Characterization of Seattle's commercial traffic patterns: A Greater Downtown Area and Ballard/Interbay vehicle count and evaluation

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EXECUTIVE SUMMARY

Seattle Freight Master Plan Vision (2016): *"A vibrant city and thriving economy connecting people and products within Seattle and to regional and international markets."*

Seattle now ranks as the nation's sixth-fastest growing city and is among the nation's densest. As the city grows, so do truck volumes—volumes tied to economic growth for Seattle and the region as a whole. But many streets are already at capacity during peak hours and bottleneck conditions are worsening. This project is designed to deliver critical granular baseline data on commercial vehicle movement in two key areas of the city to help the city effectively and efficiently plan for growing freight demand.

This timely research from the University of Washington's Supply Chain Transportation and Logistics Center (SCTL) on behalf of the Seattle Department of Transportation produces Seattle's first complete estimate of Greater Downtown area traffic volumes. And it offers a detailed analysis of commercial vehicle traffic in and around one of the city's two major industrial centers, the Ballard-Interbay Northern Manufacturing Industrial Center.

These efforts are significant because the city has lacked a comprehensive estimate of commercial vehicle volumes—until now. In the Greater Downtown area, the cordon counts (tracking traffic in and out of 39 entry/exit points) alongside traffic volume estimates will provide a powerful tool for local government to model, evaluate, develop, and refine transportation planning policies. This study lays the groundwork for the first commercial vehicle traffic model that will enable evaluation of different freight planning and traffic management strategies, economic growth scenarios, and application of new freight vehicle technologies. Ballard-Interbay is slated for major infrastructure projects in the coming years, including new Sound Transit stations and critical bridge replacements. This analysis will help inform these projects, which are critical to an efficient, reliable transportation system for goods and people.

One overall finding merits attention as it suggests the need to update some of the freight network element categories defined in the current Seattle Freight Master Plan. The SCTL research team finds that the volume of smaller commercial vehicles (such as pick-ups, vans, and step vans) is significant in both the Greater Downtown area and Ballard-Interbay, representing more than half of all commercial vehicles observed (54% in the Greater Downtown area and 60% in Ballard-Interbay.) Among those smaller commercial vehicles, it is service vehicles that constitute a significant share of commercial traffic (representing 30% in the Greater Downtown area and 40% in Ballard-Interbay.) Among the myriad possible ramifications of this finding is parking planning. An earlier SCTL research paper *(1)* found service vehicles tend to have longer dwell times, with 44% of all observed service vehicles parked for more than 30 minutes and 27% parked for an hour or more. Given this study's finding of service vehicles representing a significant share of commercial traffic volume, these vehicles may have a disproportionate impact on parking space rates at the curb.

Comprehensive planning requires comprehensive data. Yet cities like Seattle often lack the detailed data needed for effective freight planning, from peak hours and fleet composition to activity type and gateways of entry/exit. And if cities do have data, they are often too highly aggregated to be useful for management or planning or suffer from lack of comparability or data confidentiality problems.

Currently, urban traffic volume estimates by Puget Sound agencies are limited in spatial and vehicular detail. For example:

- Seattle Department of Transportation (SDOT) is responsible for recording traffic counts through the year on selected arterial streets in Seattle, providing a seasonally adjusted average weekday total vehicle traffic for all lanes at all count locations.
- Washington Department of Transportation (WSDOT) provides annual average daily traffic volumes in select locations of their jurisdiction, including the major interstates and state highways in the Seattle area. This data includes truck volume separated into three types: single, double, and triple units.
- Puget Sound Regional Council (PSRC) regional truck model has three levels of vehicle classification: light commercial, medium trucks, and heavy trucks. This is based on WSDOT Annual Traffic Flow's count locations and additional manual counts for model validation through the Puget Sound Region.

But none of these existing efforts produce enough detail to understand Seattle's vehicle movements or connect them with economic activity. To fill the gap, Seattle could consider adopting a standard freight-data reporting system that would emphasize collecting and distributing richer and better data for time-series analysis and other freight forecasting, similar to systems used in cities like Toronto and London. Seattle is a national leader when it comes to freight master plans. This study offers a critical snapshot of the detailed data needed for effective policy and planning, potentially informing everything from road maintenance and traffic signals to electric vehicle charging station sites and possible proposals for congestion pricing. That said, Seattle could benefit greatly from sustained, ongoing detailed data reporting.

INTRODUCTION

Goods movement and service activities are vital elements of a functional city. But rapid growth and densification have amplified the challenges for commercial vehicles (CVs) that navigate cities. With increasing road capacity unlikely to relieve traffic congestion, cities are under growing pressure to efficiently plan and manage freight transportation operations to meet both current and future needs.

