Final Report

River Road/Beaver Creek Road Intersection Port Alberni, BC Safety and Operational Analysis

Prepared for

The City of Port Alberni & The Insurance Corporation of British Columbia

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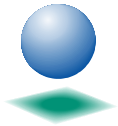
March 2007



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Executive Summary

The City of Port Alberni, the Port Authority of Port Alberni (PAPA), the Ministry of Transportation (MoT), and the Insurance Corporation of British Columbia (ICBC) are working together to improve safety and operations within the City. As part of this effort, CH2M HILL was retained to perform a review of the safety performance and operation of the River Road/Beaver Creek Road intersection. The study included not only the immediate area of the intersection, but also alternate routes in the area that could be used to alleviate the capacity and safety problems at the intersection.

The safety analysis indicated that the River Road/Beaver Creek Road intersection is collision prone as the collisions per million entering vehicles rate was above the critical rate for similar intersections; however, the frequency of collisions is relatively low (four collisions per year). The collision severity index at the intersection was lower than the average index for similar intersections, which indicates that collisions tend to be less severe compared to similar intersections.

The limited left turn capacity at the intersection, especially for the southbound left turn movement, was identified as one of the main factors contributing to collision propensity. In addition, the skewed geometry of the intersections and the proportion of large vehicles using the intersection during the summer (marina users) contributed to the problem.

A number of options to improve the traffic operation and safety at the intersection were generated and investigated. Selected options were then evaluated from a safety perspective to determine the potential ICBC contribution to safety improvements. The options considered in this study included: traffic rerouting, signage upgrade, parking lot operations, and traffic control upgrade (protected T intersection, traffic signal, and roundabout).

Traffic rerouting is likely an expensive alternative that may not have the support of the community nor the businesses in the area. In addition, redistribution of traffic will require changes to the City's Official Community Plan, which indicates that Beaver Creek Road is the main arterial in the area, and may increase collisions elsewhere. As such, it is not suggested that the City consider the option of rerouting traffic, but instead consider upgrading the traffic control at the existing intersection.

Based on ICBC's 50 percent internal rate of return on investments, the implementation of the roundabout generated the highest ICBC investment at approximately $35,000; followed by the right-in-right-out (RIRO) scheme at $11,500; the protected T intersection at $8,500; and the traffic signal at $4,400. A summary of the estimated safety benefits for each option is included in Table ES-1 at the end of this section.

Safety benefits of the improvements identified in this report are relatively low because of the low severity of the collisions. In addition, there is a high proportion of rear end collisions at this intersection, which are not entirely addressed by some of the improvements such as the traffic signal and the roundabout.

Despite the low safety benefits achieved by the proposed improvements, it is recommended that the City consider upgrading the traffic control of the intersection. Justification for any of the suggested improvements, in this particular case, is largely based on the capacity needs of the intersection more than the safety benefits that could be realized.

The choice of option will also need to address future development plans, proposed timing of improvements, and available funding. For example, whereas a protected T may be a satisfactory short to medium term solution, in the medium to longer term a signal or roundabout solution may be more appropriate. Similarly, in light of the recent comments regarding the reconfiguration of the marina parking lot and building layout, some of the options presented here may be worthy of further review, particularly if relocating the marina access further to the west becomes more viable. Other options may also become apparent with such reconfiguration of the marina.

It is recommended that the City decide the long-term role of Beaver Creek Road in the transportation network **before** implementation of any of the above improvements at the River Road/Beaver Creek Road intersection.

In the meantime, implementation of the "Left Turn Traffic Yield to Oncoming Vehicles Sign" at the River Road/Beaver Creek Road intersection could help reduce the risk of southbound left turn traffic cutting in front of traffic coming from the marina.

In conclusion, implementation of the options presented here should help improve traffic flow and mitigate the collision risk at this intersection, providing all users with a safer road environment.

TABLE ES-1
Economic Evaluation Summary

Mitigation Measure	Collision Reduction Factor (Source)	Safety Issues (Collisions per Year)	Average Collision Cost	Annual Collisions Reduced	Annual Claims Savings	Service Life (Years)	Potential ICBC Investment	Estimated Construction Costs
Traffic Signal	45% angle collisions 30% rear ends (Beaver Ck Rd) 30% **increase** rear ends (River Rd) (Ogden)	1.83 angle collisions 1.17 rear end collisions (Beaver Ck Rd) 1.0 rear end collisions (River Rd)	$5,800 $11,600 $21,100	0.83 coll. 0.35 coll. -0.3 coll. (increase)	$4,800 $4,100 -$6,300	5	$8,300 $7,100 -$11,000 $4,400	$200,000 - $300,000
Roundabout	52% injury collisions (TAC) 40% **increase** PDO collisions (Elvik)	1.67 injury collisions 2.33 PDO collisions	$25,000 $1,600	0.87 coll. -0.93 coll. (increase)	$21,600 -$1,500	5	$37,600 -$2,600 $35,000	$250,000 - $500,000
Protected T intersection	55% of left turn collisions (Eng judge)[1]	0.67 left turn collisions	$13,300	0.37	$5,000	5	$8,500	$30,000 – $50,000
Right-in-right-out	75% of left turn collisions (Eng judge)[2]	0.67 left turn collisions	$13,300	0.5	$6,600	5	$11,500	$30,000 – $50,000

[1] Based on conflict movement reduction
[2] Assumes that left turns out of the marina are allowed

1. Introduction

The City of Port Alberni, the Port Authority of Port Alberni (PAPA), the Ministry of Transportation (MoT), and the Insurance Corporation of British Columbia (ICBC) are working together to improve safety and operations within the City. As part of this effort, CH2M HILL was retained to perform a review of the safety performance and operation of the River Road/Beaver Creek Road intersection. This intersection was selected for investigation because of both the number of collisions experienced in the past and also the number of near misses that are observed on a daily basis at the intersection.

The City indicated that high traffic volumes during the summer time is a critical factor that contributes to the poor traffic operation and safety performance of this intersection. In addition to high traffic volumes, the following factors are believed to contribute to the problem:

- High proportion of large vehicles (pickup trucks, trailers, heavy trucks, etc.)
- Operation of parking lots in the vicinity of the intersection
- Alignment of River Road and Beaver Creek Road
- Traffic operation of the intersection (currently stop controlled)
- Increased tourism

As indicated by the City, the Clutesi Haven Marina (located south of River Road) generates a significant amount of traffic during summer. This includes a large proportion of pickup trucks and trailers. In the early hours of the morning, the fishers come to the marina to launch their boats. Parking at the marina is limited and the overflow parking has to be accommodated at a lot owned by the City along Beaver Creek Road north of River Road. The need to park vehicles offsite increases the interaction and conflict between marina traffic and pass-by traffic, which in turn increases congestion in the area.

The alignment of River Road and Beaver Creek Road has also been reported as a contributing factor to the poor intersection operation. As indicated by the City, large vehicles in the eastbound direction have difficulty manoeuvring across the intersection while making a left turn onto Beaver Creek Road. Vehicles making left turns from Beaver Creek Road have difficulty identifying and utilizing gaps in the River Road/Highway 4 westbound traffic due to the skewed configuration of the intersection.

This intersection is currently stop controlled on the north and south approaches. The south approach of the intersection provides access to and from the marina. Presently, vehicles on the north approach have difficulty turning left onto River Road because of the high traffic volume along River Road, which creates long queues on this approach. Finally, increased tourism over time is also believed to accentuate the problem, especially during summer when traffic to the west coast increases.

This traffic safety study suggests options to resolve engineering factors that may be contributing to the collision risk, and evaluates their safety benefits to estimate ICBC's potential contribution to road improvements.

2. Scope

The study section covers the intersection of River Road/Beaver Creek Road and nearby intersections, as shown in *Figure 2-1*. Three other intersections—River Road/Heath Road, Alexander Road/Beaver Creek Road, and Heaslip Road/Beaver Creek Road—have been included in the study area because of their proximity to the River Road/Beaver Creek Road intersection.

River Road or Highway 4 is a Ministry of Transportation (Ministry) owned two-lane highway that provides access to the Pacific Rim National Park Reserve, a big tourist attraction during the summer season. Beaver Creek Road is a two-lane rural collector that provides north-south travel for people that live in the northwest quadrant of Port Alberni. The speed limits for both River Road and Beaver Creek Road are posted at 50 km/h.

The River Road/Beaver Creek Road intersection is stop controlled on the north and south approaches. The north approach of the intersection is skewed at a 45-degree angle, which provides a free right turn for vehicles travelling in the westbound direction. The south approach of the intersection provides access to the Clutesi Haven Marina.

While the study area is limited to the above intersections, two alternate routes that cover a much larger area have been included in the study to avoid overlooking rerouting options. These alternate routes, Josephine Street and Compton Road-Gertrude Street, are potential routes that could be used to reroute traffic in hopes of reducing congestion at the River Road/Beaver Creek Road intersection. Both of these routes are shown in *Figure 2-2*. This review however is limited to determining whether rerouting traffic to any of these two routes is a feasible option.

The study was completed based on ICBC standard methodology. The following is an outline of the methodology:

1. *Data collection*. Insurance claims data were obtained from ICBC. Site visits were carried out to determine the intersection geometry; observe vehicular, pedestrian and cyclist operations; take photographs; and estimate travel speeds.

2. *Data Analysis*. The collision claims data were sorted by collision type, cause, and location. A collision diagram was completed, severity proportions were calculated, and data were sorted by time, day, month, and year to determine any temporal trends. Engineering factors, which may be contributing to collision potential, were identified.

3. *Options Development*. Improvements that have the potential to reduce collision likelihood were identified based on the data analysis.

4. *Economic Evaluation and Closing*. The economic evaluation provides an estimate of the potential ICBC investment in the proposed alternatives.

FIGURE 2-1
Port Alberni, Study Area

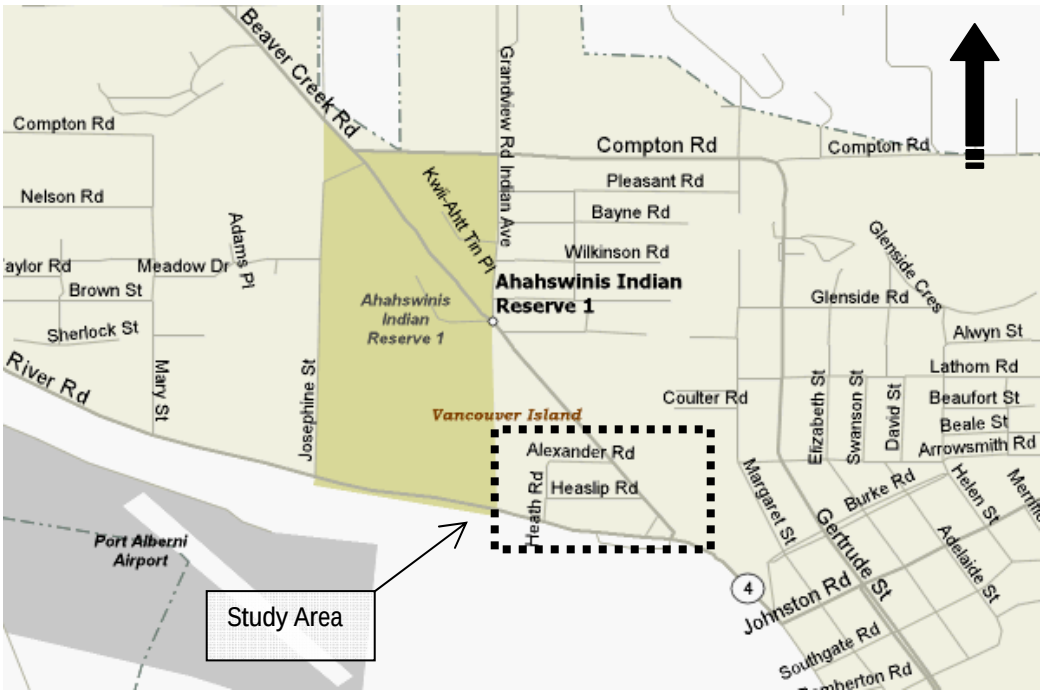
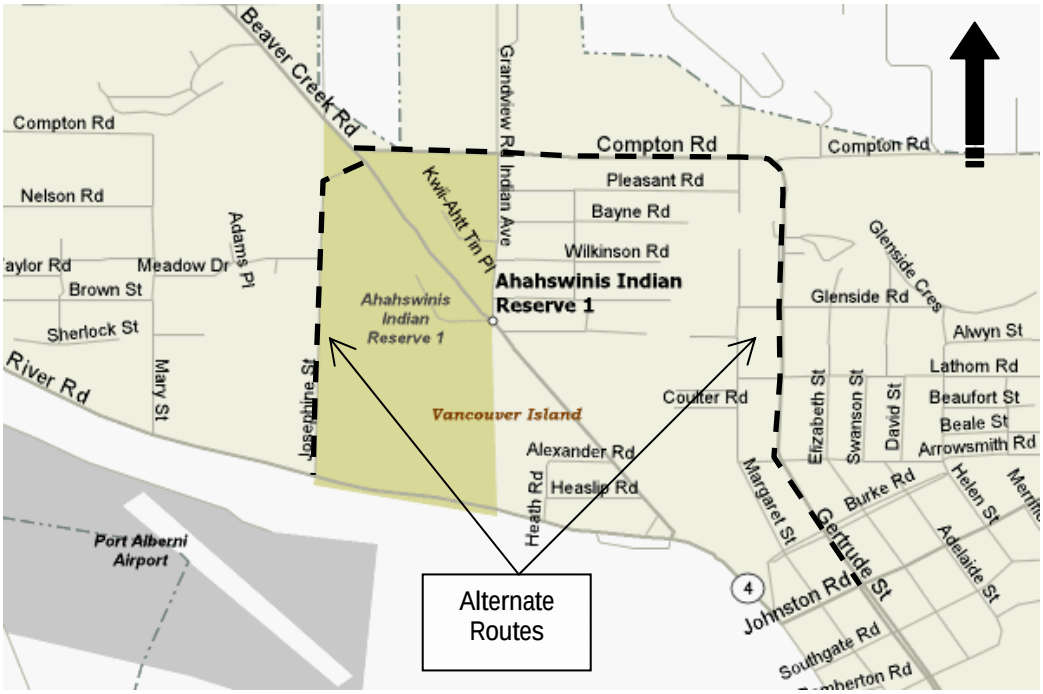


FIGURE 2-2
Alternate Routes in the Area



3. Data Analysis

This section presents the main findings of the data examined for this study. Data available at the time of the study included traffic volumes and collision data. In addition, observations during the site visit provided additional information about pedestrian and bicyclist facilities, marina operations, and travel patterns in the area. Finally, the City and the Ministry of Transportation provided information regarding alternate routes and future developments in the area.

3.1. Traffic Volumes and Level of Service

Traffic volumes at the River Road/Beaver Creek Road intersection were available for 1999, 2005, and 2006 (*Appendix A*). The traffic data indicated that traffic growth between 1999 and 2006 was approximately 0.5 percent per year, which is considered low compared to other communities on the Island.

Figure 3-1 shows the traffic volumes at the intersection in 2006. Traffic volumes are highest during the noon and the PM peak periods, which are twice as high compared to the AM peak volumes. The volumes along Beaver Creek Road indicated that there is a higher number of vehicles travelling northbound during the noon and PM peak compared to the southbound direction in the AM peak. This indicates that people do not commute between home and work along the same route. It appears that the morning traffic is divided between Beaver Creek Road and one of the alternate routes in the area (Compton Road or Josephine Street). During the noon and PM peak, more commuters prefer to return home along Beaver Creek Road, possible because of the free right turn at the intersection compared to the stop condition in the southbound direction. Additional information about travel patterns in this area is presented in Section 3.6.

Table 3-1 shows a summary of the Level Of Service (LOS) at the intersection (*Appendix B*). The table shows that the LOS of the north approach is F during the noon and the PM peak, which coincides with high traffic volumes. The poor LOS indicates that there is a lack of capacity at the intersection.

The poor LOS of the north approach is related to the proportion of southbound left (SBL) turns and the lack of traffic gaps on River Road. The capacity of the SBL was estimated at approximately 35 vehicles per hour (vph) during the noon and the PM peak period, which is significantly lower than the SBL traffic demand of approximately 140 vph.

FIGURE 3-1
Traffic Volumes at the River Road/Beaver Creek Road Intersection (2006)

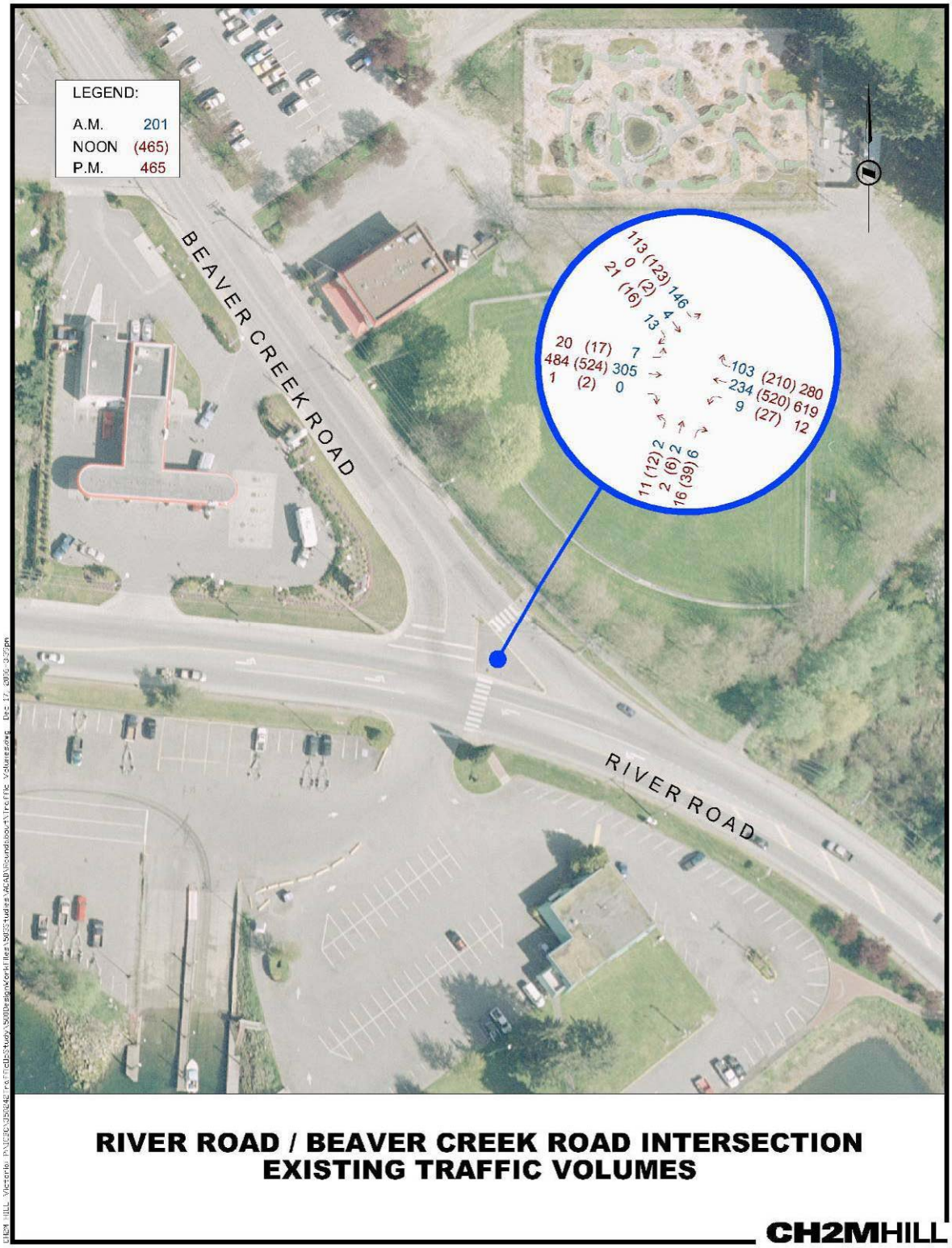


TABLE 3-1
Intersection Level of Service

Peak Period	LOS North approach	LOS South approach
AM	C	B
Noon	F	C
PM	F	C

As indicated in the Highway Capacity Manual, the capacity of stop controlled intersections depends primarily on two factors: gap availability on the main street and gap size required to complete a left, through, or right movement off the side street. *Table 3-2* summarizes some of the variables that affect each of these two factors. Depending on the movement that is completed off the minor street, the gap requirement is about five to seven seconds. Left and through movements require the longest gaps compared to right turns.

TABLE 3-2
Factors Affecting Capacity at Stop or Yield Controlled Intersections

Gap Distribution on Major Street	Gap Size Required to Complete Movement
• Total volume	• Type of movement
• Directional distribution	• Number of lanes on major street
• Number of lanes on major street	• Speed of major street traffic
• Platooning	• Sight distance
	• Length of time waiting to cross
	• Driver characteristics (eyesight, reaction, age, etc.)

HCM 200, Chapter 7

Research shows that as the length of time waiting to cross increases, the gap size required to complete a manoeuvre decreases. This increases the likelihood of errors and collisions (drivers tend to utilize shorter gaps that are less safe). This was confirmed during the site visit when several near misses were observed.

Based on the capacity of the intersection and the traffic volumes experienced, the poor LOS of this location is attributed primarily to the small (lack of gaps) number of gaps available along the main road (River Road). This is more critical during the noon and PM peak hours when traffic volumes are almost double the AM peak volumes.

