, geotechnical challenges, abundant and vast river crossings, and the threat of rising sea levels and adaptation for climate change.

2 .0 Background and History of the BC Highway Network

First Nations people were the original builders of BC's Highways. Trails and footpaths developed by the First Nations formed the backbone and skeleton of what eventually progressed into the British Columbia Highway Network. First Nations society during this period was sophisticated for the time and relied on trade between First Nations tribes in order to meet basic necessities of life that the surrounding environment could not provide. The necessity of trade during this time also required pathways and foot trails. The mountainous terrain and abundant rivers, required crossing structures to maintain connectivity within the network. One of the earliest and most famously known bridge crossings in British Columbia is the Hagwilget Bridge over the Bulkley Canyon. This bridge was constructed twice by First Nations tribes using abandoned telegraph line materials in the late 1800s [4].

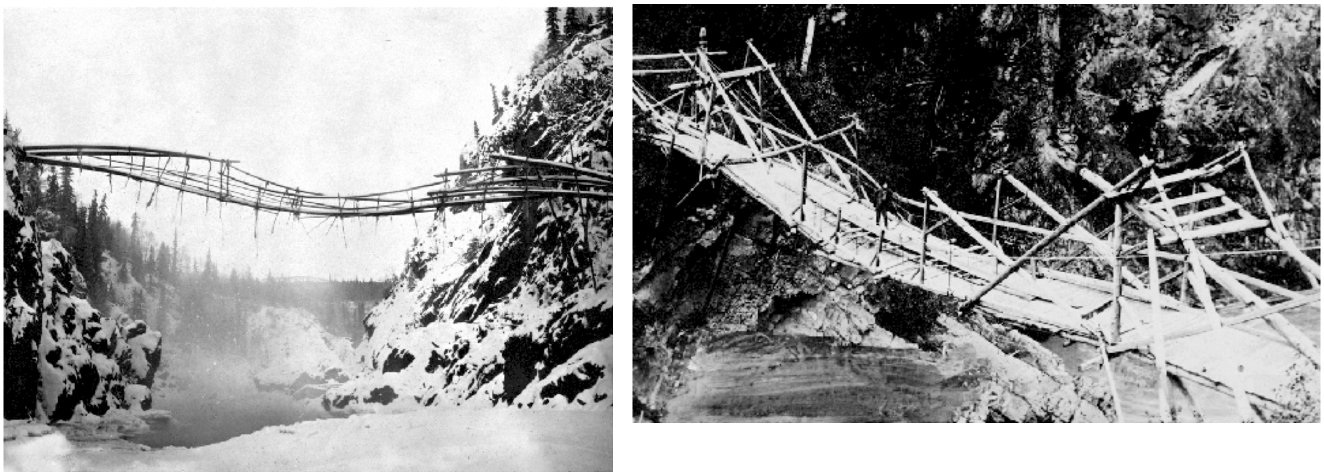

Figure 1 - First and Second Hagwilget Bridge Over Bulkley Canyon (BC Archives Photo)

As European settlers began to arrive, explorers and traders from the Hudson's Bay Company and the North West Fur Trading Company would utilize the existing First Nations Trails and create new ones of their own. The fur trade would further expand the foundation of the BC Highway network, and build upon the skeleton that was originally laid down by the First Nations of British Columbia.

In the mid-1800s, the gold rush commenced. Prior to the gold rush, roads were mainly developed in Victoria to serve farming and settlement. The pathways and settlement areas on the mainland were primarily reserved for the fur trade; however, with the discovery of gold throughout the Thompson, Fraser, and Columbia Rivers, settlement and trail building would soon flourish. Gold miners flocked to the mainland, and started to build the early connections and roads leading into the interior of BC.

Trails constructed during the gold rush would eventually be developed into wider wagon trails. While early roads were sufficient to accommodate miners and other settlers during the gold rush, their capacity for goods and trade movement was limited at the time. With the huge influx of gold miners coming up from the United States, the British had concerns about American expansion into BC. The mainland was subsequently declared a British colony, and Royal Engineers were sent to British Columbia to start building roads. Widening original trails to allow for two teams of wagons and mule trains to pass was undertaken by the Royal Engineers,whose early work included the Cariboo Road (now part of Highway 97) in the Southern Interior of BC, and North Road in New Westminster. North Road still exists today, and is one of the major north-south corridors between the City of New Westminster, Burnaby, Coquitlam, and Port Moody.