For the last decade, Seattle has been—and continues to be—one of the fastest-growing cities in the United States. *(2)*. With a population of 783,137 and a density of 9,338 residents per square mile, Seattle now ranks as the nation's sixth-fastest growing city and is among the nation's densest. *(3)*. Seattle's unprecedented growth and geographic constraints (wedged between water and mountains) create significant challenges in effectively managing the movement of people, services, and goods. This study is designed to deliver key granular data to help the city in its efforts.

With the City of Seattle's support, the University of Washington's Supply Chain Transportation and Logistics (SCTL) research team collected a baseline cordon count for 39 vehicle entry and exit points into and out of the city's most constrained area: the Greater Downtown area. This project is designed to help the city understand what CVs are traveling through the urban center and when, differentiating commercial traffic loads by day of week and time of day. To capture vehicles crossing the cordon, the research team collected 24-hour video footage on traffic volumes for two days for each of the 39 gateways between September and November 2018.

To help the city understand not just when CVs are traveling in the Greater Downtown area but what kind of CVs are going in and out of the area, the research team developed a detailed vehicle typology that includes 65 vehicle categories based on body type, vehicle usage, and the number of axles. This typology differentiates between delivery vans, service providers, construction vehicles, delivery trucks, and others.

The report also includes analysis of CVs in the Ballard/Interbay area along 29 selected gateways. As with the Greater Downtown area, 24-hour video footage was used to capture traffic loads by day of week and time of day, between December 2019 and January 2020. (But, unlike the Greater Downtown area, the Ballard analysis does not capture inbound/outbound directionality.) The research team used the same typology as the Greater Downtown area analysis to identify granular CV types.

Over the past 15 years, the Ballard-Interbay area has seen rapid development and residential growth—growth likely to continue with the implementation of key infrastructure projects, including three future Sound Transit light rail stations. The area also has maritime and industrial uses, local and regional freight routes, and an important Manufacturing Industrial Center. On November 2, 2020, SDOT submitted the Ballard-Interbay Regional Transportation System (BIRT) report to the Washington State Legislature, outlining Magnolia and Ballard bridge replacements and multimodal transportation projects and corridor investments to keep people and goods moving in Ballard-Interbay. The area's projects and changes planned are expected to affect travel beyond Ballard-Interbay, including on regional roadways such as SR 99 and I-5.

This report's detailed analysis of traffic information, including insights into CV travel in this area, fleet configuration, spatial and temporal variations, can help the city as it manages the area's myriad projects.

Understanding commercial movement patterns in the urban environment is essential toward developing and evaluating public strategies to improve Urban Goods Movement's efficiency and sustainability (UGM). Yet local governments often lack the detailed data needed for effective freight planning at the municipal level (i.e.

peak hours, fleet composition, activity type, volume, gateways of entry/exit). And if they do have data, they are often too highly aggregated to be useful for management or planning or suffer from lack of comparability or data confidentiality problems. This new data set can support the policy decision making process. Currently, urban traffic volume estimates by Puget Sound agencies are limited in spatial and vehicular detail. SDOT is responsible for recording traffic counts through the year on selected arterial streets in Seattle, providing a seasonally adjusted average weekday total vehicle traffic for all lanes at all count locations *(4)*. WSDOT provides annual average daily traffic volumes in select locations of their jurisdiction, including the major interstates and state highways in the Seattle area. This data includes truck volume separated into three types: single, double, and triple units *(5)*. Puget Sound Regional Council (PSRC) regional truck model has three levels of vehicle classification: light commercial, medium trucks, and heavy trucks. They base their model on WSDOT Annual Traffic Flow's count locations and additional manual counts for model validation through the Puget Sound Region *(6)*. But none of these existing efforts produce enough detail to effectively inform policy.

Until now, a comprehensive estimate of CV demand has been elusive. The cordon counts alongside traffic volume estimations will provide a powerful tool for local government to model, evaluate, and devise transportation planning policies. This research produces Seattle's first complete estimate of Greater Downtown area traffic volumes. It lays the groundwork for the first CV traffic model that could enable evaluation of different freight planning and traffic management strategies, economic growth scenarios, and application of new freight vehicle technologies. Finally, this research provides a deep dive evaluation of one of the region's most important urban industrial centers (Ballard-Interbay Northern Manufacturing Industrial Center) and the adjacent areas. This analysis will help inform the envisioned future infrastructure projects that are critical to an efficient, reliable transportation system for goods and people.

KEY FINDINGS

Across both the Greater Downtown area (GDA) and Ballard-Interbay area, we find the following.