3.2. Site Visit Observations

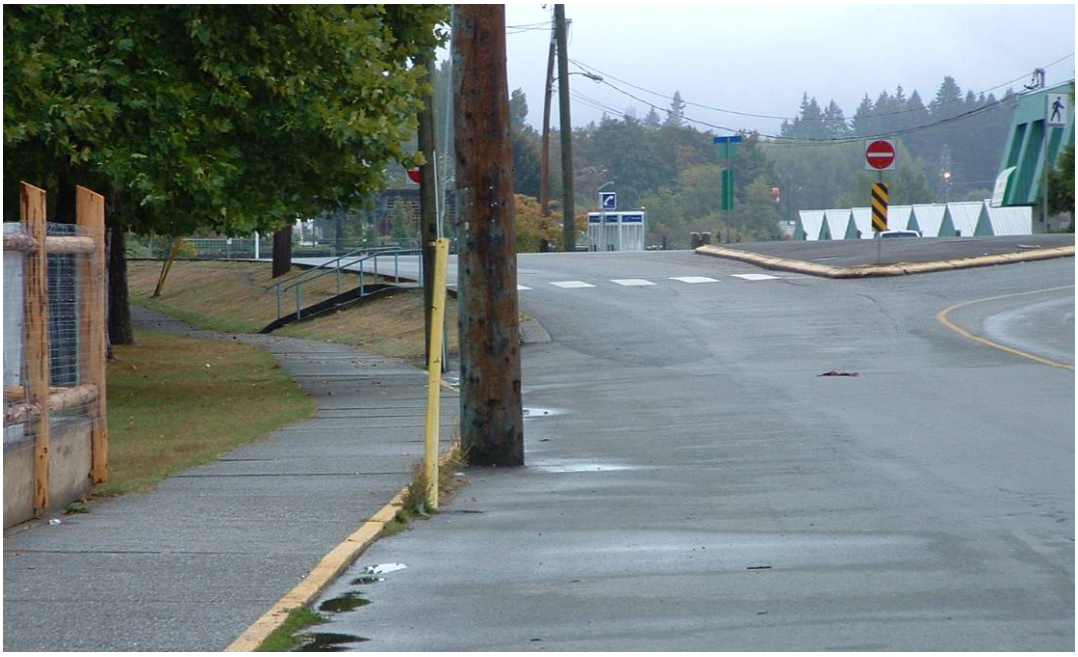
A site visit to the study area was undertaken on September 18 and 19, 2006. The site visit covered the AM, noon, and PM peak periods. Photos of the corridor along with comments are presented in this section.

Facing south at River Road/Beaver Creek Road intersection.

- Vehicles on the north approach pull forward past the stop line to better position themselves to utilize gaps in the main traffic.

Looking west at River Road/Beaver Creek Road intersection.

- Sight lines are restricted by vegetation in the area. Vegetation should be trimmed to provide better sight lines.

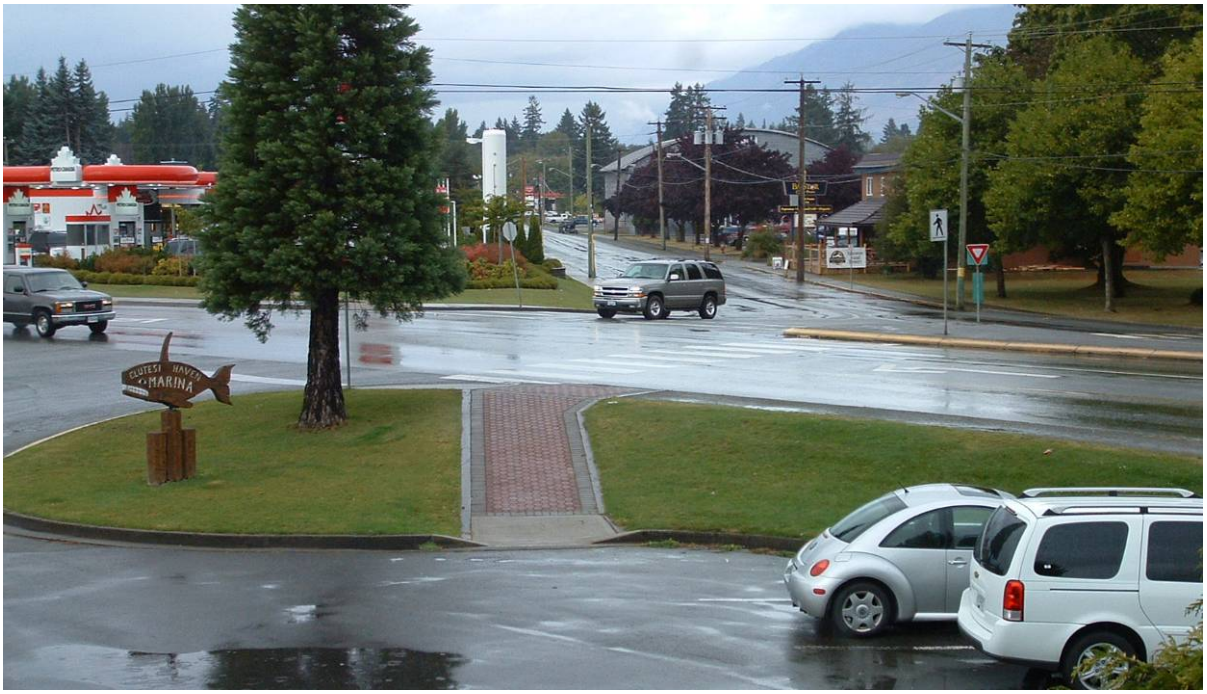


North approach of the intersection of River Road and Beaver Creek Road. .

- Utility poles on the road are a hazard and should be relocated as resources and improvements in the area become available.

Alexander Road facing east.

- Pavement on Alexander Road and Heath Road is in poor condition. If traffic is diverted to these roads, the pavement will need to be upgraded.



River Road/Beaver Creek Road Intersection facing northwest

- Walkway foreground ends at the marina parking lot, breaking the continuity of the walkway path (more on this in Section 3.4).

- Main users at the marina are trucks and trailers as shown in the picture. The length of the truck and trailer is approximately 15 metres.

- Commercial fishing boats are also launched at the marina. These boats, however, represent a small proportion of the marina users.

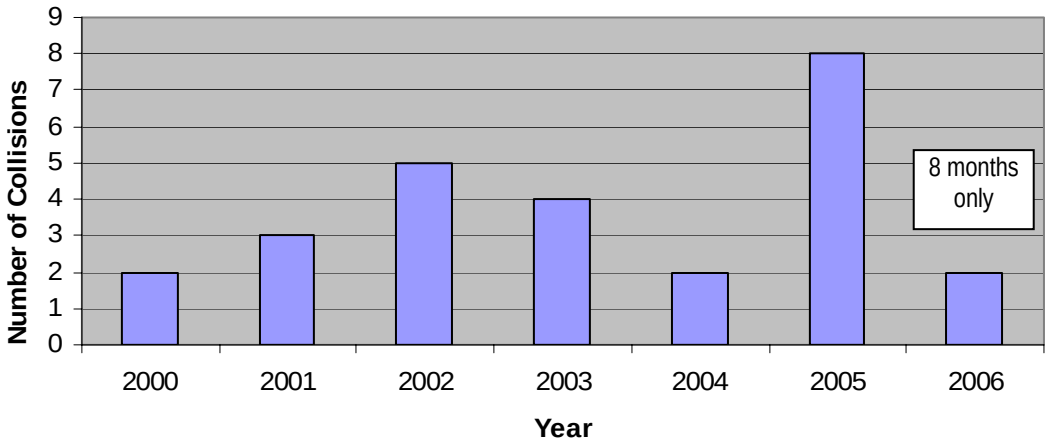
3.3. Collision Data Analysis

Claims data covering January 2000 to August 2006, a total of six years and eight months, were supplied by ICBC. This data was collated with available HAS data provided by the Ministry to avoid duplication of collisions. A total of 26 collisions occurred during the study period, for an average of approximately 4 collisions per year. All 26 collisions occurred at the Beaver Creek Road/River Road intersection. The claims database did not report any collisions at the other three intersections included in this study (River Road/Heath Road, Alexander Road/Beaver Creek Road, and Heaslip Road/Beaver Creek Road).

Annual collision data are summarized in *Figure 3-2*. The data show that collisions in the area were lowest during the year 2000 and 2004 (two collisions per year) and highest during the year 2005 (eight collisions per year). The high collision frequency in 2005 is likely related to the random nature of collisions and is not expected to represent an increasing trend.

The collision frequency at the intersection is not particularly high, however, the collision rate, 0.76 collisions per million entering vehicles (coll/mev), is above the critical rate for similar intersections (0.33 coll/mev[3]). This indicates that the intersection is collision prone.

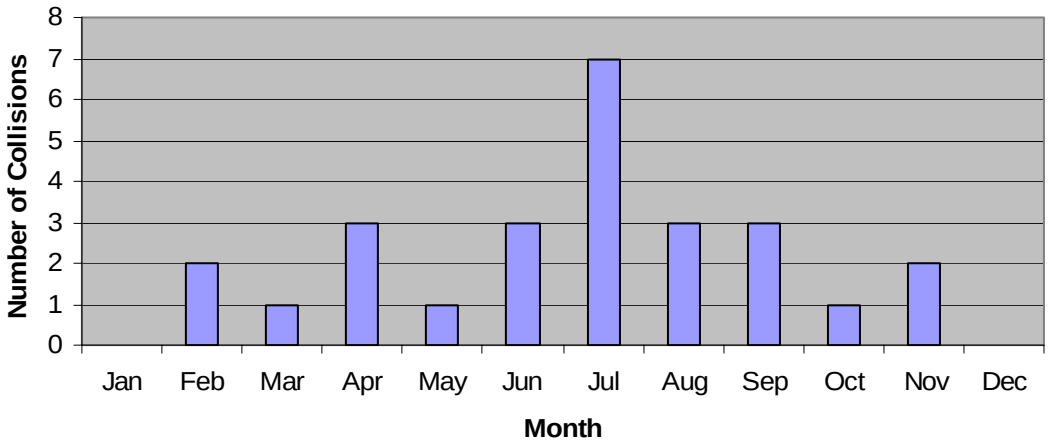
FIGURE 3-2
Collision Distribution by Year



The collisions per month were examined for trends over the study period. The summary is presented in *Figure 3-3*. The month of July had the highest number of collisions at seven collisions, which equated to 27 percent of all collisions. In all, 77 percent of all collisions occurred during the summer (April through September); this is noticeably higher compared to other municipalities. In previous studies, it was determined that the communities of Sidney and Kelowna had 49 percent and 59 percent of all collisions occurring during summer months, respectively. The proportion of collisions occurring in summer suggests that collision frequency may be related to the increase in summer traffic. Conversely, there were no recorded collisions during the winter months of December and January during the data period reviewed.

[3] Average Provincial Collision Rates by Highway Service Class 2000 to 2004, April 6, 2006

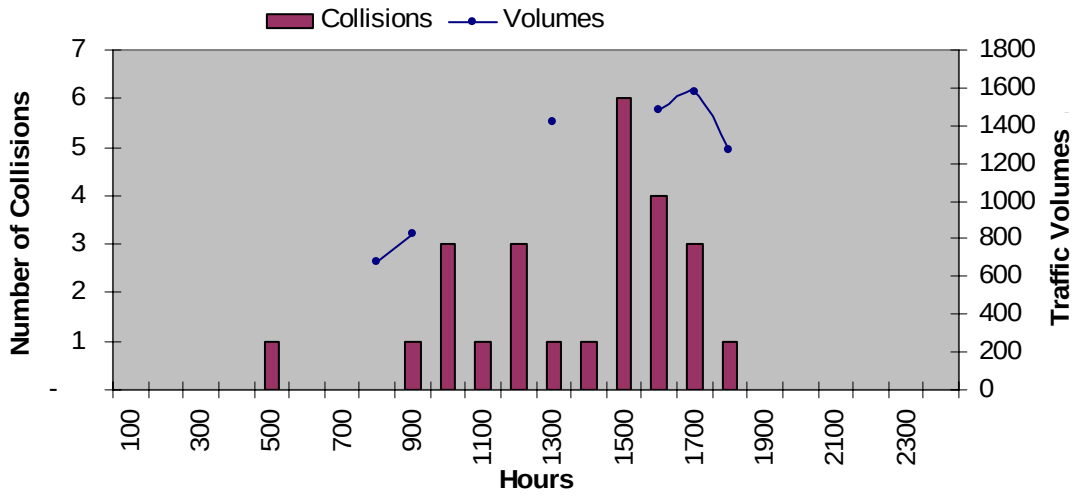
FIGURE 3-3
Collision Distribution by Month



The distributions of collisions and traffic[4] by hour are shown in *Figure 3-4*. Traffic volume data was available for only six hours of the day; however it can be assumed that traffic volumes slowly increase between 9 AM and 1 PM and then plateau until 5 PM. Following the end of the PM peak, traffic starts to decrease.

Figure 3-4 shows that collisions peaked between the noon and PM peak period, which suggests that the increase in traffic volumes may be related to collision frequency.

FIGURE 3-4
Collision Distribution by Hour



A graphic summary of the collisions at the intersection is shown on *Figure 3-5*. The figure shows that rear end collisions equated to 50 percent of all collisions. Backing and left turn related collisions each accounted for 12 percent of all collisions at this intersection.

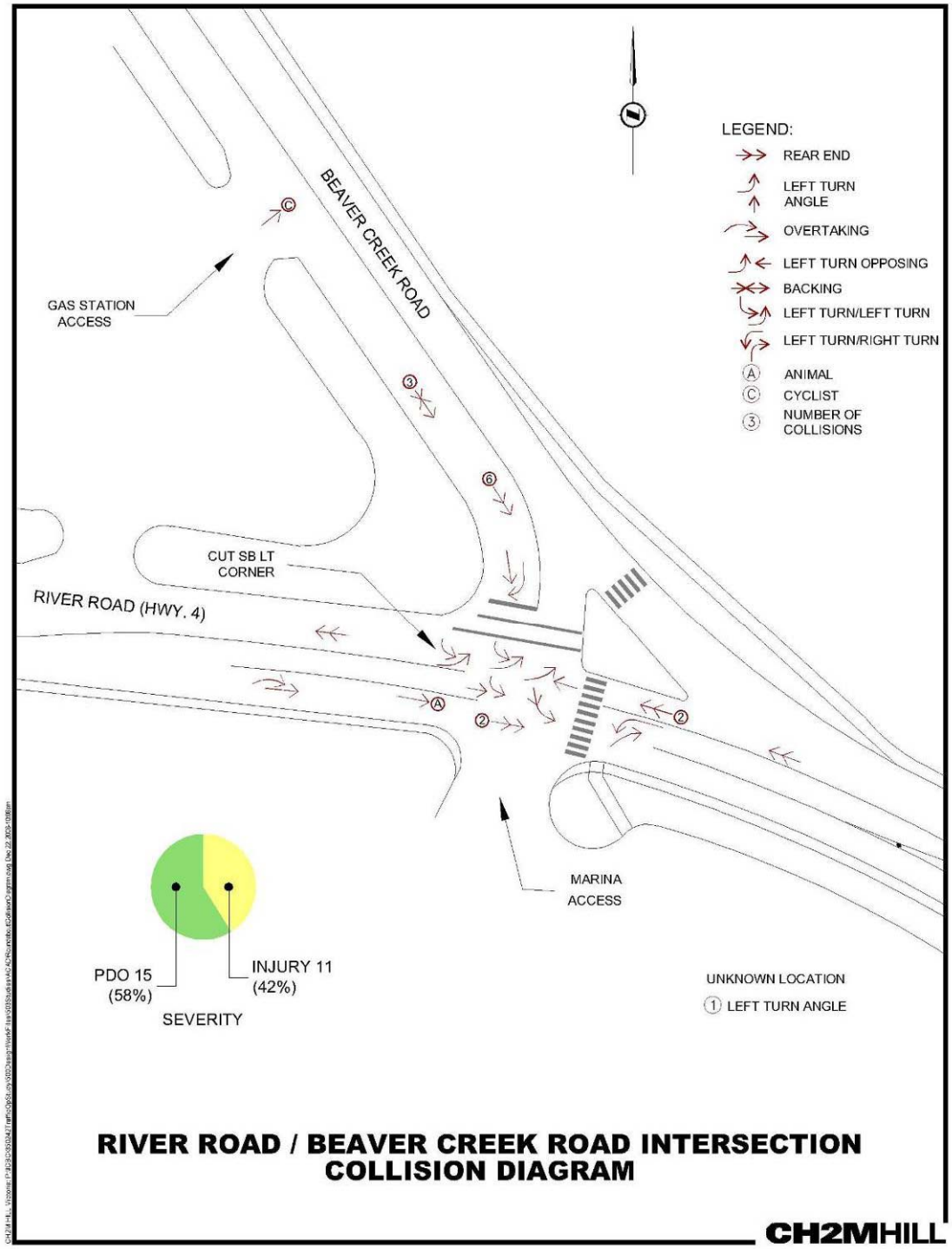
[4] Traffic volumes shown in the figure represent the average hourly traffic volume during the year 2006, derived from available traffic data at the intersection of River Road and Beaver Creek Road.

The proportion of rear end collisions is comparable to the proportion experienced by other communities. This was the case for Highway 19A in Parksville and McKenzie Avenue in Victoria, where the rear end proportions were 54 percent and 61 percent, respectively. Four rear end collisions were related to vehicles stopping abruptly due to pedestrians on the crosswalk on River Road. None of the pedestrians were injured as a result of these collisions.

Backing collisions at the River Road/Beaver Creek Road intersection occurred primarily on the north approach and were related to vehicles that pulled forward past the stop line and then backed up to avoid conflict with through traffic on River Road.

The proportion of left turn related collisions at the River Road/Beaver Creek Road intersection (12 percent) is slightly higher than the proportion of left turn related collisions experienced by other communities. The proportion of left turn related collisions in Sidney and Kelowna were approximately 5 percent and 7 percent, respectively. This indicates that left turn related collisions are a concern at the subject intersection.

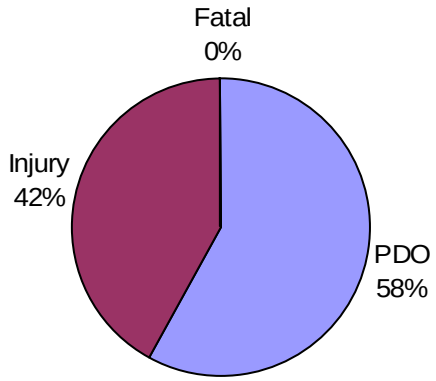
FIGURE 3-5
Collision Diagram



The distribution of collision severity was analyzed at the intersection. The data indicated that there were 15 (58 percent) property damage only (PDO) collisions, eleven (42 percent) injury collisions, and no fatal collisions. The severity proportion of collisions in the corridor is shown in *Figure 3-6*. The proportion of injury collisions is comparable to the proportion of

injuries experienced by other communities in BC. The Collision Severity Index (CSI) of the intersection is 4.8, which is lower than the average CSI for similar intersections. This indicates that the severity of the collisions is much lower than provincial rates.

FIGURE 3-6
Severity Proportions



In summary, the collision rate indicated that the intersection is collision prone as the collision rate is above the critical rate for similar intersections. On the other hand, the collision severity index was below the CSI for similar intersections. These results indicated that while collision frequency is an issue, collisions tend not to be severe. Collisions were highly related to traffic volumes, which indicated that the increase in traffic and the decrease of available gaps in the main stream of traffic increases the likelihood of collisions.

3.4. Pedestrian and Bicyclist Facilities

A pedestrian walkway and crosswalks are available in the vicinity of the River Road/Beaver Creek Road intersection. *Figure 3-7* shows the general alignment of the walkway and the location of crosswalks in the area. The walkway runs from the east along the Alberni Inlet up to the River Road/Beaver Creek Road intersection and then continues northward along the dike. Crosswalks are provided on the east and north approaches of the intersection.

Bicyclists share the road with traffic except at the bridge where bicyclists are encouraged to share the sidewalk with pedestrians. During the site visit, very few bicyclists were observed in this area, however, the low volumes may have been related to the rainy conditions at the time of the visit.

FIGURE 3-7
Pedestrian Walkway

During the site visit the portion of the walkway in the vicinity of the intersection was visited. Most of the walkway follows a paved or tiled pathway, however, in the vicinity of the intersection the walkway is discontinued and provides little accessibility to wheelchair or vision impaired people. As shown in *Figure 3-7* the east part of the pathway ends at the marina parking lot and starts again at the other end of the parking lot. The discontinuity of the walkway promotes jaywalking, which was indicated to be an issue during the start-up meeting for this project.

Curb ramps are provided at the River Road intersection, however the ramps are oriented toward the centre of the intersection rather than parallel to the crosswalk. While there are economic reasons to justify this type of scheme, ramps should ideally direct people to the crosswalk. Visually impaired people identify curb ramps as a key landmark to orientate themselves and find the location of crosswalks.

No curb ramps are provided at the centre island of the intersection. This makes it difficult for wheelchair users to safely cross the intersection. Stairs on the north side of the intersection do not make the intersection accessible for people with disabilities and result in difficult passage for the elderly.

Photos of the features described in this section are provided below.

Curb ramps are oriented towards the centre of the intersection.

No ramps are provided at the splitter island at the crosswalk.

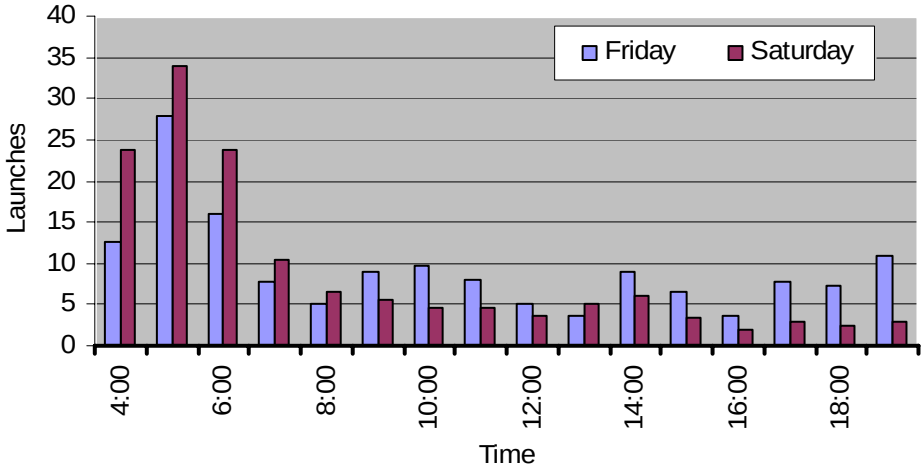
Stairs prevent wheelchair users from accessing the crosswalk.

3.5. Marina Operations and Travel Patterns

The Clutesi Haven Marina, administered by the Port Alberni Port Authority (PAPA), provides year round service for boat enthusiasts. The marina offers two main services, mooring and launching. The mooring service has a capacity of 300 boats and the launching service has four ramps. Boat launching is available year round, however, most of the operation is concentrated during the summer fishing season (between July and August).

Based on data provided by the marina (*Appendix C*), there were between 100 and 200 launches per day during the weekends of June 30th, August 25th, and September 1st. *Figure 3-8* shows the average launching activity by hour[5] for the three weekends. The figure shows that launching peaked in the early hours of the morning between 5:00 and 6:00 AM. This peak does not correspond with the peak operation of River Road and thus operation of the marina during the early hours of the morning is not an issue. However, as traffic increases along River Road, the traffic delay at the main access starts to increase.

