Evacuation Route Plan

Final Report

Regional District of Nanaimo
District of Lantzville

March 2020

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1.0 Introduction

The Regional District of Nanaimo (RDN) and the District of Lantzville (the District) received a grant from the Provincial Community Emergency Preparedness Fund, which supports and enhances emergency programs such as evacuation route planning. This Evacuation Route Plan prepared by ISL Engineering and Land Services (ISL) details the analysis undertaken to estimate how long it will take to evacuate under several different emergency scenarios.

There are five main stages to the project as follows:

- The collection of demographic information within the study area, including Census population and British Columbia (BC) Assessment household data, to understand how many residents and households would be affected by different emergency scenarios.

- Understanding evacuation behaviour to anticipate where people might be most likely to go, and how many vehicles they would take.

- The development of a traffic simulation model to test the evacuation scenarios, creating realistic simulations of the number of vehicles evacuating and the road network capacity and constraints.

- An analytical summary of the model outputs to document the estimated evacuation times for each scenario.

- Recommendations to help manage an evacuation from a traffic and transportation perspective.

The intent of the plan is to identify safe evacuation routes, determine the time to evacuate for each community and scenario, then review if a different approach to evacuation or changes to infrastructure may help to facilitate a quicker evacuation.

2.0 Background

The most likely event in the study area requiring evacuation is wildfire related. The RDN and the District provided some background to anticipated hazards and transportation issues that might arise:

- It is expected that the primary threat will be wildfire, and even then, this is most likely to impact those south of the highway. The highway acts as a partial fire barrier.

- It is anticipated that people would evacuate to both the north and south unless the hazard was to preclude one of those directions. Through discussions, it was decided traffic would initially be split 75% south and 25% north reflecting more opportunities for shelter in the City of Nanaimo. In the event that a forced split was to be made, Nanoose Bay would be the logical point to split, with traffic south being directed south and traffic north being directed north.

- Nanoose Flats creates a choke point in the road network. This could be particularly problematic if there is a collision during an evacuation as there is no alternative route.

- Likely value in testing partial evacuations for areas south of the highway, both for Lantzville and Electoral Area E.

- Local roads in the RDN are maintained by BC Ministry of Transportation and Infrastructure (BC MoTI), Lantzville has its own Public Works Department. Mainroad responsible for maintenance and signal access if necessary. Noted that Mainroad do not have access to emergency services radio frequency.

- Development is occurring in the study area that will overtime result in potentially longer evacuations. Approximately 730 units are planned for the first phase of the Foothills development in Lantzville.

- There have been no major fires to date that have resulted in a significant evacuation.

- Northwest Bay Logging Road is privately owned and not to be considered in the evacuation scenarios. Access needs to be coordinated between the Local Authority, responding agency and the landowner.

- RCMP (Royal Canadian Mounted Police), Ground Search and Rescue, First Responders and Local Authority staff would coordinate confirmation that people had evacuated the area.

- There may be an information booth/checkpoint set up at strategic locations to monitor evacuees and to add security by preventing access to the study area. If a state of emergency was declared, the Local Authority would collaborate with the responding agency to determine any legislated powers or considerations for the management of evacuated areas.

2.1 Community Wildfire Protection Plan, 2010

The *Lantzville, Nanoose Bay, Nanoose First Nation Community Wildfire Protection Plan* (CWPP) was prepared by the Ministry of Forests and Range, Union of BC Municipalities, RDN, Nanoose First Nation, Lantzville Fire Rescue, the District, Nanoose Bay Fire Department and community of Nanoose Bay, documenting Wildland Urban Interface (WUI). The CWPP program was launched in 2004 to improve fire prevention in the WUI zones. The purpose of the program is to assist communities in the development of plans that will assist them in improving fire prevention and protection in the WUI areas. The objective is to improve community safety and reduce the risk of property damage.

The report describes the climate, physiographic features, vegetation, and natural disturbance history for the area. The report also describes the history of fires, and how in 2009, 98% of wildland fires on southeastern Vancouver Island are human-caused. One out of every eight reported wildfires in the mid-island in 2009 was an interface fire.

Fires have the potential to develop into catastrophic wildfires of a scale and intensity beyond the range of historic variability. Residents of Lantzville, Nanoose Bay, and Nanoose First Nations enjoy an extensive peri-urban setting of forests and coastline situated between the cities of Nanaimo and Parksville. Recreational pursuits, industrial activities, and expanding development in forested areas have increased the risk of fire in the interface zone of these communities.

As shown in **Figure 2.1**, almost 90% of the land base covered by Lantzville, Nanoose Bay, and Nanoose First Nations is classified as a high and/or extreme hazard area for interface fire. The majority of the extreme hazard area lies south of Highway 19.

Highway 19 is immediately surrounded by high hazard areas. High hazard areas are characterized by high fire intensity, with a rapid rate of spread. This means that the highway is at risk of closing rapidly, cutting off that direction as a potential evacuation route. A successful evacuation is therefore dependent upon the early prediction of large fires and timely evacuation before roads become impassable.

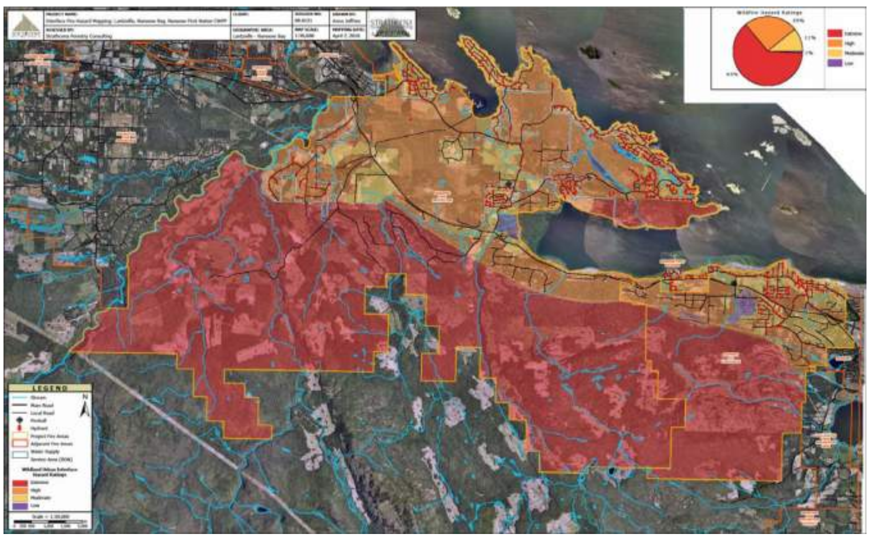

Figure 2.1: Community Wildfire Protection Plan Interface Mapping

The primary intent of this plan is to provide an estimate of evacuation times in the RDN. This will help inform the Local Authorities of the RDN to understand the necessary timing of an evacuation to get the population of the RDN area to safety, assuming the population is ready to evacuate.

3.0 Demographic Data

There are a number of useful sources that can be reviewed to better understand the likely population and vehicle demands that could be expected under certain evacuation scenarios.

3.1 Census Data

Table 3.1 provides an overview of the population demographics of the study area.

Table 3.1: Study Area Population Overview (2016 Census)

Data	RDN
Total Population	9,960
Additional Daytime Employees from Other Cities with Fixed Place of Work	640
Residents Employed Elsewhere during the Day with Fixed Place of Work	2,185
Total Private Dwellings	4,669
Average Household Size	2.27
Private Dwellings Occupied by Usual Residents	4,347
Children in Elementary School (Age 5-14)	785
Children in Secondary School (Age 15-19)	420
Unemployment Rate	8.5%
Immigrants	1,700
Immigrant with Refugee Status	10
Non-permanent Residents	20
Aboriginals	620
Non-English-speaking People	20
Seniors in their Own Homes (Age 65+)	3,035

In addition to the above data, it would be prudent for the Local Authorities of the RDN to gather information in their jurisdictions with respect to other populations, including those in daycare, special needs, nursing homes or other medical facilities, homeless, with livestock, and overnight/day visitor populations that may also require evacuation.

Census data was collected for each census dissemination area within the project study area as shown in **Figure 3.1**.

Figure 3.1: Census Population by Dissemination Area

3.2 Place of Work and Mode of Commute

The census also provides information about place of work and mode of travel, this provides some insight into the location of people and how they travel. **Table 3.2** to **3.6** outlines the place of work, location of work, working populations, and mode of commute, respectively.

Table 3.2 shows that approximately 68% of employees from the RDN have a usual place of work.

Table 3.2: Place of Work for Residents of RDN (2016 Census)

Place of Work	RDN
Worked at Usual Place	2,820
No Fixed Workplace Address	745
Worked at Home	600
Worked outside of Canada	10

Table 3.3 identifies the census division or subdivision where residents of the RDN work. It highlights that only 14% of residents that are employed, work within the study area, while 74% work elsewhere within the RDN (that is, Nanaimo, Parksville, etc.). This information is particularly relevant should an evacuation be called during a regular weekday, where we might expect a significant portion of the population to be outside of the evacuation area.

Table 3.3: Commute Destination for Residents of RDN (2016 Census)

Commute Destination	RDN
Commute within census subdivision of residence (i.e., live and work in the study area)	410
Commute to a different census subdivision within census division of residence (i.e., Nanaimo, Parksville, etc.)	2,195
Commute to a different census division (i.e., Cowichan Valley, Comox Valley, etc.)	305
Commute to a different province or territory (i.e., Alberta)	50

Table 3.4 shows where residents of the RDN that are employed work, we can see that residents are employed in many of the neighbouring municipalities, with Nanaimo, Electoral Area E of the RDN, and Parksville employing the most residents. If evacuating people from the communities, should an evacuation be called with minimal notice while people are at work, the Local Authority should be aware that a significant majority of its population work outside of the study area. There may be a desire to return home to collect belongings or family or friends, this should be discouraged unless there is sufficient time to allow this to occur safely.

Table 3.4: RDN Employed Residents - City of Work (2016 Census)

Commute Destination	RDN
Lantzville, DM	120
Nanaimo E, RDA	655
Nanaimo F, RDA	130
Nanaimo, CY	1,425
Parksville, CY	415
Qualicum Beach, CY	90
Port Alberni, CY	35
Courtenay, CY	25
Vancouver, CY	20

Table 3.5 shows the reverse of the above, residents of other municipalities that come to the RDN during the day for work. In the event of an evacuation with little notice, there could be a number of employees that reside outside of the study area that must also evacuate. More employees in the study area come from Nanaimo than the RDN itself, then increasingly small numbers of employees come from some of the neighbouring municipalities.

Table 3.5: RDN Employees - City of Residence (2016 Census)

Commute Origin	RDN
Lantzville, DM	145
Nanaimo E, RDA	220
Nanaimo F, RDA	30
Nanaimo, CY	405
Parksville, CY	60
Qualicum Beach, T	25

Table 3.6 provides the breakdown of the main mode of commute, it provides some indication of the car and transit use within the RDN, and some idea of how many may be reliant on non-car modes. Of course, some people will own vehicles but choose other modes of travel to work for other reasons. The table shows 93% commute by car while 1% commute by transit, 3% walk, and a small number cycle. Walking is unlikely practical for evacuations, a bicycle maybe, depending on the circumstances.

Table 3.6: Main Mode of Commute for Residents of RDN (2016 Census)

Main Mode of Commuting	RDN
Car, Truck, Van – as a Driver	3,210
Car, Truck, Van – as a Passenger	225
Public Transit	35
Walked	110
Bicycle	15
Other Methods	80

3.3 BC Assessment Data

The BC Assessment data provides information on the number of households within study area. However, of critical importance to this study, it also provides geographic references for each property. This allows us to cross reference the wildfire scenario with the household information and determine the number of properties affected.

Figure 3.2 illustrates the location of the 4,965 households within the study area. It highlights that the majority of the population live on the north side of Highway 19 in the Electoral Area E of the RDN.

