Applications of Radar Traffic Counter Systems for Evidence Based Decision-Making in Transportation

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Abstract

Public service organizations have a responsibility to ensure that their decision-making processes will select policy pursuits that provide the greatest possible value to their constituents. This is particularly true for decisions regarding transportation, as, in addition to wasted public funds, improper decision-making can create safety risks to road users and pedestrians, —adversely affecting the local economy by impacting the effective movement of people and goods. Employing a data-based decision-making approach ensures that the selected alternative is supported by factual information and accurate metrics. Employing data driven decision making processes will ultimately achieve the agency's strategic and administrative objectives. However, in the case of smaller municipalities and rural communities, there may be little, if any, existing data concerning transportation infrastructure within their jurisdictions. Funding and personnel constraints prove to be significant obstacles in generating such data when compared to the greater administrative capacity available to higher levels of government. Therefore, there is great value to be found in cost effective data-gathering solutions that provide a wide range of utility to assess a variety of possible transportation concerns. The BC Ministry of Transportation and Infrastructure's Vancouver Island District have been piloting a Traffic Radar System program that is flexible, effective, and provides accurate data for a relatively low startup cost. These tools have proven useful in circumstances ranging from speed control to emergency response, and it is the opinion of the Ministry that these systems could prove immensely valuable to small municipalities, regional districts, and rural communities as a convenient and cost-efficient method of validating decision-making regarding transportation.

Introduction

As servants to the public, all levels of government have an obligation to ensure that their chosen policies and processes will produce the greatest possible value for their constituents. In pursuit of delivering on this responsibility, "the contemporary policy environment persistently demands that agencies use the best information available when making decisions about policies, programs, and practices."[1] Evidence-based decision-making is a concept that's discussed with increasing excitement in the public sector since its rise in the public health policy sphere[2], and many wish to see it applied more broadly in Transportation and Infrastructure administration.[3, 4, 5] Sourcing current and well-sourced evidence is also a foundational best practice for municipal infrastructure design and management, used for improving asset understanding; determining current utilization; implementing weight and ranking systems for infrastructure inventory; and coordinating maintenance, renewal, replacement, disposal, and expansion activities.[6] However, enacting evidence-based practices often proves challenging. Regardless of the field of work, time constraints, resource constraints, limited understanding of the research process, and limited preexisting data can significantly reduce the ease with which evidence can be incorporated into the decision-making process.[7]

These constraints become especially noticeable at the municipal and regional government levels. In addition to lacking extant data specific to their jurisdictions, municipal and regional governments often have a reduced capacity to outsource research compared to their provincial and federal counterparts due to their commensurately smaller financial and administrative capacities.[8] As such, small municipalities and regional districts can find great value in tools that provide accurate, timely, and

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relevant information while remaining cost effective. The BC Ministry of Transportation and Infrastructure's Vancouver Island District (VID) has been piloting a radar traffic counter program, and it has already proven able to generate reliable, actionable information for transportation matters ranging from deployment of highway maintenance resources to validating emergency response protocols. The potential transportation management applications for these devices are extensive, while remaining affordable for smaller agencies and usable by non-technical staff.

System Overview

Radar traffic counters are discrete, battery powered devices that can be placed along the roadside to automatically collect traffic data. They typically consist of a sturdy, lockable plastic carrying case that is equipped with a tamper-resistant mounting bracket. The case contains a rechargeable battery pack and the radar head unit. The radar sensor systems used in these devices can typically detect any vehicle the same size or larger than a motorcycle, and depending on the model and manufacturer can record information such as:

- Number of vehicles.
- Date and time of detection.
- Direction of travel.
- Speed of travel.
- Travel lane used for two lane roadways.
- Vehicle length.
- Following distance.