- Smaller vehicles (such as pick-ups, vans, and step vans) make up the largest share of all CV traffic, representing 54% in the GDA and 60% in Ballard-Interbay.
- Service vehicles are an important share of CV traffic, representing 30% in the GDA and 40% in Ballard-Interbay (constituting the largest single category share identified in that area.)
- Evaluation of the selected gateways and roadway legs suggests the need to update some of the freight network element categories defined in SDOT's current freight master plan.
- On average, daily CV traffic is low in the evening and night and high during peak volume hours of 9 AM-12 PM. Over the course of 24 hours, just 15% of CV traffic on average flows from 6 PM – 6 AM in the GDA and just 9% in Ballard-Interbay. Conversely, 27% of CV traffic on average flows in the three hours of maximum volume [9 AM -12 PM] in the GDA and 31% in Ballard-Interbay.
- The vast majority of CVs were observed during regular business hours, 6 AM – 6 PM. Therefore, unlike the passenger vehicle pattern, CV time-of-day pattern has only one "hump," peaking in the morning and early afternoon and declining steadily over the day. CVs appear to utilize the 'spare' capacity freed up by the decline in private vehicles between AM and PM commuter peaks.
- Overall, CV traffic peaked at 9:15 AM in the GDA and 10:15 AM in Ballard-Interbay with observed variations between locations inside each study area. GDA gateways showed both inbound and outbound flows peaked during the morning period: at 8:30 AM and 11:30 AM, respectively.
- Although all locations showed the typical CV daily pattern for the aggregated volume, some locations in both study areas had directionality oriented traffic patterns, with CV movement in one direction during some parts of the day and in the opposite direction during others. These patterns may be explained by the temporal distribution of activities in the area, for example, where specific fleets may be leaving or returning to a warehouse, commercial area, or the port terminal.
- We observe significant variation in traffic patterns (peak hours, CV share of total traffic, CV volume, directionality) due to local conditions within and surrounding each study area, such as land use and street classification.
- In the Greater Downtown area only, with regard to the cordon entry/exit points (an analysis not performed for Ballard-Interbay), we find that nearby gateways show similar commercial traffic patterns, including:
  - peak hours for overall CV traffic
  - inbound and outbound CV peak hours
  - inbound/outbound volume ratio
  - time of day factors for overall CV traffic and by direction.

METHODOLOGY

Data-Collection Method

Traffic cameras collected traffic footage at 42 locations (39 entry/exits and three additional locations) in the Greater Downtown area (GDA) and 29 in Ballard-Interbay, for a total of 70 locations across the two study areas. Two weekdays of video footage were recorded (Tuesday through Thursday) for 24 hours per day for each location in both study areas. Additionally, seven days of data was collected for three GDA gateways to evaluate CV traffic variations throughout the week.

Data collectors watched the videos and produced manual counts of all vehicles crossing predefined screen lines in the 70 locations. The vehicle counts were recorded in a 15-minute interval as a single number on the data-collection spreadsheet. The video footage processing captured granular data about the day of the week, time of day, vehicle body type, vehicle use, number of axles, and directionality (for Greater Downtown area locations).

Extracting vehicle counts from video footage poses several challenges, including:

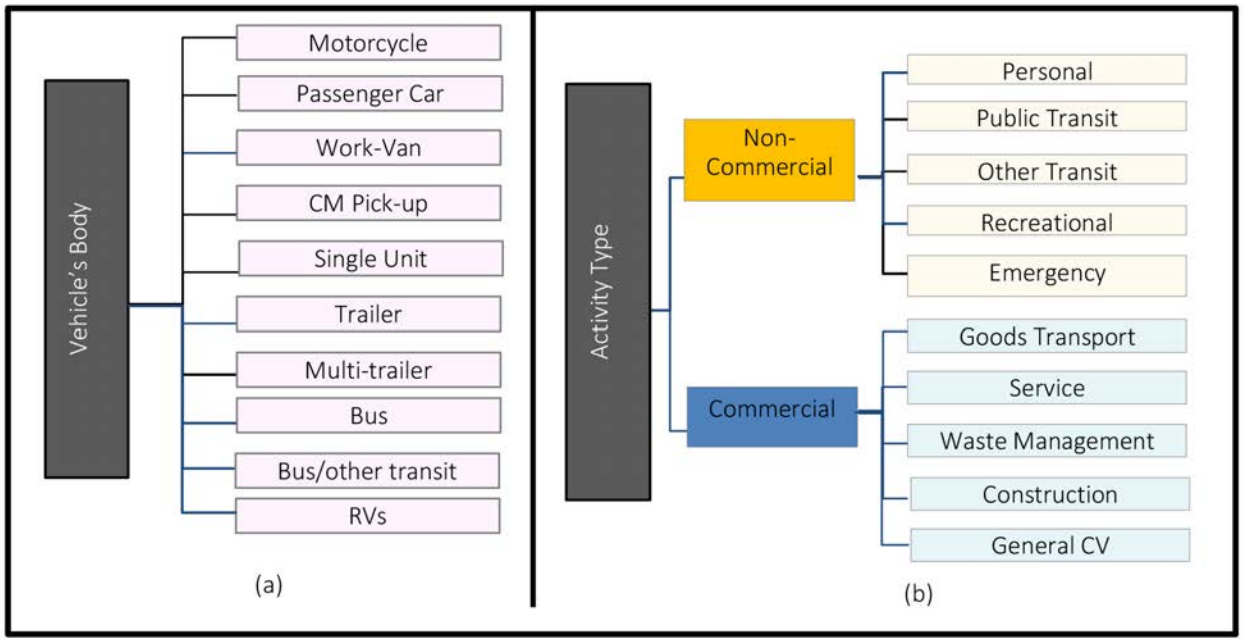
- Illumination variations: An excess or lack of light blurs the scene, making the vehicles harder to track and classify.
- Occlusion: Other vehicles or stationary objects may partially or fully obstruct a view of the vehicles passing through the video frame.
- Camera configuration: A low-viewing camera angle will increase the level of occlusion. Low-resolution videos will increase the rate of vehicle misclassification and miscounting.
- Weather conditions: Weather conditions such as fog, haze, heavy rain, or snow will reduce visibility, making the vehicles harder to track and classify.
- Variety of movement: In an intersection, vehicles may stop and turn in several directions, making vehicle trajectories more unrestricted and unpredictable than highway traffic.

