SHEDDING EXCESS WIDTH: ESTABLISHING CRITERIA FOR THE SUITABILITY OF CANDIDATE ROAD DIET PROJECTS

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ABSTRACT

A road diet is a reallocation of road space involving a reduction in the number of travel lanes. Remaining existing road space can be used for parking, landscaping, bicycle lanes, pedestrian facilities, or any combination of these. Road dieting generally creates a reduction in vehicle speeds and collisions, and encourages sustainable travel modes.

In determining the safety benefits of road diets for the Insurance Corporation of British Columbia (ICBC), the provincial crown insurer, and whether it may wish to give qualified support to road diet projects that meet identified success factors, Opus International Consultants reviewed academic literature, journal articles, and various stakeholder publications, from which the benefits of, and best practices for implementation of road diets were identified. Benefits identified through the review included: collision and speed reductions; maintenance of capacity; increased safety and comfort for pedestrians and cyclists; other benefits such as low cost of implementation and improved driveway/access safety.

Six recent road diet projects in British Columbia from Coquitlam, Esquimalt, Kamloops, Prince George and Victoria, and corresponding nearby and faraway control sites were also identified. These sites were analyzed using simple Before and After methods, in addition to comparison with faraway controls. Collision reductions were generally observed, reductions of between 23 percent and 78 percent, largely overlapping with the reductions found in the literature of 6 percent to 62 percent. Victoria and Kamloops both experienced an increase in collision rate from the before period to the after period using these methods; however, site-specific issues at these locations may have contributed to the results.

Based on the best practices identified in the literature review, and findings from the six road diet projects, a checklist with eight criteria was developed for potential road diet projects. Sites that meet most of the criteria – existing cross-section, traffic volume, access/driveway density, existing collision types, and others – are expected to be most successful in terms of ease of implementation, maintaining corridor function and improving safety.

1. Background and Objectives

A road diet is a reallocation of road space involving a reduction in the number of travel lanes. A typical road diet entails converting a four-lane undivided roadway to a two-lane roadway with a centre two-way left turn lane (TWLTL). The remaining existing road space can be used for parking, landscaping, bicycle lanes, addition or widening of sidewalks, or a combination of these features.

An illustration of a typical road diet configuration before and after conversion is provided in FIGURE 1.1.

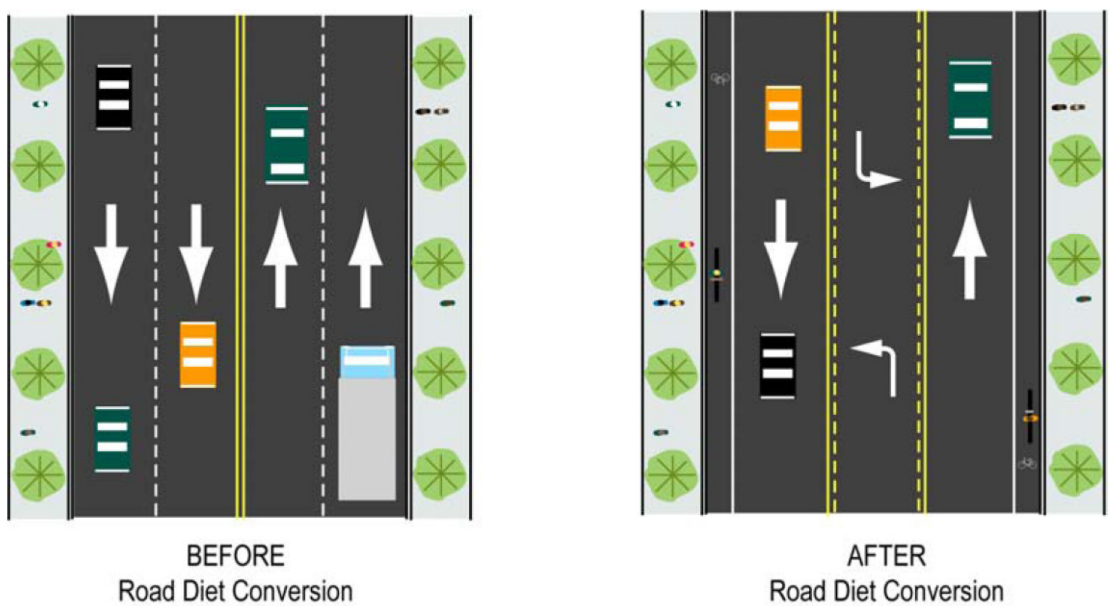

FIGURE 1 EXAMPLE ROAD DIET CONVERSION
(Road Diet Handbook – Overview, Rosales 2006)