The specific radar traffic counter system used by Vancouver Island District is the Black Cat I Plus by Jamar Technologies.[9] The capabilities discussed above all exist in the Black Cat I Plus's feature set, however, they are also broadly comparable to those offered by other radar traffic counter manufacturers, such as iComs Detections,[10] All Traffic Solutions,[11] TrafficLogix,[12] Houston Radar[13], and Sierzega Elektronik.[14]

Prior to beginning monitoring, the head unit must be programmed with measurements for the monitoring site to delineate lane areas and lane directions. This is usually done using proprietary software on a laptop and can be completed via hardwire or wirelessly. These measurements can be gathered from the site beforehand, and the unit can be preprogrammed in the office before installation, or, they can be taken in the field and the unit programmed on site. Due to the use of batteries rather

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than wired power, radar traffic counters can be placed flexibly, allowing for mounting to utility poles, signposts, lamp posts, and even trees. The lack of physical sensor hardware on the road surface also means that staff do not have to spend significant amounts of time on the roadway to place the device, making them a safer option for agencies with staff that are not accustomed to field work.

Figure 1: Radar Traffic Counter exterior view

Figure 2: Radar Traffic Counter interior view

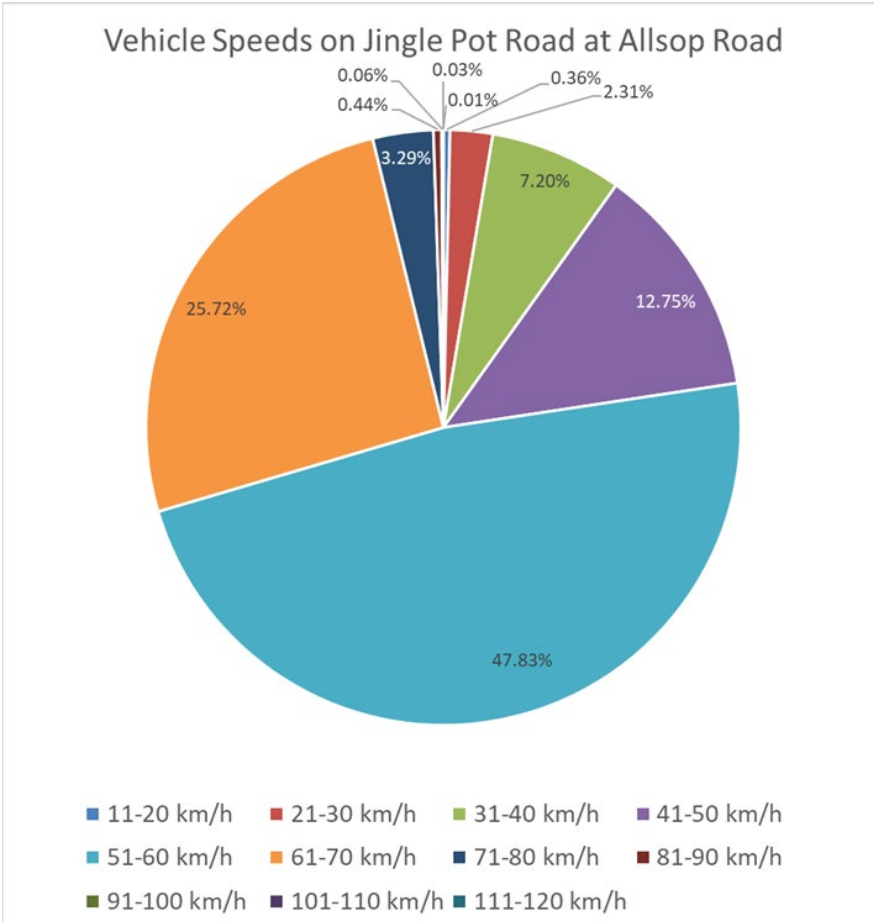
Figure 3: MOTI staff member installing traffic radar system on utility pole

Once the count is completed, the traffic counter can be retrieved and returned to the office. The data is then downloaded and interpreted using the setup software provided by the manufacturer, which can produce a number of configurable reports automatically, or output the raw data for use in other statistical analysis programs.

