TRANSPORTATION MUNICIPAL/ENVIRONMENTAL LAND DEVELOPMENT

BC MoT, City of Nanaimo and School District 68

Final Report

Highway 19A Northfield Transportation Study

ISL Engineering and Land Services

January 2009

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1.0 Introduction

1.1 Background

The Highway 19A Northfield Area is located at the west of Island Highway North and approximately one kilometre northwest of the Departure Bay Ferry Terminal in the City of Nanaimo, Vancouver Island, British Columbia. Northfield Road runs in an east-west direction and is a major link connecting the Island Highway (Highway 19A) and Nanaimo Parkway (Highway 19). Boundary Avenue runs in a north-south direction and intersects with Northfield Road within 40 metres of the Highway 19A and Northfield Road intersection. The E&N railway runs parallel to Highway 19A and crosses Northfield Road immediately east of Boundary Road.

Boundary Avenue provides one of two accesses to Woodlands Secondary School and Nanaimo Regional General Hospital, which is located at Strathmore Street. Boundary Avenue also provides access to residential developments between Northfield Road and Strathmore Street.

The Highway 19A and Northfield Road intersection is signalized intersection with an exclusive left-turn lane from the Highway 19A northbound. Northfield Road eastbound has a short left-turn bay and no acceleration and deceleration lanes are provided along Highway 19A southbound. Boundary Avenue forms a STOP control at Northfield Road with one travel lane in each direction. A multi-uses trail (for both bicyclists and pedestrians) also runs parallel to Highway 19A and a pedestrian tunnel crossing the highway is located at the south of the study intersection. Figure 1.1 shows both intersections of Highway 19A/Northfield Road and Northfield Road/Boundary Avenue.

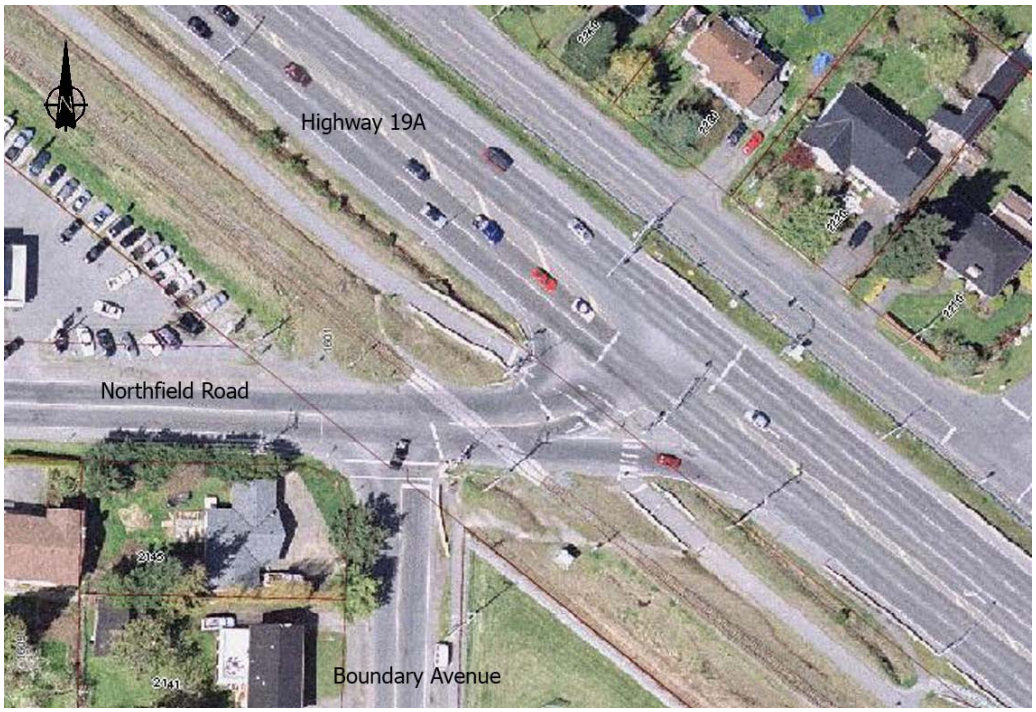

Figure 1.1 Highway 19A/Northfield and Northfield/Boundary Intersection

Several operational and safety issues exist at the intersections of Highway 19A/Northfield Road and Northfield Road/Boundary Avenue, including:

- Operational deficiencies at several left-turn movements (northbound left-turn from Highway 19A and northbound left-turn from Boundary Road) during the ferry surge condition.
- Boundary Road intersection blocked by left-turn and right-turn vehicles.
- One of the major routes for ambulances and other emergency vehicles to access the hospital.
- Collision prone locations – one of the five locations with the highest collision frequency in the City of Nanaimo.
- Multi-modal traffic conflicts – vehicles, trains, pedestrians and bicycles.

It is also expected that the future expansion of Woodlands Secondary School may further increase traffic volumes and collision risk at the study intersections.

1.2 Study Objectives

ISL Engineering has been retained by the British Columbia Ministry of Transportation and Infrastructure (BC MoT) in association with the City of Nanaimo (City) and the Nanaimo School District 68 (SD 68) to conduct a transportation study of the Highway 19A Northfield Area in Nanaimo. The study objectives are to identify and evaluate the short-term improvement option, to assess medium and long-term options for the study area and to determine the traffic operations for the extended school site which is expected to open in 2012. The study will build on the 2007 safety analysis undertaken by Opus Hamilton.

1.3 Progress Reports and Meetings

ISL submitted the two progress reports to all three public agencies (BC MoT, City and SD 68) with the following study objectives:

- Progress Update dated August 15, 2008 – reviewed the background information; conducted preliminary traffic analysis identified the possible turn restrictions for traffic surveys and, provided the summary of the feedback from public agencies whose service routes may be affected by possible movement restrictions.
- Progress Update II dated September 30, 2008 – identified the possible short-term improvement options; compared and summarized various impacts of the short-term improvement options in respect of operational, safety, surrounding streets/intersections, alternate transportation modes and necessary design elements; summarized and compared the proposed medium and long term improvement options and, recommended appropriate access(es) for the expanded Woodland Secondary School.

Two stakeholder meetings (July 10 and October 23, 2008) were undertaken at the School District office in Nanaimo. A site meeting was also arranged among BC MoT staff and ISL staff before the first stakeholder meeting to understand the existing traffic operation issues and potential constraints for the improvement options. A MS PowerPoint presentation was prepared and conducted by ISL staff during the second stakeholder meeting.

This report summarizes the results from the two progress reports, discussions during the stakeholder meetings and the follow-up work with BC MoT's railway specialist and the comments from the railway company.

2.0 Literature Review and Preliminary Analysis

2.1 Literature Review and Site Visits

ISL staff reviewed the ICBC Report, *Traffic Operations and Safety Review Highway 19A, City of Nanaimo, British Columbia*, prepared in July 2007. The study indentified traffic related concerns at the intersection of Highway 19A, Northfield Road and Boundary Avenue. It also recommended possible interim and long-term road safety improvements that may reduce the collision risks. However, with the recommended improvements, a widening of Northfield/Boundary intersection is required to accommodate an additional westbound left-turn lane, two eastbound lanes and two northbound lanes. In addition, some concerns about traffic operations and intersection safety are still unsolved.

The *2007 ICBC Report* also interviewed several public agencies, including BC Ambulance North Station, BC Ambulance South Station, Nanaimo Regional Hospital Administration Department, School District 68, Woodland Secondary School and SD 68 Bus Coordinator. A list of questions was asked and the public agency's responses to those questions were summarized in the Appendix of the 2007 ICBC Report.

ISL staff reviewed all questions and responses and understood that similar answers will be provided when consulting the similar public agencies. Therefore, ISL proposed a different type of traffic survey to identify the potential routings due to specified turning restrictions. The public agencies were requested to mark-up the possible routings in the prepared layouts. The survey was only intended to better understand the implication of the proposed road network changes on emergency responders. Broader public consultation will be required before implementation significant changes.

Details of the traffic survey and the summary of the public agency's response are discussed in Section 3.0 of this report. Based on the responses, ISL identified the most appropriate re-routing for any possible turn restrictions and assessed the potential impacts to the surrounding road network.

ISL staff conducted a site visit/meeting with BC MoT staff on Thursday, July 10, 2008. During the site visit, ISL staff conducted drive-through and walk-through at the study intersections and the surrounding road network. Existing traffic issues and potential improvements were discussed with BC MoT staff. Figure 2.1 shows the site photos for the study intersections.

2.2 Preliminary Analysis

Turning volumes were downloaded from the BC MoT and City website for Highway 19A and the surrounding road network. The *2007 ICBC Report* included 2006 turning volumes. For comparison purposes, an annual growth rate of 2 percent was applied to the data to provide 2008 turning volumes in FIGURE 2.2.

It was found that majority of turning volumes at the study intersections are similar for both BC MoT and ICBC data. The following traffic movements are relatively high:

- Highway 19A northbound left-turn to Northfield westbound;
- Northfield westbound left-turn to Boundary southbound; and,
- Boundary northbound right-turn to Northfield eastbound and then right-turn to Highway 19A southbound.

Northfield westbound - train cross the intersection with all turning movements stopped

Northfield westbound – Eastbound through vehicles overtake vehicles waiting to turn left

Boundary Northbound – Left-turn vehicle use half road width to overtake vehicles waiting to turn right

Northfield eastbound – Concentration of conflict points for turning vehicles, pedestrians, bicycles and train

Figure 2.1 Site Photos for the Study Intersections (Hwy 19A/Northfield/Boundary)
(Photos taken on July 10, 2008)

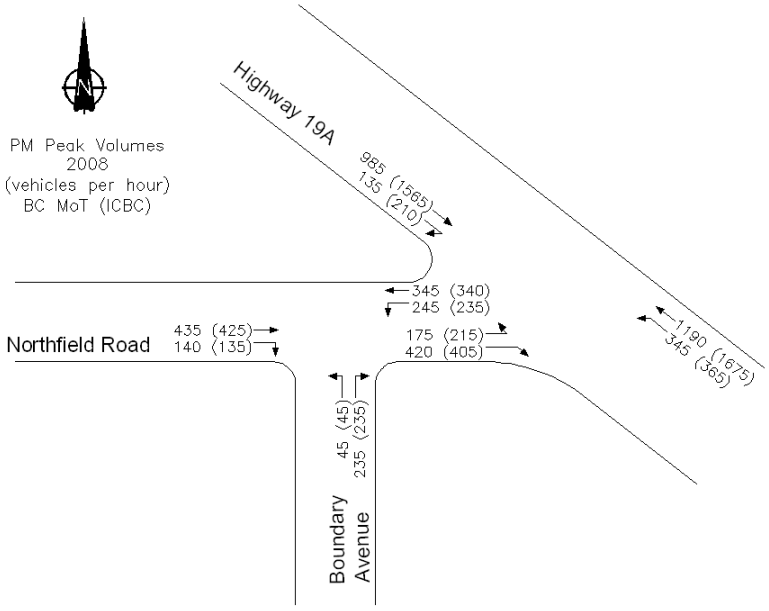

Figure 2.2 Turning Movements Provided by BC MoT and ICBC Report

ICBC data has higher through volumes on Highway 19A due to the traffic counts collected for ferry surge conditions. The BC MoT traffic volumes were based on average peak volumes during weekdays. The BC MoT traffic volumes were used for traffic operations in this study.

A preliminary analysis of the intersections included routing changes resulting in single or combinations of movement restrictions at Highway 19A/Northfield and Northfield/Boundary. Possible movement restrictions considered include: Highway 19A north/southbound left and right-turn onto Northfield Road, Northfield Road eastbound left and right-turn onto Highway 19A, Northfield Road east/westbound right and left-turn onto Boundary, and northbound left and right-turn onto Northfield.