Data-agreement checks were completed during data collectors' training to overcome these challenges and establish a standardized vehicle classification processing system, using the detailed vehicle typology created for this project. Three data collectors reduced one-hour videos and confirmed the vehicles' number and classification. Data flagged during the check were reviewed in more depth to evaluate the reason behind the differences and to improve the final vehicle classification system.

Vehicle Typology

The SCTL research team designed a detailed vehicle typology to track specific vehicle categories consistently and accurately drawing on several components: the vehicle classification system used by the Federal Highway Administration (FHWA) and the U.S. Environmental Protection Agency (EPA); an assessment of more than 20 hours of collected video footage in the project area; and prior fieldwork and knowledge of curb operations in the Seattle area (Source: SCTL Reports). The typology covers 65 separate vehicle categories based on three attributes: (a) body type, (b) activity type, and (c) number of axles, differentiating between delivery vans, service providers, construction vehicles, and delivery trucks, among others (see Figure 1).

FIGURE 1. Greater Downtown Area's cordon study vehicle typology.



This section is intended to describe only the categories mentioned throughout this report for each of the three attributes and is not exhaustive. For the complete 65-category vehicle typology, please see Appendix A for the complete metadata.

a. Body Type

This attribute describes the vehicle body type based on its frame configuration. For this report, we only highlight the commercial body types:

- **CM pick-up:** Pick-up used for commercial purposes.
- **Work van:** Unibody vehicle, which includes mini-vans, vans, and step-vans, with partial or no rear windows, manufactured primarily for commercial or emergency purposes (e.g. ambulances).
- S**ingle unit:** Truck on a single frame, including truck tractor units traveling without a trailer.

For the complete description of all 10 body type categories considered in the vehicle counts, please see Appendix A. In this report, the term "small CV fleet" is used to refer to both **CM pick-up** and **Work van** categories, see Table 1 for examples.

TABLE 1. Vehicles that followed the "small CV fleet" body type category.

SMALL CV FLEET		VISUAL DESCRIPTION
CM Pick-Up		 
Work van	a. Mini-Van	
	b. Van	
	c. Step-Van	 

b. Activity Type

This attribute indicates the primary purpose for which the vehicle was manufactured or its primary usage purpose, including commercial and non-commercial categories. For this research, commercial vehicles (CVs) include all counted vehicles performing some sort of commercial activities, including:

- goods transport to business and homes
- service providers
- construction and demolition
- waste removal

Although private vehicles are also used to deliver goods (e.g., Uber Eats, Amazon Prime Now, Amazon Fresh) or provide services, these vehicles were not recorded as commercial vehicles due to video footage limitations. Additionally, it is worth noting that Seattle parking policies allow passenger vehicles to hold commercial vehicle permits. This study does not distinguish between passenger vehicles with or without permits: All passenger vehicles, regardless of potential commercial purpose, were counted as private (non-commercial) vehicles.

For this report, we use these activity categories:

A.I. **Private**: Vehicles manufactured primarily to carry passengers (i.e., clients or workforce) for individual or business needs with eight-person maximum seating capacity. Two vehicle body types follow this category: "**Motorcycle**" or "**Passenger vehicle**."