Figure 4: Example raw data output from VID traffic counter

	A	B	C	D	E	F	G	H
1	Name:	Jingle Pot Road Volume Count July 20						
2	Date/Time:	2023-07-20	3:37 PM					
3	Site Code:	01						
4	Station ID:	0						
5	Location 1:	South facing						
6	Location 2:							
7	Location 3:							
8	Location 4:							
9	Latitude:	0.000000						
10	Longitude:	0.000000						
11	Channels:	, Channel 1 - Direction X, Lane 1, Channel 2 - Direction X, Lane 2						
12	Filters Applied:	None						
13	Date	Time	Channel	Speed	Gap	Length	Headway	Following Distance
14	2023-07-20	3:37:59 PM	Direction X, Lane 1	66	29	381	14.2	26033.3
15	2023-07-20	3:38:14 PM	Direction X, Lane 1	57	15	353	15.2	23737.3
16	2023-07-20	3:38:16 PM	Direction X, Lane 1	66	2	457	2.4	3991.2
17	2023-07-20	3:38:38 PM	Direction X, Lane 2	32	22	358	53.9	47911.1
18	2023-07-20	3:38:39 PM	Direction X, Lane 2	34	73	439	54.9	51850
19	2023-07-20	3:38:42 PM	Direction X, Lane 1	47	3	612	25.5	32966.6
20	2023-07-20	3:38:52 PM	Direction X, Lane 2	45	12	1161	12.9	15543.7
21	2023-07-20	3:38:54 PM	Direction X, Lane 1	53	11	399	11.7	16534.5
22	2023-07-20	3:38:58 PM	Direction X, Lane 2	40	5	455	5.6	5190
23	2023-07-20	3:39:00 PM	Direction X, Lane 1	60	6	381	6.7	10715
24	2023-07-20	3:39:07 PM	Direction X, Lane 1	65	7	455	7.2	12586.5
25	2023-07-20	3:39:12 PM	Direction X, Lane 1	34	4	417	4.1	3634.2
26	2023-07-20	3:39:18 PM	Direction X, Lane 1	53	6	498	6.5	8920.2
27	2023-07-20	3:39:24 PM	Direction X, Lane 2	43	26	470	26.1	30686.5
28	2023-07-20	3:39:39 PM	Direction X, Lane 2	34	14	373	14.6	13417.7
29	2023-07-20	3:39:48 PM	Direction X, Lane 2	53	9	505	9.4	13257.4
30	2023-07-20	3:40:13 PM	Direction X, Lane 1	42	55	378	55	63772.3
31	2023-07-20	3:40:31 PM	Direction X, Lane 2	22	42	368	43	26068.2
32	2023-07-20	3:40:33 PM	Direction X, Lane 1	46	20	353	20.4	25652.7
33	2023-07-20	3:40:34 PM	Direction X, Lane 1	46	0.7	366	1	925.1
34	2023-07-20	3:40:39 PM	Direction X, Lane 1	54	4	503	4.4	6171
35	2023-07-20	3:40:44 PM	Direction X, Lane 2	43	12	1072	13.4	15285.3
36	2023-07-20	3:40:47 PM	Direction X, Lane 2	41	2	478	3	2395.1
37	2023-07-20	3:40:49 PM	Direction X, Lane 2	35	1.6	516	2	1537.1
38	2023-07-20	3:40:52 PM	Direction X, Lane 2	39	2	485	2.2	1809.2
39	2023-07-20	3:40:54 PM	Direction X, Lane 2	39	1.5	467	1.9	1573
40	2023-07-20	3:40:56 PM	Direction X, Lane 2	39	2	417	2.3	2024.7
41	2023-07-20	3:40:58 PM	Direction X, Lane 2	39	2	470	2.3	2074.6
42	2023-07-20	3:41:07 PM	Direction X, Lane 2	45	8	1377	8.9	10582.5
43	2023-07-20	3:41:10 PM	Direction X, Lane 2	49	2	559	2.5	1904.2
44	2023-07-20	3:41:12 PM	Direction X, Lane 2	46	2	467	2.7	2924.8

Figure 5: Example derived data visualization showing average vehicle speeds through the tracked section in 10 km/h increments



Benefits and Limitations

As adoption of the radar traffic counter program has increased throughout Vancouver Island District, several immediate benefits have been noted by staff. These include:

Cost Effectiveness and Convenience

The counters provide an excellent value proposition. The units cost between C$5,000.00 to C$7,500.00 each, with the only ongoing costs being maintenance and labor to place the counters. By comparison, traffic counts conducted by external consultants have cost VID anywhere from C$3,000.00 to C$15,000.00 and beyond, depending on the complexity of the roadways being monitored. Counters can quickly recoup their initial costs in savings on consultant fees when used regularly. These lowered costs, in turn allow the counters to be deployed rapidly, as they avoid the various approval processes and wait times that inevitably come with substantial expenditures. This convenience makes deploying counters a viable option in response to stakeholder complaints or emergent situations. In addition to reducing avoidable consulting expenditures, the data gathered using these trackers can also be used to demonstrate a need for more in-depth study that would be better served by a consultant, thus aiding the procurement process and ensuring public funds are being applied where they are most needed.