FIGURE 3-8
Launch Activity at the Marina



The marina has two accesses as shown in *Figure 3-9*. Generally, the west access is used primarily to access the boat launching queue, and the east or main access is used for boat launching egress and for full access (in and out) for single vehicle users (mooring service).

[5] The marina keeps records of boat launches only; boat retrieval is free and, therefore, no records of this activity exist.

FIGURE 3-9
Marina Accesses and Launch Ramps

The west marina access operates relatively well except during the peak of the fishing season when launching demand exceeds the marina launching capacity. On those days, trucks and trailers queue up along River Road. Vehicles waiting their turn to launch their boats extend past the intersection of River Road and Beaver Creek Road.

The main marina access operates reasonably well except for occasional southbound left turn traffic not yielding to traffic exiting the marina. Sight lines were observed to be adequate, however, it is recommended that vegetation be trimmed on the southwest corner of the River Road/Beaver Creek Road intersection to provide unobstructed sight lines to drivers (previously shown in Section 3.2). The PAPA indicated that during periods of low activity, the west access, although signed as ingress only, is used as an additional exit because it provides better sight lines and is less congested than the main access.

The process of recovering the boats follows a process similar to that of launching. There are, however, more challenges involved in the removal process as vehicles waiting in line to retrieve their boats are not necessarily in the same order as the boats to be removed from the water. Therefore, vehicles need to be sorted while in line to match the order in which boats are pulled out of the water. Two marina staff help coordinate and direct traffic within the marina parking lot during the busiest days.

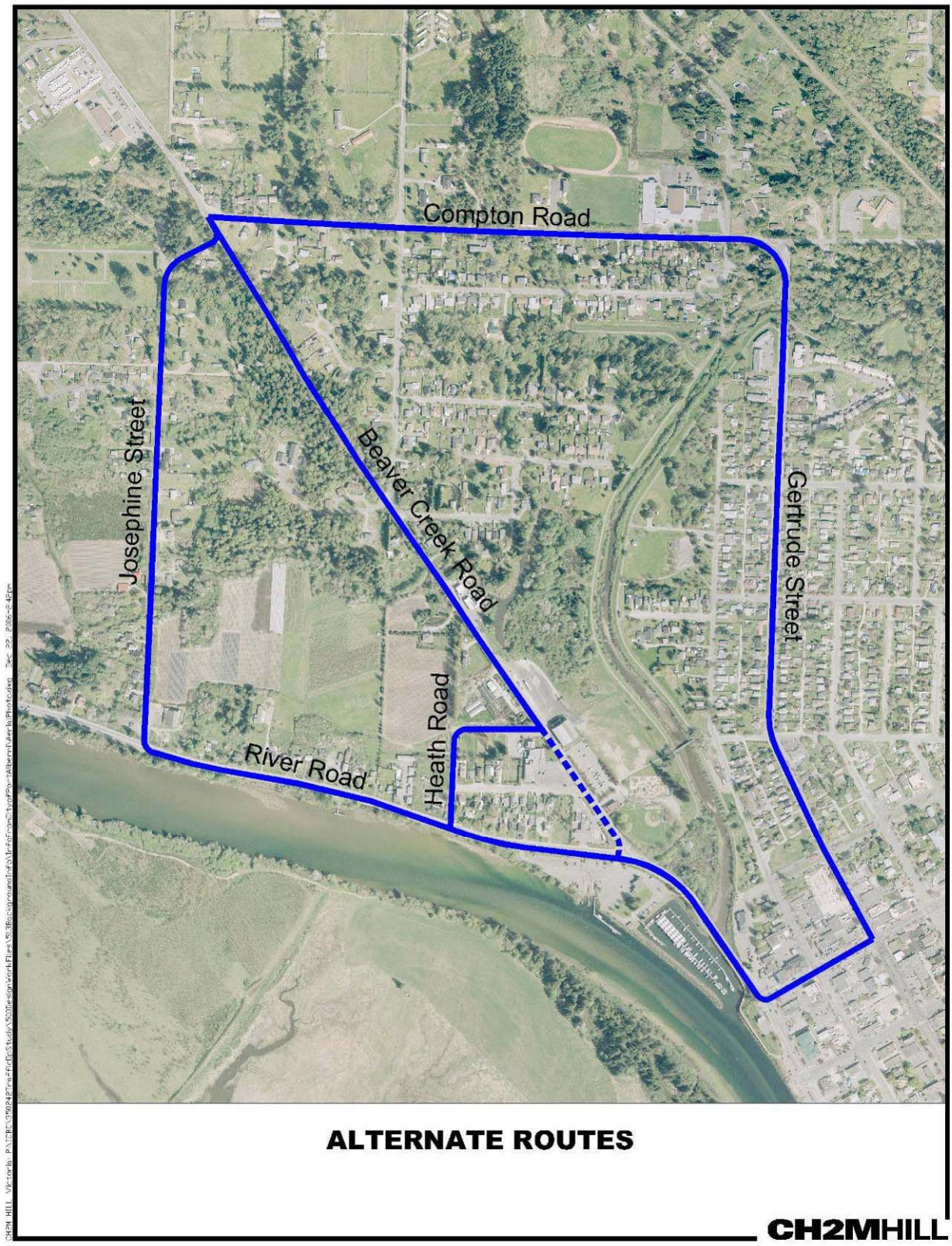
Since there is limited parking at the marina, overflow parking is provided on a City owned lot north of River Road along Beaver Creek Road. This effectively doubles the number of times marina users have to go through the River Road/Beaver Creek Road intersection, increasing congestion at the intersection.

Very little traffic information is available about the travel patterns of marina users. However, based on the information available from the traffic counts and anecdotal information provided by the marina manager, most of the traffic going into the marina comes from the east. It is estimated that about 60 percent of traffic comes from the east, 15 percent from the north, and the remainder (25 percent) from the west.

3.6. Alternate Routes

Several network solutions to the problematic southbound left turn at Beaver Creek Road are possible. Potentially, this movement could be closed and traffic diverted to other routes that have adequate capacity. The three potential alternate routes are Josephine Street, Heath Road, and Gertrude Street (via Compton Road) as shown in *Figure 3-10*.

FIGURE 3-10
Alternate Routes



The three alternate routes were compared and analyzed from a planning perspective to determine whether rerouting traffic to any of these routes could be a feasible option. Available traffic data, as well as anecdotal data provided by the City's engineer, were used to determine the general travel pattern of traffic in this area.

Based on the available traffic counts, it was determined that the southbound left turn traffic at the Beaver Creek Road/River Road intersection originates primarily from the northwest area of Port Alberni and travels along Beaver Creek Road. *Figure 3-11* shows the most recent traffic counts available and Figure 3-12 shows a graphic representation of the travel pattern in the area (traffic volumes are included in *Appendix A*). In general, traffic that comes from the northwest part of Port Alberni travels primarily to the City centre (95 percent) and a small proportion of the traffic travels to the west part of Port Alberni away from the City centre (5 percent).

During the AM peak period, the majority of traffic travels along Beaver Creek Road to get to the City centre. It was estimated that about 60 percent of AM peak period traffic travels along Beaver Creek Road, 35 percent along Compton Road, and the rest (5 percent) along Josephine Street. During the PM peak, both Beaver Creek Road and Compton Road are equally preferred for travel to the City centre, although Compton Road carries a slightly higher proportion of traffic. The increase in the proportion of traffic that travels along Compton Road correlates to the increase in delay at the intersection of Beaver Creek Road and River Road. This indicates that as delays start to increase at the intersection of Beaver Creek Road/River Road, traffic diverts to Compton Road.

Trips between the City centre and the northwest part of Port Alberni use both Beaver Creek Road and Compton Road. During the AM peak period, 40 percent of traffic travels along Compton Road and about 55 percent travels along Beaver Creek Road. During the PM peak, this proportion changes considerably to about 70 percent of traffic travelling along Beaver Creek Road and 25 percent along Compton Road. The increase in traffic on Beaver Creek Road is likely related to the fact that Beaver Creek Road does not have a school zone and is a more expedite road compared to Compton Road.

Anecdotal information provided by the City's engineer indicated that people that live in the area of Indian Avenue prefer to use Beaver Creek Road on their way to the City centre. Compton Road is preferred when they expect additional delays at the Beaver Creek Road/River Road intersection due to events (such as the salmon festival) or during the fishing season.

FIGURE 3-11
Traffic Volumes in the Area

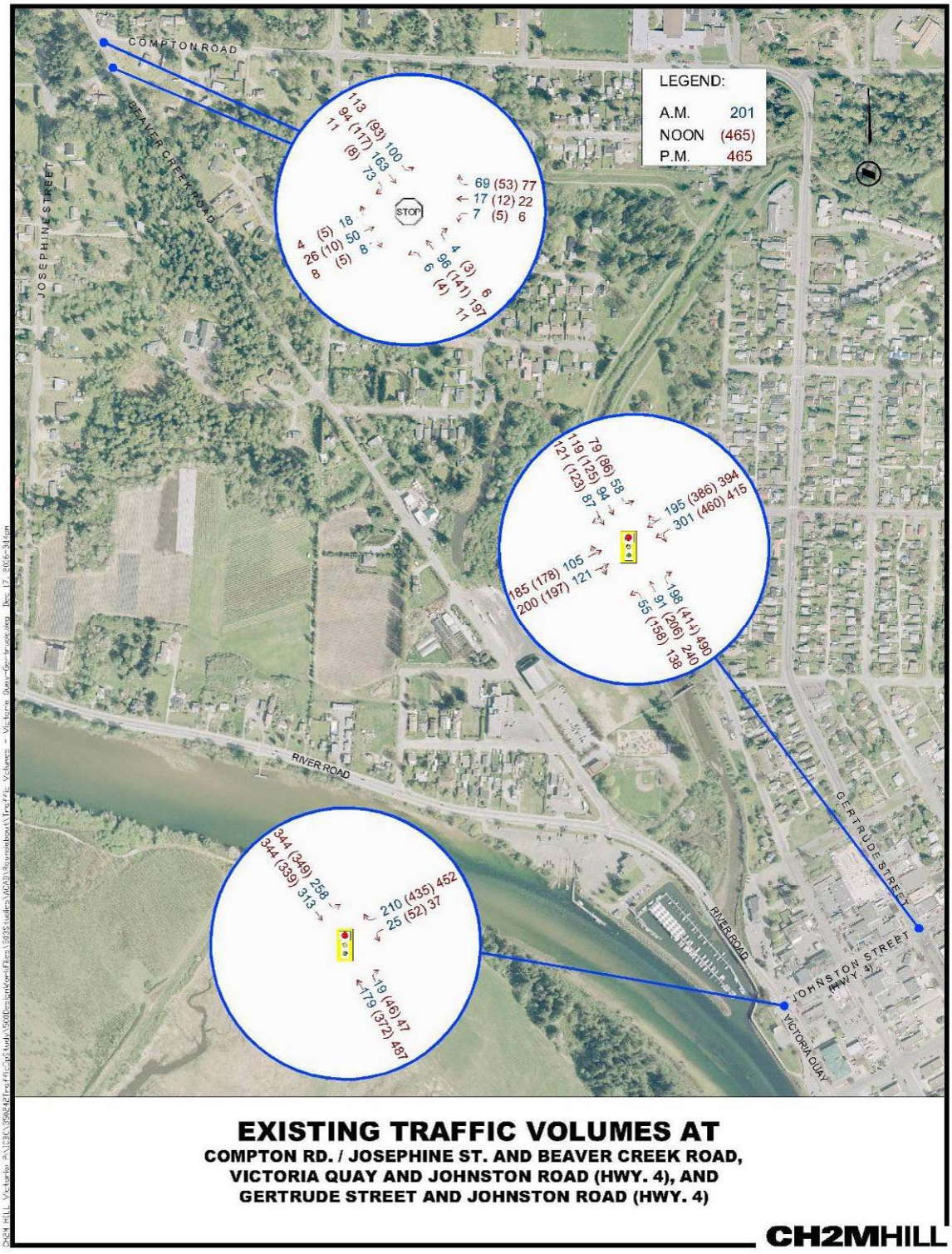
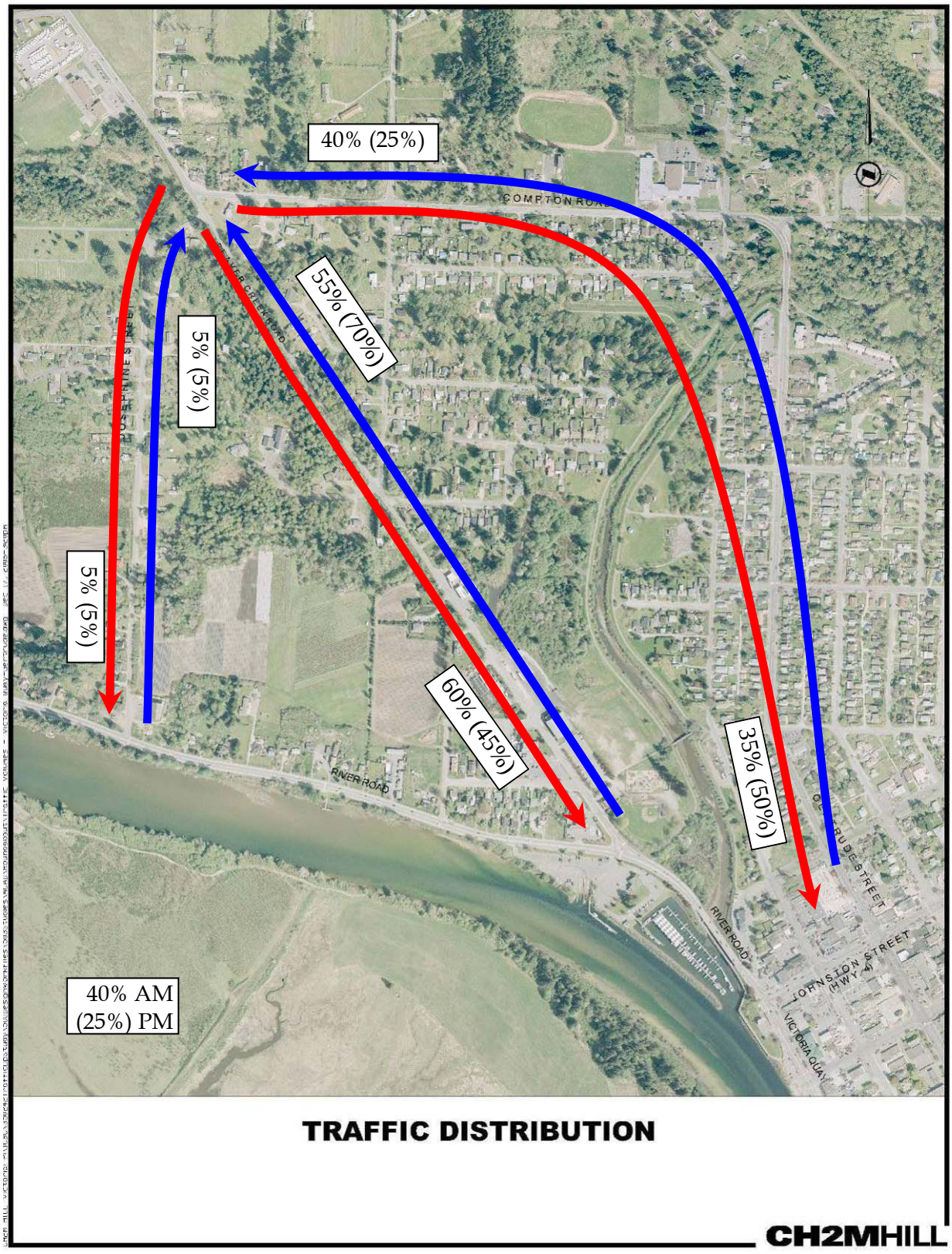


FIGURE 3-12
Traffic Distribution



Rerouting to Compton Road, Josephine Street, and Heath Road is feasible, however, there are considerations that make some of these routes better options than others. *Table 3-3* provides a comparison of the potential routes in the area.

TABLE 3-3
Alternate Route Comparison

Criteria	Beaver Creek Road	Josephine Street	Heath Road	Compton Road/ Gertrude Street
Road Standard/ Alignment[6]	Rural two lane arterial; narrow lanes with asphalt curb and narrow shoulders	Rural two lane collector; gravel shoulders; lane width similar to Beaver Creek Road	Rural two lane local road; pavement in poor condition	Urban collector with curb, gutter, and sidewalk on both sides along Gertrude Street; rural collector with paved/gravel shoulder and open ditches along Compton Road; wide lanes along both Gertrude Street and Compton Road
Adjacent Land Use[7]	Native Reserve, Commercial, Agricultural, Residential	Native Reserve, Residential, Recreational, Agricultural	Agricultural, Commercial, Residential	Native Reserve, School, Residential, Recreational
Road Capacity	Adequate	Adequate	Adequate	Adequate
Southbound Left Turn Capacity at River Road	Inadequate between noon and PM	Inadequate between noon and PM	Inadequate between noon and PM	NA
Intersection Sight Distance[8]	Adequate	Slightly better than Beaver Creek Road	Slightly better than Beaver Creek Road	NA
Travel Time[9] *(mins:secs)*	2:30	3:30	2:35[10]	3:30
Travel Distance (km)	1.9	2.37	2.1	2.2

As indicated in *Table 3-3*, left turn capacity at any intersection along River Road is limited and thus relocation of southbound left turn traffic to another intersection on River Road (Heath Road or Josephine Street) will not address the problem unless a different intersection

6 Based on visual inspection; no measurements taken or design standards checked

7 City of Port Alberni Zoning Map

8 Based on site visit observations only

9 Travel time measured between Beaver Creek Road/Compton Road and a point midway between Gertrude Road and Victoria Quay along Johnston Road; travel time does not include delays at intersections

10 Estimated

control is provided. Capacity at other intersections such as River Road/Victoria Quay and Gertrude Street/Johnston Road were adequate[11].

Relocation of traffic to Compton Road will not require additional major improvements and this alternate route will be able to handle the traffic volume. However, rerouting traffic to Compton Road will impact an established residential area and the existing school.

Table 3-3 indicates that Beaver Creek Road is the shortest and fastest route to travel between north of Beaver Creek Road and the City centre. Heath Road is estimated to add another five to ten seconds of travel if such a route were considered. Josephine Street and Gertrude Street are about one minute longer. However, if traffic delay is considered in the analysis, it is estimated that the River Road/Beaver Creek Road intersection, depending on the time of day, could add another minute or so to the overall trip. During the AM peak period, delay at the intersection is about 20 seconds per vehicle but during the noon and PM peak periods the intersection delay could add between one and two minutes to the travel time.

In conclusion, Beaver Creek Road and Compton Road are the preferred routes to travel into and out of the City centre. Relocation of the southbound left turn traffic at the Beaver Creek Road and River Road intersection is feasible, however, it will require the provision of a different intersection traffic control if traffic is required to use another intersection on River Road. Rerouting of traffic to Compton Road is possible and does not require the provision of additional traffic control infrastructure. However, rerouting traffic to Compton Road will negatively effect an existing school and a residential neighbourhood.

3.7. Future Developments and Improvements

The City indicated that residential and commercial developments are likely to occur in the near future. Presently, there is an application for a 45 unit residential development near the River Road/Heath Road intersection. In addition, it is likely that the northeast quadrant of the River Road/Beaver Creek Road intersection will be rezoned to allow residential developments. Both of these potential developments suggest that traffic demand in the vicinity of the River Road/Beaver Creek Road intersection will increase in the future. The increase in traffic demand from future developments will primarily effect the southbound left turn traffic, which will increase the delay at the intersection.

A potential intersection improvement in this area is the construction of a protected T intersection at the River Road/Heath Road intersection. This improvement was recommended by the Ministry in the event that the proposed residential development on Heath Road proceeds.

[11] Generated three different traffic distributions and selected the most reasonable one for analysis. Analysis based on critical lane analysis (manual method) and basic lane capacities.

4. Option Development

Road improvement options that may address collision risk and the lack of left turn capacity are presented in this section. A variety of options are suggested, some of which may not be likely in the short term but which have value if implemented in the future.

Improvement options presented in this section have been divided in two groups: options that do not require rerouting of traffic and options that do require rerouting.

4.1. No Rerouting Options

The options that do not require rerouting are primarily improvements at the River Road/Beaver Creek Road intersection and cover the following areas: traffic control, signage, pedestrian infrastructure, and parking lot operations.

4.1.1. Traffic Control Options

Protected T intersection

Protected T intersections provide staged crossing of the main road for left turn traffic. Vehicles on the side street waiting to turn left are required to find gaps in one direction of traffic at a time. This improves the capacity and simplifies the operation of regular T intersections. In addition, cost of this improvement is relatively low compared to other traffic control options and can be implemented in a relatively short period of time.

It is estimated that a protected T at the River Road/Beaver Creek Road intersection will improve the Level of Service (LOS) during the PM peak from LOS F to LOS C[12]. However, future increases in traffic, especially southbound left turn traffic, will worsen the level of service of the intersection. If a traffic growth of 2 percent[13] per year is assumed, it is expected that a protected T will operate at reasonable LOS for 10 to 15 years.

A conceptual design of a protected T intersection is shown in *Figure 4-1*[14]. As shown in the figure, the location of the intersection within a curve and also the short spacing between the intersection and the bridge make this option less attractive. From a safety standpoint, construction of a protected T at the River Road/Beaver Creek Road intersection will provide safer left turn crossing for vehicles on the minor road, but could introduce new safety problems that may be of a more severe nature. For example, collisions occurring at the merge area near the bridge could result in vehicles impacting the bridge, resulting in severe collisions and/or the closure of the bridge for long durations.

The distance between the merge area and the bridge could be maximized by shortening the acceleration lane in the eastbound direction; however, this will reduce the capacity of the

12 Analysis based on 2006 traffic volumes (Appendix B)

13 This assumes a more conservative projection of traffic volumes in the future. It does not represent the actual traffic growth of the study area (0.5 percent per year), which is considered low.

14 The figure is provided for display purposes only and is not intended as a functional or final design.

intersection and offset the benefits provided by the protected T intersection. Lane widths, as shown in the figure, are also substandard and will likely need to be increased. This will require additional right-of-way on the south side of the road (marina side).