This study examined road diets on both an international level through a review of relevant studies and on a local level through an examination of road diets within British Columbia.

The overall study method included a the following tasks:

1. *Literature Review*
2. *Identification of Local Projects in British Columbia*

3. *Compilation of Before / After Data including road layout and crash data*
4. *Identification of Comparison Sites*
5. *Identification of Characteristics of Successful Projects*

Literature Review

The benefits of road diets identified in the literature review include: collision reductions, speed reductions, maintenance of capacity, increased safety and comfort for pedestrians and cyclists, and other benefits such as low cost of implementation and improved driveway / access safety. The collision reductions identified in the literature review are summarized graphically in FIGURE 2.

The studies documented in the literature reviewed reported reductions in total collisions from 6 to 62 percent as shown in using one or more of the following methods of statistical analysis: Before & After, Yoked Comparison, Empirical Bayes and Grouped Comparison. Of the four methods, Empirical-Bayes is considered to be the most robust.

The NCHRP study by Harkey et.al.(4) re-analyzed the data from the Huang and Pawlovich studies using an Empirical Bayes approach, The re-analysis of the Washington/California data indicated a 19 percent decrease in total crashes, rather than 6 percent. These sites were predominantly corridors within suburban areas surrounding larger cities, with an average population of 269,000, with AADT ranging from 6,000 to 17,000. The reanalysis of the Iowa data showed a reduction of 47 percent in total crashes for highway routes (AADT of 4,000 to 14,000) within small urban areas, with an average population of 17,000. If the characteristics of the treated site can be defined on the basis of road and area type (as shown above), these factors should be applied. Otherwise, it was recommended that the aggregate 29 percent reduction be applied.

Based on this review of documented collision reduction factors, it is recommended that a collision reduction factor of 19 to 47 percent be applied for road diet projects. This is the range of factors estimated by those studies using Empirical Bayes method, and also encompasses most studies using the Yoked or Grouped Comparison. Practitioners may wish to choose a collision reduction factor at the higher end of this range for lower volume roads in smaller urban areas, and use the lower end of this range in urban areas with a population greater than 200,000. A collision reduction factor of 57 to 74 percent may be applied to left-turn opposing collisions, based on findings documented by Stout (12). No other collision types had documented collision reductions in more than one study.

Review of Road Diet Projects in British Columbia

Six local projects were used to assist in confirming a BC-specific collision reduction factor. These projects are listed in TABLE 1 as case study sites along with their location, segment length, date of conversion, as well as access and unsignalized intersection densities. Nearby and faraway control sites are provided for each study location, and are identified through corresponding reference numbers. Control sites were identified for each case study site through the following criteria:

- similar laning to the pre-conversion case study site based on aerial images;
- proximity to the case study site (as close as possible for nearby controls and on the other side of the city for faraway controls);
- similar land use and similar unsignalized intersection and access densities (67 percent of control sites were within 55 percent of the study site total unsignalized intersection and access density); and,
- similar segment length (75 percent of control sites were within 50 percent of the case study segment length).

Factors such as weather and driver/population characteristics also need to be comparable; therefore the control sites are from the same or adjacent municipality.

Available data was provided by the municipalities and ICBC case study sites and their corresponding comparison sites. The control sites were originally intended to serve two purposes:

1) To determine if road dieting displaces traffic onto nearby streets
2) To use in analysis to account for changes in changes external to road diets.