Addressing Stakeholder Concerns

When addressing stakeholder concerns, VID staff reported that referencing data from the counter program to validate decision-making has consistently led to more receptive reactions from stakeholders, even when the resultant data did not support the stakeholder's suggestions. A simple judgement call, even when entirely legitimate, may feel dismissive to a stakeholder, especially when their concerns are regarding road safety. Providing objective data to support MOTI's approach increases confidence that the approach is legitimate, and that the Ministry has taken the stakeholder's concerns seriously. Deploying counters in response to complaints that warrant further investigation has also had the side benefit of producing current data on roadways, which can then be retained and referenced by VID staff for other uses later.

Limitations

While radar traffic counter systems provide useful data and present a great value proposition, they are subject to several limitations that may make them unsuitable for certain use cases. Tracking can only be carried out on relatively straight stretches of road, and vehicle travel cannot be tracked through intersections. Vehicles entering the roadway from driveways and intersections can interfere with the readings, reducing accuracy of the resulting data. This makes radar traffic counters less suitable for use in heavily urbanized areas or near intersections. They are also less effective for measuring specific types of traffic. Radar traffic counters record vehicle length with reasonable accuracy, but they do not differentiate vehicle types, making determining volumes for exact types of traffic (e.g. commercial freight vs. logging trucks vs. industrial traffic) more difficult. The readings typically cannot be viewed remotely and must be manually gathered at the monitoring site. For longer-term studies the batteries must be swapped out every 2-3 weeks for monitoring to continue. Radar traffic counters are generally not well suited for monitoring active transportation routes, as the systems are not sensitive enough to reliably monitor cyclists and pedestrians. Finally, it should also be noted that most of these devices rely on proprietary software to process the initial data, which in turn makes them reliant on continuing support from the manufacturer to function.

Consideration should be given to operational needs prior to purchasing any of these tools, to ensure that the selected device will be the one that best fulfills these needs. There are a variety of other traffic counting technologies available that provide other types of data, which may be more valuable to a given agency depending on the types of data sought. Radar traffic counters were deemed most suitable for Vancouver Island District's purposes, as BC MOTI is solely responsible for maintenance roadways and vehicle traffic and does not own or maintain active transportation infrastructure. Furthermore, the findings provided by these tools are only as powerful as the owner's ability to interpret them. The supporting software is generally intuitive, to an extent that the units can be set up even by non-technical personnel after some brief training. If existing staff lack the ability to conduct statistical analyses, or otherwise draw useful conclusions from the data, then greater value would be drawn from relying on external consultants than an internal traffic counting program.

Primary Use Cases

Vancouver Island Districts radar traffic counter program has proven valuable in numerous contexts where up-to-date information on road usage was needed to support decision-making. Outlined below are several of the most common situations where these devices have been employed, that may also be encountered by small municipalities, regional districts, and rural communities as they manage their own infrastructure.

Allocation of Highway Maintenance Resources

The BC Ministry of Transportation and Infrastructure assigns Summer and Winter maintenance classifications to all roads in its inventory. These classifications then dictate the level of maintenance services the road should receive to keep it in good working order for the lifetime of the surface, with roadways that see greater use receiving a higher classification to reflect their greater need for maintenance services. Summer maintenance classifications are assigned solely based on Average Daily Traffic counts, while winter maintenance classifications also consider road usage, with school bus routes, regular industrial traffic routes, and heavily utilized commuter routes all receiving elevated classifications compared to other side roads.[15] Development is continuing throughout Vancouver Island at a rapid rate, which has long term impacts for usage of surrounding roadways as developments are completed and become populated.