As the 20th Century approached, governing authorities determined that roads and trails developed out of necessity as a result of the gold rush and fur trade were disjointed.

This left the network with gaps that did not meet the needs for continuity and further growth and development of the province. The development of trunk roads began, with the Province of British Columbia beginning to construct major trunk roads under a new policy developed to encourage economic growth and settlement. Long stretches of road trunk systems were constructed in the Southern Interior and the Lower Mainland. Building these systems was costly due to their extensive length and construction time, and even today some of the highways are still being upgraded and completed.

In the early 1900s, the gasoline-powered automobile was becoming more affordable and accessible to the everyday person. Within 10 years (between 1920 and 1930), vehicle registration increased from approximately 28,000 vehicles to almost 100,000 (4). The need to upgrade the trunk systems with paved surfaces was growing with urgency. Faster, larger, and safer vehicles required better engineered roads to maintain pace with the growing popularity of the car.

In the 1950s, population growth and increasing vehicle ownership began to tax the available capacity within the existing two-lane engineered highway system. Widening of existing highways began in population-dense areas such as the Lower Mainland of BC (Greater Vancouver), and have since moved onto more remote highways. There are still sections of highway along major transportation and trade routes that are two lanes. Several sections of Highway 3 between Hope and Princeton BC have been widened to 3 or 4 lanes in recent years.

Today, British Columbia is considered the Pacific Gateway to the rest of Canada. With two major ports (Vancouver and Prince Rupert) and several major points of entry to the United States, gateway infrastructure has been a focal point of infrastructure upgrades over the last few years. Most recently, the Port Man Highway 1 Project is close to completion, upgrading approximately 37 kilometres of highway from Vancouver to Langley (5). Major projects such as the Port Mann Highway 1 project and the South Fraser Perimeter Road (running along the south bank of the Fraser River between Delta and Surrey BC) were largely being driven by the need to increase highway capacity, to accommodate the expansion of port infrastructure, and to facilitate the movement of goods. With increased trade with Asian Pacific countries, British Columbian ports are competing with American ports such as Los Angeles and Seattle for container and goods shipments (1).

Population growth and the development of revenue sources within the province will drive further capacity needs and push the limits of current guidelines. Natural resource developments such as Liquefied Natural Gas and wind farm infrastructure will require highway upgrades not only for capacity, but also to accommodate large transport vehicles required to support expansion or construction of growing sectors in our society.

As we move forward into the 21st century, the continuing evolution of vehicles and the need for adaptation due to climate change will require increased consideration in the next few decades of roadway design and engineering in BC. Our highway infrastructure will need to accommodate new types of vehicles and infrastructure such as electric and autonomous vehicles. And, climate change is requiring engineers to rethink and innovate new ways to adapt, design, and construct resilient highways.

3 .0 Challenges of Design and Construction in BC

British Columbia has many unique challenges to consider when designing highway infrastructure owing to its diverse terrain. Highways in British Columbia traverse through mountainous terrain, along oceans and lakes, across large rivers and canyons, and through environmentally and archaeologically sensitive areas. Port expansion and new resource related economic development are providing new challenges and considerations for design when upgrading the province's existing highway network.

Highway design through mountainous terrain requires consideration of several challenges and constraints. Landslides, debris flows, and other geotechnical considerations play a large role in determining the alignment and design of highways. Several British Columbia highways have fallen victim to landslides throughout the past several decades. One of the largest slides in Canada occurred just 18 kilometres east of Hope, BC, spreading over 46 million cubic metres [(6)] of earth across 3 kilometres of the Hope-Princeton Highway (Highway 3). Due to BC's high precipitation, abundant amount of unconsolidated glacial tills, steep mountainous terrain, and geographic location along an earthquake zone that stretches along the Pacific Rim, highways in BC are particularly susceptible to landslides and debris flows.

Seismic considerations and soft compressible soils are also obstacles that need to be considered when designing a highway in BC. Compressible peat underlays many of BC's highways and often requires extensive geotechnical investigation, mitigative measures, and careful consideration of alignment.

Mountainous terrain often requires steep road grades, and in some cases, canyon crossings. Highways located along steep mountain sides are susceptible to avalanches. The grades and limited physical room often presents issues with sight distances and challenges with increasing capacity and widening. This posess challenges when constructing or upgrading highways due to availability of space, limited alignment options, geometric constraints, as well as archaeological and environmental concerns.