Data collected included the following:

- Time period
- Laning
- Presence / absence of a median, centre two-way left turn lane and bicycle lanes
- Availability of on-street parking
- Traffic volumes (based on best available information from municipal websites)

Many municipalities collect traffic volumes infrequently or as needed. In many cases, traffic volumes were not available that would be truly representative of either the before or after implementation period. For example, for site C-5, Summit Drive in Kamloops, the pre-implementation volumes are from 1997, seven years before the road diet was constructed in 2004. No post-implementation traffic volumes were available, so data from 2004 was used. Traffic volumes in 2004 may very well have been affected by the road diet construction project itself. Therefore, in general, there was insufficient data around the time of conversion to confirm if traffic was displaced by the road diet project.

Where possible, at least 3 years of pre- and post-implementation collision data were obtained. Exceptions are for the 1998 conversions, for which only 1996 and 1997 data was obtained for the pre-conversion period and for 2005 – 2006 conversions as data could only be obtained up to and including 2008. It is also important to note that while 1996 data is available, it is generally considered to be less robust than the most recent data as ICBC only commenced collecting collision data midway through 1996.

Results

A preliminary review was conducted of the available sites. This data was analyzed using a simple Before and After percent difference comparison. In order to compensate for the different segment lengths and length of time for which data was obtained, the collisions were normalized for these factors before comparison. A simple before and after analysis was conducted for total annual collisions per kilometre for the six study sites. The percent reductions were plotted against traffic volume as shown in FIGURE 3, and are also summarized in TABLE 1.

It can be seen that the findings generally support the findings of the literature review. The sites in Esquimalt, Prince George and Coquitlam all had collision reductions of 31 percent to 47 percent, within the range of 19 to 47 percent that we are recommending. The Victoria site only achieved a 2 percent reduction using simple before and after, but the Victoria site had traffic volumes in the range of 21,000 vehicles per day, outside of the recommended upper limit of up to 20,000 vehicles per day. The Kamloops site did not experience a reduction; it experienced an increase of 20 percent, for reasons that are uncertain. Conversations with Kamloops staff indicated that the area in the vicinity of the road diet site had experienced more significant growth in development than other parts of the city, which may have resulted in increased traffic volumes and contributed to increases in collisions. This growth cannot be confirmed, due to the lack of traffic volume data. Nevertheless, with such a small sample size and time period of data, it is unsurprising to find an outlier.

In order to account for changes which may effect collisions within the municipality (for example increasing driver education) total collisions per year per kilometre for each study segment were also normalized for volume and then compared to the faraway control sites.

While collision reductions were experienced at both the road diet and the control sites, the reductions at the road diet sites were generally larger. The average reduction in total collisions for the study sites was found to be 40 percent whereas an average reduction of 13 percent was observed across the control sites. It should also be noted that the average reduction in injury and fatal collisions for the study sites was about 42 percent, compared to 9 percent at the control sites.

Assuming the same external factors causing the change in collision rate in the faraway controls effect the study sites in the same way, the “predicted” collision rate for the study site without the road diet can be determined by applying the percent difference obtained from the faraway controls. It is then assumed that the remaining percent change in collision rate is due to the implementation of the road diet. The result of this analysis is summarized in FIGURE 4. Similar to the results using the simple before and after, both Victoria and Kamloops still experience an increase in collision rate from the before period to the after period using these methods. As discussed previously, this result is affected by the lack of contemporaneous traffic volume data to correctly calculate the collision rate. Where collision reductions are observed, the reduction is between 23 and 78, largely overlapping with the reductions found in the literature of 6 to 62.

A more detailed review of the collision data, beyond the scope of this study, would be required to fully understand the reasons for the collision increases in Victoria and Kamloops.