Figure 6: BC MOTI Highway Maintenance Agreement Highway Classifications[14]

BC MOTI Summer Maintenance Classes

Class	A.D.T (Average Daily Traffic)
1	Over 10,000;
2	5,000 – 10,000;
3	1,000 – 5,000;
4	500 – 1,000;
5	100 – 500;
6*	10 – 100;
7*	0 – 10;
8	Roads typically not constructed or not open but for which maintenance responsibilities may exist pursuant to Additional Maintenance Responsibilities.
*Highways Classed 6 or 7 with heavy industrial use shall be increased one Class	

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BC MOTI Winter Maintenance Classes

Class	A.D.T (Average Daily Traffic)
A	high volume traffic (over 5,000 winter average daily traffic count) or commuter routes and certain expressways and freeways through mountain passes. For the purposes of Classification, a freeway is a multi-lane highway with fully controlled access. Class A are heavy commuter traffic routes extended to include the bulk of vehicles commuting daily to a center and cut-off where traffic drops below a 2,500 winter average daily traffic count. These include, but are not limited to, high volume ski hill and commuter routes;
B	trunk and main routes (or portion thereof as designated by the Province) not included in Class A, with a cut-off traffic volume of 1,000 winter average daily traffic count. These include but are not limited to lower volume ski hill and commuter routes;
C	school bus routes and industrial (truck) traffic routes (more than 25% trucks) not included in Class A and B;
D	other regularly maintained winter routes;
E	other irregularly maintained winter routes; and
F	roads not maintained or not open in the winter, or not maintained by the Contractor.

MOTI staff may detect a need for a review of a roadway's maintenance specification at several stages in the development process. This could occur during initial plan submissions which may indicate than an existing roadway will see increased use when the development is completed, or as a response to trends in increased maintenance issues for a given roadway, or increased public complaints of maintenance defects from residents. Radar traffic counters can then be rapidly deployed, to gather objective data on the levels and types of vehicle traffic on the roadway(s) in question. The results then serve as evidence to support any resulting changes in maintenance classification. One recent example took place in spring 2024 on a rural side road in the Regional District of Nanaimo. Increased maintenance needs had been noted on this roadway over the past year, with an accompanying increase in complaints by residents of deteriorating road conditions. A traffic counter was placed and found that Average Daily Traffic numbers were just over 1000 vehicles per day, well in excess of those anticipated by its current Summer maintenance classification of 5, which allows for between 100 to 500 vehicles per day. In response, the road's summer maintenance class was raised to reflect its true typical usage, ensuring that it would receive adequate maintenance servicing.

Reviewing maintenance needs has proven to be one of the most common use cases for the radar traffic counter program to this point. The program has made the process much easier and more cost effective simply by removing the need to hire external consultants to execute traffic surveys.

Speed Surveying

Speed surveying has been another frequent reason for deployment of traffic counter systems. Speed enforcement assets are finite and must therefore be applied in areas likely to see a significant impact (and subsequent improvements) in safe driving. Since the radar traffic counter systems are automated, they can be installed in response to staff observations or resident complaints of speeding and provide an initial report of speed patterns for the area. If the report indicates frequent and unsafe levels of speeding in the area, it can then be referred to enforcement agencies such as the RCMP or local police, who will feel more confident that their activities will yield positive results.

Figure 7: Radar traffic counter deployed on a side road for speed surveying.

In the case of results obtained by Vancouver Island District's radar traffic counter programs, out of eight speeding complaints which received counter analysis in the past twelve months, only two returned a result showing significant amounts of speeding through the test zone. While anecdotal in nature, these results still demonstrate the value in having objective data available to support, or in this case oppose, deploying public resources to address a particular concern.