The alternate routes are based on the shortest routes from origin to destination and review of the survey results provided by public agencies. To identify the impacts for different origins and destinations of trips, the Northfield area is divided into six different zones shown in Figure 2.3:

- School – Woodlands Secondary School block
- Hospital – Nanaimo Regional Hospital block
- Area 1 – area east of Dorman Road and between Northfield Road and Highway 19A
- Area 2 – northwest quadrant of Meredith Road and Boundary Avenue
- Area 3 – southwest quadrant of Meredith Road and Boundary Avenue
- Area 4 - area east of Kiwanis Crescent and between Dufferin Street and Highway 19A

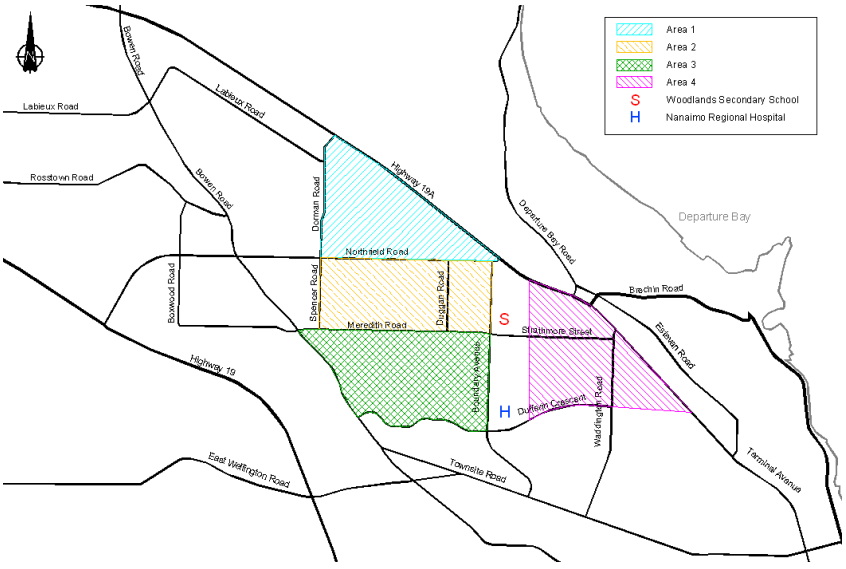

Figure 2.3 Study Area Zone Map

The study area zones were used to estimate the impacts for each possible turn restriction and determine the feasible implementation of those turning restrictions.

3.0 Survey Questionnaire

3.1 Suggested Possible Restrictions in Survey

Traffic analysis suggests several movement restrictions are not practical and feasible. It is not expected that any turning restrictions on Hwy 19A be implemented. The queuing of right-turning vehicles on Highway 19A onto Northfield westbound do not affect the section between the two intersections and an existing left turn bay provides adequate storage for left-turning vehicles into Northfield Road. Restricting the high volume of right-turning vehicles from Northfield eastbound to Highway 19A will create re-routing to surrounding local roads and generate more safety and traffic operational problem areas.

Eastbound right-turn vehicles on Northfield into Boundary Avenue have no impact on the operation and safety of the road section east of the intersection. Through volume at the unsignalized intersection make it difficult for vehicles to turn left resulting in long queues and delays on the east and south leg of the intersection. The Boundary northbound right-turning vehicles often have to wait for left-turning vehicles and will pull out of the one lane approach, driving along the shoulder to make the right-turn.

Ideally eastbound vehicles on Northfield should not stop in either the Boundary/ Northfield intersection or on the adjacent train tracks. Unfortunately drivers do stop in these areas in part to ensure “their” spot is not taken by a right-turn vehicles entering from Boundary. Drivers coming from the highway, going west on Northfield who wish to make a left-turn onto Boundary are blocking the westbound through movement. This leaves following vehicles queued up across the train tracks with potentially no way to clear should a train arrive.

Therefore, the following three turning movement restrictions at Northfield/Boundary were considered to improve the operation and safety of the area:

- Boundary northbound left-turn
- Boundary northbound right-turn
- Northfield westbound left turn

3.2 Traffic Survey Feedback Summary

A traffic survey/questionnaire form was distributed to relevant public agencies whose service vehicles may be affected by the above three possible turning restrictions. The sample cover letter and survey form are included in Appendix A. Route changes and comments are collected and will be used in the analysis to determine impacts of movement restrictions on the Northfield area. Table 3.1 provides a summary of the progress on the traffic survey feedback. The additional information from various public agencies:

BC Ambulance Central Island Office – John McKinstry
Ambulance service (patient transfers) is available to Nanaimo Regional Hospital from Ladysmith, Lantzville, Parksville and Qualicum Beach hospitals. Mentioned approximately 30-40 trips are made in the day shift alone to Nanaimo Regional Hospital. Service vehicles try to avoid intersection and try to use Waddington Road, but northbound left-turn into Waddington is difficult because of unsignalized intersection. If barriers are introduced for turning restrictions, suggests/prefers less barricades and obstructions to reduce impact on emergency vehicles or open for emergency vehicle access.

Table 3.1 Summary of Returned Traffic Survey/Questionnaire

Agency	Contact	Date Contacted	Status	Response Date
BC Ambulance North Station	Rob Boorman	31-Jul	Returned traffic survey forms, provided alternate routes to and from hospital if movements restricted	1-Aug
BC Ambulance South Station	Bill Auston	29-Jul	No responses	-
BC Ambulance Central Island Office	John McKinstry	29-Jul	Returned traffic survey forms, provided alternate routes with comments	8-Aug
Nanaimo Fire Rescue	Bob Simpson	29-Jul	Returned several comments on possible movement restrictions	8-Aug
Nanaimo RCMP	Elzo Devries	29-Jul	Returned traffic survey forms, provided alternate routes with comments	8-Aug
Nanaimo Regional Hospital	Deanna Fourt	28-Jul	No major impacts to all staff vehicles	9-Sep
School District 68	Pete Sabo	29-Jul	Returned traffic survey forms, provided alternate routes to and from Woodlands Secondary School for trucks and buses	8-Aug
Regional District of Nanaimo	Laura Kiteley	31-Jul	Provided new proposed bus route (effective Sept 2009)	8-Sep
Woodland Secondary School	Lee Venables	9-Sep	Returned traffic survey forms, provided alternate routes with comments	25-Sep

Nanaimo Fire Rescue – Bob Simpson
Indicated uncomfortable with closing Boundary Road completely, needs access to residential district attached to Boundary Road. Agree with both Northfield westbound and Boundary northbound left-turn restrictions.

Nanaimo RCMP – Elzo DeVries
Suggested a major reconfiguration of the intersection to solve the problem. RCMP is not in favour of Northfield westbound left-turn and Boundary northbound right-turn movement restrictions at Northbound/Boundary intersection.

School District 68 – Pete Sabo
Provided a fourth option (with alternate routing) of closing Boundary Road to any access to or from Northfield Road.

Regional District of Nanaimo – Laura Kiteley
Current bus route does not pass through study intersections (Highway 19A/Northfield or Northfield/Boundary). However, a new route with 30 minute frequency will be implemented in September 2009. The routing will be as follows:
Departure Bay onto Highway 19A North, turn left onto Northfield Road, left on Duggan Road and then left onto Meredith Road for inbound trips (outbound in the opposite direction).

A summary of the traffic survey/questionnaire form and the results marked up routes and existing intersection traffic controls at potential affected intersections are included in Appendix A.

4.0 Improvement Options

4.1 Short-term Improvement Options

With further consideration of the traffic survey feedback from various public agencies, it was recommended that the northbound right-turn from Boundary Road should be maintained in the short-term improvement options. The difficulty in effective enforcement and the relatively high traffic volumes are also considerations to maintain the northbound right-turn movement. Therefore, the following three short-term improvement options were proposed in this study:

- Option 1: Boundary NBLT (Northbound left-turn) Restriction
- Option 2: Northfield WBLT (Westbound left-turn Restriction
- Option 3: Boundary Right-in/right-out

The schematic drawings (Figures 4.1, 4.2 and 4.3) show the above short-term improvement Option 1, 2 and 3 respectively. To regulate the restrictions, painted or raised forced-turn islands are considered for each option. Right-turn-only and/or No Left-turn signs should also be provided as well as the appropriate pavement markings.

4.2 Comparison of the Short-term Improvement Options

The potential impacts of these short-term improvement options are identified and summarized in the following evaluation criteria:

- Operational impacts at the study intersections
- Safety considerations
- Traffic Impacts to the surrounding area
    - Impacts to the surrounding streets
    - Impacts to the Highway 19A intersections
    - Impacts to the City of Nanaimo's major intersections
- Impacts to alternative transportation modes (pedestrian, bicycle, train and transit); and,
- Geometric design and relative cost.

Operational Impacts at the Study Intersections

Traffic count data for the Northfield/Boundary intersection and the Northfield/Highway 19A intersection for the 2008 year (as shown in Figure 2.2) were found by projecting BC MoT traffic count data (2005 and 2007) using an annual growth rate of 2 percent. With the possible turning restrictions, the following assumptions were made:

- Northbound Left Turning Restriction: left-turn traffic will take an alternate route and will avoid the Northfield/Boundary intersection.
- Westbound Left Turning Restriction: One third of left-turn traffic will continue westbound, one third will re-route and become eastbound right turning traffic, and the remaining third of traffic will avoid the Northfield/Boundary intersection.

The intersection performance was assessed using Synchro version 7.0 and the 95th percentile queues were measured from the results of the SimTraffic analysis. The afternoon peak hour was considered in this study. Table 4.1 shows the summary of major operational items for three improvement options when compared to the current condition.

Table 4.1 Summary of Operational Impacts

	Direction	Units	Current Condition	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Traffic Volume at Boundary Road and Northfield Road	EBRT	vph	139	139	221	221
	EBT	vph	433	433	433	433
	WBLT	vph	247	247	N/A	N/A
	WBT	vph	344	344	426	426
	NBLT	vph	47	N/A	47	N/A
	NBRT	vph	237	237	237	237
	TOTAL	vph	1447	1364	1364	1317
Performance at Boundary Road and Northfield Road	WB	LOS (s/veh)	A (6.4)	A (6.4)	N/A	N/A
	NB	LOS (s/veh)	F (82.0)	C (17.7)	C (19.8)	C (19.2)
Total Dealy per vehicle	Boundary	sec/veh	82	18	27	19
	Northfield	sec/veh	15	15	14	14
95th Queue Length at Boundary Road and Northfield Road	WB	metres	44	43	N/A	N/A
	NB	metres	238	249	209	207
95th Queue Length at Highway 19A and Northfield Road	EBLT	metres	44	40	43	44
	NBLT	metres	241	258	92	79

Notes:
EB, WB, NB denote eastbound, westbound and northbound respectively.
LT and RT denote left-turn and right-turn respectively.
vph denotes vehicles pet hour, LOS (s/veh) denotes Level of Service with average delay (seconds per vehicle)

The results indicate that the Boundary northbound movements are expected to significantly improve from LOS F to LOS C for all three improvement options. The total delays per vehicle on Boundary are greatly reduced for the improvement options when compared to the existing condition. The 95th queue lengths on Boundary are reduced for Option 2 and Option 3. With the removal of Northfield westbound left-turn at Boundary (Options 2 and 3), the westbound queue will be removed and a free through movement will be created. The northbound left-turn queue length at Highway 19A will be substantially reduced.

Safety Considerations

Based on the study findings from the 2007 ICBC Report, the majority of the collision types found at the Northfield Road and Boundary Avenue intersection were northbound sideswipe and rear-end, northbound left-turn crossing and eastbound rear-end collisions. Table 4.2 shows the comparison of collision types for each improvement option when compared to the current condition.

With the restriction of northbound left-turns and westbound left-turns at Northfield/ Boundary, left-turn crossing collision will be eliminated. The left-turn opposing collisions will also be eliminated with the restriction of westbound left-turn (Options 2 and 3). The number of rear-end collisions will also be reduced as the occurrences of leading vehicles stopped/waited to turn left and hit by following vehicles will be eliminated. For the Boundary right-in/right-out option (Option 3), the numbers of other collision types (rear-end, sideswipe, bicycle-related and pedestrian-related) will de reduced. Should the raised median be installed on Northfield Road, the number of head-on collision will also be reduced.