Best Practices

The literature findings related to the recommended best practices of implementing road diet projects is summarized below:

- Look for easy conversions first. If possible, coordinate a 4-3 lane conversion (road diet) project with concurrent pavement overlay projects., Cost and time savings for municipality and residents. Residents are more likely to accept road lane changes safely on a newly resurfaced road, which results in less driver confusion. (1,2,8)
- Look for roads with safety issues that may respond to road dieting such as high correctible crash frequencies / high left turning volumes, Road diets are proven to reduce crash rates. The centre TWLTL removes the left-turning vehicles from the through traffic, making the road safer and more efficient.
- Cyclists find four-lane roads too narrow to ride comfortably and 4-3 road diets yield extra width for bicycle lanes; the reduction in speed along the road way may also contribute to heightened safety. (Multiple sources)
- Hold public open house discussions to gain input from a variety of people., In the past, planners have faced opposition to 4-3 lane conversions because local residents fear heightened congestion as a result of less overall lanes along the corridor; allowing for education and input gives understanding and ownership of the results to the stakeholders.(1,2,8)
- First project sites should have moderate traffic volumes (8-15,000 ADT). , This allows local drivers the opportunity to experience the advantage of the road diet in moderate traffic conditions. (1,2,3,12)
- Upper comfort range appears to be approximately 20,000 ADT., Although higher volume roads have successfully been dieted, this is the general traffic volume threshold that allows the same level of service to be maintained with no significant increase in delay or diversion of traffic onto nearby streets. (1,2,13)
- Post speed limits not exceeding 60 kph.
- Following road dieting, signal timings should be updated. For example, a left turn protected phase can be considered. (8)
- Check for consistency with adjacent road segments, sidewalk connectivity, and bike lane connectivity. Pedestrian and cyclist facilities will be more likely to be used when part of a larger continuous network. Even if cycle lanes are provided on one street, if the connecting streets are difficult for cyclists to use, the lanes will not be utilized. (2)Access Density should be in the range of about 30 to 50 access points per km (2,3)
- Lack of On Street Parking: If the curb-lane parking must be removed to accommodate the road diet, the project may face opposition from residents. (Opus International project experience)

- Lack of left turn lanes at intersections: If the municipality has already widened the roadway at intersections to provide left turn lanes, the collision reduction benefits may be less significant. Additionally, there will be extra pavement width at the intersection to reduce from 5 to 3 lanes. (Opus International project experience)

Conclusions

Six road diet projects in British Columbia from Coquitlam, Esquimalt, Kamloops, Prince George and Victoria and corresponding nearby and faraway control sites were identified. These sites were analyzed using simple Before and After methods, in addition to comparison with faraway controls. Collision reductions were generally observed, reductions of between 23 percent and 78 percent, largely overlapping with the reductions found in the literature of 6 percent to 62 percent. Victoria and Kamloops both experienced an increase in collision rate from the before period to the after period using these methods; however, site-specific issues at these locations may have contributed to the results.

Based on the best practices identified in the literature review, a checklist was developed for potential Road Diet projects, shown in TABLE 2. Sites that meet most of the criteria are expected to be most successful in terms of ease of implementation, maintaining corridor function and improving safety.

When road diets are implemented at suitable locations they can have desirable reductions in speed, improving safety and community liveability, at minimal cost. Based on the results of the literature review, Road Diets have been shown to provide significant collision reduction benefits. ICBC may wish to invest in road diets projects put forward by municipalities.

When evaluating potential investments, ICBC should consider the identified success factors, including:

- Coordinating road diet implementation with road repaving;
- Targeting locations with high left-turning volumes and high correctible collision frequencies;
- Setting an upper limit of 20,000 vehicles per day; and,
- Consistency throughout the road network and sidewalk and bicycle network connectivity.

One local project in Victoria that had traffic volumes that exceeded the recommended range experienced only a nominal reduction in collisions. One project in Kamloops showed an increase in collisions, for reasons that are unclear, but may be related to growth in development which cannot be confirmed due to a lack of traffic volumes. Due to the small sample of projects, and lack of appropriate volume data Empirical-Bayes analysis was not conducted.

Based on the results of this preliminary analysis into the benefits of road diets, ICBC may wish to give qualified support to road diet projects that meet the identified success factors.