Figure 2 - Hope Slide (BC Archives Photo)

Highway designers in BC are facing challenges due to up-and-coming industries such as Liquefied Natural Gas and expanding ports. Trucks and their loads are progressively getting longer, larger, and heavier, with some highways in BC seeing trucks with as many as 14 axles and 60 metres long [(7)]. Accommodating these vehicles within existing roadway infrastructure or with emerging alternative intersection designs such as roundabouts proves to be a significant challenge.

With the development of the automobile, British Columbians gained a significant increase in mobility and accessibility; however, natural terrain and location, separate many communities with water bodies, such as oceans and rivers. It is a challenge in BC to keep these communities connected, and provide the highway infrastructure to allow these communities to remain economically stable. Within the Lower Mainland of Vancouver, there are 22 major multi-lane crossings over the Fraser River, which is also a major shipping corridor.

4 .0 Examples of Highway Design and Construction in British Columbia

There are many examples of projects designed and constructed in British Columbia that overcame the challenges and obstacles that the natural topography and climate present. The following section provides some brief highlights of innovative projects, unique features specific to British Columbia, and project delivery methods and design philosophy.

Projects in Mountainous Terrain

Many of British Columbia's highways traverse through steep, winding mountain passes and across river valleys and canyons. A large number of them are built on top of existing footpaths and wagon trails developed in the early 19^{th} and 20^{th} century during the gold rush and fur trade eras. The Transportation Association of Canada (TAC) Geometric Design Guidelines and Engineering Best Practices set out minimum horizontal and vertical radius of curvatures, maximum grades, clear zone requirements, and other geometric and roadside safety guidelines to maximize safety and mobility. When designing and constructing in mountainous terrain, the physical topography makes it challenging to achieve these geometric design values.

Rock Cuts

Geometric designers must often cut a swath through a mountain in order to achieve a safe design. This has been the case for highway and roadway design since the first roads were built. Rock cuts are common place in much of BC highway construction, and can be well over 30 metres high.

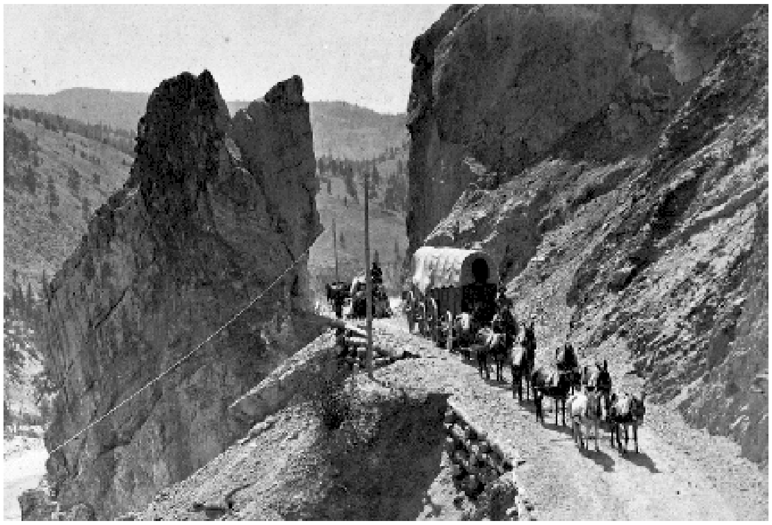

Figure 3 - Freight Wagons at 8 Mile Bluff - Thompson River (BC Archives Photo)

The BC Ministry of Transportation and Infrastructure (the Ministry) has created a BC Supplement to TAC Geometric Design Guidelines [8] which contains a section specific to rock cuts. Typical cross-sections for rock cut in the BC Supplement provide guidance on catchment areas for rock fall and clear zone, as well as guidelines for stabilization of rock cuts and overburden.