It also does not include the Nanoose First Nation properties, these were added manually by counting the number of households apparent through aerial mapping.

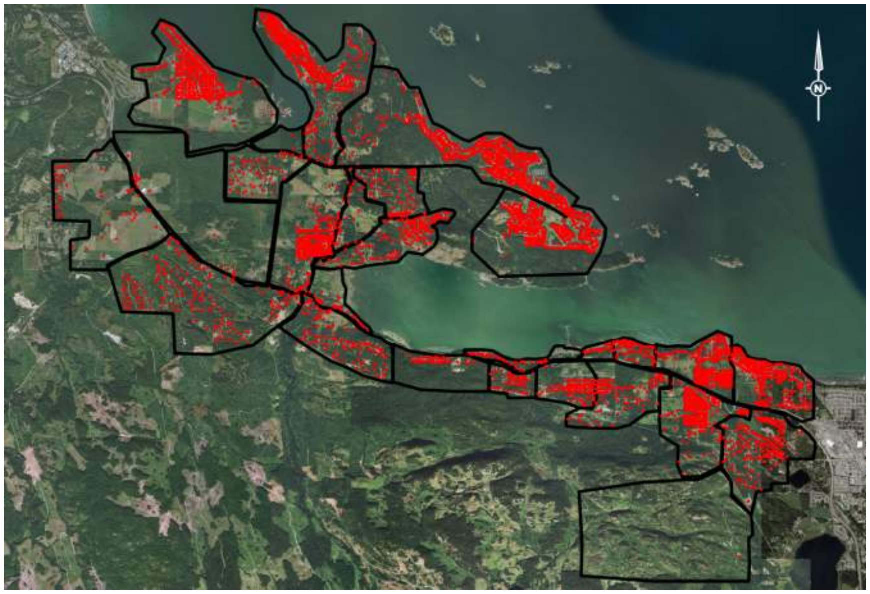

Figure 3.2: Study Area and BC Assessment Household

3.4 Traffic Data and Signal Timing Plan

Traffic signal timing plans were collected from BC MoTI for signals along Highway 19 and the City of Parksville at the Franklin's Gull Road and Highway 19A intersection to/from the interchange. The signal timings are used as input to the traffic model of the evacuation road network.

Intersection traffic volumes were not available nor necessary. In an evacuation, no traffic other than for emergency access would be permitted into the evacuation zone, through traffic would typically be restricted, and the majority of traffic on the road network would be evacuating. Volumes were based on the number of households, the population, and estimated car ownership within each zone.

3.5 Car Ownership

Other evacuation route plans undertaken by ISL in similar and somewhat rural locations found people would use an average of 1.49 vehicles per household to evacuate. This factor has been utilized in the RDN to determine traffic volumes evacuating. A limited evacuation survey conducted by the RDN supports this factor with the majority of respondents (66.7%), indicating they would evacuate using one vehicle. ICBC vehicle count data was analyzed and traffic volumes could increase if residents evacuated using all registered vehicles.

3.6 Other Transportation Options

3.6.1 Maximizing Car Efficiency

Not all members of the population will have access to a personal vehicle to evacuate in. It is recommended that messaging to the public encourages those without access to a vehicle to pre-arrange a ride share with a nearby relative or friend. This reduces the strain on other transportation services and maximizes the efficiency of the vehicle trips evacuating the study area.

3.6.2 Transit

In partnership with BC Transit, RDN operates a bus-based transit service. It serves the areas of Lantzville and Electoral Area E along Lantzville Road, Aulds Road, Superior Road, Northwest Bay Road, Southwind Road, Eastwind Road, Northwind Road, Dickinson Road, Philip Road, Harby Road, and the main highways. On the next two pages, the RDN transit services and details are provided in **Table 3.7**, while **Figure 3.4** and **3.5** provide the transit route maps.

In the event of an evacuation, it may be desirable to coordinate transit services, and any other available buses to evacuate those without access to a private vehicle. This would require a coordinated plan, with muster points for pick-up, or ability to identify households that require assistance. If this can be kept as close to regular service as possible, those already reliant on transit will be familiar with local stops. However, there may be some less familiar or that live outside of the transit catchment that require assistance. Furthermore, the limited service frequency might not support an immediate evacuation, nor be available if the evacuation were to occur outside of service operational hours.

Table 3.7: RDN Transit Service

Route	Description	Frequency
11	Nanaimo to Lantzville (7 Stops)	60+ Minutes
91	Intercity: Nanaimo, Lantzville, Nanoose, Parksville, and Qualicum Beach (10 Stops)	30-60 Minutes with Express Services and Routes (use highway)

Figure 3.4: Lantzville Transit Route

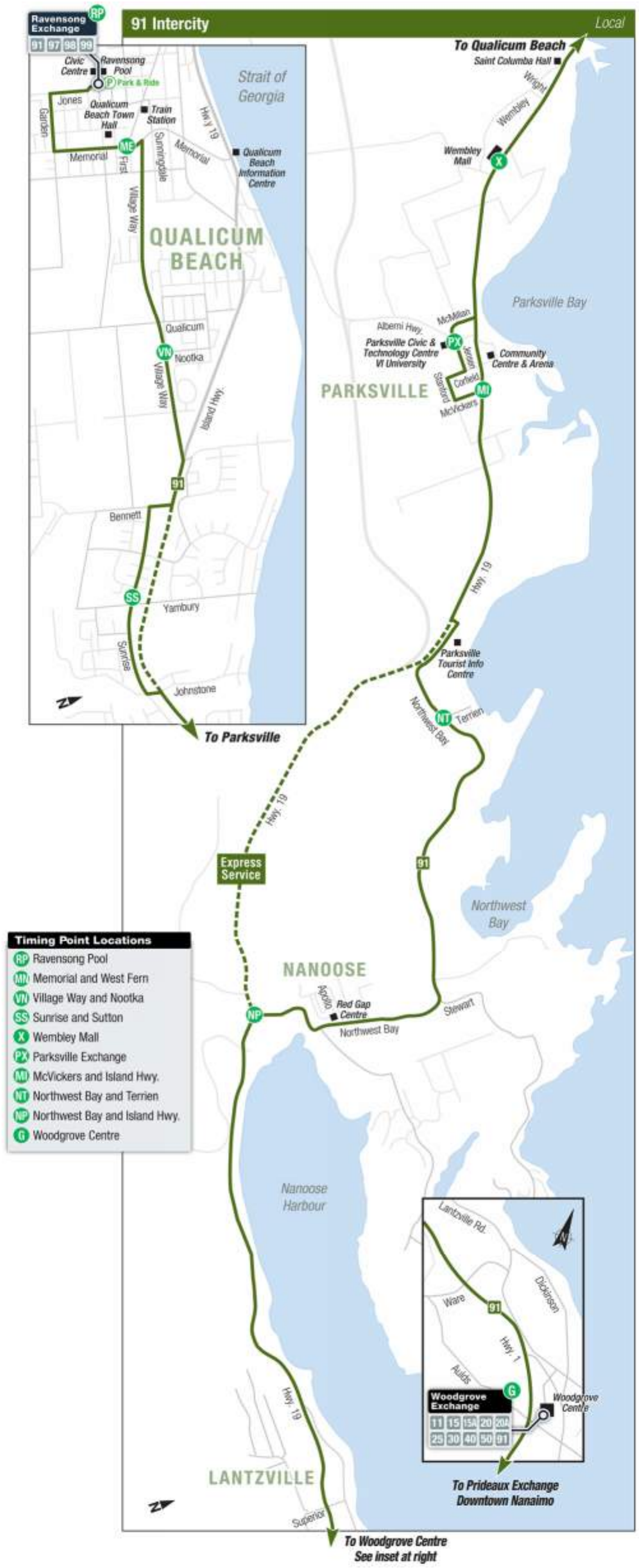

Figure 3.5: Electoral Area E Transit Route

4.0 Evacuation Zone

Evacuation zones were determined based upon neighbourhoods with distinct points of access to the road network. **Figure 4.1** and **Table 4.1** shows the 28 evacuation zones developed broadly based on connectivity to key evacuation routes such as Highway 19, Highway 19A, Northwest Bay Road, Powder Point Road, Lantzville Road, and Franklin's Gull Road.

Figure 4.1: Evacuation Zone

Table 4.1 Evacuation Zone (Access Point)

Evacuation Zone	
Zone 1 (Arbutus Drive)	Zone 15 (Summerset Road)
Zone 2 (Northwest Bay Logging Road)	Zone 16 (Hillview Road)
Zone 3 (Sanders Road)	Zone 17 (Rumming Road)
Zone 4 (Claudet Road)	Zone 18 (Bayview Park Drive)
Zone 5 (Stewart Road)	Zone 19 (Millard Way)
Zone 6 (Fairwinds Drive)	Zone 20 (Capilano Road)
Zone 7 (Florence Drive)	Zone 21 (Superior Road)
Zone 8 (Garry Oak Drive)	Zone 22 (Lantzville Road)
Zone 9 (Apollo Drive)	Zone 23 (Lantzville Road)
Zone 10 (Red Gap Road)	Zone 24 (Lantzville Road)
Zone 11 (Northwest Bay Logging Road)	Zone 25 (Aulds Road)
Zone 12 (Morello Road)	Zone 26 (Aulds Road)
Zone 13 (Northwest Bay Logging Road)	Zone 27 (Lantzville Road)
Zone 14 (Nanoose Station Road)	Zone 28 (Aulds Road)

5.0 Constraint

5.1 Road Network Constraint

Subject to the evacuation scenario, some constraints may be more critical than others. The following constraints have been identified:

5.1.1 Road Capacity

Road capacity of a single lane is typically around 1,800 vehicles per hour, this is based on a continuous stream of traffic maintaining a 2 second headway between vehicles. This capacity assumes uninterrupted flow, therefore wherever there is a requirement for a vehicle to come to a stop, this will be reduced, often by a significant amount.

The *Sea to Sky Evacuation Multimodal Plan* (ISL, 2019 for District of Squamish and Resort Municipality of Whistler) measured headways of vehicles leaving Whistler at the end of a busy ski day.
It found headways were slightly above 2 seconds, and that highway capacity based on those conditions was likely closer to 1,600 vehicle per hour.

Highway 19 typically provides two lanes in both directions providing an approximate maximum capacity of 3,200 vehicles per hour in each direction. However, each approach to the highway is typically just one lane reducing the maximum evacuation capacity from individual neighbourhoods to around 1,600 vehicles per hour, that might reduce further subject to intersection controls.

5.1.2 Intersection Control

Intersection constraints include stop controls, traffic signals, and highway ramps at interchange. In an evacuation, with most traffic evacuating in the same direction, there may be relatively little opposing traffic, maximizing the capacity of some intersections. However, at some locations demand may come from competing approaches, limiting capacity along a particular route, but also better managing demand between competing routes.

Traffic Signal

There are nine traffic signals in the study area located along Highway 19 and Highway 19A. Should a hazard require only the evacuation of particular evacuation zones for example, it would be possible to restrict traffic on the other approaches and allow traffic to flow freely from the neighbourhood maximizing capacity of the evacuation route to close to the 1,600 vehicles per lane.

However, in a mass evacuation situation, there would be competing demands from all approaches to the traffic signal and capacity for individual approaches will reduce significantly. Likely 1,000 vehicles per hour or less, subject to the demands. Queues would then form on all approaches if evacuation demand exceed this capacity.

Stop Controls

At stop controls, there is a legal requirement for every vehicle to come to a stop, reducing capacity even if there is little conflicting traffic. Where this is anticipated to be an issue, the use of Traffic Control Personnel (TCP) to direct traffic through without stopping will increase capacity while managing any conflicting movements.

Some key stop controls in the study area include the Powder Point Road (one-way stop) and Franklin’s Gull Road (all-way stop), both at Northwest Bay Road. These two intersections accommodate all of the traffic evacuating from Nanoose Bay. These locations would be a high priority for TCP in a mass evacuation.