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TABLES and FIGURES

TABLE 1 ANNUAL COLLISION TOTALS PER KILOMETRE

REFERENCE NUMBER	LOCATION	PRE-IMPLEMENTATION				POST-IMPLEMENTATION				% CHANGE: TOTAL COLLISIONS /YR/KM
		COLLISION PERIOD	TOTAL ANNUAL INJURY/ FATAL COLLISIONS	TOTAL ANNUAL PDO COLLISIONS	TOTAL ANNUAL COLLISIONS	COLLISION PERIOD	TOTAL ANNUAL INJURY/ FATAL COLLISIONS	TOTAL ANNUAL PDO COLLISIONS	TOTAL ANNUAL COLLISIONS	
C-3	Coquitlam	2001 - 2003	22.64	20.64	43.28	2007 - 2008	9.46	13.33	22.79	**-47%**
C-4	Esquimalt	1996 - 1997	16.00	30.00	46.00	1999-2001	11.11	20.44	31.56	**-31%**
C-5	Kamloops	2001-2003	6.52	3.26	9.78	2005-2007	5.54	6.19	11.73	20%
C-6	Prince George (Westwood)	1999-2003	2.12	6.59	8.71	2005 - 2008	1.18	3.53	4.71	**-46%**
C-7	Prince George (Tabor)	1996 - 1997	6.00	12.00	18.00	1999-2001	5.67	6.33	12.00	**-33%**
C-15	Victoria	2001 - 2003	14.31	14.82	29.13	2007 - 2008	13.03	15.59	28.62	**-2%**
N-3	Coquitlam	2001 - 2003	17.24	28.10	45.34	2007-2008	14.85	29.21	44.06	**-3%**
N-4	Esquimalt	1996 - 1997	15.24	22.86	38.10	1999-2001	23.49	29.84	53.33	40%
N-5	Kamloops	2001-2003	3.41	3.41	6.82	2005-2007	2.92	5.36	8.28	21%
N-6	Prince George	1999 - 2003	5.99	5.99	11.97	2005 - 2008	4.36	9.35	13.72	15%
N-7	Prince George	1996 - 1997	8.57	26.67	35.24	1999-2001	8.25	16.51	24.76	**-30%**
N-15	Victoria	2001 - 2005	42.27	72.69	114.96	2007 - 2008	45.62	68.43	114.05	**-1%**
F-3	Coquitlam	2001 - 2003	15.94	20.87	36.81	2007 - 2008	16.09	22.61	38.70	5%
F-4	Esquimalt	1996 - 1997	4.00	5.33	9.33	1999-2001	5.04	4.74	9.78	5%
F-5	Kamloops	2001 - 2003	6.78	4.52	11.30	2005-2007	2.91	4.20	7.11	-37%
F-6	Prince George	1999 - 2003	4.92	5.15	10.07	2005 - 2008	7.03	7.90	14.93	48%
F-7	Prince George	1996 - 1997	10.74	23.56	34.30	1999-2001	12.24	17.56	29.80	-13%
F-15	Victoria	2001-03	21.37	29.76	51.14	2007-08	20.70	21.10	41.80	-18%

TABLE 2 CHECKLIST FOR CANDIDATE ROAD DIET PROJECTS

CRITERIA	PREFERRED CONDITION	CHECK
Existing Cross-Section	4 lanes, on-street parking not permitted at any time	☐
Existing Configuration of intersections along the corridor	Left-turn lanes generally not provided.	☐
Traffic Volume	AADT should range from 8,000 to 15,000	☐
Access/Driveway Density	Density 30 – 50 access points per km	☐
Existing Collision types	Left-turn opposing, weaving	☐
Roadway Function	Local, Collector or Minor Arterial	☐
Pavement Condition	Pavement overlay planned in the near future	☐
Network Connectivity	Good transitions can be made between road diet and the remainder of the network for motor vehicles and for bicycles.	☐