Depending on the median type, raised or painted, vehicle tracking, especially for large trucks, may be challenging. If a painted median is provided, it is possible that large vehicles will track over the painted median and into the through lane, therefore introducing a feeling of safety that may not actually exist. Raised medians on the other hand provide an extra level of safety; however, they require much wider lanes to allow large vehicles to navigate through the channelized lanes. This will again require additional right-of-way.

Access to the marina will be negatively effected by a protected T intersection, as the main access will have to be relocated to the west. While it is feasible to relocate the access to the west, new challenges to the parking lot operation will be introduced. A more detailed discussion of these challenges is provided in Section 4.1.4.

Pedestrians and bicyclists could also be negatively effected as protected T intersections are perceived as barriers to their movement. Pedestrian crossing is not generally provided at protected T intersections as they are intended to facilitate vehicular movements. If a protected T intersection is implemented, the pedestrian crossing should preferably be provided upstream or downstream of the intersection. Bicyclists, on the other hand, could be accommodated at the protected T intersection but will have to share the road with other vehicles. Thus, southbound bicyclists turning left will have to merge with the eastbound traffic from the left side of the lane. This will not be a comfortable manoeuvre for most bicyclists.

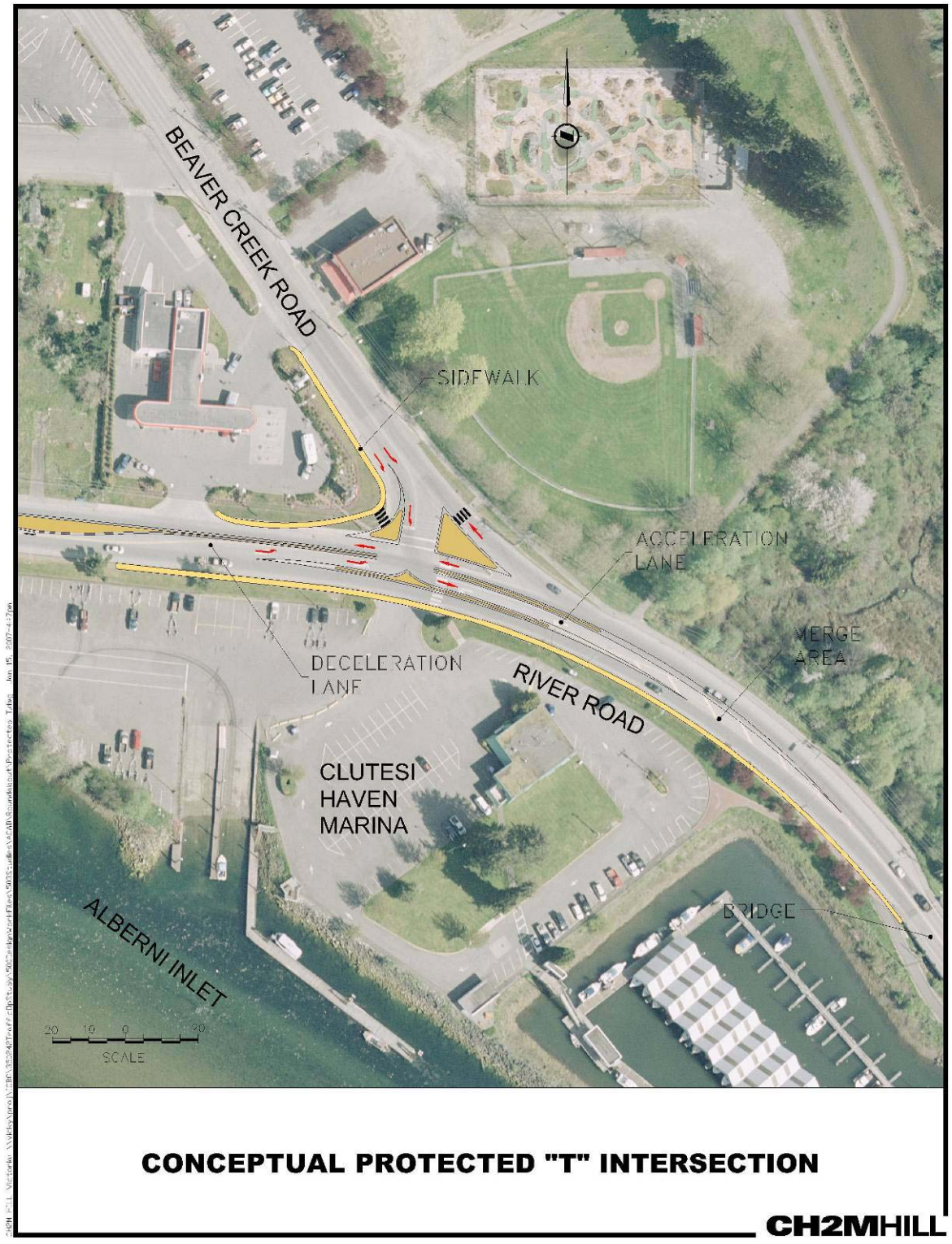
Despite some of the shortcomings presented in this report, a protected T intersection could potentially enhance safety at the River Road/Beaver Creek Road intersection. The shortcomings presented here will have to be considered, and mitigated or minized during the design stages of the protected T.

The benefits of a protected T intersection could be better realized at other intersections along River Road such as Heath Road or Josephine Street. Both of these intersections are located on straight sections of road and have longer spacing with nearby intersections. Implementation of a protected T intersection at Josephine Street or Heath Road would require rerouting of the traffic on Beaver Creek Road as explained in more detail in Section 4.2.

The following table summarizes the benefits and shortcoming of a protected T intersection at the River Road/Beaver Creek Road intersection.

Benefits	Shortcomings
• Moderate increase in southbound left turn capacity • Provides adequate LOS for 10 to 15 years (assuming 2 percent traffic growth) • Reduction in left turn related collisions • Short time to implement • Moderate construction cost depending on median type (raised or painted median)	• May introduce new safety risks for vehicles, especially around the merge area • May require relocation of pedestrian crosswalks • Requires relocation of marina access • May require additional property • May negatively impact pedestrians and bicyclists

FIGURE 4-1
Protected T Intersection



Traffic Signal

Implementation of a traffic signal at the River Road/Beaver Creek Road intersection can improve the flow of traffic at the intersection by assigning right of way to both the main and the side street in an organized manner.

Preliminary warrant analyses indicate that three of the nine warrants used by the Ministry of Transportation (Ministry) are satisfied. These warrants include the peak hour volume, peak hour delay, and 4-hour volume warrants. Note that fulfillment of all or any of the warrants does not necessarily justify the need for a traffic signal, but provide the Ministry with valuable data to support and prioritize need and construction of traffic signals in the province.

The three warrants satisfied by the intersection indicate that a traffic signal would only be beneficial between the noon and the PM peak periods. All other periods would experience undue delay, especially along River Road, which is currently an uninterrupted movement. During the PM peak period, it is expected that the traffic signal would reduce long delays (more than 100 seconds per vehicle) experienced by approximately 10 percent[15] of the traffic and introduce about 10 seconds[16] per vehicle of new delay to 90 percent of the traffic. Therefore, in order to minimize delay for traffic along River Road, it is important to provide the shortest green light phase possible for the side street and only as needed. For example, a less responsive system can provide green light time to Beaver Creek Road only when a set of conditions that include vehicle occupancy, waiting time, and perhaps queue length criteria are satisfied so as to avoid stopping the main direction of traffic every time a vehicle is present on the minor road.

Preliminary analysis indicated that a traffic signal at this intersection would operate at Level of Service (LOS) B or better[17] for all approaches. If a 2 percent[18] traffic growth is assumed, it is expected that the traffic signal will operate at a reasonable LOS for 25 to 30 years. At that point, queues in the westbound direction are expected to exceed queue storage capacity in the westbound direction, thus blocking the River Road/Johnston Road intersection[19].

In terms of collisions, the signal is expected to reduce some of the left turn related collisions (currently 12 percent of all the collisions), but it may increase the number of rear end collisions. This is especially true for traffic that travels along River Road, which currently does not have to stop at the intersection.

Advance warning flashers (AWF) are not required on 50 km/h roads, however, depending on visibility of the traffic signal, AWF may be required in the westbound direction due to the horizontal geometry.

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15 This proportion represents the through and left turn traffic on Beaver Creek Road.

16 Analysis based on the PM peak period.

17 Based on 2006 traffic volumes (Appendix B)

18 This assumes a more conservative projection of traffic volumes in the future. It does not represent the actual traffic growth of the study area (0.5 percent per year), which is considered low.

19 Based on the existing traffic volumes, the longest queues expected in the westbound direction are about 80 metres.

The construction cost of a traffic signal is expected to be in the order of $250,000 and its implementation can take between one and two years, depending on financing mechanisms, geometric improvements, stakeholders involved, etc.

Interaction with future improvements in the area, such as the potential protected T intersection at Heath Road (see Section 3.7), will need to be considered during the design stages of the signal. In addition, improvements to the geometry to allow turning for larger vehicles should be considered. This is especially important for the eastbound left turn movement where large vehicles seem to have difficulties turning. Finally, reducing the radius of the westbound right turn may help to control speeds for this movement.

The following table summarizes the benefits and shortcoming of a traffic signal at the River Road/Beaver Creek Road intersection.

Benefits	Shortcomings
• Provide adequate operation and LOS for 25 to 30 years (assuming 2 percent traffic growth) • Provide conspicuous crossing for pedestrians • Reduce left turn related collisions	• High construction cost • Long time to implement (1 to 2 years) • May increase the number of rear end collisions • Delay issues in non-peak periods (although these could be minimized by providing adequate signal timing)

Roundabout

A roundabout at the River Road/Beaver Creek Road intersection can improve the traffic flow of the intersection while reducing the frequency and severity of collisions. Roundabouts reduce traffic delay (compared to signals) by minimizing the need to stop when there is no traffic at the intersection. This is especially important during off peak periods. Roundabouts effectively reduce the number of conflict points[20] compared to regular intersections, which in turn reduces the frequency of collisions. Right angle collisions, which tend to result in severe collisions, are minimized by merging traffic at acute angles. Finally, roundabouts control speeds through the intersection by introducing deflection at each approach, which also contributes to a decrease in the severity of collisions. Thus, collisions that take place in roundabouts tend to occur at low speed and are less severe compared to collisions that occur at 4-leg intersections. Single-lane approach roundabouts typically provide greater safety benefits than multi-lane approaches because of fewer potential conflicts between road users, and shorter pedestrian crossing distances. Research shows, however, that roundabouts could lead to a potential increase in rear end collisions. However, this increase is not generally as high as that compared to the introduction of traffic signals.

Preliminary analysis indicated that a roundabout at this intersection would operate at a reasonable Level of Service (LOS) for all approaches (LOS C or better)[21]. A potential roundabout is expected to provide adequate LOS for a long time as traffic growth in the area

[20] 4-leg intersections have 32 vehicle-vehicle conflict points, whereas roundabouts only have 8.

[21] Based on 2006 traffic volumes (Appendix B)

has been low. If a 2 percent[22] traffic growth is considered, it is estimated that a single-lane roundabout could operate at a reasonable LOS for 15 to 20 years.

Although there is relatively little circulatory traffic in front of the westbound approach, the westbound volume is not so high that adequate gaps will not be available to traffic entering from Beaver Creek Road. This has been confirmed by the SIDRA analysis and by a separate analysis carried out for the protected T intersection.

Figure 4-2 shows a conceptual drawing of a single lane roundabout at the River Road/Beaver Creek Road intersection. The single lane roundabout provides an indication of the minimum land requirements for a roundabout. This roundabout includes a truck apron to accommodate large vehicles such as trucks and trailers.

It should be noted that the roundabout option shown is conceptual only and is only provided to show their approximate size and intent. The dimensions shown are typical of those used for single-lane roundabouts. Although we have carried out a cursory check for most turning movements using a WB-20 vehicle, it is envisaged that these dimensions will require modification to accommodate all desired movements and vehicles (for example, logging trucks). Depending on specific vehicle requirements, the overall size of the roundabout, islands, and any mountable features, may therefore need adjusting. The determination of the final layout of the roundabout would thus be the result of a more detailed design exercise than envisaged by this assignment.

One potential shortcoming of roundabouts is the safety of pedestrians, bicyclists, and the visually impaired community. Roundabouts simplify pedestrian crossing by allowing pedestrians to cross one direction of traffic at a time. However, when pedestrians cross exiting lanes of roundabouts, they interact with vehicles that otherwise are in the process of accelerating. On the other hand, there are several studies that indicate that the implementation of roundabouts have led to reductions in pedestrian related collisions[23].

Roundabouts can also negatively affect bicyclists. In roundabouts, bicyclists are encouraged to use the vehicular travel lane rather than riding closer to the curb alongside cars. Otherwise, conflict arises between exiting vehicles and circulating bicycles.

Finally, the visually impaired community has reported difficulties using crosswalks at roundabouts. This is primarily related to the fact that vehicles are constantly moving and therefore the identification of gaps in traffic from "vehicular noise" becomes a challenging exercise for people with vision impairment.

The conflict between pedestrians, bicyclists, and vehicles can be addressed through design. For example, by providing good sight lines and by designing roundabouts that incorporate bike lanes or provide alternative bike routes that do not necessarily take bicyclists through the roundabout.

Access to the marina could be negatively impacted by a roundabout as the main access may need to be relocated to the west (see Section 4.1.4). However, this could be mitigated by providing an access for single vehicle users just east of the roundabout (right-in only). In

[22] This assumes a more conservative projection of traffic volumes in the future. It does not represent the actual traffic growth of the study area (0.5 percent per year), which is considered low.

[23] The Handbook of Road Safety Measures, Elvik R and Vaa,T,2004 page 298.

fact, the roundabout easily facilitates this movement for vehicles approaching from any direction (for example, drivers approaching from the east can U-turn via the roundabout and enter the Marina at the said access). Those users desiring to access the back launch area will use the existing access approximately 160 metres west of the proposed roundabout. A single "right-out only" exit could be provided about 40 metres west of the roundabout. Once again, the roundabout facilitates all desired movements. For example, a vehicle exiting the marina to travel west on River Road will turn right out of the marina and then use the roundabout to perform a U-turn and head west).

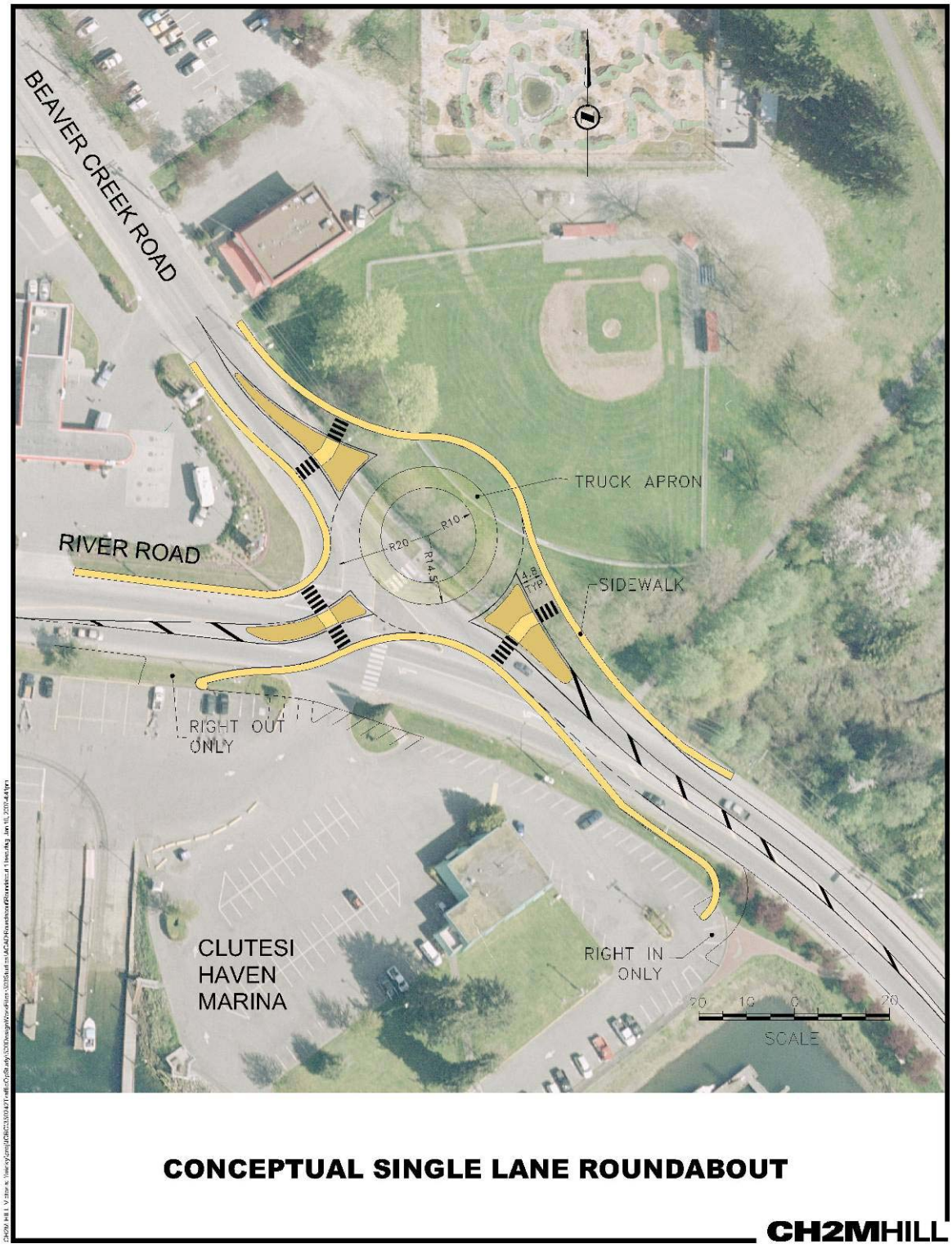
As previously explained in Section 3.5, queuing for launching along River Road will be limited and it is possible that queuing will occur into and through the roundabout. This would not be desirable as it would affect the operation of the roundabout and possibly cause it to become blocked. A potential solution to this, although not ideal, is to queue marina traffic on Heath Road.

Typically, the cost of roundabouts start at about $250,000 and can be as high as $1 million, depending on the configuration of the roundabout and land requirements. Impact of future improvements in the area, such as the potential protected T at Heath Road (Section 3.7), will have to be considered during the design stages of the roundabout.

The following is a list of benefits and shortcomings associated with a potential roundabout at the River Road/Beaver Creek Road intersection.

Benefits	Shortcomings
• Provide adequate operation and LOS for 25 to 30 years (assuming 2 percent traffic growth) • Reduce conflict points between opposing traffic • Control for speed • Reduce the severity of collisions • Facilitate U-turn movements	• May introduce new problems for pedestrians and bicyclists • Access to the marina during peak fishing season, may need to be rerouted to Heath Road. • Relocation of marina access • High construction cost • Long time to implement • Requires additional property • Potential for queuing back into roundabout from marina access in peak periods, which may "block" off roundabout • Driver unfamiliarity • May increase the number of rear end collisions

FIGURE 4-2
Conceptual Single Lane Roundabout



Extend Westbound Right Turn Lane

Extending the channelization of the westbound right turn lane will minimize the number of gaps that are wasted by southbound traffic. Presently, there are a number of gaps that are not utilized because southbound traffic cannot easily determine if a vehicle is going to continue straight or turn right at the intersection. This option, while simplifying the operation of the intersection; it does not significantly increase the capacity nor improve the safety performance of the intersection.

Eliminate Westbound Left Turn Lane

Elimination of the westbound left turn will simplify the operation of the intersection, however, it will not significantly increase the capacity of the intersection. Similarly, the safety performance of the intersection is not expected to be significantly improved. The westbound left turn movement primarily serves as access to the marina for single vehicle users. The volume for that movement is relatively low compared to the other movements at the intersection. In addition, elimination of this movement will force single vehicle users to share the western access with trucks and trailers (refer also to Section 4.1.4).

4.1.2. Signage Options

Some of the short-term improvements that can be implemented in this area are the improvement of traffic signs. This section describes two signs that can be installed in the area to address some of the problems at the intersection.

"Left Turn Traffic Yield to Oncoming Vehicles" signs can be used at intersections where one of the intersection's legs is perceived as having a lower priority compared to the other approaches. This is usually the case of residential and/or commercial accesses at signalized intersections. The sign effectively reminds drivers that oncoming vehicles have the right of way. *Figures 4-3 and 4-4* show an example of the use of this sign.

While we are not aware of any studies that assess the benefits of using such a sign, the use of this sign at the marina access could improve the existing issue of southbound left turn traffic cutting in front of traffic coming out of the marina.

FIGURE 4-3
Signalized Intersection at a Commercial Access

FIGURE 4-4
Left Turn Traffic Yield to Oncoming Vehicles Sign

Additional signs can also be implemented in this area to provide guidance to drivers on the preferred route to use in their commute to the City centre. For example, the use of the sign "To City Centre Use Compton Road" north of the Beaver Creek Road/Compton Road intersection may persuade more traffic going into town to travel on that route, which will in

turn reduce the left turn volumes at the Beaver Creek Road/River Road intersection. It is expected, however, that such a sign will have little or no impact on traffic as most of the traffic is comprised of local drivers, who have been using Beaver Creek Road for many years. They are not likely to change their driving habits because of the new sign. In addition, actively rerouting traffic to Compton Road will not likely be supported by the community as both a residential neighbourhood and a school will be effected by the increase in traffic. Impacts of rerouting traffic to Compton Road and other roads are discussed in more detail in Section 4.2.

4.1.3. Pedestrian Options

Pedestrian improvements that can be incorporated in this area include the relocation of the crosswalk at River Road/Beaver Creek Road and the realignment of the walkway path to connect with the crosswalk at the intersection.

Three options were considered for relocating the pedestrian crosswalk.

1. Relocation of the crosswalk to the west side of the intersection. This would eliminate the conflict between the southbound left turn movement, which is a predominant movement, and pedestrians in the crosswalk.

2. Retain the crosswalk and upgrade with pedestrian push buttons and flashers. As indicated by the City and the Port Authority, pedestrian activity is high during the fishing season and during weekends.

3. Relocate the crosswalk towards the east, midway between the bridge and the intersection, to provide a direct connection to the walkway and therefore minimize jaywalking. This option is not recommended for the following two reasons. Firstly, mid-block pedestrian crossings tend to be less noticeable compared to crosswalks at intersections. Secondly, moving the crosswalks to the east will locate the crosswalks in the middle of a curve, which could increase the safety risks for pedestrians as sight distance may be restricted.

