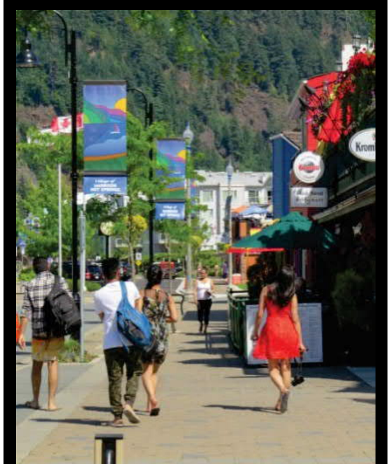
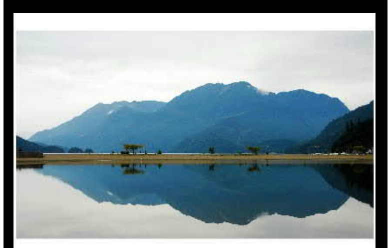
Village of Harrison Hot Springs

ROAD, BRIDGE, AND ACTIVE TRANSPORTATION MASTER PLAN





CTQ

ENGINEERING PLANNING URBAN DESIGN

JULY 2019

HARRISON HOT SPRINGS

Naturally Refreshed

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

STATEMENT OF QUALIFICATIONS & LIMITATIONS

The Road and Bridge Master Plan Report (the "Report") contained herein has been prepared by CTQ Consultants Ltd. (CTQ) for the benefit of The Village of Harrison Hot Springs (VHHS) in accordance with the agreement between CTQ and VHHS, including the scope of work detailed therein (the "Agreement").

The information used to prepare the decision matrix, work plan, recommendations, and this Report was obtained from record information provided by VHHS, site reconnaissance by CTQ, CWMM, and Star Tech.

The Report has been prepared to assist the VHHS to understand the existing condition of the overall transportation system and to plan for future growth within the community. Possible growth patterns were provided to CTQ by VHHS.

The information contained herein is to be read as a whole and such sections should not be extracted and read out of context.

As the Report is based on possible future population and development growth patterns, trigger points for capital and operational improvements have been identified and should be updated periodically to reflect actual conditions.

Unless expressly stated to the contrary in the Report or the Agreement, CTQ:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared
- shall not be responsible for any inaccuracies contained in information that was provided to CTQ by other firms or agencies
- agrees that the Report represents professional judgment for the specific purpose described in the Report and the Agreement, but CTQ makes no other representations with respect to the Report or any part thereof

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed, in writing, by CTQ and VHHS
- as required by law
- for use by governmental reviewing agencies

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report.

LETTER OF SUBMISSION

Project No.: 12004-37

26 July 2019

Village of Harrison Hot Springs
495 Hot Springs Road
Harrison Hot Springs, BC V0M 1K0

Attention: Mr. Troy Davis, Infrastructure Manager

Dear Troy:

Re: Village of Harrison Hot Springs Road and Bridge Master Plan

Please find attached the Road and Bridge Master Plan. Do not hesitate to contact the undersigned at any time regarding this report.

Yours truly,
CTQ CONSULTANTS LTD.
Per:

Matt Cameron P.Eng., FEC
Managing Partner
mcameron@ctqconsultants.ca

SIGNATURES

Report Prepared By:	**Report Reviewed By:**
Justin VannPashak, E.I.T. Municipal Projects Engineer CTQ Consultants Ltd.	Dave Cullen, P. Eng. Transportation Engineer/Principal CTQ Consultants Ltd.

ACKNOWLEDGEMENTS

As a Resort Municipality, VHHS faces the difficulty of constructing and maintaining infrastructure sufficient to serve a large number of day trip and short-term visitors sustained by a relatively small tax base. Funding provided through UBCM for the completion of the Transportation Utility Master Plan is gratefully acknowledged.

The VHHS operations personnel were invaluable in finding archived data, responding to inquiries, and providing context. Thanks to:

Troy Davis, Infrastructure Manager
Tyler Simmonds, Chief Utilities Operator
Todd Kafi, Public Works Foreman

This report could not have been completed without the contributions of the CWMM Consulting Engineers Ltd. team, who provided the structural expertise required to assess the condition of the VHHS bridges and make recommendations for the maintenance of these assets. Thanks to:

Don Bergman, P. Eng.
Peter Ackerman, P. Eng.

STATEMENT OF QUALIFICATIONS & LIMITATIONS

The Road and Bridge Master Plan Report (the "Report") contained herein has been prepared by CTQ Consultants Ltd. (CTQ) for the benefit of The Village of Harrison Hot Springs (VHHS) in accordance with the agreement between CTQ and VHHS, including the scope of work detailed therein (the "Agreement").

The information used to prepare the decision matrix, work plan, recommendations, and this Report was obtained from record information provided by VHHS, site reconnaissance by CTQ, CWMM, and Star Tech.

The Report has been prepared to assist the VHHS to understand the existing condition of the overall transportation system and to plan for future growth within the community. Possible growth patterns were provided to CTQ by VHHS.

The information contained herein is to be read as a whole and such sections should not be extracted and read out of context.

As the Report is based on possible future population and development growth patterns, trigger points for capital and operational improvements have been identified and should be updated periodically to reflect actual conditions.

Unless expressly stated to the contrary in the Report or the Agreement, CTQ:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared
- shall not be responsible for any inaccuracies contained in information that was provided to CTQ by other firms or agencies
- agrees that the Report represents professional judgment for the specific purpose described in the Report and the Agreement, but CTQ makes no other representations with respect to the Report or any part thereof

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed, in writing, by CTQ and VHHS
- as required by law
- for use by governmental reviewing agencies

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report.

LETTER OF SUBMISSION

Project No.: 12004-37

26 July 2019

Village of Harrison Hot Springs
495 Hot Springs Road
Harrison Hot Springs, BC V0M 1K0

Attention: Mr. Troy Davis, Infrastructure Manager

Dear Troy:

Re: Village of Harrison Hot Springs Road and Bridge Master Plan

Please find attached the Road and Bridge Master Plan. Do not hesitate to contact the undersigned at any time regarding this report.

Yours truly,
CTQ CONSULTANTS LTD.
Per:

Matt Cameron P.Eng., FEC
Managing Partner
mcameron@ctqconsultants.ca

SIGNATURES

Report Prepared By:

Justin VannPashak, E.I.T.
Municipal Projects Engineer
CTQ Consultants Ltd.

Report Reviewed By:

Dave Cullen, P. Eng.
Transportation Engineer/Principal
CTQ Consultants Ltd.

ACKNOWLEDGEMENTS

As a Resort Municipality, VHHS faces the difficulty of constructing and maintaining infrastructure sufficient to serve a large number of day trip and short-term visitors sustained by a relatively small tax base. Funding provided through UBCM for the completion of the Transportation Utility Master Plan is gratefully acknowledged.

The VHHS operations personnel were invaluable in finding archived data, responding to inquiries, and providing context. Thanks to:

Troy Davis, Infrastructure Manager
Tyler Simmonds, Chief Utilities Operator
Todd Kafi, Public Works Foreman

This report could not have been completed without the contributions of the CWMM Consulting Engineers Ltd. team, who provided the structural expertise required to assess the condition of the VHHS bridges and make recommendations for the maintenance of these assets. Thanks to:

Don Bergman, P. Eng.
Peter Ackerman, P. Eng.

EXECUTIVE SUMMARY

The Harrison Hot Springs transportation network moves people and goods to and through the Village of Harrison Hot Springs (VHHS). Over the past decade, upgrades have been undertaken to ensure the efficient movement of residents and visitors continues to be available for a growing population. The system currently includes an arterial highway right-of-way under the jurisdiction of MoTI and a network of collectors, local roads, and lanes.

The transportation network infrastructure is approximately 12.3 km total in length including 6 bridges; however, there is very little active transportation and micro-mobility infrastructure other than a discontinuous gravel path system which includes 3 pedestrian bridges and an informal single-track trail system.

VHHS recognizes the infrastructure is not complete, and commissioned CTQ Consultants Ltd. (CTQ) to generate a comprehensive Road and Bridge Master Plan to address current issues and to provide a roadmap for the integrated transportation network, including active transportation, over the coming years.

The purpose of any master plan is to establish a strategy for providing the required levels of service to the taxpayers of the community both now and into the future. It is very difficult to forecast future needs in a resort-based community like VHHS as the permanent population is substantially less that the Visitor population that is seasonal. As such CTQ reviewed several options for projections and based the report on lifecycle project events rather than timelines based on traditional population growth models. The population of the VHHS is not of sufficient size to use a capacity or Level of Service (LOS) based analysis. Roadway conditions will govern over capacity in this network since congestion is rare and confined to the highway right-of-ways under MoTI jurisdiction when large volumes of tourists enter the Village.

The existing system infrastructure was reviewed, input into a GIS database, and work plans were generated to accommodate various budgetary scenarios using historical data and field inspections. Scenarios were created to determine necessary improvements as the population changes and budgets change. The impact of adding all the existing lots and then combining the various growth scenarios was investigated and found to have negligible effect on system-wide LOS.

Active Transportation and micro-mobility recommendations focused on best practices associated with second-generation micro-mobility infrastructure.

Since the improvement plan is lifecycle based as opposed to capacity driven, the projects identified by the Road and Bridge Master Plan were itemized as Capital Projects. These projects were reviewed based on a “Triple Bottom Line” (Social, Environmental and Economic) assessment. As there is a function development plays in the increased demand on the infrastructure there could be a portion of the improvements attributed to the DCC program.

This Road and Bridge Master Plan is to be read in conjunction with the Figures and Tables found in the appendices and includes recommendations based on CTQ’s knowledge and expertise in transportation systems. It is very much a living document and needs to be revisited from time to time to confirm the outcomes, based on the increased future demands.

ABBREVIATIONS

AV	Autonomous Vehicle
DTAM	Daily Trips by Active Mode
FVRD	Fraser Valley Regional District
HRS	Harrison Hot Springs Resort & Spa
HSR	Hot Springs Road. Under MoTI jurisdiction
ITN	Integrate Transportation Network
LOS	Level of Service
LAE	Lillooet Avenue East. The portion of Lillooet Avenue under MoTI jurisdiction
MMCD	Master Municipal Construction Documents. Documents created by MMCD Association - a non-profit society supported by BC municipalities to create improved construction documents for roads, sidewalks, sewers, transportation, traffic signals and street lighting
MoTI	Ministry of Transportation and Infrastructure
OCP	Village of Harrison Hot Springs Official Community Plan. Bylaw 864 March 2007
VHHS	Village of Harrison Hot Springs

1. Introduction

1.1 Transportation System Background

A reliable and efficient transportation system is essential to the environmental, economic and social wellbeing of any community. The function of a safe and dependable transportation system extends beyond the significant social requirements of basic health and wealth. A public transportation system also contributes to the local economy by providing capacity for commercial enterprises, and, through efficiency, aesthetic design, and sustainability, enhances the environment surrounding businesses, homes, and public spaces. In doing all of this, the system must also be financially sustainable while meeting stringent government standards.

The Harrison Hot Springs Integrated Transportation Network (ITN) supplies transportation for the VHHS. Over the past decade, upgrades have been undertaken to ensure safe transportation continues to be available for a growing population of residents and visitors. The system now includes traffic calming, intersection upgrades, and a modernized Subdivision and Development Servicing Bylaw that specifies updated road cross-sections (pending approval).

VHHS is a destination community with a small full-time population. During the summer months, demands on infrastructure increase significantly with seasonal residents and tourist visits. This fluctuation puts immense pressure on the transportation network. A sharp increase or decrease in the number of overnight tourist visits, could greatly impact the system requirements.

VHHS recognizes the challenges ahead, and commissioned CTQ Consultants to generate a comprehensive Road and Bridge Master Plan to review the system in its entirety and provide a roadmap for the ITN over the coming years.

1.2 Purpose of this Master Plan

The purpose of any master plan is to establish a comprehensive strategy for the proposed infrastructure. In the absence of a crystal ball, certain assumptions must be made to predict the future so that the infrastructure is able to respond to the actual needs of the community. This includes long term planning, required levels of service and identifying the most cost-effective means of delivering the current and future service.

The creation of this Road and Bridge Master Plan is the first step towards cohesive, long term planning for VHHS utilities. It is important that the transportation network not be looked at in isolation, that master planning documents for sanitary sewer, drainage, and water be incorporated as they become available. It is recommended that an overall Asset Management Program be developed for VHHS. The objectives of this Plan are to:

- Review existing and forecast future transportation demands
- Identify threats to transportation network efficiency and safety
- Review existing infrastructure and identify current deficiencies
- Recommend infrastructure improvements to meet future demand and renew infrastructure at the end of its lifecycle
- Estimate costs of future works

2. Existing System (2019)

2.1 Process Overview

The Village has a total of 12.3 km of paved roads, with the Ministry controlled roadways totaling an additional 4.6 km. The Village also has bridges and culverts as part of the municipal infrastructure.

The Existing Transportation Network is illustrated on **FIGURE 1**.

1. Vehicles enter and exit the VHHS system through a Hot Springs Road (HSR, Highway 9), an arterial roadway under Ministry of Transportation and Infrastructure (MoTI) jurisdiction which extends just over one kilometer north into the VHHS where it becomes Lillooet Avenue and moves traffic northeast of the Village.
2. Two Collector class roads diffuse traffic further, McPherson Road brings drivers to the McCombs Road/Eagle Drive Collector.
3. A network of local roads and lanes connects the remaining lots to the transportation network.

The **TABLE 2.1** lists the length of each roadway in the network.

TABLE 2.1 Road Segment Lengths

STREETNAME	ROADCLASS	LENGTH (m)
Alder Ave	LOCAL	202.8
Angus Pl	LOCAL	68.64
Balsam Ave (Chestnut to Clover)	LOCAL	134.38
Balsam Ave (Clover to Miami River)	LOCAL	135.05
Balsam Ave (Hot Springs to Chestnut)	LOCAL	65.25
Bear Ave	LOCAL	83.34
Cedar Ave (Hot Springs to Maple)	LOCAL	183.81
Cedar Ave (West of Hot Springs)	LOCAL	232.05
Chehalis St	LOCAL	73.48
Chestnut Ave	LOCAL	500.52
Clover Pl	LOCAL	68.03
Cottonwood Ave	LOCAL	320.93
Cottonwood Pl	LOCAL	69.56
Diamond St	LOCAL	156.79
Driftwood Ave	LOCAL	300.3
Eagle St (Bear to Echo)	COLLECTOR	122.46
Eagle St (Cottonwood to Naismith)	COLLECTOR	84.85

Eagle St (Driftwood to Cottonwood)	COLLECTOR	85.42
Eagle St (Echo to Naismith)	COLLECTOR	111.27
Eagle St (Lillooet to Bear)	COLLECTOR	86.26
Eagle St (Miami River to Naismith)	COLLECTOR	147.54
Eagle St (Naismith to Driftwood)	COLLECTOR	105.83
Echo Ave (East of Eagle)	LOCAL	348.71
Echo Ave (West of Eagle)	LOCAL	107.84
Emerald Ave	LOCAL	196.96
Esplanade Ave (Chehalis to Spruce)	COLLECTOR	227.2
Esplanade Ave (Hot Springs to Maple)	COLLECTOR	175.44
Esplanade Ave (Maple to Chehalis)	COLLECTOR	225.93
Esplanade Ave (Saint Alice to Hot Springs)	LOCAL	191.07
Fern Pl	LOCAL	67.94
Hadway Dr N	LOCAL	121.54
Hadway Dr S	LOCAL	49.57
Hope Pl	LOCAL	159.51
Hot Springs Rd (Alder to Pine)	ARTERIAL	301.47
Hot Springs Rd (Balsam to Walnut)	ARTERIAL	260.9
Hot Springs Rd (Cedar to Lillooet)	ARTERIAL	79.42
Hot Springs Rd (Emerald to Alder)	ARTERIAL	369.06
Hot Springs Rd (Lillooet to Esplanade)	COLLECTOR	94.09
Hot Springs Rd (McPherson to Ramona)	ARTERIAL	714.55
Hot Springs Rd (Miami River to Cedar)	ARTERIAL	183.63
Hot Springs Rd (Pine to Balsam)	ARTERIAL	330.69
Hot Springs Rd (Ramona to Emerald)	ARTERIAL	171.8
Hot Springs Rd (South of McPherson)	ARTERIAL	92.54
Hot Springs Rd (Walnut to Miami River)	ARTERIAL	161.99
Juniper Pl	LOCAL	56.72
Lakberg Cres	LOCAL	58.9
Lillooet Ave (East of Chehalis)	ARTERIAL	547.43
Lillooet Ave (Hot Springs to Maple)	ARTERIAL	177.36
Lillooet Ave (Maple to Chehalis)	ARTERIAL	224.16
Lillooet Ave (Saint Alice to Hot Springs)	LOCAL	204.86
Maple St (Cedar to Lillooet)	LOCAL	72.81
Maple St (Lillooet to Esplanade)	LOCAL	68.95
McCombs Dr (Alder to Pine)	COLLECTOR	301.25
McCombs Dr (Chestnut to Miami River Dr)	COLLECTOR	113.43
McCombs Dr (Emerald to Alder)	COLLECTOR	363.81
McCombs Dr (Hadway S to Emerald)	COLLECTOR	197.8
McCombs Dr (McPherson to Hadway S)	COLLECTOR	652.66
McCombs Dr (Pine to Chestnut)	COLLECTOR	147.91
McPherson Rd (to Eagle	COLLECTOR	400.09

Miami River Dr (Balsam to Juniper)	LOCAL	90.76
Miami River Dr (Fern to Balsam)	LOCAL	110.7
Miami River Dr (Hot Springs to Poplar)	LOCAL	104.28
Miami River Dr (Juniper to McCombs)	LOCAL	93.34
Miami River Dr (Loop)	LOCAL	128.89
Miami River Dr (Poplar to Walnut)	LOCAL	536.81
Miami River Dr (Walnut to Fern)	LOCAL	92.8
Mount St	LOCAL	110.47
Myng Cres (Hadway S to Hadway N)	LOCAL	57.38
Myng Cres (Hope to Hadway S)	LOCAL	202.82
Myng Cres (North of Hadway N)	LOCAL	44.8
Naismith Ave (East of Eagle)	LOCAL	337.91
Naismith Ave (West of Eagle)	LOCAL	430.12
Pine Ave (Hot Springs to Lakberg)	LOCAL	258.61
Pine Ave (Lakberg to Eagle)	LOCAL	77.48
Poplar St	LOCAL	198.81
Ramona Pl (Hot Springs to Hadway)	LOCAL	80.41
Ramona Pl (North of Hadway)	LOCAL	100.03
Rockwell	ARTERIAL	1100
Schooner Pl	LOCAL	228.13
Spruce St (Esplanade to Lillooet)	COLLECTOR	73.36
Spruce St (Lillooet to Echo)	LOCAL	144.32
St Alice St N	LOCAL	108.16
St Alice St S	LOCAL	64.32
Walnut Ave (Hot Springs to Poplar)	LOCAL	115.45
Walnut Ave (Poplar to Eagle)	LOCAL	178.01

2.2 System Capacity for Various Modes

Infrastructure that prioritizes automobiles dominates the transportation network. All modes share space that is designed for the movement of automobiles on these routes.

The Active Transportation network includes recreational paths, with a gravel multi-use trail on the Miami River Banks and another along the Harrison Lakefront. Several informal single-track trails meander through the forest in the East Sector and West of HSR. These trails are also illustrated on **FIGURE 3**.

There is no electrified micromobility infrastructure, although many of these modes can share space dedicated to automobiles due to their mechanized acceleration and higher travel speeds. Electrical Charging stations are located along Esplanade Avenue and the tourist Information Parking Lot.

2.3 Permeability and Connectivity

There are 754 properties in VHHS serviced by the VHHS Integrated Transportation Network. Although the network has a high degree of Permeability and Connectivity for automobiles, the active transportation network is not well-connected or permeable. **FIGURE 1** illustrates the transportation network for all VHHS properties.

2.4 System Age

The Village's transportation network consists of roadways of different ages. Of the entire integrated road network owned by the Village, 21% of roads will need major maintenance in the next 10 years, another 63% will need preservation in the following 10 years. Much of the MoTI owned roadways are nearing the end of their lifecycles as well and will need to be rehabilitated. The mean surface layer age of the Village's transportation infrastructure is 12 years old; the median age is 15 years. The mean base layer age of the Village's transportation infrastructure is 37 years old; the median age is 36 years. The overall system age is neither young, nor old suggesting that maintenance investment can be distributed evenly.

2.5 Bridges

The Village owns two highway bridges that cross the Miami River at two locations along McCombs Drive. The Village also owns and maintains two pedestrian bridges that cross the Miami River. Along HSR, the MoTI owns and maintains two more bridges.

Pedestrian Bridge 1 is a single 20m span bridge with a 1.8m wide pathway that crosses the Miami River. The bridge consists of two aluminum trusses spanning the full length. Each aluminum truss also serves as a 1.1m high guardrail. The truss consists of 100x100mm square tube webs, a 150Vx100Hmm rectangular tube (orientated on edge) bottom chord, and a 100Vx150Hmm rectangular tube (flat oriented) top chord. The pathway consists of 300mm wide x 50mm deep perforated C-shaped panels tight to each other and spanning in the longitudinal direction over top of 100x100mm rectangular tube floor beams spaced at 600mm on centre and spanning between trusses. Each end of the aluminum trusses bears on a bearing pad which in turn bears on top of a concrete abutment. The concrete abutment appears to be a large concrete block that extends below the grade and that matches the width of the bridge superstructure. Wooden guard rail members are fastened with screws to the aluminum truss webs and top chord.

Pedestrian Bridge 2 is 40m long, three span bridge with a 1.8m wide pathway that crosses the Miami River. The end spans are both 9m long with a 22m intermediate span. The superstructure frame and abutments are nearly identical to the pedestrian bridge #1 with the exception of intermediate bearing supports at the two piers. Each pier consists of a built-up steel plate cap beam spanning between two 250mm diameter steel columns which in turn are supported on a combined concrete footing. A traction mat has been fastened to the bridge pathway along the entire length of the bridge.

The McCombs Drive North Bridge is a 10.0m long x 9.6m wide single span bridge that carries two vehicle lanes and one sidewalk over the Miami River). The bridge superstructure consists of 8-400mm deep pre-cast concrete stringers supported at each end by a 600mm deep cast-in-place concrete cap beam which is in turn supported on 4-610mm diameter steel pipe piles. The bridge deck consists of an asphalt wearing surface placed on top of the stringers over the extent of the road lanes and a jointed concrete layer at the sidewalk. A concrete curb divides the road section from the sidewalk. This bridge was constructed in 2011 over an existing timber bridge structure which still remains in place to this date with the timber bridge being relied upon to retain backfill materials. An approximate 150mm gap exists between the underside of the new concrete stringers and top surface of the existing timber superstructure.

The superstructure of the existing timber bridge consists of cross ties supported on stringers which are spanning between abutments. The abutments consist of a cap beam supported on timber piles. Ballast logs are located behind the piles and retain backfill materials. The wingwalls consist of timber piles and ballast logs. Timber piles at the abutment are treated while the timber piles at the wingwalls are untreated.

The barriers along each side of the bridge consist of a three beam with a steel pipe bicycle guardrail mounted on top. The total height of these barriers is 1.3m. The barriers along the edges of the approaches consist of Jersey style concrete barriers with the barriers along the south/west bridge approach being mounted with a steel pipe bicycle guardrail.

The McCombs Drive South Bridge is a skewed 10.0m long x 9.6m wide single span bridge that carries two vehicle lanes and one sidewalk over the Miami River and is very similar to the McCombs Road North Bridge. The bridge consists of 8-400mm deep pre-cast concrete stringers supported at each end by a 600mm deep cast-in-place concrete cap beam which is in turn supported on 4-610mm diameter steel pipe piles. The bridge deck consists of an asphalt wearing surface placed on top of the stringers over the extent of the road lanes and a jointed concrete layer at the sidewalk. A concrete curb divides the road section from the sidewalk. This bridge was constructed in 2011 over an existing timber bridge that remains in place to this date with the timber bridge being relied upon to retain backfill materials. An approximate 150mm gap exists between the undersides of the new concrete stringers and top surface of the existing timber superstructure.

The superstructure of the existing timber bridge consists of cross ties supported on stringers which are spanning between abutments. The abutments consist of a cap beam supported on timber piles. Ballast boards are fastened to the backside of the piles and retain backfill materials. The wingwalls consist of timber piles and ballast boards.

The barriers along each side of the bridge consist of a three beam with a steel pipe bicycle guardrail mounted on top. The total height of these barriers is 1.3m. The barriers along the edges of the approaches consist of Jersey style concrete barriers. A chain link fence is located on the north/east bridge approach along the sidewalk.

A Note Regarding MoTI Infrastructure

Hot Springs Road and Lillooet Avenue East are not owned by the VHHS. They are under the jurisdiction of MoTI and designated as Highway 9. As the major transportation route to and through the Village, these components are of vital importance to the ITN and this Road and Bridge Master Plan.

On December 13, 2018 Village, CTQ, and MoTI Staff convened to discuss MoTI infrastructure in the Village. Hot Springs Road and Lillooet Avenue are MoTI assets and have been identified as infrastructure needing improvement due to cross-section inconsistencies, deteriorating road structures, and safety. It was vital to have MoTI engaged early in the process of developing the Village's framework for future transportation investment. MoTI representatives demonstrated a willingness to consider proposed cross-sections for these roads. After the meeting, MoTI representatives sent example plans from a similar revitalization project in Mission, BC to CTQ. CTQ has prepared drawings for MoTI review, comment, and future acceptance. The drawings will propose solutions intended to increase public safety, asset value, and parking in a more consistent, urban form.

Discussions are underway for the urbanization of these roads that combine urban and rural road cross-sections. Drainage systems used are inconsistent and do not conform to current best practices for drainage. Recently updated segments of HSR use catch basins with standard curb and gutter edge treatments while older segments use ditches to convey stormwater. These roads do not include active transportation infrastructure and most crossings do not conform to best practices for crossing as identified in the Pedestrian Crossing Control Manual for British Columbia.

At the November 21, 2019 Committee of the Whole Meeting the following motions were passed:

- That Council accept Lillooet Ave design profile Option 1 for inclusion in the Active Transportation Master Plan;
- That Council included both Option 1 and Option 2 design proposals in the Active Transportation Plan to be referenced as required along different sections of Hot Springs Road.

The design proposals are included in Appendix E – Proposed MoTI Cross Sections.

3. Integrated Transportation Network: Automobility, Micromobility, and Active Transportation

The Village of Harrison is ideally situated on the shores of Harrison Lake with access to the eponymous and famous Hot Springs. The Village is the destination at the apparent end of BC Highway 9. It is a community that demonstrates compact land use, where amenities are easily accessible from any part of the Village using any mode. It also experiences a moderate climate.

The combination of these characteristics perfectly positions the Village to sustain a robust, connected, and permeable transportation network. A large proportion of human-powered movement is sustainable in the Village which is fortunate that only minor changes to existing infrastructure are needed to multiply the people-moving performance of its existing transportation network.

Today's transportation networks must serve some traditional transportation modes like driving, walking, and cycling while also accommodating emerging technologies like e-bikes, e-scooters, e-skateboards, narrow track electric vehicles, and "hover boards." This is what is meant by an integrated transportation network; not only does an integrated transportation network accommodate as many of today's transportation modes as possible, but a good integrated transportation system is also notably adaptable to new technologies we may not consider today but will emerge in the near future. This is applicable to municipalities of all sizes.

3.1 Automobility

In the Village of Harrison Hot Springs, the transportation network has sufficient capacity for the volume of automobiles that use it. With nearly constant free flow conditions in the VHHS, a high Level of Service (LOS), capacity is not a system-wide deficiency. Commuter traffic is also very low. The evolution of automobility in the near future will consist of the automation of driving. Level 2 AVs are already on the road along with Level 3 AVs in some jurisdictions and many experts predict further automation soon. Automation will require some adaptation of the Village's automobile-focused infrastructure.

The potential to have the full spectrum (Level 0 to Level 5) of autonomous vehicles sharing the road further increases the complexity facing urban transportation networks. Level 5 AV's may eliminate or dramatically reduce parking needs and will certainly reduce car ownership.

Recommendations

- Update this plan in 2022 to adapt to changes in Autonomous Vehicle technology and best practices for design.

3.2 Micromobility

Micromobility refers to any mode of transportation with a small footprint that typically moves up to two people. Electrified micromobility in the form of e-bikes, e-skateboards, and e-scooters presents a complex challenge since these vehicles often travel faster than human-powered bicycles and pedestrians, but slower than automobiles. Electrified micro-mobility is a growing trend. Unfortunately, there is not much available data regarding just how fast it is growing. In most cases, despite the faster speeds, electrified micromobility can share space with non-mechanized bicycles and, given enough space and appropriate engineering, can share space with pedestrians. Second Generation active transportation infrastructure can accommodate electrified micromobility; therefore, the terms active transportation and micromobility are practically synonymous.

An interesting aspect of the growing electrified micromobility trend is the way that the ages split. Baby Boomers, those born between 1946 and 1964, make up the majority of e-bike users in Canada. When surveyed, baby boomer respondents identified the following motivations:

- 35% for recreation and exercise;
- 20% for commuting; and
- 9% for trail/mountain biking.

Based both on the demographics and the recreational motivation, the VHHS should expect to see growing numbers of electrified modes, particularly e-bikes, on it's streets in the near future.

3.3 Active Transportation

Canadian municipalities are moving away from first-generation active transportation infrastructure and towards more complete solutions. First generation active transportation infrastructure was built for either recreational users on separate trails or very experienced vehicular cyclists in close proximity to automobiles. First-generation infrastructure includes shoulder enhancements (paint-line bike lanes) and separated multi-use trails. Technology and shifting demographics are driving change in the way active transportation infrastructure is integrated into urban and suburban streetscapes.

Active transportation is about space efficiency, moving the most people using the least land. When engineered properly, this fundamental and natural form of transportation is comfortable, safe, convenient, accessible, and easily shared with mechanized modes of all sizes. Micro-mobility shares the same space-saving goals offering liberated path choice, range, and speeds to users. Since electrified micro-mobility modes are currently restricted and regulated to move at the same speed and use the same space as cyclists, the use of the term micro-mobility here encompasses all active transportation modes as well as all electrified small vehicles like e-bikes, e-scooters, e-skateboards, hoverboards, and segways. Each micro-mobility mode offers varying degrees of activity to the person who chooses it, from fully human-powered or motor-assisted to fully motor-powered.

Prioritizing micro-mobility has tremendous potential to lower noise, light, and air pollution while promoting more efficient land use. Walking, cycling, and electrified micro-mobility decreases resource-intensive and land-intensive car traffic, reduces taxpayer burden, helps alleviate parking demand, saves energy, uses land and road space efficiently, provides mobility, saves money, improves health and fitness, and improves accessibility to people of all abilities. Finally, these modes are quick, simple, and fun, but only if the network is designed properly with widespread connectivity and permeability that gets people to where they want to go.

Recommendations

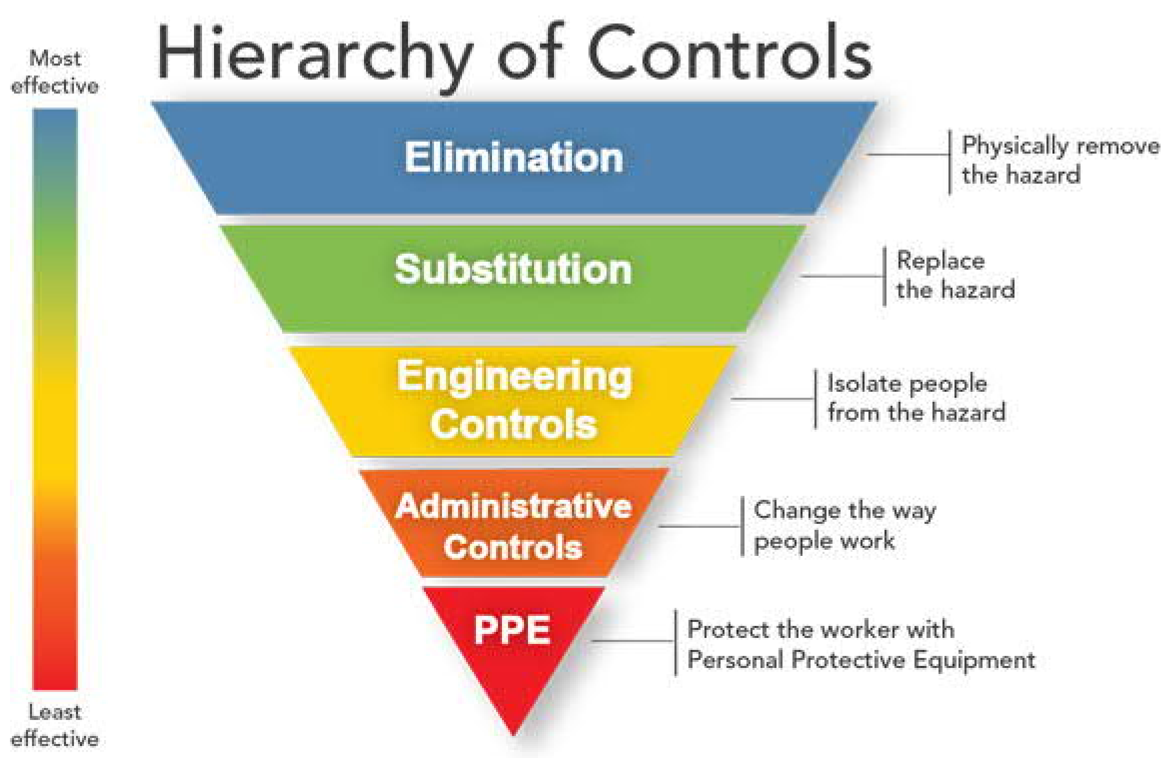
- Transportation networks should be built under the principles of 8 – 80 Cities. Cities that efficiently, easily, and safely move 8-year-olds and 80-year-olds are successful for everyone, encourage ageing-in-place, and attract families. These networks are safe and enjoyable for all, fostering widespread prosperity.
- Revisit the data regarding electrified micro-mobility in 2022.
- Focus on active transportation solutions that also accommodate electrified micro-mobility, they share many of the same constraints. This includes Complete Streets and Shared Streets.