FIGURE 2 SUMMARY OF COLLISION REDUCTIONS IDENTIFIED IN THE LITERATURE REVIEWED

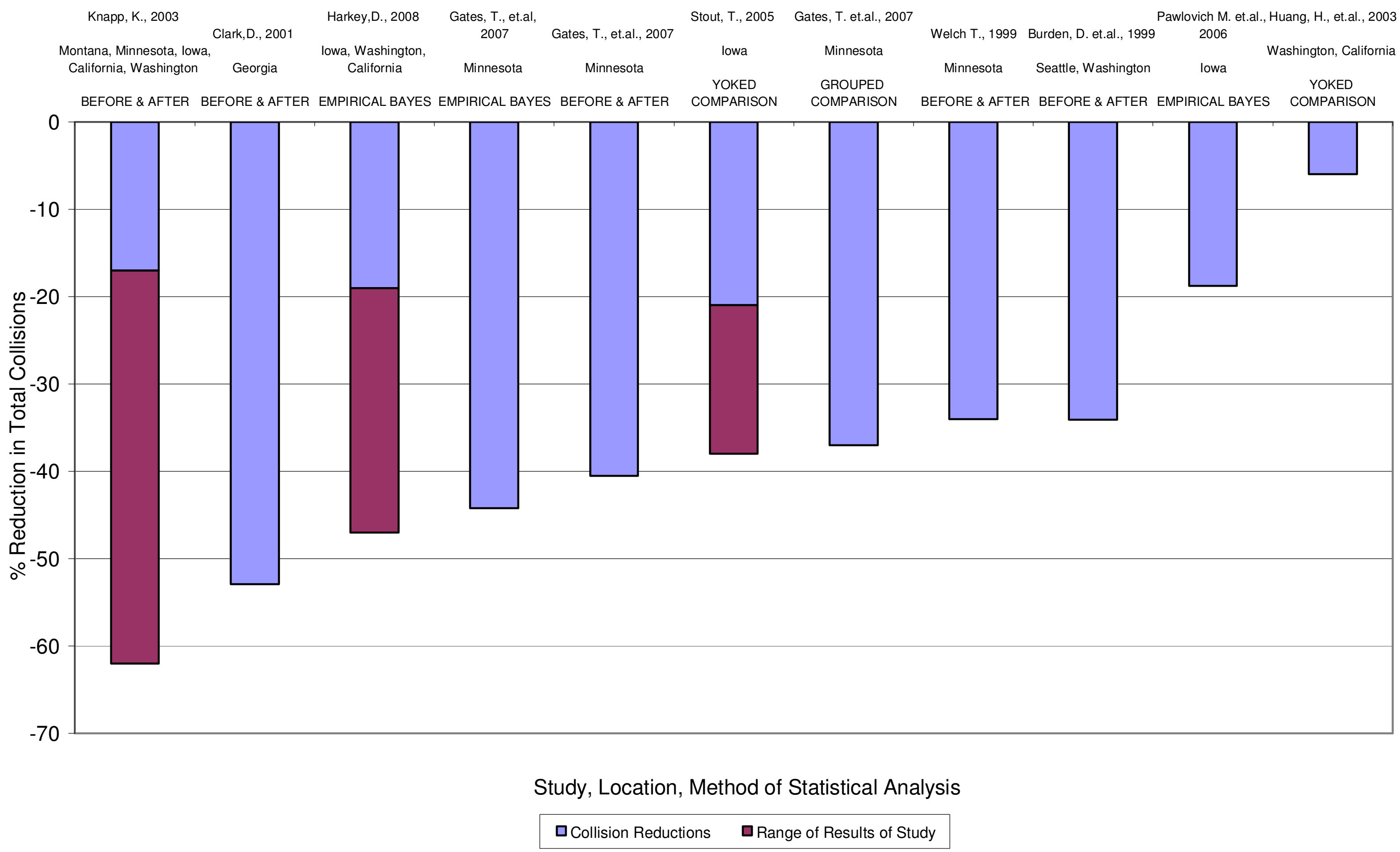

FIGURE 3 REDUCTION IN TOTAL COLLISIONS PER KILOMETRE PER VOLUME VS PRE-IMPLEMENTATION TRAFFIC VOLUME FOR BC STUDY SITES