Potential improvements to the pedestrian walkway include realignment and sidewalk upgrading. Realignment of the walkway to provide a more direct connection to the crosswalk can effectively reduce jaywalking and increase safety for pedestrians. Upgrading of the sidewalk in the area south of River Road, as shown in *Figure 4-5,* can also decrease jaywalking and enhance the walking experience for pedestrians. If implemented, the ultimate alignment of the walkway should be confirmed and should consider future developments in the area. The use of vegetation as a barrier could be considered near the bridge to reinforce the use of the pedestrian crosswalk.

FIGURE 4-5
Improvements to Pedestrian Walkway

4.1.4. Parking Lot Operation Options

As discussed previously, some of the options presented in this report require the relocation of the main marina access (currently opposite Beaver Creek Road) further to the west. While it is feasible to relocate the main access, the parking lot operation will become more challenging under this new configuration.

Figures 4-6 and 4-7 show the parking lot internal circulation for trucks and trailers and large trucks (WB-20). The figures show that the marina will be able to operate under this different scheme, however, the parking lot operation will be more challenging as there is a conflict between entering and exiting vehicles that will require more supervision from marina staff.

Single vehicle users will be negatively affected if the existing main marina access is relocated further to the west. Single vehicle users will have to drive through the launching bays to get to the single vehicle parking on the east part of the marina. Single vehicle users using the west access will also have to line up with trucks and trailers during busy days. This will add unnecessary delay to the single vehicle users. Furthermore, the new layout will reduce the number of parking stalls as more space will be required for vehicles to manoeuvre. As noted in Section 4.1.1 under the roundabout option, it may be feasible to provide an access (right-in only) for single vehicle users just to the east of the roundabout. Although this will require the removal of some parking bays to facilitate this access, it should be possible to provide an equal number of parking spaces (or more) in the vicinity of the existing main access.

Finally, left turns out of the marina will likely be restricted and rerouted to Beaver Creek Road/Heath Road via the right-out only egress as shown in *Figure 4-8*. This is a circuitous route compared to the existing condition and will affect approximately 25 percent of the marina traffic.

In conclusion, relocation of the marina main access to the west is feasible but likely not desirable as the new layout has a number of disadvantages compared to the existing layout. However, a right-in access to the east may be possible with the roundabout option. This will avoid some of the difficulties associated with relocating the access further to the west.

As this study was being finalized the Port Authority indicated that future plans for the marina included the demolition of the existing building and the reconstruction of a new building. While it is envisaged that the new building will remain in the same general area (i.e., east of the launch bays), there is an opportunity to redesign the layout of the marina parking lot, without being constrained by the location of the existing building. It is recommended that a potential main access in the west part of the parking lot be considered for further investigation.

FIGURE 4-6
Parking Lot Internal Circulation – Pick Up Truck and Trailers

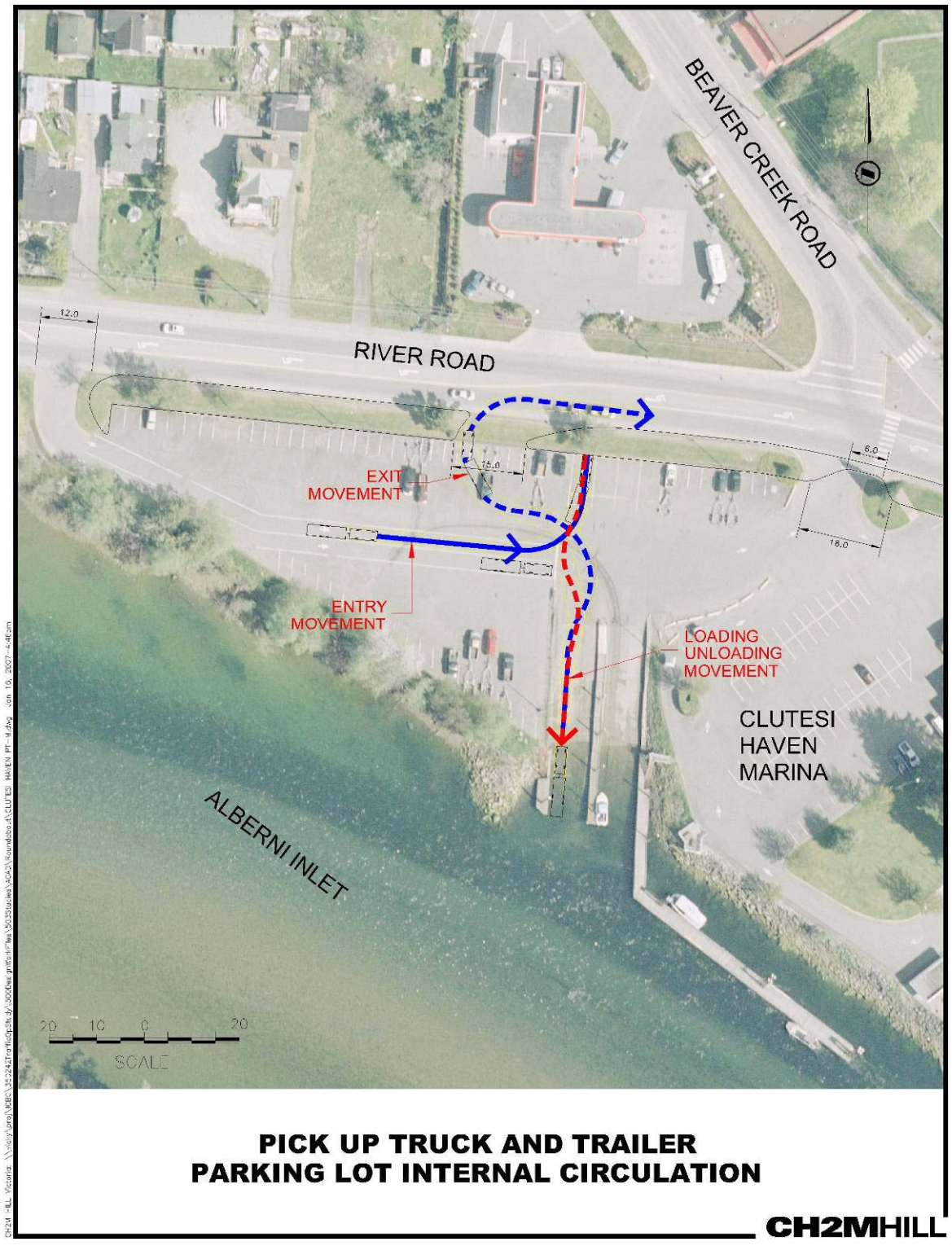


FIGURE 4-7
Parking Lot Internal Circulation – Large Trucks

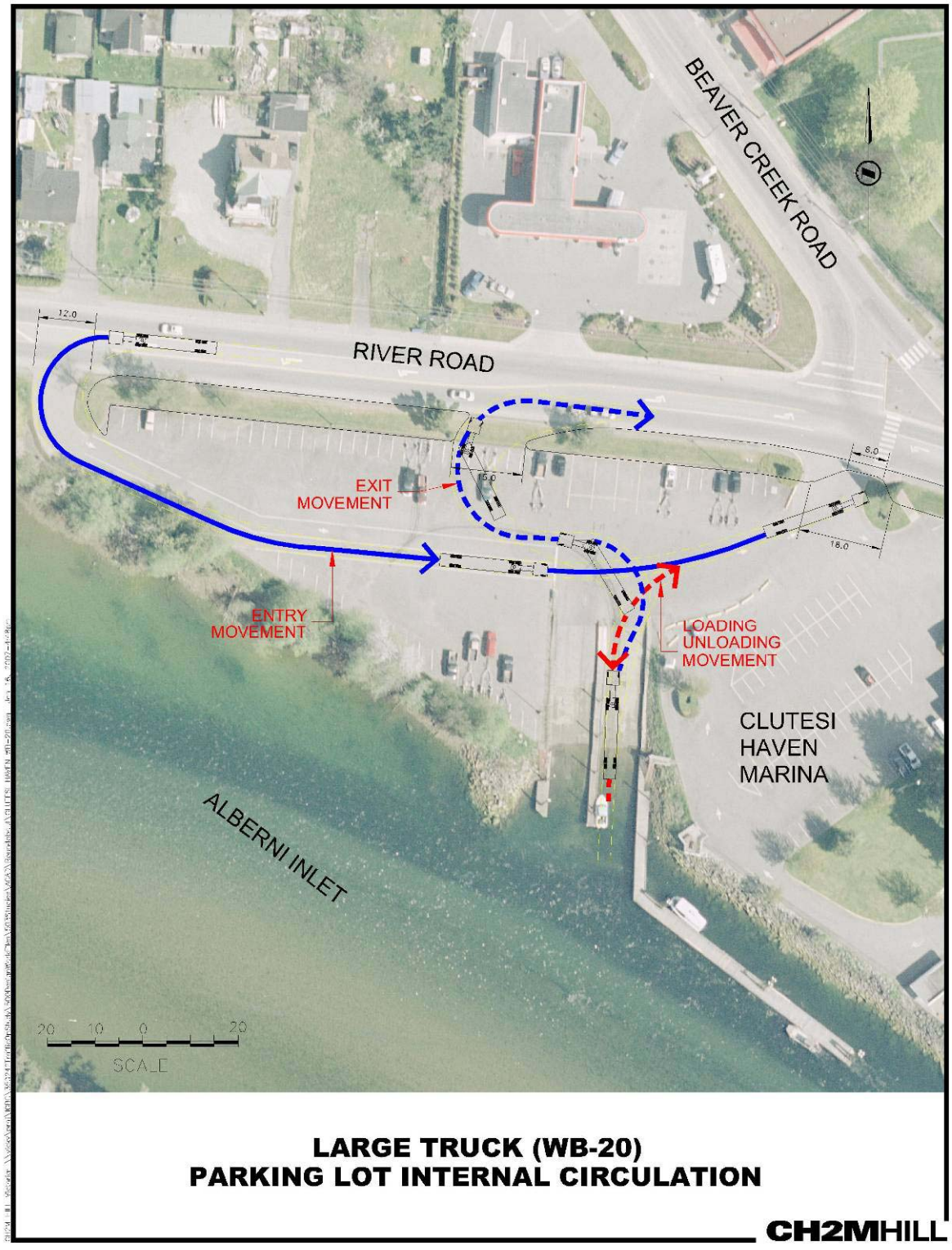
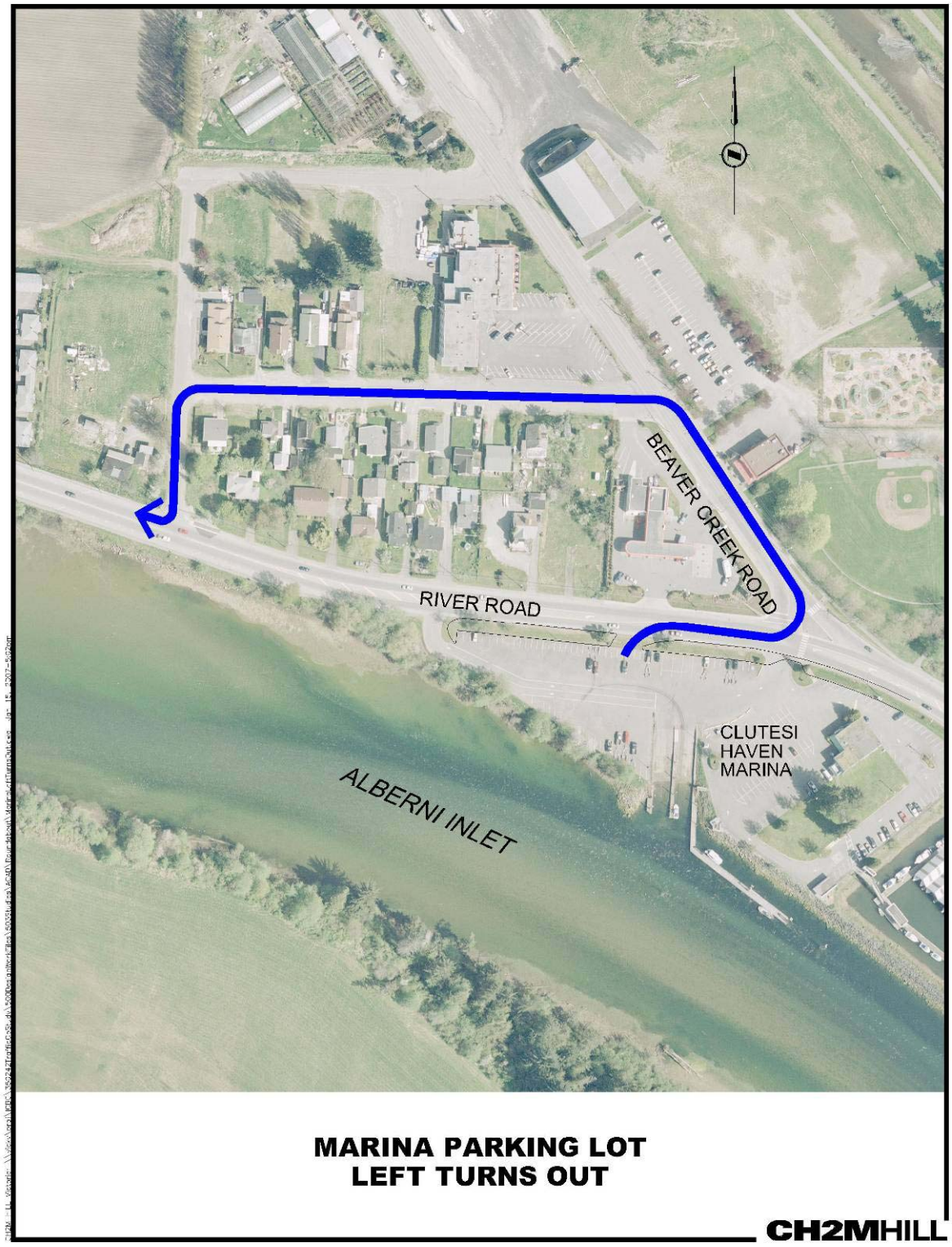


FIGURE 4-8
Marina Parking Lot Left Turns Out



4.2. Active Rerouting

4.2.1. Alternate Route Options

Redistribution of the southbound left turn traffic at the River Road/Beaver Creek Road intersection has been considered as a potential option. Section 3.6 presented a comparison between Beaver Creek Road and three alternate routes in the area.

Of the three alternate routes (i.e., Josephine Street, Heath Road, and Compton Road), Heath Road is preferred because it provides the shortest deviation and minimizes the impacts to adjacent land uses. If Heath Road is adopted as an alternate route, it is recommended that the road be upgraded to accommodate truck traffic and a north-south connector be built to connect to Beaver Creek Road. The new connector will tie into Beaver Creek Road at a right angle to better accommodate large vehicles as shown in *Figure 4-9*. Alternatively, consideration should be given to improving turn radii along Heath Road and Alexander Road to accommodate large trucks. Finally, improvements at the River Road/Heath Road intersection will need to be considered to provide adequate left turn capacity for the southbound traffic. All of these improvements have a significant capital cost, making this option less attractive than the no rerouting options.

Rerouting traffic to Josephine Street will result in longer travel time and travel distance compared to any of the other alternate routes. Josephine Street will also require road upgrades to accommodate large trucks and upgrades to the River Road/Josephine Street intersection. Therefore, this option is less attractive compared to the Heath Road alternative.

Rerouting to Compton Road does not require major infrastructure, but additional traffic will affect an established residential neighbourhood and a school zone. While it may be possible to provide improvements at the school zone to enhance safety, it is expected that the community will not support this option.

None of these alternate routes is particularly unfavourable or unacceptable because the current route, Beaver Creek Road, is already very narrow with minimal shoulders and power poles (fixed object hazards) close to the travel lanes. The Compton Road diversion offers an existing good road standard whereas the Josephine Street diversion avoids effecting the school (along Compton Road). Note that traffic rerouting will negatively effect businesses that currently are in the vicinity of the River Road/Beaver Creek Road intersection.

The three routes included only singular diversions. In practice, it would be better to consider multiple diversions, or an open network with multiple route options available. This allows drivers to optimize their route choice depending on their destination and the time of day travel patterns. For example, choosing one of the western diversions (Josephine Street or Heath Road) provides better access to the marina and Highway 4 (River Road) west, because the routing avoids impacting the critical movements at Johnston Road/Gertrude Street and Johnston Road /River Road intersections. On the other hand, Compton Road-Gertrude Street may be the preferred routing for accessing Highway 4 (Johnston Road) east.

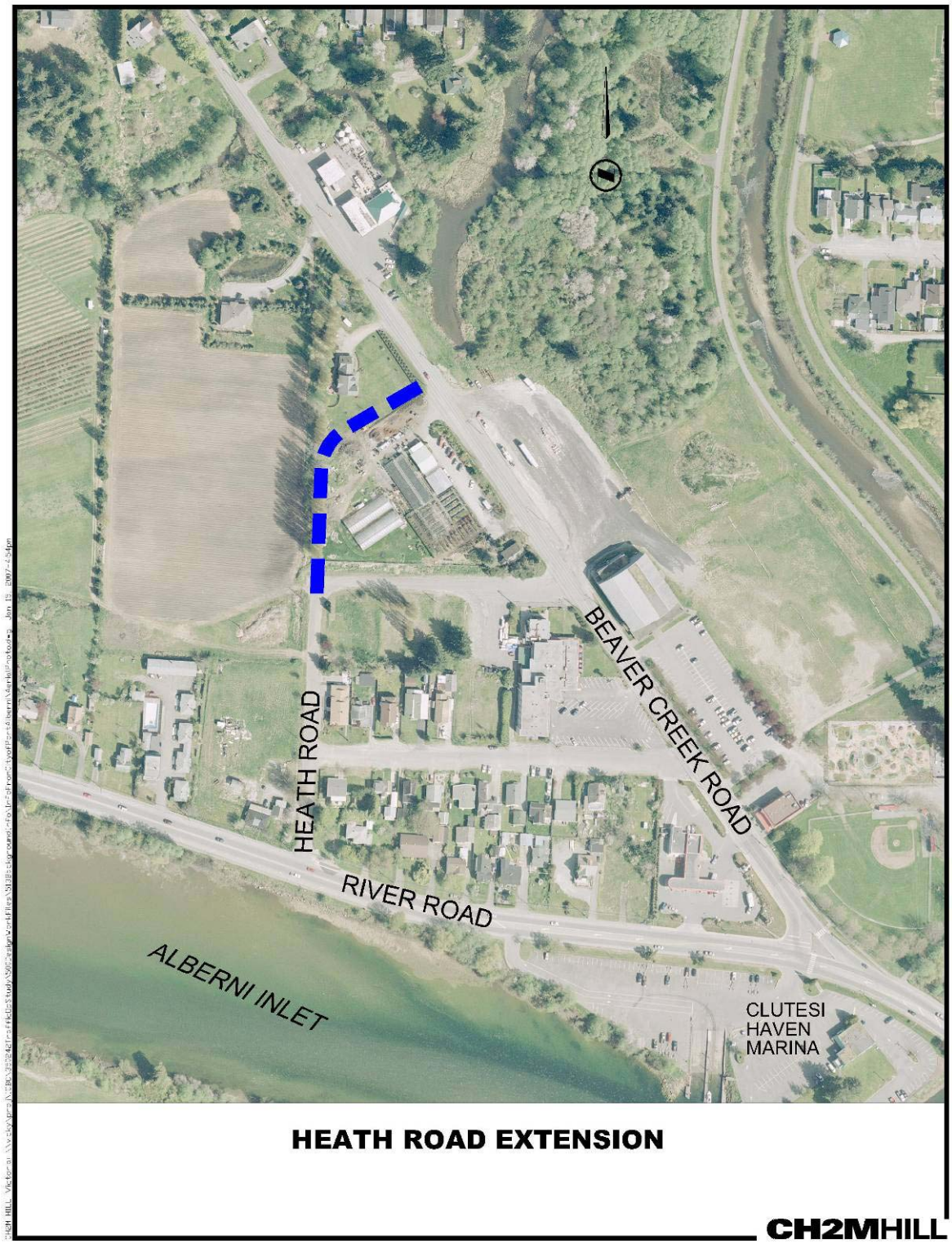
This open network concept would also better accommodate future changes in land use/ destination patterns. For example, if commercial development were to increase along

Gertrude Street north, Gertrude Street may become the more favoured route (minimizing impact on the Gertrude Street/Highway 4 and Victoria Quay/Highway 4 intersections).

In conclusion, closure of the southbound left turn at Beaver Creek Road with an open network to accommodate the diverted traffic is a viable option, although not required. A more directed diversion through the use of guide signs at Compton Road or Josephine Street is possible though not desired because it reduces flexibility in route choice. The left turning movement is predominantly local and, therefore. directional signage is not necessary except at the south end toward the Heath Road diversion.

The decision about which route to favour or promote will have to be based on the capital cost to implement alternate routes, land use along new routes, future developments (traffic growth), and long-term transportation strategy in the area. Based on the Official Community Plan (OCP), Beaver Creek Road is the main arterial in the area, although from a road form perspective, it does not represent one. As such, if the City wants to be consistent with its OCP, traffic should be maintained and concentrated along Beaver Creek Road.

FIGURE 4-9
Heath Road Extension



4.2.2. Eliminating Left Turn Movements

Eliminating the southbound left (SBL) turn movement at the River Road/Beaver Creek Road intersection will eliminate the conflict between SBL turn traffic and through traffic along River Road. Prohibition of the movement can be achieved by reconfiguring the intersection to a right-in-right-out scheme.

A direct consequence of eliminating left turns at the intersection is that southbound left turn traffic (left turn out) and eastbound left turn traffic (left turn in) will have to be accommodated at other intersections. It is expected that some of the left turn out traffic will be relocated to Compton Road while a small proportion will be relocated to other routes such as Josephine Street and Heath Road. Left turn in traffic, on the other hand, will be relocated to either Heath Road or Josephine Street. Alternate routes will be impacted in different ways as explained in Section 4.2.1, and improvements to offset these impacts will be required.

The marina access could operate as full access as left turn out traffic represents a small proportion. Alternatively, the marina access could become a right-in-right-out access. Through traffic coming out of the marina will also be impacted and will have to relocate to other intersections such as Heath Road and Josephine Street, which will negatively effect the operation of the marina. Access to the overflow parking lot north of River Road will be more difficult, as marina traffic will have to use alternate routes to access the overflow parking lot.

The following table presents the benefits and shortcomings of implementation of a right-in-right-out operation at the River Road/Beaver Creek Road intersection.