Most other neighbourhoods along the highway, access the highway through stop-controlled minor road. For the low volumes that are typical, this is not an issue. However, in an evacuation, if the highway is busy, it will be difficult to turn out of these access roads, particularly if a left-turn is required to evacuate.

This is something RDN should be cognizant of when anticipating the need for TCP as these accesses are most vulnerable to high traffic demands.

5.2 Roadway Feature

5.2.1 Railway Crossing

Railway crossings are found within the study area, grade separated where it crosses the highway and level crossings elsewhere on some roadways to/from the highway. It is understood that freight as well as passenger services have been suspended indefinitely; thus it will not impact an evacuation if triggered.

5.2.2 Topographic Constraints

There are a few places where tight curves and/or steep grades can impact capacity. In theory, if traffic flow is uninterrupted the road capacity should remain constant; however, driver behaviour can reduce capacity.

Capacity is determined by vehicle headways, thus where drivers of differing abilities or confidence may tackle challenging terrain differently larger gaps can open up between vehicles, and this effectively reduces capacity.

Once the challenging section of roadway has passed, traffic will often revert back to normal operation, but even that is not always guaranteed, as a more aggressive driver may pull out a gap on a less aggressive driver behind, with any gap over 2 seconds reducing the theoretical capacity of the roadway at a rate of 1 vehicle every 2 seconds of gap.

5.2.3 Routes Affected by Wildfire

While the intent will be to evacuate the affected population prior to an approaching hazard, some roads may be impacted by the wildfire and restrict evacuation options; this would have to be assessed on a case-by-case basis.

5.3 Population Constraints

5.3.1 General Readiness

While the network constraints can present challenges, they are defined and somewhat predictable. The general behaviour of the public and their readiness or willingness to evacuate are less predictable. Therefore, while the actual time to evacuate a defined number of vehicles across a defined number of routes can be determined with reasonable accuracy, the actual evacuation of the population could take considerably longer.

While it is possible to stage an evacuation in the traffic model to take longer than necessary, the calculations provided later in this report assume all residents are ready to evacuate immediately, providing a worst-case traffic analysis.

Whenever possible, evacuation alerts and evacuation orders should be called in advance to provide evacuees with sufficient time to evacuate in the direction of their choosing in a safe and controlled manner. As an example, the Evacuation Plan for Squamish and Whistler provides an evacuation timeline for an identified approaching hazard as follows:

- 72 hours prior to hazard – evacuation alert
- 36 hours prior to hazard – evacuation order
- 12 hours prior to hazard – last people leave

5.3.2 Vehicle Usage and Occupancy

Efficiencies can be created by reducing the number of vehicles used in multi-vehicle families, or assisting neighbours, friends, or family that do not have access to a private vehicle. Many owners will be reluctant to leave vehicles if at risk from a hazard, and may have a need for both vehicles to carry on with their day-to-day needs from their temporary location.

5.3.3 Direction of Evacuation

Traffic often flows best where it can avoid the most conflicts, thus when leaving a neighbourhood and determining the best direction to evacuate, right turns are always preferable to left turns which typically have much less capacity. Vehicles must yield to two direction of traffic compared with just one for right turn movements.

Ideally, an evacuation would be ordered with sufficient time to evacuate in a controlled manner to everybody's destination of choice. However, the constraint of traffic itself, can be somewhat overcome by evacuating traffic strategically to reduce conflicts. For example, those south of the highway evacuating east and those north evacuating west.

Similarly, evacuating those at the east to the east and those at the west to the west can yield similar benefits by reducing conflicting traffic volumes.

5.3.4 Need for Assistance

The analysis focusses on evacuation routes and their capacity to evacuate vehicles. For those without access to a private vehicle, they may be reliant on support from local, regional, or provincial agencies to evacuate. With sufficient advance notice of an approaching hazard, those reliant on transit may be able to use regularly scheduled routes to leave. However, it may be necessary to coordinate with RDN Transit services, other agencies or Emergency Management BC to arrange additional services for those in need.

6.0 Evacuation Analysis

6.1 Evacuation Modelling

A traffic simulation model was developed to assess the evacuation scenarios and estimate the evacuation durations. The model was developed using PTV Vissim, a microsimulation traffic modelling tool that has become the industry standard software for assessing complex traffic scenarios. **Figure 6.1** shows the individual vehicles queueing along Northwest Bay Road and waiting to access Highway 19 at the traffic signals, while **Figure 6.2** shows a similar condition at the Powder Point Road stop-controlled intersection with Northwest Bay Road.

Figure 6.1: Vissim Simulation of Highway 19 at Northwest Bay Road

Figure 6.2: Vissim Simulation of Northwest Bay Road at Powder Point Road

The software was selected for this study as it provides a number of useful capabilities:

- It can model the road network in great detail including the geometry constraints, such as low speed curves and intersection controls.
- It models each vehicle loaded into the simulation individually with each vehicle having unique driving behaviour characteristic to reflect a range of driver aggression levels.
- It can load traffic onto the network at locations deemed appropriate and in varying levels of demand; for example, all at once reflecting an immediate evacuation or over time reflecting strategically staged evacuations.
- It provides powerful routing options to create precise evacuation scenarios.
- It can operate over longer durations than some software options that typically focus on only a peak hour.
- It provides detailed analytics to measure travel times and queue lengths, and can produce traffic density heatmaps and video simulations over the evacuation.

There were several key steps to simulating and assessing evacuations of the study area:

1. **Model Development:** develop the traffic simulation model including road network features, intersection controls, and traffic analysis zones.
2. **Evacuation Scenario Development:** determine the evacuation scenarios and utilize BC Assessment data, cross-referenced with GIS (Geographic Information System) map of impacted regions, to determine number of households impacted.
3. **Scenario Modelling:** cross-reference the traffic analysis zones with the household data multiplied by the vehicle ownership factor to determine the number of vehicles evacuating from each zone in the traffic model.
4. **Evacuation Analysis:** run the model and collect travel time and queue length information to determine evacuation times and locations that experience greater delays.

6.2 Model Development

The Vissim model extents in blue and purple colours are shown in **Figure 6.3**, which include the study areas of Lantzville and Electoral Area E (Nanoose Bay), the northwest edge of Nanaimo with Aulds Road at Highway 19 and Mary Ellen Drive at Highway 19A, and the southeast end of Parksville (corner of Electoral Area G) with Highway 19 at Highway 19A (interchange) plus Franklin's Gull Road at Highway 19A.

Figure 6.3: Vissim Model Extent on OpenStreetMap

The model includes the traffic signals and timings provided by BC MoTI as well as the City of Parksville, stop controls, interchange, laning, geometry, and posted plus advisory speeds.

Each point of entry into and out of the modelled road network provides a location with which to load traffic onto the network, or direct traffic to exit the network. The traffic loaded onto the network reflects the number of properties accessed from each road that are evacuated in each scenario multiplied by the average number of vehicles used to evacuate.

6.3 Evacuation Scenario

There are a few primary evacuation routes that will accommodate evacuating traffic:

- To the south, Highway 19 or Highway 19A towards Nanaimo, Duncan (~ 65 kilometres and 50 minutes drive time), and Victoria (~ 130 kilometres and 95 minutes drive time), are the most likely options.
- To the north, Highway 19 or Highway 19A provides access to Parksville, Courtenay (~ 85 kilometres and 55 minutes drive time), Campbell River (~ 130 kilometres and 75 minutes drive time), and beyond.
- To the west, Highway 19/19A then Highway 4/4A directly to Port Alberni (~ 60 kilometres and 50 minutes drive time) could be an alternative choice.

There are many hazard types that could lead Emergency Management staff to evacuate neighbourhoods in a different way:

- An approaching or occurring hazard places a specific neighbourhood at greater risk and requires it to be evacuated as a priority. This could also be a partial evacuation rather than mass evacuation subject to the hazard.
- An evacuation order is called with sufficient notice that residents may evacuate with time to spare, leave in a controlled manner, and select their route and destination of choice.
- Due to a specific hazard, some routes are impassable, that is, due to roadway being cut off by wildfire or structural issues forcing the closure of a bridge/overpass. This may force people to evacuate in the only remaining direction.
- The community could be largely cut off, requiring people to shelter in place and/or require search and rescue operations to evacuate people stranded due to a hazard.
- The evacuation is called with no-notice requiring the community to evacuate as soon as possible.

For each scenario considered in this plan, the number of evacuees was determined by cross-referencing the selected zones deemed vulnerable with BC Assessment household data. Evacuation routes were determined by distributing the population and vehicles across the available evacuation routes. Evacuation time was then determined for each neighbourhood and its assigned route.

At the outset of the project, three initial scenarios were anticipated including:

1. A mass evacuation of the entire study area reflecting a worst case.

2. A partial evacuation based on those affected by wildfire in Electoral Area E (Nanoose Bay).

3. A partial evacuation based on those affected by wildfire in Lantzville.

During the project development two other scenarios were added as follows:

4. A mass evacuation of the entire study area with 2 southbound lanes out to Highway 19 by reversing the inbound travel lane on Northwest Bay Road from Powder Point Road, while all zones from Lantzville evacuate south to Nanaimo.

5. A split direction mass evacuation with Nanoose Bay all evacuating to the north through the Highway 19 and Highway 19A interchange, while all zones from Lantzville evacuate south to Nanaimo.

Given in an evacuation, through traffic from both ends of Highway 19 would typically be restricted, and that is reflected in Scenario 1 to 3. However, through discussion with RDN staff, to be conservative, hourly highway background volumes were also loaded in all simulation models (Scenario 1 to 5) for this study additionally.

The model still includes very low levels of background traffic that might reflect emergency vehicle activity, but for the most part, the predominate traffic volumes are all evacuating from neighbourhoods out of the traffic model.

6.3.1 Scenario 1: Mass Evacuation

This scenario anticipates a possible mass evacuation of the entire community. It assumes all roads are open and unobstructed, and most traffic utilizes the primary evacuation routes.

The hazard is likely an approaching wildfire with sufficient time to perform an evacuation. **Figure 6.4** illustrates the impacted zones (neighbourhoods) and expected traffic volumes for a mass evacuation (7,412 vehicles) if the population evacuated using the number of vehicles (1.49 per household) and routes as expected for the community (75% to the south and 25% to the north).

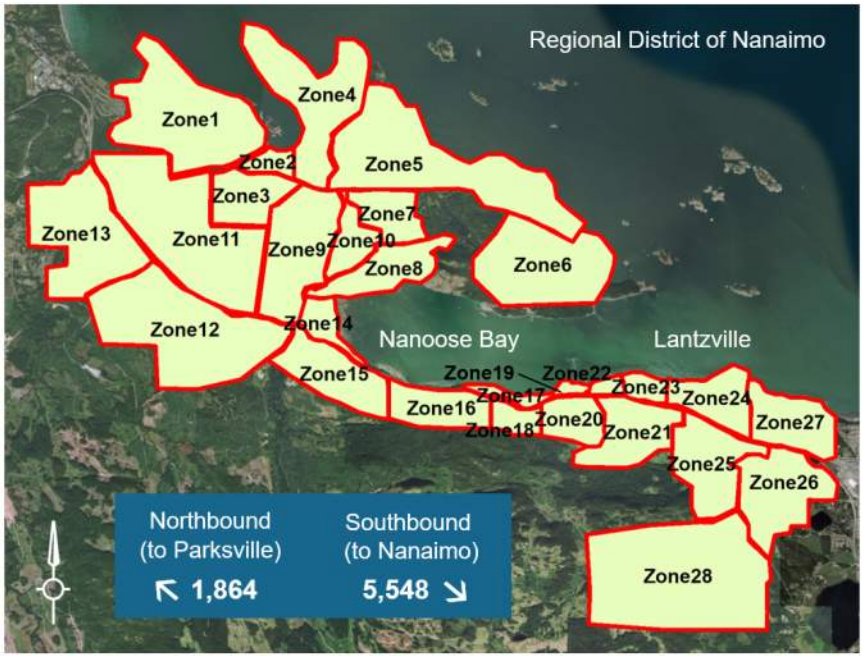

Figure 6.4: Mass Evacuation (SC 1) Impacted Zone and Volume

This is further broken down in **Table 6.1** on the next page, which indicates the number of households for each zone in the traffic simulation model extracted from BC Assessment Data, the population extracted from Census data, the expected number of vehicles, and the volume of traffic from each zone that would evacuate north or south.