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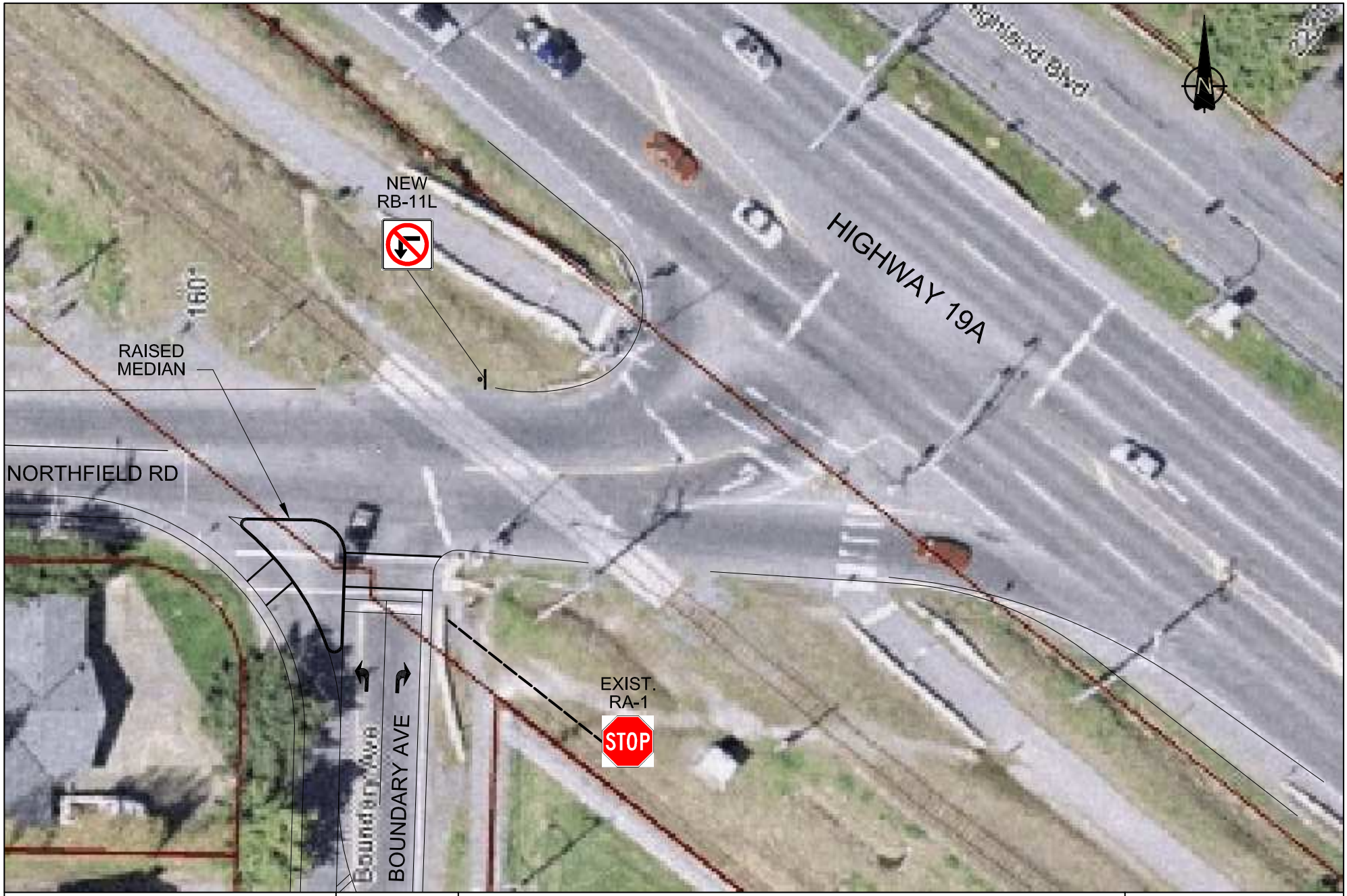
ISL PROJECT No: 30414		



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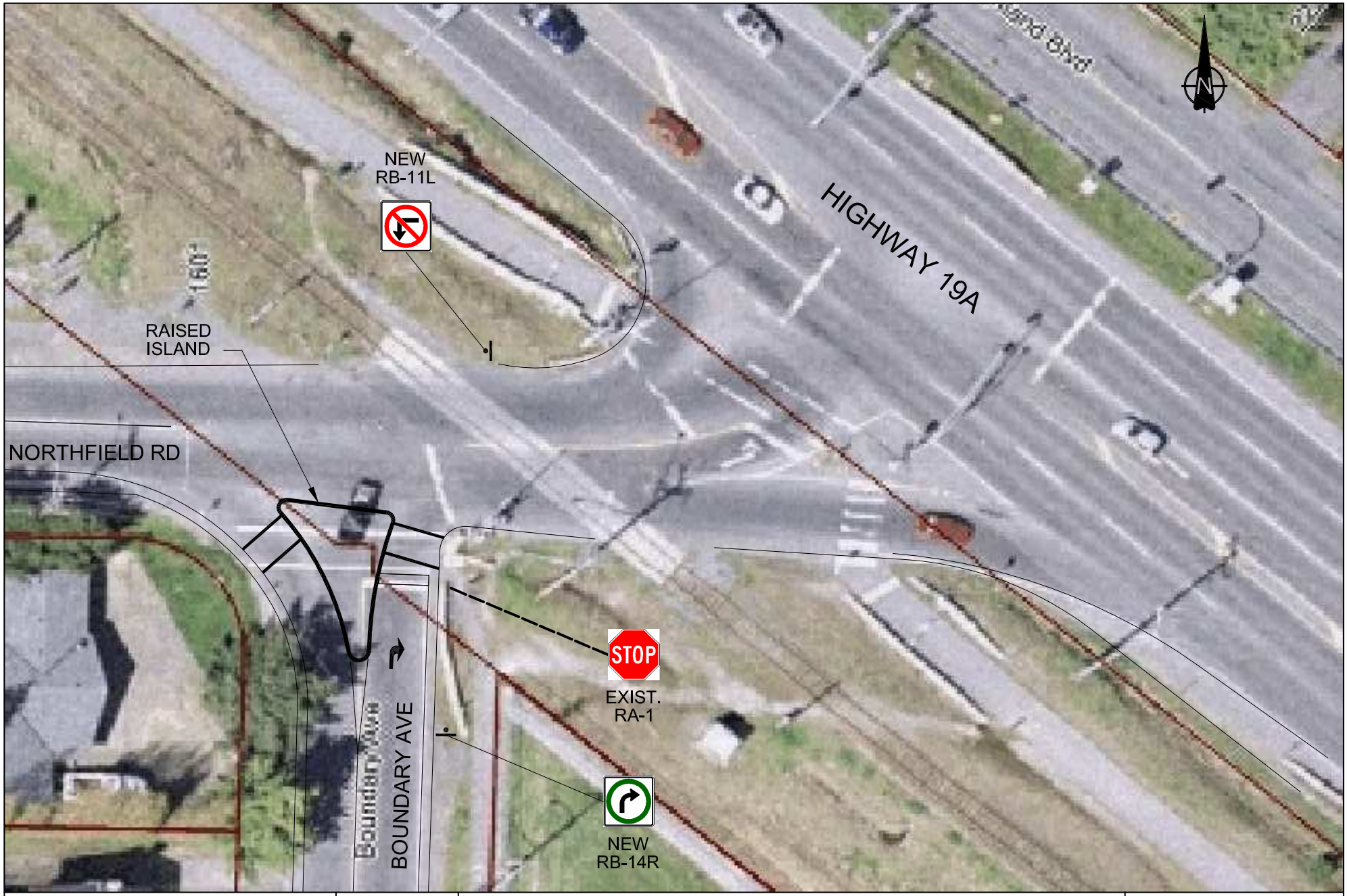
4.2



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APPROVED:			
ISL PROJECT No: 30414			

Table 4.2 Comparison of Collision Types when Compared to the Current Condition

Type of Collision/Conflict	Direction of Movement	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Left-Turn Crossing	WBLT	Eliminated	Eliminated	Eliminated
	NBLT	Eliminated	Eliminated	Eliminated
Left-Turn Opposing	WBLT and EBT	No Change	Eliminated	Eliminated
Rear-end	WB	No Change	Reduced	Reduced
	NB	Reduced	No Change	Reduced
Sideswipe	WB	No Change	Reduced	Reduced
	NB	Reduced	No Change	Reduced
Head-on		No Change	No Change	Reduced
Bike related		No Change	Reduced	Reduced
Pedestrian related		No Change	Reduced	Reduced

Notes:
WB and NB denote westbound and northbound respectively.
LT and T denote left-turn and through movements respectively.

Traffic Impacts to Surrounding Area

Based on the estimated origins and destinations for local traffic and the re-routing of the public agency vehicles, the traffic impacts to the surrounding roads and intersections were determined. To identify the extent of the traffic impacts, the impacts were grouped into two categories:

- Minor – a change of less than 20 vehicles per peak hour; and,
- Major – a change of 20 to 150 vehicles per peak hour.

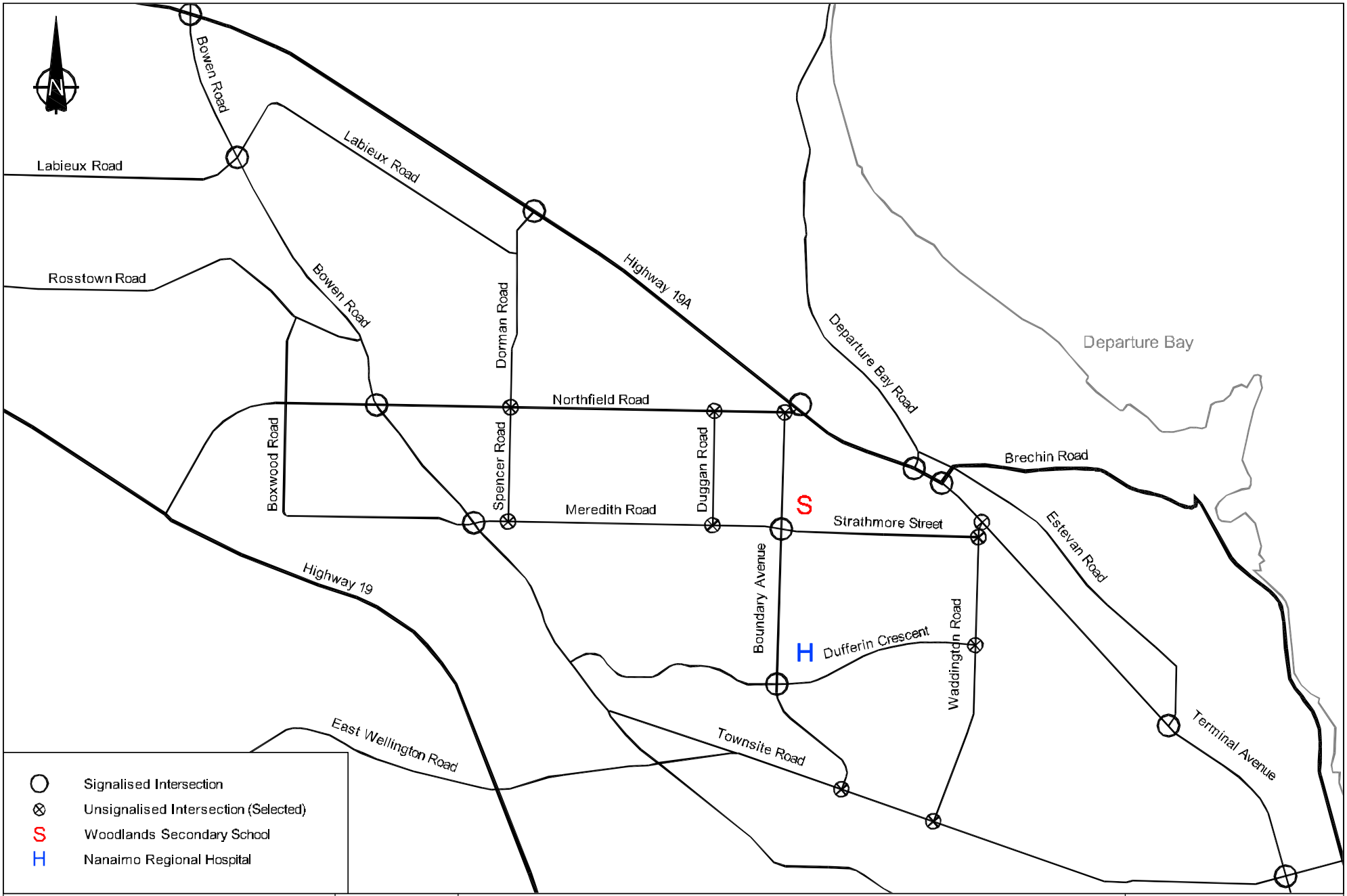
Using the above categories, the minor/some increase/decrease in traffic volumes could be identified in the three types of comparisons considered in this study:

- Impacts to surrounding streets (Table 4.3);
- Impacts to Highway 19A Intersections (Table 4.4); and,
- Impacts to City of Nanaimo's major intersections (Table 4.5).

The locations of the surrounding streets and intersections can be found in Figure 4.4.