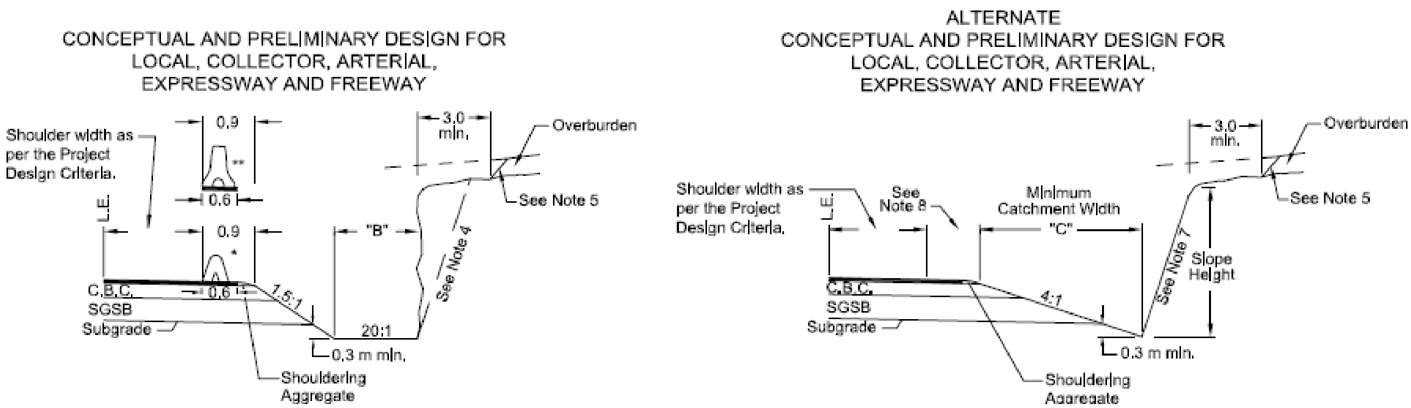

Figure 4 - Rock Cut Typical Section - Excerpt from BC Supplement to TAC Geometric Design Guidelines

A recent project on Highway 1 in the interior included a large 90 metre rock cut that created a path through a large rock bluff in Kicking Horse Canyon. Rock slope stabilization and catchment widths were provided in the cross section.

Figure 5 - 90 Metre Rock Cut on Kicking Horse Canyon Project (BC MoTI Photo)

Rock cut sections of highways aren't just simply applying the typical section provided by design guides. Significant investigations are required to determine depths of overburden at the top of the cut, and the overburden depths can vary greatly. This can cause uncertainty with respect to construction limits and can affect property acquisition requirements. Clear zone widths and catchment areas may also need to be increased in order to achieve sight distances around curves.

Stopping sight distance can be difficult to achieve in mountainous areas. In mountainous areas, the governing object height may be the use of rock as object height (policy for Low Volume Roads in the BC Supplement to TAC), which will increase the rates of vertical curvature and achievable stopping sight distances. This can present a significant challenge to designers when the nature of the terrain requires safer design parameters, but the topography places constraints on geometric design. It is often a balancing act to create a safe design that is feasible to construct with a reasonable capital cost.

Skagit Bluffs

In some cases, other mitigating measures and adaptation to challenges are required for design when it is not feasible or practical to upgrade an existing highway to current Geometric Design Guidelines. An example of adaptation to geometric design challenges can be shown on Highway 3 near Skagit Bluffs [9].

Some motorists find the highway geometry on Highway 3, near Skagit Bluffs to be challenging to navigate. The eastbound direction features tight curves and steep embankments immediately adjacent to the highway. The posted speed through this stretch of mountainous highway is 80 km/h. West of this location is a reverse curve warning and speed advisory sign posted for 50 km/h. There have been several incidents of travelers entering the curves at speeds higher than the posted advisory speed failing to negotiate the curve safely. Further site visits and observations by the Ministry observed drivers consistently driving faster than the posted advisory speed.

Due to the location of the project and the topography, there were limited options available to ensure drivers adhered to the posted advisory speed. The chevron signs located at the curve were replaced with illuminated LED signs to increase visibility. The implementation of the signs also meant that maintenance required during snowstorm events was minimal, as the illuminated chevrons would be visible even when covered in snow.

Vehicle-activated curve ahead and advisory speed signs were also installed prior to the reverse curve section. Vehicles travelling at speeds greater than 60 km/h would cause the sign to activate, advising drivers to slow down as they approach the curves. Four warning flashers on the sign also activate, to increase the visibility and provide visual cues to drivers. When drivers are travelling at less than 60 km/h, the sign remains blank. Public feedback and observations have indicated that this approach to safety improvement at the Skagit Bluffs location is effective.