3.4 Threats to Transportation Quality

3.4.1 Safety

Safety remains the major threat to transportation networks. Transportation engineers and planners use the "Hierarchy of Controls" when solving safety problems in the transportation network. The hierarchy separates different safety strategies on the basis of approach and effectiveness.

The Hierarchy of Controls for Safety



Many municipalities in the past focused on the types of controls with the lowest return on investment, Administrative Controls (Enforcement) and Personal Protective Equipment (PPE). Good money goes after bad and measurable improvements in safety are negligible. PPE puts the burden of safety on the user in an attempt to absolve engineers and planners from responsibility for the safety of those who use the infrastructure they design.

While many Administrative and PPE solutions have merit and deserve consideration at the individual, micro level, they should not be relied upon by administrators, planners, and engineers that should take a systemic, macro approach to transportation. Administrative controls are a failure of engineering controls, the space and environment have been incorrectly designed for their intended use. Relying on PPE is negligent design and planning of the transportation network.

The risk posed to human life on streets in urban contexts are well-documented, but elimination or substitution are only practicable in the rarest of situations. The initial costs are simply too high, the change in paradigm too drastic. It is for this reason that we recommend focused investment in Engineering Control solutions. We recommend that the Village commit to the design of transportation elements that isolate people from hazards and consider behavioural science in the application of transportation solutions. Many forms that subscribe to this strategy are discussed below.

Recommendations

- Use the Hierarchy of Controls in solving transportation safety problems
- Prioritize Engineering Controls. Substitution and Elimination are too difficult and costly; Administrative Controls and PPE are too ineffective.
- Momentum based design, if the momentum difference between two mods is over a threshold the two modes should be separated.
- Decrease speeds and volumes.
- Separation is essential for high level of subjective safety.
- Protected or separate cycle paths significantly increase levels of subjective safety, but must be built to a suitable standard, a minimum 2.5m width is recommended for one-way lanes, 4m width is recommended for two-way lanes.
- Paths for pedestrians are separate from faster modes or pedestrians are encouraged to face oncoming cyclists, meaning pedestrians walk on the left side of the multi-use path. This applies the same principles as when pedestrians walk on highways without sidewalks.
- No blind corners
- Well-lit, human scale lighting
- Wide cycle paths
- Clear zone between path and nearest visual obstruction
- Clear, litter free, and graffiti-free
- Good maintenance of nearby landscaping
- Adopt Vision Zero

3.4.2 A Fragmented Demand

The challenges of balancing the few modes of urban transportation in the 20th Century are nothing compared to the complexity of managing the further fragmentation of urban mode-shares today and into the near future. Electrified micromobility in the form of e-bikes, e-skateboards, and e-scooters presents a complex challenge since these vehicles often travel faster than human-powered bicycles and pedestrians, but slower than automobiles. These technologies are bringing more ages into active transportation than ever before. The potential to have the full spectrum (Level 0 to Level 5) of autonomous vehicles sharing the road further increases the complexity facing urban transportation networks. Adding even more traffic signs and pavement markings is unfeasible; more robust solutions are needed.

Recommendation

- Network must be robust and resilient in the face of shifting patterns.
- Complete solutions are necessary, segments of the network need to accommodate a wide range of modes, select Complete Street and Share Street designs whenever possible.

3.4.3 Land Use

The primary challenge of any integrated land use and transportation plan is to balance the livability of the local community while accommodating transportation demand. Livability is focused on balancing vehicular service requirements with local business, neighbourhood and pedestrian needs. There is a fundamental interrelationship between land use and transportation planning. There are three major factors that shape travel activity:

- Transportation demand—the characteristics, the needs, and the determinants of travel behaviour and desires of individuals;
- Transportation supply—the infrastructure, vehicles, and services that people use to travel; and
- Land use—the location of homes, workplaces, schools, and other places that people travel to and from.

These three components are tightly linked. Any change in one can lead to a change in the others. In combination, these components determine whether, why, when, where and how people make trips.

Recommendation

- Ensure VHHS is identified as a stakeholder for projects and activities within the FVRD transportation network.

3.4.4 Maintenance (Snow Clearing, Sweeping)

As protected active transportation infrastructure becomes the new standard, municipalities face new challenges in maintaining these spaces. Snow clearing and debris removal in these spaces is difficult using older road clearing equipment. New equipment will be necessary to remove snow and debris in protected active transportation infrastructure.

Recommendation

- Consider purchasing sweeping and clearing equipment that can be used on protected active transportation infrastructure.

4. Transportation Capital Plan – Setting Priorities

The most quantifiable metric of transportation infrastructure performance is infrastructure age and observed condition. This is the metric used to set the project plan baseline. Using a customized Microsoft Excel™ spreadsheet, current condition, drainage, traffic volume, budget, and infrastructure age data were input and used to generate a Dynamic Priority Matrix.

The Dynamic Priority Matrix was based on VHHS asset management data provided by VHHS operations personnel. CTQ allocated two experienced staff, for a period of approximately 3 days, to conduct a visual assessment of the pavement condition and stormwater systems for the entire Village paved road inventory. The Ministry Roads (Hot Springs Drive and Lillooet Ave) are the responsibility of the province, but inclusion within the Village condition assessment will support any request for upgrades and or identify maintenance deficiencies. Existing road widths, pavement and gravel shoulders, are included. Pavement markings were also reviewed and included in the assessment. Daily traffic volumes have been estimated for each section of road. This data has been aggregated to build a picture of pavement lifespan and usage.

The road and bridge information has been compiled into an Asset Management Plan spread sheet in the format required by the Village. The Plan conforms to the format currently used by the Village which consists of the costs and useful lives values of Village infrastructure. CTQ has reviewed the costs and useful lives values currently used in Village records and has made recommendations on modifications to these data. CTQ has also provided recommended increases to the annual costs.

The raw data collected has been coupled with the GIS information for other utilities and factored by the approximate traffic volumes and expected traffic growth volumes within the Village. This information was used to form a matrix of priority for road and infrastructure works. The matrix differentiates between 'preventative maintenance works' or 'preservation', which will be required to extend the life of the roads and storm systems, and 'full replacement works' or 'rehabilitation.' The matrix offers a 'priority' ranking identifying in which order the works for each segment of road should be undertaken based on the condition and age of the pavement and utilities within the right of way. The priority matrix is adjusted beyond expected service life data by traffic volumes, visual inspection scores, and finally by budgetary constraints to establish what year the already ranked segments are recommended to be undertaken.

Using this information and process, CTQ leveraged the capabilities of software to develop a dynamic transportation infrastructure management program. This program strategically balances multiple criteria to objectively determine infrastructure improvement and maintenance priorities, scheduling, and budgets. It responds dynamically to the Village's fluctuating parameters and constraints, which the Village can adjust over time to generate a new maintenance schedule. The analytical components of this program adjust to changing budgets, public opinion, traffic, environmental conditions, and expected service life of infrastructure. CTQ's work will give the Village a dynamic tool that will provide value to the Village's budgeting, planning, and infrastructure efforts over the long term. The tool is dynamic and can adjust to shifting priorities, funding, and demographics in the Village. The recommendations in this report are static and give a snapshot of a point in time. The analytical tools add longevity to the plan, by applying the fundamental rationale behind these recommendations to changing budgetary constraints.

5. 2019 System Deficiencies

5.1 Ageing Assets

The Village of Harrison Hot Springs, like many municipalities across Canada, is responsible for many roads that are nearing the end of their service life. These roads must be repaired or replaced at significant expense. It will be challenging to fund new road improvements when significant resources will be required to maintain and rebuild the existing network. The transportation network has developed over a long period of time and requires continual maintenance and eventually complete reconstruction. **Appendix A** lists the age and condition related maintenance schedule. It also shows the capital costs of the works by year. These are a guideline; the schedule can be altered in response to funding constraints and road conditions that are better than extended. In some cases, crack sealing may be used to prolong the life of roadways by up to 10%, but conditions for this kind of performance must be ideal.

The Dynamic Priority Matrix accounts for age, traffic, current condition, and budget. It is independent of any new construction projects and only accounts for maintenance related deficiencies which are weighted towards theoretical life expectancy. According to the VHHS listing of Tangible Capital Assets, the oldest top layers were installed in 1998 and therefore all surface courses within the VHHS have been in service for 21 years or less. The oldest base layers were installed in 1949 and therefore all base courses within the VHHS have been in service for 70 years or less, suggesting the approaching need for rehabilitation work. Arterial and collector roads have a theoretical design life span of 75 years until rehabilitation and require preservation re-surfacing at 25-year intervals. For local roads and lanes, the theoretical design life span is 75 years with preservation every 20 years.

One of the weaknesses of the VHHS transportation system is the lack of readily available information with respect to record drawing and construction conditions. Because VHHS has not yet adopted development guidelines which include design and installation policies, there has been some inconsistency in the requirements for the design and construction of municipal infrastructure. Other road work within the Village has also revealed installation practices which could adversely impact the service life of underground assets including missing or thin base and sub-base materials or thin asphaltic concrete pavement courses. To address these concerns in the future, it is strongly recommended that strict requirements be adopted in the new development guidelines.

Recommendations

- Adopt Best Practice Design guidelines, with modifications as necessary, for all construction of Municipal Works and Development projects within VHHS

5.2 Safety

Safety continues to be major focus of transportation network design. Many opportunities to improve the safety of VHHS roads exist.

5.2.1 Required Traffic Calming and Unsafe Local Road Intersections

Effective traffic calming can do more than simply slow automobiles. The best solutions slow automobiles, while also increasing the potential uses of streetscapes, fostering serendipitous community interactions, reducing carbon and toxin emissions. There are traffic calming solutions that only slow drivers down. Other traffic calming solutions, particularly those that re-engineer the street environment can increase micromobility and active transportation, increase accessibility, encourage community interactions, and expand capacity for trees and other plants, all while reducing the average roadway momentums and vehicles speeds.

Not surprisingly, almost 80% of all road user casualties are motor vehicle occupants. The safety of all users improves as transportation engineers and planners bring calm to roads and streets. Traffic calming and micromobility are fundamentally linked. What calms automobiles benefits all other road users. Most, if not all, active transportation solutions will help calm traffic. Shared Space, traffic path management, protected bike lanes, and better intersections will all help slow traffic.

Traffic calming starts with the design and engineering of space. Signs, paint lines, and vertical deflections are not enough. The most effective way to ensure high compliance with speed limits is design the spaces to be used at the intended speed.

No matter the mode, designing safe and efficient transportation networks starts with the design of intersections. The segments of road between intersections often receive most of the attention and investment despite the fact that they are the least dangerous parts of the transportation network.

TABLE 5.1 Roads Encouraging Non-Compliant Speeds

Road Name	Narrow Road / Tight Radius Corners	Vertical Deflections	Horizontal Deflections	Vehicle Path Management	Intersection Treatment
Alder Avenue	**NO**	**NO**	**NO**	**NO**	Yes
McPherson Road	**NO**	**NO**	**NO**	**NO**	**NO**
Hadway Drive	Yes	**NO**	**NO**	**NO**	**NO**

McCombs Drive	NO	SOME	NO	NO	SOME
Eagle Street	NO	NO	NO	NO	NO

MoTI Road Name	Narrow / Tight Radius Corners	Vertical Deflections	Horizontal Deflections	Vehicle Path Management	Intersection Treatment
Hot Springs Road	NO	NO	NO	NO	NO
Lillooet Avenue E	NO	NO	NO	NO	NO

Straight, wide, and flat roads facilitate "rat racing." Introducing complexity by bringing other modes safely into the streetscape help to keep speeds low. Intersections remain the most dangerous parts of the road. Signs and lines are often not enough to influence driver behaviours and enforcement shows diminishing returns with high costs. Careful engineering of the environment will result in safer outcomes and high return on investment.

Investments in linear infrastructure whether it is just shoulder enhancements and paint lines or if it is completely separate infrastructure will not generate maximum returns without first designing safe and efficient intersections that suit the demands of various modes. Cyclists are safer if they are moving. Pedestrians are safer if they are given refuge and provided optimum routes through intersections. Automobiles are quite flexible to various intersection configurations.

Recommendations

- Village-Wide Speed limit reduction to 40 km/h on Local Roads and Collectors
- Formalize the use of other modes on streets, narrowing perceived road width
- Vehicle path management at trouble intersections
- Increase space available to Active and Micro modes of transportation (Road Diet)
- Vehicle path management

5.2.2 Protected and Separate Active Transportation Infrastructure

While the existing active transportation network is separate from automobile traffic, it achieves this by sacrificing permeability, connectivity, and coverage. In other words, it does not bring people to where they are going, it is simply a destination for those seeking recreation. In order to increase the efficiency and use of the Village's active transportation network, it will have to share some of the right-of-way's currently devoted to automobile traffic. First generation active transportation infrastructure like shoulder enhancements, often referred to as "bike lanes," are not safe enough to draw cautious, but willing participants onto roadways. Second generation solutions have emerged over the past 20 years to address these concerns. These solutions offer protection or separation for vulnerable road users on Arterial and Collector roads. In the VHHS, there are no protected bike lanes that share road right-of-way's with automobiles.

Recommendations

- Install protected active transportation infrastructure on Arterial and Collector roads

5.2.3 Crossing Safety

The VHHS has several unsafe pedestrian crossings. The highest risk crossings are the long crossings on the MoTI owned LAE. According to the manual, high volume crossings or crossings that serve a large elderly population require overhead signage at the minimum. Unsafe crossings are listed in **TABLE 5.2.**

TABLE 5.2 Unsafe Crossing Locations

Major Road	Minor Road	Overhead Sign	Pedestrian Refuge/Median	Advance Stop Line
LAE	Midblock W	**No**	**No**	**No**
LAE	Midblock E	**No**	**No**	**No**
LAE	Eagle Drive	**No**	**No**	**No**
HSR	Miami River Drive	**No**	**No**	**No**
HSR	Poplar Avenue	**No**	**No**	**No**
HSR	Chestnut Avenue	**No**	**No**	**No**
HSR	Pine Avenue	**No**	**No**	**No**

Recommendations

- A “Road Diet” on Lillooet Avenue East that sees the narrowing of driving lanes by installing protected active transportation infrastructure, a median that can act as a pedestrian refuge, and a new parking configuration
- Overhead pedestrian crossing signage at all identified crossings
- Protected active transportation infrastructure on HSR
- Urbanization of HSR with grade-separated delineation of pedestrian spaces
- Advance stop lines at all midblock pedestrian crossings

5.3 Micromobility/Transportation Use Choice/Active Transportation

Fully integrated transportation network that offer a wealth of mode choice to residents and visitors achieve optimum levels of social, environmental, and economic sustainability. These networks are safer by design and indirectly safer due to the mixing of uses. At present, the Village’s transportation network is divided into areas that heavily favour a single use over another. Re-configuring existing infrastructure is the most cost-effective way to encourage different modes to use the same spaces and same corridors.

Active modes are growing in popularity. Cycling numbers are on the rise in Canada. The statistics from Stats Canada represented in Figure 11 do not have the required fine-grained detail to directly relate to the situation in the VHHS. Stats Canada presents a snapshot of the circumstances in Canada’s large and medium Census Metropolitan Areas (CMA’s). This data focuses on commuters, not those simply looking for a form of recreation and exercise. For active commuters, micromobility including and active transportation is integrated into their everyday lives. The proportion of overall commuters in Canada's CMAs has grown by 35.6% over the 20 years between 1996 and 2016 while the proportion of people commuting by bicycle or public transit has out paced this growth substantially. Bicycle commuter numbers are up 87.9% over the same period, public transit numbers are up 58.7%.

Again, these data were collected in Canada's medium to large metropolitan populations, the data is not directly applicable to the Village, but it is reasonable to assume that the majority of tourists visiting the Village and part time residents living in the Village are coming from one of these larger CMAs or similar cities world-wide and may enjoy the types of infrastructure that their communities have embraced. In fact, Canada's large CMA – what Stats Canada classifies in the category "Largest CMA" - with the highest proportion of active commuters is also the one closest to the Village. Vancouver, BC has a population of over 1.1 million commuters, 9.7% of which commute by active mode.

A local metric that applies at the municipal level and is easy to track is Daily Trips by Active Mode (DTAM). Nearby municipalities are currently achieving around 10% trips by bicycle or walking with targets of between 15% and 25% of trips using these modes by 2030. Setting a DTAM goal of 15% is feasible for the VHHS. A rudimentary process for achieving this goal is to re-configure the transportation network so that 30% (twice the DTAM goal) of linear assets are dedicated to active modes and electrified micromobility, by length, conforming to best practices for protected infrastructure on arterial and collector roads and shared spaces on local roads and lanes. Permeability and connectivity are much more important drivers of demand for active modes than overall infrastructure share but measuring the percentage of infrastructure allocated to active modes is more easily quantifiable. Some solutions will be more effective than others in inducing demand for active transportation, **TABLE 5.3** is a decision matrix for active transportation/micromobility projects on the basis of cost-to-benefit.

TABLE 5.3 Achieving Active Transportation Goals

Project	Infrastructure Type	Route Volume	Easy Construction	Length	Percentage of Network
McCombs Drive	Separate Two-Way Bike Lane	High	Yes	1777m	15%
Eagle Drive	Protected Two-Way Bike Lane	High	No	744m	6%
Miami River Drive	Protected Two-Way Bike Lane	Moderate	No	1158m	10%
Hadway Avenue	Vehicle Single - Laning, Over Sized Shoulder Bike Lanes	Low	Yes	252m	2%
McPherson Drive	Protected Two-Way Bike Lane	Miami River Drive	Yes	400m	3%
			Total:	4331m	36%

Recommendations

- Goal: 15% of daily trips by active mode or electrified micromobility by 2030, 30% of linear assets devoted to active modes
- Use Momentum Based Design for safer shared spaces
- Provide protected active transportation infrastructure on high-speed, high-volume roads
- Construct a fully permeable, wide-reaching, and connected active transportation network
- Modify existing infrastructure rather than building new
- Conduct a Household Travel Survey to measure the effectiveness of investments in Active Transportation

5.4 Bridges

5.4.1 Pedestrian Bridge 1

This bridge generally appeared to be in good condition. Some light honeycombing was noted at the concrete abutment on the west end of the bridge It should be noted that erosion was observed below the front face of each abutment (facing river). Current conditions are not of concern; however, CWMM recommends this erosion be monitored on an annual basis. It was noted that paint for wooden railing members was only fully applied along the interior face.

Recommendation

- CWMM recommends applying paint on all exposed faces to prolong the life span of these wooden members

5.4.2 Pedestrian Bridge 2

The bridge appears to be generally in good condition. It was noted that the protective coating at the pier columns has corroded exposing bare steel for the lower 600mm of the column. The remaining protective coating at steel members is starting to deteriorate. Current corrosion of steel columns is considered to be light with no section loss of steel members being observed. At the bridge deck it was noted that several caps for the C-shaped panels are missing, puddle weld connecting panel members are cracked, fasteners used to secure the traction mat to panels are corroding, and occasional attachment of traction mat is loose. All these items are not of structural concern.

Recommendation

- CWMM recommends that lost protective coating be re-instated to prevent further corrosion of steel components and thus prolong the lifespan of the bridge substructure

5.4.3 McCombs Drive – North Bridge

In general, the newer concrete bridge structure appeared to be in good condition as there were no obvious signs of distress or deterioration. In general, the existing timber substructure appeared to be in poor to very poor condition with movement being evident. Localized settlement was noted at the approach at the north/east corner of the bridge (App. E – Photo 3). Barriers along the north east section are leaning and are only partially bearing.

The condition of the treated timber piles of the abutments appeared to be good while the condition of the untreated timber piles of the wing walls varied between fair to very poor as some of these piles were observed being severely worn, weathered, leaning, and/or have partially failed (App. E – Photo 5). The cap beams on both abutments were observed to be in poor condition as they were heavily deteriorated and not sitting level on top of the piles and are leaning in the opposite direction of the piles (App. E – Photo 6 and 7). The timber ballast boards of the abutment appeared to be in fair condition while the timber ballast boards of the wingwall appeared to be in poor condition as they were heavily deteriorated. Plywood sheets have been added to the logs behind the piles near the upper portion of the abutment wall assembly to close gaps within the wall, likely an attempt to mitigate sloughing soil.

Overall the timbers in the abutments and wingwalls exhibit severe decay, stress, and vulnerability to ongoing movement. It is the opinion of CWMM that the primary evidence of movement to be seen has already occurred during the construction phase of the new bridge, likely during compaction of the new approach fill material. Some ongoing movement since construction of the new bridge is evident at the road surface through localized settlement of the asphalt at the north/east bridge corner. The existing timber bridge structure is unstable and will continue to exhibit ongoing movement. Such movement will likely result in the need for ongoing maintenance requirements at the road surface of the bridge approach. The timber structure is expected to fail, though failure will likely occur slowly through continued deterioration and movement of timber members, as has been the case since the construction of the new bridge. As the new bridge structure is supported on steel piles, a failure of the timber bridge structure will not impose an immediate stability risk to the new bridge structure. Instead, a failure of the timber bridge structure would result in backfill materials to spill into the creek and an accelerated erosion of approach fill materials causing settlement of the approach roadway.

The expected eventual failure of the timber bridge structure will need to be addressed in the not too distant future. The difficulty of removing the existing timber bridge structure and providing support for the bridge approach has been significantly magnified with the new bridge being constructed while leaving the existing timber bridge structure in place. There is no easy solution to remediate this issue. A workable solution to this problem will require input including but not limited to structural, hydrological, geotechnical, and environmental expertise.

Recommendation

- CWMM recommends inspecting the timber substructure on an annual basis for ongoing deterioration and movement

5.4.4 McCombs Drive – South Bridge

The timber of the abutment piles appears to be in poor to very poor condition while the piles along the wingwalls appear to be in good to fair condition. The timber piles at the abutments are severely leaning, split or cracked (App. F – Photo 4 and 5). The cap beams on both abutments were observed to be in poor to very poor condition. They are not sitting level on top of the piles and are leaning in the opposite direction of the piles (App. F – Photo 2). In addition, the cap beams toward the west half of the north and south abutment are no longer bearing on top of the piles and are severely split (App. F – Photo 5 and 6). The ballast boards behind the piles at the abutments are separating and partially caving as piles have moved and no longer provide support for the ballast boards.

Overall the timbers in the abutments exhibit severe decay, stress, and vulnerability to ongoing movement. It is the opinion of CWMM that the primary evidence of movement to be seen has already occurred during the construction phase of the new bridge, likely during compaction of the new approach fill material. Some ongoing movement since construction of the new bridge is evident at the road surface through localized settlement of the asphalt at the north/east bridge corner and at the north approach to bride deck interface. The predominant movement is evident along the abutments while some minor movement is occurring along the wingwalls.

The existing timber bridge structure is unstable and will continue to exhibit ongoing movement.

The condition of the timber bridge structure is similar to that of the timber structure at McCombs Road North bridge, although deterioration of the timber abutment has comparatively progressed further, and failure has already partially occurred. Although failure of timber abutments has started, the backfill materials are still being restrained by the timber structure and thus movement of the approach roadway is minor. The failure of the timber structure is expected to continue to slowly progress through continued deterioration and movement of timber members, as appears to have been the case since the construction of the new bridge to this date. As the new bridge structure is supported on steel piles, a failure of the timber abutments will not impose an immediate stability risk to the new bridge structure. Instead, a failure of the timber bridge structure would result in backfill materials to spill into the creek and an accelerated erosion of approach fill materials causing settlement of the approach roadway.

The expected eventual failure of the timber bridge structure will need to be addressed in the not too distant future. The difficulty of removing the existing timber bridge structure and providing support for the bridge approach has been significantly magnified with the new bridge being constructed while leaving the existing timber bridge structure in place. There is no easy solution to remediate this issue. A workable solution to this problem will require input including but not limited to structure, hydrological, geotechnical, and environmental expertise.

Recommendation

- CWMM recommends inspecting the timber substructure on an annual basis for ongoing deterioration and movement.

5.5 School Safety

A method of getting adults to consider their transportation choices is to have their own children explain the benefits of alternative travel modes. School travel plans (STP) identify real and perceived barriers to students walking and cycling and then develop a plan to address these over time.

Activities identified in STPs to increase the number of students walking or cycling to school can include:

- Parent education about parking congestion at student drop-off and afternoon pick-up
- School newsletters and school websites
- Community outreach and social media
- “Walking school bus” program (a volunteer walks a specified route at a specified time to and from school, meeting students along the way to avoid students walking alone)
- Re-visiting schools to assess programs over time

- Implementing road safety programs such as the Pace Car Program (aims to reduce vehicle speeds around schools)
- Annual pedestrian, cycling safety education, and skills programs
- Upgrades to crosswalks and signage
- The construction of missing sections of sidewalk and cycling facilities
- Implementation of the provincial Right to Bike Courses with the teachers previously trained in cycling skills
- Challenges and competitions
- Poster contests for Clean Air Day and Earth Day
- Promoting and supporting Earth Day, Bike to School and Work Week; and
- International Walk to School Day events

Recommendation

- Have students work with parents to develop School Travel Plans

5.6 Emergency Egress

The VHHS has only one point of ingress and egress. In the case of emergencies that necessitate evacuation, this could pose a serious risk.

Recommendation

- Ensure VHHS is identified as a stakeholder for projects and activities within the FVRD transportation network.

5.7 Parking Capacity

The north end of the Village contains several streets that could be better utilized to provide the public with close convenient parking while at the same time increasing their aesthetic value.

Parking facilities today are about more than predicting demand and providing spaces; today's parking facilities must support a wider range of municipal pursuits. The placement, size, cost, and type of parking options available will significantly impact land use, nearby and further afield. Managing the parking assets and selecting new additions must be done in a cost-effective manner that considers the long-term impacts of today's decisions.

Effective parking strategy balances the use, supply, and pricing of parking assets, no single objective governs. Revenue cannot be the sole objective; it will dampen development activity and push parking to other areas. Congestion caused by parking facilities and occupancy controls negatively affect economic activity. In other cases, providing large quantities of cheap parking may stimulate economic development, but it will not cover the operating and maintenance costs while negatively influencing the liveability of the community. A balanced parking strategy is one that has policies and pricing that drive economic development while generating the revenue needed to support the infrastructure.

In general, on-street parking is an asset in downtown environments, as it buffers pedestrians from vehicle traffic and adds a sense of activity and vibrancy to the streetscape. However, on-street parking requires valuable real estate that could be used for other purposes, for example, bike lanes, bioswales, or wider sidewalks.

The decision of whether on-street parking is appropriate in any given location depends on a variety of factors including the availability of other parking, competition for right-of-way by other modes, and the perceived ease of access to street front businesses. Users will tend to consistently select on-street parking spaces over off-street surface lots. The on-street spaces will experience the most use and the highest turnover when compared to off-street lots. In the Village, an abundance of wide, unused road right-of-way's provides ample opportunity for a variety of on-street parking options as well as room for active transportation and pedestrian friendly options.

Improvements in the north end can range from simple bump outs with space for parking to a full redesign with landscaping, seating, and parking options. On top of the on-street parking options, the village has several location options for new/improved off-street parking areas. Starting with upgrading and improving a few of the existing and unofficial parking areas would greatly improve the efficiency of these options.

Lillooet Avenue has a wide 30m road right-of-way that currently has a mix of angled and parallel parking options. Where these options are not present, the side of the road is still heavily but inefficiently used for parallel parking. Maximizing the use of the right-of-way will provide convenient parking options and ease of access to commercial and beachfront activities. Use of well-designed streetscapes will increase the visual appeal of the street while at the same time provide shade and rest areas for pedestrians. With the increased parking and landscaping, vehicular traffic will naturally slow which will in turn boost safety along the street.

Increasing parking is a top priority for the Village. Two options were explored for increasing the Village's parking capacity; they both involve parking expansions on publicly owned land in the possession of the VHHS. These efforts are focused on areas north of the Miami River since this is the most highly trafficked area of the Village due to concentration of accommodations, commerce, and the beach.

Many of the Village road right-of-ways extend much beyond the extents of the paved portions of roadways. In these circumstances, widening of the roadway could provide additional parallel parking. Widening efforts can be undertaken in many ways. Varying levels of pavement and concrete works could achieve substantial increases to parking capacity in the Village. Any such treatments would lead to improved drainage. Some examples are presented below.
Roads that have the necessary ROW widths:

- Maple Street
- Echo Street
- Cedar Avenue
- Bear Avenue

Types of widening:

- Gravel Shoulders

The most cost-effective alternative for increasing parking on these roadways involves widening the roadway with gravel shoulders. Such shoulders would need to be a minimum of 2.5m wide.

- Pavement
- A simple pavement widening
- Parking Bays

Parking Bays offer the highest aesthetic value of any of the parking capacity increase strategies. Parking bays also act as traffic calming mechanisms. They can be used for parallel or angle parking.

Recommendations

- Allocate funds for an engineering study and cost estimate to determine how to increase parking along Maple Street, Echo Street, Cedar Avenue, and Bear Avenue.

5.8 Formal Service Request Process

Feedback from residents regarding elements of the transportation network typically come in the form of Service Requests. To date, the VHHS does not have a formal process for transportation network service requests. In order to efficiently and effectively act on resident service requests, a formalized Service Request process is recommended.

The simplest implementation of a Service Request Process would be the provision of Service Request Forms available to residents online and in hard copy format. Forms should collect the resident's name, address, and contact information. Requests should be sorted into the following categories:

- Maintenance: General, Boulevard, Bus Stops, Facility Damage, Garbage, Line Painting, Potholes, Sidewalks, Stair Maintenance, Snow Clearing
- Noise
- Drainage
- Signage
- Traffic Calming
- Active Transportation
- Parking
- Crossings / Intersections
- Speed Zone Reductions

The forms will need to collect the service location and a description of the issue. Residents should be provided the opportunity to include a photograph as well.

Review of Service Requests should escalate through the following steps as necessary:

- Formal response confirming receipt of request
- Review by public relations staff, immediate resolution if possible
- Review current projects and relevant Master Plans
- Review by Senior Staff
- Review by Operations Staff
- Review by Engineering Service provider or relevant professional
- Recommend action
- Perform action
- Confirm with resident that action has been taken

Requests should only escalate through the review sequence if immediate, trivial solutions are not possible and the request is reasonable. Requests for services not offered by the VHHS or not under the jurisdiction of the VHHS should be redirected to appropriate authorities. For instance, speed enforcement concerns should be redirected to the RCMP.

If a person should not want to use the official form, contact information for submission by phone or in person should be provided. Provision of an email address is not recommended; this will likely result in very high volumes of requests of widely varying formats.

Finally, residents will need to know how their personal information is handled. It is recommended that the VHHS handle the personal information collected through Service Request Forms in accordance with British Columbia's Freedom of Information and Protection of Privacy Act. A contact for residents who have questions about privacy should be provided.

Recommendations

- Formalize the Transportation Service Request process by providing Service Request Forms to residents
- Formalize the request review process to control time and expense
- Make phone or in-person submissions available, but avoid free-form email submissions
- Conform to British Columbia's Freedom of Information and Protection of Privacy Act

6. Future Development & Demand

6.1 Pedestrian Profile and Population Projection

Population growth is challenging to predict for a community such as Harrison Hot Springs. VHHS is heavily tourism-dependent, with a high percentage of seasonal residents. The lack of industry, combined with the single sector job opportunities, aging demographic, and relatively small population within the community mean that typical population growth models cannot be applied.

TABLE 6.1 compares Statistics Canada population and age data for VHHS.

TABLE 6.1 Census data

	1991	1996	2001	2006	2011	2016	Average Annual Growth Rate
Village of Harrison Hot Springs (VHHS)	655	898	1,343	1,573	1,468	1,242	3.2% (1991-2011)

Between 1991 and 2016, the population of VHHS increased an average of 3.2% per year. During the five-year interval between 2011 and 2016, the population **decreased** by 15.4%. Between 1991 and 2016, the population of the Village increased an average of 4.2% per year. During the five-year interval between 2006 and 2011, the population decreased by 6.7%.

Age	Total	Male	Female
0 to 14 years	9.7 %	10 %	10.2 %
15 to 64 years	54 %	52.2 %	55.5 %
65 years and over	36.3%	38.3 %	34.4 %
85 years and over	1.6 %	1.7 %	1.6 %
Average age of the population	52.4	53.2	51.5

The largest age range of the population is 65 and over (36%), with the average age for the Village being 52 (see chart below).

The profile of the VHHS population is distinct from the Fraser Valley Regional District **(FVRD)** and indeed from the province of BC, projecting that population 25, 50 or even 10 years into the future is challenging. **FIGURE 7** illustrates several different population projections for VHHS. The 1991-2016 census data is a heavy, bright green line, with the most recent census population (1,242) noted at year 2016. Statistical analysis of the census data results in a linear regression illustrated by the black dotted line, with a population forecast in the year 2036 of 2,100.

The blue dashed line, which is based on 3.87% cumulative annual growth (based on the VHHS census data between 1991 and 2016), results in a population in the year 2036 which is also out of line with the current declining population.

For resort focused communities, the disposable income of people both within and outside the province has a large impact on population growth and is strongly connected to the economy. when only the data within recent years between 1996 and 2016 is examined, the 2036 population is estimated at **2,100**. (black line).