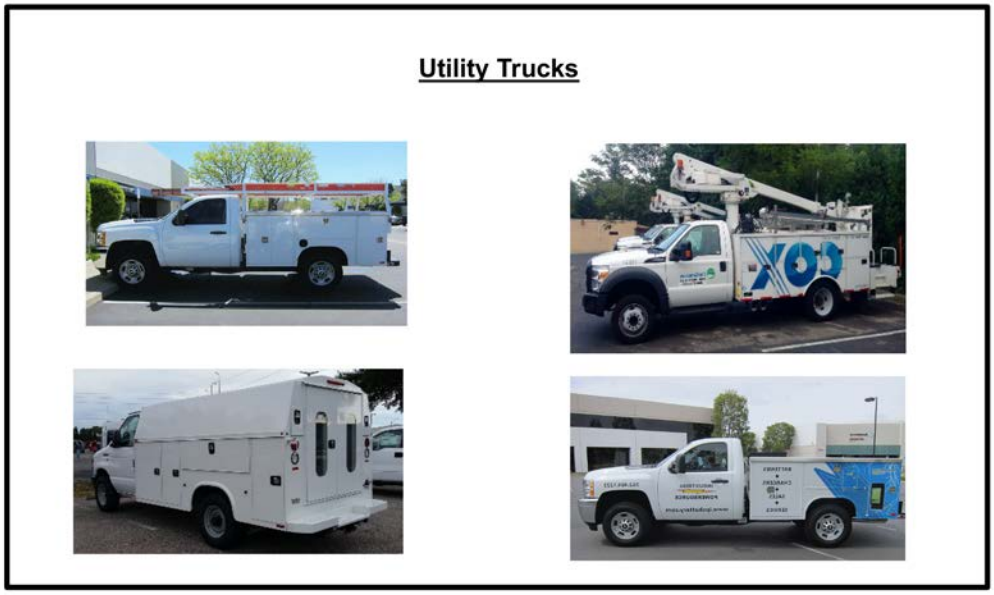
A.II. **Goods Transport**: CVs designed or used for carrying commodities (e.g., carrier and shipper work van; auto-transporters; tankers; box trucks; and containers). For this project, only work vans with either readable or recognizable carrier or shipper logos were considered in this category, including:

1. Parcel Carriers (e.g., UPS, USPS, FedEx, DHL)
2. Shippers, including retailers and food & beverage companies (e.g., Coca-Cola, Doritos, Budweiser, Merlino Foods, Sysco); and

3. Truck Rental Services (e.g., Peske, Enterprise, U-Haul)

A.III. **Service**: Commercial vehicles designed or used typically by maintenance or service providers (e.g., electricity, plumbing, internet, telecommunication, catering, gardening, public utilities, and pest control); including food trucks, bucket trucks, service provider pick-ups, or work vans, and any other utility truck (see Figure 2).

FIGURE 2. Examples of service's single unit truck.



A.IV. **Waste Management (WM)**: Vehicles manufactured primarily for collection, transportation, disposal, recycling, and monitoring of waste, including street sweepers and sewage waste trucks. Only trucks were considered in this category.

A.V. **Construction**: Manufacturers primarily sell vehicles for building, civil engineering, or engineering work. (e.g., rack trucks; stake trucks; concrete mixers; dumpers; empty flatbeds; and flatbeds carrying construction materials or equipment). Only trucks were considered in this category.

A.VI. **General CV**: When it was not possible to assign a commercial vehicle in any of the commercial categories described above (due to the challenges cited earlier), it followed the "**General CV**" category.

Appendix A describes all 10 activity type categories considered in the vehicle counts.

c. Number of Axles

This attribute represents the vehicle's number of axles. Certain truck configurations utilize axles that can be lifted when the vehicle is empty or lightly loaded. The position of these axles (touching or not the ground) affects the vehicle classification. For example, a site may exhibit directional differences in vehicle classification even though the same trucks may be traveling one direction loaded (with axles down) and the other direction empty (with axles lifted). *(7)* Following the Federal Highway Administration (FHWA) classification system, the axles of recreational or other light trailers attached to vehicles were not considered.