Figure 6 - View of Vehicle Activated Signs Approaching the Reverse Curve (BC MoTI Photo)

Figure 7 - Illuminated LED Chevron Signs (BC MoTI Photo)

Snow Sheds and Tunnels

Mountainous terrain often means that BC's highways are often vulnerable to avalanches. In order to keep the highway network connected, it is sometimes necessary to align highway infrastructure through avalanche zones. It may not be practical or feasible to realign highways to remain outside avalanche areas. In order to mitigate the risks and danger to motorists and maintain trade corridors should an avalanche occur, the use of snow sheds and debris walls has been implemented on several highways.

Several sections of the Coquihalla Highway (Highway 5) wind through mountainous terrain at the foot of steep embankments. During the winter, several of these sections can be at risk for avalanches. Generally, mitigative measures such as earthen berms and catchment areas can be used to help prevent avalanches from impacting the highway; however, in some cases snow sheds are used to further mitigate the risk of damage and danger from avalanches.

The Ministry is responsible for 4 of 9 snow sheds in the province (the rest are maintained by Parks Canada and are located in Glacier National Park) [10], one of which is the Great Bear Snow Shed. At approximately 285 metres long, the Great Bear Snow Shed is located along the Coquihalla Highway. The snow shed is designed to withstand the huge impact of sliding snow, but is not designed to stop the avalanche. In principle, snow sheds are designed to deflect the sliding snow, allowing the avalanche to continue over travelling vehicles, minimizing risk.

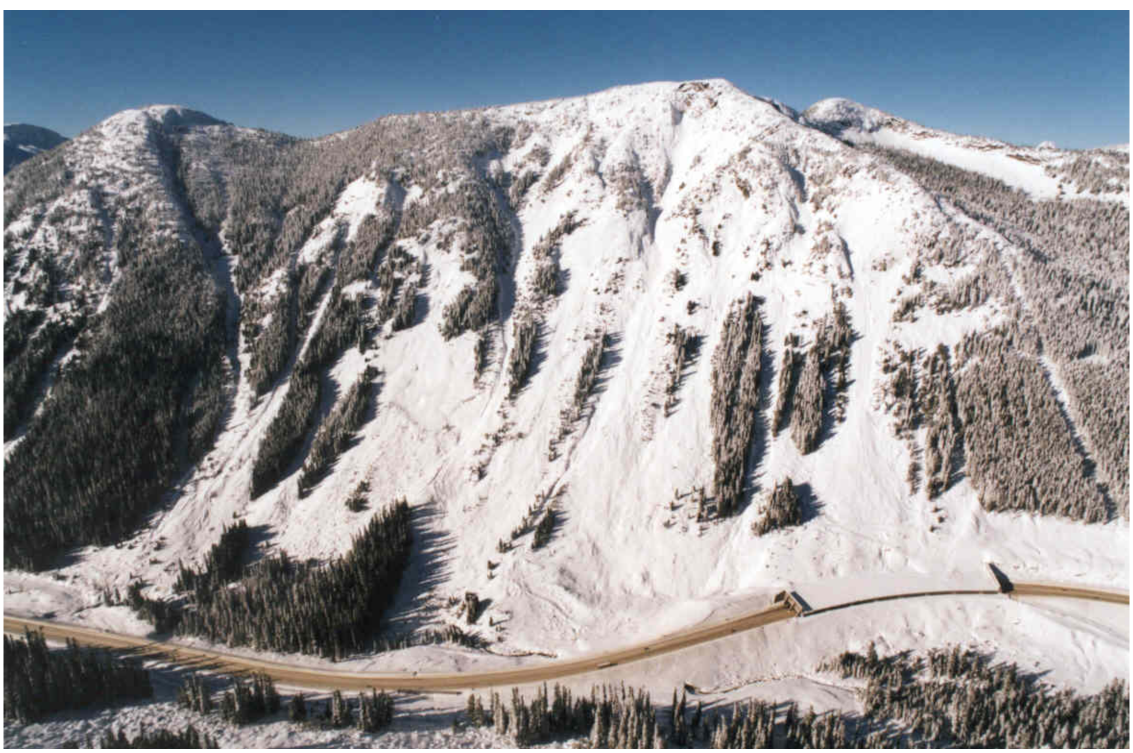

Figure 8 - Great Bear Snow Shed on the Coquihalla Highway (BC MoTI Photo)

Geometric designers are often left with few options for highway alignments owing to the steep terrain in mountainous environments. Often designers are left with no alternatives other than to go through the rock bluffs or mountain sides. There are several examples of stretches of highway in BC that have tunneled through rock to maintain sufficient road widths and curvature.