So where does that leave the VHHS population projection over the next two decades? In the absence of a crystal ball, and with the development community subject to highs and lows similar to those experienced over the past 25 years, it is estimated that the 2036 population will be about 2,100 people. It will be important to re-evaluate this projection when the next census becomes available in 2021. A single large development, or sharp increase or decrease in the number of overnight tourist visits, could greatly impact the projected numbers.

Commuter Profiles for the Village show that of the 340 residents that reported commuting to work, 9% commute within the census subdivision, 14% commute to a different census subdivision but stay within their census division, and 5% commute to a different census division within the province. Many of those who commute drive themselves (270), 10 were passengers, 10 reported taking transit, 90 Walk, and 20 biked to work. Most commuters have a commute time of fewer than 15 minutes. The next largest group has a commute time of between 30 to 44 minutes.

Recommendation

- Re-evaluate population projections when then the next census data becomes available

6.2 Development Projections:

In 2016, a detailed study was conducted by the VHHS Department of Development and Community Services which projects ultimate buildout densities for all land within the Village.

Based on OCP land use designations, except where zoning has been amended to a Comprehensive Development Zone, maximum future development is predicted to be comprised of 15,976m^2 commercial area, 1,240 potential new redevelopment units, and 45 units of residential infill (construction on vacant lots).

FIGURE 8 shows the Development Projection areas, as well as a breakdown of the type of development anticipated in each area.

Recommendations

- Re-evaluate population growth rate assumptions when the 2016 census data becomes available
- Establish a plan to increase portion of transportation network devoted to micromobility and active transportation within VHHS within 10 or 25 years
- Allocate funds for a minor Road and Bridge Master Plan update in 2022 to incorporate 2021 census data and re-evaluate multi-modal demand

6.3 Impact of Incremental Development:

TABLE 6.2 has been developed to "put numbers" to the impact that specific future development projects could have on the transportation system. The concept of Single-Family Equivalent (SFE) has been used, allowing for a direct comparison of residential and commercial units for demand and storage requirements. It can be seen from the table that a 40-unit condo development has less of an impact on the system than 40 detached housing lots (single family subdivision).

Table 6.2 illustrates that commercial development of the size likely to occur in VHHS will have minimal impact on the system. Residential development in the form of single or multi-family developments will have more impact, but in all cases population growth will not result in significant changes to LOS values in the Village.

TABLE 6.2 SFE Demands - Future Development

	Number Units	SFE	Automobiles
Single Family Subdivision	40	40	80
Multi Family	40	26.7	21
Campground Site	40	26.7	26
Commercial (C-4) 300 m^2	N/A	0.9	1
Commercial (C-5) 300 m^2	N/A	1	1
Commercial (Other) 300 m^2	N/A	2	2

7. Capital Works Plan and Cost Estimates

7.1 Improvements

TABLE 7.1 identifies and quantifies the capital improvements for each year of the 25 Year Capital Plan identified as part of this Road and Bridge Master Plan. Pricing and timing will depend on preliminary design and the ability to secure funding. Refer to the relevant sections for discussion and recommendations.

TABLE 7.1 Maintenance Plan and Capital Improvements (by Year of 25 Year Capital Plan)

Road Name	Road Type	Years	Purpose	Cost
Echo	Ave	2020-2037	Rehabilitation	$ 624,750
Alder	Ave	2021	Rehabilitation	$ 276,500
McPherson	Rd	2022	Rehabilitation	$ 807,250
Esplanade	Ave	2023-2027	Rehabilitation	$1,656,000
Lillooet	Ave	2025	Rehabilitation	$ 414,000
Cedar	Ave	2028-2029	Rehabilitation	$ 569,750
Spruce	St	2030-2031	Rehabilitation	$ 185,250
Chehalis	St	2031	Rehabilitation	$ 100,000
St Alice	St	2031-2037	Preservation	$ 100,000
McCombs	Dr	2032-2035	Preservation	$1,506,250
Maple	St	2035-2036	Rehabilitation	$ 195,000
Bear	Ave	2036	Rehabilitation	$ 48,750
Naismith	Ave	2036-2038	Preservation	$ 439,750
Miami	Dr	2038-2041	Preservation	$ 663,250
Eagle	St	2039-2040	Preservation	$ 631,500
Balsam	Ave	2040-2041	Preservation	$ 192,500
Lakberg	Cres	2041	Preservation	$ 34,250
Chestnut	Ave	2042	Preservation	$ 286,250
Cottonwood	Ave	2043-2044	Preservation	$ 224,250
Driftwood	Ave	2043	Preservation	$ 171,750
Walnut	Ave	2043-2044	Preservation	$ 168,250
Clover	Pl	2044	Preservation	$ 39,000
Fern	Pl	2044	Preservation	$ 39,000
Juniper	Pl	2044	Preservation	$ 33,000
Mount	St	2044	Preservation	$ 63,500
Poplar	St	2044	Preservation	$ 114,500
Emerald	Ave	2045	Preservation	$ 113,250
Pine	Ave	2045	Preservation	$ 191,500
Ramona	Pl	2045-2047	Preservation	$ 102,500
Diamond	St	2046	Preservation	$ 90,250
Hope	Pl	2046	Preservation	$ 91,500
Myng	Cres	2046-2047	Preservation	$ 174,500
Schooner	Pl	2046	Preservation	$ 131,500
Angus	Pl	2047	Preservation	$ 40,250
Hadway	Dr	2047	Preservation	$ 98,750

Utility revenue sources available to VHHS include:

- Developer Funding
- Grants
- Taxes
- Public Private Partnerships (P3)
- Tolls

It is important to examine each capital project in terms of the applicable revenue source(s). For a municipality such as VHHS, where there is no industrial base and costs are shouldered by a relatively small commercial and residential population, identifying and pursuing grant funding from higher levels of government is a necessity.

The VHHS transportation network has undergone numerous improvements over the past 5 years, including repaving on Myng Crescent, Hadway Drive, Ramona Place, Angus Place, Hope Place, Emerald Avenue, Diamond Street, Pine Avenue, and Lakburg Crescent. Funds should be placed in reserves annually for eventual replacement of these newer components, over the next 25 years capital asset renewal of other roadways will be the main focus.

7.2 Cost Estimates

Detailed project cost estimates are presented in **APPENDIX C**.

8. Recommendations

Recommendations are summarized in the Figures and Appendices.

9. Figures

Figures 1 through 2 are included in Appendix A – Maintenance Schedule and Capital Plan.
Figures 3 through 6 are included in Appendix B – Active Transportation.
Figure 7 through 8 is included in Appendix H – Population Projections.
Figure 9 is included in Appendix L – Stormwater Surface Structures

10. References

Documents:

Ministry of Transportation and Highways, Highway Safety Branch (1994). Pedestrian Crossing Control Manual for British Columbia. Victoria, BC

City of Chilliwack (2017). Cycle Plan. Chilliwack, BC

City of Kelowna (2016). Kelowna on the Move: Pedestrian and Bicycle Master Plan. Kelowna, BC

City of Vancouver (2015). Cycling Safety Study. Vancouver, BC

Accident Compensation Corporation and Land Transport Safety Authority (2000). Down with Speed: A Review of the Literature, and the Impact of Speed on New Zealanders.

National Cycle Network (2011). Chapter 5

Statistics Canada (1997). Harrison Hot Springs, British Columbia 1996 Community Profiles. 1996 Census. Ottawa, Ontario

Statistics Canada (2002). Harrison Hot Springs, British Columbia 2001 Community Profiles, 2001 Census, Ottawa, Ontario.

Statistics Canada (2007). Harrison Hot Springs, British Columbia 2006 Community Profiles, 2006 Census, Ottawa, Ontario.

Statistics Canada (2011). Harrison Hot Springs, British Columbia 2006 Community Profiles, 2006 Census, Ottawa, Ontario.

Statistics Canada (2016). Harrison Hot Springs, British Columbia 2006 Community Profiles, 2006 Census, Ottawa, Ontario.

J. Lacoste with A. Campbell, S. Klassen, J. Montufar (2014)
Pedestrian Safety at Crosswalks – Examining Driver Yielding Behavior at Crosswalks with GM1 and OF Systems. Montréal, PQ. Paper prepared for presentation at the Evolution of Traffic Control Devices Enhancing Safety, Active Modes and Effective Traffic Flow Session

City of Montréal, Infrastructure, Roads and Transportation Services, Transportation Branch, Road Network Design and Safety Division (2018). Shared Streets Accessible to All: A Collaborative Research Initiative to Establish Design Parameters in Québec. Montréal, PQ (TAC Sustainable Urban Transportation Award Submission)

Master Municipal Construction Documents (2005). MMCD Design Manual (Gold Edition) Vancouver, BC.

Village of Harrison Hot Springs (2007) Official Community Plan Bylaw 864. Harrison Hot Springs, BC

Village of Harrison Hot Springs (2016). Village of Harrison Hot Springs Development Projections. Department of Planning, Harrison Hot Springs, B.C.

New York City (2012). Measuring the Street: New Metrics for 21st Century Streets. New York, NY

Websites:

https://docs.google.com/forms/d/e/1FAIpQLSf5nPAjM5FJNFVwzVPNXIBUKeTfrghWm-KRkpWciDrwR-wuuA/viewform?usp=sf_link
http://canadawalks.ca/about/benefits/
https://calgaryherald.com/news/local-news/transit-bikes-or-cars-whats-the-most-cost-effective-way-of-getting-commuters-downtown
https://bikecalgary.org/faqs/
https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016029/98-200-x2016029-eng.cfm
https://www.theglobeandmail.com/news/national/census-2016-spike-in-number-of-canadians-cycling-taking-public-transit-to-work/article37127643/
https://www.cbc.ca/news/canada/calgary/calgary-2018-downtown-cordon-count-cars-bikes-transit-1.4876641
https://engage.gov.bc.ca/app/uploads/sites/391/2018/08/THE-BRITISH-COLUMBIA-CYCLING-COALITION.pdf
https://www.cbc.ca/news/canada/toronto/ebike-sales-challenges-2018-1.4897300
http://civil-reactlab.sites.olt.ubc.ca/files/2018/11/Aono_2018_BC-e-bike-market-review-report.pdf
https://www.portlandoregon.gov/transportation/article/158497
https://www.citylab.com/transportation/2016/01/the-4-types-of-cyclists-youll-meet-on-us-city-streets/422787/
https://www.fastcompany.com/3021074/making-the-economic-case-for-cycling-friendly-cities-with-bikeonomics
https://betterbikelanes.ca/why/research
https://www.citylab.com/transportation/2013/02/women-will-ride-bikes-when-its-safer-them-do-so/4730/
https://www.citylab.com/transportation/2016/11/why-protected-bike-lanes-save-lives/508436/
https://www.citylab.com/transportation/2014/06/protected-bike-lanes-arent-just-safer-they-can-also-increase-cycling/371958/
https://www.vox.com/2014/6/5/5782472/study-bike-lanes-really-do-increase-biking
https://globalnews.ca/news/2899289/bike-lanes-around-the-world-where-mere-paint-wont-do-it/
https://www.theatlantic.com/technology/archive/2018/03/a-new-bible-for-bike-lanes/554450/
https://usa.streetsblog.org/2014/06/26/study-motorists-give-cyclists-in-bike-lanes-more-room-when-passing/
https://www.halifax.ca/about-halifax/regional-community-planning/argyle-grafton-shared-streetscape-project

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=2ahUKEwjCqoq-_ebgAhVzKH0KHYxmC44QFjADegQICRAC&url=https%3A%2F%2Fcanmore.ca%2Fdocuments%2F2653-draft-2018-itp-update&usg=AOvVaw2IvM6bsdtNtl_lXBDcCUbz
http://banff.ca/index.aspx?NID=969
https://www.kelowna.ca/sites/files/1/docs/related/sutherland_bikelanes_phase1_design_construction_2019-02_web.pdf
https://everybodyhatestraffic.com/2017/12/04/mode-oriented-street-design/
http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=13

Appendix A – Maintenance Schedule and Capital Plan

1. VHHS INFRASTRUCTURE
2. MOTI INFRASTRUCTURE

Project Name	Description	Year	Drainage	Sanitary	Water	Construction Cost	Engineering and C.A.	Class C Contingency (25%)	Total Cost
Echo Ave (East of Eagle)	Rehabilitation	2020	Yes			$ 341,000	$ 51,000	$ 85,250.00	$ 477,250
Alder Ave	Rehabilitation	2021				$ 198,000	$ 29,000	$ 49,500.00	$ 276,500
McPherson Rd (to Eagle	Rehabilitation	2022	Yes			$ 577,000	$ 86,000	$ 144,250.00	$ 807,250
Esplanade Ave (Chehalis to Spruce)	Rehabilitation	2023				$ 328,000	$ 49,000	$ 82,000.00	$ 459,000
Esplanade Ave (Maple to Chehalis)	Rehabilitation	2024				$ 326,000	$ 48,000	$ 81,500.00	$ 455,500
Lillooet Ave (Saint Alice to Hot Springs)	Rehabilitation	2025	Yes			$ 296,000	$ 44,000	$ 74,000.00	$ 414,000
Esplanade Ave (Saint Alice to Hot Springs)	Rehabilitation	2026				$ 276,000	$ 41,000	$ 69,000.00	$ 386,000
Esplanade Ave (Hot Springs to Maple)	Rehabilitation	2027				$ 254,000	$ 38,000	$ 63,500.00	$ 355,500
Cedar Ave (West of Hot Springs)	Rehabilitation	2028	Yes		Yes	$ 227,000	$ 34,000	$ 56,750.00	$ 317,750
Cedar Ave (Hot Springs to Maple)	Rehabilitation	2029	Yes			$ 180,000	$ 27,000	$ 45,000.00	$ 252,000
Spruce St (Lillooet to Echo)	Rehabilitation	2030				$ 88,000	$ 13,000	$ 22,000.00	$ 123,000
Chehalis St	Rehabilitation	2031				$ 72,000	$ 10,000	$ 18,000.00	$ 100,000
Spruce St (Esplanade to Lillooet)	Rehabilitation	2031				$ 45,000	$ 6,000	$ 11,250.00	$ 62,250
St Alice St S	Preservation	2031				$ 27,000	$ 4,000	$ 6,750.00	$ 37,750
McCombs Dr (McPherson to Hadway S)	Preservation	2032	Yes			$ 395,000	$ 59,000	$ 98,750.00	$ 552,750
McCombs Dr (Emerald to Alder)	Preservation	2033	Yes			$ 220,000	$ 33,000	$ 55,000.00	$ 308,000
McCombs Dr (Alder to Pine)	Preservation	2034	Yes			$ 183,000	$ 27,000	$ 45,750.00	$ 255,750
McCombs Dr (Hadway S to Emerald)	Preservation	2035	Yes			$ 120,000	$ 18,000	$ 30,000.00	$ 168,000
McCombs Dr (Pine to Chestnut)	Preservation	2035	Yes			$ 90,000	$ 13,000	$ 22,500.00	$ 125,500
Maple St (Cedar to Lillooet)	Rehabilitation	2035				$ 72,000	$ 10,000	$ 18,000.00	$ 100,000
McCombs Dr (Chestnut to Miami River Dr)	Preservation	2035		Yes		$ 69,000	$ 10,000	$ 17,250.00	$ 96,250
Maple St (Lillooet to Esplanade)	Rehabilitation	2036				$ 68,000	$ 10,000	$ 17,000.00	$ 95,000
Bear Ave	Rehabilitation	2036	Yes		Yes	$ 35,000	$ 5,000	$ 8,750.00	$ 48,750
Naismith Ave (East of Eagle)	Preservation	2036	Yes		Yes	$ 139,000	$ 20,000	$ 34,750.00	$ 193,750
Echo Ave (West of Eagle)	Rehabilitation	2037	Yes			$ 106,000	$ 15,000	$ 26,500.00	$ 147,500
St Alice St N	Preservation	2037				$ 45,000	$ 6,000	$ 11,250.00	$ 62,250
Miami River Dr (Poplar to Walnut)	Preservation	2038				$ 220,000	$ 33,000	$ 55,000.00	$ 308,000
Naismith Ave (West of Eagle)	Preservation	2038				$ 176,000	$ 26,000	$ 44,000.00	$ 246,000
Eagle St (Miami River to Naismith)	Preservation	2039				$ 90,000	$ 13,000	$ 22,500.00	$ 125,500
Eagle St (Bear to Echo)	Preservation	2039				$ 75,000	$ 11,000	$ 18,750.00	$ 104,750
Eagle St (Echo to Naismith)	Preservation	2039				$ 68,000	$ 10,000	$ 17,000.00	$ 95,000
Eagle St (Naismith to Driftwood)	Preservation	2039				$ 64,000	$ 9,000	$ 16,000.00	$ 89,000
Balsam Ave (Clover to Miami River)	Preservation	2040	Yes			$ 56,000	$ 8,000	$ 14,000.00	$ 78,000
Balsam Ave (Chestnut to Clover)	Preservation	2040	Yes			$ 55,000	$ 8,000	$ 13,750.00	$ 76,750
Miami River Dr (Loop)	Preservation	2040				$ 53,000	$ 7,000	$ 13,250.00	$ 73,250
Eagle St (Lillooet to Bear)	Preservation	2040				$ 53,000	$ 7,000	$ 13,250.00	$ 73,250
Eagle St (Driftwood to Cottonwood)	Preservation	2040				$ 52,000	$ 7,000	$ 13,000.00	$ 72,000
Eagle St (Cottonwood to Naismith)	Preservation	2040				$ 52,000	$ 7,000	$ 13,000.00	$ 72,000
Miami River Dr (Fern to Balsam)	Preservation	2041		Yes		$ 46,000	$ 6,000	$ 11,500.00	$ 63,500
Miami River Dr (Hot Springs to Poplar)	Preservation	2041	Yes	Yes		$ 43,000	$ 6,000	$ 10,750.00	$ 59,750
Miami River Dr (Juniper to McCombs)	Preservation	2041		Yes		$ 39,000	$ 5,000	$ 9,750.00	$ 53,750
Miami River Dr (Walnut to Fern)	Preservation	2041		Yes		$ 38,000	$ 5,000	$ 9,500.00	$ 52,500
Miami River Dr (Balsam to Juniper)	Preservation	2041		Yes		$ 38,000	$ 5,000	$ 9,500.00	$ 52,500
Balsam Ave (Hot Springs to Chestnut)	Preservation	2041				$ 27,000	$ 4,000	$ 6,750.00	$ 37,750
Lakberg Cres	Preservation	2041				$ 25,000	$ 3,000	$ 6,250.00	$ 34,250
Chestnut Ave	Preservation	2042				$ 205,000	$ 30,000	$ 51,250.00	$ 286,250
Cottonwood Ave	Preservation	2043				$ 132,000	$ 19,000	$ 33,000.00	$ 184,000
Driftwood Ave	Preservation	2043				$ 123,000	$ 18,000	$ 30,750.00	$ 171,750
Walnut Ave (Poplar to Eagle)	Preservation	2043				$ 73,000	$ 10,000	$ 18,250.00	$ 101,250
Walnut Ave (Hot Springs to Poplar)	Preservation	2044				$ 48,000	$ 7,000	$ 12,000.00	$ 67,000
Mount St	Preservation	2044				$ 46,000	$ 6,000	$ 11,500.00	$ 63,500
Cottonwood Pl	Preservation	2044				$ 29,000	$ 4,000	$ 7,250.00	$ 40,250
Clover Pl	Preservation	2044				$ 28,000	$ 4,000	$ 7,000.00	$ 39,000
Poplar St	Preservation	2044				$ 82,000	$ 12,000	$ 20,500.00	$ 114,500
Fern Pl	Preservation	2044				$ 28,000	$ 4,000	$ 7,000.00	$ 39,000
Juniper Pl	Preservation	2044				$ 24,000	$ 3,000	$ 6,000.00	$ 33,000
Pine Ave (Hot Springs to Lakberg)	Preservation	2045				$ 106,000	$ 15,000	$ 26,500.00	$ 147,500
Emerald Ave	Preservation	2045				$ 81,000	$ 12,000	$ 20,250.00	$ 113,250
Ramona Pl (Hot Springs to Hadway)	Preservation	2045				$ 33,000	$ 4,000	$ 8,250.00	$ 45,250
Pine Ave (Lakberg to Eagle)	Preservation	2045				$ 32,000	$ 4,000	$ 8,000.00	$ 44,000
Schooner Pl	Preservation	2046				$ 94,000	$ 14,000	$ 23,500.00	$ 131,500
Myng Cres (Hope to Hadway S)	Preservation	2046				$ 83,000	$ 12,000	$ 20,750.00	$ 115,750
Hope Pl	Preservation	2046				$ 66,000	$ 9,000	$ 16,500.00	$ 91,500
Diamond St	Preservation	2046				$ 65,000	$ 9,000	$ 16,250.00	$ 90,250
Hadway Dr N	Preservation	2047				$ 50,000	$ 7,000	$ 12,500.00	$ 69,500
Ramona Pl (North of Hadway)	Preservation	2047				$ 41,000	$ 6,000	$ 10,250.00	$ 57,250
Angus Pl	Preservation	2047				$ 29,000	$ 4,000	$ 7,250.00	$ 40,250
Myng Cres (Hadway S to Hadway N)	Preservation	2047				$ 24,000	$ 3,000	$ 6,000.00	$ 33,000
Hadway Dr S	Preservation	2047				$ 21,000	$ 3,000	$ 5,250.00	$ 29,250
Myng Cres (North of Hadway N)	Preservation	2047				$ 19,000	$ 2,000	$ 4,750.00	$ 25,750

Project Name	Description	Year	Drainage	Sanitary	Water	Construction Cost	Engineering and C.A.	Class C Contingency (25%)	Total Cost
Lillooet Ave (Maple to Chehalis)	Rehabilitatior	2020		Yes		$ 323,259	$ 48,000	$ 80,814.73	$ 452,074
Lillooet Ave (East of Chehalis)	Rehabilitatior	2023	Yes		Yes	$ 789,443	$ 118,000	$ 197,360.83	$1,104,804
Lillooet Ave (Hot Springs to Maple)	Rehabilitatior	2023				$ 255,769	$ 38,000	$ 63,942.28	$ 357,711
Hot Springs Rd (McPherson to Ramona)	Preservation	2032	Yes			$ 773,107	$ 115,000	$ 193,276.85	$1,081,384
Hot Springs Rd (Emerald to Alder)	Preservation	2032	Yes			$ 399,305	$ 59,000	$ 99,826.13	$ 558,131
Hot Springs Rd (Pine to Balsam)	Preservation	2032	Yes			$ 357,790	$ 53,000	$ 89,447.50	$ 500,238
Hot Springs Rd (Alder to Pine)	Preservation	2032	Yes			$ 326,176	$ 48,000	$ 81,543.88	$ 455,719
Hot Springs Rd (Balsam to Walnut)	Preservation	2032	Yes			$ 282,281	$ 42,000	$ 70,570.20	$ 394,851
Hot Springs Rd (Miami River to Cedar)	Preservation	2032	Yes			$ 198,679	$ 29,000	$ 49,669.63	$ 277,348
Hot Springs Rd (Ramona to Emerald)	Preservation	2032	Yes			$ 185,879	$ 27,000	$ 46,469.75	$ 259,349
Hot Springs Rd (Walnut to Miami River)	Preservation	2032	Yes			$ 175,265	$ 26,000	$ 43,816.28	$ 245,081
Hot Springs Rd (Lillooet to Esplanade)	Preservation	2032	Yes			$ 101,801	$ 15,000	$ 25,450.18	$ 142,251
Hot Springs Rd (South of McPherson)	Preservation	2032	Yes			$ 100,124	$ 15,000	$ 25,030.93	$ 140,155
Hot Springs Rd (Cedar to Lillooet)	Preservation	2032	Yes			$ 85,929	$ 12,000	$ 21,482.13	$ 119,411

Appendix B – Active Transportation

1. NEAR-TERM ACTIVE TRANSPORTATION AND MICROMOBILITY INVESTMENTS
2. SHORT-TERM ACTIVE TRANSPORTATION AND MICROMOBILITY INVESTMENTS
3. LONG-TERM ACTIVE TRANSPORTATION AND MICROMOBILITY INVESTMENTS

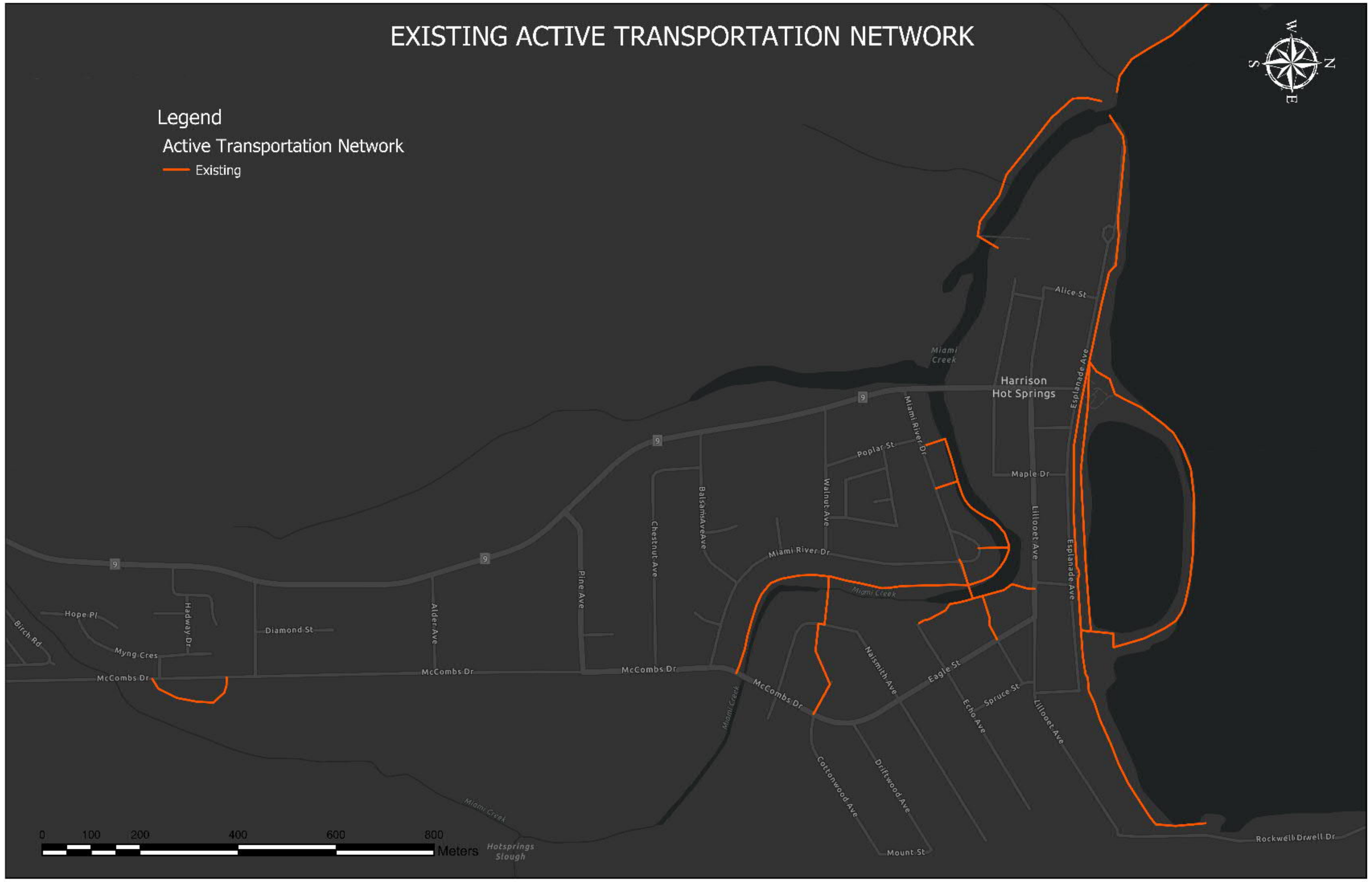


FIGURE 3: Existing Active Transportation

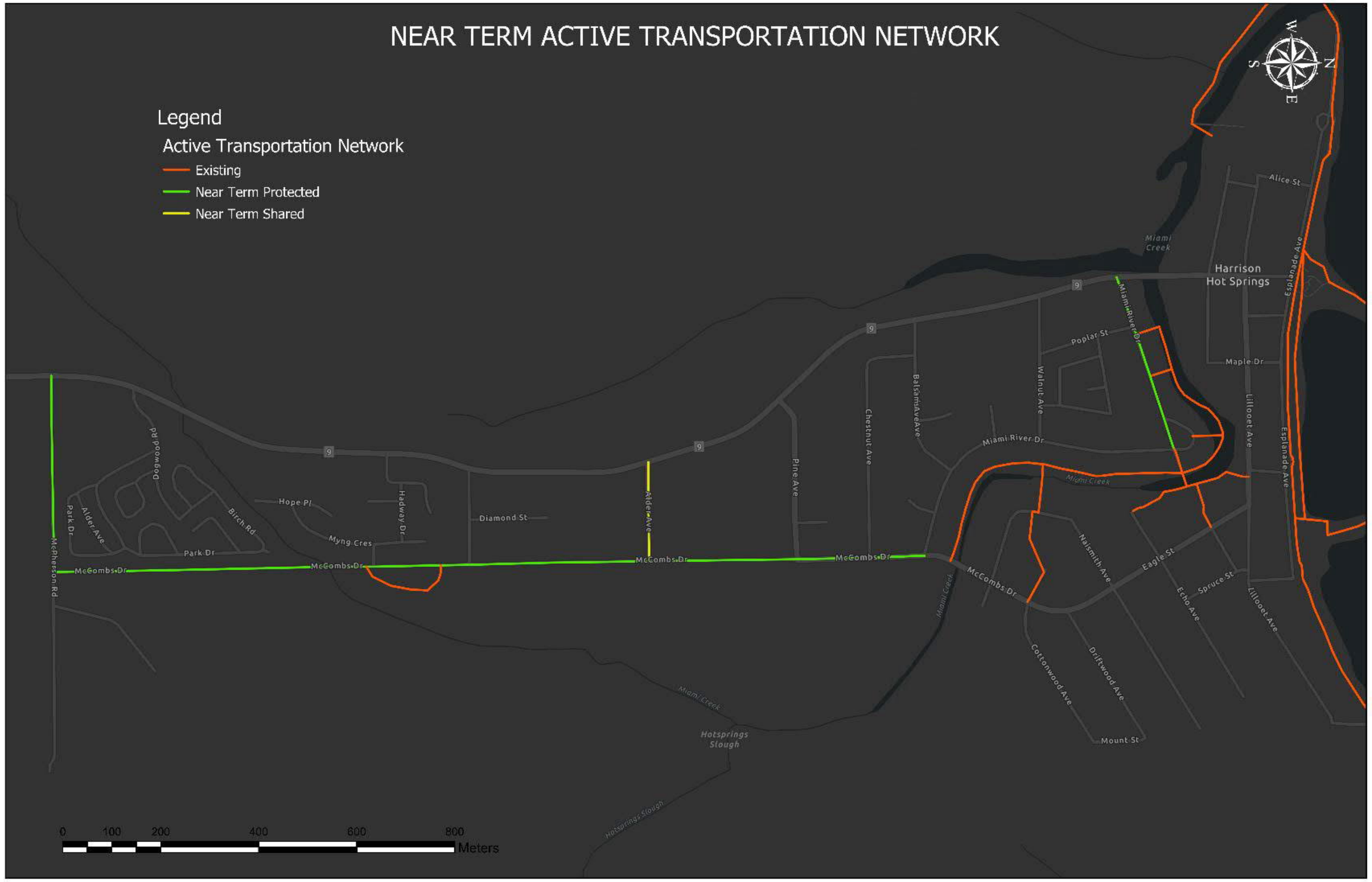
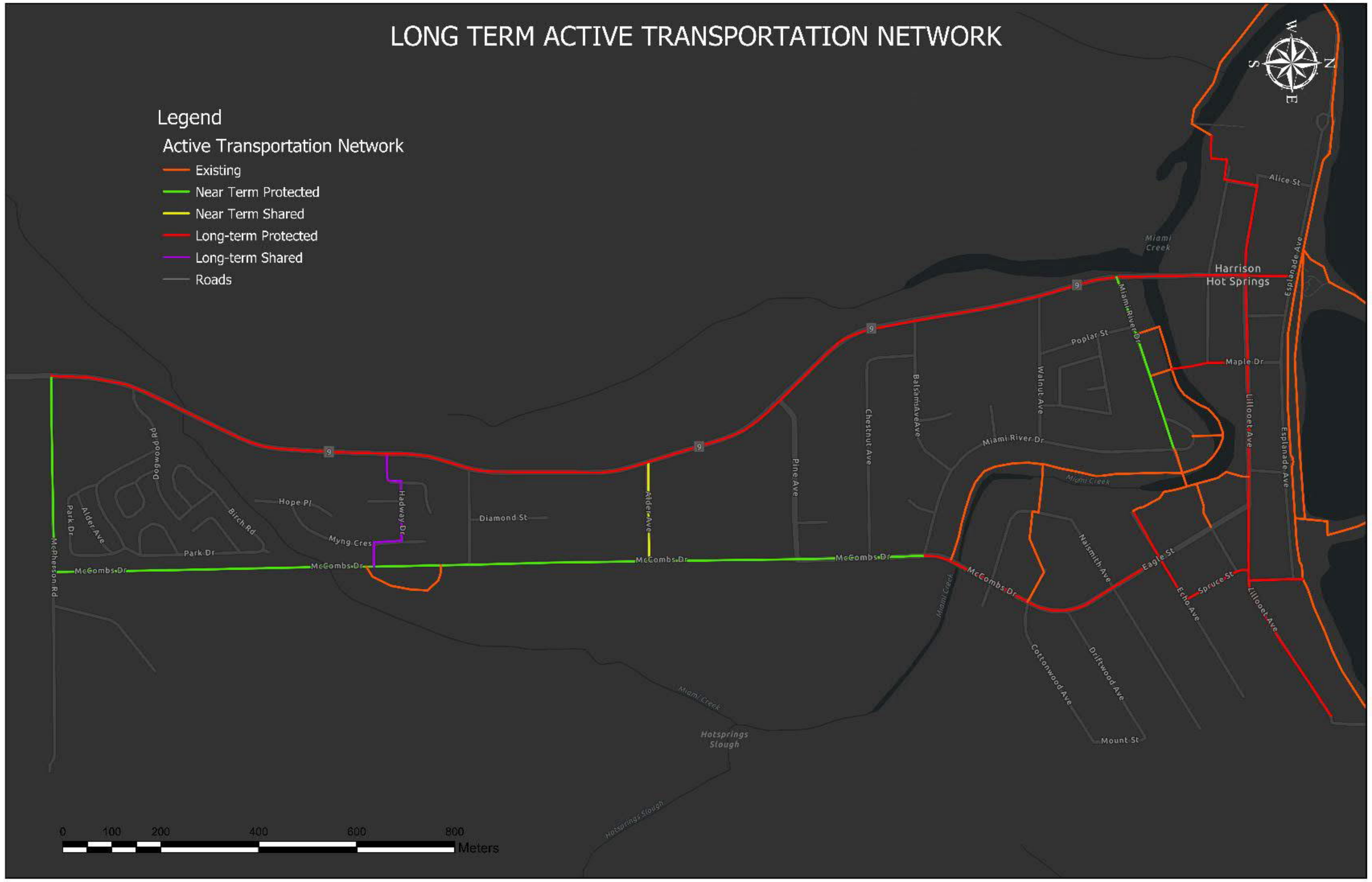