Benefits	Shortcomings
• Eliminate conflict between southbound left turn traffic and through traffic • Reduce left turn related collisions • Short time to implement • Relatively inexpensive (excluding alternate route costs)	• Marina access may need to be relocated depending on movements allowed at the Marina main access • Left turns into Beaver Creek Road will need to be rerouted • Traffic will have to be relocated to alternate routes (Compton Road, Heath Road, and/or Josephine Street • Additional improvements will be needed to provide left turn capacity at other intersections along River Road • Access to the overflow parking lot will be negatively effected. • Business in the area will be negatively effected

5. Evaluation of Countermeasures

A safety evaluation was performed on the range of options presented in *Section 4.* The collision reduction factors (CRFs) were taken from reliable sources[24], previous studies, and engineering judgment. A summary of the safety evaluation is shown in *Table 5-1* at the end of this section. Notes and assumptions pertaining to *Table 5-1* follow.

Notes and assumptions:

1. The collision costs used were provided by ICBC as follows: $281,000 for fatal, $25,000 for injury, and $1,600 for property damage only collisions.
2. The values shown in the "Collision Reduction Factor" column represent the expected reduction (or increase if specifically noted otherwise) of the collision type indicated.
3. The average collision cost for all collisions at the River Road/Beaver Creek Road intersection was calculated at $11,500.
4. Revision and upgrade of traffic signs are not included in the economic evaluation; however, ICBC will consider contributing 100 percent of the material cost of regulatory and warning signs as long as highly reflecting sign faces are used.
5. The potential ICBC investment is based on an internal rate of return of 50 percent over either a 2-year or a 5-year period post-implementation depending on the type of improvement. Improvements that are expected to have a long lasting impact on safety are evaluated based on a 5-year service life and short-term improvements are evaluated on a 2-year service life. Examples of improvements, expected service life, and sample calculations are shown in *Appendix D*.
6. The intersection of River Road/Beaver Creek Road is under the jurisdiction of the Ministry of Transportation. ICBC funding is contingent on Ministry support of the road improvement projects.
7. The collision reductions have been estimated to provide guidance on the safety benefits and do not imply a warranty as to the efficacy of the road improvements.
8. An evaluation of pedestrian improvements in the area was not included as no collisions directly involved pedestrians.
9. The safety evaluation was performed at River Road/Beaver Creek Road intersection only and does not consider any positive or negative impacts that may occur elsewhere.
10. The construction cost of the options presented in this report are for guidance only and should be confirmed before committing to the implementation of any of the options.

[24] "Safer Roads" by K.W. Ogden
"The Handbook of Road Safety Measures" by R. Elvik and T. Vaa
"The Canadian Guide to In-service Road Safety Reviews" Transportation Association of Canada

11. It is anticipated that implementation of the traffic signal or the roundabout may increase rear end collisions on River Road as this traffic does not currently have to stop at the intersection. The increase in rear end collisions is expected to be more critical for the traffic signal. Rear end collisions on Beaver Creek Road, which are primarily related to queue interaction and not necessarily to vehicles not being able to stop at the back of the queue, are likely to decrease because the new traffic control (signal or roundabout) will improve traffic flow at the intersection by reducing queue length and delay.

12. Improvement options presented in Section 4.1.1 "Extend Westbound Right Turn Lane" and "Eliminate Westbound Left Turn Lane" were not included in the safety evaluation because they are not expected to significantly improve the safety performance of the intersection.

TABLE 5-1
Economic Evaluation Summary

Mitigation Measure	Collision Reduction Factor (Source)	Safety Issues (Collisions per Year)	Average Collision Cost	Annual Collisions Reduced	Annual Claims Savings	Service Life (Years)	Potential ICBC Investment	Estimated Construction Costs
Traffic Signal	45% angle collisions 30% rear ends (Beaver Ck Rd) 30% **increase** rear ends (River Rd) (Ogden)	1.83 angle collisions 1.17 rear end collisions (Beaver Ck Rd) 1.0 rear end collisions (River Rd)	$5,800 $11,600 $21,100	0.83 coll. 0.35 coll. -0.3 coll. (increase)	$4,800 $4,100 -$6,300	5	$8,300 $7,100 -$11,000 $4,400	$200,000 - $300,000
Roundabout	52% injury collisions (TAC) 40% **increase** PDO collisions (Elvik)	1.67 injury collisions 2.33 PDO collisions	$25,000 $1,600	0.87 coll. -0.93 coll. (increase)	$21,600 -$1,500	5	$37,600 -$2,600 $35,000	$250,000 - $500,000
Protected T Intersection	55% of left turn collisions (Eng judge)[25]	0.67 left turn collisions	$13,300	0.37	$5,000	5	$8,500	$30,000 – $50,000
Right-in-right-out	75% of left turn collisions (Eng judge)[26]	0.67 left turn collisions	$13,300	0.5	$6,600	5	$11,500	$30,000 – $50,000

[25] Based on conflict movement reduction.
[26] Assumes that left turns out of the marina are allowed.

6. Closing

A safety evaluation of the options presented in this report was performed using ICBC's 50 percent internal rate of return[27] on the investments. The evaluation indicated that implementation of a roundabout at the intersection generated the highest ICBC investment at approximately $35,000; followed by the right-in-right-out (RIRO) scheme at $11,500; the protected T intersection at $8,500; and the traffic signal at $4,400. Note that implementing the RIRO scheme at the intersection will require rerouting of traffic, which will likely effect the safety performance of alternate routes. As such the safety benefits of the right-in-right-out intersection will result in redistribution of collisions in the area (i.e., safety benefits at the intersection level, but no net safety benefits at the network level) making this option less attractive. Similarly, implementation of the protected T intersection could lead to an increase of sideswipe collisions in the merge area of the protected T intersection.

Safety benefits of improvements are relatively low because of the low severity of the collisions. In addition, there is a high proportion of rear end collisions, which are not entirely addresses by the implementation of some of the improvements such as the traffic signal and the roundabout. Implementation of the roundabout or the traffic signal could lead to an increase in rear end collisions although the likelihood of such an increase is more critical for the traffic signal.

Despite the low safety benefits achieved by the proposed improvements, it is recommended that the City consider upgrading the traffic control of the intersection. Justification of any of the suggested improvements, in this particular case, is largely based on the capacity needs of the intersection more than the safety benefits that could be realized. As traffic increases and gaps between vehicles become even shorter, collision frequency will likely increase. At this point implementation of these improvements would be justifiable from a safety standpoint, particularly as these collisions will potentially be of a severe nature (i.e., angle type collisions).

The choice of option will also need to address future development plans, proposed timing of improvements, and available funding. For example, whereas a protected T may be a satisfactory short to medium term solution, in the medium to longer term a signal or roundabout solution may be more appropriate. Similarly, in light of the recent comments regarding the reconfiguration of the marina parking lot and building layout, some of the options presented here may be worthy of further review, particularly if relocating the marina access further to the west becomes more viable. Other options may also become apparent with such reconfiguration of the marina.

It is recommended that the City decide the long-term role of Beaver Creek Road in the transportation network **before** implementation of any of the above improvements at the River Road/Beaver Creek Road intersection.

[27] ICBC's investment criteria is further explained in Appendix D

A decision to actively reroute traffic to alternate routes is likely an expensive alternative that may also not have the support of the community. Improvements to the Josephine Street and Heath Road options are likely to be significant as improvements to both roads and intersections will be required. The Compton Road option is not likely to be nearly as expensive, however, it is expected that the community will not support this option because of impacts to residential and school areas. Businesses on Beaver Creek Road will also be negatively effected. Finally, redistribution of traffic that currently travels on Beaver Creek Road will contradict the City's Official Community Plan, which indicates that Beaver Creek Road is the main arterial in the area. As such, it is suggested that the City does not consider the option of rerouting traffic but instead consider upgrading the traffic control at the existing intersection.

In the meantime, implementation of the "Left Turn Traffic Yield to Oncoming Vehicles Sign" at the River Road/Beaver Creek Road intersection could help reduce the risk of southbound left turn traffic cutting in front of traffic exiting the marina.

Implementation of the options presented here should help improve traffic flow and mitigate the collision risk at this intersection, providing all users with a safer road environment.

APPENDIX A

TRAFFIC VOLUME DATA

APPENDIX B

LEVEL OF SERVICE ANALYSES

APPENDIX C

MARINA OPERATIONS

APPENDIX D

POTENTIAL ICBC INVESTMENT CRITERIA

Investment Criteria

The ICBC investment criteria are based on achieving a minimum of 50 percent Internal Rate of Return (i.e., 50 percent IRR) over either a 2-year or a 5-year post-implementation period**.** The investment period depends on the expected service life of the road safety engineering measures being implemented. Examples of measures with 2- and 5-year service life are shown in the following table. In addition to achieving an IRR of 50 percent, the RIP applies a maximum cap of $250,000 on ICBC funding for any one project in any one financial year. Large multi-year projects with staged safety improvements may receive more than $250,000 over the life of the project

Examples of Road Safety Engineering Measures

2-year Service Life	5-year Service Life
• Rumble strips	• Concrete median and roadside barriers
• Reflectorized guide posts and delineation	• Climbing lane
• Signing and pavement marking improvements	• Flatten horizontal curve
• Skid resistant pavement/resurfacing	• Traffic calming
• Larger signal display	• Intersection channelization (add turn lanes)
• Pedestrian crosswalk	• Sight distance improvements
• Signal progression	• Roundabout
	• New traffic signal

Note:

The service life indicated here are for investment purposes only, the actual service life may exceed those shown in the table.

Three examples are given below to illustrate the level of funding for projects using the new criteria (50 percent IRR).

Example 1: Improvements with 2-Year Service Life

Improvements are proposed at an intersection to reduce rear-end crashes. The improvements include new signage, pavement markings, high friction surfacing, and installation oflarger signal heads. The improvements are expected to cost $40,000 and are estimated to result in an annual reduction of $12,000 in claims for ICBC.

Under the new funding criteria of 50 percent IRR, ICBC could fund up to $13,300 for the improvements since the improvements have a service life of two years, and receive benefits of approximately $24,000 over two years.

$$Potential\ ICBC\ Investment = \frac{12{,}000}{1.5} + \frac{12{,}000}{1.5^2} \approx 13{,}300$$

Example 2: Improvements with 5-Year Service Life

Improvements are proposed on a rural highway to reduce crashes involving vehicles going off-road. The improvements include sight distance improvements, the installation of concrete roadside barriers, and flattening of a horizontal curve. The improvements are expected to cost $500,000 and are estimated to result in an annual reduction of $60,000 in claims for ICBC.

Under the new funding criteria of 50 percent IRR, ICBC could fund up to $104,000 for the improvements since the improvements have a service life of five years and receive estimated benefits of $300,000 over five years

$$Potential\ ICBC\ Investment = \frac{60{,}000}{1.5} + \frac{60{,}000}{1.5^2} + \frac{60{,}000}{1.5^3} + \frac{60{,}000}{1.5^4} + \frac{60{,}000}{1.5^5} \approx 104{,}000$$

Example 3: Improvements with 5-Year Service Life and Maximum Cap

Improvements are proposed at an urban intersection to reduce left-turn and rear-end crashes. The improvements include the construction of left-turn lanes and revised signal timing. The improvements are expected to cost $3,000,000, and are estimated to result in an annual reduction of $225,000 in claims for ICBC.

Under the new funding criteria of 50 percent IRR and the maximum cap, ICBC could fund up to $250,000 for the improvements since the improvements have a service life of five years (without the cap, the maximum investment is $389,000). Total estimated benefits would be $1,125,000 over five years.

VEHICLE TURNING MOVEMENT SURVEY
MOTH - Region 6
by TransTech Data Services

Major Route: ROUTE 4
Minor Route: Beaver Creek Rd/Marina
Municipality: Port Alberni
Filename: 4@BEAV.XLS Site Code:

Date: September 2, 1999
Day-of-week: Thursday

Speed Limit Major Rte: 50kph
Speed Limit Minor Rte: 50kph

East/West Route: Route 4
Intersection Type: 1 ---> 4-leg
Signalized (y/n?): no
Weather: Daylight/Clear/Dry

	Lanes								Bus Stop		Bus
	TLR	R	(ch)	TR	T	TL	L	Grade	Near	Far	Bay
North Approach	1										
South Approach	1										
West Approach				1			1				
East Approach		1	B		1		1				

note: (ch) - channelized A: parallel lane B: taper

	Start	Duration
A.M. Shift	07:00	2.00
Noon Shift	11:00	2.00
P.M. Shift	15:00	3.00
	Total	7.00

Note: duration: decimal hours
start time: 24 hr clock (15 min increments)

Comments:
7:35am- 8 cars lined up S/B to turn left onto Hwy 4
11:00am- 9 cars lined up S/B to turn left onto Hwy 4
12:05pm- 13 cars lined up S/B to turn left onto Hwy 4
5:50pm- 10 cars lined up S/B to turn left onto Hwy 4

Notes:
North Approach - vehicles approaching intersection from the north
15x4 - 15 min volume (from max 15 minute period [+] in peak hour period [*]) x 4
Pedestrians - N indicates pedestrians crossing north approach (east/west)

Survey Data

Location: ROUTE 4 @ Beaver Creek Rd/Marina
Date: September 2, 1999

Time	NORTH Approach			SOUTH Approach			WEST Approach			EAST Approach			Total	Pedestrians			
Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Volume	N	S	W	E
07:00	33	0	4	1	3	1	0	40	0	0	36	14	132	0	0	1	0
07:15	28	0	2	1	0	1	1	65	0	2	28	10	138	0	0	2	1
07:30	33	0	1	0	0	2	0	85	1	1	40	13	176	0	0	0	0
07:45	40	0	2	0	0	2	2	109	0	3	56	20	234	0	0	0	0
08:00	36	0	2	2	0	5	5	67	2	3	59	23	204 *	1	0	0	0
08:15	27	0	4	0	1	0	4	97	0	1	52	24	210 *	0	0	1	0
08:30	36	0	0	0	0	6	1	77	1	4	66	24	215 *	0	0	0	1
08:45	28	0	1	0	5	5	1	135	3	1	73	33	285 +	1	0	0	1
n/a													0				
n/a													0				
n/a													0				
n/a													0				
Total	261	0	16	4	9	22	14	675	7	15	410	161	1594	2	0	4	3
Pk Hr	127	0	7	2	6	16	11	376	6	9	250	104	914 *	2	0	1	2
15x4	112	0	4	0	20	20	4	540	12	4	292	132	1140 +	4	0	0	4
11:00	35	0	4	1	1	16	2	136	2	13	113	49	372	2	0	1	1
11:15	29	3	5	3	2	26	0	112	1	12	109	55	357	3	1	0	3
11:30	31	0	7	2	2	11	2	145	3	8	109	50	370	1	1	2	2

11:45	27	0	5	5	2	20	4	128	1	11	99	48	350 *	0	0	0	0
12:00	30	2	2	1	5	18	2	155	1	10	136	44	406 +	1	0	0	3
12:15	28	0	3	4	3	14	4	127	3	6	122	45	359 *	1	1	0	2
12:30	34	0	1	3	2	15	5	139	4	7	137	39	386 *	0	0	0	1
12:45	24	1	3	2	1	19	3	136	0	4	114	36	343	2	0	0	1

Total	238	6	30	21	18	139	22	1078	15	71	939	366	2943	10	3	3	13
Pk Hr	119	2	11	13	12	67	15	549	9	34	494	176	1501 *	2	1	0	6
15x4	120	8	8	4	20	72	8	620	4	40	544	176	1624 +	4	0	0	12

15:00	36	0	7	1	4	13	4	115	2	7	154	71	414	1	0	1	1
15:15	24	0	4	4	1	13	4	140	0	11	133	72	406	1	0	1	0
15:30	47	0	2	1	3	4	7	125	2	5	126	46	368	2	0	1	1
15:45	37	1	7	0	11	1	3	119	0	9	136	52	376	0	0	1	0
16:00	51	0	6	0	1	10	4	139	0	9	147	69	436	0	1	0	1
16:15	33	0	3	0	0	13	5	104	0	5	159	53	375	3	2	0	3
16:30	39	0	4	1	2	8	3	117	2	10	157	87	430 *	3	0	0	3
16:45	42	0	1	1	2	10	4	130	0	12	159	73	434 +	2	0	0	2
17:00	31	0	7	1	4	18	4	123	2	8	156	75	429 *	0	0	0	0
17:15	42	2	5	1	3	9	6	137	1	8	143	50	407 *	2	0	1	3
17:30	23	0	4	0	1	5	3	99	0	10	137	70	352	3	0	0	1
17:45	38	1	7	0	1	4	4	92	1	12	106	36	302	1	0	0	2

Total	443	4	57	10	33	108	51	1440	10	106	1713	754	4729	18	3	5	17
Pk Hr	154	2	17	4	11	45	17	507	5	38	615	285	1700 *	7	0	1	8
15x4	168	0	4	4	8	40	16	520	0	48	636	292	1736 +	8	0	0	8

AM Peak Period

Location: ROUTE 4 @ Beaver Creek Rd/Marina
Date: September 2, 1999

Time	NORTH Approach			SOUTH Approach			WEST Approach			EAST Approach			Total	Pedestrians			
Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Volume	N	S	W	E
07:00	33	0	4	1	3	1	0	40	0	0	36	14	132	0	0	1	0
07:15	28	0	2	1	0	1	1	65	0	2	28	10	138	0	0	2	1
07:30	33	0	1	0	0	2	0	85	1	1	40	13	176	0	0	0	0
07:45	40	0	2	0	0	2	2	109	0	3	56	20	234	0	0	0	0
08:00	36	0	2	2	0	5	5	67	2	3	59	23	204 *	1	0	0	0
08:15	27	0	4	0	1	0	4	97	0	1	52	24	210 *	0	0	1	0
08:30	36	0	0	0	0	6	1	77	1	4	66	24	215 *	0	0	0	1
08:45	28	0	1	0	5	5	1	135	3	1	73	33	285 +	1	0	0	1
n/a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n/a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n/a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n/a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Total	261	0	16	4	9	22	14	675	7	15	410	161	1594	2	0	4	3
Pk Hr	127	0	7	2	6	16	11	376	6	9	250	104	914 *	2	0	1	2
15x4	112	0	4	0	20	20	4	540	12	4	292	132	1140 +	4	0	0	4
Avg Hr	130.5	0	8	2	4.5	11	7	337.5	3.5	7.5	205	80.5	797	1	0	2	1.5

Peak Hour	08:00
Peak 15min	08:45
North approach PHF	1.16
South approach PHF	0.60
West approach PHF	0.71
East approach PHF	0.85

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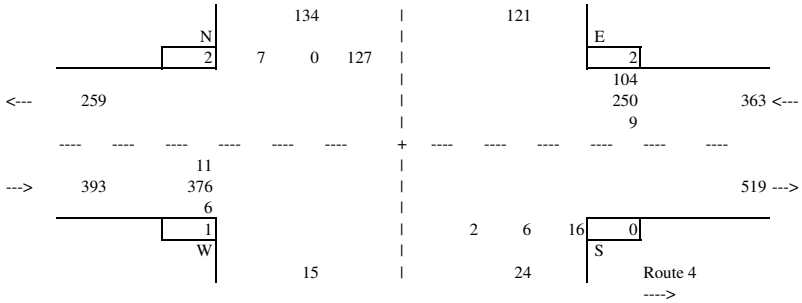
AM Peak Hour Volumes



Noon Peak Period

Location: ROUTE 4 @ Beaver Creek Rd/Marina
Date: September 2, 1999

Time	NORTH Approach			SOUTH Approach			WEST Approach			EAST Approach			Total	Pedestrians			
Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Volume	N	S	W	E
11:00	35	0	4	1	1	16	2	136	2	13	113	49	372	2	0	1	1
11:15	29	3	5	3	2	26	0	112	1	12	109	55	357	3	1	0	3
11:30	31	0	7	2	2	11	2	145	3	8	109	50	370	1	1	2	2
11:45	27	0	5	5	2	20	4	128	1	11	99	48	350 *	0	0	0	0
12:00	30	2	2	1	5	18	2	155	1	10	136	44	406 +	1	0	0	3
12:15	28	0	3	4	3	14	4	127	3	6	122	45	359 *	1	1	0	2
12:30	34	0	1	3	2	15	5	139	4	7	137	39	386 *	0	0	0	1
12:45	24	1	3	2	1	19	3	136	0	4	114	36	343	2	0	0	1
Total	238	6	30	21	18	139	22	1078	15	71	939	366	2943	10	3	3	13
Pk Hr	119	2	11	13	12	67	15	549	9	34	494	176	1501 *	2	1	0	6
15x4	120	8	8	4	20	72	8	620	4	40	544	176	1624 +	4	0	0	12
Avg Hr	119	3	15	10.5	9	69.5	11	539	7.5	35.5	469.5	183	1471.5	5	1.5	1.5	6.5

Peak Hour	11:45
Peak 15min	12:00
North Leg PHF	0.97
South Leg PHF	0.96
West Leg PHF	0.91
East Leg PHF	0.93

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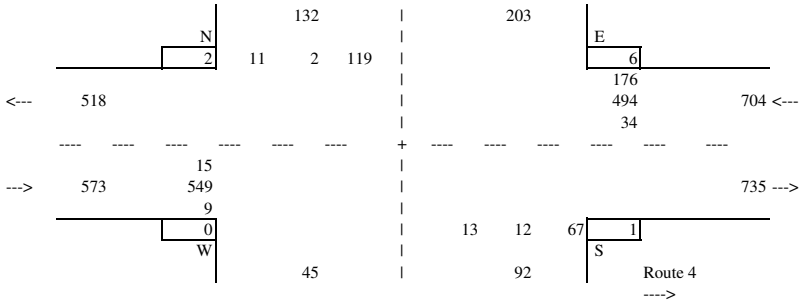
Noon Peak Hour Volumes