The Fraser Canyon section of Highway 1 just north of Yale contains 7 such tunnels bored through rock bluffs. The tunnels through this section of Highway range from 90 metres up to 640 metres long. Some of the tunnels along this stretch are replacements of older tunnels that were constructed prior to the construction of Highway 1 upgrades through this section in the 1960's. The longest of the seven tunnels, the China Bar Tunnel, also includes lighting and a cyclist-activated push button warning system.

Figure 9 - China Bar Tunnel on Highway 1 (Screenshot from Google Street View)

Sea-To-Sky Highway

Leading up to the 2010 Olympic Winter Games, the Sea to Sky Highway Improvement project involved over 60 kilometres of highway improvements. The Highway winds through mountainous and rocky terrain between West Vancouver and Whistler. The previous highway was primarily a two-lane cross section with limited passing opportunities that was perched atop rocky bluffs overhanging sheer drops to the Pacific Ocean. The highway had a reputation for being a harrowing and dangerous drive, with nicknames like the "Highway of Death". The Sea to Sky Highway Project aimed to improve the highway by adding additional lanes and passing opportunities along the corridor, as well as improving safety, mobility, and reliability.

The highway was designed using context-sensitive design guidelines [11], which was a departure from the guidelines typically used for BC Highway infrastructure. One of the primary objectives of the context-sensitive design guidelines was to improve the overall safety performance of the highway by influencing driver behaviour.

British Columbia has also been at the forefront of Collision Prediction Modelling (CPM) and Collision Modification Factors (CMF). In recent times, the Ministry has published technical circulars on CPM's and CMF's, as well as commissioned studies and reports from consultants [12]. In BC, CPMs were developed specific to BC highways [13]. It has been found that when compared to models in the Highway Safety Manual, the BC specific models are a better fit, and the Ministry continues to use them. CPMs are used in road safety audits and value engineering exercises as well as during planning stages. One of the important factors that will affect the outcome of the model is the road cross section. During the proposal stage of the Sea to Sky Highway improvement project, CPMs were used to evaluate the safety of the proponent's preliminary design concept. Proponents were given a score as part of their proposal evaluation for how safe their design was when the CPMs were applied.

Figure 10 - Sea to Sky Highway During Construction (BC MoTI Photo)

Highway Design Policies and Features

The Ministry has developed several highway design policies unique to BC that affect the geometric design of highways.

Roundabouts

The Ministry adopted a roundabout first policy in 2007. The adoption of this policy was also in support of the 2007 Climate Action Program [(8)]. The Ministry requires that any intersection that requires a four-way stop controlled or signalized intersection as supported by traffic analysis, must first consider a roundabout. The decision to not use a roundabout at an intersection must be supported by documentation and sufficient reasoning as to why a roundabout should not be supported at specific locations. This roundabout policy also applies to intersections at interchange off-ramps.

Since the implementation of this policy in 2007, there have been several projects on BC highways that have implemented roundabouts. Two such projects include the McTavish Interchange in Victoria and the McCallum Interchange in Abbotsford.

The McTavish Interchange is located just south of the Swartz Bay ferry terminal on Vancouver Island, as well as the gateway to the Victoria International Airport. The design featured 3 roundabouts, two of which were multi-lane modern roundabouts. This design had advantages in mobility, fuel emissions, and noise reduction compared to a traditional diamond interchange [(14)].

The McCallum Interchange featured two roundabouts at the on and off-ramps. The design also included a six-leg roundabout. The original partial clover interchange developed during the concept stage was value engineered and the dual roundabout design solution was proposed as the result. The design provided enough cost savings to enable the Ministry to construct additional works such as a third westbound lane on Highway 1 and additional park and ride facilities. Like the McTavish Interchange, it was determined that this roundabout interchange design had several advantages over a traditional interchange design that included increased mobility, noise reduction, and reduced fuel consumption and greenhouse gas emissions.


Figure 11 - McTavish Interchange (BC MoTI Photo)


Figure 12 - McCallum Interchange

Currently, a roundabout is in the design stages for a location in Clearwater, between Kamloops and Jasper. It will be BC's first roundabout located on a four-lane numbered highway corridor. This highway intersection is expected to see heavy truck traffic and may be required to accommodate large oversize and overweight vehicles. Vehicles as large as 60 metres in length are expected to become more common on BC Highways.