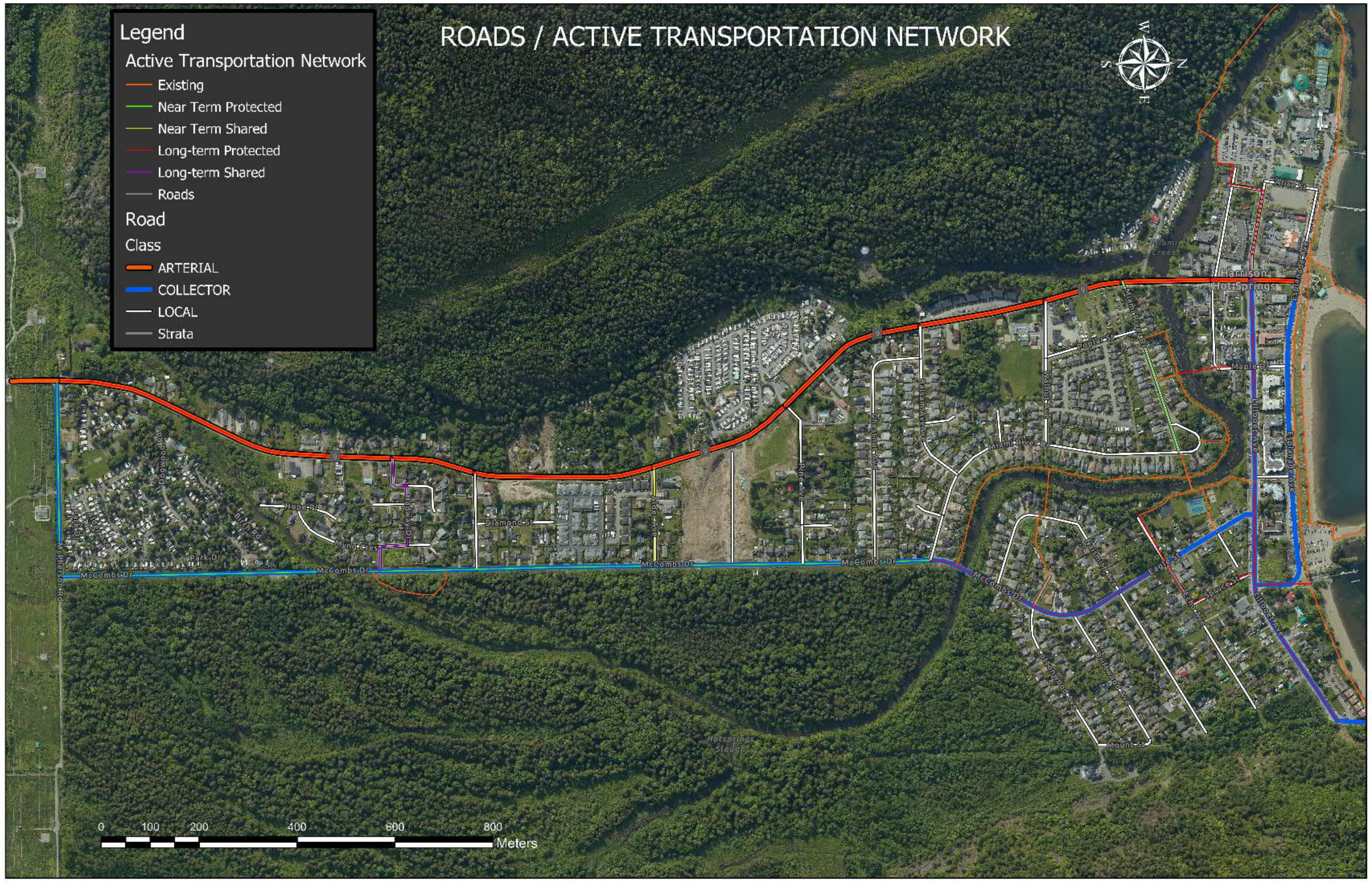
FIGURE 4: Near-Term Active Transportation



HARRISON HOT SPRINGS
Naturally Refreshed

CTQ

FIGURE 5: Long-Term Active Transportation



HARRISON HOT SPRINGS
Naturally Refreshed

CTQ

FIGURE 6: Future Integrated Transportation Network

Appendix C – Cost Estimates

CTQ

HARRISON HOT SPRINGS
Naturally Refreshed

Timeline	Project	Description	Next Maintenance	Construction Cost	Contingency (10%)	Engineering and CA	Total Cost	DCC Eligible
Active Transportation								
Near-Term	McCombs Drive	Separate/Protected Bike Lane	2033-2036	$ 166,257	$ 16,626	$ 24,939	$ 207,830	No
	McPherson Drive	Separate/Protected Bike Lane	2022	$ 62,556	$ 6,256	$ 9,383	$ 78,200	No
	Alder Avenue	Vehicle Path Management Shared Street / Single Laning	2021	$ 10,150	$ 1,015	$ 1,523	$ 12,690	No
	North Miami River Drive	Protected Two-Way Bike Lane	2042	$ 118,440	$ 11,844.0	$ 17,766	$ 148,050	No
Short-Term	Hadway-Ramona	Vehicle Path Management / Shared Street / Single Laning	2048	$ 12,650	$ 1,265	$ 1,898	$ 15,820	No
	Eagle Drive	Protected Two-Way Bike Lane	2040	$ 93,444	$ 9,344	$ 14,017	$ 116,810	No
	Miami River	Multi-Use Trail Upgrade	-	$ 34,545	$ 3,455	$ 5,182	$ 43,190	
	Spruce Street	Parking Protected Bike Lane (not including widening)	2032	$ 10,950	$ 1,095	$ 1,643	$ 13,690	No
Long-Term	Miami River Drive South	Vehicle Path Management / Shared Street / Single Laning	2042	$ 46,300	$ 4,630	$ 6,945	$ 57,880	No
	Echo Avenue	Parking Protected Bike Lane (not including widening)	2020	$ 22,850	$ 2,285	$ 3,428	$ 28,570	No
	Maple Street	Pedestrian Bridge (25%)	-	$ 1,500,000	$ 375,000	$ 112,500	$ 1,987,500	No
Parking								
Timeline	**Project**	**Description**	**Next Maintenance**	**Construction Cost**	**Contingency (10%)**	**Engineering and CA**	**Total Cost**	**DCC Eligible**
Near-Term	Mount Street	Parking Lot	2020	$ 75,000	$ 7,500	$ 3,750	$ 86,250	No
	Echo Avenue	Widening / Draiange / Neck Downs	2020	-	-	-	(Included in Maintenance Plan)	Partial
	Maple Street / Cedar Avenue	Widening / Draiange / Neck Downs	2027	-	-	-	(Included in Maintenance Plan)	Partial
Short-Term	Spruce Street	Widening / Draiange / Neck Downs	2031	-	-	-	(Included in Maintenance Plan)	Partial
Long-Term	Bear Avenue	Widening / Draiange / Neck Downs	2036	-	-	-	(Included in Maintenance Plan)	Partial
Crossings								
Timeline	**Project**	**Description**	**Next Maintenance**	**Construction Cost**	**Contingency (10%)**	**Engineering and CA**	**Total Cost**	**DCC Eligible**
Near-Term	Hadway-Ramona	Vertical Deflection	-	$ 1,500	$ 150	$ -	$ 1,650	No
Near-Term	Alder Avenue	Active Transportation Intersection / Vehicle Path Management	-	$ 7,500	$ 750	$ 2,000	$ 10,250	No
Short-Term	Hadway-Ramona	Active Transportation Intersection / Vehicle Path Management	-	$ 7,500	$ 750	$ 2,000	$ 10,250	No
Long-Term	Miami River Drive South	Active Transportation Intersection / Vehicle Path Management	-	$ 7,500	$ 750	$ 2,000	$ 10,250	No
	Eagle Drive Echo Avenue	Active Transportation Intersection / Vehicle Path Management	-	$ 7,500	$ 750	$ 2,000	$ 10,250	No
Additional Traffic Calming - Active Transportation, Crossings will Calm Traffic								
Timeline	**Project**	**Description**	**Next Maintenance**	**Construction Cost**	**Contingency (10%)**	**Engineering and CA**	**Total Cost**	**DCC Eligible**
Near-Term	Speed Limit Reduction	Village-Wide Reduction of Speed Limits	-	$ 15,000	$ 1,500	$ 1,200	$ 17,700	No
Short-Term	McCombs Drive	Vehicle Path Management	2033-2036	$ 56,550	$ 5,655.0	$ 8,482.50	$ 70,690	No
Long-Term	Eagle Drive	Vehicle Path Management	2040	$ 29,950	$ 2,995	$ 4,493	$ 37,440	No

Active transportation doesn't need to be installed at the same time as maintenance works, but some cost savings might be available if they happen in concert.
The crossings projects listed should coincide with adjacent active transportation works.

Timeline	Project	Description	Next Maintenance	Length	Construction Cost	Contingency (15%)	Engineering and CA	Total Cost	DCC Eligible
Active Transportation									
MoTI	Lillooet Avenue	Protected Bike Lane / Median / Road Diet	2020	978	$ 337,410	$ 50,612	$ 50,612	$ 438,633	No
	Hot Springs Road	Separate/Protected Bike Lane	2032	2214	$ 110,700	$ 16,605	$ 16,605	$ 143,910	No
Parking									
Timeline	**Project**	**Description**	**Next Maintenance**		**Construction Cost**	**Contingency (15%)**	**Engineering and CA**	**Total Cost**	**DCC Eligible**
MoTI	Lillooet Avenue	Parking Lot / Angle or Parallel Parking Conversion	2020					(Included Above)	No
Crossings									
Timeline	**Project**	**Description**	**Next Maintenance**		**Construction Cost**	**Contingency (15%)**	**Engineering and CA**	**Total Cost**	**DCC Eligible**
MoTI	Lillooet Avenue Maple Street	Overhead Signs / Extend Neck Downs	2020		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Lillooet Avenue Maple Street	Overhead Signs / Advance Stop Lines / Neck Downs	2020		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Lillooet Avenue Spruce Street	Overhead Signs / Advance Stop Lines / Neck Downs	2020		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Lillooet Avenue Mount Street	Overhead Signs / Advance Stop Lines	2020		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Hot Springs Road Aspen Lane	Overhead Signs / Advance Stop Lines	2032		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Hot Springs Road Balsam Avenue	Overhead Signs / Advance Stop Lines	2032		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Hot Springs Road Walnut Avenue	Overhead Signs / Advance Stop Lines	2032		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Hot Springs Road Walnut Avenue	Overhead Signs / Advance Stop Lines	2032		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Hot Springs Road Miami River Drive	Overhead Signs / Advance Stop Lines	2032		$ 25,000	$ 3,750	-	$ 28,750	No
MoTI	Hot Springs Road Lillooet Avenue	Green Scramble for Pedestrians and Micromobility	2032		$ 25,000	$ 3,750	-	$ 28,750	No

Appendix D – Signage and Pavement Marking Plan

In accordance with MoTI recommended methodology, the following detailed Signage and Paint Marking recommendations are proposed:

Location: Driftwood Ave.

- Sign Type: PLAYGROUND AHEAD (SP-3)
- PLAYGROUND AHEAD signs are placed throughout the Village, even where there are no playgrounds.

Recommendation:
With the recommended speed limit change to 40km/h, these PLAYGROUND AHEAD signs will no longer be required. These signs should only be placed where there are playgrounds.

Chapter 5, Page 2

Location: Lakberg Cres.

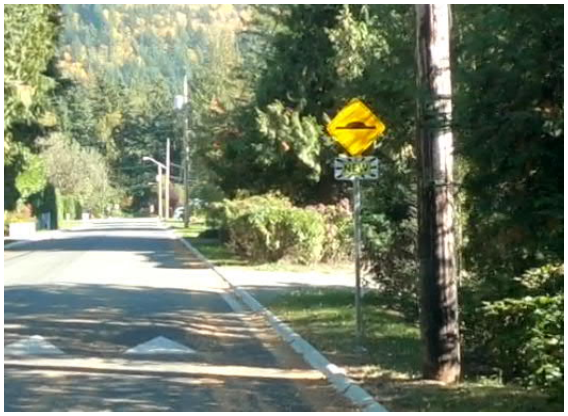
- Sign Type: Unknown
- The ‘No Parking – Snow Removal’ sign is not recognized in MOT’s ‘Manual of Standard Traffic Signs & Pavement Markings’ and is used inconsistently throughout the Village.

Recommendation:
This sign is not required. If the Village wishes to continue using this sign, all cul-de-sacs should have it for consistency.

Location: Pine Ave.

- Sign Type: Unknown
- This sign is not consistent with any other sign in the Village, nor is it recognized in MoTI’s ‘Manual of Standard Traffic Signs & Pavement Markings’.

Recommendation:
With the recommended speed limit change to 40km/h, this sign will no longer be required. Sign removal is advised.

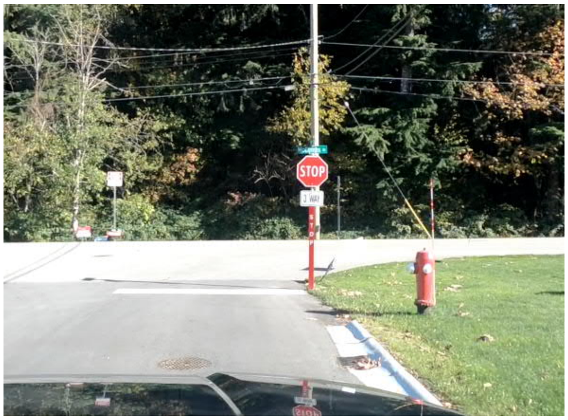


Location: Pine Ave.

- Sign Type: BUMP
- Longitudinal sign placement varies throughout the Village. On some speed bumps, the sign is located right at the bump and on others it is located anywhere from 10m to 50m before.

Recommendation:
Consistency with sign location is ideal wherever possible. As a guide moving forward, have all BUMP signs at the speed bump.

Chapter 3 page 22



Location: Pine Ave. & McCombs Dr.

- Sign Type: STOP (R-1)
- The STOP sign is too close to the edge of pavement.

Recommendation:
Move STOP sign so that there is a minimum of 0.3m separation from pavement edge to the outermost side of sign. Please refer to Figure 1.1 (Chapter 1, Page 13) of the MOT's 'Manual of Standard Traffic Signs & Pavement Markings'.

Chapter 3 page 22

Location: McCombs Dr.

- Sign Type: SLOW (W-21)
- The SLOW sign is not useful as a speed bump should prompt cars to decelerate already.

Recommendation:
It is not necessary to remove these signs but moving forward, further usage is not warranted.

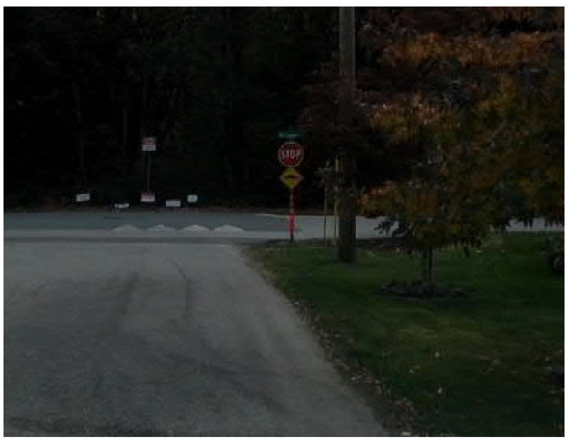
Chapter 3 page 9

Location: Lillooet Rd.

- Sign Type: CYCLIST CROSSING (W-129)
- There is no real indication of this cyclist crossing anywhere along this road.

Recommendation:
Either remove sign or identify crossing so that it is more apparent where bikes will be crossing Lillooet Road.

Chapter 3 page 26



Location: Alder Ave. & McCombs Dr.

- Sign Type: STOP (R-1) and BUMP
- Bump sign is not permitted on the same post as a stop sign; as well, the BUMP sign is redundant in this scenario.

Recommendation:
Remove BUMP sign.

Chapter 3 page 9

Location: Echo Ave. & Eagle St.

- Sign Type: NO THROUGH ROAD
- There are both NO THROUGH ROAD signs and NO EXIT signs in the village.

Recommendation:
Either use the NO THROUGH ROAD sign or the NO EXIT sign. Consistency in signage selection is recommended.

Chapter 3 page 28

Location: Eagle St. near Driftwood Ave.

- Sign Type: MAXIMUM SPEED LIMIT (R-4)
- MAXIMUM SPEED LIMIT is too low to the ground.

Recommendation:
Remove PLAYGROUND AHEAD sign and raise the MAXIMUM SPEED LIMIT sign so that the sign bottom is 1.5m from the ground.

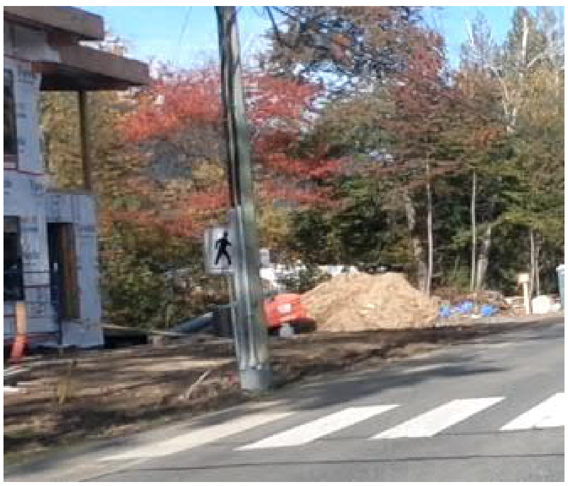
Chapter 2 page 7

Location: Hadway Dr. & Myng Cres.

- Sign Type: STOP (R-1)
- STOP sign does not have its own post, it is grouped with a Block Watch sign, and would be better positioned closer to the back of curb.

Recommendation:
Put the STOP sign on its own post separate from the Block Watch sign. Move STOP sign closer to the curb so that it is more visible and matches the other stop signs lateral positioning in the Village.

Chapter 1 page 13



Location: Hot Springs Rd. & Walnut Ave.

- Sign Type: PEDSETRIAN CROSSWALK (SP-5)
- PEDSETRIAN CROSSWALK sign is visually obstructed by the power pole.

Recommendation:
Put the SP-5L sign on a new post where it will not be obstructed by the power pole. Leave the southbound SP-5R sign as is.

Chapter 5 page 3

Location: Hot Springs Rd. & Cedar Ave.

- Sign Type: BICYCLE (G-125)
- BICYCLE lane starts without signage.

Recommendation:
Have a “Bike Lane Begins” sign to indicate the start of the bike lane.

Chapter 4 page 16

Location: Lillooet Rd. &Hot Springs Rd

- Sign Type: BICYCLE (G-125)
- No signage at beginning of bicycle lane.

Recommendation:
Have a “Bike Lane Begins” sign to indicate the start of the bike lane.

Chapter 4 page 16

Location: Angus Dr. & Hadway Dr.

- Sign Type: STOP (R-1)
- STOP sign does not have its own post and would be better positioned closer to the back of curb. The stop bar is also missing at this intersection.

Recommendation:
All STOP signs should have their own post and should not be put on a light pole or hydro pole. Stop bars are also required at all STOP signs.

Chapter 1 page 13, Figure 7.2

Location: Angus Dr. & Hadway Dr.

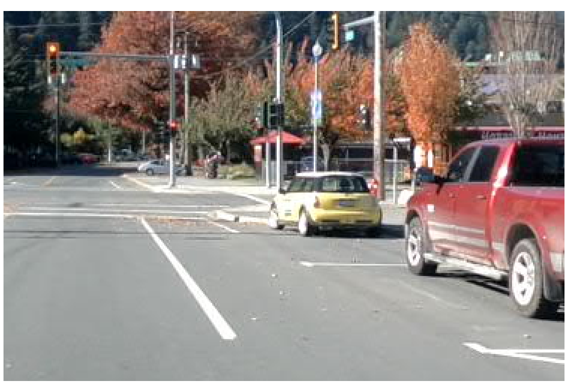
- Sign Type: STOP (R-1)

Recommendation:
Relocate STREET NAME signs to proposed STOP signpost mentioned in previous example.

Location: McCombs Dr.

- Stop bar is not need here anymore.

Recommendation:
Stop bar to be removed



Location: Lillooet Rd. &Hot Springs Rd

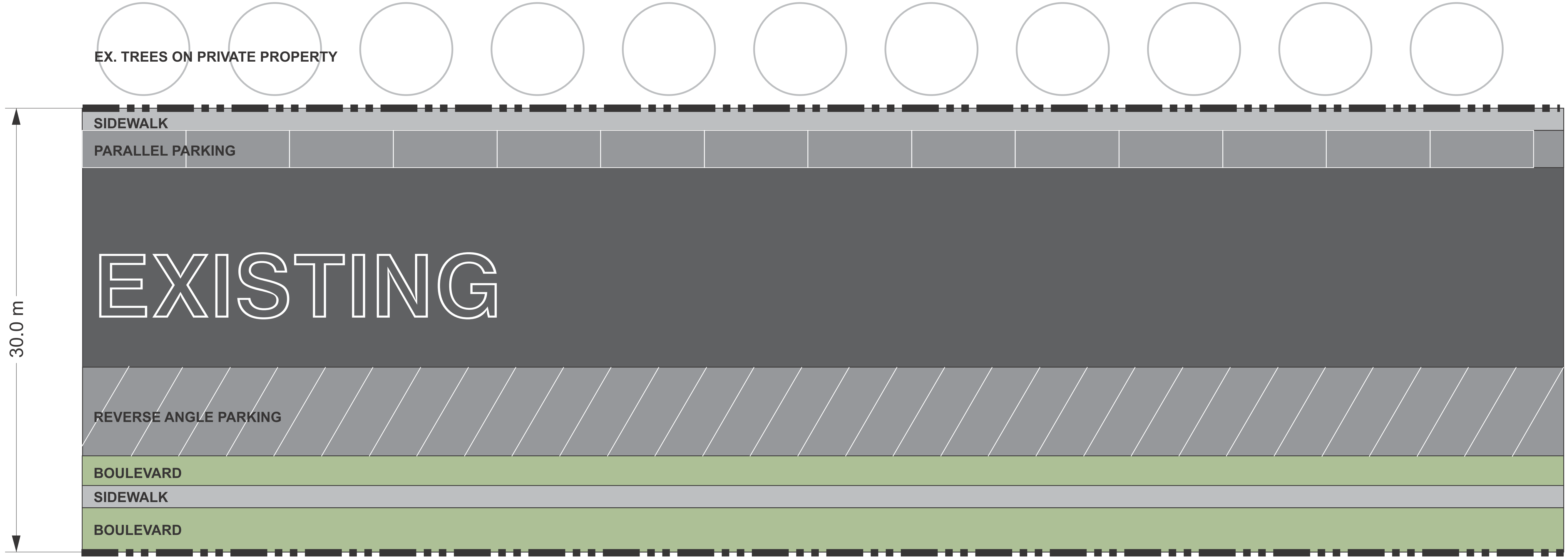
- Bicycle pavement markings required on all bike lanes.

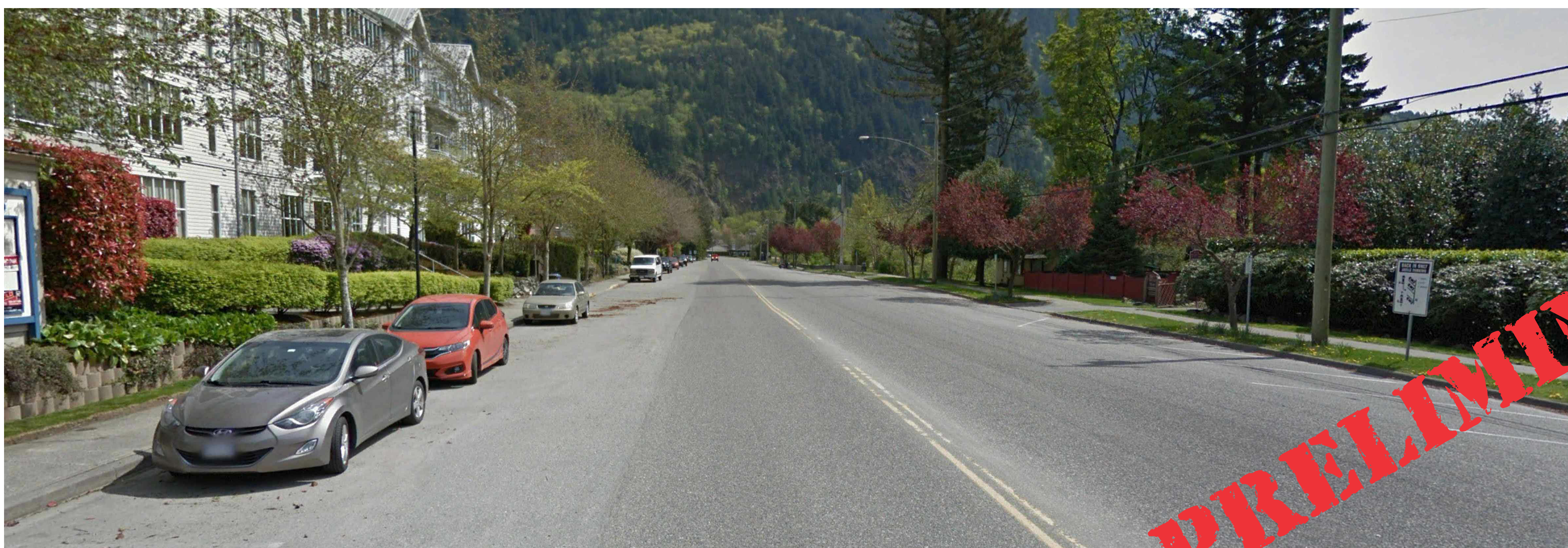
Recommendation:

[This came up during public feedback sessions.]