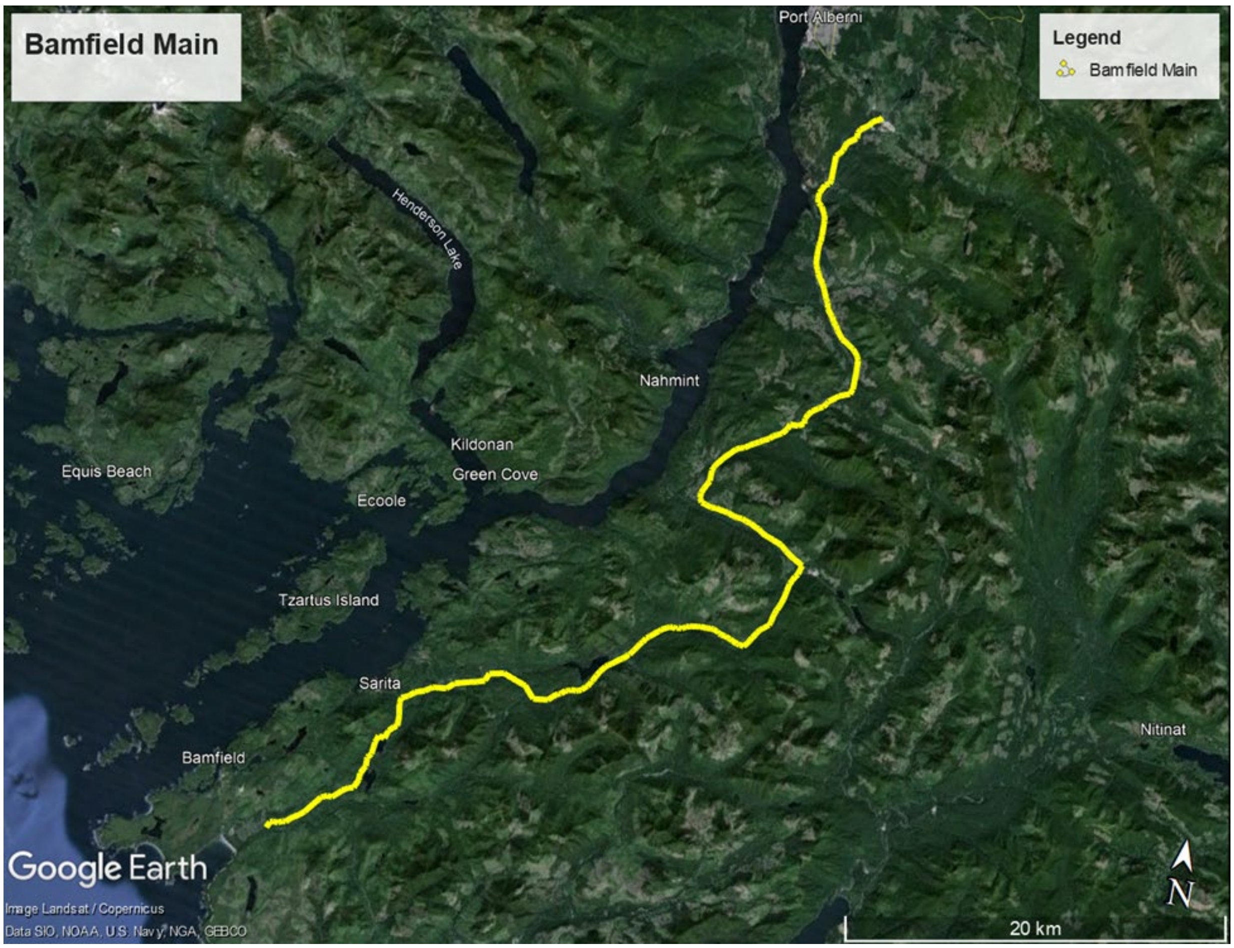
Transportation Planning

In addition to addressing day-to-day operational concerns, radar traffic counters have also provided valuable data as part of longer-term studies for transportation planning. VID staff are currently working towards constructing a traffic circle at the intersection of Highway 4 and Beaver Creek Road in Port Alberni, BC. The intersection is currently configured as a hybrid T and Y-intersection divided by a triangular traffic island, with the Y-leg servicing westbound traffic on Highway 4 (turning onto Beaver Creek Road); and the T-leg servicing east bound traffic from Highway 4 entering Beaver Creek Road – allowing access from Beaver Creek Road onto Highway 4 in both directions.

Figure 8: Overhead View of Beaver Creek Road x Highway 4 Intersection

The intersection of Beaver Creek Road and Highway 4 is heavily trafficked. It is often used by industrial vehicles from several logging operations located further north on Beaver Creek Road, as well as boat and trailer traffic entering and leaving the marina immediately to the south, with plentiful passenger vehicle traffic heading to and from the downtown area of Port Alberni to the west on Highway 4. This heavy use, combined with generally unintuitive turning movements in the existing intersection configuration, made the site a strong candidate for safety improvements. A traffic circle was determined to be the best solution to facilitate the continuous traffic flows seen at the intersection, and a preliminary design has been developed based on estimated usage. To supplement the design process, VID staff deployed radar traffic counters on both Beaver Creek Road and Highway 4 to gather current data on road usage in the area and ensure that the final design will be able to handle necessary levels of capacity.