The design and implementation of roundabouts can have a significant impact on travel time and mobility for extra-large vehicles. It can take substantially longer for an oversize and overweight vehicle to traverse through a typical modern roundabout. Depending on the geometrics of the roundabout, it could take more than 20 minutes to clear a roundabout if multiple turning maneuvers are required [7]. This would effectively shut down the roundabout and have a large impact on the traffic operations, as well as require additional traffic management and pilot cars for the transport vehicle. Consequently, the Clearwater roundabout is being designed to accommodate a 10-axle 60 metre transport and dolly truck in order to avoid these issues.

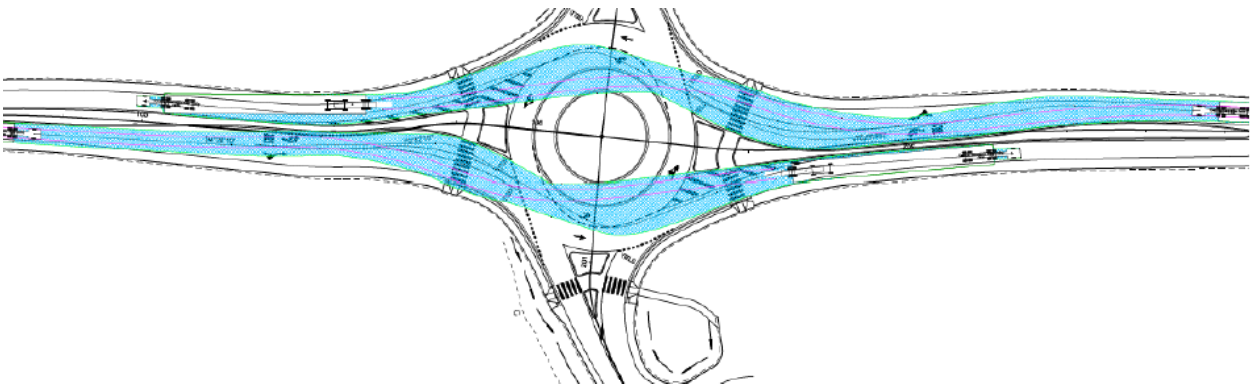

Figure 13 - 60 Metre Long Truck Movement (BC MoTI Schematic)

Figure 14 - Empty Oversize Dual Trailer Truck (BC MoTI Photo)

Protected T Intersections

The Ministry has developed a guideline for implementation of a Protected-T Intersection. Protected-T Intersections are used in place of regular T-intersections in certain circumstances on BC Highways. The Protected-T intersection design allows drivers to eliminate the need to look for oncoming traffic in the direction of travel that the turning vehicle wishes to turn. This simplifies the decision making process for the driver. An appropriate acceleration lane and taper are then provided for the turning driver to provide sufficient length merging into the through lane.