Appendix E – Proposed MoTI Cross Sections

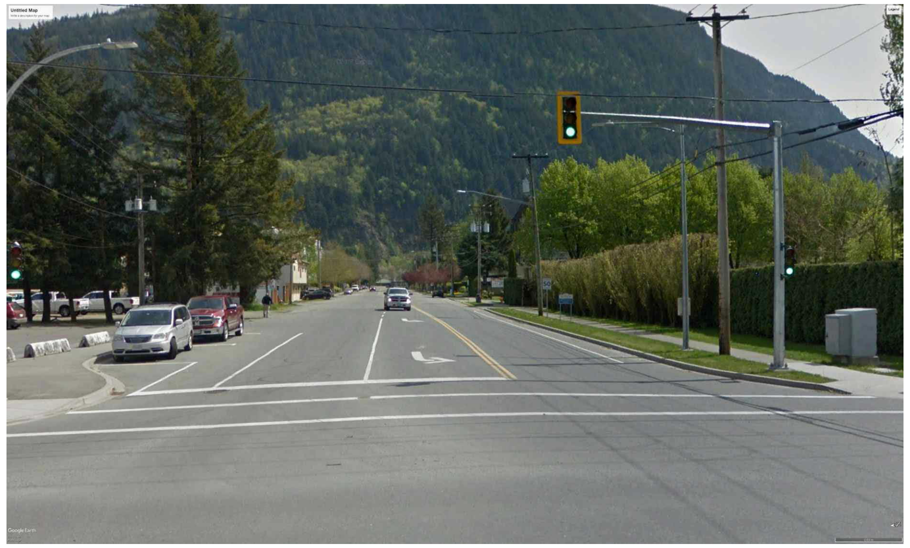
LILLOOET ROAD

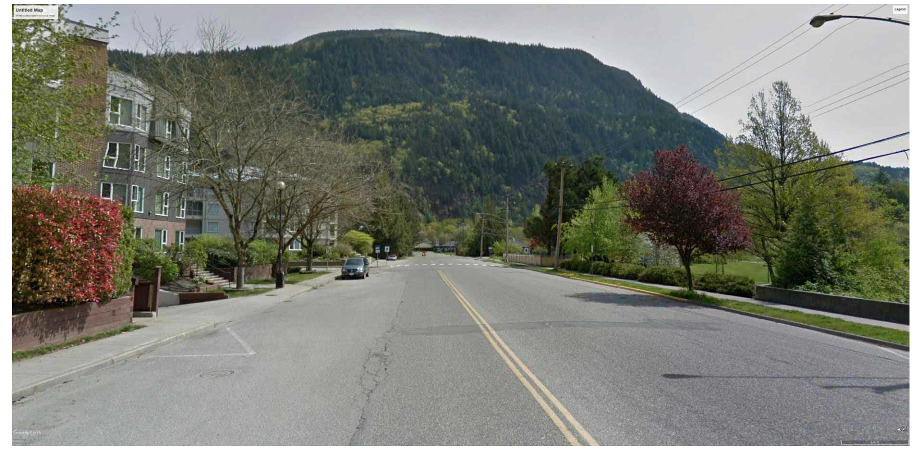


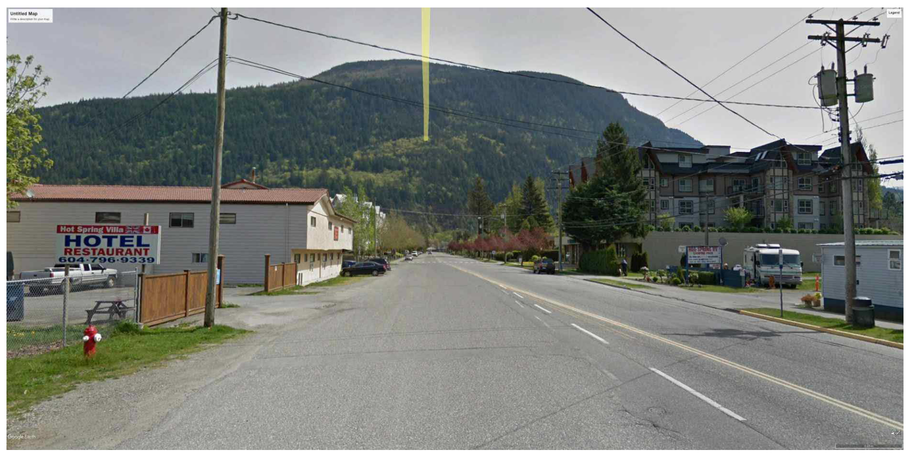


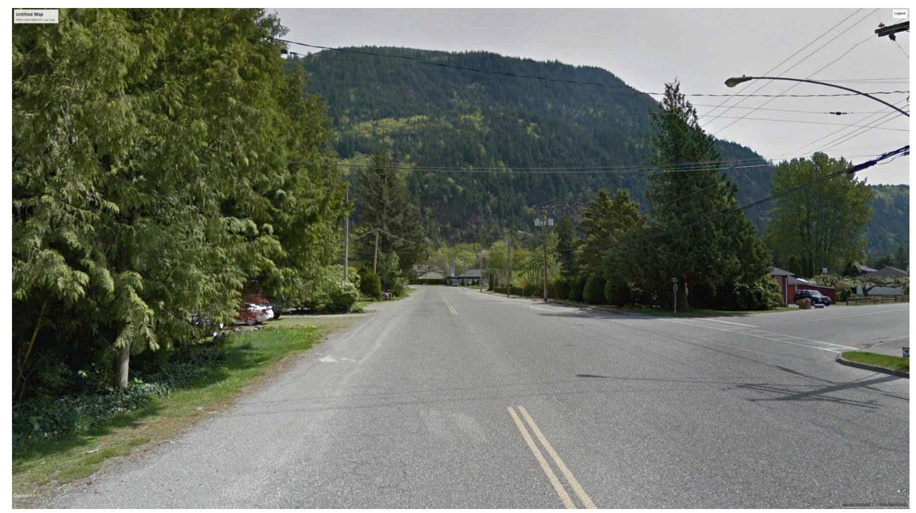
PRELIMINARY

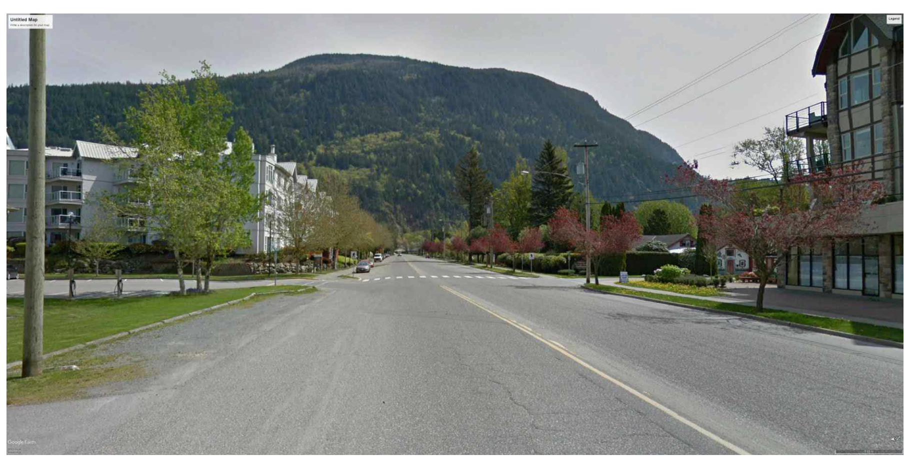
LILLOOET ROAD

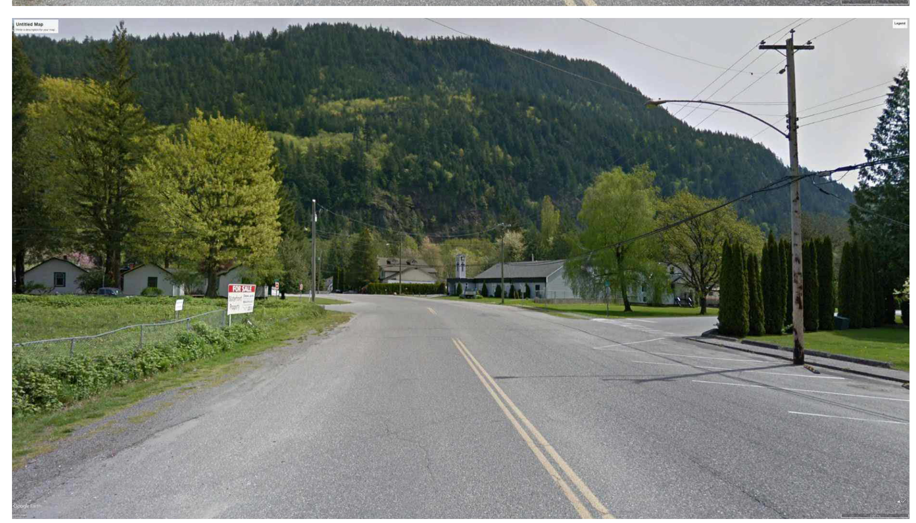


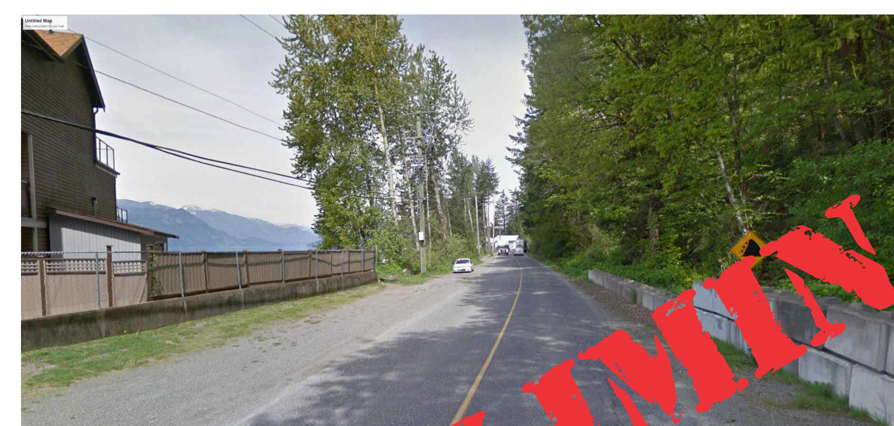








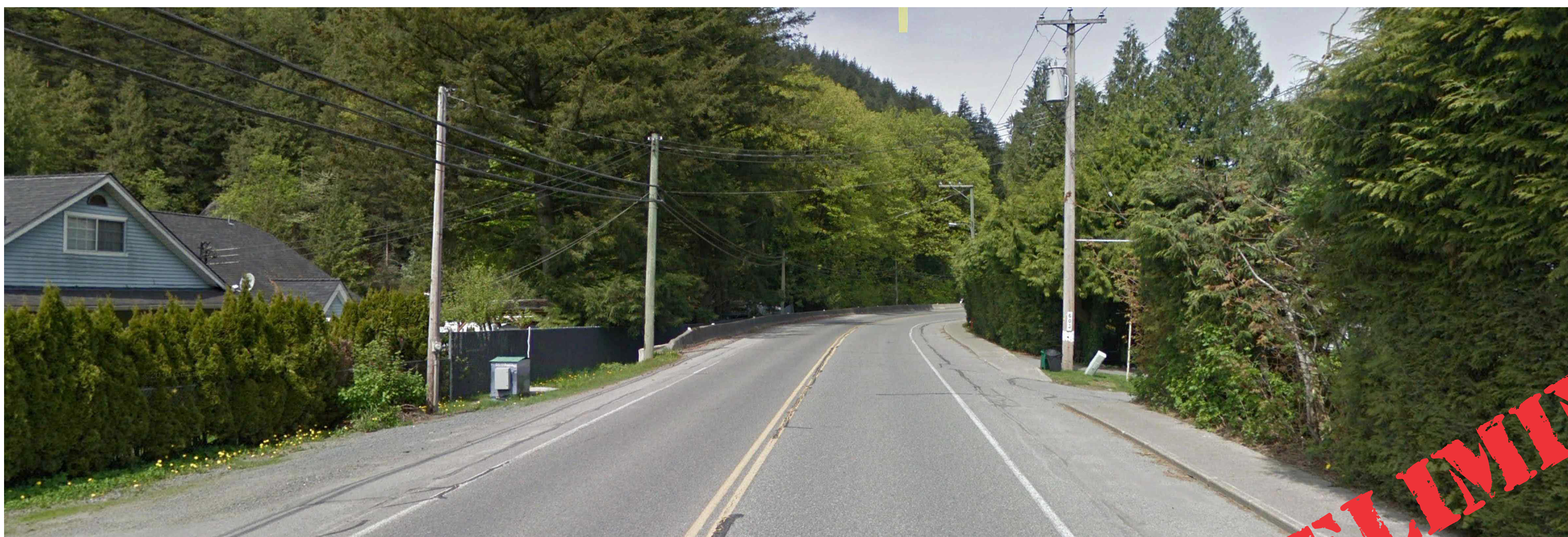




PRELIMINARY

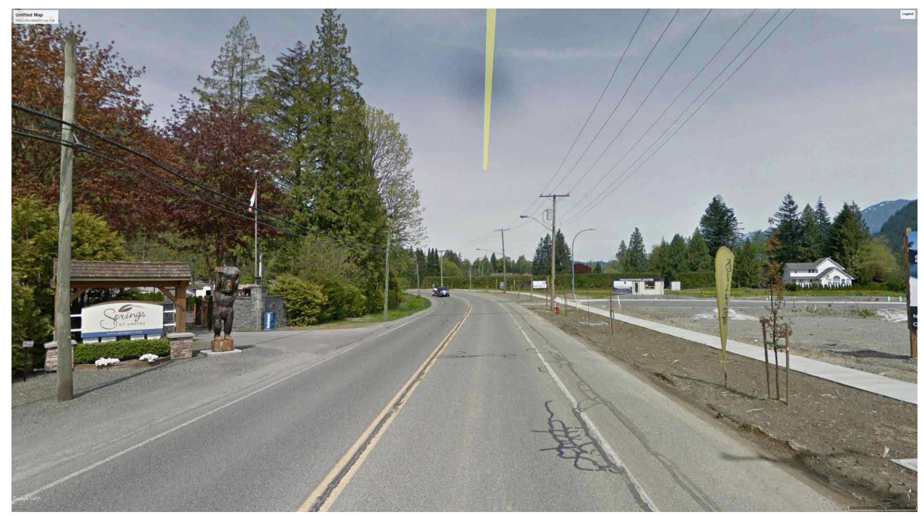

LILLOOET ROAD
OPTION 1
EX. TREES ON PRIVATE PROPERTY
1.5m
EX. SIDEWALK
3.0m
PROPOSED BIKE LANE/MULTI-USE TRAIL
3.0m
PROPOSED BOULEVARD
PROPOSED TREES
6.0m
PROPOSED ANGLE PARKING
3.75m
3.75m
2.5m
PROPOSED PARALLEL PARKING
2.0m
EX. BOULEVARD and EXISTING TREES
1.5m
EX. SIDEWALK
3.0m
EX. BOULEVARD
30.0 m
0
5
15
25
PRELIMINARY

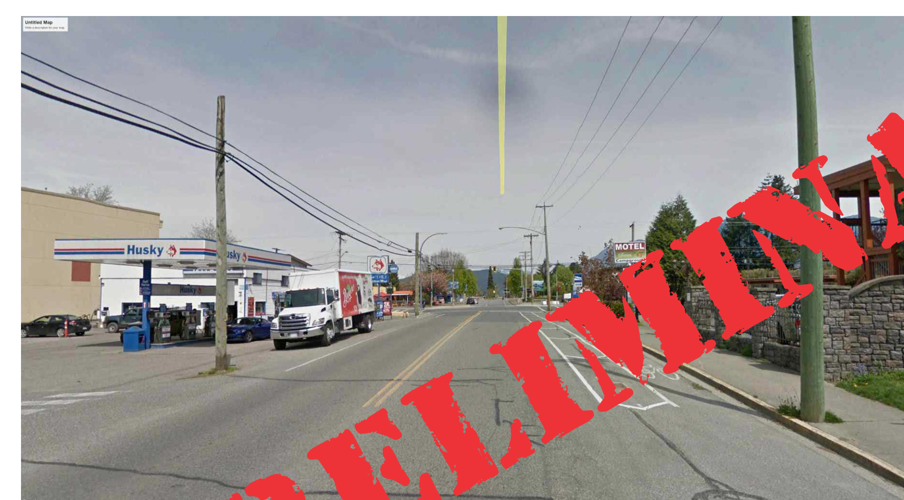
HOT SPRINGS ROAD



PRELIMINARY

HOT SPRINGS ROAD



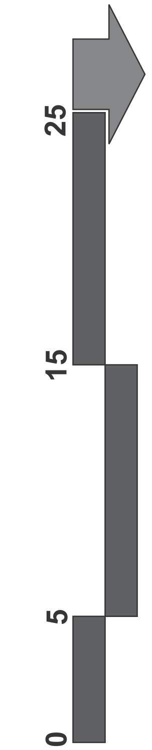


PRELIMINARY

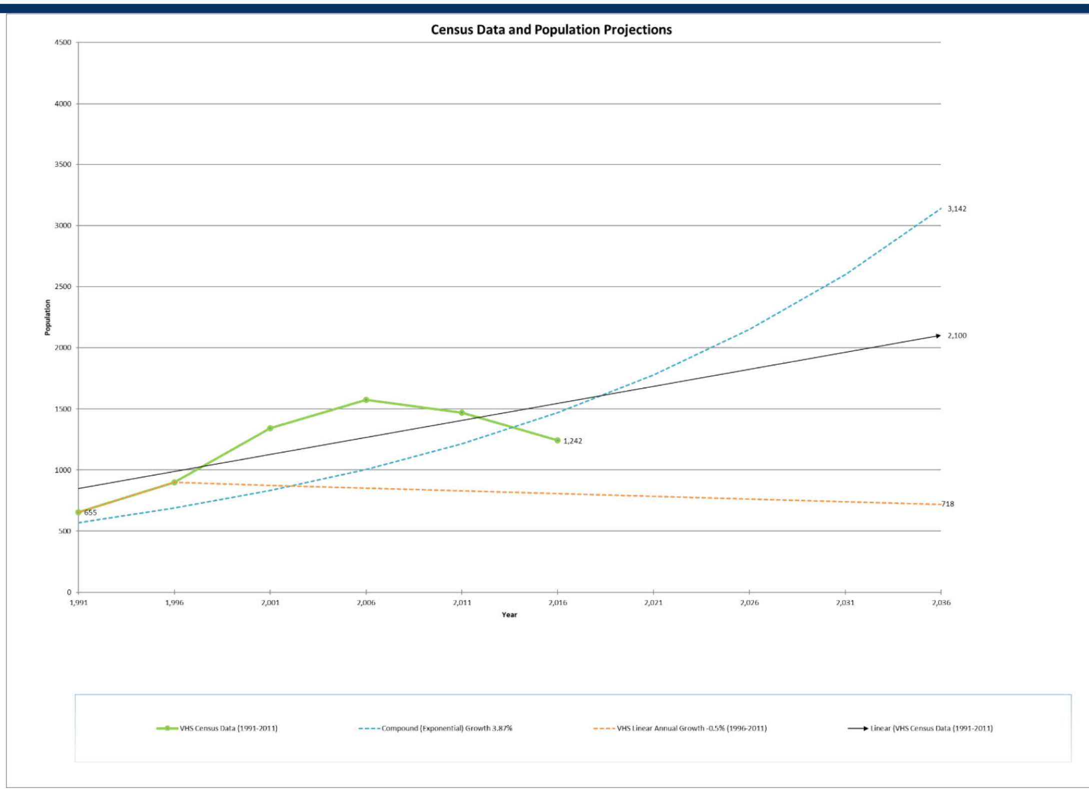
HOT SPRINGS ROAD
OPTION 2
20.00 m
3.25
PROPOSED PARALLEL PARKING
1.5m
PROPOSED BIKE LANE
3.75m
3.75m
1.5m
PROPOSED BIKE LANE
3.25m
PROPOSED BOULEVARD
1.5m
SIDEWALK
0
5
15
25
PRELIMINARY

HOT SPRINGS ROAD

OPTION 1



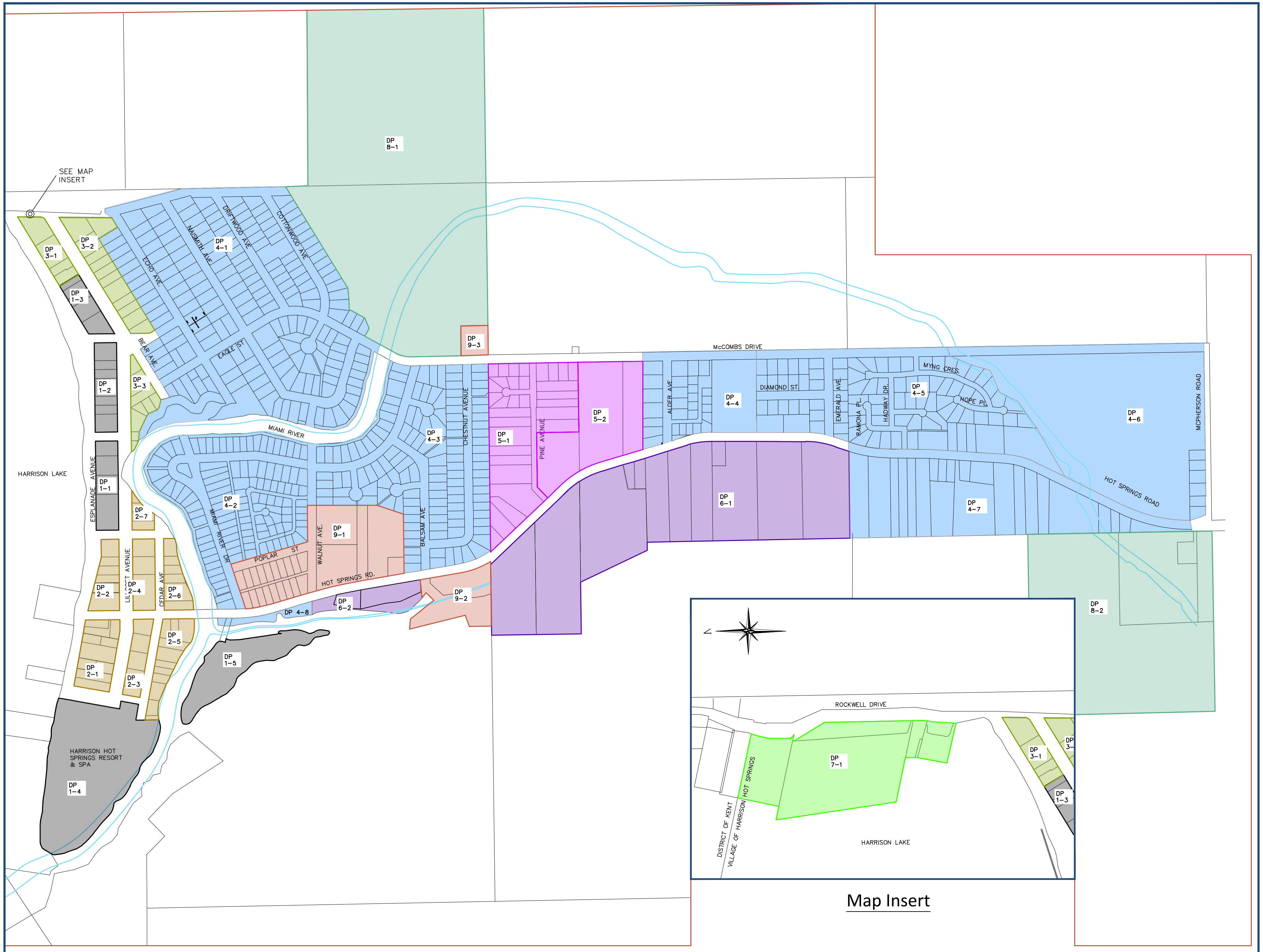
Appendix F – Population Projections



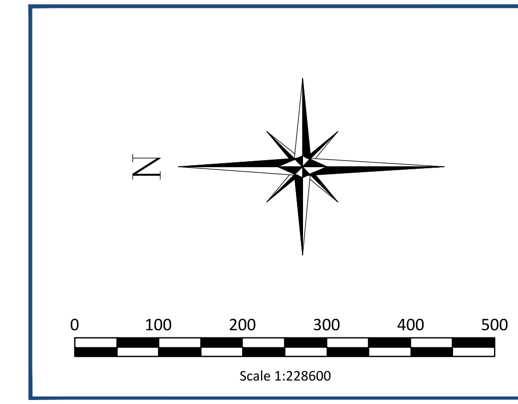
HARRISON HOT SPRINGS
Naturally Refreshed

CTQ

FIGURE 7: Population Projections



Map Insert



Density projections are based on OCP land use designations, except where zoning has been amended to a Comprehensive Development zone.

Summary of development projections:

Density Projection Area	Commercial	New Lots	Residential Infill
1	5,035 m2	130 units	-----
2	9,941 m2	289 units	-----
3	-----	84 units	-----
4	-----	59 units	43 units
5	-----	128 units	2 units
6	*246	138 units	-----
7	1,000 m2	90 units	-----
8	-----	322 units	-----
9	-----	-----	-----
Total	1,5976 m2	1,240 units	45 units

*New commercial in this area is campsites and/or accommodation rooms.

Village of Harrison Hot Springs

Development Projections

Figure 8

Project No. 12004 -37
Date: July 2019
Revision No. 0

HARRISON HOT SPRINGS
Naturally Refreshed

CTQ
ENGINEERING PLANNING URBANDESIGN

L:\General Data\Projects-2012\12004-37 - Road Inventory\4-CAD\12004-37 - Report Figure 8.dwg

Appendix G – Design Guidelines

1. VISION ZERO
2. MOMENTUM BASED DESIGN
3. ADVANCED STOP LINES

1. Vision Zero

How many traffic fatalities are acceptable? Zero. That's the motivation behind vision zero. Municipalities that have committed to vision zero have been driving the development of best practices for engineering safer roads. If humans don't use a technology as intended, then that technology is improperly engineered. The returns on trying to force behaviour on the population through enforcement are losses. Vision Zero reconciles the disparity between human behaviour and intended use through behaviour-focused engineering that is process driven. The criteria and guidelines are clear and provide the framework for design that reflects zero tolerance for traffic fatalities. A large number of pioneering municipalities have already set the bar and continue to move it further.

Vision Zero is a commitment that municipalities have made to target zero traffic fatalities per year. It sounds redundant to some, but the argument of these communities is that the design standards of the last century knowingly result in traffic deaths and that traffic fatalities are an accepted trade-off for maintaining higher speeds. From speeds that are too high to poorly designed crossings, many of the minimum road design standards are failing people in Canada. The Vision Zero concept doesn't necessarily present design standards, but commitment to the concept has driven the development of engineering standards in municipalities across the world. New York City (NYC) was one of the first large municipalities in North America to commit to Vision Zero and that city has developed some design standards motivated by their commitment. Vision Zero Street reduce automobile traffic, increase accessibility, and protect the most vulnerable street users. To qualify as a Vision Zero Street in NYC, a design must meet 3 core criteria:

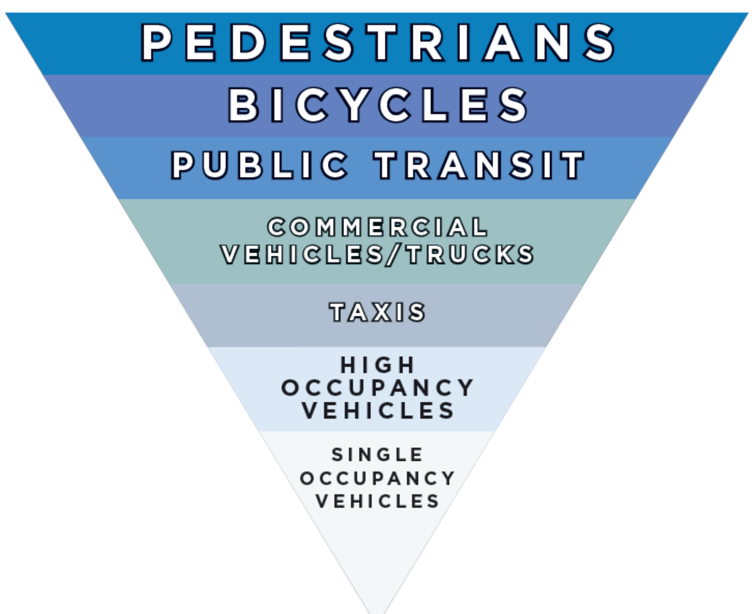
1. Discourage speeding by design rather than by signage or pavement marking;
2. Encourage walking, biking, electrified micro-mobility use, and/or public transit use; and
3. Provide simple accessibility to all, regardless of age or physical ability.

Most collisions on urban streets are preventable and in cases where they are not, actions can be taken to ensure that they are not fatal whether between two automobiles or an automobile and a vulnerable road user.

From the NYC DOT:

> The Vision Zero Street Design Standard is a guide to planning, designing and building streets that can save lives. By showing how streets can be re-engineered to prevent dangerous driving and encourage multi-modal usage, it paves a practical way toward creating a city where crashes are preventable and deaths and serious injuries can be eliminated. These street design protocols were developed with the expertise of traffic engineers and urban planners, and are based on solutions already available in the New York City Department of Transportation's Street Design Manual.

Safety must be engineered into the fabric of the street itself. When this happens, behaviour is forced to change. In the best of cases, the change in driver behaviour happens subconsciously. Without major changes in street design, no city will eliminate deaths and serious injuries on its roads. Traditional roads, from the first century of the automobile, encourage speeding, limit space for unprotected humans, treat all unmotorized users as second-class citizens, and force cyclists into the most vulnerable position on the road. These roads will not reach zero. These flaws in design can all be fixed. Luckily for the Village, other municipalities have trodden much new ground in solving these problems.
The ranking of priorities for NYC Vision Zero is as follows:



This conforms nicely to the principles of 8-80 Cities discussed earlier. It also helps the Village achieve goals of environmental, social, and economic sustainability. It's less land intensive than

traditional roadways as well. There are many potential benefits, although, in the Village's case, some modifications would be needed to suit the Village's unique requirements.
A Vision Zero street according to NYC DOT, the North American Pioneers of Vision Zero, there are 10 elements that make up a Vision Zero street:

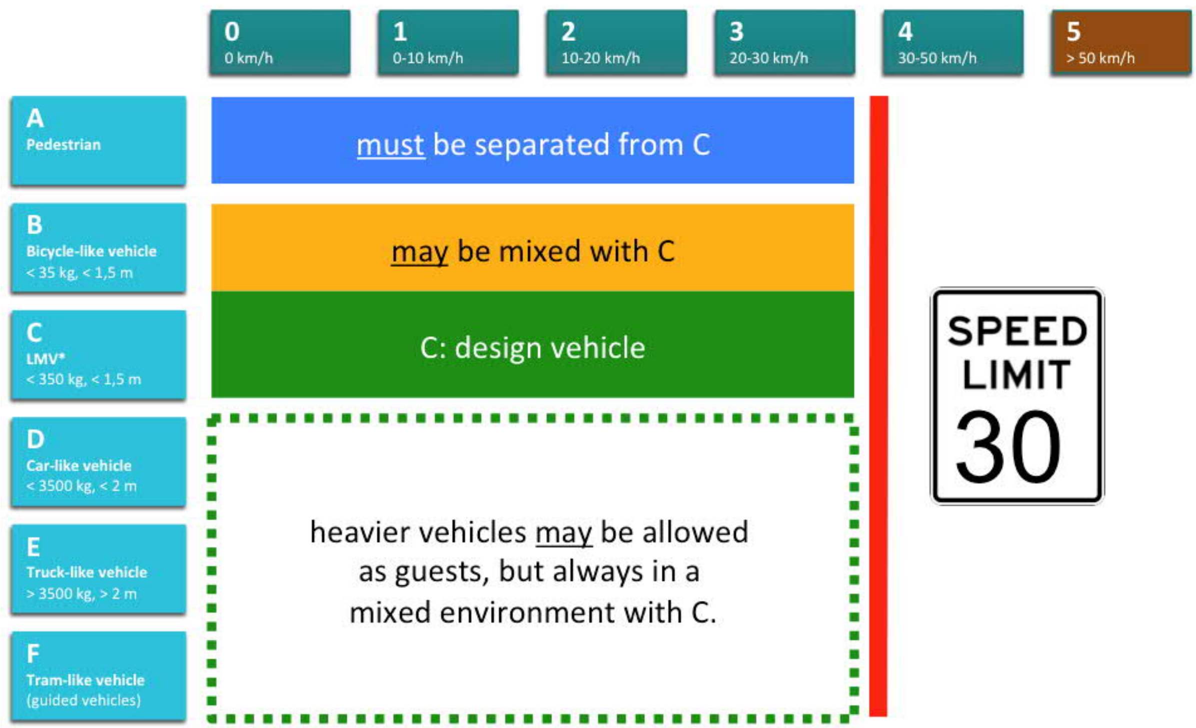
1. American Disabilities Act (Canada doesn't have a Disabilities Act) Compliance – Pedestrian access for people of all abilities
2. Public Amenities – wayfinding, benches, shelters, greenery, and other enhancements to public realm
3. Protected Bike Lanes – Protected by parked cars, barriers, greenery, or other infrastructure
4. Narrow Vehicle Lanes - reduce car lanes by 150mm or more to accommodate protected infrastructure
5. Pedestrian Islands – On all wide roads
6. Wide Sidewalks – A minimum of 2.5m wide
7. Dedicated Mass Transit Facilities – Tour bus shelters, etc.
8. Signal-Protected Pedestrian Crossings – Exclusive crossing time for pedestrians in all directions. Can be shared with other active modes. Green Scrambles, etc.
9. Dedicated Unloading Zone – for commercial traffic
10. Signal Retiming (not relevant to the Village)

We recommend the use of the NYC Vision Zero street design standards for the Village, particularly in discussions regarding MoTI jurisdiction on Hot Springs Road and Lillooet Avenue.

2. Momentum-Based Design

A solution that achieves both traffic calming goals while increasing micromobility and active transportation usage is to re-engineer roads classified as local roads or lanes for mixed use. To suit that aim, the Village will design these spaces for momentum, offering a slight shift in perspective from speed-based design. In this way, these environments will not exclude heavy modes of transportation, but the environment can be designed for pedestrians and wheelchairs as the primary user of the space.

Rather than dividing traffic into speed groups, modes are grouped into “momentum classes.” The mass of every mode is a constant and speed is treated as a design variable. Momentum combines speed and mass. Designing by speed and separating modes by momentum relates each mode to the environment and forms the basis for the recommended classification. The momentum classification for each environment will inform decisions on which modes can mix and which cannot. Consider the following example illustrated by **Figure 17:**



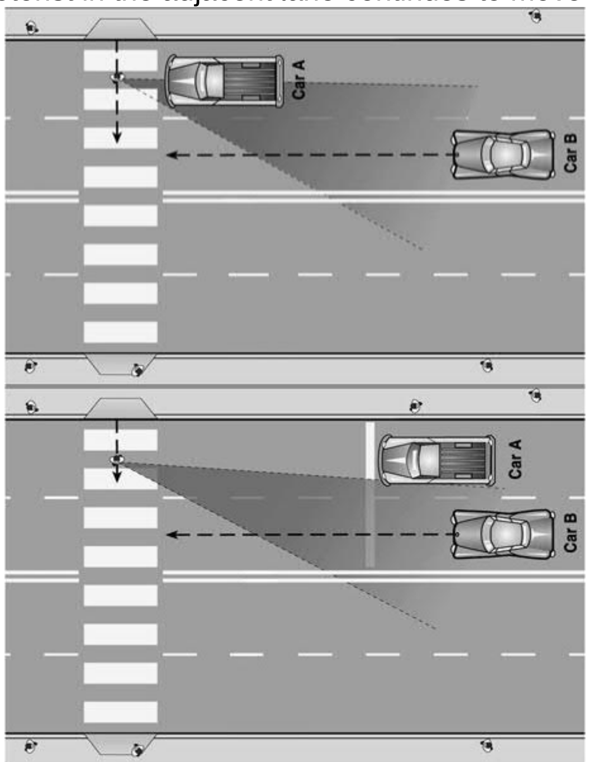
In the example: the environment has been designed for a 30 km/h speed for Light Motor Vehicles like mopeds and scooters. Pedestrians are too light to mix with the design vehicle at the design speed, but bicycles and e-bikes can achieve similar speeds and therefore are at less risk if mixed. Heavier vehicles must travel at the design speed to reduce the risk to the design vehicle and the environment must be designed for mixing at this speed.

Applying the same concepts with a pedestrian design “vehicle” with a design speed of 5 km/h, the space is shared by all users and designed to keep all users at 5 km/h. On the flip side, using automobiles at their optimum highway speed of 100 km/h means that no other modes can share the same space as the design vehicle since no other modes come close to this momentum. Momentum based design is necessary for Shared Streets, but has applications to other types of transportation infrastructure as well. These methods can integrate electrified micromobility more readily than traditional mode-based divisions of the space. Additionally, momentum-based analysis provides a clearer definition of what exactly pedestrian or cycling infrastructure should look like, avoiding tokenized marginalization to the periphery of the street.

Momentum-based design lets the space guide the speed of traffic. It uses Engineering Controls as discussed in the Hierarchy of Controls to guide driver behaviour.

3. ADVANCED STOP LINES

An advance stop or yield line placed 10 to 20 metres ahead of the crosswalk can greatly reduce the likelihood of a multiple-threat crash at unsignalized midblock crossings. A multiple-threat collision is a pedestrian crash that occurs when pedestrians must cross more than one lane in each direction. A motor vehicle in one lane stops and provides a visual screen to the motorist in the adjacent lane. The motorist in the adjacent lane continues to move and hits the pedestrian.



The line encourages drivers to stop back far enough so a pedestrian can see if a second motor vehicle is not stopping and, if necessary, be able to take evasive action. A setback of 10 metres for the line has been found to be a good distance for most purposes. Also, parking should be restricted between the stop or yield line and the crosswalk to allow for better visibility.

The advance stop or yield line should be supplemented with "Stop (or Yield) Here for Pedestrians" signs (R1-5, R1-5a, R1-5b, or R1-5c) to alert drivers where to stop to let a pedestrian cross. In the United States, one study found that use of a "sign alone reduced conflicts between drivers and pedestrians by 67 percent, and with the addition of an advanced stop or yield line, this type of conflict was reduced by 90 percent compared to baseline levels" (Van Houten & Malenfant, 1992).

Studies have found that advance yield markings at midblock crossings can be particularly useful when combined with signs and beacons, such as the Pedestrian Hybrid Beacon or rectangular rapid flash beacon (RRFB).