Table 6.1: Mass Evacuation (SC 1) Evacuating Volume and Direction

Zone	Household	Population	Number of Vehicles	Southbound Traffic Volume	Northbound Traffic Volume
Zone 1 (Arbutus Drive)	444	871	662	496	166
Zone 2 (Northwest Bay Logging Road)	3	5	5	3	2
Zone 3 (Sanders Road)	53	119	79	59	20
Zone 4 (Claudet Road)	552	1001	823	617	206
Zone 5 (Stewart Road)	685	1155	1021	765	256
Zone 6 (Fairwinds Drive)	518	906	772	579	193
Zone 7 (Florence Drive)	85	153	127	95	32
Zone 8 (Garry Oak Drive)	166	297	248	186	62
Zone 9 (Apollo Drive)	340	552	507	380	127
Zone 10 (Red Gap Road)	27	46	41	30	11
Zone 11 (Northwest Bay Logging Road)	19	42	29	21	8
Zone 12 (Morello Road)	191	411	285	213	72
Zone 13 (Northwest Bay Logging Road)	47	105	71	53	18
Zone 14 (Nanoose Station Road)	34	61	51	38	13
Zone 15 (Summerset Road)	112	240	167	125	42
Zone 16 (Hillview Road)	49	105	74	55	19
Zone 17 (Rumming Road)	44	92	66	49	17
Zone 18 (Bayview Park Drive)	48	120	72	54	18
Zone 19 (Millard Way)	39	115	59	44	15
Zone 20 (Capilano Road)	142	368	212	159	53
Zone 21 (Superior Road)	111	244	166	124	42
Zone 22 (Lantzville Road)	27	65	41	30	11
Zone 23 (Lantzville Road)	86	197	129	96	33
Zone 24 (Lantzville Road)	306	726	456	342	114
Zone 25 (Aulds Road)	305	752	455	341	114
Zone 26 (Aulds Road)	197	431	294	220	74
Zone 27 (Lantzville Road)	334	767	498	373	125
Zone 28 (Aulds Road)	1	2	2	1	1
Total	4,965	9,948	7,412	5,548	1,864

The Vissim model provides two primary metrics to evaluate the evacuation, queue length on each approach to the evacuation route (in some cases on the evacuation route itself) and the travel time between various points in the model (mainly set on the municipality boundaries).

Scenario 1: Queue Length

The queue lengths are useful as they can highlight where a particular neighbourhood may have trouble evacuating. Typically, when queue lengths have returned to zero, we can consider the evacuation to be complete from the immediate area.

With respect to queue lengths, because there are so many measurements, our analysis is focused on those that see the highest queues and/or take the longest time to dissipate.

Figure 6.5 highlights the five neighbourhoods that take the longest to evacuate, albeit several of the locations with the longest queue length such as Powder Point Road and Northwest Bay Road accommodate evacuating traffic from multiple neighbourhoods and is the last major constraint before accessing the highway.

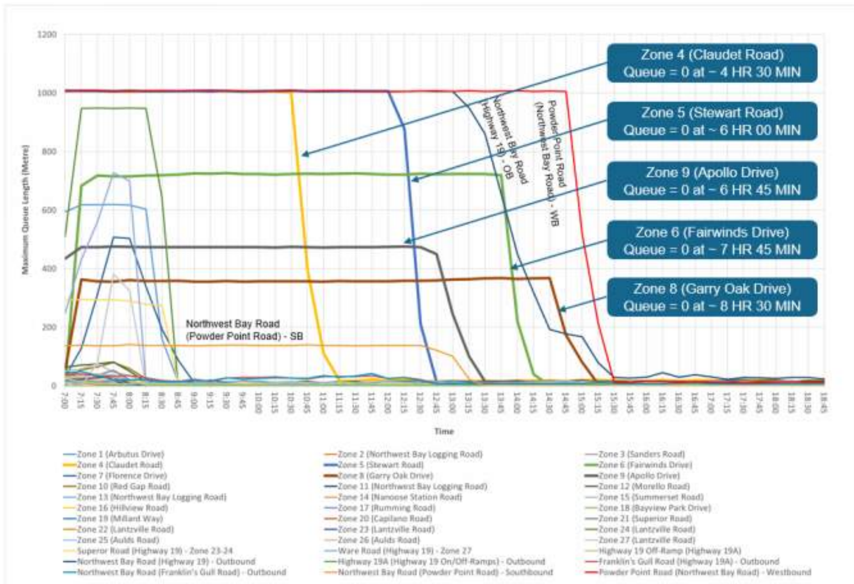

Figure 6.5: Mass Evacuation (SC 1) Queue Length

From the chart above we can draw the following conclusions:

- Due to the one-way stop (T-intersection) with high volume and competing demands, traffic on Powder Point Road, particularly evacuating from Zones 6 (Fairwinds Drive) and 8 (Garry Oak Drive), could experience a long period of queue during a mass evacuation, ranging from about 7.5 to 8.5 hours.

- Various lower speed and vertical curves could create minor roadway congestion along Northwest Bay Road, causing back ups and preventing outbound vehicles, especially if in close vicinity to the point of access, such as Zone 4 (Claudet Road, queueing for about 4.5 hours), 5 (Stewart Road, about 6 hours), and 9 (Apollo Drive, less than 7 hours).

- Only one point of entry to the highway for half of the population could generate a long queue line along Northwest Bay Road, affecting all point of accesses for neighbourhoods.

Figure 6.6 shows condition of the same neighbourhood accesses during a mass evacuation without background highway traffic, assuming restricted. It highlights the same five neighbourhoods and three roadways that take the longest to evacuate, last major constraint before accessing the Highway 19. However, for this scenario, it indicates that evacuation duration would drop by 1.5 hours; that is, overall evacuation time of less than 7.5 hours instead of 9 hours.

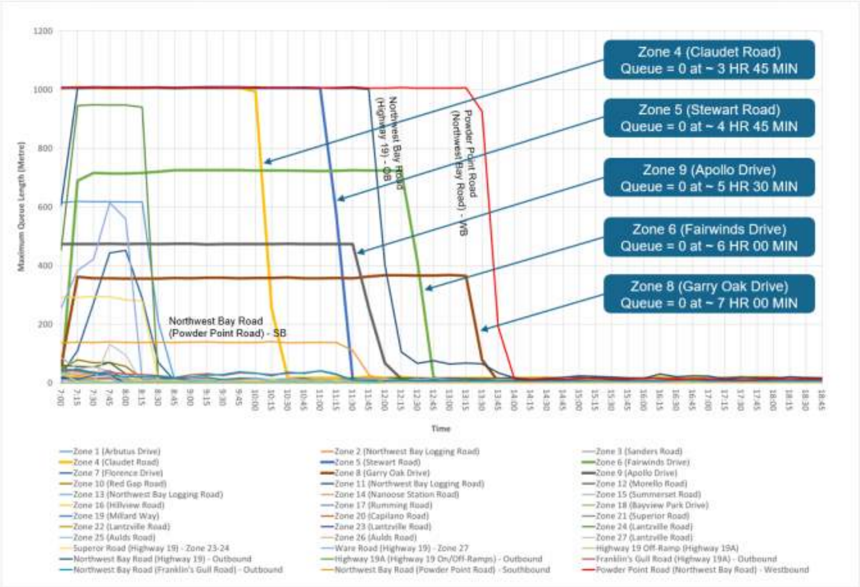

Figure 6.6: Mass Evacuation (SC 1) Queue Length with Highway Traffic

Scenario 1: Travel Time

Travel times are provided between specified points in the modelled road network, they provide an additional metric to evaluate potential congestion along the evacuation routes. If traffic is free flowing there should be some consistency in the travel times, but if intersections or other constraints become congested, this chart will identify that issue. A return to typical travel times does not necessarily mean the evacuation is complete, but does indicate that congestion has disappeared. This data should be interpreted along with the queue data to better understand the evacuation.

Figure 6.7 shows an increase in travel times (during the first hour before returning to normal) for all southbound routes on Highway 19 from the interchange at Parksville to Nanaimo, indicating that with most traffic evacuating to the south that this sees the most congestion. All routes to the north maintain a consistent travel time indicating no significant congestion. For this scenario without background highway traffic, condition shows only a minor increase in travel time during the beginning of evacuation.

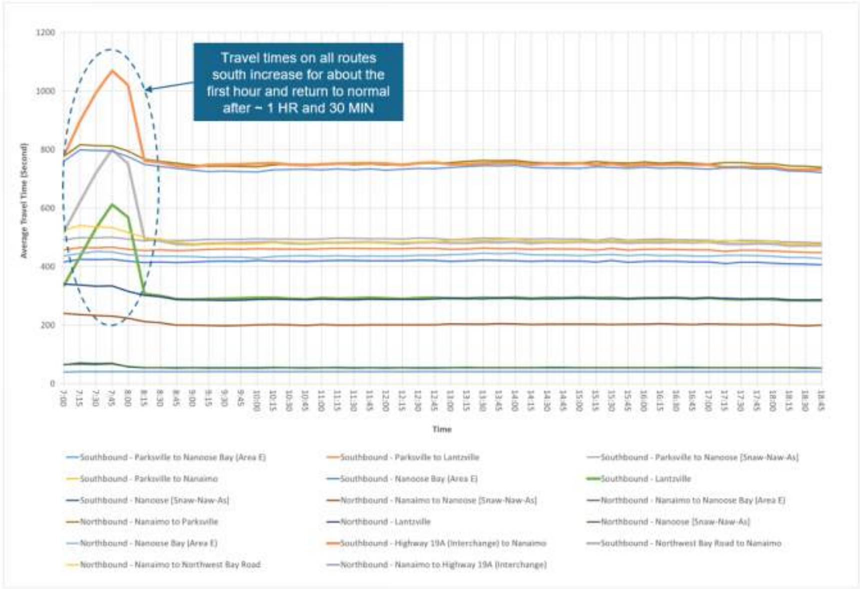

Figure 6.7: Mass Evacuation (SC 1) Travel Time

Scenario 1: Evacuation Time

The above results indicate that a mass evacuation could be completed in under nine hours without restricting highway traffic, but seven and a hlaf hours if restricted; assuming the community is prepared and ready to evacuate, the number of vehicles and direction of evacuation is similar to that in the scenario assumptions, and there are no accidents or other delays that block the evacuation routes.

6.3.2 Scenario 2: Partial Evacuation – Nanoose (Southside)

This scenario reflects a wildfire south of Highway 19 within Electoral Area E. This scenario evacuates only a part of the population, excluding those north of the highway in Nanoose Bay and all of Lantzville. It is important to consider that while the properties within the remaining study areas may not be affected by wildfire, routes in and out as well as supply of goods may be restricted due to the fire. For instance, if the fire were to impact Highway 19, particularly at Nanoose Bay, it could impact the movement of people and goods through the region. Thus if the wildfire is expected to last for a duration beyond which people can sustain themselves, a mass evacuation may still be appropriate, or supplies would have to be brought in to support the population.

Figure 6.8 shows the evacuation routes assigned and vehicle volumes. Compared with Scenario 1 which evacuated 7,412 vehicles, Scenario 2 only requires the evacuation of 597 vehicles, approximately 8% of the population and vehicles.