The results indicated majority of surrounding streets and intersections are affected for the Option 2 (Northfield Westbound left-turn Restriction) and Option 3 (Boundary Right-in/right-out) as more vehicles are required to change the original routings. It is expected that a maximum of 150 vehicles were re-routed during the afternoon peak hour. It is noted that the traffic re-routing was based on the existing origins and destinations in the area during the peak hour period. With possible turning restrictions, drivers may change their origins and destinations as well as the time of traveling.

The City may consider some local road and intersection improvements for potential re-routed paths, such as Duggan Road, Meredith Road and Northfield Road further east. Traffic calming measures may be required to address short-cutting traffic, such as speed hump and curb extensions.



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ISL Engineering and Land Services

TRAFFIC CONTROL TYPE AT POTENTIAL AFFECTED INTERSECTIONS HIGHWAY 19A NORTHFIELD AREA TRANSPORTATION STUDY

FIGURE

4.4

Table 4.3 Traffic Impacts to Surrounding Streets

Road	Section	Direction	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Bowen Road	n/o Meredith	NB	Minor Increase	No Change	Minor Increase
		SB	Minor Increase	Minor Increase	Minor Increase
Spencer Road	n/o Meredith	NB	Minor Increase	No Change	Minor Increase
		SB	No Change	Minor Increase	Minor Increase
Duggan Road	n/o Strathmore	NB	Major Increase	No Change	Major Increase
		SB	No Change	Major Increase	Major Increase
Boundary Avenue	n/o Strathmore	NB	Major Decrease	No Change	Major Decrease
		SB	No Change	Major Decrease	Major Decrease
Waddington Road	s/o Strathmore	NB	No Change	No Change	No Change
		SB	No Change	Minor Increase	Minor Increase
Northfield Road	w/o Boundary	EB	No Change	Minor Increase	Minor Increase
		WB	Major Decrease	No Change	Major Decrease
Meredith Road	w/o Boundary	EB	No Change	Major Increase	Major Increase
		WB	Major Increase	No Change	Major Increase
Strathmore Street	e/o Boundary	EB	No Change	No Change	No Change
		WB	No Change	Major Increase	Major Increase

Table 4.4 Traffic Impacts to Highway 19A Intersections

Highway 19A Intersection	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Bowen Road	No Change	Minor Increase	Minor Increase
Dorman Road	Minor Increase	Minor Increase	Minor Increase
Northfield Road	Minor Decrease	Major Decrease	Major Decrease
Departure Bay Road	No Change	Minor Increase	Minor Increase
Brechin Road	No Change	Minor Increase	Minor Increase
Waddington Road	Minor Increase	Major Increase	Major Increase
Terminal Avenue	No Change	Minor Increase	Minor Increase
Townsite Road	No Change	Minor Increase	Minor Increase

Table 4.5 Traffic Impacts to City of Nanaimo's Major Intersections

Intersection	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Strathmore Street and Waddington Road	Minor Increase	Major Increase	Major Increase
Meredith/Strathmore and Boundary Avenue	Major Increase	Major Increase	Major Increase
Meredith Road and Spencer Road	Major Increase	Minor Increase	Major Increase
Meredith Road and Bowen Road	Major Increase	Minor Increase	Major Increase
Northfield Road and Duggan Road	Major Increase	Major Increase	Major Increase
Northfield Road and Dorman Road	Minor Increase	Minor Increase	Minor Increase
Northfield Road and Bowen Road	Minor Increase	Minor Increase	Minor Increase

Traffic Impacts to Alternative Modes

In additional to vehicular impacts, the potential impacts to other road users were also reviewed and summarised in Table 4.6. These road users include:

- Pedestrian – walking along and crossing at Boundary and Northfield;
- Bicycle – on-street bicycles traffic travel through Boundary and Northfield as well as bicyclists on the existing E&N trails;
- Train - existing train services provided by the Southern Railway;
- Transit – currently no transit service provided, however, a new bus route is proposed from September 2009, travelling through Northfield Road from Highway 19A south; and,
- Emergency vehicles – flexibility of the use by emergency vehicles.

Table 4.6 Impacts to Alternative Modes in the Area

Alternative Transportation Modes	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Pedestrian	No Change	Positive – Refuge island for crossing Boundary	Positive – Refuge island for crossing Boundary
Bicycle	Positive – NB vehicles will not cut into the shoulder but the conflict between WBLT bicycles and eastbound vehicles will be maintained	Positive – WB through vehicles will not cut into the shoulder to pass the WBLT queue	Positive – Vehicles will not cut into the shoulders
Train	No Change	Positive – WBLT traffic will no longer queue over the train tracks.	Positive – WBLT traffic will no longer queue over the train tracks.
Transit	No Change	Positive - WBLT traffic queues will not hold up the proposed transit route.	Positive - WBLT traffic queues will not hold up the proposed transit route.
Emergency Vehicles	Positive - NBLT traffic queues will not hold up the emergency vehicles. Rollover curb should be considered at the forced-turn island.	Positive - WBLT traffic queues will not hold up the emergency vehicles but WB vehicles will not be able to turn left and will need to be re-routed.	Positive - NBLT traffic queues will not hold up the emergency vehicles. Rollover curb should be considered at the forced-turn island.

The rail operator has reviewed the 3 options at the conceptual level. Should one of the options go forward to design and construction the rail operator would need to review the drawings for the compliance with Transport Canada RTD-10 railway crossing design guideline.

The results in Table 4.6 indicated that Option 2 and Option 3 generally receive positive impacts (improvements) to all other road users.

Geometric Design and Relative Cost

The geometric modifications and associated traffic control requirements for three improvement options were reviewed and summarised in Table 4.7, including:

- Forced–turn island at the Boundary approach;
- Raised Median along Northfield Road;
- Quantity of additional pavement markings;
- Number of new road signs; and,
- Conceptual estimates of modification costs.

Table 4.7 Comparison of Geometric Design and Relative Costs

Design Items	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Forced-turn Island*	Painted/Raised	Raised	Raised
Raised Median	Not Required	Not Required	Could be Considered
Pavement Markings	Minor	Major	Minor
Signage	Two (Right-turn only and an Advanced Warning Sign**)	One (No Left-turn)	Three (Right Turn Only, No Left Turn, and an Advanced Warning Sign**)
Relative Cost	Low	Low	Medium

Notes:
** Use of roll over curb at the raised forced-turn island could be decided at the design stage.*
*** Advanced warning sign to be installed at the intersection of Boundary Avenue and Meredith/ Strathmore for restricted northbound left turning vehicles at Northfield.*

The results in Table 4.7 indicated that the geometric requirements for Options 1 and 2 are generally minimal. The Option 3 may require a higher modifications cost with larger forced-turn island and more signage.

Summary

Based on the above elevation criteria, three improvement options were compared. As majority impacts are considered as positive to improve the operation and safety of the study intersection. A selection of Good, Better and Best was used for each evaluation criteria and each improvement options. Table 4.8 shows the summary of the comparisons by the evaluation criteria.

Table 4.8 Summary of Evaluation Criteria

Evaluation Criteria	Option 1 Boundary NBLT Restriction	Option 2 Northfield WBLT Restriction	Option 3 Boundary Right In/ Right Out
Operational Impact (Based on LOS)	Good	Better	Best
Safety Considerations	Good	Better	Best
Impacts on Surrounding Areas	Best	Better	Good
Impacts to Alternative Transportation Modes	Good	Better	Best
Geometric Design and Relative Cost	Best	Best	Better
OVERALL	Good	Better	Best

Based on the results from Table 4.8, the Short-term Improvement Option 3 (Boundary Right-in/Right-out Option) is the best option for majority of criteria and is the preferred option.

4.2 Medium and Long-term Improvement Options

In addition to the short-term improvement options, a list of medium and long-term improvements options are also identified and reviewed. These options generally require higher construction cost, longer modification time and more public consultation process. These options include:

- Installation of deceleration lane along Highway 19A southbound;
- Installation of acceleration lane along Highway 19A southbound;
- Restriction of left-turn movements at Highway 19A/Northfield intersection
- Closure of Highway 19A/Northfield intersection
- Re-alignment of Highway 19A/Northfield intersection perpendicular to Highway 19A
- Re-alignment of Highway 19A/Northfield intersection in providing Boundary intersecting Highway 19A
- Provision of Pedestrian Overpass
- Provision of Train Overpass
- Provision of Highway 19A Overpass
- Modification to a highway interchange

A summary table includes the brief descriptions for each option, the advantages (PROS) and disadvantages (CONS) are included in Appendix C. It was suggested that BC MoT and the City should consider the following preferred long-term options:

- Installation of deceleration lane along Highway 19A southbound;
- Installation of acceleration lane along Highway 19A southbound; and
- Re-alignment of Highway 19A/Northfield intersection.

5.0 Proposed Access for Expanded School

5.1 Existing Conditions

The existing Woodland Secondary School is located at the northeast corner of the Boundary Avenue and Strathmore Street intersection. Along Boundary Avenue, an ingress/egress point to the school parking lot is provided at about 80m north of Strathmore Street. Along Strathmore Street, 90 degree angle parking spaces are found along the north side and a pick-up/drop-off lay-by is provided near the intersection with Boundary Avenue.

Pedestrian counts were conducted by BC MoT staff during the afternoon school peak period (2:45pm to 3:30pm) on November 4 and 12, 2008. All pedestrians (mainly students) along Boundary Avenue between Northfield Road and Meredith Road were recorded. Figure 5.1 shows the summary of the 45-minute pedestrian counts.

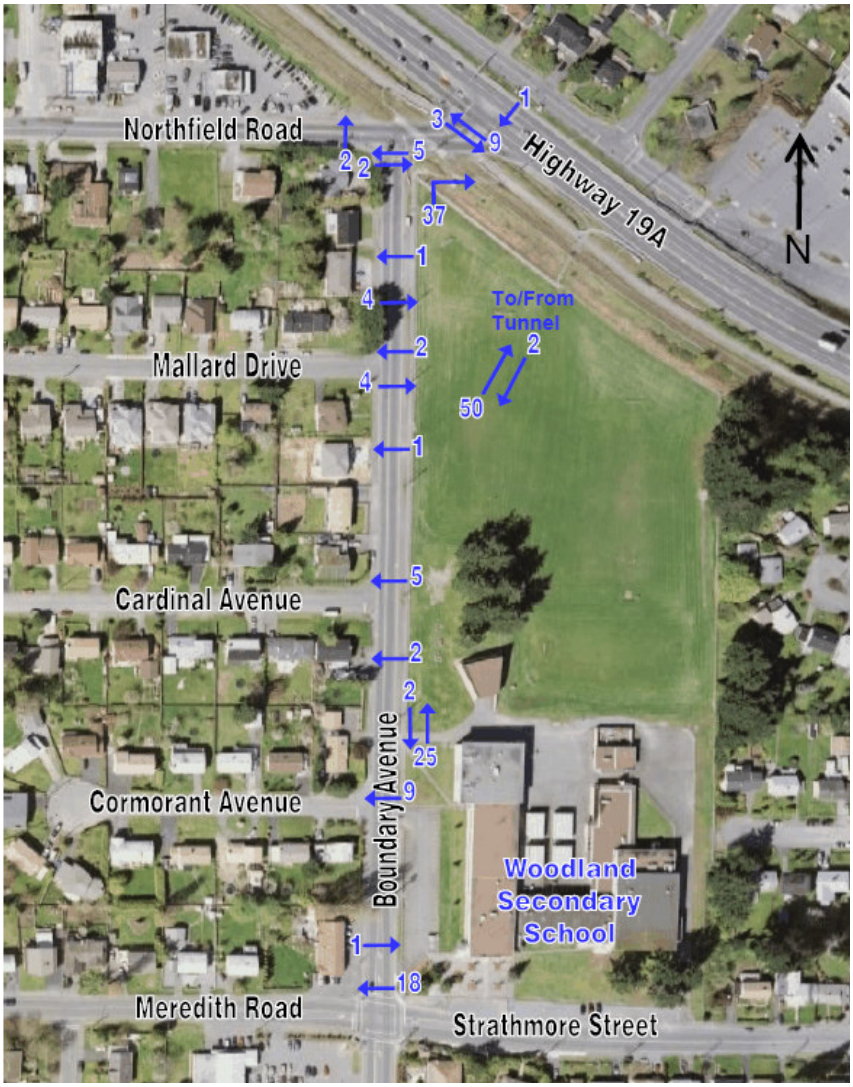


Figure 5.1 Pedestrian Counts During Afternoon School Peak

5.2 Future Conditions

Based on the School District information, the existing school building will be rebuilt and expanded. The number of students will be increased from 700 in 2008 to 1,200 in 2012. The future access locations will be identified and assessed.