Appendix H – Assessment Results

Road Segment	Traffic Level	Direction	EOP Width	Length	Lane 1 (L1)	Lane 2 (L2)	L1 Parking	L2 Parking	L1 Drainage	L2 Drainage
Esplanade Ave (Saint Alice to Hot Springs)	High	W	10.6		WBL	N/A - One Way	Reverse Angle	N/A - One Way	Sidewalk Barrier Curb	N/A - One Way
Esplanade Ave (Hot Springs to Maple)	High	E	10.6		EBL	N/A - One Way	Reverse Angle	N/A - One Way	Sidewalk Barrier Curb	N/A - One Way
Esplanade Ave (Maple to Chehalis)	High	E	15.6		EBL	N/A - One Way	Reverse Angle	N/A - One Way	Sidewalk Barrier Curb	N/A - One Way
Esplanade Ave (Chehalis to Spruce)	High	E	15.6		EBL	N/A - One Way	Reverse Angle	N/A - One Way	Ditch	N/A - One Way
St Alice St N	High	NS	11.3		NBL	SBL	Angle	Angle	Barrier Curb	Sidewalk Barrier Curb
St Alice St S	High	NS	11.3		NBL	SBL	Bus - Parallel	Angle	Barrier Curb	Sidewalk Barrier Curb
Cedar Ave (West of Hot Springs)	High	EW	14.45		EBL	WBL	Angle	Angle	Sidewalk Barrier Curb	Barrier Curb
Cedar Ave (Hot Springs to Maple)	High	EW	3.25; 11; 7.9		EBL	WBL	Angle	Angle	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Maple St (Cedar to Lillooet)	Moderate	NS	7.2		NBL	SBL	Angle	None	No Curb, no Sidewalk, no Ditch	Sidewalk Barrier Curb
Maple St (Lillooet to Esplanade)	Moderate	NS	7.2		NBL	SBL	Angle	None	No Curb, no Sidewalk, no Ditch	Sidewalk Barrier Curb
Chehalis St	High	NS	13.3		NBL	SBL	Angle	Angle	Barrier Curve - Boulevard - Sidewalk	Barrier Curve - Boulevard - Sidewalk
Spruce St (Lillooet to Echo)	High	NS	11.8		NBL	SBL	Parallel	None	No Curb, no Sidewalk, no Ditch	Ditch
Spruce St (Esplanade to Lillooet)	High	NS	11.8		NBL	SBL	Reverse Angle	Parallel	Barrier Curb	Barrier Curb
Echo Ave (West of Eagle)	Low	EW	6		EBL	WBL	Parallel	Parallel	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Echo Ave (East of Eagle)	Low	EW	6		EBL	WBL	Parallel	Parallel	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Cottonwood Pl	Low	EW	10.6		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Cottonwood Ave	Low	EW	8.2		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
McCombs Dr (McPherson to Hadway S)	High	NS	7.3		NBL	SBL	None	None	Ditch	Ditch
McCombs Dr (Hadway S to Emerald)	High	NS	7.3		NBL	SBL	None	None	Ditch	Ditch
McCombs Dr (Emerald to Alder)	High	NS	7.3		NBL	SBL	None	None	Ditch	Barrier Curb
McCombs Dr (Alder to Pine)	High	NS	7.8		NBL	SBL	None	None	Ditch	No Curb, no Sidewalk, no Ditch
McCombs Dr (Pine to Chestnut)	High	NS	8		NBL	SBL	None	None	Ditch	Rollober Curb
McCombs Dr (Chestnut to Miami River Dr)	High	NS	7.5		NBL	SBL	None	None	Ditch	Rollober Curb
Lillooet Ave (Saint Alice to Hot Springs)	High	EW	18.3		EBL	WBL	Parallel	Perpendicular	Barrier Curb	Sidewalk Barrier Curb
Lillooet Ave (Hot Springs to Maple)	High	EW	17.6		EBL	WBL	Parallel	Parallel	Barrier Curb	Sidewalk Barrier Curb
Lillooet Ave (Maple to Chehalis)	High	EW	13.9		EBL	WBL	Reverse Angle	Parallel	Sidewalk Barrier Curb	Sidewalk Barrier Curb
Lillooet Ave (East of Chehalis)	High	EW	11		EBL	WBL	Parallel	Parallel	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Pine Ave (Hot Springs to Lakberg)	Moderate	EW	7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Pine Ave (Lakberg to Eagle)	Moderate	EW	7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Lakberg Cres	Low	NS	7		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Poplar St	Moderate	NS	10.7		NBL	SBL	Parallel	Parallel	Sidewalk Rollover Curb	Rollober Curb
Walnut Ave (Hot Springs to Poplar)	Low	EW	10.7		EBL	WBL	Parallel	Perpendicular	Sidewalk Rollover Curb	Rollober Curb
Walnut Ave (Poplar to Eagle)	Low	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Fern Pl	Low	EW	8.8		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Balsam Ave (Hot Springs to Chestnut)	Moderate	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Balsam Ave (Chestnut to Clover)	Moderate	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Balsam Ave (Clover to Miami River)	Moderate	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Clover Pl	Low	NS	8.9		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Juniper Pl	Low	NS			NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Chestnut Ave	Low	EW	10.6		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Schooner Pl	Low	EW	8.9		EBL	WBL	Parallel	Parallel	Rollober Curb	Sidewalk Rollover Curb
Alder Ave	Moderate	EW	7.3;8.7		EBL	WBL	Parallel	Parallel	Barrier Curb	Barrier Curb
Emerald Ave	Moderate	EW	9		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Diamond St	Low	NS	9		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Hadway Dr N	Low	EW	9		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Hadway Dr S	Low	EW	6.9		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Myng Cres (Hope to Hadway S)	Low	NS	6.5		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Myng Cres (Hadway S to Hadway N)	Low	NS	6.5		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Myng Cres (North of Hadway N)	Low	NS	6.5		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Angus Pl	Low	NS	6.5		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Hope Pl	Low	NS	6.5		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Ramona Pl (Hot Springs to Hadway)	Moderate	NS			NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Ramona Pl (North of Hadway)	Low	NS	6.5		NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb
McPherson Rd (to Eagle	High	EW			EBL	WBL	Parallel	Parallel	Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Miami River to Naismith)	High	NS	10.7		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Cottonwood to Naismith)	High	NS	10.7		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Driftwood to Cottonwood)	High	NS	10.4		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Naismith to Driftwood)	High	NS	10.4		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Echo to Naismith)	High	NS	10.9		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Bear to Echo)	High	NS	10.9		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Eagle St (Lillooet to Bear)	High	NS	10.9		NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Bear Ave	Moderate	EW			EBL	WBL	Parallel	Parallel	Ditch	No Curb, no Sidewalk, no Ditch
Naismith Ave (West of Eagle)	Low	EW			EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Naismith Ave (East of Eagle)	Low	EW			EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Cottonwood Pl	Low	EW			EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Cottonwood Ave	Low	EW			EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Hot Springs to Poplar)	High	EW	10.8		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Poplar to Walnut)	High	EW	10.8		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Loop)	High	EW	10.8		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Walnut to Fern)	High	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Fern to Balsam)	High	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Balsam to Juniper)	High	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Miami River Dr (Juniper to McCombs)	High	EW	10.7		EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Hot Springs Rd (South of McPherson)	High	NS			NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (McPherson to Ramona)	High	NS			NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Ramona to Emerald)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Emerald to Alder)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Alder to Pine)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Pine to Balsam)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Balsam to Walnut)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Walnut to Miami River)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Miami River to Cedar)	High	NS			NBL	SBL	None	None	Sidewalk Barrier Curb	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Cedar to Lillooet)	High	NS			NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Hot Springs Rd (Lillooet to Esplanade)	High	NS			NBL	SBL	None	None	No Curb, no Sidewalk, no Ditch	No Curb, no Sidewalk, no Ditch
Driftwood Ave	Low	EW			EBL	WBL	Parallel	Parallel	Rollober Curb	Rollober Curb
Mount St	Low	NS			NBL	SBL	Parallel	Parallel	Rollober Curb	Rollober Curb

Road Segment	L1 Alligator Crack Severity	L1 Transverse Crack Severity	L1 Longitudinal Crack Severity	L1 Edge Breakdown Severity	L2 Alligator Crack Severity	L2 Transverse Crack Severity	L2 Longitudinal Crack Severity	L2 Edge Breakdown Severity
Esplanade Ave (Saint Alice to Hot Springs)	None	None	None	None	None	None	None	None
Esplanade Ave (Hot Springs to Maple)	None	None	None	None	None	None	None	None
Esplanade Ave (Maple to Chehalis)	None	Moderate	Moderate	None	None	None	None	None
Esplanade Ave (Chehalis to Spruce)	None	None	None	None	None	None	None	None
St Alice St N	None	None	None	None	None	None	None	None
St Alice St S	None	None	None	None	None	None	None	None
Cedar Ave (West of Hot Springs)	Severe	Severe	Severe	None	Severe	Severe	Severe	None
Cedar Ave (Hot Springs to Maple)	None	None	None	None	None	None	None	None
Maple St (Cedar to Lillooet)	None	None	None	None	None	None	None	None
Maple St (Lillooet to Esplanade)	None	None	None	None	None	None	None	None
Chehalis St	None	None	Minimal	None	None	None	None	None
Spruce St (Lillooet to Echo)	None	Minimal	Minimal	None	None	Minimal	Minimal	None
Spruce St (Esplanade to Lillooet)	None	Minimal	Minimal	None	None	Minimal	Minimal	None
Echo Ave (West of Eagle)	Severe	Moderate	None	None	Severe	Moderate	Moderate	None
Echo Ave (East of Eagle)	Moderate	None	Minimal	None	Severe	Minimal	Moderate	None
Cottonwood Pl	None	Minimal	Moderate	None	None	Minimal	Moderate	None
Cottonwood Ave	None	None	None	None	None	Minimal	Severe	None
McCombs Dr (McPherson to Hadway S)	Moderate	None	None	Moderate	Moderate	None	None	Moderate
McCombs Dr (Hadway S to Emerald)	Moderate	None	None	None	Moderate	None	None	Moderate
McCombs Dr (Emerald to Alder)	Moderate	None	None	None	None	None	None	None
McCombs Dr (Alder to Pine)	Moderate	None	None	None	None	None	None	None
McCombs Dr (Pine to Chestnut)	None	None	None	None	Moderate	None	None	None
McCombs Dr (Chestnut to Miami River Dr)	None	None	None	None	Moderate	None	None	None
Lillooet Ave (Saint Alice to Hot Springs)	Minimal	None	Moderate	None	Severe	None	None	None
Lillooet Ave (Hot Springs to Maple)	None	Moderate	None	None	Severe	None	Moderate	None
Lillooet Ave (Maple to Chehalis)	Moderate	Minimal	Minimal	None	Moderate	Minimal	None	None
Lillooet Ave (East of Chehalis)	Moderate	Minimal	Minimal	Severe	Moderate	None	Minimal	Severe
Pine Ave (Hot Springs to Lakberg)	None	None	None	None	None	None	None	None
Pine Ave (Lakberg to Eagle)	None	None	None	None	None	None	None	None
Lakberg Cres	None	None	None	None	None	None	None	None
Poplar St	None	None	Moderate	None	None	Minimal	Minimal	None
Walnut Ave (Hot Springs to Poplar)	Minimal	None	Minimal	None	Severe	Moderate	Severe	None
Walnut Ave (Poplar to Eagle)	None	None	None	None	Minimal	Moderate	None	None
Fern Pl	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	None	None
Balsam Ave (Hot Springs to Chestnut)	None	Minimal	Minimal	None	None	None	Minimal	None
Balsam Ave (Chestnut to Clover)	Moderate	None	Minimal	None	Moderate	Moderate	Minimal	None
Balsam Ave (Clover to Miami River)	Severe	Severe	Minimal	None	Severe	Severe	Minimal	None
Clover Pl	Severe	Moderate	Minimal	Minimal	Severe	Moderate	None	None
Juniper Pl	Minimal	Moderate	None	None	Severe	Moderate	Minimal	None
Chestnut Ave	Moderate	Minimal	Moderate	None	None	Moderate	Moderate	None
Schooner Pl	None	None	None	None	None	None	None	None
Alder Ave	Minimal	Moderate	Minimal	None	Minimal	Moderate	Minimal	None
Emerald Ave	None	None	None	None	None	None	None	None
Diamond St	None	None	None	None	None	None	None	None
Hadway Dr N	None	None	None	None	None	None	None	None
Hadway Dr S	None	None	None	None	None	None	None	None
Myng Cres (Hope to Hadway S)	None	None	None	None	None	None	None	None
Myng Cres (Hadway S to Hadway N)	None	None	None	None	None	None	None	None
Myng Cres (North of Hadway N)	None	None	None	None	None	None	None	None
Angus Pl	None	None	None	None	None	None	None	None
Hope Pl	None	None	None	None	None	None	None	None
Ramona Pl (Hot Springs to Hadway)	None	None	None	None	None	None	None	None
Ramona Pl (North of Hadway)	None	None	None	None	None	None	None	None
McPherson Rd (to Eagle	Severe	None	None	None	Severe	None	None	None
Eagle St (Miami River to Naismith)	None	None	None	None	None	None	None	None
Eagle St (Cottonwood to Naismith)	None	None	None	None	None	None	None	None
Eagle St (Driftwood to Cottonwood)	None	None	None	None	None	None	Severe	None
Eagle St (Naismith to Driftwood)	None	None	Moderate	None	Minimal	None	Severe	None
Eagle St (Echo to Naismith)	None	Minimal	None	None	None	None	Severe	None
Eagle St (Bear to Echo)	None	None	None	None	None	Moderate	Severe	None
Eagle St (Lillooet to Bear)	None	None	Minimal	None	None	None	None	None
Bear Ave	Severe	Severe	Severe	None	Severe	Severe	Severe	None
Naismith Ave (West of Eagle)	Severe	Severe	Severe	Moderate	Severe	Severe	Severe	Moderate
Naismith Ave (East of Eagle)	None	None	Minimal	None	None	None	None	None
Cottonwood Pl	None	Severe	Minimal	None	None	Severe	None	None
Cottonwood Ave	None	Minimal	Moderate	None	None	None	None	None
Miami River Dr (Hot Springs to Poplar)	None	None	None	None	None	None	None	None
Miami River Dr (Poplar to Walnut)	Moderate	None	Moderate	None	None	Minimal	Moderate	None
Miami River Dr (Loop)	None	None	None	None	None	None	None	None
Miami River Dr (Walnut to Fern)	None	Severe	Moderate	None	Moderate	None	None	None
Miami River Dr (Fern to Balsam)	None	Moderate	None	None	Severe	None	Moderate	None
Miami River Dr (Balsam to Juniper)	None	Moderate	Moderate	None	Moderate	Moderate	Severe	None
Miami River Dr (Juniper to McCombs)	None	None	None	None	None	None	None	None
Hot Springs Rd (South of McPherson)	None	None	None	None	None	None	None	None
Hot Springs Rd (McPherson to Ramona)	None	Moderate	Moderate	None	None	None	None	None
Hot Springs Rd (Ramona to Emerald)	None	None	Severe	None	None	None	None	None
Hot Springs Rd (Emerald to Alder)	None	Moderate	Severe	None	None	None	None	None
Hot Springs Rd (Alder to Pine)	None	Severe	Moderate	None	None	None	None	None
Hot Springs Rd (Pine to Balsam)	None	Minimal	None	None	None	None	None	None
Hot Springs Rd (Balsam to Walnut)	Moderate	Severe	Severe	None	None	None	None	None
Hot Springs Rd (Walnut to Miami River)	None	Minimal	Severe	None	None	None	None	None
Hot Springs Rd (Miami River to Cedar)	None	None	Severe	None	None	None	None	None
Hot Springs Rd (Cedar to Lillooet)	None	None	None	None	None	None	None	None
Hot Springs Rd (Lillooet to Esplanade)	None	None	None	None	None	None	None	None
Driftwood Ave	None	Minimal	Minimal	None	Minimal	Minimal	Moderate	None
Mount St	None	None	Minimal	None	None	Minimal	None	None

Road Segment	L1 Comments	L2 Comments
Esplanade Ave (Saint Alice to Hot		
Esplanade Ave (Hot Springs to M		
Esplanade Ave (Maple to Chehali		
Esplanade Ave (Chehalis to Spruc		
St Alice St N		
St Alice St S		
Cedar Ave (West of Hot Springs)		
Cedar Ave (Hot Springs to Maple)		
Maple St (Cedar to Lillooet)		
Maple St (Lillooet to Esplanade)		
Chehalis St	Apparent patch joint, full length; recommend crach sealing	Under Construction during assessment, visually matches other lane
Spruce St (Lillooet to Echo)	Sealed Cracks; sealant in good condition; Good general condition; long. Cracking about 1.5m off EOP	Worn, but in good condition
Spruce St (Esplanade to Lillooet)		
Echo Ave (West of Eagle)	Some Crack Sealing, Not Effective; Sub-Surface Failure	Gravel Shoulder placed by residents
Echo Ave (East of Eagle)		
Cottonwood Pl	Crack Sealing degrading, recommend new crack seal; patch at address 5000, in good condition	Grass growing in gutter/EOP line
Cottonwood Ave		Patches around valves and MHs
McCombs Dr (McPherson to Had		
McCombs Dr (Hadway S to Emer		
McCombs Dr (Emerald to Alder)		
McCombs Dr (Alder to Pine)		
McCombs Dr (Pine to Chestnut)		
McCombs Dr (Chestnut to Miami		
Lillooet Ave (Saint Alice to Hot S	Utility trenches and many patches; new pavement at HSR intersection; settlement at valves	Utility trenches and many patches; new pavement at HSR intersection; settlement at valves
Lillooet Ave (Hot Springs to Mapl	Utility trenches and many patches; new pavement at HSR intersection; settlement at valves	Utility trenches and many patches; new pavement at HSR intersection; settlement at valves
Lillooet Ave (Maple to Chehalis)	Utility trenches and many patches; settlement at valves	Utility trenches and many patches; settlement at valves
Lillooet Ave (East of Chehalis)	severe structure failure	severe structure failure
Pine Ave (Hot Springs to Lakberg)		
Pine Ave (Lakberg to Eagle)		
Lakberg Cres		
Poplar St		
Walnut Ave (Hot Springs to Popla		Longitudinal patch in good condition; Transverse patch in good condition
Walnut Ave (Poplar to Eagle)		
Fern Pl		
Balsam Ave (Hot Springs to Chest		Paver join crack; Trench settlement is moderate to severe, whole length
Balsam Ave (Chestnut to Clover)		
Balsam Ave (Clover to Miami Riv		
Clover Pl	Patches are still good	
Juniper Pl	Valve patch in poor condition	
Chestnut Ave	EBL showing some fatigure, worse condition than WBL	
Schooner Pl		
Alder Ave	Short Sidewalk at HSR	
Emerald Ave		
Diamond St		
Hadway Dr N	Parking Bays Beyond RC	
Hadway Dr S		
Myng Cres (Hope to Hadway S)	Parking Bays Beyond RC	
Myng Cres (Hadway S to Hadway	Parking Bays Beyond RC	
Myng Cres (North of Hadway N)	Parking Bays Beyond RC	
Angus Pl	Parking Bays Beyond RC	
Hope Pl	Parking Bays Beyond RC	
Ramona Pl (Hot Springs to Hadwa		
Ramona Pl (North of Hadway)	Parking Bays Beyond RC	
McPherson Rd (to Eagle	Potholes throughout, some new, patches failing	Utility trench full length, differential settlement and wear; severe transverse trench settlement multiple locations
Eagle St (Miami River to Naismith	Root damage	
Eagle St (Cottonwood to Naismit		
Eagle St (Driftwood to Cottonwo		
Eagle St (Naismith to Driftwood)		Alligator cracking 1m off EOP
Eagle St (Echo to Naismith)		
Eagle St (Bear to Echo)		
Eagle St (Lillooet to Bear)		
Bear Ave		
Naismith Ave (West of Eagle)		
Naismith Ave (East of Eagle)		MH settlement; Grass between EOP and gutter
Cottonwood Pl		
Cottonwood Ave		
Miami River Dr (Hot Springs to Po		
Miami River Dr (Poplar to Walnu		
Miami River Dr (Loop)		
Miami River Dr (Walnut to Fern)	Utility Crossing, Settlement	
Miami River Dr (Fern to Balsa		Alligtor Cracking around path at Fern
Miami River Dr (Balsam to Junipe		
Miami River Dr (Juniper to McCo		Alligator Cracking around valves at Juniper
Hot Springs Rd (South of McPher		
Hot Springs Rd (McPherson to Ra	New Pavement North of Miami River	
Hot Springs Rd (Ramona to Emer		
Hot Springs Rd (Emerald to Alder		
Hot Springs Rd (Alder to Pine)	Trench Patch Settlement	
Hot Springs Rd (Pine to Balsam)	Trench Patch Settlement	
Hot Springs Rd (Balsam to Walnu	Intersection patch in good condition at Balsam; Pavement Failure in front of Fire hall	
Hot Springs Rd (Walnut to Miami		
Hot Springs Rd (Miami River to C		
Hot Springs Rd (Cedar to Lillooet	Paver joint about to need crack sealing	
Hot Springs Rd (Lillooet to Esplar		
Driftwood Ave		
Mount St		

Road Segment	General Comments
Esplanade Ave (Saint Alice to Hot Springs)	
Esplanade Ave (Hot Springs to Maple)	
Esplanade Ave (Maple to Chehalis)	
Esplanade Ave (Chehalis to Spruce)	
St Alice St N	Pavement in Good Condition; Curb and Gutter in Good Condition
St Alice St S	
Cedar Ave (West of Hot Springs)	Trench settlement, multiple locations; severe surface wear; structural failure; recommend reabilitation
Cedar Ave (Hot Springs to Maple)	
Maple St (Cedar to Lillooet)	
Maple St (Lillooet to Esplanade)	
Chehalis St	
Spruce St (Lillooet to Echo)	
Spruce St (Esplanade to Lillooet)	
Echo Ave (West of Eagle)	Some trenches and patches, no settlement
Echo Ave (East of Eagle)	
Cottonwood Pl	Cracks have extended beyond crack sealing/patches, recommend re-sealing
Cottonwood Ave	Cracks have extended beyond crack sealing/patches, recommend re-sealing
McCombs Dr (McPherson to Hadway S)	Edge breakdown, unsuitable pavement structure, 0.75m off of EOP
McCombs Dr (Hadway S to Emerald)	Edge breakdown, unsuitable pavement structure, 0.75m off of EOP
McCombs Dr (Emerald to Alder)	
McCombs Dr (Alder to Pine)	
McCombs Dr (Pine to Chestnut)	
McCombs Dr (Chestnut to Miami River Dr)	
Lillooet Ave (Saint Alice to Hot Springs)	Trench settlement, multiple locations; severe surface wear; structural failure; recommend reabilitation
Lillooet Ave (Hot Springs to Maple)	
Lillooet Ave (Maple to Chehalis)	Drainage from 50mm pipe directly to Miami River
Lillooet Ave (East of Chehalis)	Sidewalk Replacement necessary
Pine Ave (Hot Springs to Lakberg)	Paved 2018
Pine Ave (Lakberg to Eagle)	Paved 2018
Lakberg Cres	Paved 2018
Poplar St	Sidewalk does not connect to Miami River Drive
Walnut Ave (Hot Springs to Poplar)	Grass between EOP and Gutter; Some crack sealing, recommend re-sealing
Walnut Ave (Poplar to Eagle)	Grass between EOP and Gutter; Some crack sealing, recommend re-sealing
Fern Pl	Grass between EOP and Gutter; Some crack sealing, recommend re-sealing; pavement failure approximately 1 m from curb
Balsam Ave (Hot Springs to Chestnut)	Grass between EOP and Gutter; Recommend new crack sealing
Balsam Ave (Chestnut to Clover)	Grass between EOP and Gutter; Recommend new crack sealing
Balsam Ave (Clover to Miami River)	Grass between EOP and Gutter; Recommend new crack sealing
Clover Pl	Recommend new crack-sealing; Grass growin in cracks
Juniper Pl	Recommend new crack-sealing; Grass growin in cracks; CB lead trench settlement
Chestnut Ave	Recomemend new crack-sealing
Schooner Pl	New pavement; waiting for top lift; Home construction 50% complete; re-assess after top lift
Alder Ave	New pavement from HSR 100m west; trench settlement throughout east section
Emerald Ave	New Pavement, curb, and gutter (2018)
Diamond St	New Pavement, curb, and gutter (2018)
Hadway Dr N	New Pavement, curb, and gutter (2018)
Hadway Dr S	New Pavement (2018); No Parking Bay
Myng Cres (Hope to Hadway S)	New Pavement, curb, and gutter (2018)
Myng Cres (Hadway S to Hadway N)	New Pavement, curb, and gutter (2018)
Myng Cres (North of Hadway N)	New Pavement, curb, and gutter (2018)
Angus Pl	New Pavement, curb, and gutter (2018)
Hope Pl	New Pavement, curb, and gutter (2018)
Ramona Pl (Hot Springs to Hadway)	New Pavement, curb, and gutter (2018)
Ramona Pl (North of Hadway)	New Pavement, curb, and gutter (2018)
McPherson Rd (to Eagle	Structural and surface failures; recommend rehabilitation
Eagle St (Miami River to Naismith)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Eagle St (Cottonwood to Naismith)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Eagle St (Driftwood to Cottonwood)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Eagle St (Naismith to Driftwood)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Eagle St (Echo to Naismith)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Eagle St (Bear to Echo)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Eagle St (Lillooet to Bear)	Some large patches in good condition; settlement and cracking around MHs; Previous crack sealing is wearing, recommend new crack sealing
Bear Ave	
Naismith Ave (West of Eagle)	Pavement Fatigue
Naismith Ave (East of Eagle)	Ditches come and go, many filled; severe alligator cracking
Cottonwood Pl	Crack sealing in good condition; recommend localised preservation work, stay ahead of problems
Cottonwood Ave	Crack sealing in good condition; recommend localised preservation work, stay ahead of problems
Miami River Dr (Hot Springs to Poplar)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Miami River Dr (Poplar to Walnut)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Miami River Dr (Loop)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Miami River Dr (Walnut to Fern)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Miami River Dr (Fern to Balsam)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Miami River Dr (Balsam to Juniper)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Miami River Dr (Juniper to McCombs)	Small Amount of Crack Sealing, Grass between EOC and Gutter; Longitudinal and Transverse cracks starting to form; Trench Settlement Throughout; Evidence of compaction problems
Hot Springs Rd (South of McPherson)	
Hot Springs Rd (McPherson to Ramona)	
Hot Springs Rd (Ramona to Emerald)	
Hot Springs Rd (Emerald to Alder)	
Hot Springs Rd (Alder to Pine)	
Hot Springs Rd (Pine to Balsam)	
Hot Springs Rd (Balsam to Walnut)	
Hot Springs Rd (Walnut to Miami River)	
Hot Springs Rd (Miami River to Cedar)	
Hot Springs Rd (Cedar to Lillooet)	
Hot Springs Rd (Lillooet to Esplanade)	
Driftwood Ave	
Mount St	

Appendix I – Bridge Photo Inventory

1. PEDESTRIAN BRIDGE 1
2. PEDESTRIAN BRIDGE 2
3. McCOMBS DRIVE NORTH BRIDGE
4. McCOMBS DRIVE SOUTH BRIDGE

1, PEDESTRIAN BRIDGE 1

Photo 1: Side view of bridge

Photo 2: Approach view of bridge

Photo 3: View of underside of bridge

Photo 4: View of concrete abutment at west end. Light honeycombing at bottom left corner

Photo 5: View of concrete abutment at east end. Erosion of abutment should be monitored.

Photo 6: Side view of bridge. Full coating of paint was only applied on the inside face of the bridge.

2. PEDESTRIAN BRIDGE 2

Photo 1: Side view of bridge

Photo 2: Approach view of bridge

Photo 3: View of underside of bridge and pier support

Photo 4: Protective coating corroded at the bottom portion of steel piles at pier support


Photo 5: Minor general corrosion of protective coating at steel members


Photo 6: Caps missing at deck channels. Traction mat starting to loosen from support.

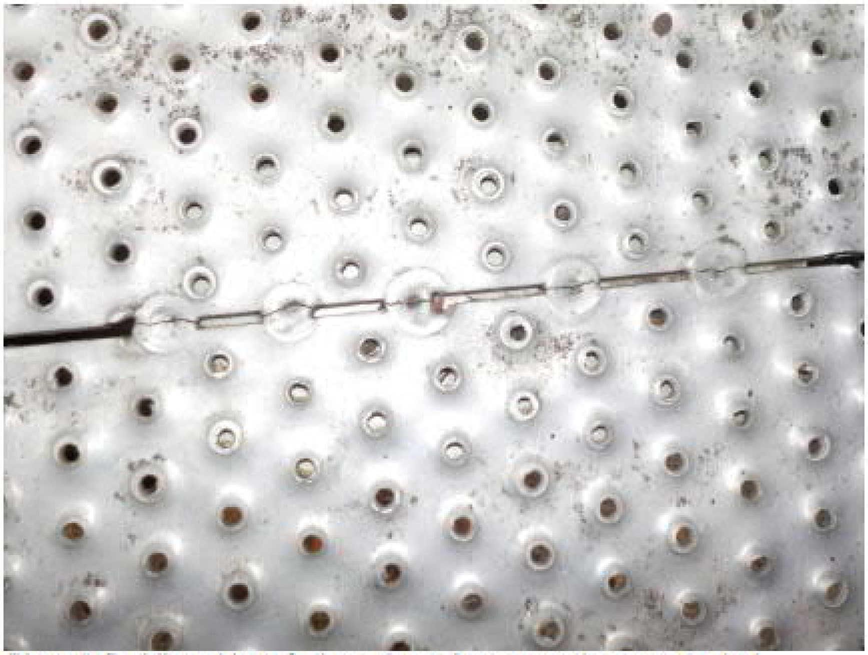


Photo 7: Puddle welds at C-channel member connections are cracked

3. McCOMBS DRIVE NORTH BRIDGE

Photo 1: Approach view of bridge

Photo 2: Side view of bridge

Photo 3: Localized settlement visible between asphalt crack and road barrier

Photo 4: View of underside of road barrier showing extent of bearing material erosion

Photo 5: Timber piles and ballast logs at wingwall

Photo 6: Cap beam and timber pile connection at south abutment

Photo 7: Cap beam and timber pile connection at north abutment. Note severe decay of cap beam.

4. McCOMBS DRIVE SOUTH BRIDGE

Photo 1: Approach view of bridge

Photo 2: Side view of bridge

Photo 3: Differential settlement at sidewalk at bridge/approach interface

Photo 4: South abutment – Left pile cracked near bottom.
Adjacent pile has severe split.


Photo 5: North abutment - note cap beam severely split and no longer bearing on top of piles


Photo 6: South abutment - note cap beam severely split and large gap between pile and ballast boards

Appendix J – Stormwater Surface Structures

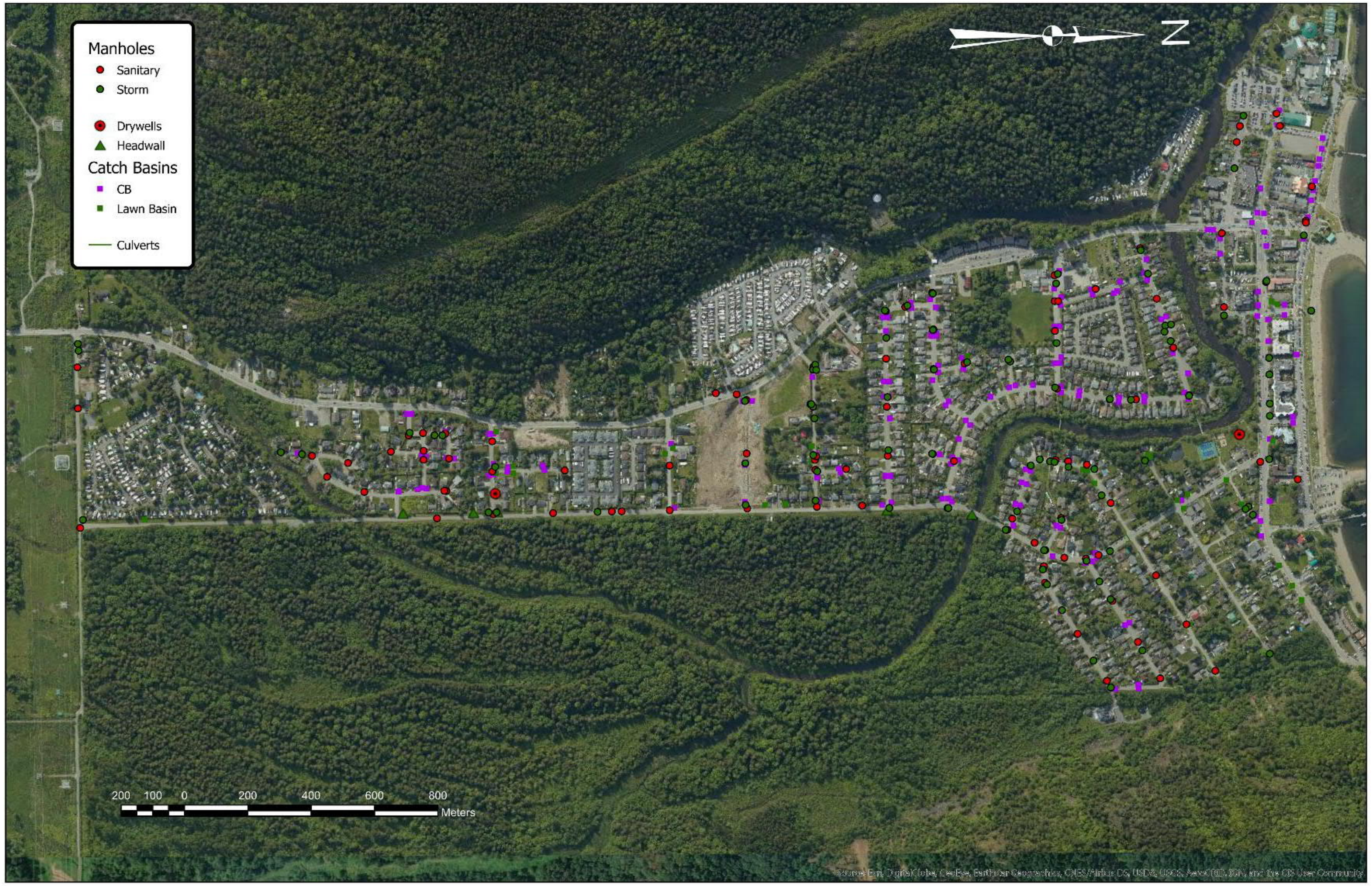


FIGURE 9: Stormwater Surface Structures

Appendix K – Vehicle Path Management Design Brief

VEHICLE PATH MANAGEMENT DESIGN BRIEF

Background

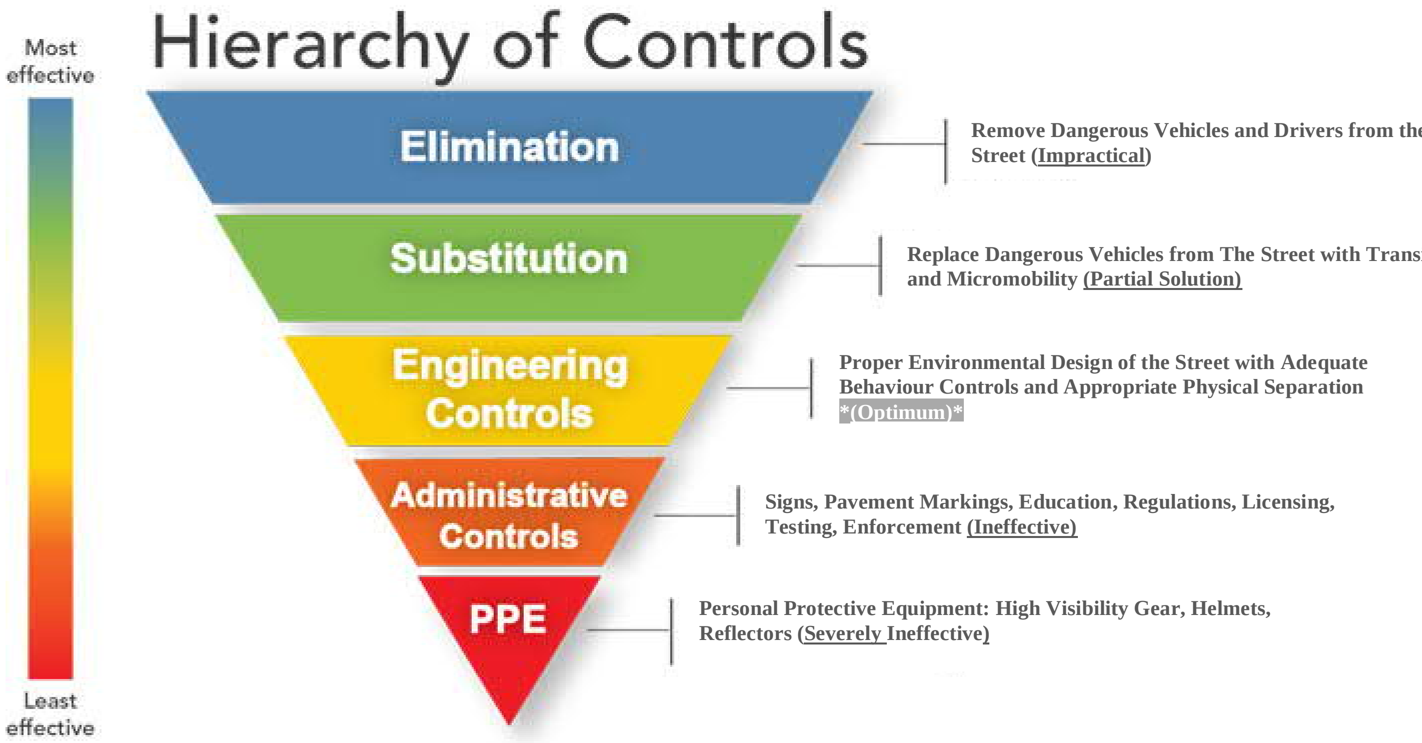
Increasing the capacity of streets to mix modes and promote sharing amongst all street users ensures municipalities can optimize their transportation network and receive greater returns on investment with regards to social, environmental, and economic sustainability. This strategy is also more robust to innovations in the transportation space like Electrified Micromobiliy (E-Bikes, E-Scooters, etc.) and Autonomous Vehicles. Vehicle Path Management (VPM) is a form of environmental design where a streetscape is engineered in a way to optimize safe and efficient movement of a large volume of people. It is a multimodal form of transportation engineering in a true sense and represents a solution that integrates equity between people and transportation modes into the streetscape.