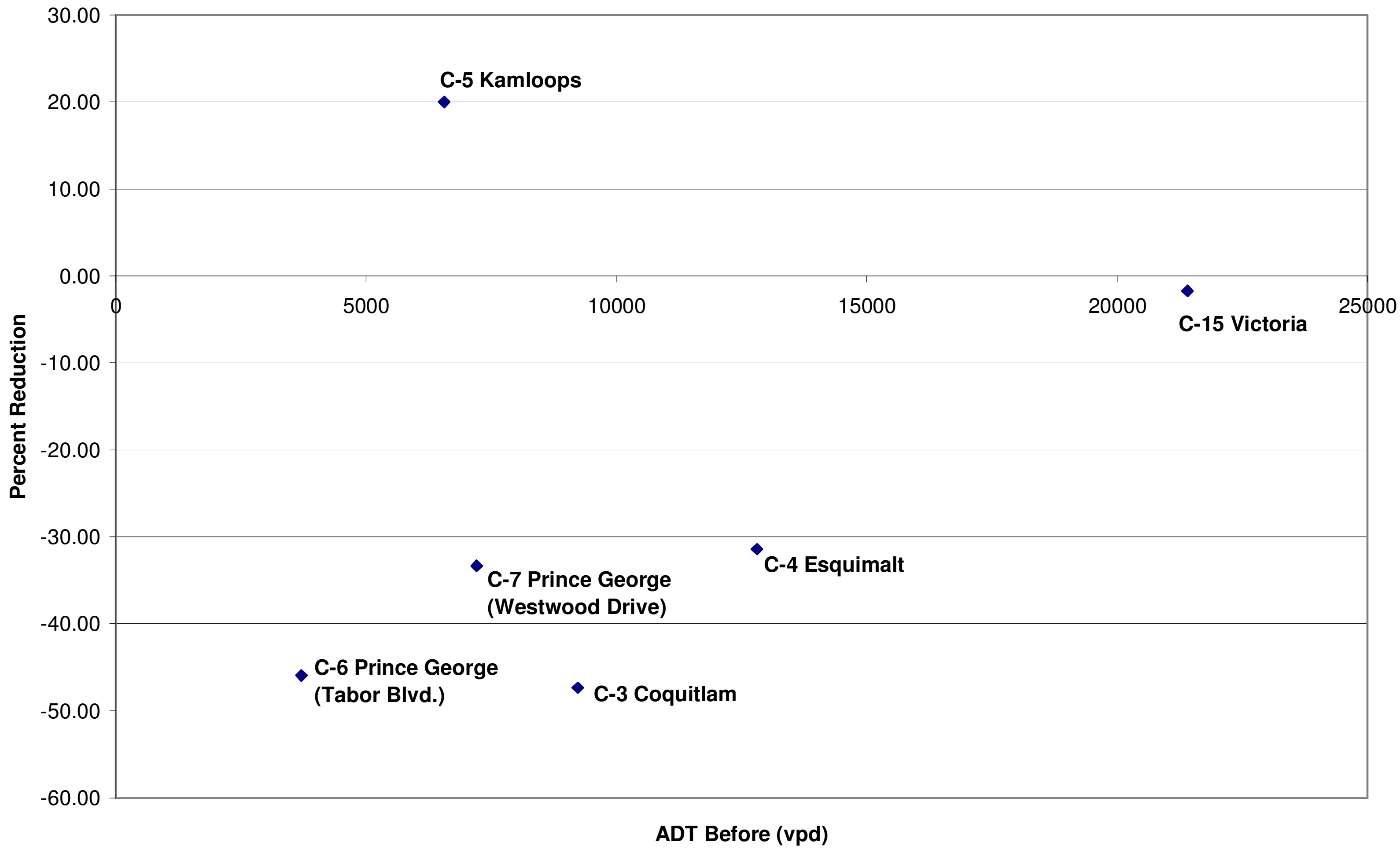

FIGURE 4 REDUCTION IN TOTAL COLLISIONS PER KILOMETRE PER VOLUME BY SIMPLE BEFORE & AFTER ANALYSIS AND BY PRORATING FOR COMPARISON CONTROLS

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