Using roadway speed limit of 50 kilometres per hour, the preferred access spacing based on stopping sight distance would be 65m (Table 10.5 from the *Traffic Engineering Handbook 5th Edition*). This results in three areas that would best suit a school access:

1. On Strathmore Street, a minimum of 65m away from the near side of Boundary Avenue, with the far side of the school access being a minimum distance of 15 m from the closest residential driveway.
2. On Boundary Avenue, directly across from Cormorant Avenue (85m away from Strathmore Street).
3. On Boundary Avenue, directly across from Cardinal Avenue (180m away from Strathmore Street).

There should be no access points north of Cardinal Avenue as the access operations may impact the Boundary/Northfield intersection.

Figure 5.2 shows the proposed access locations and Table 5.1 shows the advantages and disadvantages for various access locations. It is noted that the traffic volumes along Boundary Road will be reduced if any turn restrictions are applied to the Boundary/Northfield intersection.

FIGURE 5.2 Proposed Access Locations for Woodland Secondary School

TABLE 5.1 Potential Access Locations for the Woodland Secondary School

School Access Location	Pros (Advantages)	Cons (Disadvantages)
Otpion 1: Access on Strathmore Street	Lower traffic volumes on Strrathmore Street compared to Boundary Avenue (traffic volumes on Boundary may be lower if left-turns are restricted at Northfiled/Boundary).	The current and proposed catchment area is primarily to the south of the school. Traffic traveling eastbound along Strathmore will be required to turn left into the access, possibly queueing up to the intersection.
Option 2: Access on Boundary Avenue, across from Cormorant Avenue	Low through traffic from Cormorant Avenue. The proposed catchment area is primarily to the south of the school and northbound traffic would be able to turn right into the school access.	Heavier traffic on Boundary Avenue compared to Strathmore Street (traffic volumes on Boundary may be lower if left-turns are restricted at Northfiled/Boundary).
Option 3: Access on Boundary Avenue, across from Cardinal Avenue	Further from the Strathmore/Meredith and Boundary Avenue intersection compared to Option 1 and Option 2.	Heavier traffic on Boundary Avenue compared to Strathmore Street. Some traffic may attempt to short-cut on Cardinal Avenue (traffic volumes on Boundary may be lower if left-turns are restricted at Northfiled/Boundary).

Based on the considerations of the pros/cons of different access locations, The School District may consider:

- A right-in-only access on Boundary Avenue (across from Cardinal Avenue) to the school parking lot and pick-up/drop-off lay-by.
- A right-out-only access on Boundary Avenue (across Cormorant Avenue or even further north).
- Removal/relocation of the existing on-street parking and pick-up/drop-off lay-by along Strathmore Street.
- A secondary access or an access to staff parking along Strathmore Street and at least 65m away from Boundary Avenue.

The actual access locations for the future expansion of the Woodland Secondary School should be reviewed with the results of the future traffic impact assessment at the time of redevelopment.

At the time of finalization of this report, the new Woodland Secondary School was in limbo as a new school board reviewed its capital program. All planning and design work to the proposed school is suspended until the capital program is resolved.

Appendix A

Traffic Survey Questionnaire Example And Summary Results

Aug 6, 2008

BC Ambulance Service

Attention: Superintendent John McKinstry

Re: Highway 19A Northfield Area Traffic Survey

Dear Sir/Madam:

ISL has been retained by the Ministry of Transportation and Infrastructure and the City of Nanaimo to conduct a traffic analysis of the Northfield area. The study objectives are to determine a long-term option for the intersections of Northfield/19A and Northfield/Boundary and to determine the traffic impacts of additional school traffic expected in 2012.

Possible options to improve safety and traffic operations at the study intersection may include turn restrictions. Route changes due to potential turn restrictions at Northfield/19A and Northfield/Boundary are necessary in assisting the assessment of the potential impacts to the surrounding road network.

Enclosed are three maps of the Northfield area showing a close up aerial photo of the existing Northfield/19A and Northfield/Boundary intersections. On each aerial photo, a movement is clearly marked at the intersection representing the restricted turn. Please indicate with a felt marker the northbound and southbound alternate route from Highway 19A for your service vehicle. Please feel free to leave any comments on the proposed movement restriction or route change.

Please fax the mark-up drawing(s) to the ISL office at 604-530-1132 or send the scanned drawings to my email at bchan@islengineering.com. To assist our study to be completed on time, please fax or send back to us preferably by Tuesday, August 12th 2008.

If you have any questions or need more information, please do not hesitate to contact the undersigned or Geneve Lau at 604-530-2288. We look forward to hearing from you.