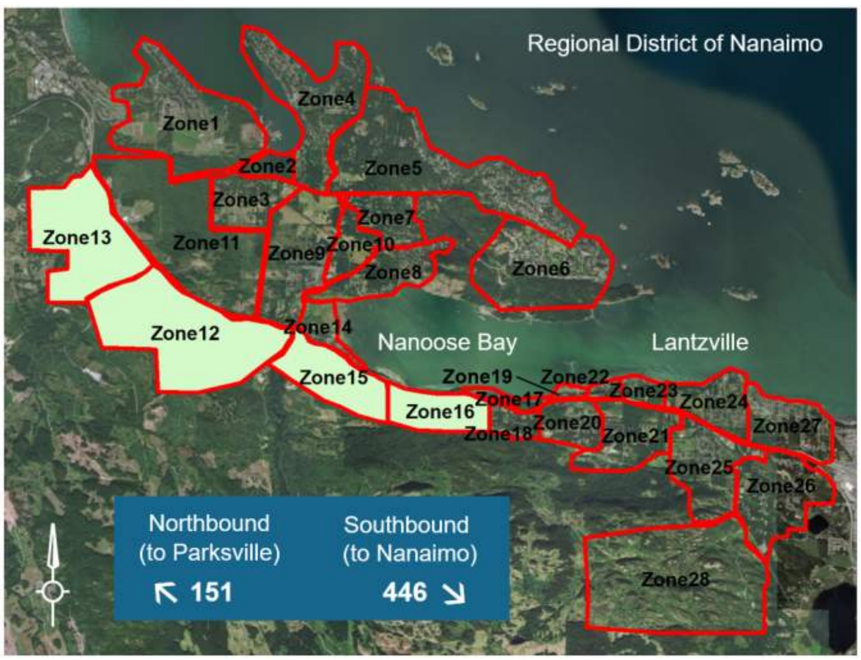

Figure 6.8: Partial Evacuation (SC 2) Impacted Zone and Volume

This is further broken down in **Table 6.2**, which indicates the number of households for each zone in the traffic simulation model, the population, the expected number of vehicles, and the volume of traffic from each zone that would evacuate north or south.

Table 6.2: Partial Evacuation (SC 2) Evacuating Volume and Direction

Zone	Household	Population	Number of Vehicles	Southbound Traffic Volume	Northbound Traffic Volume
Zone 12 (Morello Road)	191	411	285	213	72
Zone 13 (Northwest Bay Logging Road)	47	105	71	53	18
Zone 15 (Summerset Road)	112	240	167	125	42
Zone 16 (Hillview Road)	49	105	74	55	19
Total	**399**	**861**	**597**	**446**	**151**

Scenario 2: Queue Length

Focusing on those that see the highest queues and/or take the longest time to dissipate, **Figure 6.9** highlights two neighbourhoods; that is, Zone 12 (Morello Road) and 15 (Summerset Road) with higher volumes. Their queues would dissipate within the first two evacuating hour. Similar duration is found for this scenario without background highway traffic, but with a slightly shorter queue length (two to three vehicles in length).

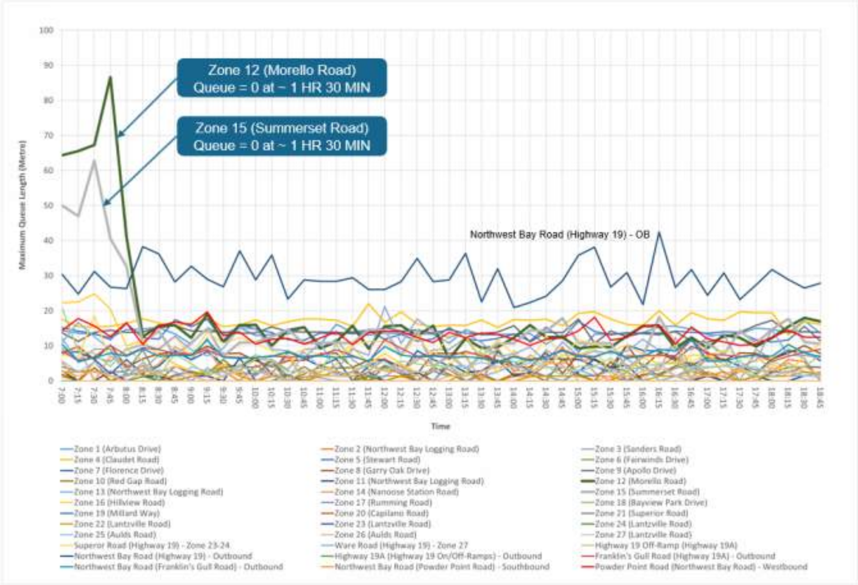

Figure 6.9: Partial Evacuation (SC 2) Queue Length

Scenario 2: Travel Time

Figure 6.10 shows no increase in travel times on all routes within the study area, indicating that with relatively low evacuating volumes, most movements as right turns to the south, and two travel lanes in each direction of the highway, all routes maintain a consistent travel time with no significant congestion. Steady travel time is also found for this scenario without background highway traffic.

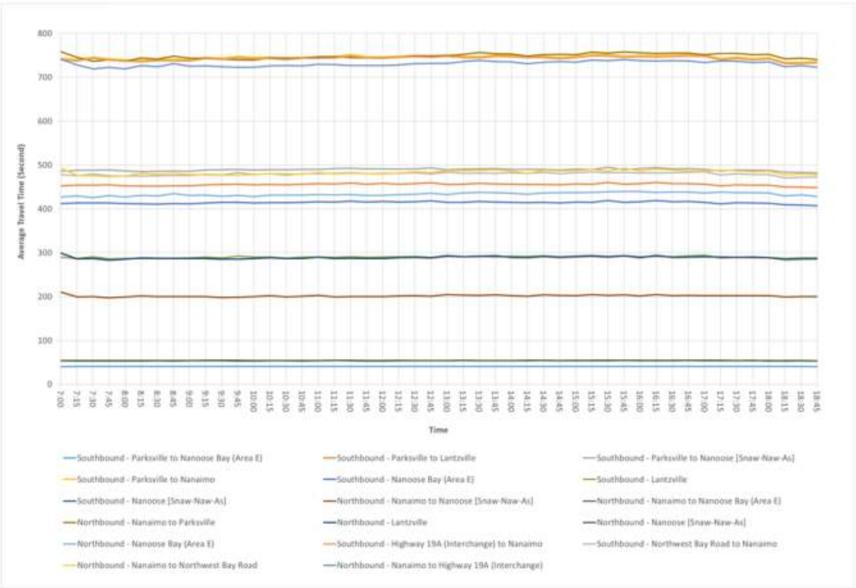

Figure 6.10: Partial Evacuation (SC 2) Travel Time

Scenario 2: Evacuation Time

The above results indicate that a partial evacuation of Electoral Area E south of the highway could be completed in under two hours assuming the community is prepared and ready to evacuate, the number of vehicles and direction of evacuation is similar to that in the scenario assumptions, there are no accidents or other delays that block the evacuation routes, and with or without background highway traffic.

6.3.3 Scenario 3: Partial Evacuation – Lantzville (Southside)

Similar to Scenario 2, this scenario reflects a wildfire south of Highway 19 within Lantzville. This scenario evacuates only a part of the population, excluding those north of the highway in Lantzville and all of Electoral Area E.

It is important to consider that while the properties within the remaining study areas may not be affected by wildfire, routes in and out as well as supply of goods may still be restricted due to the fire. That is, if the fire were to impact Highway 19, it could impact the movement of people and goods through the region. Especially if the wildfire is expected to last for a duration beyond which people can sustain themselves, a mass evacuation may still be appropriate, or supplies would have to be brought in to support the population.

Figure 6.11 shows the evacuation routes assigned and vehicle volumes. Compared with Scenario 1 which evacuated 7,412 vehicles, Scenario 3 only requires the evacuation of 1,201 vehicles, approximately 16% of the population and vehicles.

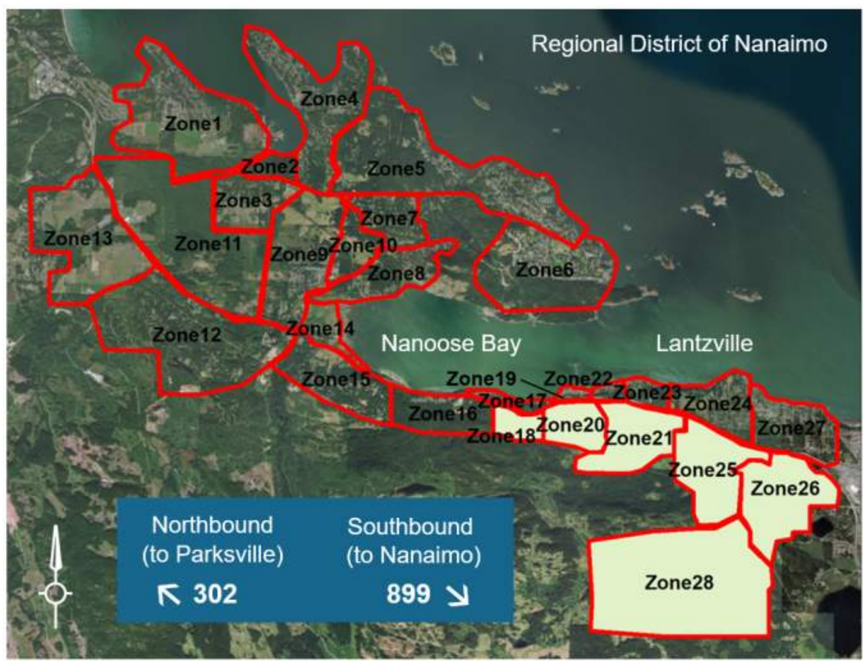

Figure 6.11: Partial Evacuation (SC 3) Impacted Zone and Volume

This is further broken down in **Table 6.3**, which indicates the number of households for each zone in the traffic simulation model, the population, the expected number of vehicles, and the volume of traffic from each zone that would evacuate north or south.

Table 6.3: Partial Evacuation (SC 3) Evcuating Volume and Direction

Zone	Household	Population	Number of Vehicles	Southbound Traffic Volume	Northbound Traffic Volume
Zone 18 (Bayview Park Drive)	48	120	72	54	18
Zone 20 (Capilano Road)	142	368	212	159	53
Zone 21 (Superior Road)	111	244	166	124	42
Zone 25 (Aulds Road)	305	752	455	341	114
Zone 26 (Aulds Road)	197	431	294	220	74
Zone 28 (Aulds Road)	1	2	2	1	1
Total	804	1,917	1,201	899	302

Scenario 3: Queue Length

Focusing on those that see the highest queues and/or take the longest time to dissipate, **Figure 6.12** highlights three neighbourhoods; that is, Zone 21 (Superior Road) and Zones 25 and 26 (Aulds Road) with higher volumes. Their queues would dissipate within the first two evacuating hours. Similar duration and queue length are found for this scenario without background highway traffic.