PM Peak Period

Location: ROUTE 4 @ Beaver Creek Rd/Marina
Date: September 2, 1999

Time	NORTH Approach			SOUTH Approach			WEST Approach			EAST Approach			Total	Pedestrians			
Period	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Volume	N	S	W	E
15:00	36	0	7	1	4	13	4	115	2	7	154	71	414	1	0	1	1
15:15	24	0	4	4	1	13	4	140	0	11	133	72	406	1	0	1	0
15:30	47	0	2	1	3	4	7	125	2	5	126	46	368	2	0	1	1
15:45	37	1	7	0	11	1	3	119	0	9	136	52	376	0	0	1	0
16:00	51	0	6	0	1	10	4	139	0	9	147	69	436	0	1	0	1
16:15	33	0	3	0	0	13	5	104	0	5	159	53	375	3	2	0	3
16:30	39	0	4	1	2	8	3	117	2	10	157	87	430 *	3	0	0	3
16:45	42	0	1	1	2	10	4	130	0	12	159	73	434 +	2	0	0	2
17:00	31	0	7	1	4	18	4	123	2	8	156	75	429 *	0	0	0	0
17:15	42	2	5	1	3	9	6	137	1	8	143	50	407 *	2	0	1	3
17:30	23	0	4	0	1	5	3	99	0	10	137	70	352	3	0	0	1
17:45	38	1	7	0	1	4	4	92	1	12	106	36	302	1	0	0	2
Total	443	4	57	10	33	108	51	1440	10	106	1713	754	4729	18	3	5	17
Pk Hr	154	2	17	4	11	45	17	507	5	38	615	285	1700 *	7	0	1	8
15x4	168	0	4	4	8	40	16	520	0	48	636	292	1736 +	8	0	0	8
Avg Hr	147.7	1.333	19	3.333	11	36	17	480	3.333	35.33	571	251.3	1576.3	6	1	1.667	5.667

Peak Hour	16:30
Peak 15min	16:45
North Leg PHF	1.01
South Leg PHF	1.15
West Leg PHF	0.99
East Leg PHF	0.96

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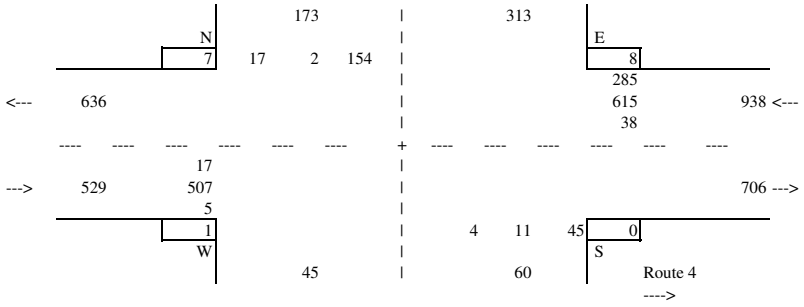
PM Peak Hour Volumes

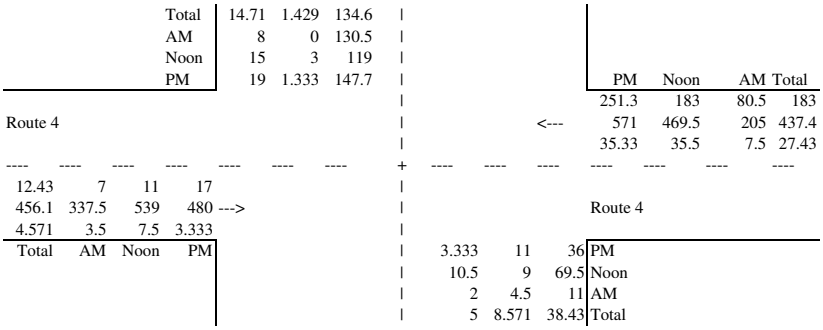


Average Hour Period

Location: ROUTE 4 @ Beaver Creek Rd/Marina
September 2, 1999

	NORTH Approach			SOUTH Approach			WEST Approach			EAST Approach			Total	Pedestrians			
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Volume	N	S	W	E
Survey																	
Total	942	10	103	35	60	269	87	3193	32	192	3062	1281	9266	30	6	12	33
Hours	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Avg Hr	134.6	1.429	14.71	5	8.571	38.43	12.43	456.1	4.571	27.43	437.4	183	1323.7	4.286	0.857	1.714	4.714
AM Period																	
Total	261	0	16	4	9	22	14	675	7	15	410	161	1594	2	0	4	3
Hours	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Avg Hr	130.5	0	8	2	4.5	11	7	337.5	3.5	7.5	205	80.5	797	1	0	2	1.5
Noon Period																	
Total	238	6	30	21	18	139	22	1078	15	71	939	366	2943	10	3	3	13
Hours	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Avg Hr	119	3	15	10.5	9	69.5	11	539	7.5	35.5	469.5	183	1471.5	5	1.5	1.5	6.5
PM Period																	
Total	443	4	57	10	33	108	51	1440	10	106	1713	754	4729	18	3	5	17
Hours	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Avg Hr	147.7	1.333	19	3.333	11	36	17	480	3.333	35.33	571	251.3	1576.3	6	1	1.667	5.667

Average Hour Volumes

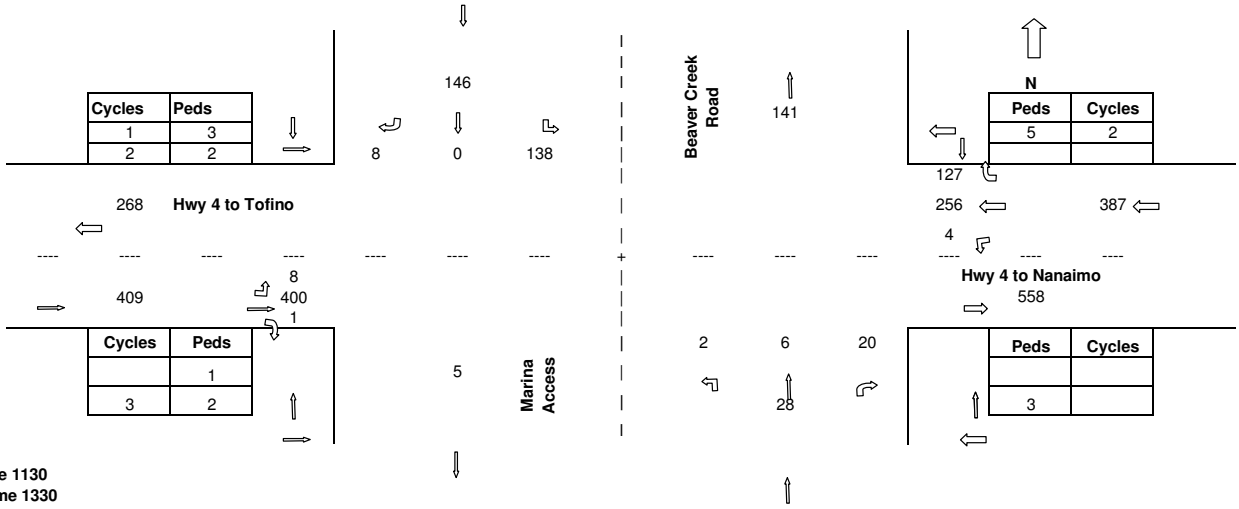


Date August 10, 2005
Day Wedn Tuesday
Weather Si Cloudy
Road Conc Dry
Location: Hwy 4 at Beaver Creek Road, Port Alberni

AM PEAK **Start Time 0700** **Finish Time 0900**

	Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Highway 4 to Tofino					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cyclists**
0700	0	0	2	0	43	0	28	0	2	1	27	14	**117**	0	2
0715	1	1	2	2	75	0	26	1	2	1	37	21	**169**	0	1
0730	1	0	2	0	99	0	36	0	1	1	48	17	**205**	4	2
0745	1	3	3	0	90	1	37	1	1	1	49	22	**209**	2	2
0800	1	2	3	0	88	0	32	0	2	0	60	23	**211**	3	0
0815	1	1	8	3	87	0	41	0	2	0	62	43	**248**	0	1
0830	0	2	5	4	100	0	33	0	3	3	62	31	**243**	3	0
0845	0	1	4	1	125	1	32	0	1	1	72	30	**268**	4	0
AM PEAK	**2**	**6**	**20**	**8**	**400**	**1**	**138**	**0**	**8**	**4**	**256**	**127**	**970**	**10**	**1**

AM Peak

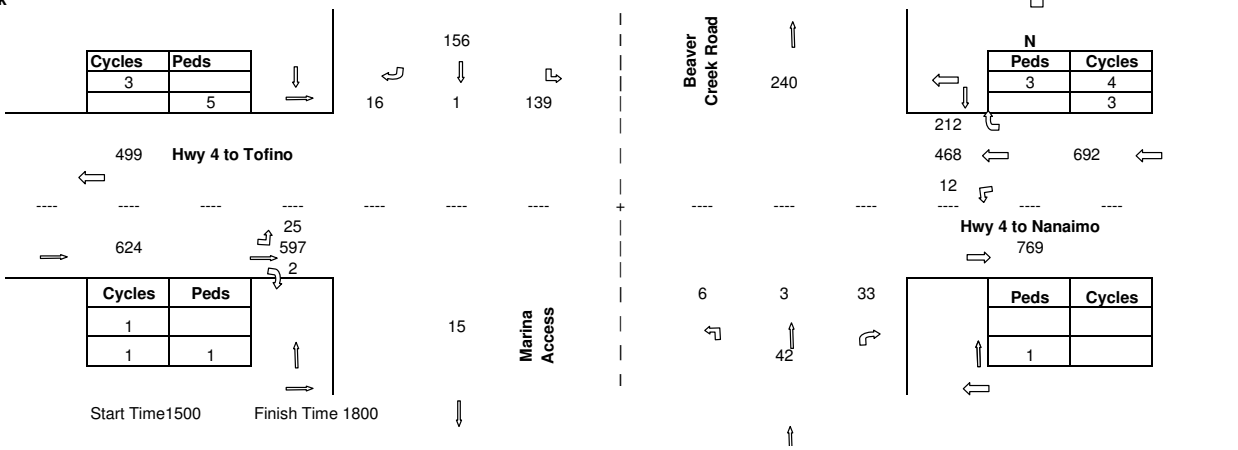


Start Time 1130
Finish Time 1330

NOON PEAK

	Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cycles**
1130	1	0	18	4	105	3	38	1	5	2	135	50	362	4	1
1145	1	0	11	4	155	0	21	2	4	6	105	38	347	2	5
1200	0	1	9	9	176	0	30	0	3	2	128	61	419	2	0
1215	1	0	4	7	148	0	40	0	1	0	113	44	358	3	3
1230	2	1	9	4	127	1	33	0	7	4	115	55	358	4	2
1245	3	1	11	5	146	1	36	1	5	6	112	52	379	3	1
1300	1	2	16	4	133	0	16	0	7	3	134	59	375	1	0
1315	0	1	18	2	140	0	31	0	4	6	124	51	377	4	0
NOON PEA	**6**	**3**	**33**	**25**	**597**	**2**	**139**	**1**	**16**	**12**	**468**	**212**	**1514**	**12**	**6**

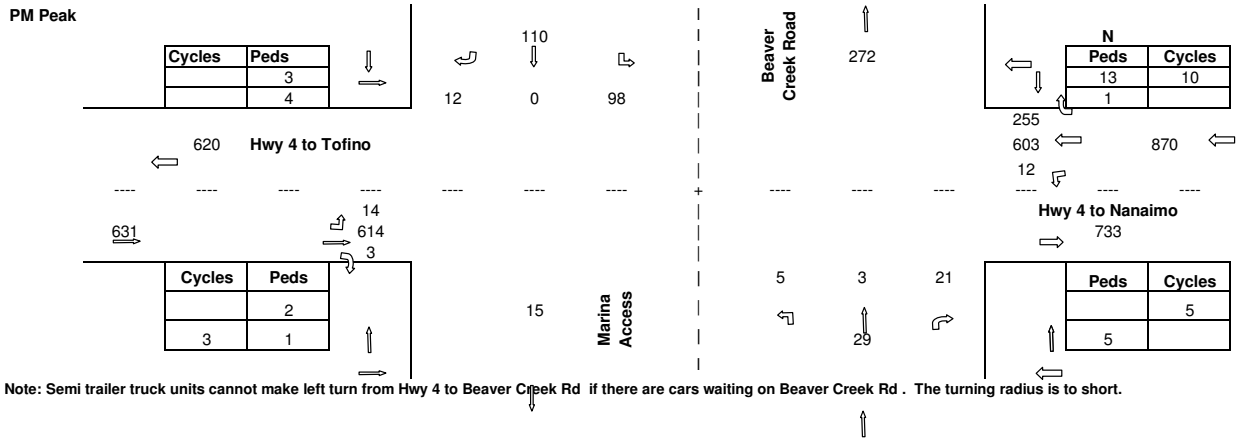
Noon Peak



PM Peak Start Time1500 Finish Time 1800

	Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cycles**
1500	1	0	3	7	152	5	37	0	3	4	146	57	**415**	1	2
1515	1	0	7	4	160	0	21	2	4	1	133	55	**388**	2	1
1530	3	1	7	4	139	1	24	1	4	3	134	65	**386**	2	0
1545	2	0	8	6	146	1	17	0	3	4	157	62	**406**	1	0
1600	0	2	5	4	150	1	35	0	3	1	158	59	**418**	2	0
1615	1	0	5	0	173	1	24	0	3	1	122	66	**396**	3	6
1630	2	1	3	4	145	0	22	0	3	6	166	68	**420**	5	3
1645	2	0	7	8	138	2	27	1	2	4	122	68	**381**	3	2
1700	2	0	4	4	116	0	36	0	8	2	135	73	**380**	3	2
1715	1	0	2	4	111	1	27	1	0	4	111	59	**321**	0	1
1730	1	0	5	3	105	0	21	0	4	1	89	58	**287**	6	1
1745	1	0	2	4	135	0	20	1	1	1	101	58	**324**	0	0
PM Peak	**5**	**3**	**21**	**14**	**614**	**3**	**98**	**0**	**12**	**12**	**603**	**255**	**1[illegible]0**	**11**	**9**

PM Peak



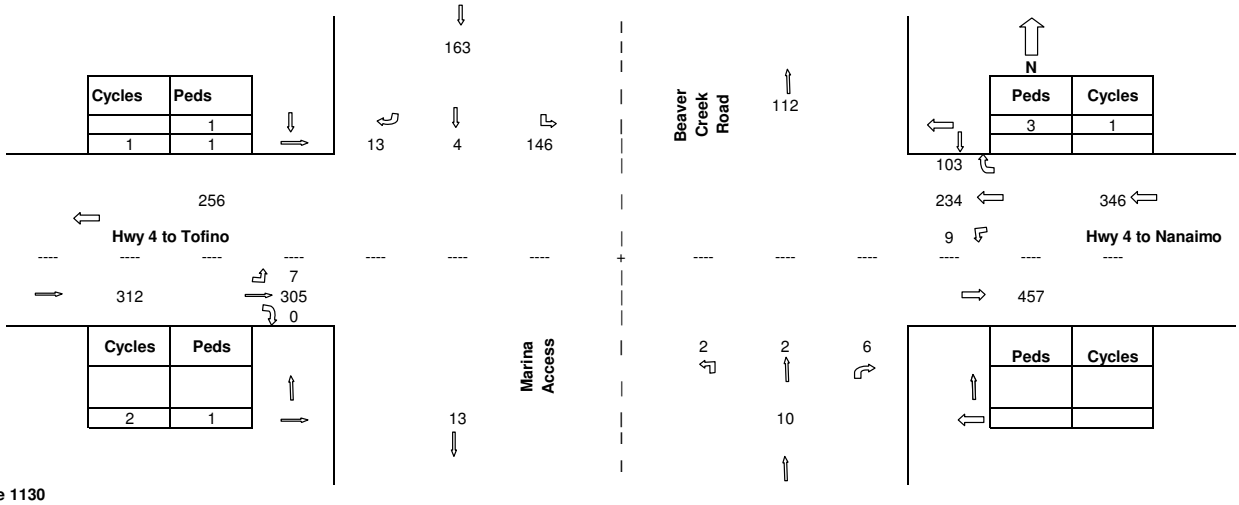
Note: Semi trailer truck units cannot make left turn from Hwy 4 to Beaver Creek Rd if there are cars waiting on Beaver Creek Rd . The turning radius is to short.

Date August 22, 2006
Day of Week: Tuesday
Weather Sunny
Road Condition Dry
Location: Hwy 4 at Beaver Creek Road, Port Alberni
Start Time 0700
Finish Time 0900

AM PEAK

	Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Highway 4 to Tofino					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cyclists**
0700	0	1	1	1	44	0	22	1	4	0	47	13	**134**		
0715	1	1	0	0	54	0	19	1	2	0	28	16	**122**		
0730	0	1	2	3	75	1	35	0	0	2	33	20	**172**		
0745	1	0	1	1	106	0	41	1	4	5	72	22	**254**		
0800	0	0	4	0	4	0	29	0	3	0	48	27	**115**		
0815	0	1	1	2	105	0	42	2	1	2	50	34	**240**		
0830	1	1	0	4	90	0	34	1	5	2	64	20	**222**		
0845	2	0	3	3	99	0	30	1	0	7	79	29	**253**		
AM PEAK	**2**	**2**	**6**	**7**	**305**	**0**	**146**	**4**	**13**	**9**	**234**	**103**	**831**	**0**	**0**

AM Peak

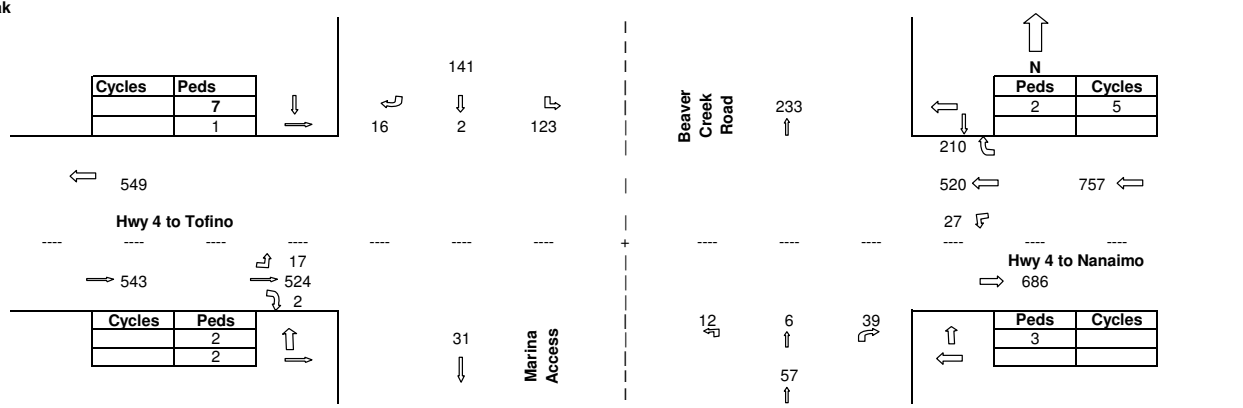


Start Time 1130
Finish Time 1330

NOON PEAK

	Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cycles**
1130	1	3	9	4	139	0	24	1	7	8	116	43	355		
1145	2	1	12	5	124	1	29	0	1	7	145	61	388		
1200	4	1	11	0	134	1	42	0	4	6	139	60	402		
1215	5	1	7	8	127	0	28	1	4	6	120	46	353		
1230	0	1	3	7	91	3	27	0	1	2	124	45	304		
1245	4	2	5	7	107	0	24	0	4	7	155	45	360		
1300	6	2	6	7	127	0	44	0	3	4	154	46	399		
1315	1	1	6	3	3	3	19	0	5	3	128	37	209		
NOON PEAK	**12**	**6**	**39**	**17**	**524**	**2**	**123**	**2**	**16**	**27**	**520**	**210**	**1498**	**0**	**0**

Noon Peak

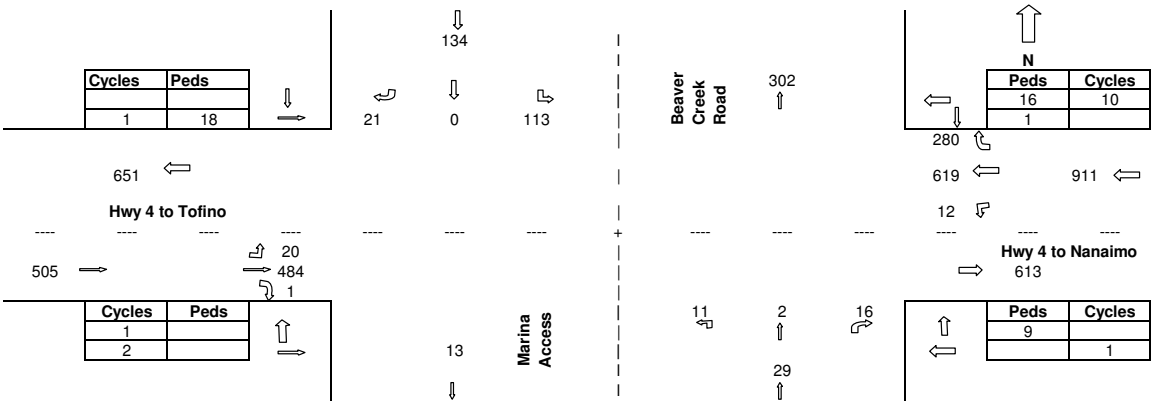


Start Time1500
Finish Time 1800

PM Peak

	Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cycles**
1500	2	2	11	0	126	2	29	0	3	5	146	41	**367**		
1515	2	0	6	6	119	0	31	0	8	4	130	63	**369**		
1530	2	2	2	1	97	2	22	0	2	3	145	70	**348**		
1545	1	0	4	7	132	1	32	0	5	4	142	67	**395**		
1600	2	1	6	7	120	0	30	0	3	1	136	65	**371**		
1615	3	1	4	5	89	0	25	0	7	4	162	75	**375**		
1630	2	0	3	2	144	1	28	0	9	1	155	72	**417**		
1645	4	0	3	6	131	0	30	0	2	6	166	68	**416**		
1700	6	0	2	5	112	2	26	1	3	1	146	67	**371**		
1715	5	1	5	4	100	0	28	0	5	5	121	53	**327**		
1730	5	1	8	6	82	2	26	1	4	6	107	53	**301**		
1745	2	1	3	5	82	1	22	0	3	2	99	49	**269**		
PM Peak	**11**	**2**	**16**	**20**	**484**	**1**	**113**	**0**	**21**	**12**	**619**	**280**	**1579**	**0**	**0**

PM Peak



Note: Semi trailer truck units cannot make left turn from Hwy 4 to Beaver Creek Rd if there are cars waiting on Beaver Creek Rd . The turning radius is to short.