SEATTLE'S STREET NETWORK AND LAND USE CONNECTION

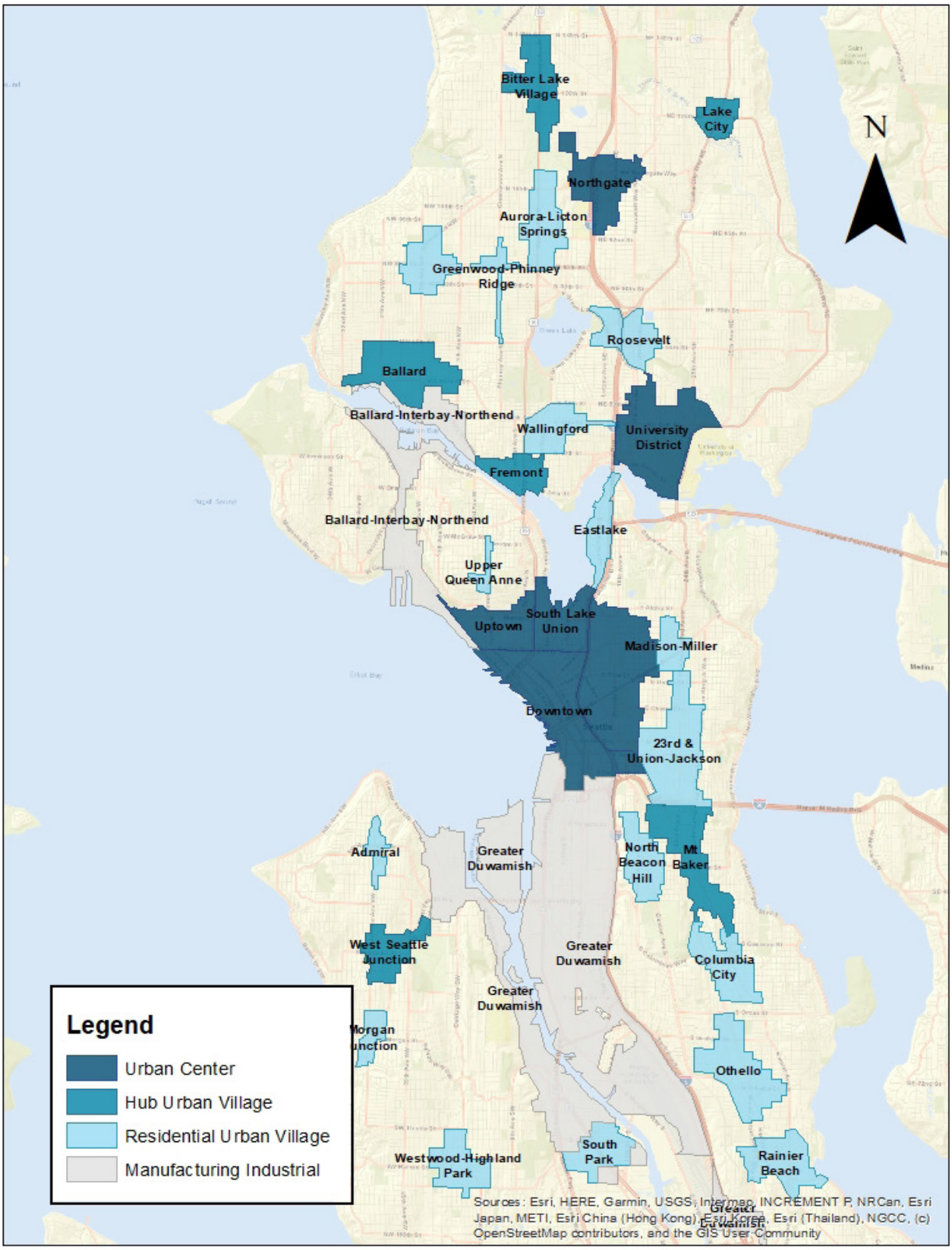
Land Use

The City of Seattle established the urban village strategy to sustainably accommodate population and economic growth in order to ensure residents a livable future *(8).* Urban villages are areas determined to best support increased housing, employment, and commercial density. By concentrating development, the city can have more pedestrian-friendly mixed-use neighborhoods and make transit and other public services more efficient. Four categories of urban villages recognize the roles different areas will play in the city's future based on the *(8)*:

1. **Urban centers** - The city's densest neighborhoods, with diverse uses, housing, and employment opportunities.
2. **Manufacturing/Industrial Centers (MIC)** – Home to the city's industrial businesses and carrying regional designations as essential regional resources, established to ensure that adequate, accessible industrial land is available to promote a diversified employment base and sustain Seattle's contribution to regional living-wage job growth.
3. **HUB urban villages** – Communities with a balance of housing and employment at a lower density than the urban center, providing access to goods, services, and employment to communities that are far from the urban center.
4. **Residential urban villages** - Neighborhoods that provide a focus of goods and services for residents and surrounding communities but that may not offer a concentration of employment.

With this strategy, the city manages and promotes growth in specific areas: regionally significant urban centers and MICs and, at a more local scale, urban villages with existing neighborhood business districts. Figure 3 maps Seattle's urban centers, urban villages, and MICs.

FIGURE 3. Seattle's Urban village map.



Seattle Freight Network

Nearly all freight network elements are owned and operated by the City of Seattle. The regional highways (Interstate 5, Interstate 90, and State Route 99) are in the jurisdiction of the Washington State Department of Transportation (WSDOT). Most of the Seattle freight network is designated on arterial streets, with the non-arterial segments operating as first/last mile connectors within the MICs. This classification system does not necessarily change the elements' overall function, design, or character. But it does underscore the importance of ensuring that commercial flows can be safely accommodated on all relevant roads.

The City of Seattle's Freight Master Plan established four designations for Seattle's freight network *(9)*, see Figure 4:

1. **Limited Access Facility** –Facilities like interstate and state highways (e.g. I-5 and SR 99) that support through movement and/or long-distance trips throughout the region and movements from MICs and from the urban center.
2. **Major Truck Street** – Arterial with a minimum threshold of 500+ trucks per day, serving connections to the regional network, between and through industrial land uses (MICs and intermodal terminals), commercial districts, and urban centers.
3. **Minor Truck Street** - Connections for goods delivery to urban villages and neighborhood commercial districts that also provide critical secondary connections to the significant truck street network, creating system redundancy and resiliency. Minimum threshold of 500+ trucks per day.
4. **First/Last Mile Connector** – Locations within MICs where short truck movements are required to access key freight activity centers, such as Port facilities and intermodal terminals. These roads may not have high enough traffic volume to be classified as arterials, but the relatively high percentage of trucks they carry and their access to the Port and industrial lands make them essential to the overall freight network. Minimum threshold of 250+ trucks per day.