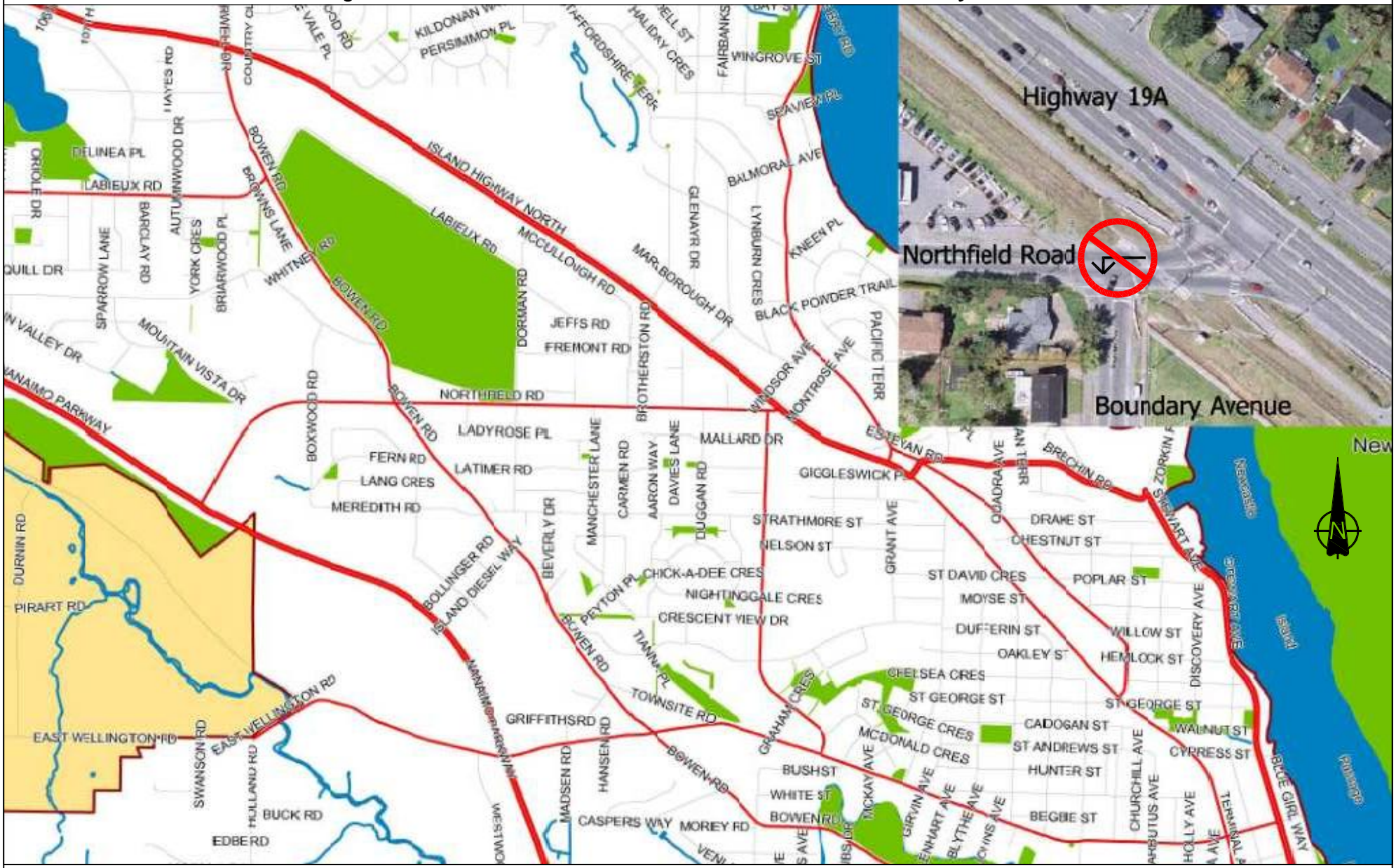
Yours truly,

Borg Chan, P.Eng., PTOE
Senior Transportation Engineer

Enclosure

HIGHWAY 19A NORTHFIELD AREA TRAFFIC STUDY

Turning Restriction at Northfield Westbound to Boundary Southbound



PLEASE MARK THE ALTERNATIVE ROUTE IF TURNING MOVEMENT IS RESTRICTED

NOTES: _____

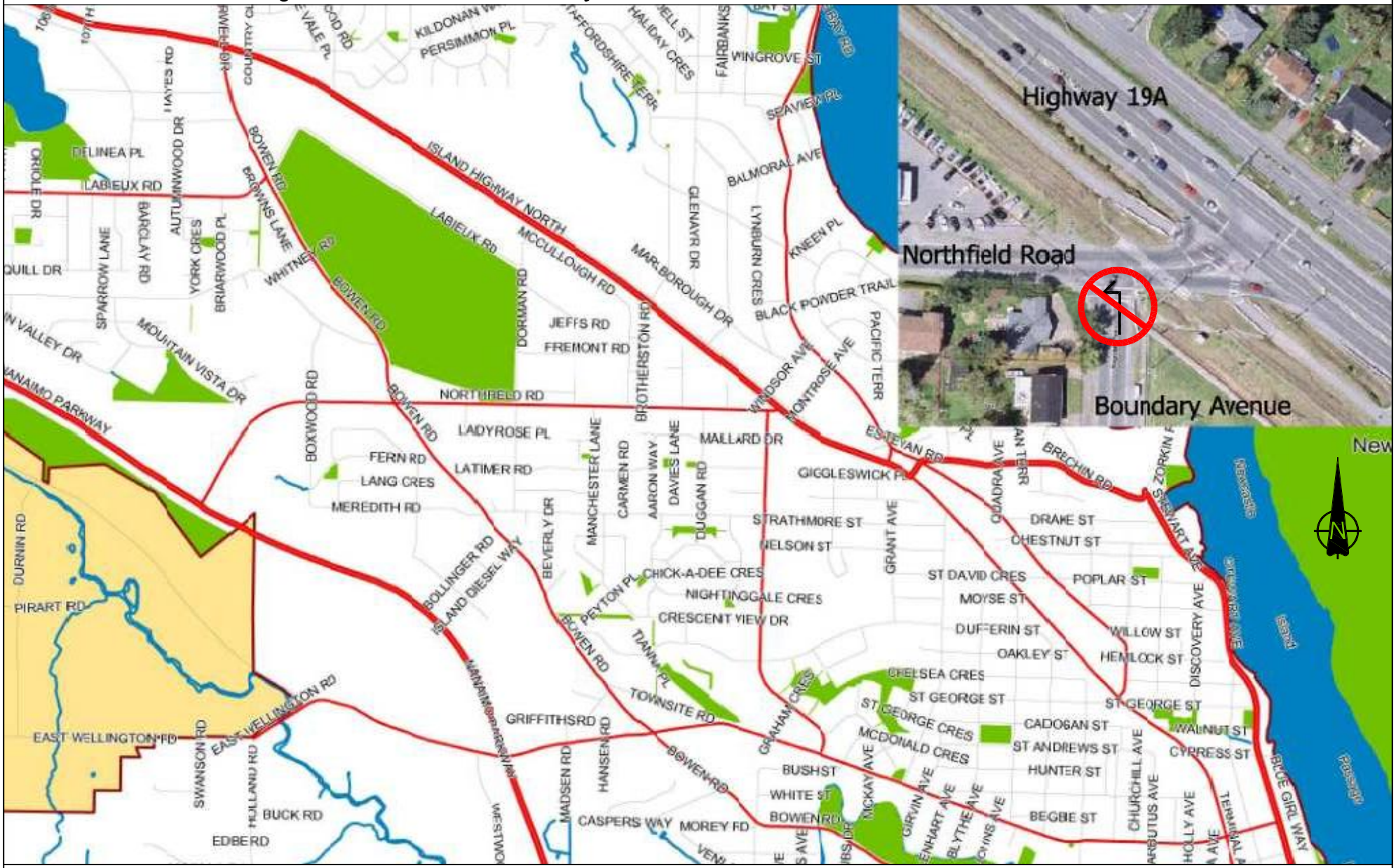
_____

AGENCY: _____ NAME: _____ DATE: _____

ISL Engineering and Land Services
604-530-2288

HIGHWAY 19A NORTHFIELD AREA TRAFFIC STUDY

Turning Restriction at Boundary Northbound Left–Turn to Northfield Westbound



PLEASE MARK THE ALTERNATIVE ROUTE IF TURNING MOVEMENT IS RESTRICTED

NOTES: _____

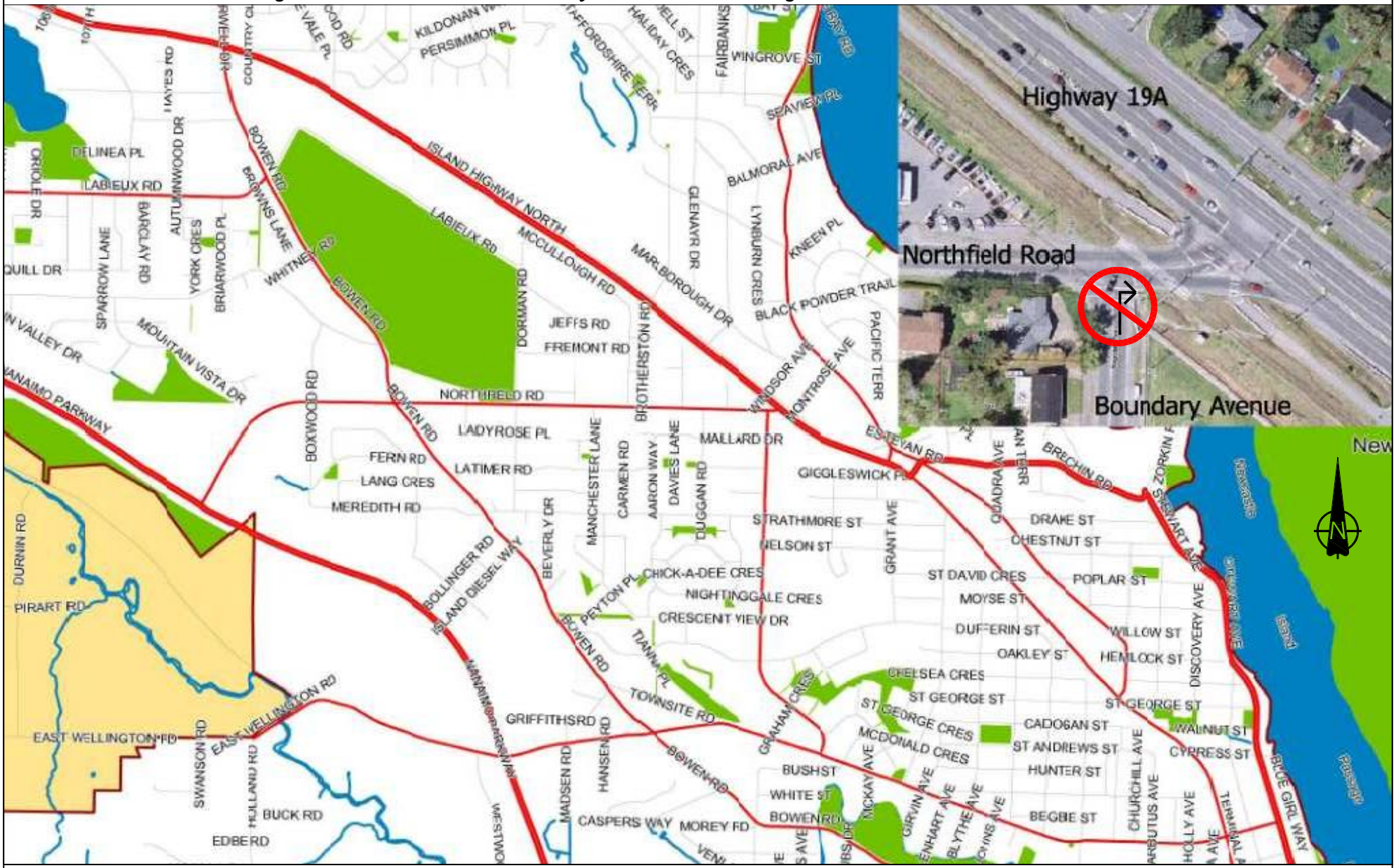
_____

AGENCY: _____ NAME: _____ DATE: _____

ISL Engineering and Land Services
604–530–2288

HIGHWAY 19A NORTHFIELD AREA TRAFFIC STUDY

Turning Restriction at Boundary Northbound Right–Turn to Northfield Eastbound



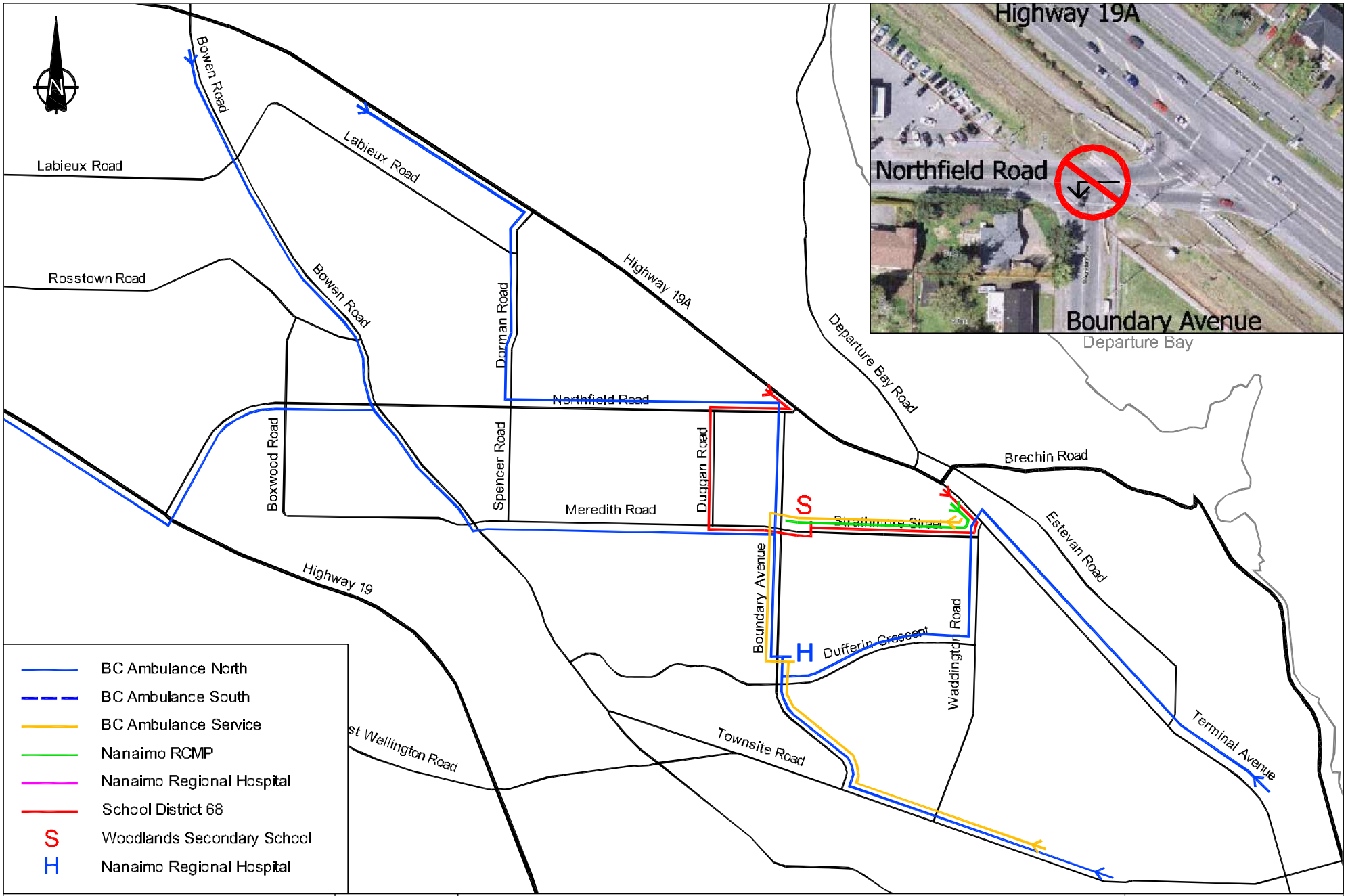
PLEASE MARK THE ALTERNATIVE ROUTE IF TURNING MOVEMENT IS RESTRICTED

NOTES: _____

_____

AGENCY: _____ NAME: _____ DATE: _____

ISL Engineering and Land Services
604–530–2288



SCALE: N.T.S	
DRAWN: G.L DATE: 08/08/12	
CHECKED: B.C.	
APPROVED:	
ISL PROJECT No: 30414	

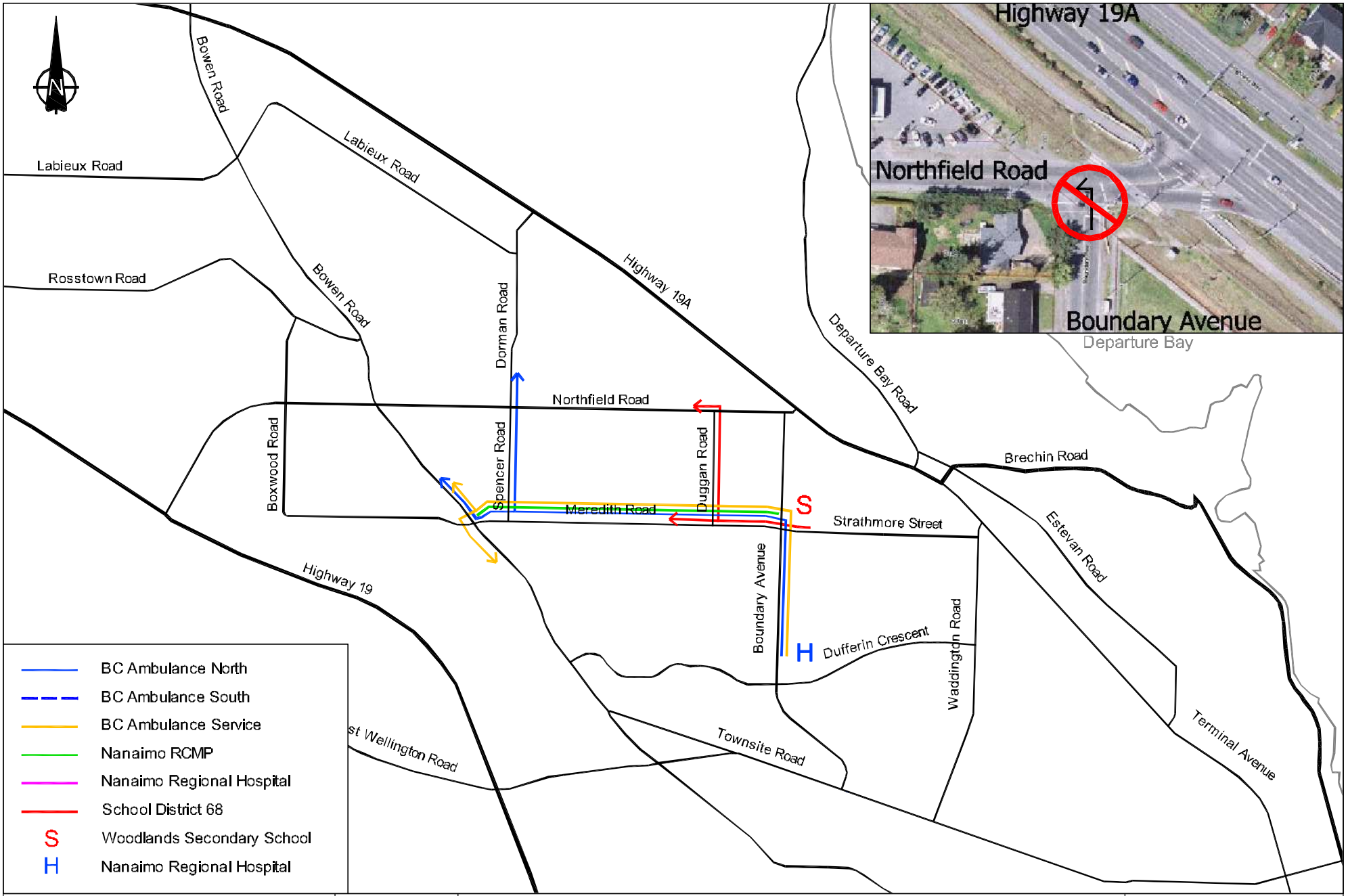
ISL Engineering and Land Services

TRAFFIC SURVEY RE-ROUTING OF SERVICE VEHICLES FOR PUBLIC AGENCIES RESTRICTED WESTBOUND LEFT-TURN

HIGHWAY 19A NORTHFIELD AREA TRANSPORTATION STUDY

FIGURE

A.1



SCALE: N.T.S	
DRAWN: G.L DATE: 08/08/12	
CHECKED: B.C.	
APPROVED:	
ISL PROJECT No: 30414	

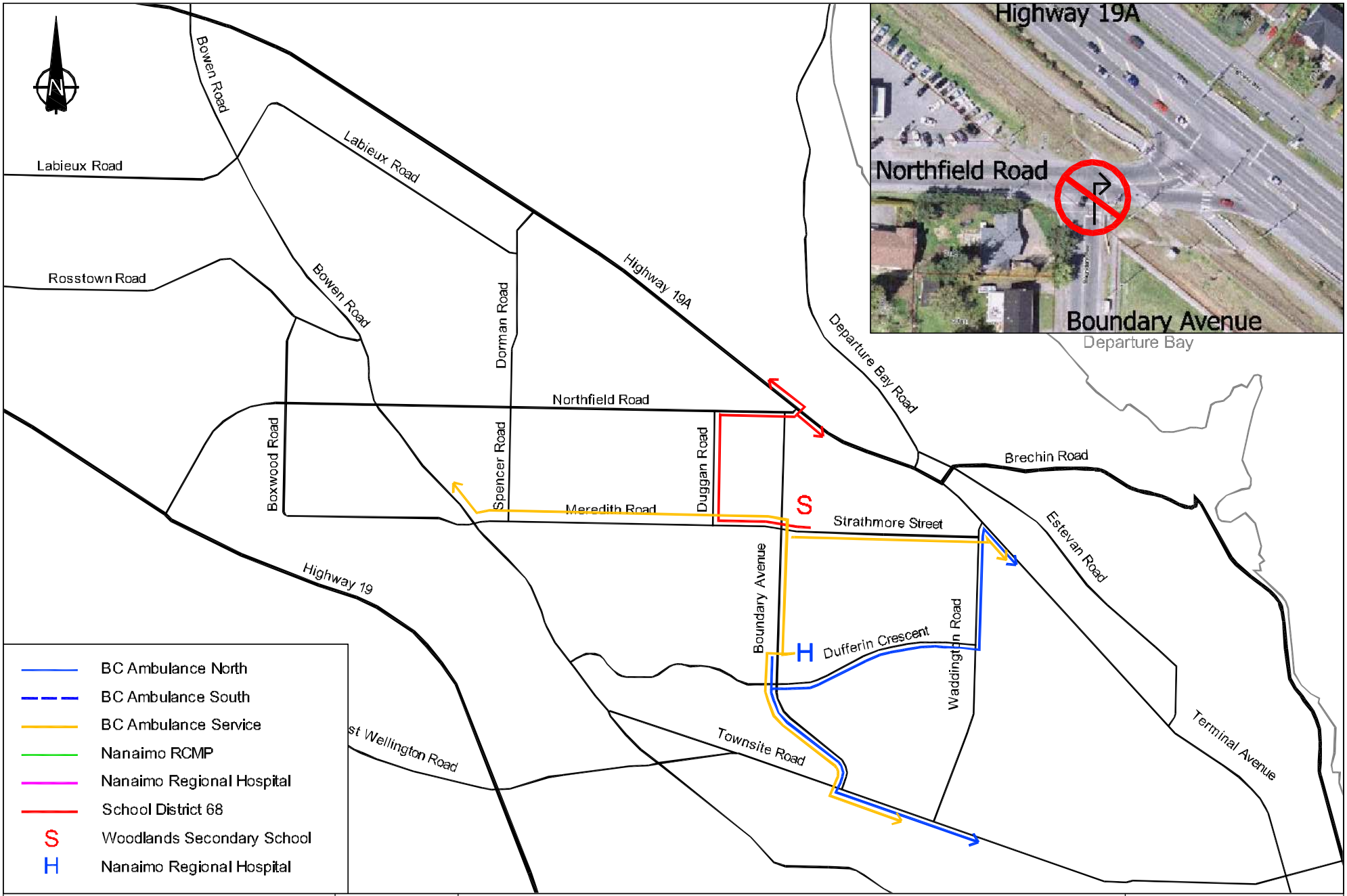
ISL Engineering and Land Services

TRAFFIC SURVEY RE-ROUTING OF SERVICE VEHICLES FOR PUBLIC AGENCIES RESTRICTED NORTHBOUND LEFT-TURN

HIGWAY 19A NORTHFIELD AREA TRANSPORTATION STUDY

FIGURE

A.2



SCALE: N.T.S	
DRAWN: G.L DATE: 08/08/12	
CHECKED: B.C.	
APPROVED:	
ISL PROJECT No: 30414	

ISL Engineering and Land Services

TRAFFIC SURVEY RE-ROUTING OF SERVICE VEHICLES FOR PUBLIC AGENCIES RESTRICTED NORTHBOUND RIGHT-TURN

HIGHWAY 19A NORTHFIELD AREA TRANSPORTATION STUDY

FIGURE

A.3

Appendix B

Synchro and SimTraffic Outputs

Lane Group	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations						
Volume (vph)	170	414	966	132	339	1169
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95
Frt		0.850	0.982			
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	3476	0	1770	3539
Flt Permitted	0.950				0.102	
Satd. Flow (perm)	1770	1583	3476	0	190	3539
Satd. Flow (RTOR)		214	16			
Adj. Flow (vph)	185	450	1050	143	368	1271
Lane Group Flow (vph)	185	450	1193	0	368	1271
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Detector Phase	4	4	6		5	2
Switch Phase						
Minimum Initial (s)	7.0	7.0	10.0		6.0	10.0
Minimum Split (s)	21.0	21.0	21.0		11.0	21.0
Total Split (s)	34.0	34.0	49.0	0.0	29.0	78.0
Total Split (%)	30.4%	30.4%	43.8%	0.0%	25.9%	69.6%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	0.0	-1.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	5.0
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	None	None	Max		None	Max
Act Effct Green (s)	23.2	23.2	49.1		74.3	73.3
Actuated g/C Ratio	0.22	0.22	0.47		0.70	0.69
v/c Ratio	0.48	0.87	0.73		0.82	0.52
Control Delay	39.5	38.8	28.3		38.6	9.5
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	39.5	38.8	28.3		38.6	9.5
LOS	D	D	C		D	A
Approach Delay	39.0		28.3			16.0
Approach LOS	D		C			B

Intersection Summary	
Cycle Length: 112	
Actuated Cycle Length: 105.5	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.87	
Intersection Signal Delay: 24.4	Intersection LOS: C
Intersection Capacity Utilization 69.1%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 8: Northfield Street & Highway 19A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	433	139	247	344	47	237
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	471	151	268	374	51	258
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				74		
pX, platoon unblocked						
vC, conflicting volume			622		1457	546
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			622		1457	546
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			72		50	52
cM capacity (veh/h)			959		103	537

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	622	642	309