As a form of environmental design, it is best to engineer a VPM system tailored to the specific geometric, environmental, and economic constraints of a site; however, it is possible to use a prescriptive design protocol that is flexible to budgetary constraints and achieves satisfactory, if not fully optimized, results. These streets provide intrinsic traffic calming which simultaneously slows automobile traffic and encourages active transportation by increasing the capacity, connectivity, and permeability of the micromobility network.

It is important in upgrading the micromobility network to ensure connectivity and permeability between all sections to create multiple continuous, safe routes. That said, the Village may not have enough resources to implement the entire route to the highest standard all at once. Rather than implement the routes in a piecemeal fashion, which would not benefit cyclists and could provoke criticism of the project, it would be preferable to implement the Active Transportation Master Plan (Plan) at a low cost, focusing the initial investment in the sections and intersections that would provide the greatest "return on investment" in terms of safety improvements, and attract the greatest number of cyclists of all ages and abilities. After the initial implementation at a low cost, iterative improvements can be made as budgets allow in order to achieve the long-term vision of the Plan.

It will also be important to stretch the Village's available funding by implementing bicycle facilities within existing road cross-sections, rather than looking to buy property and widen roads in order to construct new facilities. The Village has indicated a desire to consider the full range of options for reconfiguring road cross-sections to safely accommodate cyclists.

VPM solutions are an innovative solution that will require some adaptation from users over a period of transition. In early implementations of this optimized solution, it will be important to identify opportunities to construct bicycle facilities to a “temporary” or “interim” standard to test geometry and operations and minimize initial implementation costs before constructing permanent facilities. The plans discussed below involve pavement marking, signs, and removable pieces of infrastructure to keep costs low, ensure re-usability of physical infrastructure, and provide flexibility to adapt these spaces to their optimized use.



In line with the Hierarchy of Controls, Engineering Controls are the most optimized way of ensuring the safety of all people sharing the street, regardless of mode. Personal Protective Equipment and Administrative Controls are too ineffective, Elimination and Substitution too expensive. Vehicle Path Management on streets is a form of engineering control, it requires careful engineering of the street environment. It is different from other forms of Engineering Controls like protected infrastructure due to the emphasis on engineering shared spaces rather than separate spaces.

VPM moves away from out-dated notions of Positive Guidance, where streetscapes were kept non-complex and predictable to facilitate high-speed movement of automobiles. In place of Positive Guidance, we see an environment engineered to implicitly and indirectly manage behaviours of drivers in dangerous automobiles to provide more comfortable spaces for all users. This is all accomplished without punishing automobile drivers.

Engineered VPM solutions increase the capacity of streets to facilitate the sharing the space between modes. VPM design is the method best able to accommodate the rising use of e-bikes and e-scooters as well. The use of electrically motorized bicycles is growing each year. So is the use of e-scooters. Municipalities are struggling with what do with this form of traffic which is stretching bike lane and sidewalk capacity beyond it's limits in many cities. The concept of adding yet another "lane" - or painting another dividing line on existing roads - is impractical at this point since this strategy has also been used to adjust haphazardly for increased cyclist traffic. Another token lane will not improve the situation on roads. At the same time, electrified modes are slightly faster than walking or casual cycling, therefore posing a risk to more human-powered modes of transportation that share the tiny spaces on the fringes of roadways currently allotted to active modes. The least costly and most effective solution may also be the simplest. VPM solutions that accommodate more modes sharing the entire street space are inclusive of all modes of transportation and adapt to the increased mode choice of today's street user.

Principles for Vehicle Path Management in the Village of Harrison Hot Springs

The principle behind managing the path of vehicles is to slow the automobiles down such that these residential streets become a calmed shared environment. Rather than having separate areas of street designated for specific users i.e. motorized vehicles get the asphalt in a straight line and pedestrians get the sidewalks on the edges, the street is treated as one shared surface. These streets are identified by marked and signed entry treatments indicating to drivers that this is a slow vehicle environment. By the strategic placement of parked vehicles, street furniture or trees (which can also be used for surface water treatment), parklets, or other physical features, the street changes from being a straight through corridor designed to promote vehicle speeds to one where the vehicles have to reduce their speed and share the environment with the other users and neighbours. These often include areas used by children playing in summer and for snow storage in winter.

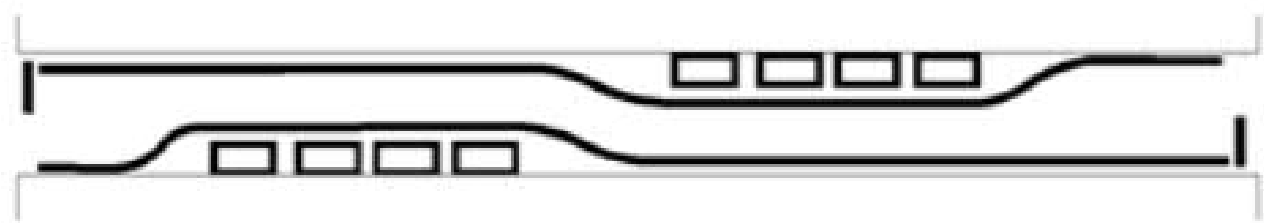


Figure 2 - Conceptual Sketch of Vehicle Path Management showing a travel path that meanders around parked cars between two intersections.

In the Village there are a number of residential streets that do not currently have sidewalks or separated pedestrian facilities but do have an asphalt surface. The spaces are already being shared by different modes, but still signal an automobile-dominated space and do not formalize the equity amongst all road users. Residents concerned that they might hold up the passing traffic often walk and travel as far off the travel lanes as possible, sometimes, completely in the boulevard. This has the effect of giving the traffic no reason to slow down. This then leads to residents only occupying the street for the least amount of time possible.

Without formalizing equity amongst modes on KEY corridors, automobile speeds will continue to be dangerous. An expensive alternative to VPM is vertical deflections in the form of speed bumps and speed humps, which achieve lower speeds while doing nothing to improve equity amongst users while punishing all automobile users regardless of their historical performance. Additionally, vertical deflections are contradictory, they preserve a roadways automobile-dominance while punishing only automobile users.

VPM offers an alternative that achieves much more than vertical deflections ever could. Should suitable locations in the Village see inappropriate vehicle speeds then they could, through strategically placed parking and physical infrastructure, create a new vehicle path, marked out in road paint at a relatively low cost. Should a more permanent means altering the vehicle path be desired then chicanes can be installed using other physical barriers.

The Design Process

Vehicle Path Management, as the name suggest, designs a unique path taken by vehicles, particularly automobiles, but as volumes of active transportation users increases, the strategies can be applied to other modes and types vehicles. The design approach uses engineered elements of the streetscape to calm traffic, make room for active modes of transportation, accommodate electrified micromobility, and increase accessibility to vulnerable road users.

The VPM Design Process can be broken down into the following steps:

1. Identify the automobile volume of the road being improved.
2. Select a design vehicle based on the priorities of the improvement or according to the Plan.
3. Identify the Design Momentum of the road section using the typical speed and mass of the design vehicle.
4. Identify the mode separation requirements according to Momentum-Based Design best practices.
5. Two options at this stage:
    a. Engineer a tailor-made, optimized solution to the specific intersection in question; or
    b. Adapt the following prescriptive examples that may not be performance optimized but will control design costs while providing satisfactory outcomes.

Treatments vary depending on the application to where the road fits into the hierarchy/classification

Identifying Automobile Volume

Design vehicle traffic volumes may be measured through traffic counts or estimated by a professional engineer in good standing with EGBC. It is important to tailor the VPM solution to the target level of automobile volume, which may differ from existing volumes. Decisions should be based on the project's goals, the following table can facilitate improved decision making:

Score the following goals from 1 (Low Priority) to 5 (High Priority):

Decrease the Volume of Automobiles:	________
Increase the Volume of Micromobility:	________
Increase the Volume of Pedestrians:	________
Decrease the Speed of Automobiles:	________
Improve the safety for 8 and 80 year-olds:	________
Improve safety for people with disabilities:	________
Improve the aesthetic quality of the Streetscape:	________
Total Score:	________

The higher the score, the more intensive the Vehicle Path Management should be.

Identify the Design Vehicle

If the selected street segment has been identified as part of the Priority Active Transportation Network in the Plan, it is recommended that a human-powered design vehicle be selected. Whether the design vehicle is a bicycle or pedestrian is determined by the current mode share or the desired mode share for the project.

Momentum Based Design

Design Momentum

Having identified the street's design vehicle, the design team moves on to calculating the design momentum. Momentum is simply mass multiplied by velocity. For a given design vehicle, multiply the vehicle's typical velocity by its gross mass (including any human users) to determine the Design Momentum. This will be used to further establish the geometric constraints of the intersection improvement.

Separation of Incompatible Modes

Active transportation infrastructure is intended primarily for human-powered modes of transportation. As new electrified micromobility modes of transportation like e-bikes and e-scooters are starting to share the streets, second generation active transportation infrastructure is best able to integrate these modes. This is a result of similar momentum between these modes and other human powered modes like cycling. Streetscapes that prioritize active transportation must be designed to mix all modes at safe momentums and where momentum differs beyond a safe threshold, the space must be divided. Engineering teams designing the VPM solution must ensure that there is physical separation of modes whose momentums differ beyond an allowable maximum and, if the intention is to increasing the sharing of space amongst many modes, the streetscape must be designed to restrict momentum of all modes within the acceptable range.

The prescriptive example VMP solutions below use a bicycle design vehicle as they are part of the Village's Active Transportation Plan to provide dedicated, permeable and connected cycling infrastructure capable of adapting to the exponential growth of electrified micromobility. Cyclists prioritize the preservation of momentum over direct paths and share similar objective safety and perceived safety perspectives with pedestrians and electrified micromobility vehicles. They travel at a casual speed of roughly 20km/h, setting the design speed.

According to Stats Canada, the average Car and Truck mass is over 1,800kg. The human tolerance for a pedestrian hit by a well-designed car or truck is approximately 30 km/h (NACTO). That represents a momentum of roughly 15,000kg m/s. This is the limit to what an unprotected human can survive with over 99% probability. Applying a factor of safety of 20%, we used a Maximum

Differential Momentum of 12,000 kg m/s as the maximum differential momentum where modes must be separated.

Design Vehicle: Bicycle, m = 100kg, v = 20 km/h or 4.2 m/s,
Maximum Differential Momentum: 12,000 kg m/s.

The Following is Matrix of Separated vs Shared Space at 20 km/h:

	Pedestrian (70 kg)	Electric Scooter (70kg)	Cyclist (100kg)	Electric Bicycle (110 kg)	Electric Wheel Chair (120 kg)	Automobile: ICE, Electric, Autonomous (2200 kg)
Pedestrian (70 kg)	Shared	Shared	Shared	Shared	Shared	Shared
Electric Scooter (70kg)	Shared	Shared	Shared	Shared	Shared	Shared
Cyclist (100kg)	Shared	Shared	Shared	Shared	Shared	Shared
Electric Bicycle (110 kg)	Shared	Shared	Shared	Shared	Shared	Shared
Electric Wheel Chair (120 kg)	Shared	Shared	Shared	Shared	Shared	Shared
Automobile: ICE, Electric, Autonomous (2200 kg)	Shared	Shared	Shared	Shared	Shared	Shared

The Following is Matrix of Separated vs Shared Space at 40 km/h:

	Pedestrian (70 kg)	Electric Scooter (70kg)	Cyclist (100kg)	Electric Bicycle (110 kg)	Electric Wheel Chair (120 kg)	Automobile: ICE, Electric, Autonomous (2200 kg)
Pedestrian (70 kg)	-	Shared	Shared	Shared	Shared	Separate
Electric Scooter (70kg)	Shared	-	Shared	Shared	Shared	Separate
Cyclist (100kg)	Shared	Shared	-	Shared	Shared	Separate
Electric Bicycle (110 kg)	Shared	Shared	Shared	-	Shared	Separate
Electric Wheel Chair (120 kg)	Shared	Shared	Shared	Shared	-	Separate
Automobile: ICE, Electric, Autonomous (2200 kg)	Separate	Separate	Separate	Separate	Separate	-

Any instance where two modes exhibit a difference in momentum that exceeds 12,000 kg m/s requires physical separation of modes.

Separation Methods

Each Separation/Delineation method comes with a range of performance characteristics that suit a variety of outcomes. Various methods and separation types can be combined to achieve optimal results to achieve desired outcomes. The table below lists the performance scores of various separation/delineation methods.

The following streetscape elements can be engineered to improve the multi-modal performance of any street. Elements can be selected to satisfy budgetary, cultural, socials, or commercial constraints.

The higher the score, the better the option.

	Cost	Separation Effectiveness	Traffic Calming	Safety and Accessibility for Vulnerable Users	Objective Safety	Perceived Safety	Maintenance (Snow Removal, Street Cleaning, etc.)
Paint Lines	5	1	1	1	1	1	5
Paint Lines and Strategic Parking	5	2	4	1	2	4	4
Pavement Colour	4	1	1	1	2	1	5
Tactile Strips	4	1	2	3	2	1	3
Bollards	4	5	5	4	5	4	3
Planters	3	5	5	5	5	5	1
Pocket Cafes	2	5	5	5	5	5	2
Different Surfacing Materials (Brick, Concrete)	1	2	4	2	2	3	5

The combination of Pavement Colour, Tactile Strips, and strategically place Bollards are recommended to optimize accessibility, perceived safety, objective safety, and budget. Additionally, the use of strategically placed, temporary no post barrier can improve the transition to these new street types.

There are two approaches to this type of intersection treatment: A prescriptive, one-size-fits-all approach outlined in the recommendations above; or an engineered solution tailored to the specific site constraints optimized for parking, volume, geometry, commerce. While the prescriptive approach will be sub-optimal in the truest sense of the term, it will be more than satisfactory and represents a significant improvement over any 20th Century road cross-section with regards to multi-modal performance as well as social, environmental, and economic sustainability.

Detailed Engineering

Having Selected the Design Vehicle, the engineering team moves to detailed design of the following components:

1. Separation Infrastructure
2. Conforming to unique site constraints
    a. ROW Width
    b. Parking Needs
    c. Type of Land Use
    d. Access Points, Crossings, and Driveways

Separation Infrastructure

Separation methods must be selected to optimize safety, budget, flexibility, and effectiveness. Different projects will impose unique constraints on the selection of appropriate separation infrastructure. A prescriptive approach must err on the side of caution and use the most conservative safety infrastructure possible. An engineering approach will optimize the selection to be more cost-effective while maintaining the same level of safety.

Conforming to Unique Site Constraints

Each site comes with unique characteristics, particularly on sites surrounded by existing infrastructure. Shallow utilities, emergency access, demographics, adjacent land use, grade changes, site distances, and other site characteristics require careful review by a qualified professional.

The Outcomes of the Engineering Process Should include the following deliverables:

- Vehicle Path Drawing(s) in Plan: showing the modeled turning movements of Fire Trucks and other control vehicles.
- Drawing Identifying Sight Distances.
- Notes about accessibility, defense of AAA status.
- Drawing providing construction information, including but no limited to pavement structures, separation infrastructure, and design vehicles and momentum.

Broadly Applicable Prescriptive Examples

The recommendations for the Village start with the fundamental cross-section which consists of two wide multi-modal, two-way shared space lanes on either side of a central two-way automobile lane. Shared spaces are delineated with a broken white line, 100mm thick where automobiles are permitted to enter the space when necessary and temporarily in order to pass on-coming vehicles. The shared space should further be delineated by being surfaced with Green Surface treatments or some other visible surface treatment that differentiates it from the asphalt surfaced, automobile space. Shared spaces should be a minimum of 3.0m wide whenever possible and never less than 2.4m.

For narrow roadways, one shared lane may - for short segments and to accommodate parking - be reduced to the Minimum Effective Active Transportation Lane width of 1.5m for short segments. This reduction in shared lane width should only be used on narrow roadways (<9m) and only affect one of the two shared lanes for the length of the street segment. Automobile drivers should be encouraged to use the shared lane only when necessary and always yield to other modes.

A vital component of this VPM solution is the that one of the shared lanes be 3.0m wide for the entire segment, except in Chicane Zones approaching intersections.

Option 1 - Chicane Zone Near Intersections. For wider roads (>10m wide), this can be used for the entire street segment keeping one shared lane 3.0m wide:

Key Components:

- Parking Protected Bike Lanes in Chicane zones, minimum 1.5m width;
- One automobile passing through zone at one time, automobiles entering the chicane yield to those already maneuvering the chicane;
- On linear segments of the street, there are two, bi-directional 3.0m wide shared lanes on either side of a central automobile priority lane;
- Automobiles share a bi-directional automobile priority lane, using the shared lanes to pass each other, this lane should be a minimum of 1.6m wide;
- Additional road complexity provided by parked vehicles for traffic calming;
- Additional parking bays can be provided for additional calming;
- Negligible grade separation on the transportation surface makes it easier for all modes to traverse;
- Excellent for low volume applications;
- Little to no obvious user preference, mode equity;

- Forces awareness, attention, and alertness while using infrastructure for all users;
- Clearly marked areas when modes are interacting in a shared space;
- Can use tactile strips or linear drainage to further delineate shared lanes and provide warning for visually impaired users.
- Physical Barriers are recommended to ensure no vehicles encroach on the shared lanes adjacent to parking;
- Physical Barriers are recommended at strategic locations throughout the entire road length to increase complexity for automobiles and to protect vulnerable users, these can be features like planters or purely functional like no pose barriers or reflective delineators.

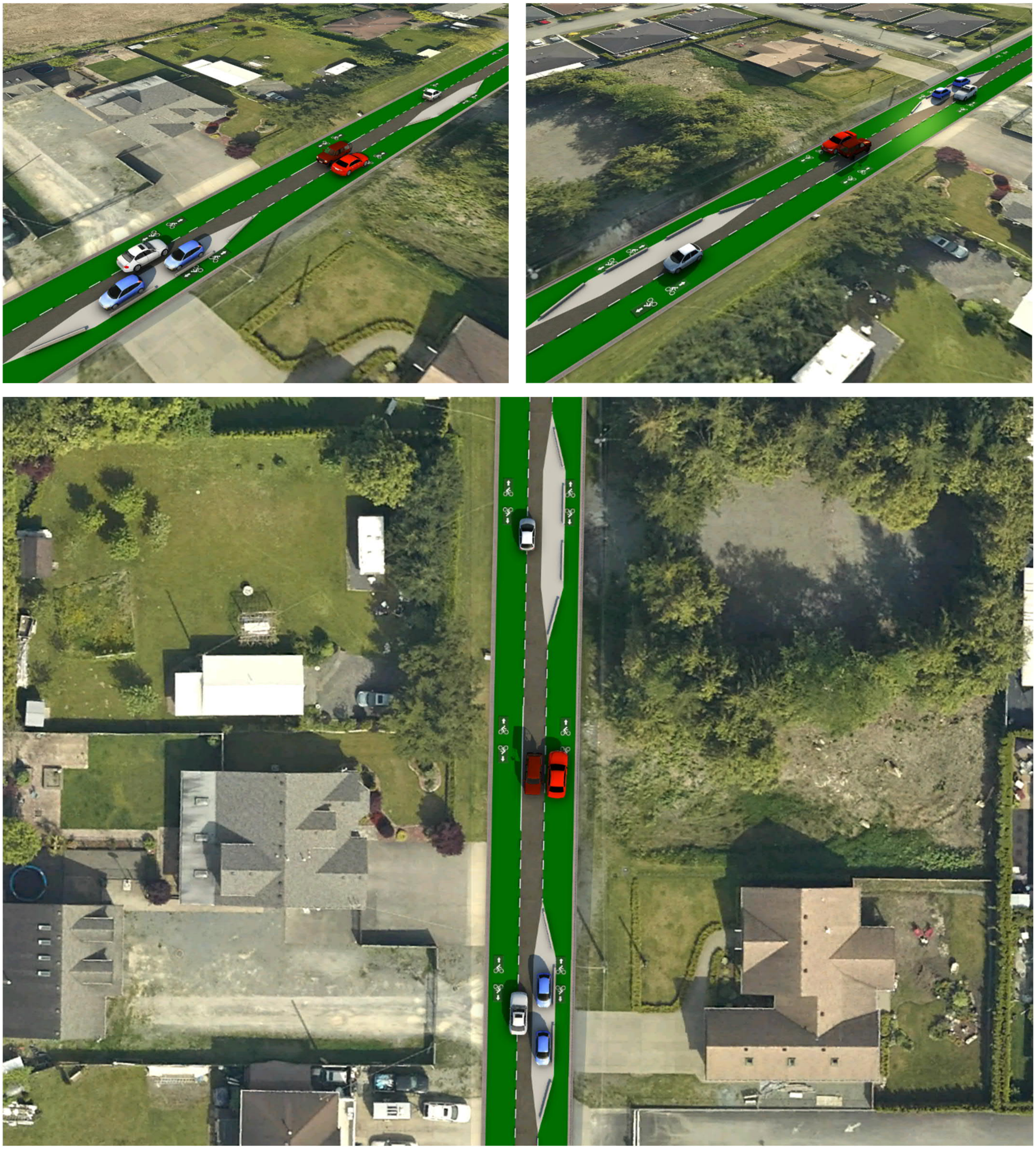
Cross-Sections:

Parking Bay on Right

Parking Bay on Left

No Parking Bays (Barrier Separation Optional)

Option 2 is more suitable to the width of many roadways in the VHHS (<10m):

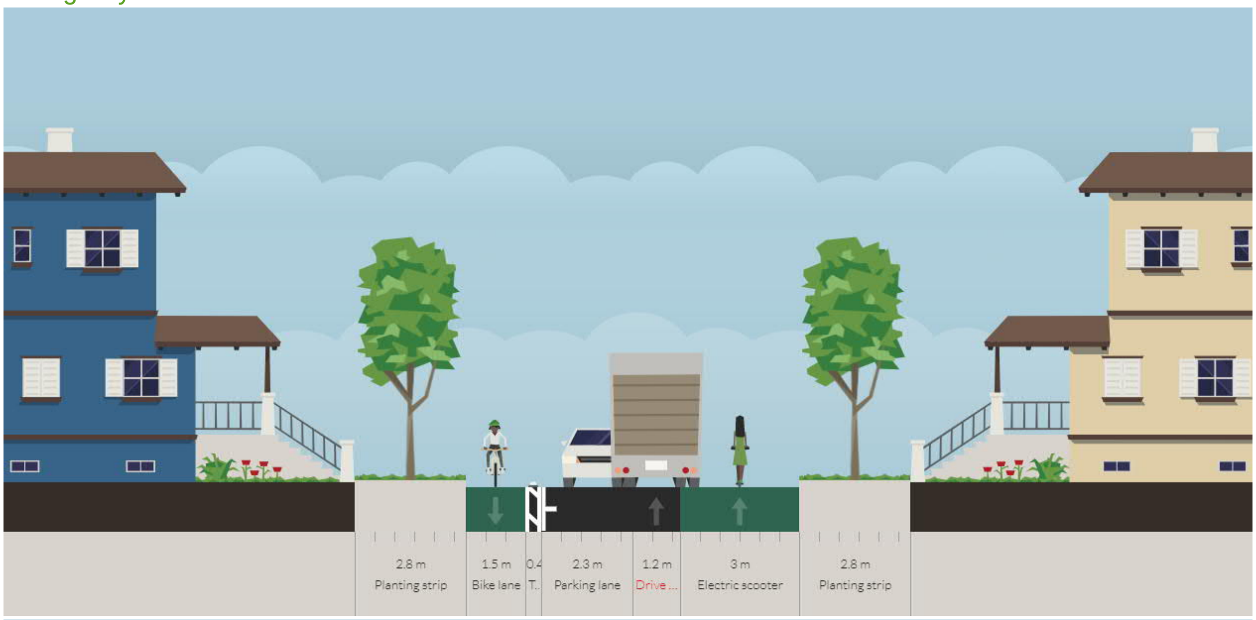


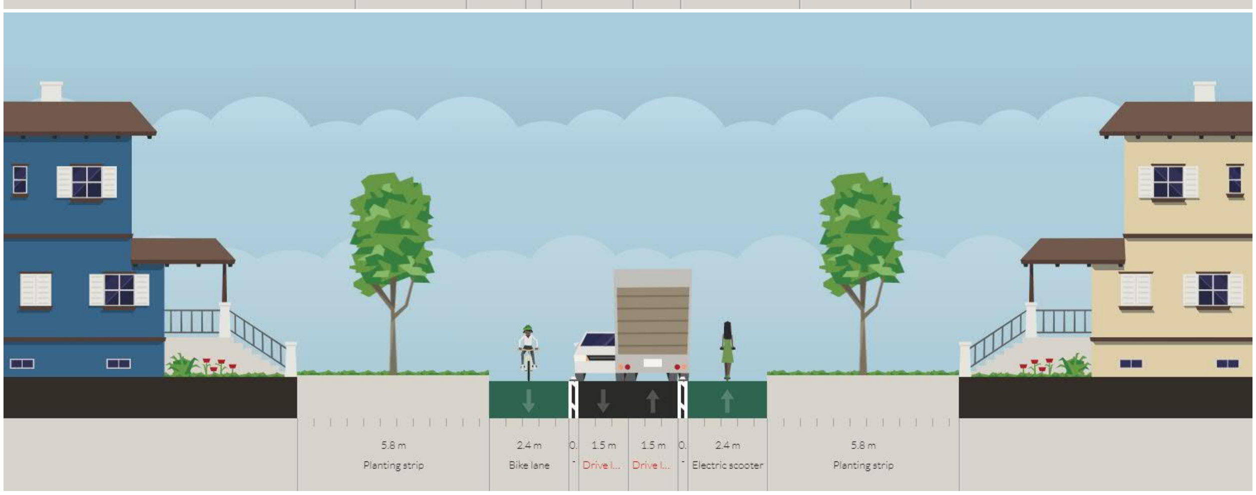
Key Components:

- Segments where automobiles can enter the shared space are delineated with a broken white line, otherwise the shared lane must only be shared by all other modes.
- One Active Transportation Lane is a fixed width of 3m, in sections where there is parking it is delineated by a Broken White Line of 100mm width, in sections where there is no parking it is delineated by a Solid White Line of 100mm width. This lane must share with vehicles that are passing one another in opposite directions at specific locations. Barriers are recommended everywhere a solid line is painted, at least for new introductions of this street type.
- One Active Transportation Lane is a variable width alternating from 3.0m width in segments without parking and 1.5m in segments with parking;
- Parking Protected Bike Lanes in parking zones, minimum 1.5m width with physical separation to prevent automobile encroachment and door opening danger for cyclists and electrified micromobility;
- One automobile passing through parking zone at one time, automobiles entering the parking zone yield to those already maneuvering the chicane, automobiles may cross broken line to pass on-coming automobile traffic while continuing to yield to all other modes;
- On linear segments of the street, there are two, bi-directional 3.0m wide shared lanes on either side of a central automobile priority lane, one with a broken line to permit automobile crossing, the other with a solid like and recommended physical separation infrastructure to protect the maximum possible shared lane width;
- Automobiles share a bi-directional automobile priority lane, using the shared lanes to pass each other, this lane should be a minimum of 2.4m wide, but the width is dependent on the total street width from the face of one curb to the other and how much shared lane is available;
- Additional road complexity provided by parked vehicles for traffic calming;
- Additional parking bays can be provided for additional calming;
- Negligible grade separation on the transportation surface makes it easier for all modes to traverse;
- Excellent for low volume applications;
- Little to no obvious user preference, mode equity;
- Forces awareness, attention, and alertness while using infrastructure for all users;
- Clearly marked areas when modes are interacting in a shared space;
- Can use tactile strips or linear drainage to further delineate shared lanes and provide warning for visually impaired users; and
- Physical barriers may be used to reinforce solid lines, preventing automobiles from entering these spaces.

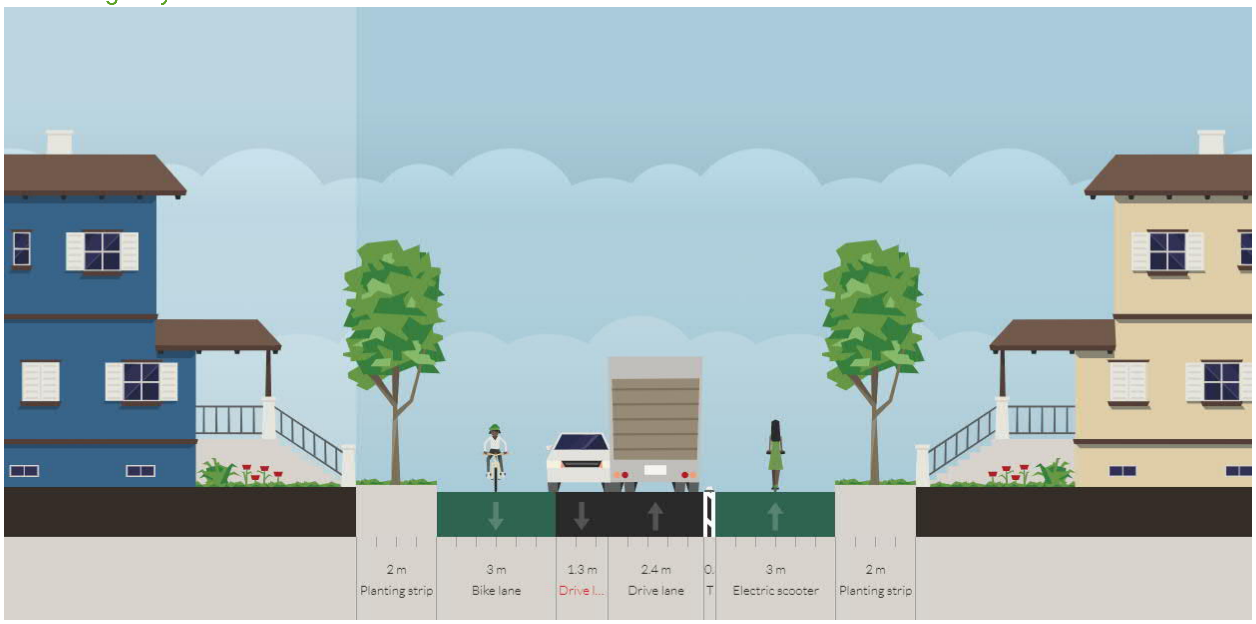
Cross-Sections

Parking Bay Section





No Parking Bay Section



Signage:

There is no standard sign for this type of Shared Space roadway, the Transportation Association of Canada (TAC) is reviewing options. In the United States, the National Association of City Transportation Officials (NACTO) has some recommended options. That said, it is our recommendation that the Village use this type of signage developed by the City of Chicago.