FIGURE 4. Seattle's freight network designations and criteria *(9)*.

Seattle's Street Classification

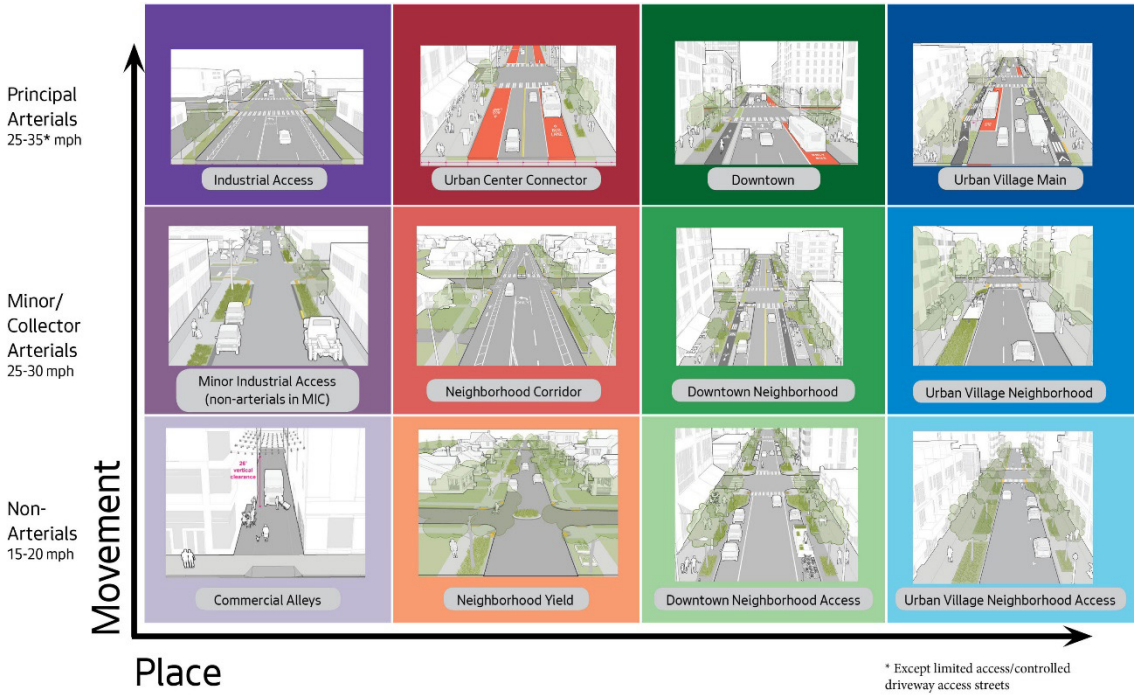
As shown in Figure 5, Seattle is required by state law to classify city streets into primary functional classifications, which are generally based on the American Association of State Highway and Transportation Officials (AASHTO) standards *(10)*. These standards are intended to supplement the traditional functional classification system of streets, which define how a road should function to support the movement of people, goods, and services and provide access to the property.

The traditional functional classification system focuses on use and operation (arterial, non-arterial, etc.). But Seattle's newer street type standards provide evaluative design features necessary to produce a street network that is responsive to individual communities' needs and desires. These new street types are compatible with the City's Comprehensive Plan, Seattle 2035, and Seattle's modal plans.

The selected locations for both study areas include these Seattle street types *(10)*:

- **Downtown** - Have active street-level uses and provide access to downtown businesses, residences, and transit services. Many have freight restrictions for vehicles larger than 30 feet.
- **Downtown Neighborhood** - Serve a more diverse variety of land uses and are typically smaller in scale than Downtown streets. Many have freight restrictions in place.
- **Industrial Access** - Located within the MICs and/or part of the Freight network. Adjacent to industrial and manufacturing land uses and designed to accommodate significant volumes of large CVs.
- **Minor Industrial Access** - Located within the MICs but are not part of the Freight network. Serve a range of existing industrial, commercial, or manufacturing uses.
- **Urban Center Connector** - Located outside urban villages or centers and are part of the Freight network and the Frequent Transit Network linking urban centers and villages, with high-level investment to support transit service.
- **Urban Village Mai**n - Spines of Seattle's urban villages and centers.
- **Urban Village Neighborhood** - Located within urban villages or centers and play a supporting role to Urban Village Main Streets by serving various land uses, emphasizing residential uses.

FIGURE 5: Seattle's street type standard based on Seattle Right-of-Way Improvement Manual *(10)*.