Figure 9: Bamfield Main route map



Another, more in-depth use example of the traffic counter programs for transportation planning is currently ongoing. In 2023, the Huu-ay-aht First Nations, in cooperation with the Ministry of Indigenous Relations and Reconciliation, completed their Bamfield Road Recovery Project to chip seal the 76.6 km stretch of the Bamfield Main forest service road. This road connects Port Alberni in east-central Vancouver Island over to the west coast communities of Bamfield and Anacla, and while the BC Ministry of Transportation holds infrastructure on either side of the connector in Port Alberni and in Bamfield itself. The Bamfield Main remains under forestry ownership.

Negotiations regarding long term ownership and maintenance contributions for the Bamfield Main are ongoing. In support of these negotiations, Vancouver Island District has been conducting continuous monitoring of the Bamfield Main since early December 2023, with the aim of establishing exactly how the roadway is used now that resurfacing is completed. The initial expectation was that the vast majority of traffic would be industrial in nature, as the Bamfield Main is actively logged throughout its length and is therefore frequently used for hauling. Thus far the recorded data has returned a different and altogether unexpected conclusion. Rather than hauling, the bulk of traffic on Bamfield Main was standard passenger vehicles. Studies are set to continue for at least the rest of this year in case hauling increases, or usage patterns in general change in the summer months where tourism travel to the west coast of Vancouver Island typically increases. This study has monitored four separate sites starting from the eastern end of Bamfield Main and proceeding west towards the coast, for a period of approximately two weeks each, with at least four more sampling locations planned for the remainder of 2024.

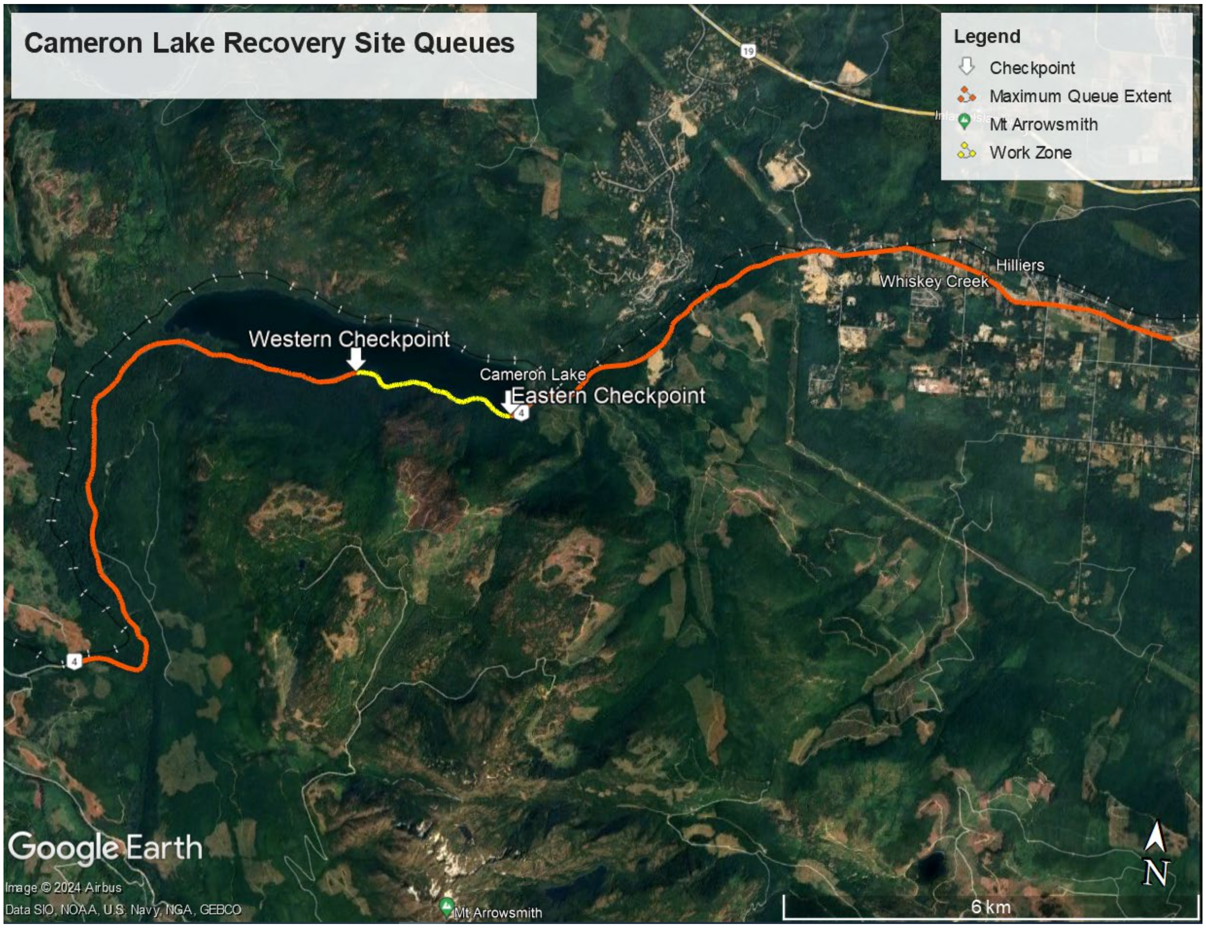
Since only existing equipment and internal personnel were required to conduct the study, it could be undertaken quickly and at minimal cost beyond man hours and equipment upkeep. This allowed for proactive information gathering as the time, logistical challenges, and expense of securing an external consultant could be avoided. A municipality or regional district with more constrained resources would therefore see great benefits in their planning processes due to reduced research costs, and the more current data would support informed decision-making for transportation planning.