Consultation and approval of relevant Federal and Provincial organizations will be necessary. This sign should be displaced at the entrance to this streetscape from intersections. It is recommended that it also be placed at regular intervals along the length of the street segment between intersections as well.

A similar treatment in a real world, British Columbian example:

New Westminster: The purpose of these improvements was to create a continuous AAA bicycle route by eliminating “barriers” to cycling such as crossings at high-traffic roads. New facilities protect cyclists from traffic as they jog between Keary and Shiles Streets and allow cyclists to continue north on Richmond Street to connecting bicycle routes. The design accommodates a bus stop and a curb extension at a crosswalk used by students walking to school. The raised bicycle lane minimizes construction costs by making use of an existing over-wide sidewalk. This example is wide cross-section, allowing for two automobile priority lanes.

Appendix L – Active Transportation Intersection Design Brief

ACTIVE TRANSPORTATION INTERSECTION DESIGN BRIEF

Background

Good transportation engineering starts with the treatment of intersections. No matter the mode, intersections between corridors are the most important part of the transportation network. This is both in terms of safety and of efficiency. Intersections that are poorly designed are unsafe, cause congestion, and frustrate drivers. Intersections are not one-size-fits-all; the intersection strategy and design is dependent on modes, volumes, speeds, directions, and time. There is no prescriptive design process that can be applied to all intersections to achieve optimized, multi-modal levels of service.

Just like the transportation network at full scale, good active transportation starts with good intersection engineering. People using each type of transportation mode have different Level of Service (LOS) criteria upon which they evaluate intersections:

- Cyclists want to pass through safely without losing momentum;
- Pedestrians want to pass through safely on the most direct path;
- Disabled users want to pass through safely and comfortably with consideration given to their particular needs;
- Motorists want to pass through safely in the shortest amount of time;
- E-cyclists share the attitude of cyclists and motorists;
- E-scooters are looking for the same type of service as pedestrians;
- Large trucks are looking for larger turning radii; and
- Autonomous vehicles should be optimized to accommodate all other users' goals.

Nuances separate all of these objectives, but safety is common to all users. In many ways, each mode's efficiency objective works to enhance safety as well. Efficiency and safety go together. Momentum keeps cyclists safe, accommodating direct paths for pedestrians improves interactions between cars and pedestrians, and so on.

Cyclist and Other Micromobility Safety at Intersections

As cycling infrastructure becomes more widely used and constructed, some common issues have been encountered the world over, on both sides of the road. Nothing has been more troublesome to the design of effective Active Transportation Networks than intersections. According to various studies, including one carried out by the City of Vancouver (Cycling Safety Study, January 22, 2015), both left-turning and right-turning vehicles present the most risk to cyclists who use cycle tracks, designated bike lanes, or simply do not "take the lane." Another intersection issue is the lack of left turning movements that are both safe and efficient for cyclists when they are using cycling infrastructure and not practicing "vehicular cycling."

Case-in-point, indirect left turns (also known as the hook turn or perimeter-style turn) are safe, but inefficient, whereas "vehicular" left turns for cyclists are widely perceived as unsafe, but efficient. These issues and more make intersections dangerous and cumbersome for cyclists while exacerbating tensions between drivers and cyclists. As the proportion of commuters who choose cycling as their primary mode of transportation grows, infrastructure will need to change to avoid conflicts, injuries, and system-wide delays.

A broad range of intersection solutions have been stood up to testing in many places around the world from Holland, Denmark, and Australia, to places closer to home like NYC, Portland, and Vancouver. The solution for the Village's active transportation intersections must provide short-term easing of congestion, danger, and conflicts, but its greatest strength will need to be its ability to keep pace with changing transportation demographics and technologies.

The Foundations of Optimized Active Transportation Intersections

Pedestrian, E-Scooter, and Low Mobility Safety at Intersections

- Most Direct Path: pedestrians and other vulnerable street users benefit by being able to safely take the most direct path possible though the intersection, particularly those with reduced mobility;

The Keys to Safe Intersections for Cyclists and Electrified Micromobility:

- Preserve momentum: Cyclists, E-Cyclists, and E-Scooters clear intersections sooner and are in more control of their movements if they are able to preserve momentum, at least 5 to 10 km/h; and
- Avoid Left Hook Turns: The double-crossing movement endorsed for cyclists making left turns is a failure of intersection design and perhaps only contributes marginally, if at all, to cyclist safety in intersections. Forcing or encouraging these movements will keep suppress ridership numbers.
- Avoid Grade Changes: No road user enjoys grade changes like curbs, but they are perhaps most obstructive to cyclists, electrified microbility, and to those with mobility issues.

Automobile Safety at Intersections

- Automobiles are flexible to accommodate the requirements of other modes at intersections. Slow and continuous speeds are most efficient for automobiles rather than stops with rapid acceleration. Congestion can be alleviated by adjusting the mode split in favour of micromobility and slow, continuous speeds are achieved when preserving momentum. The intersections that best serve automobiles in urban environments, meet the service requirements of the intersections' most vulnerable users, people using human-powered transportation modes.

- Turning radii: the design of the turning radii at intersections depends on the types of vehicles expected to be using the intersection and the dimensions that make up the approaching and receiving lanes. A compromise must often be made between a small curb radius, which is desirable to reduce the speed at which vehicles turn the corner, and a larger curb radius to prevent large vehicles from travelling across the curb and into the pedestrian zone when making a turn.

Equity Between Modes

No matter the mode, designing safe and efficient transportation networks starts with the design of intersections. The segments of road between intersections often receive most of the attention and investment despite the fact that they are the least dangerous parts of the transportation network. Token bike infrastructure like shoulder enhancements, often referred to as “bike lanes,” in many municipalities come before making improvements to intersections. Investments in linear infrastructure whether it’s just shoulder enhancements and paint lines or if it’s completely separate infrastructure will not generate maximum returns without first designing safe and efficient intersections that suit the demands of various modes. Cyclists are safer if they are moving. Pedestrians are safer if they are given refuge and provided optimum routes through intersections. Automobiles are flexible to various intersection configurations.

Canadian municipalities are moving away from first-generation active transportation infrastructure and towards more complete solutions. First generation active transportation infrastructure was built for either recreational users on separate trails or very experienced vehicular cyclists in close proximity to automobiles. First-generation infrastructure includes shoulder enhancements (narrow, paint-line bike lanes) and separated multi-use trails. It was not focused on the comfort of vulnerable road users and did not comply with current best practices in Transportation Engineering as described below. First-Generation active transportation infrastructure did not comply with the requirements of AAA infrastructure or 8-80 cities. Technology and shifting demographics are driving change in the way active transportation infrastructure is integrated into urban and suburban streetscapes.

Keys to the Design of Second-Generation Active Transportation Intersections and Transportation Mode Equity at Intersections:

- Intersections should be built under the principles of 8 – 80 Cities. Cities that efficiently, easily, comfortably, and safely move 8-year-olds and 80-year-olds are successful for everyone, encourage ageing-in-place, and attract families. This type of infrastructure is also referred to as All Ages and Abilities (AAA) in professional literature. The advantages of this infrastructure are that it directly describes the objective of attracting and accommodating all street users even if they are new to the active mode they are choosing, while avoiding prescribing specific facilities so as to maintain flexibility in the types of facilities that can be used to achieve an AAA route.

- Engineering teams must focus on active transportation solutions that also accommodate electrified micro-mobility, they share many of the same constraints as cyclists, but come with a few differences.
- It's important to rearrange the streetscape rather than building something new. This enables the team to minimize cost as well as impacts to adjacent land uses:
  - On moderate to high volume roads, we recommend that modes are separated on the basis of momentum. The separation come via protected and segregated infrastructure.
  - On low volume routes, fully integrating all modes into the same space is the recommended solution. To do this, high mass vehicles must move slowly to decrease their momentum within an acceptable limit, low mass vehicles can move more quickly.

The Design Process

The Active Transportation Intersection Design Process can be broken down into the following steps:

6. Identify the automobile volume of the intersection being improved.
7. Select a design vehicle based on the priorities of the improvement or according to the Active Transportation Plan.
8. Identify the Design Momentum of the adjacent street sections using the typical speed and mass of their design vehicle.
9. Identify the mode separation requirements according to Momentum-Based Design best practices.
10. Two options at this stage:
    a. Engineer a tailor-made, optimized solution to the specific intersection in question; or
    b. Adapt the following prescriptive examples that may not be performance optimized but will control design costs while providing satisfactory outcomes.

Identifying Automobile Volume

Active Transportation Intersections (ATIs) should correspond to the road classification system and observed automobile traffic volumes. Design vehicle traffic volumes may be measured through traffic counts or estimated by professional engineering in good standing with EGBC. The following table identifies the ATI(s) that best correspond with different road classifications and vehicle traffic volumes:

Classification	In-Class Relative Automobile Volume	Top ATI	Alternative ATI
Local Road	Low	Vehicle Path Management	Dutch or Reverse Dutch Traffic Circle
Local Road	High	Vehicle Path Management	Dutch or Reverse Dutch Traffic Circle
Collector	Low	Vehicle Path Management	Dutch or Reverse Dutch Traffic Circle
Collector	High	Reverse Dutch Traffic Circle	Dutch Traffic Circle

Arterial roadways have been omitted from the table. These should only be considered for this type of treatment if high volumes of active transportation commuters have been already demonstrated. Additionally, prescriptive solutions are not possible for ATIs on arterial roadways; ATI solutions for these roadways must be fully engineered. Further, the Village Arterials are under MoTI jurisdiction.

Identify the Design Momentum

If any of the intersecting roads have been identified as Priority Active Transportation Infrastructure, the intersection must be upgraded to an Active Transportation Intersection.

This treatment may also be applicable to other locations on a case by case basis considering volumes of all modes. In a Low Automobile Volume application, it is recommended that a human-powered design vehicle be selected. Whether the design vehicle is a bicycle or pedestrian is determined by the current mode share or the desired mode share for the project. In intersections where automobile volumes will continue dominate, but active transportation improvements are desirable, faster active modes and electrified micromobility is a more appropriate design vehicle.

Design Momentum

Having identified the intersection's design vehicle, the design team moves on to calculating the design momentum. Momentum is simply mass times velocity. For a given design vehicle, multiply the vehicle's typical velocity by its gross mass to determine the Design Momentum. This will be used to further establish the geometric constraints of the intersection improvement.

Momentum Based Design

Separation of Incompatible Modes

Active transportation infrastructure is intended primarily for human-powered modes of transportation. As new electrified micromobility modes of transportation like e-bikes and e-scooters are starting to share the streets, second generation active transportation infrastructure is best able to integrate these modes. This is a result of similar momentum between these modes and other human powered modes like cycling. Streetscapes that prioritize active transportation must be designed to mix all modes at safe momentums and where momentum differs beyond a safe threshold, the space must be divided. Engineering teams designing the VPM solution must ensure that there is physical separation of modes whose momentums differ beyond an allowable maximum and, if the intention is to increasing the sharing of space amongst many modes, the streetscape must be designed to restrict momentum of all modes within the acceptable range.

The prescriptive example VMP solutions below use a bicycle design vehicle as they are part of the Village's Active Transportation Plan to provide dedicated, permeable and connected cycling infrastructure capable of adapting to the exponential growth of electrified micromobility. Cyclists prioritize the preservation of momentum over direct paths and share similar objective safety and perceived safety perspectives with pedestrians and electrified micromobility vehicles. They travel at a casual speed of roughly 20km/h, setting the design speed.

According to Stats Canada, the average Car and Truck mass is over 1,800kg. The human tolerance for a pedestrian hit by a well-designed car or truck is approximately 30 km/h (NACTO). That represents a momentum of roughly 15,000kg m/s. This is the limit to what an unprotected human can survive with over 99% probability. Applying a factor of safety of 20%, we used a Maximum Differential Momentum of 12,000 kg m/s as the maximum differential momentum where modes must be separated.

Design Vehicle: Bicycle, m = 100kg, v = 20 km/h or 4.2 m/s,
Maximum Differential Momentum: 12,000 kg m/s.

The Following is Matrix of Separated vs Shared Space at 20 km/h:

	Pedestrian (70 kg)	Electric Scooter (70kg)	Cyclist (100kg)	Electric Bicycle (110 kg)	Electric Wheel Chair (120 kg)	Automobile: ICE, Electric, Autonomous (2200 kg)
Pedestrian (70 kg)	Shared	Shared	Shared	Shared	Shared	Shared
Electric Scooter (70kg)	Shared	Shared	Shared	Shared	Shared	Shared
Cyclist (100kg)	Shared	Shared	Shared	Shared	Shared	Shared
Electric Bicycle (110 kg)	Shared	Shared	Shared	Shared	Shared	Shared
Electric Wheel Chair (120 kg)	Shared	Shared	Shared	Shared	Shared	Shared
Automobile: ICE, Electric, Autonomous (2200 kg)	Shared	Shared	Shared	Shared	Shared	Shared

The Following is Matrix of Separated vs Shared Space at 40 km/h:

	Pedestrian (70 kg)	Electric Scooter (70kg)	Cyclist (100kg)	Electric Bicycle (110 kg)	Electric Wheel Chair (120 kg)	Automobile: ICE, Electric, Autonomous (2200 kg)
Pedestrian (70 kg)	-	Shared	Shared	Shared	Shared	Separate
Electric Scooter (70kg)	Shared	-	Shared	Shared	Shared	Separate
Cyclist (100kg)	Shared	Shared	-	Shared	Shared	Separate
Electric Bicycle (110 kg)	Shared	Shared	Shared	-	Shared	Separate
Electric Wheel Chair (120 kg)	Shared	Shared	Shared	Shared	-	Separate
Automobile: ICE, Electric, Autonomous (2200 kg)	Separate	Separate	Separate	Separate	Separate	-

Any instance where two modes exhibit a difference in momentum that exceeds 12,000 kg m/s requires physical separation of modes.

Separation Methods

Each Separation/Delineation method comes with a range of performance characteristics that suit a variety of outcomes. Various methods and separation types can be combined to achieve optimal results to achieve desired outcomes. The table below lists the performance scores of various separation/delineation methods.

The following streetscape elements can be engineered to improve the multi-modal performance of any street. Elements can be selected to satisfy budgetary, cultural, socials, or commercial constraints.

The higher the score, the better the option.

	Cost	Separation Effectiveness	Traffic Calming	Safety and Accessibility for Vulnerable Users	Objective Safety	Perceived Safety	Maintenance (Snow Removal, Street Cleaning, etc.)
Paint Lines	5	1	1	1	1	1	5
Paint Lines and Strategic Parking	5	2	4	1	2	4	4
Pavement Colour	4	1	1	1	2	1	5
Tactile Strips	4	1	2	3	2	1	3
Bollards	4	5	5	4	5	4	3
Planters	3	5	5	5	5	5	1
Pocket Cafes	2	5	5	5	5	5	2
Different Surfacing Materials (Brick, Concrete)	1	2	4	2	2	3	5

The combination of Pavement Colour, Tactile Strips, and strategically place Bollards are recommended to optimize accessibility, perceived safety, objective safety, and budget. Additionally, the use of strategically placed, temporary no post barrier can improve the transition to these new street types.

There are two approaches to this type of intersection treatment: A prescriptive, one-size-fits-all approach outlined in the recommendations above; or an engineered solution tailored to the specific site constraints optimized for parking, volume, geometry, commerce. While the prescriptive approach will be sub-optimal in the truest sense of the term, it will be more than satisfactory and represents a significant improvement over any 20th Century road cross-section with regards to multi-modal performance as well as social, environmental, and economic sustainability.

Selections are further limited by budgets, space, and other constraints that must be reviewed on a per-project basis.

The combination of Pavement Colour, Tactile Strips, parking curbs, and strategically place Bollards are recommended to optimize accessibility, perceived safety, objective safety, and budget. Additionally, the use of strategically placed, temporary no post barrier can improve the transition to these new street types.

Detailed Engineering

There are two approaches to this type of intersection treatment: A prescriptive, one-size-fits-all approach that is not fully engineered outlined in the recommendations in this memo; or, an engineered solution tailored to the specific site constraints optimized for parking, volume, geometry, commerce, and efficiency. While the prescriptive approach will be sub-optimal in the truest sense of the term, it will be more than satisfactory and represents a significant improvement with regards to multi-modal performance as well as social, environmental, and economic sustainability.

Having Selected the Design Vehicle, the engineering team moves to detailed design of the following components:

3. Turning Radii
4. Separation Infrastructure
5. Conforming to unique site constraints
    a. ROW Width
    b. Parking Needs
    c. Type of Land Use

Turning Radii

Design Vehicle versus Control Vehicle

Control vehicles are typically the largest vehicle type required to manoeuvre a right turn at an intersection corner. Control vehicles make up a small fraction of all vehicles and manoeuvre turns at intersection corners at a relatively low frequency. Control vehicles use more space than design vehicles to manoeuvre right turns.

Paraphrase: Transportation Association of Canada (TAC) curb radii design tables should be used as a reference only and vehicle tracking software should be used where intersection corners are being redesigned. The following schematic sketches were created without using vehicle tracking software, specified vehicle types, vehicle speeds, vehicle starting positions, vehicle ending positions, and vehicle envelope clearances, but are intended to be flexible to any control vehicle. This is achieved by exceeding the requirements for the following Control Vehicle:

- WB-20, Occasional Truck Turn

The Control Vehicle Selected is larger than what is expected to use Village ATIs, using vehicle tracking software will provide optimized results and be more flexible to different configurations that what is shown below. The Control vehicle is larger than Fire Trucks and Recreational Vehicles.

Separation Infrastructure

Separation methods must be selected to optimize safety, budget, flexibility, and effectiveness. Different projects will impose unique constraints on the selection of appropriate separation infrastructure. A prescriptive approach must err on the side of caution and use the most conservative safety infrastructure possible. An engineering approach will optimize the selection to be more cost-effective while maintaining the same level of safety.

Conforming to Unique Site Constraints

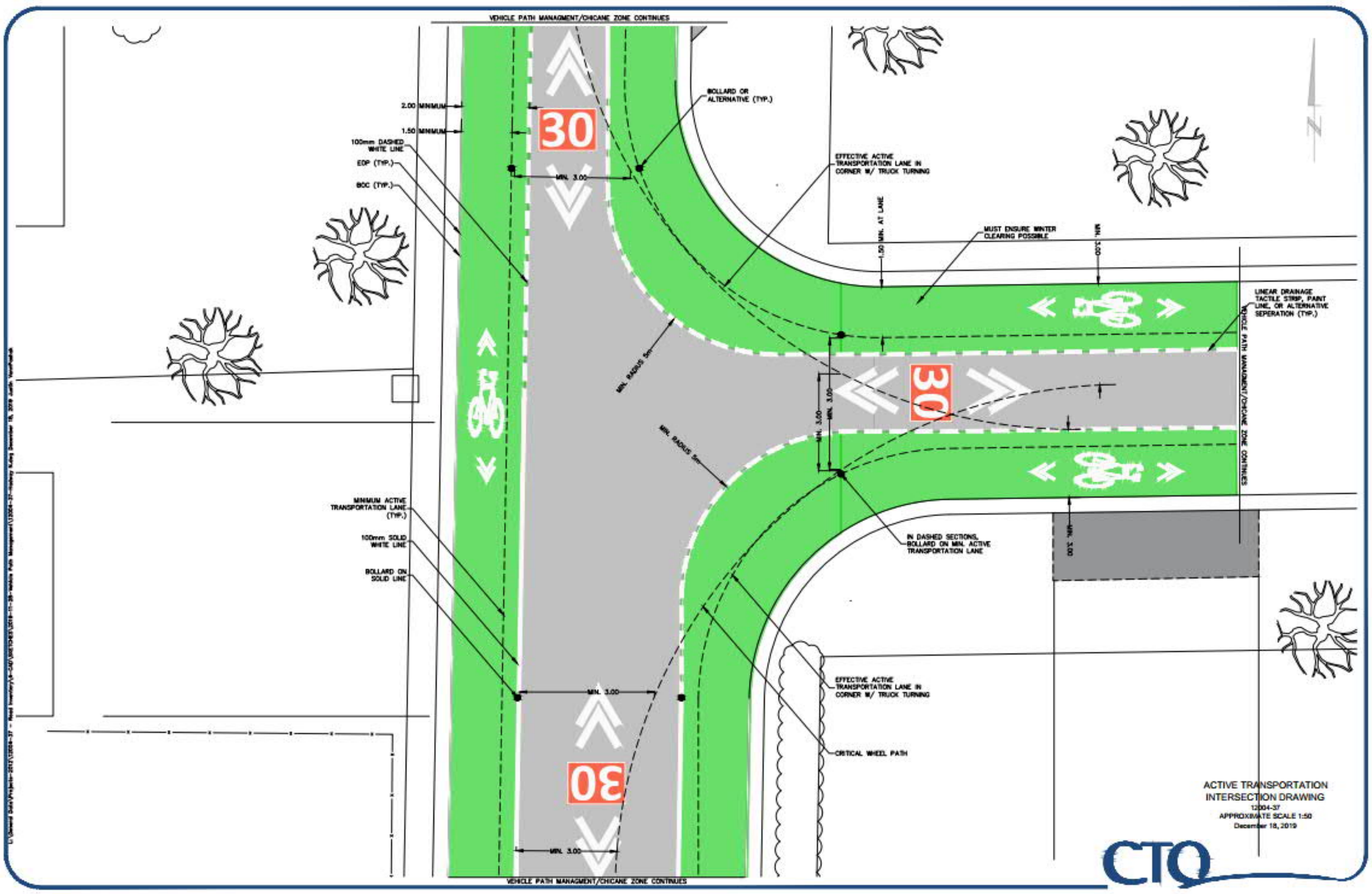
Each site comes with unique characteristics, particularly on sites surrounded by existing infrastructure. Shallow utilities, emergency access, demographics, adjacent land use, grade changes, site distances, and other site characteristics require careful review by a qualified professional.

The Outcomes of the Engineering Process Should include the following deliverables:

- Turning Movement Drawing(s) in Plan: showing the modeled turning movements of Fire Trucks and other critical vehicles.
- Drawing identifying all key radii and dimensioning between all separation points.
- Drawing Identifying Sight Distances.
- Notes about accessibility, defense of AAA status.
- Drawing providing construction information, including but no limited to pavement structures, separation infrastructure, and design vehicles and momentum.

Broadly Applicable Prescriptive Examples

Low Volume



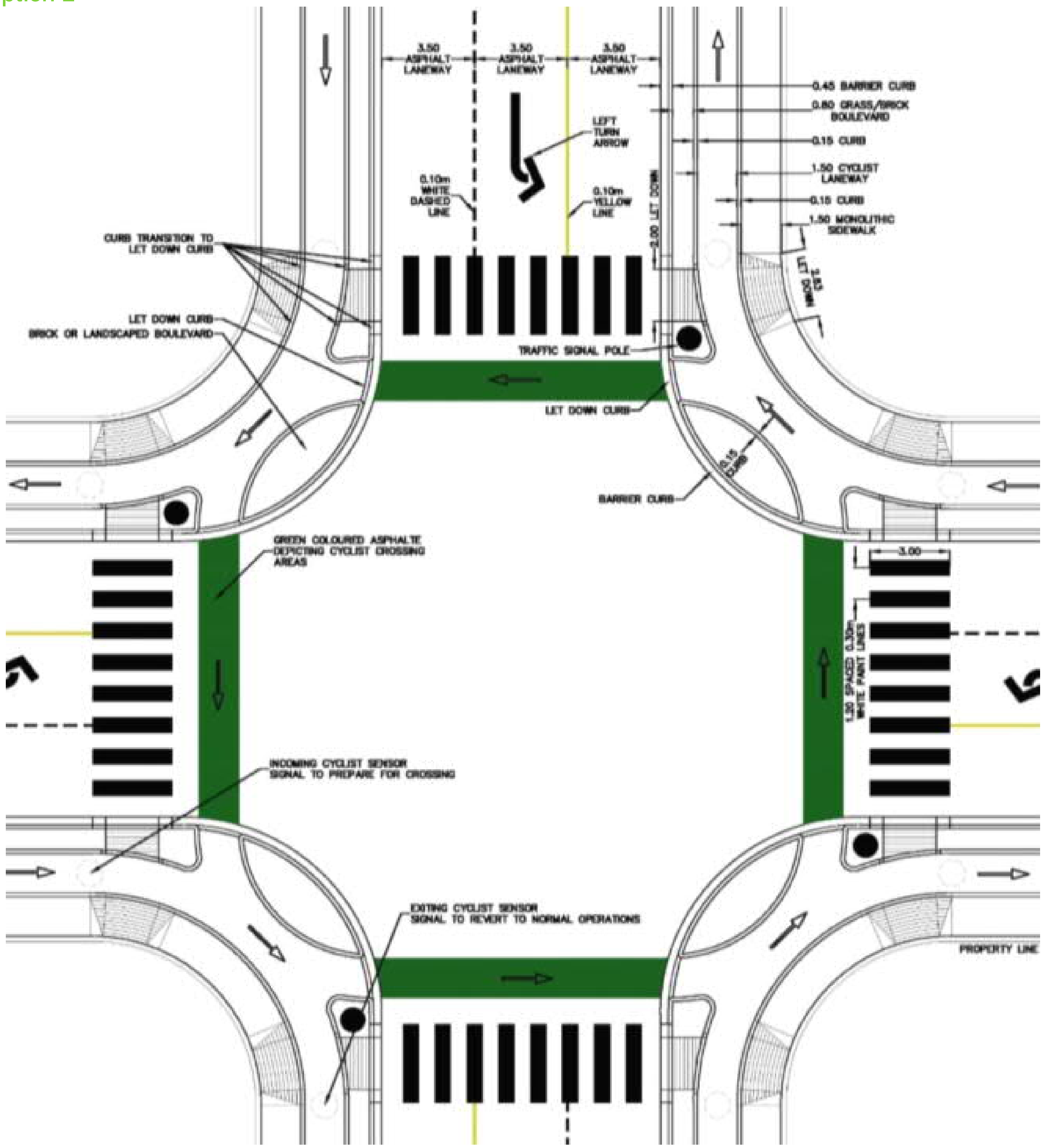
Key Components:

- Effective Radius: 15m;
- Marked Radius: 5m;
- Minimum Effective Active Transportation Lane Width: 1.5m;
- Shared Lane width corresponds to whatever cross section is used in linear segments beyond intersection, Vehicle Path Management is recommended;
- The use of strategically place bollards provides pedestrian safety and controls implicitly the turning movement path of vehicles, preventing automobiles from “cutting” the corner;

- Negligible grade separation on the transportation surface makes it easier for all modes to traverse;
- Paint lines can be reinforced with the use of tactile strips, linear drainage, or other forms of non-grade-separated delineation;
- Segments where automobiles can enter the shared space are delineated with a broken white line, otherwise the shared lane must only be shared by all other modes.
- One automobile passing through the intersection at one time, automobiles entering the intersection yield to those already maneuvering their movement, automobiles may cross broken line to pass on-coming automobile traffic while continuing to yield to all other modes;
- Excellent for low volume applications;
- Little to no obvious user preference, mode equity;
- Forces awareness, attention, and alertness while using infrastructure for all users;
- Clearly marked areas when modes are interacting in a shared space;
- Physical barriers may be used to reinforce solid lines, preventing automobiles from entering these spaces.

High Volume

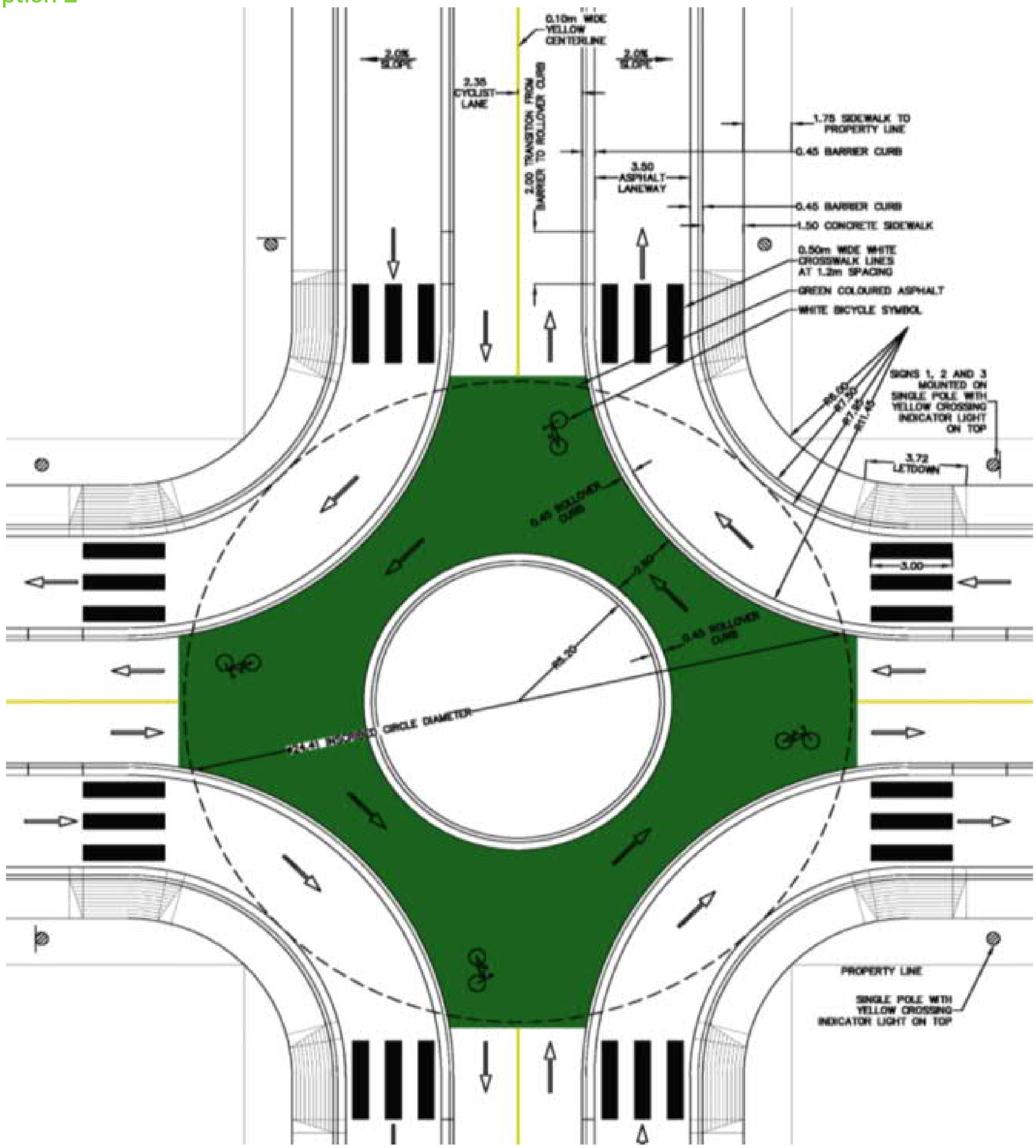
Option 1



Key Components:

- Based on the existing design in the Netherlands.
- Cyclists are kept separate from other modes by grade and lateral separation.
- Cyclist sensors are placed in the cycle tracks in order to trigger cyclist light signal phasing.

Option 2



Key Components:

- A roundabout within a roundabout;
- Cyclists and Micromobility always given priority;
- Small grade separation and colour differentiation between shared lanes and vehicle lanes;
- Central island is a rollover curb and paved to allow emergency access.;

- Grade separation between the modes;
- Cyclists in the dominant position of the roadway;
- Rolling through motion, no stopping for cyclists and electrified micromobility required unless yielding to present traffic;
- No change to driving rules, still yield to the left;
- Cohesive and complete, clearly shows equity between modes;
- Rollover curbs still allow for large vehicular access;
- Integration of landscaping is possible;
- Physical traffic calming when crossing cyclist roundabout accesses;
- Functions very similarly to existing infrastructure;
- Large bike lanes to allow for more relaxed and comfortable use; and
- If intersection is blocked by vehicle traffic, the inner bike roundabout can still be navigated by cyclists.

To facilitate the use of this intersection, Active Transportation Lanes in linear sections of roadway may either occupy the centre of the Road ROW for the entire length of the segment or transitions from the edge of the roadway to the centre of the roadway can occur outside of intersections where it is safer. This transition removes a conflict point between modes from the intersection, where it is most dangerous, to the safer linear segment of the street.

It simpler terms, all is needed is a “Super-Wide” Crosswalk, 25m to 50m from the intersection, that is over 20m wide (in direction of travel) allowing for diagonal change of positions for all cyclists, pedestrians, and other sharing modes to move from the edge of the roadway to the middle prior to entering the intersection. It is recommended that this very wide cross-walk is treated with the same surfacing as the Active Transportation Lane, whether that is green asphalt or another treatment. It is important to install this transition zone in safer, linear segments of roadway where changing lanes is safer and cyclists must only contend with automobiles traveling in the same direction with nearly identical speeds and, therefore, with safer momentum.

Final Comparison of ATI Solution

The Higher the Score, the better the option.

Name	Cost	Traffic Calming	Performance for Automobiles	Automobile Capacity	Performance for Cyclists	Cyclist Capacity	Performance for Pedestrians (8-10 year Olds)	Weighted Score
Weight	-	-	-	-	-	-	-	
Vehicle Path Management	5	5	3	1	5	5	5	-
Dutch Traffic Circle	2	2	4	4	2	2	3	-
Reverse Dutch Traffic Circle	1	5	2	3	4	3	4	-

We recommend that Designers and Engineers assign weights to each mode based on project goals and multiply individual scores in each cell by the weight factors then sum the results for each intersection type to select the solution best suited to the project.