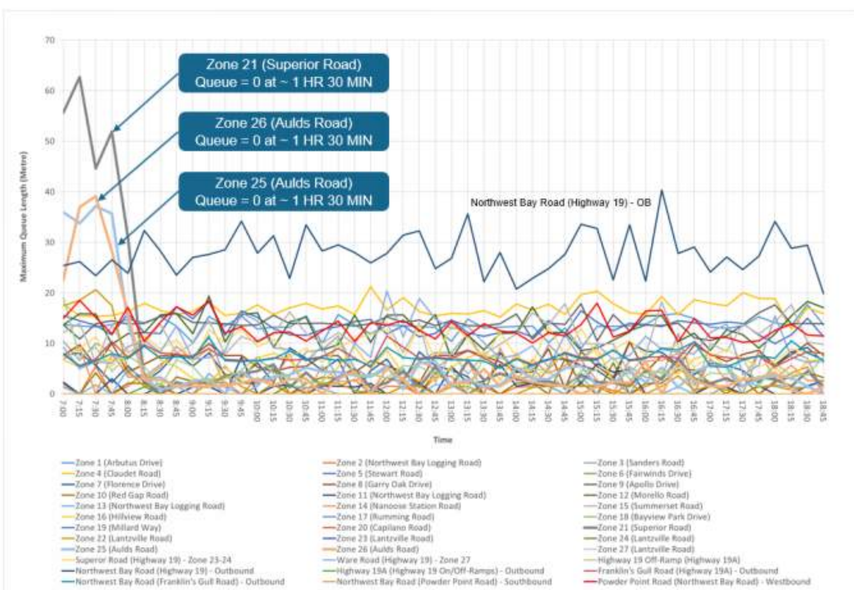

Figure 6.12: Partial Evacuation (SC 3) Queue Length

Scenario 3: Travel Time

Figure 6.13 shows no increase in travel times on all routes within the study area, just like Scenario 2, with relatively low evacuating traffic, channelized right-turns plus signalized intersection, and two travel lanes in each direction of the highway, all routes maintain a consistent travel time with no significant congestion; similar condition without background highway traffic.

Figure 6.13: Partial Evacuation (SC 3) Travel Time

Scenario 3: Evacuation Time

The above results indicate that a partial evacuation could be completed in under two hours assuming the community is prepared and ready to evacuate, the number of vehicles and direction of evacuation is similar to that in the scenario assumptions, there are no accidents or other delays that block the evacuation routes, and with or wihout background highway traffic.

6.3.4 Scenario 4: Mass Evacuation with 2 Outbound Lanes

Scenario 4 uses the same volume data as Scenario 1, but improves the capacity of one of the major constraints in the road network.

The changes to the road network and evacuation behaviour include two southbound lanes to the highway from Northwest Bay Road; that is, utilize all lanes by reversing the inbound travel lane of Northwest Bay Road between Powder Point Road and Highway 19. The dual southbound left-turn lanes were represented in the model by having southbound traffic from Northwest Bay Road (north of Powder Point Road) to use the right lane and having southbound vehicles from Powder Point Road (westbound-left turn) directly use the left lane, which is typically the opposing inbound traffic lane. It should be noted that this would restrict emergency vehicle access into Nanoose Bay.

Furthermore, all vehicles in Lantzville were distributed to the south (100% to Nanaimo) to avoid competing at Northwest Bay Road and Highway 19.

Figure 6.14 illustrates the location of the dual left-turn outbound lanes to the highway, along with evacuation routes assigned and vehicle volumes.

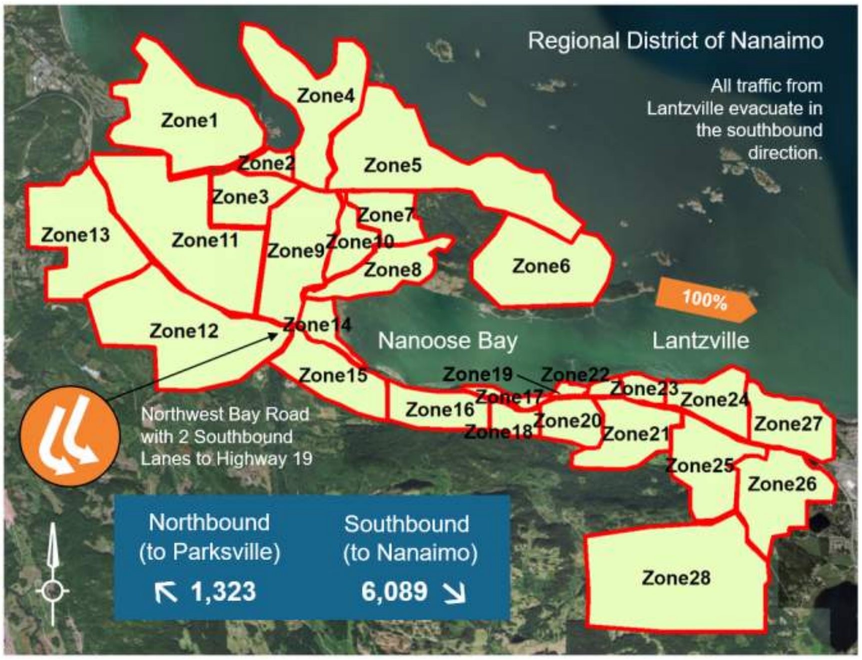

Figure 6.14: Evacuation with Dual Lanes (SC 4) Impacted Zone and Volume

Compared with Scenario 1 which evacuated vehicles 75% south and 25% north, Scenario 4 distributed the traffic about 80% south and 20% north.

Scenario 4: Queue Length

With respect to queue lengths, because there are so many measurements, our analysis is focused on those that see the highest queues and/or take the longest time to dissipate. **Figure 6.15** highlights the four neighbourhoods that take the longest to evacuate, albeit several of the locations with the longest queue length such as Powder Point Road and Northwest Bay Road accommodate evacuating traffic from multiple neighbourhoods and is the last major constraint before accessing the highway.

Compared with Scenario 1 which had 5 distinct Nanoose Bay neighbourhoods, Scenario 4 did not impact Zone 6 (Fairwinds Drive) as much, most likely due to the dedicated outbound lane on Northwest Bay Road from Powder Point Road to Highway 19. However, T-intersections with competing demands, various low speed and vertical curves, as well as one direct entry to the highway with high volume neighbourhoods would still affect Nanoose Bay overall, queueing for about 4 hours.

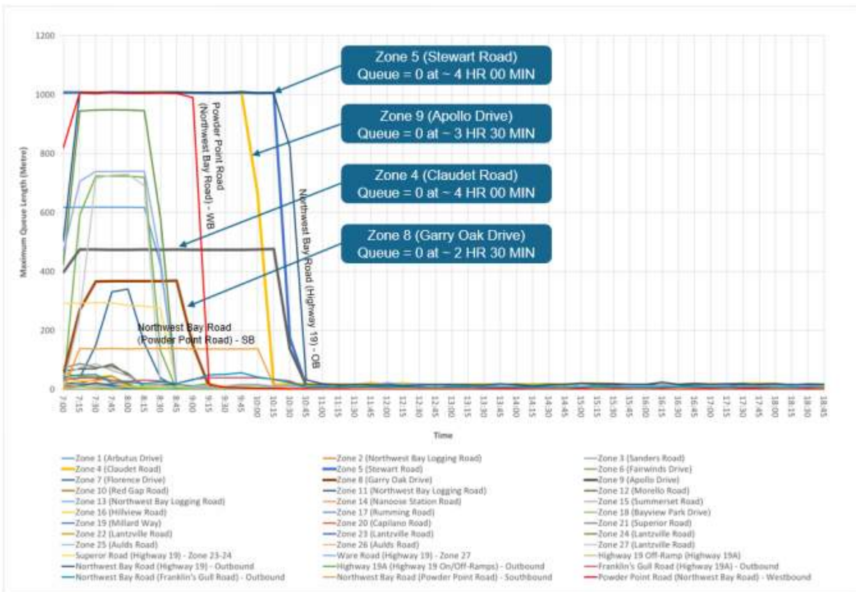

Figure 6.15: Evacuation with Dual Lanes (SC 4) Queue Length

Scenario 4: Travel Time

Figure 6.16 shows a similar increase in travel times as Scenario 1 on all routes between the study area and Nanaimo, indicating that with most traffic evacuating to the south that this sees the most congestion. All routes to the north maintain a consistent travel time indicating no significant congestion.

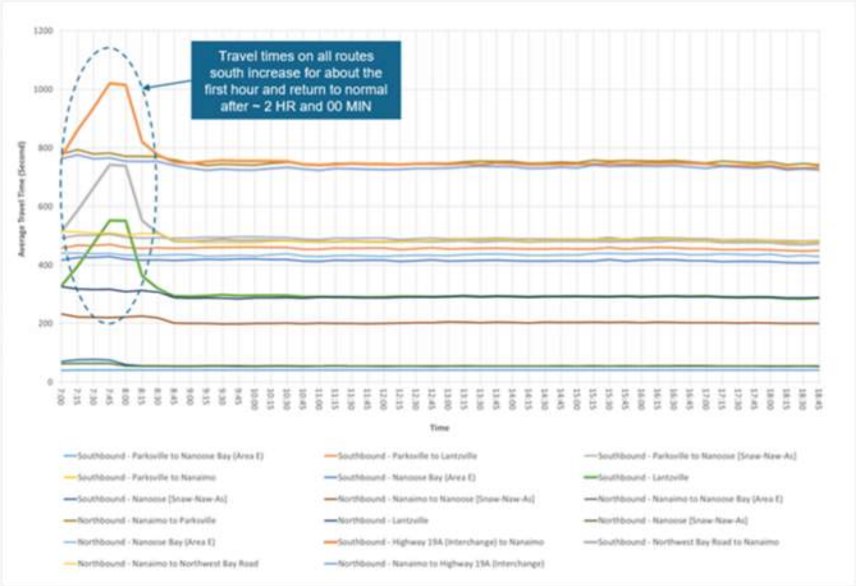

Figure 6.16: Evacuation with Dual Lanes (SC 4) Travel Time

Scenario 4: Evacuation Time

The above results indicate that a mass evacuation could be completed in under four hours. In other words, with the adjusment to the road network and evacuation behavour, the total evacuation time could be decreased significantly by half at least; again subject to the assumption that the community is prepared and ready to evacuate, the number of vehicles and direction of evacuation is similar to that in the scenario assumptions, and there are no accidents or other delays that block the evacuation routes.

6.3.5 Scenario 5: Split Direction Mass Evacuation

Using the same volume data as Scenario 1, this scenario reflects the evacuation behaviour to be split between Nanoose Bay and Lantzville; that is, all traffic from Nanoose Bay evacuate north (mostly through the interchange from Highway 19A and Northwest Bay Road) while all traffic from Lantzville evacuate south. It could also mimic if the road network is cut off along the highway due to wildfire hazard from the south.

Figure 6.17 indicates the total evacuation volume is distributed 60% and 40% south, as compared to Scenario 1 with 75% south and 25% north.

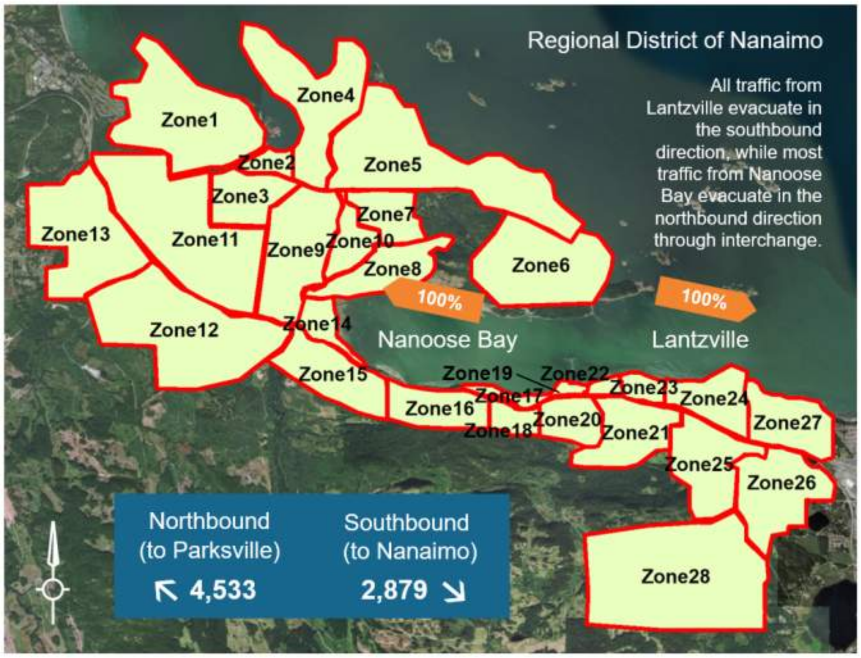

Figure 6.17: Split Direction Evacuation (SC 5) Impacted Zone and Volume

Scenario 5: Queue Length

Focusing on those that see the highest queues and/or take the longest time to dissipate, **Figure 6.18** (next page) highlights the five neighbourhoods that take the longest to evacuate, albeit several of the locations with the longest queue length such as Powder Point Road and Northwest Bay Road accommodate evacuating traffic from multiple neighbourhoods and is the last major constraint before accessing the highway.