Assessing Traffic Management Plan Effectiveness

For most road works lane closures and traffic pattern changes are a minor inconvenience to motorists, but for longer term projects an improperly structured closure can pose a significant obstacle to the passage of traffic through the area. Due to the speed with which they can be installed, radar traffic counters can quickly provide data on traffic volumes successfully transiting the work zone. If these results are considerably out of step with expectations for the plan, or if the slowdowns are greater than the minimum allowable throughput for an arterial or other high use roadway, then adjustments to the traffic management setup can be made with any additional costs justified by impartial data.

MOTI extensively employed Vancouver Island District's radar traffic counter program during the Cameron Bluffs Recovery Project in summer 2023. Early high temperatures and drought conditions led to extreme fire conditions throughout the province, including Vancouver Island. In early June, a human-caused forest fire spread along the bluffs overlooking Cameron Lake and BC Highway 4, burning with such intensity that it destroyed much of the vegetation and organic materials supporting the bluff's structure. As a result, the Highway was fully closed from June 3rd until June 23rd for the fire to be brought under control and damages assessed, and then opened to single lane traffic from June 23rd until August 31st for recovery work to remove hazardous materials from the bluffs. Throughout the period of single lane traffic, radar counters were installed at the midpoint of the work zone to assess whether the majority of traffic was originating from the eastern or western sides of the island, as well as the overall impact of the lane closure on throughput. The results of these surveys contributed to establishing closure scheduling, as well as public releases alerting drivers to likely wait times at the work zone. It also showed that the closure maintained approximately 80% throughput compared with counts taken in earlier years, indicating that the traffic management layout was performing well despite extensive closure times.

Figure 10: Cameron Bluffs Recovery Project queue lengths



Confirming that traffic management setups are performing within expected parameters can make road works much more palatable to stakeholders as they travel through the area. Effective use of radar traffic counters can help detect opportunities for efficiencies and to correct errors, ensuring continuity of travel while work is ongoing.

Conclusion

Vancouver Island District's use of radar traffic counters has shown them to be a useful multi-purpose tool for any government or agency with a need to monitor road usage. The devices are subject to some limitations that make them unsuitable for certain use cases, but if these are accounted, for then they can provide up-to-date data on everything from speeding concerns to ongoing emergency response efforts. They have the potential to be of great value to smaller municipalities, regional districts, and rural communities that would benefit from a current and accurate understanding of their infrastructure, but lack the resources of a larger government or agency. The expansion of evidence-based decision-making in the transportation sector is an outcome desired at all levels of government, and the effective us of radar traffic counters are yet another way to further its advancement.

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