Volume Left	0	268	51
Volume Right	151	0	258
cSH	1700	959	316
Volume to Capacity	0.37	0.28	0.98
Queue Length 95th (m)	0.0	9.2	82.4
Control Delay (s)	0.0	6.4	82.0
Lane LOS		A	F
Approach Delay (s)	0.0	6.4	82.0
Approach LOS			F

Intersection Summary			
Average Delay	18.7		
Intersection Capacity Utilization	90.2%	ICU Level of Service	E
Analysis Period (min)	15		

Intersection: 8: Northfield Street & Highway 19A

Movement	EB	EB	SE	SE	NW	NW	NW
Directions Served	L	R	T	TR	L	T	T
Maximum Queue (m)	35.2	22.5	77.3	86.1	212.4	230.7	230.7
Average Queue (m)	25.3	15.6	70.8	71.7	177.8	139.6	117.7
95th Queue (m)	44.4	31.2	80.5	80.8	241.8	289.4	264.1
Link Distance (m)	32.8		66.9	66.9		220.3	220.3
Upstream Blk Time (%)	20		23	23		18	5
Queuing Penalty (veh)	132		0	0		0	0
Storage Bay Dist (m)		15.0			205.0		
Storage Blk Time (%)	33	1			25	1	
Queuing Penalty (veh)	137	2			148	5	

Intersection: 10: Northfield Street & Boundary Avenue

Movement	EB	WB	NB
Directions Served	TR	LT	LR
Maximum Queue (m)	146.8	42.6	212.4
Average Queue (m)	38.0	34.5	194.5
95th Queue (m)	100.3	43.8	238.4
Link Distance (m)	236.9	32.8	
Upstream Blk Time (%)		12	
Queuing Penalty (veh)		59	
Storage Bay Dist (m)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Zone Summary

Zone wide Queuing Penalty: 482

Lane Group	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations						
Volume (vph)	170	414	966	132	339	1169
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95
Frt		0.850	0.982			
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	3476	0	1770	3539
Flt Permitted	0.950				0.102	
Satd. Flow (perm)	1770	1583	3476	0	190	3539
Satd. Flow (RTOR)		214	16			
Adj. Flow (vph)	185	450	1050	143	368	1271
Lane Group Flow (vph)	185	450	1193	0	368	1271
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Detector Phase	4	4	6		5	2
Switch Phase						
Minimum Initial (s)	7.0	7.0	10.0		6.0	10.0
Minimum Split (s)	21.0	21.0	21.0		11.0	21.0
Total Split (s)	34.0	34.0	49.0	0.0	29.0	78.0
Total Split (%)	30.4%	30.4%	43.8%	0.0%	25.9%	69.6%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	0.0	-1.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	5.0
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	None	None	Max		None	Max
Act Effct Green (s)	23.2	23.2	49.1		74.3	73.3
Actuated g/C Ratio	0.22	0.22	0.47		0.70	0.69
v/c Ratio	0.48	0.87	0.73		0.82	0.52
Control Delay	39.5	38.8	28.3		38.6	9.5
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	39.5	38.8	28.3		38.6	9.5
LOS	D	D	C		D	A
Approach Delay	39.0		28.3			16.0
Approach LOS	D		C			B

Intersection Summary	
Cycle Length: 112	
Actuated Cycle Length: 105.5	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.87	
Intersection Signal Delay: 24.4	Intersection LOS: C
Intersection Capacity Utilization 69.1%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 8: Northfield Street & Highway 19A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	433	139	247	344	0	237
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	471	151	268	374	0	258
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				74		
pX, platoon unblocked						
vC, conflicting volume			622		1457	546
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			622		1457	546
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			72		100	52
cM capacity (veh/h)			959		103	537

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	622	642	258
Volume Left	0	268	0
Volume Right	151	0	258
cSH	1700	959	537
Volume to Capacity	0.37	0.28	0.48
Queue Length 95th (m)	0.0	9.2	20.6
Control Delay (s)	0.0	6.4	17.7
Lane LOS		A	C
Approach Delay (s)	0.0	6.4	17.7
Approach LOS			C

Intersection Summary			
Average Delay		5.7	
Intersection Capacity Utilization		69.7%	ICU Level of Service C
Analysis Period (min)		15	

Intersection: 8: Northfield Street & Highway 19A

Movement	EB	EB	SE	SE	NW	NW	NW
Directions Served	L	R	T	TR	L	T	T
Maximum Queue (m)	35.0	22.5	71.5	78.8	212.5	224.9	230.7
Average Queue (m)	31.4	21.4	70.6	71.6	196.5	206.5	189.5
95th Queue (m)	39.8	28.0	74.8	75.7	258.1	296.9	288.8
Link Distance (m)	31.5		66.9	66.9		220.3	220.3
Upstream Blk Time (%)	29		35	39		28	5
Queuing Penalty (veh)	198		0	0		0	0
Storage Bay Dist (m)		15.0			205.0		
Storage Blk Time (%)	49	2			45	1	
Queuing Penalty (veh)	201	3			260	2	