Since a higher evacuation volume is distributed to the north for this scenario, new zone and roadway have been impacted comparatively; that is Zone 1 (Arbutus Drive, queuing for about 7 hours) and Franklin's Gull Road, towards the interchange at Highway 19A.

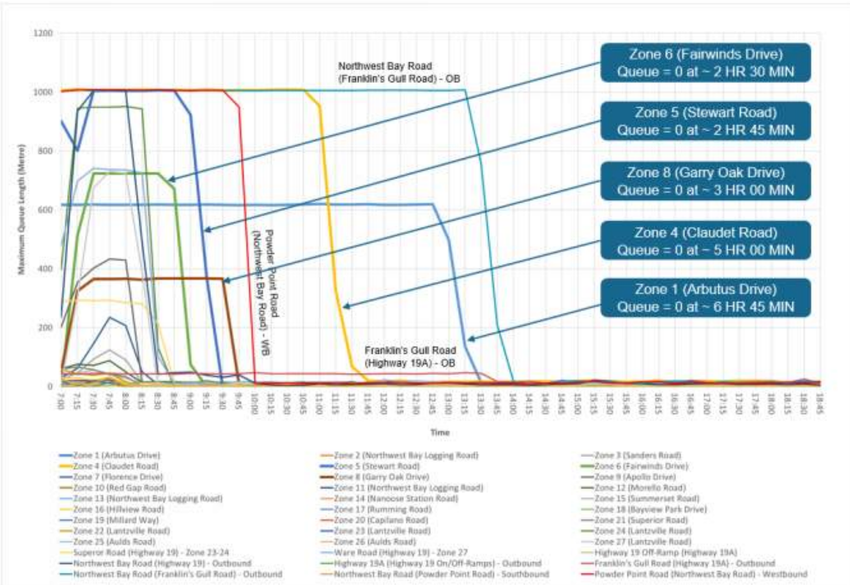

Figure 6.18: Split Direction Evacuation (SC 5) Queue Length

Scenario 5: Travel Time

Figure 6.19 shows a minor increase in travel times as compared to Scenario 1 on all routes between the study area and Nanaimo, indicating that due to the split distributions, the routes mostly maintain a steady travel time indicating no significant congestion.

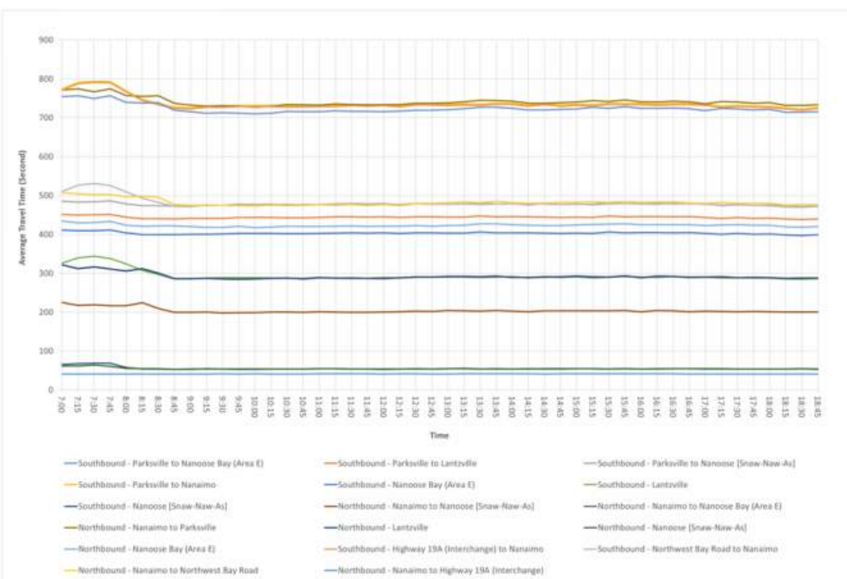

Figure 6.19: Split Direction Evacuation (SC 5) Travel Time

Scenario 5: Evacuation Time

The above results indicate that a mass evacuation could be completed in under seven and a half hours. In other words, with the adjustment to the evacuation behaviour, the total evacuation time could be decreased slightly; subject to the assumption that the community is prepared and ready to evacuate, the number of vehicles and direction of evacuation is similar to that in the scenario assumptions, and there are no accidents or other delays that block the evacuation routes.

Evacuation Time Summary

Table 6.4 summarizes the evacuation times estimated for each scenario. These are subject to the population's general readiness, the restriction of most other traffic on the road networks being evacuated to, and no train activity.

Table 6.4: Evacuation Time Summary

Evacuation Scenario	Vehicle Volume (Split)	Evacuation Time
Scenario 1: Immediate Mass Evacuation	7,412 (75% SB : 25% NB)	< 9 Hours
Scenario 2: Partial Evacuation – Nanoose Bay (South of Highway 19)	597 (75% SB : 25% NB)	< 2 Hours
Scenario 3: Partial Evacuation – Lantzville (South of Highway 19)	1,201 (75% SB : 25% NB)	< 2 Hours
Scenario 4: Immediate Mass Evacuation with 2 Outbound Lanes and Lantzville Volume Redistributed	7,412 (80% SB : 20% NB)	< 4 Hours
Scenario 5: Split Direction Immediate Mass Evacuation between Nanoose Bay and Lantzville	7,412 (40% SB : 60% NB)	< 7.5 Hours

7.0 Recommendations

The following recommendations are made to support evacuation, some of which are subject to the evacuation scenario occurring:

7.1 General Readiness

- Monitor wildfire threats, and call an evacuation with sufficient time to comfortably evacuate those threatened, if possible.
- Assign neighbourhoods (through an app, paper notifications, or website information) with a primary evacuation route, should there be a need to call for a rapid no-notice evacuation.
- It is understood that an evacuation would be announced by Evacuation Alert or Order and notification to the impacted area made through public emergency notification systems, social and traditional media, and Local Authority websites. If an evacuation is triggered, include alternate notification strategies for those who do not have access to these technologies such as door-to-door. Royal Canadian Mounted Police, Search and Rescue, First Responders, Local Authority staff and volunteers can assist with door-to-door notifications and flag houses as appropriate to identify evacuation status.
- Establish lines of communication with appropriate agencies and support staff. Have one unified command post for all stakeholders. As necessary, TCP and/or Mainroad (BC MoTI) staff should have the same radio frequency as First Responders.
- To avoid lineups at gas station, where an evacuation is anticipated, encourage residents to maintain at least half a tank of gas in their vehicles. For example, lineups for gas at Petro-Canada on the northwest corner of the Northwest Bay Road and Highway 19 intersection could cause delays on the evacuation route; could close the driveways to/from the gas station during evacuation.

7.2 Traffic Management

- Clearly identify evacuation routes for each neighbourhood or evacuation zone, if appropriate. Through discussion with the RDN, the District and various stakeholders, an immediate mass evacuation might be unlikely, so phased evacuation could also be considered for this study area.

- In the event of a hazard that only affects one of the study areas and requires rapid evacuation, call on BC MoTI and their contractors (Mainroad) to close Ministry highway and roadways to reduce conflicting traffic. As needed, First Responders can control traffic along the highway, but only BC MoTI can block traffic or approve such action. If it is traffic signal related, MoTI staff need to be on site to adjust any equipment. It is also understood that the Local Authority would collaborate with the responding agency to determine any legislated powers or considerations for the management of evacuated areas.

- Maintain lanes into the evacuation zone for emergency personnel, transit, as well as fuel or tow trucks.

- Have tow trucks and refueling trucks strategically located to manage breakdowns. Inbound lanes should be mostly free to drive around any broken down vehicles.

- Determine available traffic management resources required for a rapid no-notice evacuation.

- Have information booth or checkpoint at key locations to prevent entry and increase security.

- Determine if there are particular neighbourhoods more at threat than others and prioritize evacuation using appropriate traffic control measures.

- Place highest priority for traffic control where there are stop-controlled left turns onto the evacuation route in the direction of evacuation, particularly those with a higher population. Where necessary, direct traffic through without stopping and ensuring any conflicting movements are managed. See **Figure 7.1** and **7.2** for location of stop controls in Electoral Area E (Nanoose Bay) and Lanztville (including Nanoose First Nations) along the highway.

7.3 Transit

- Determine the need for those without walkable access to a transit stop, and a strategy to pick those people up. It is understood that there is a separate plan in place for school and transit for the RDN during an evacuation – not reviewed in this study.

- Determine if there are school buses that can be used in an evacuation, if not already required to evacuate school children.

- Limit those evacuating by bus to one hand luggage size item per person to increase person carrying capacity on transit vehicles.

- Determine if additional buses can be used in an evacuation for those that require assistance to evacuate.

- Consider the need to create muster stations where people could assemble for evacuation assistance via transit or other means.

7.4 Other Modes

- While unlikely to be a primary mode of evacuation. Bicycles have the benefit of being able to ride through moderate conditions that might otherwise prevent vehicle access, allowing people to escape during a hazard. Consider the potential need for secure bicycle storage at muster stations.

- Walking is also unlikely to be a primary mode of evacuation, but people may walk to muster stations, or transit stops, and may need help in evacuating from there.

7.5 Wayfinding

- Fixed Message Signs may be permanent signs that are covered or uncovered, they may indicate an evacuation route to a particular destination. It should be noted that this is only anticipated to be necessary in a no-notice mass evacuation, where time is limited and traffic capacity more of a concern

- With sufficient warning and a timely evacuation order, the community should have sufficient time to evacuate to the destination of their choosing.

- Dynamic Message Signs could be used at strategic locations for many purposes. The most useful may be in the event that the community is on evacuation notice, the message could inform drivers of this and to check for up-to-date information helping improve community readiness, especially if evacuating to neighbouring municipalities and/or temporary shelters.

- In the event that an evacuation is called, such signs with dynamic messages may be used to advise traffic in Nanaimo and Parksville not to proceed towards the study area. This will avoid conflicting traffic and help maintain capacity for those evacuating. It also keeps more people out of the hazard area.

7.6 Infrastructure Improvement

- The two current points of highway access and many stop-control intersections for Nanoose Bay, relatively highly populated area, increase risk for the community should that become blocked. An alternate access would provide comfort that in the event of a collision or other hazards that were to block an existing access, available route options.

- Potential connections to improve access from Northwest Bay Road to Highway 19 could include Northwest Bay Logging Road (privately owned). It is understood that option needs to be coordinated between the Local Authority, responding agencies and the landowner – not considered in this evacuation plan.