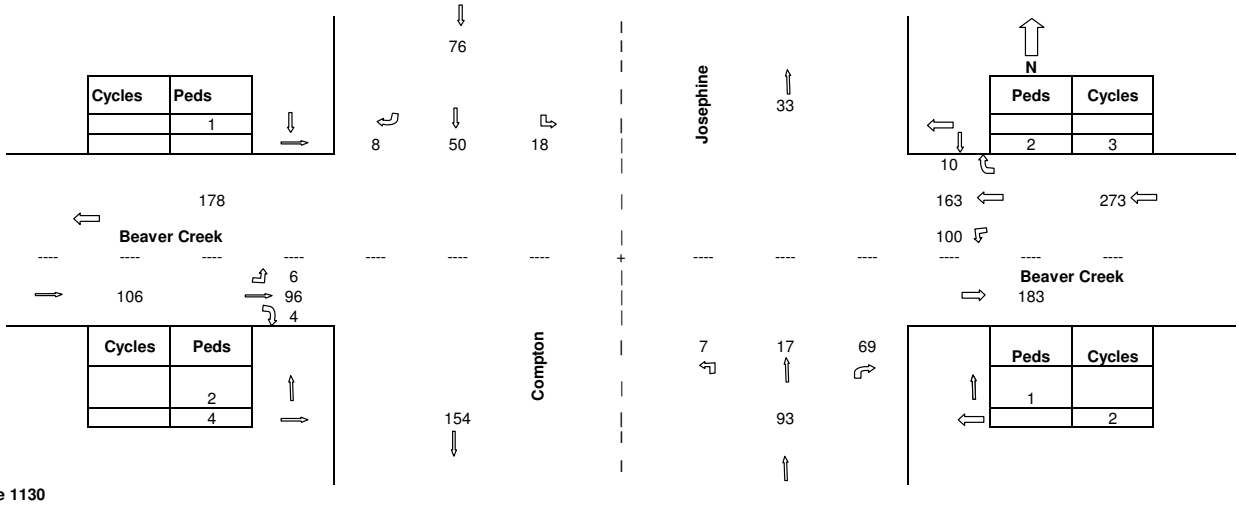
Date October 24, 2006
Day of Week: Tuesday
Weather Cloudy with Sunny Breaks in the Afternoon
Road Condition Wet in the morning drying out about noon
Location: Beaver Creek Road at intersection with Compton Road and Josephine Street, Port Alberni

Start Time 0700
Finish Time 0900

AM PEAK

	Compton Road			Beaver Creek Road			Josephine Street			Beaver Creek Road					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cyclists**
0700	1	1	2	0	4	1	2	1	1	9	18	1	**41**	0	0
0715	0	7	5	1	13	0	1	2	2	10	30	0	**71**	0	0
0730	1	2	1	0	16	1	0	2	0	12	35	0	**70**	0	0
0745	0	1	11	0	19	1	0	4	2	29	43	0	**110**	1	1
0800	0	1	6	1	17	1	3	7	1	19	27	3	**86**	0	3
0815	0	5	12	2	21	0	1	10	3	35	36	2	**127**	6	1
0830	2	4	23	3	30	1	6	22	1	37	48	2	**179**	2	0
0845	5	7	28	0	28	2	8	11	3	9	52	3	**156**	1	0
TOTAL	**7**	**17**	**69**	**6**	**96**	**4**	**18**	**50**	**8**	**100**	**163**	**10**	**548**	**10**	**5**

AM Peak

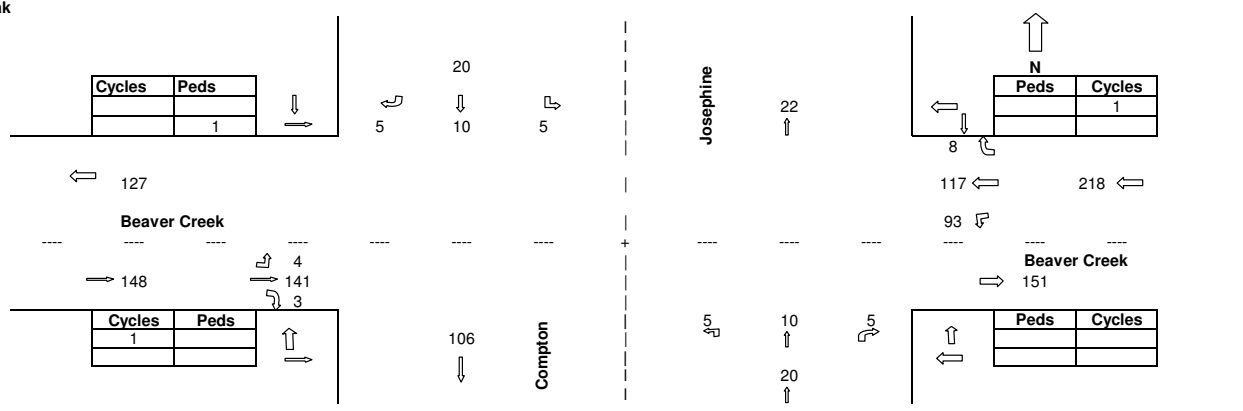


Start Time 1130
Finish Time 1330

NOON PEAK

	Compton Road			Beaver Creek Road			Josephine Street			Beaver Creek Road					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cycles**
1130	1	3	19	1	33	1	0	1	3	15	15	2	94	0	0
1145	0	3	13	1	33	1	1	3	1	25	19	2	102	0	0
1200	2	4	13	1	39	2	1	4	1	33	23	0	123	0	2
1215	1	2	16	3	32	0	0	0	1	18	28	1	102	1	0
1230	2	1	9	1	29	0	1	4	4	16	32	3	102	0	0
1245	1	4	8	2	24	0	0	4	0	29	39	1	112	0	0
1300	1	3	18	1	40	1	0	0	1	26	22	1	114	0	0
1315	1	4	18	0	48	2	4	2	0	22	24	3	128	0	0
TOTAL	**5**	**12**	**53**	**4**	**141**	**3**	**5**	**10**	**5**	**93**	**117**	**8**	**456**	**1**	**2**

Noon Peak

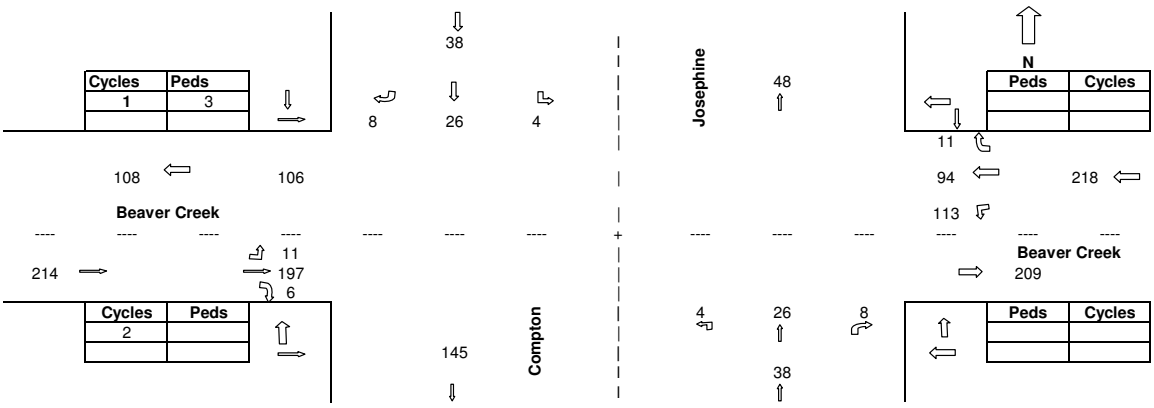


Start Time1500
Finish Time 1800

PM Peak

	Compton Road			Beaver Creek Road			Josephine Street			Beaver Creek Road					
Time	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Peds**	**Cycles**
1530	0	7	27	3	60	3	0	3	0	13	24	1	**141**	0	0
1545	2	3	23	0	45	3	4	3	0	27	17	1	**128**	0	0
1600	0	11	19	3	42	1	0	7	5	23	25	4	**140**	1	1
1615	1	3	20	3	52	3	2	9	0	30	18	5	**146**	0	0
1630	4	3	20	3	48	1	0	4	3	29	24	0	**139**	0	0
1645	1	5	18	2	55	1	2	6	0	31	27	2	**150**	2	0
1700	1	5	18	1	59	0	2	4	1	23	17	1	**132**	0	2
1715	2	6	20	1	39	1	1	4	1	25	22	3	**125**	0	0
TOTAL	**6**	**22**	**77**	**11**	**197**	**6**	**4**	**26**	**8**	**113**	**94**	**11**	**575**	**3**	**3**

PM Peak



Note: Compton Road and Josephine Street are offset intersections with about 6 metres between the end of the constructed road of Josephine and the beginning beginning of Compton Road with Compton being easterly of Josephine.

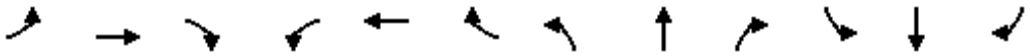
Traffic Volume Summary
Traffic Growth

		Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino				
	AM	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	**Growth**
2-Sep-99	1999	2	6	16	11	376	6	127	0	7	9	250	104	914	
10-Aug-05	2005	2	6	20	8	400	1	138	0	8	4	256	127	970	101.0% per year
22-Aug-06	2006	2	2	6	7	305	0	146	4	13	9	234	103	831	85.7%

		Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino				
	Noon	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	
2-Sep-99	1999	13	12	67	15	549	9	119	2	11	34	494	176	1501	
10-Aug-05	2005	6	3	33	25	597	2	139	1	16	12	468	212	1514	100.1% per year
22-Aug-06	2006	12	6	39	17	524	2	123	2	16	27	520	210	1498	98.9%

		Marina			Hwy 4 to Nanaimo			Beaver Creek Road			Hwy 4 to Tofino				
	PM	**NBL**	**NBT**	**NBR**	**EBL**	**EBT**	**EBR**	**SBL**	**SBT**	**SBR**	**WBL**	**WBT**	**WBR**	**Total**	
2-Sep-99	1999	4	11	45	17	507	5	154	2	17	38	615	285	1700	
10-Aug-05	2005	5	3	21	14	614	3	98	0	12	12	603	255	1640	99.4% per year
22-Aug-06	2006	11	2	16	20	484	1	113	0	21	12	619	280	1579	96.3%

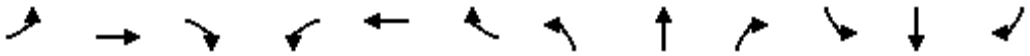
Average Growth 99-05	100.2%
Average Growth 05-06	93.6%



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	7	305	0	9	234	103	2	2	6	146	4	13
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	332	0	10	254	112	2	2	7	159	4	14
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	254			332			637	621	332	628	621	254
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	254			332			637	621	332	628	621	254
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			99			99	99	99	59	99	98
cM capacity (veh/h)	1311			1228			376	398	710	386	398	784

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	8	332	10	254	112	11	177
Volume Left	8	0	10	0	0	2	159
Volume Right	0	0	0	0	112	7	14
cSH	1311	1700	1228	1700	1700	532	403
Volume to Capacity	0.01	0.20	0.01	0.15	0.07	0.02	0.44
Queue Length 95th (m)	0.1	0.0	0.2	0.0	0.0	0.5	16.6
Control Delay (s)	7.8	0.0	8.0	0.0	0.0	11.9	20.8
Lane LOS	A		A			B	C
Approach Delay (s)	0.2		0.2			11.9	20.8
Approach LOS						B	C

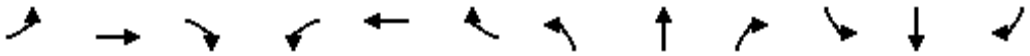
Intersection Summary				
Average Delay	4.4			
Intersection Capacity Utilization	38.5%	ICU Level of Service		A
Analysis Period (min)	15			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	17	524	2	27	520	210	12	6	39	123	2	16
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	18	570	2	29	565	228	13	7	42	134	2	17
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	565			572			1250	1232	571	1276	1233	565
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	565			572			1250	1232	571	1276	1233	565
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			97			91	96	92	0	99	97
cM capacity (veh/h)	1007			1001			138	169	521	123	169	524

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	18	572	29	565	228	62	153
Volume Left	18	0	29	0	0	13	134
Volume Right	0	2	0	0	228	42	17
cSH	1007	1700	1001	1700	1700	289	136
Volume to Capacity	0.02	0.34	0.03	0.33	0.13	0.21	1.13
Queue Length 95th (m)	0.4	0.0	0.7	0.0	0.0	6.1	66.6
Control Delay (s)	8.6	0.0	8.7	0.0	0.0	20.8	180.5
Lane LOS	A		A			C	F
Approach Delay (s)	0.3		0.3			20.8	180.5
Approach LOS						C	F

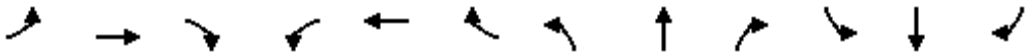
Intersection Summary			
Average Delay	18.0		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	20	484	1	12	619	280	11	2	16	113	0	21
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	526	1	13	673	304	12	2	17	123	0	23
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	673			527			1292	1269	527	1287	1270	673
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	673			527			1292	1269	527	1287	1270	673
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			99			91	99	97	7	100	95
cM capacity (veh/h)	918			1040			129	162	551	132	162	455

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	22	527	13	673	304	32	146
Volume Left	22	0	13	0	0	12	123
Volume Right	0	1	0	0	304	17	23
cSH	918	1700	1040	1700	1700	229	148
Volume to Capacity	0.02	0.31	0.01	0.40	0.18	0.14	0.98
Queue Length 95th (m)	0.6	0.0	0.3	0.0	0.0	3.6	55.1
Control Delay (s)	9.0	0.0	8.5	0.0	0.0	23.2	129.6
Lane LOS	A		A			C	F
Approach Delay (s)	0.4		0.1			23.2	129.6
Approach LOS						C	F

Intersection Summary				
Average Delay	11.6			
Intersection Capacity Utilization	53.5%	ICU Level of Service		A
Analysis Period (min)	15			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	20	0	0	0	619	280	0	0	0	113	0	21
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	22	0	0	0	673	304	0	0	0	123	0	23
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	673			0			739	716	0	716	716	673
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	673			0			739	716	0	716	716	673
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			100			100	100	100	64	100	95
cM capacity (veh/h)	918			1623			311	347	1085	339	347	455

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	22	0	0	673	304	0	146
Volume Left	22	0	0	0	0	0	123
Volume Right	0	0	0	0	304	0	23
cSH	918	1700	1700	1700	1700	1700	353
Volume to Capacity	0.02	0.00	0.00	0.40	0.18	0.00	0.41
Queue Length 95th (m)	0.6	0.0	0.0	0.0	0.0	0.0	14.9
Control Delay (s)	9.0	0.0	0.0	0.0	0.0	0.0	22.2
Lane LOS	A					A	C
Approach Delay (s)	9.0		0.0			0.0	22.2
Approach LOS						A	C

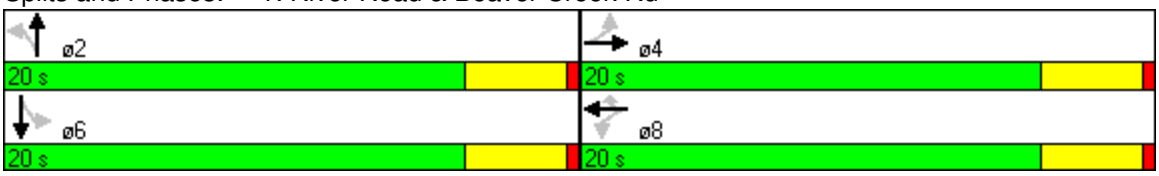
Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	20	484	12	619	280	11	2	113	0
Lane Group Flow (vph)	22	527	13	673	304	0	31	0	146
Turn Type	Perm		Perm		Perm	Perm		Perm	
Protected Phases		4		8			2		6
Permitted Phases	4		8		8	2		6	
Detector Phases	4	4	8	8	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Min	Min	Min	Min
Act Effct Green (s)	16.1	16.1	16.1	16.1	16.1		8.2		8.2
Actuated g/C Ratio	0.50	0.50	0.50	0.50	0.50		0.25		0.25
v/c Ratio	0.09	0.56	0.05	0.72	0.32		0.07		0.39
Control Delay	6.5	9.2	5.8	14.2	2.1		6.3		9.7
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0		0.0
Total Delay	6.5	9.2	5.8	14.2	2.1		6.3		9.7
LOS	A	A	A	B	A		A		A
Approach Delay		9.1		10.4			6.3		9.7
Approach LOS		A		B			A		A
Queue Length 50th (m)	0.5	15.5	0.3	22.1	0.0		0.6		5.1
Queue Length 95th (m)	3.1	40.7	2.0	#74.3	7.3		3.6		13.2
Internal Link Dist (m)		294.2		137.7			33.9		160.3
Turn Bay Length (m)	45.0		30.0		50.0				
Base Capacity (vph)	234	936	277	936	949		647		577
Starvation Cap Reductn	0	0	0	0	0		0		0
Spillback Cap Reductn	0	0	0	0	0		0		0
Storage Cap Reductn	0	0	0	0	0		0		0
Reduced v/c Ratio	0.09	0.56	0.05	0.72	0.32		0.05		0.25

Intersection Summary			
Cycle Length: 40			
Actuated Cycle Length: 32.3			
Natural Cycle: 50			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.72			
Intersection Signal Delay: 9.8		Intersection LOS: A	
Intersection Capacity Utilization 53.5%		ICU Level of Service A	
Analysis Period (min) 15			

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: River Road & Beaver Creek Rd



SIDRA INTERSECTION

Intersection Summary

Single Lane Roundabout

Enter subtitle

Performance Measure	Vehicles	Persons
Demand Flows - Total	1670 veh/h	2004 pers/h
Percent Heavy Vehicles	2.0 %	
Degree of Saturation	0.620	
Effective Intersection Capacity	2691 veh/h	
95% Back of Queue (m)	64 m	
95% Back of Queue (veh)	8.3 veh	
Control Delay (Total)	2.96 veh-h/h	3.55 pers-h/h
Control Delay (Average)	6.4 s/veh	6.4 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	769 veh/h	923 pers/h
Effective Stop Rate	0.46 per veh	0.46 per pers
Proportion Queued	0.34	0.34
Travel Distance (Total)	1053.6 veh-km/h	1264.3 pers-km/h
Travel Distance (Average)	631 m	631 m
Travel Time (Total)	19.8 veh-h/h	23.7 pers-h/h
Travel Time (Average)	42.7 secs	42.7 secs
Travel Speed	53.2 km/h	53.2 km/h
Operating Cost (Total)	340 $/h	340 $/h
Fuel Consumption (Total)	116.5 L/h	
Carbon Dioxide (Total)	291.6 kg/h	
Hydrocarbons (Total)	0.463 kg/h	
Carbon Monoxide (Total)	21.84 kg/h	
NOX (Total)	0.718 kg/h	

SIDRA SOLUTIONS

Site: SingleLaneRb3Legs
C:\Documents and Settings\rdisegni\Desktop\Tempfiles\Roundabout.aap
Processed Mar 13, 2007 11:03:54AM

A1442, CH2M HILL, Medium Office
Produced by SIDRA Intersection 3.1.061208.34

www.sidrasolutions.com

SIDRA INTERSECTION

Movement Summary

Single Lane Roundabout

Enter subtitle

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
WB										
6T	T	673	1.9	0.620	5.0	LOS A	64	0.21	0.38	55.2
6R	R	304	2.0	0.620	4.5	LOS A	64	0.21	0.36	55.7
Approach		**976**	**1.9**	**0.621**	**4.9**	**LOS A**	**64**	**0.21**	**0.38**	**55.3**
SB										
15L	L	123	1.6	0.217	16.2	LOS B	12	0.71	0.84	45.1
12R	R	23	4.3	0.217	12.2	LOS B	12	0.71	0.81	48.1
Approach		**145**	**2.1**	**0.217**	**15.6**	**LOS B**	**12**	**0.71**	**0.84**	**45.5**
EB										
5L	L	22	4.5	0.468	14.7	LOS B	36	0.46	0.66	46.0
2T	T	526	2.1	0.468	6.3	LOS A	36	0.46	0.51	52.5
Approach		**549**	**2.2**	**0.468**	**6.6**	**LOS A**	**36**	**0.46**	**0.51**	**52.2**
All Vehicles		**1670**	**2.0**	**0.620**	**6.4**	**LOS A**	**64**	**0.34**	**0.46**	**53.2**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: SingleLaneRb3Legs
C:\Documents and Settings\rdisegni\Desktop\Tempfiles\Roundabout.aap
Processed Mar 13, 2007 11:03:54AM

2006 Clutesi Haven Launch History

Day of Month	June	July	August	September
1	11	139	27	197
2	23	100	30	157
3	14	71	38	84
4	12	85	90	70
5	10	80	62	50
6	14	84	34	32
7	16	114	28	33
8	16	126	40	36
9	44	96	19	67
10	45	75	41	73
11	25	70	36	94
12	22	63	40	18
13	19	53	60	15
14	41	94	52	8
15	32	99	54	46
16	35	101	60	35
17	42	44	92	16
18	28	48	66	
19	29	50	151	
20	22	75	114	
21	25	80	89	
22	41	65	104	
23	71	46	102	
24	75	37	90	
25	60	31	130	
26	64	37	129	
27	76	30	164	
28	70	56	86	
29	92	36	70	
30	136	26	154	
31		27	120	
Total	**1,210**	**2,111**	**2,252**	**1,031**
Avg Per Day	**40.3**	**68.1**	**72.6**	**60.6**

6604 Season Total to Date

*Note - Launching activity flucuates depending on quality of fishing, weather, and day of the week.
Saturdays and Sundays are typically busiest.
Sept 1-4 represents the Annual Salmon Festival.

Clutesi Launch Activity

Time	Fri, June 30/06	Sat, July 1	Fri, Aug 25	Sat, Aug 26	Fri, Sept 1	Sat, Sept 2
4:00-4:59	18	29	5	15	15	27
5:00-5:59	19	28	42	33	23	41
6:00-6:59	7	25	20	21	21	25
7:00-7:59	5	10	7	6	11	15
8:00-8:59	1	1	5	11	9	8
9:00-9:59	5	4	12	6	10	7
10:00-10:59	3	4	4	2	22	8
11:00-11:59	2	3	6	5	16	6
12:00-12:59	2	6	6	3	7	2
1:00-1:59	3	4	2	6	6	5
2:00-2:59	7	9	3	7	17	2
3:00-3:59	8	6	4	1	8	3
4:00-4:59	3	1	1	4	7	1
5:00-5:59	10	3	4	4	9	2
6:00-6:59	9	2	3	2	10	3
After 7 pm	7	4	5	3	21	2
Totals	109	139	129	129	197	157