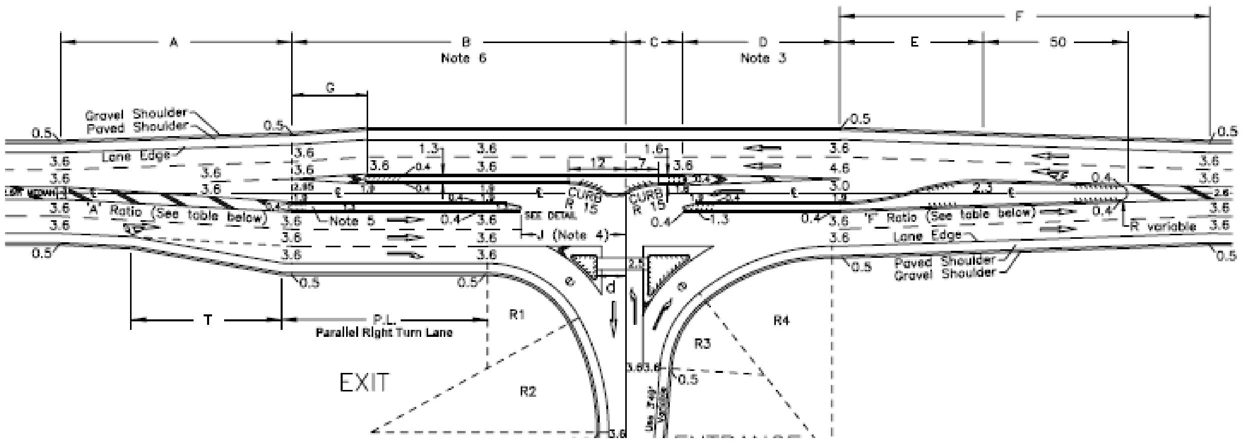

Figure 15 - Protected T Intersection Excerpt from BC Supplement to TAC

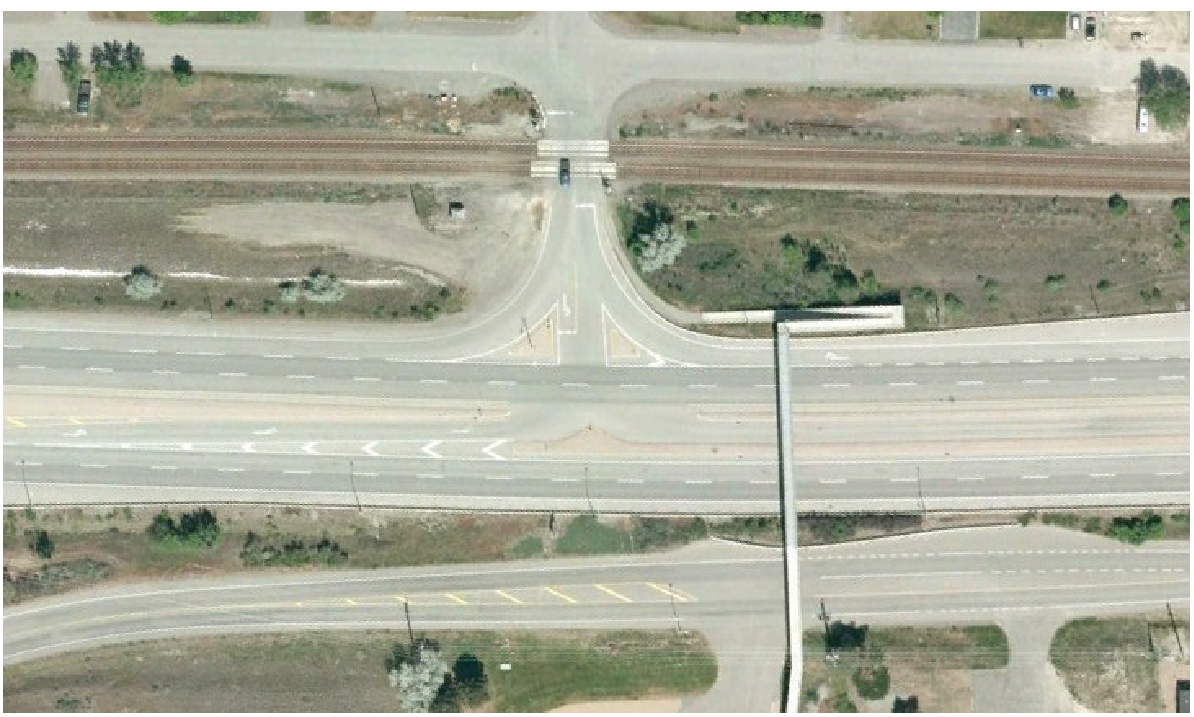

Figure 16 - Pat Road and Highway 1 in Kamloops (Google Earth Image)

Project Delivery - Public Private Partnerships

British Columbia is one of the leading authorities on Public Private Partnerships (P3), and regularly delivers large infrastructure projects through this mechanism. The province has created its own Crown Corporation called Partnerships BC to facilitate the majority of P3 projects by acting as the procurement manager, or as an advisor to the public entity seeking the procurement through a P3 process [(15)]. Essentially, P3's transfer risk of construction to the Contractor, and ties payment to the performance of the infrastructure and construction. BC has procured several large transportation projects through this mechanism including the Sea to Sky Highway project, South Fraser Perimeter Road Project, and the Port Mann Highway 1 Project.

Nearing substantial completion at the end of 2014, the Port Mann Highway 1 Project involved upgrading 37 kilometres of highway, including replacing nine interchanges and replacing the existing five-lane Port Mann Bridge with a new 10-lane structure. This stretch of highway is the main corridor connecting Vancouver to the Fraser Valley. During the proposal stage of this mega project, a reference concept was provided to proponents that gave parameters for performance and laning. Proponents were then free to modify, improve, and innovate upon the reference concepts and designs in their proposal bid.

Figure 17 - Port Mann Highway 1 Project (BC MoTI Photo)

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