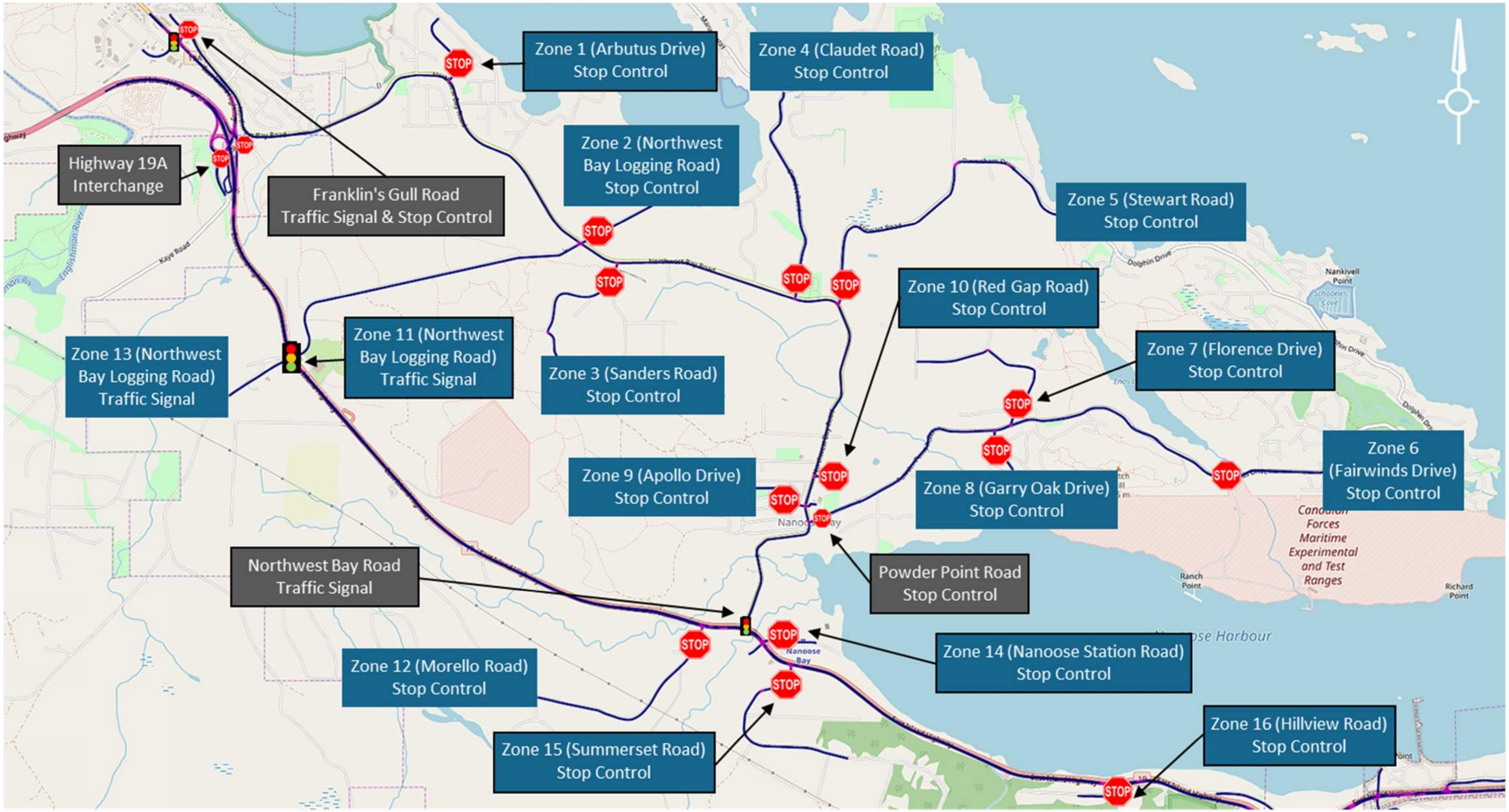

Figure 7.1: Nanoose Bay Constraints Map

Figure 7.2: Lantzville Constraints Map

8.0 Monitoring and Evaluation

With any plan, it is important to update it as new scenarios, updated demographics, or relevant experience become available. Documenting past experiences allows future generations to learn and make better decisions in the future.

8.1 Evacuation Route Exercise

RDN organized an evacuation route exercise with a few neighbourhoods on the east end of Nanoose Bay on February 13, 2020. About 90 residents, the majority from Zone 6, participated in this small-scale mock evacuation. Emergency evacuation notice was sent through an emergency notification system to have these participants begin travelling to their assigned destination. Drivers were reminded to follow regular rules of the road, particularly not to speed or rush during the exercise.

The evacuation started at 10:00 AM, participants drove from Fairwinds Golf Club in Nanoose Bay to Tigh-Na-Mara Resort and Convention Centre in Parksville, which is typically a 16 to 18 minutes drive according to Google Maps. As illustrated in the map from RDN's *Evacuation Route Participant Instructions* (**Figure 8.1**), 50% of the participants (about 45 vehicles) were assigned to the destination (Tigh-Na-Mara) in the northwest corner through either Stewart Road in red (and turn right on Northwest Bay Road) or Powder Point Road in blue (and turn left on Northwest Bay Road then right on Highway 19).

Figure 8.1: Nanoose Bay Evacuate Route Exercise Map

8.1.1 Evacuation Model Comparison

To compare with the evacuation model, ISL staff filmed the evacuating traffic and observed the vehicle headways at the Northwest Bay Road intersections crossing Stewart Road and Powder Point Road, both identified to be major constraints based on the analysis.

Vehicle headway is a measure of the space between two vehicles passing a given point. This varies by driver based on their driving style and level of aggression. Driver behaviour can vary in terms of acceleration from a stop, driver aggression getting up to speed, vehicle performance, and general attentiveness. These all impact how frequently vehicles cross the stop bar within a given time period. The Insurance Corporation of British Columbia driving guides recommend drivers to leave a gap of 2 seconds between themselves and the vehicle in front, extending this to 3 seconds for highways.

From recordings of the exercise along Northwest Bay Road, it was found that the average headways were approximately 7.3 seconds at the right-turn yield-controlled approach of Stewart Road and 6.5 seconds at the stop-controlled approach of Powder Point Road (mainly left turns).

For comparison, with the most likely yet worst case, Scenario 1 (mass evacuation) was used, where 75% of the evacuees heads south on Northwest Bay Road then east on Highway 19. However, for the Stewart Road approach, due to the difference in characteristics between observed and modelled turning movements (most turning right for the exercise instead of left) and traffic controls (yielding instead of stopping), it was not a fair comparison.

The Powder Point Road was a much better comparison. The modelled average vehicle headways of the westbound approach at the Powder Point Road and Northwest Bay Road intersection was estimated to be approximately 9.7 seconds, compared with 6.5 seconds observed. With a difference of 3.2 seconds, it indicated that modelled driving behaviour is more conservative than in real life, coming to complete stops rather than rolling stops sometimes observed.

In summary, the modelled behavior would appear to be more conservative indicating that the evacuation times may also be somewhat conservative, subject to the same caveats made earlier about general readiness to evacuate.

8.1.2 Post Exercise Survey

RDN also carried out a survey of 16 questions related to the exercise with the participants after the mock evacuation. The following summarizes the 79 survey responses; when asked:

- How long it took participants to complete the exercise, on average it took the participants about 24 minutes. The minimum trip time was 16 minutes and the maximum was 32 minutes.

- If the respondents saw a difference from normal traffic conditions, 58% of respondents stated that there was no noticeable change. 36% of respondents stated there were some minor delays. 6% of respondents stated there were moderate delays.

- If they felt frustration or panic during the evacuation exercise, 77% of respondents said no while 23% stated somewhat.

- About their own driving behaviour, 64% of respondents stated it stayed about the same and 36% felt it was more important to drive carefully.

- About others' driving behaviour, 67% stated it stayed about the same and 33% felt like others were driving more carefully.

- If there were delays on specific routes (**Figure 8.2**). For the blue route (Powder Point Road), 28% of respondents stated there were minor to moderate delays along Powder Point Road, followed by 23% along Northwest Bay Road, and minimal delays on the highway. For the red route (Stewart Road), only 19% noted minor delays on Stewart Road itself, while 40% stated minor to moderate delays along Northwest Bay Road, and 43% of respondents stated there were minor to long delays along the highway.

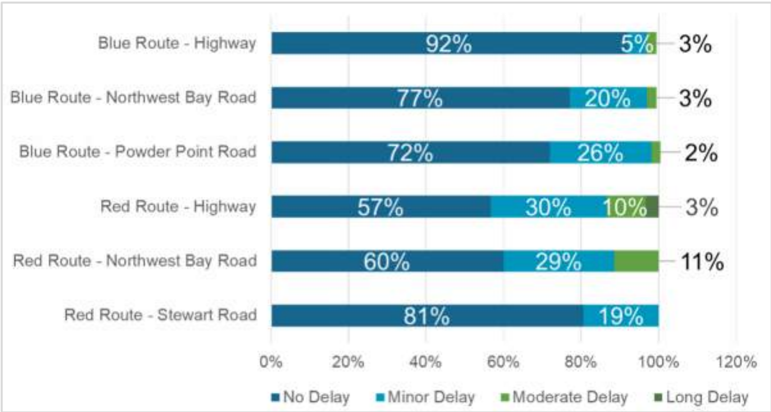

Figure 8.2: Exercise Survey Response – Route Delays

- Respondents were asked an open ended question about improvements, Key themes were extracted from the responses as shown below (**Figure 8.3**), 46% of respondents said no improvements were needed. 23% of respondents stated that turning movements needed to be managed better. 15% of respondents stated there needed to be more flag persons to control traffic which broadly addresses the comments of the previous 23% that had issues at turns.

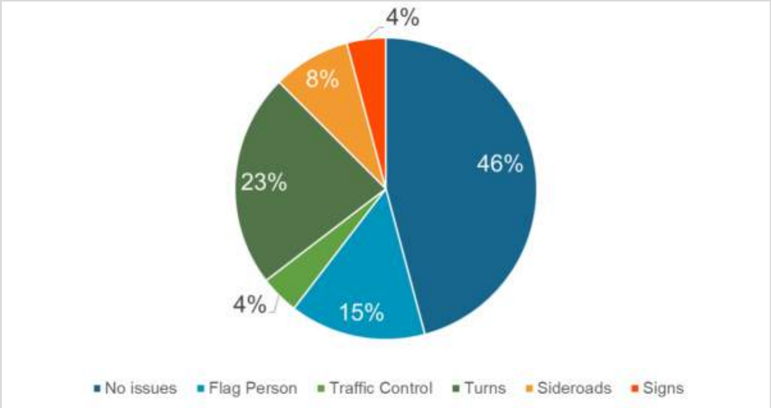

Figure 8.3: Exercise Survey Response – Congestion Improvements

- About if they were prepared to evacuate on short notice, 55% of respondents stated yes, 30% responded somewhat, and 15% responded no.

- How full their gas tank was, 54% stated it was more than 3/4 full, 22% stated it was 1/4 to 1/2 full, 20% stated it was 1/2 to 3/4 full, and 4% stated it was less than 1/4 full.

- If they always keep their gas tank half full, 64% of respondents responded yes and 36% responded no.

- Which assigned route was taken, 52% of respondents answered blue (Powder Point Road) and 48% answered red (Stewart Road).

- Which route they would normally take to leave, 46% responded red (Stewart Road), 45% responded the blue (Powder Point Road), and 9% answered other (mostly specified both).

- How many vehicles are in their household, 63% responded 2 vehicles, 26% responded 1 vehicle, 9% responded 3 vehicles, followed by 1% each for 4 and 5 vehicles; averaging 1.89 vehicles per household.

- How many vehicles they would take in an emergency evacuation, 67% responded 1 vehicle, 31% stated they would take 2 vehicles, and 1% each for 3 and 4 vehicles. This works out to an average of 1.37 vehicles per respondent. It should be noted this is less that the 1.49 value used in the modelling, and thus another reason the model may be somewhat conservative.

- Where they would evacuate to, the top five destinations (out of a total 15 options) listed in order were Nanaimo (39%), Parksville (13%), Victoria (9%), Campbell River (8%), followed by Vancouver (8%). Overall 67.5% would go south (13% to the ferry), 32% would go north. This is slightly different than the 75% south, 25% north assumption used primarily in the model, splitting the traffic more evenly would likely have the benefit of reducing volumes in the most heavily trafficked direction.

- What kind of accommodation they would stay in after evacuating, 47% of respondents stated they would stay with relatives. Another 40% of respondents stated they would stay with friends. 10% of respondents stated they would stay in a hotel. Furthermore, 3% stated they would stay in an alternate home (i.e., second home).