Intersection: 10: Northfield Street & Boundary Avenue

Movement	EB	WB	NB
Directions Served	TR	LT	R
Maximum Queue (m)	117.9	37.8	210.7
Average Queue (m)	56.9	33.6	163.9
95th Queue (m)	115.4	42.5	248.8
Link Distance (m)	239.1	31.5	
Upstream Blk Time (%)		12	
Queuing Penalty (veh)		57	
Storage Bay Dist (m)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Zone Summary

Zone wide Queuing Penalty: 721

Lane Group	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations						
Volume (vph)	170	414	966	132	339	1169
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95
Frt		0.850	0.982			
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	3476	0	1770	3539
Flt Permitted	0.950				0.102	
Satd. Flow (perm)	1770	1583	3476	0	190	3539
Satd. Flow (RTOR)		214	16			
Adj. Flow (vph)	185	450	1050	143	368	1271
Lane Group Flow (vph)	185	450	1193	0	368	1271
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Detector Phase	4	4	6		5	2
Switch Phase						
Minimum Initial (s)	7.0	7.0	10.0		6.0	10.0
Minimum Split (s)	21.0	21.0	21.0		11.0	21.0
Total Split (s)	34.0	34.0	49.0	0.0	29.0	78.0
Total Split (%)	30.4%	30.4%	43.8%	0.0%	25.9%	69.6%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	0.0	-1.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	5.0
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	None	None	Max		None	Max
Act Effct Green (s)	23.2	23.2	49.1		74.3	73.3
Actuated g/C Ratio	0.22	0.22	0.47		0.70	0.69
v/c Ratio	0.48	0.87	0.73		0.82	0.52
Control Delay	39.5	38.8	28.3		38.6	9.5
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	39.5	38.8	28.3		38.6	9.5
LOS	D	D	C		D	A
Approach Delay	39.0		28.3			16.0
Approach LOS	D		C			B

Intersection Summary	
Cycle Length: 112	
Actuated Cycle Length: 105.5	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.87	
Intersection Signal Delay: 24.4	Intersection LOS: C
Intersection Capacity Utilization 69.1%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 8: Northfield Street & Highway 19A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	433	139	0	426	47	237
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	471	151	0	463	51	258
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				74		
pX, platoon unblocked						
vC, conflicting volume			622		1009	546
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			622		1009	546
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		81	52
cM capacity (veh/h)			959		266	537

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	622	463	309
Volume Left	0	0	51
Volume Right	151	0	258
cSH	1700	1700	460
Volume to Capacity	0.37	0.27	0.67
Queue Length 95th (m)	0.0	0.0	39.0
Control Delay (s)	0.0	0.0	27.4
Lane LOS			D
Approach Delay (s)	0.0	0.0	27.4
Approach LOS			D

Intersection Summary			
Average Delay	6.1		
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	15		

Intersection: 8: Northfield Street & Highway 19A

Movement	EB	EB	SE	SE	NW	NW	NW
Directions Served	L	R	T	TR	L	T	T
Maximum Queue (m)	38.9	22.5	77.0	77.3	119.5	224.9	74.5
Average Queue (m)	31.3	19.8	68.9	69.5	51.2	69.6	39.5
95th Queue (m)	43.2	30.6	78.4	78.9	91.9	200.6	64.2
Link Distance (m)	32.8		66.9	66.9		220.3	220.3
Upstream Blk Time (%)	19		18	20		1	
Queuing Penalty (veh)	130		0	0		0	
Storage Bay Dist (m)		15.0			205.0		
Storage Blk Time (%)	40	4					
Queuing Penalty (veh)	165	7					

Intersection: 10: Northfield Street & Boundary Avenue

Movement	EB	NB
Directions Served	TR	LR
Maximum Queue (m)	133.7	218.0
Average Queue (m)	52.3	203.5
95th Queue (m)	123.8	209.0
Link Distance (m)	236.9	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 302

Lane Group	EBL	EBR	SET	SER	NWL	NWT
Lane Configurations						
Volume (vph)	170	414	966	132	339	1169
Lane Util. Factor	1.00	1.00	0.95	0.95	1.00	0.95
Frt		0.850	0.982			
Flt Protected	0.950				0.950	
Satd. Flow (prot)	1770	1583	3476	0	1770	3539
Flt Permitted	0.950				0.102	
Satd. Flow (perm)	1770	1583	3476	0	190	3539
Satd. Flow (RTOR)		214	16			
Adj. Flow (vph)	185	450	1050	143	368	1271
Lane Group Flow (vph)	185	450	1193	0	368	1271
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Detector Phase	4	4	6		5	2
Switch Phase						
Minimum Initial (s)	7.0	7.0	10.0		6.0	10.0
Minimum Split (s)	21.0	21.0	21.0		11.0	21.0
Total Split (s)	34.0	34.0	49.0	0.0	29.0	78.0
Total Split (%)	30.4%	30.4%	43.8%	0.0%	25.9%	69.6%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	0.0	-1.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	5.0
Lead/Lag			Lag		Lead	
Lead-Lag Optimize?			Yes		Yes	
Recall Mode	None	None	Max		None	Max
Act Effct Green (s)	23.2	23.2	49.1		74.3	73.3
Actuated g/C Ratio	0.22	0.22	0.47		0.70	0.69
v/c Ratio	0.48	0.87	0.73		0.82	0.52
Control Delay	39.5	38.8	28.3		38.6	9.5
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	39.5	38.8	28.3		38.6	9.5
LOS	D	D	C		D	A
Approach Delay	39.0		28.3			16.0
Approach LOS	D		C			B

Intersection Summary	
Cycle Length: 112	
Actuated Cycle Length: 105.5	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.87	
Intersection Signal Delay: 24.4	Intersection LOS: C
Intersection Capacity Utilization 69.1%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 8: Northfield Street & Highway 19A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	433	221	0	426	0	237
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	471	240	0	463	0	258
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)				74		
pX, platoon unblocked						
vC, conflicting volume			711		1054	591
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			711		1054	591
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	49
cM capacity (veh/h)			889		250	507

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	711	463	258
Volume Left	0	0	0
Volume Right	240	0	258
cSH	1700	1700	507
Volume to Capacity	0.42	0.27	0.51
Queue Length 95th (m)	0.0	0.0	22.7
Control Delay (s)	0.0	0.0	19.2
Lane LOS			C
Approach Delay (s)	0.0	0.0	19.2
Approach LOS			C

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	57.6%	ICU Level of Service	B
Analysis Period (min)	15		

Intersection: 8: Northfield Street & Highway 19A

Movement	EB	EB	SE	SE	NW	NW	NW
Directions Served	L	R	T	TR	L	T	T
Maximum Queue (m)	46.5	22.5	82.5	86.1	88.8	224.9	80.8
Average Queue (m)	28.7	18.8	67.3	67.9	46.6	46.0	32.3
95th Queue (m)	43.6	30.9	81.6	85.4	78.6	147.1	61.8
Link Distance (m)	31.5		66.9	66.9		220.3	220.3
Upstream Blk Time (%)	18		22	20		0	
Queuing Penalty (veh)	119		0	0		0	
Storage Bay Dist (m)		15.0			205.0		
Storage Blk Time (%)	35	3					
Queuing Penalty (veh)	146	5					

Intersection: 10: Northfield Street & Boundary Avenue

Movement	EB	NB
Directions Served	TR	R
Maximum Queue (m)	173.7	203.3
Average Queue (m)	46.0	98.6
95th Queue (m)	124.6	207.3
Link Distance (m)	239.1	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Zone Summary

Zone wide Queuing Penalty: 269

Appendix C

Advantages and Disadvantages of the Medium and Long-Term Improvement Options

Table C.1 Medium and Long Term Improvement Options (Continued)

OPTION	DESCRIPTION	PROS	CONS
Deceleration Lane	Deceleration lanes could be added to Highway 19A to assist vehicles merge to Northfield Road.	• Traffic travelling southbound along Highway 19A would be able to safely slow down to make a right turn onto Northfield Road. • Less rear-end collisions and less conflict for right-turn vehicles and crossing pedestrians.	• Land requirement. • Pave shoulder as deceleration lane. • Low traffic volumes may not justify the construction cost. • If free flow is on Northfield westbound (restricted WBLT), the frequency of rear-end collisions will be significantly reduced. • May require costly changes to accommodate truck turning.
Acceleration Lane	Acceleration lane could be added to Highway 19A to assist vehicles merge from Northfield Road to Highway 19A.	• Traffic travelling EB along Northfield Road would be able to turn right onto Highway 19A and safely accelerate to speed and then merge into traffic.	• Widening Highway 19A will affect the pedestrian underpass. It will need to be lengthened and possibly relocated. • Land requirement. • Pave shoulder as acceleration lane. • May generate safety issues with crossing pedestrian.
Restricted Left-Turn movements at Northfield Road and Highway 19	Turning movement could be restricted to right in, right out movements.	• The need for signal lights would be eliminated and traffic could run more smoothly. • No traffic queue resulting from Highway 19A northbound left-turn.	• The closest Highway 19A accesses from the south side of the highway would be Waddington Road and Dorman Road which are approximately 2 km apart. As a result, long detours would be required by some traffic. • Increase of traffic volumes and delays on Highway 19A and relevant intersections.
Closure of the Northfield and Highway 19 Intersection	Northfield Road could end at Boundary Avenue forcing all EB traffic to turn Right and all NB traffic to turn left.	• Many safety hazards at the intersection would be eliminated including train and pedestrian transportation modes.	• The closest Highway 19A accesses from the south side of the highway would be Waddington Road and Dorman Road which are approximately 2 km apart. As a result, long detours would be required by traffic on the south side of the highway travelling to the north side of the highway. • Increase of traffic volumes and delays on Highway 19A and relevant intersections.
Re-Align Intersection Perpendicular to Highway 19A	Northfield Road could be re-aligned perpendicular to Highway 19A.	• Would make turning to and from Northfield Road easier for traffic. • Improved sight lines for right-turn vehicles.	• Land requirements • Relocation of railway crossing.

Table C.1 Medium and Long Term Improvement Options (Continued)

OPTION	DESCRIPTION	PROS	CONS
Re-Align Intersection so that Boundary Road intersects Highway 19A	Re-align intersection so that Boundary Road intersects Highway 19A at a perpendicular angle and Northfield would be connected to Boundary with a T intersection.	• Would make turning to and from Boundary Road easier for traffic. • Improved sight lines for right-turn vehicles	• Land requirements • Relocation of railway crossing.
Pedestrian Overpass/Tunnel	A pedestrian overpass/tunnel could be constructed across Northfield Road, just east of the train tracks and west of Highway 19A.	• Reduced safety risks for pedestrians crossing Northfield Road.	• A high clearance height would be required to accommodate truck traffic (Overpass). • Crossing pedestrians may not use the overpass due to long grade. • Long ramps would be needed to accommodate wheelchairs. • Very expensive. • Land requirement.
Train Overpass	A train overpass could be constructed across Northfield Road and just west of Highway 19A.	• Eliminate train conflict with vehicular traffic on Northfield Road. • Reduced train conflict with Pedestrians walking to the Highway 19A underpass.	• Due to the low maximum grade that trains can tolerate, the ramps to the overpass will need to be extremely long. • Very expensive. • Land requirement
Traffic Overpass	An overpass could be built over Highway 19A to accommodate traffic from Northfield Road. This overpass would not allow access to Highway 19A. It could possibly connect to Montrose Avenue.	• Traffic turning onto Northfield Road from Highway 19A would no longer be able to queue back into the highway through lanes. • The need for signal lights at Northfield Road and Highway 19A would be eliminated. • Would make travelling north/south simpler (including trips to/from Woodland secondary School and Nanaimo Regional Hospital.)	• Land requirements. • Very expensive. • No access to Highway 19A. As a result, detours would be required by some traffic.
Traffic Interchange	An interchange could be built over Highway 19A to accommodate traffic from Northfield Road. This overpass would have access to Highway 19A using ramps. It could possibly connect to Montrose Avenue.	• Traffic turning onto Northfield Road from Highway 19A would no longer be able to queue back into the highway through lanes. • Would make travelling north/south simpler (including trips to/from Woodland secondary School and Nanaimo Regional Hospital.)	• Very expensive. • Land requirements. • May not appropriate in urban environment.