GREATER DOWNTOWN AREA CORDON STUDY

Overview

In July 2018, the Seattle Department of Transportation (SDOT) provided $250,000 for a baseline vehicle cordon study of 39 gateways and three additional locations (two inside the cordon and one outside) for a total of 42 locations. The research team collected these counts and vehicle classification by manually processing video footage from the 39 selected gateways in the Greater Downtown area (GDA). Notably, WSDOT and SDOT gathered this video data before major construction, transit, and traffic changes started in fall 2018. (These changes include removal of the Alaskan Way Viaduct, construction of its replacement tunnel, and the rerouting onto surface streets of all downtown tunnel bus routes to enable Convention Place Station demolition.) The research team generated counts at the 42 locations, with detailed vehicle classification using a 65-vehicle typology based on vehicle body type and vehicle use. This analysis provides for the first time an evidence-based understanding of who is coming to the urban center, differentiating commercial traffic loads by day and time. This chapter explains the data analysis and findings from this critical effort.

Key Findings

- We observe no significant difference in CV volume among days of the week, Monday-Friday. But weekends show much lower volume, with Sunday having the lowest share of CV volume.
- About half (54%) of all CVs entering/exiting the GDA were smaller CV vehicles (i.e., work-vans and commercial pick-ups), the highest share of all CV Traffic. About 80% were two-axle vehicles (including both small fleet and two-axle trucks). This is consistent across study locations within the GDA.
- Measured by activity type, Service vehicles make up the study area's biggest share of commercial vehicle (CV) traffic (3%).
- On average, daily CV traffic is not significant during the nighttime period [6 PM – 6 AM] (15%) with a higher-volume share during the three hours of maximum volume [9 AM -12 PM] (27%).
- Overall study area CV traffic peaked between 9:15 AM.
- Overall GDA gateways inbound and outbound flows peaked during the morning period: at 8:30 AM and 11:30 AM, respectively.
- In all locations, CV traffic peaked between 7:45 AM – 1 PM, with 54% peaking in the 9 AM – 12 PM period.
- When considering both small CV fleets and trucks, 9 approximately 50% of the Minor & Major truck routes showed more than five time (2,500+ CVs/day) of the 500+ daily truck volume threshold set in the Seattle Freight Master Plan.
- In the Greater Downtown area only, with regard to the cordon entry/exit points (an analysis not performed for Ballard-Interbay), we find that nearby gateways show similar commercial traffic patterns, including:
  - peak hours for overall CV traffic
  - inbound and outbound CV peak hours
  - inbound/outbound volume ratio
  - time of day factors for overall CV traffic and by direction.

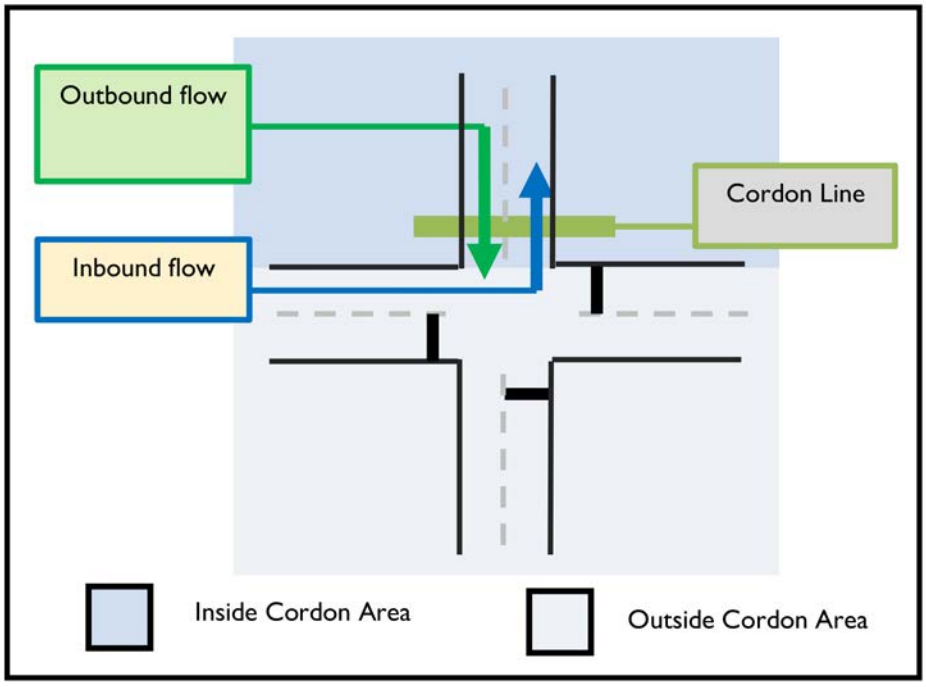
Data collection

The research team collected a baseline cordon count for 39 entry/exit points into and out of Seattle's most constrained area. An imaginary line (the cordon) representing the study area boundary was defined based on the gateway locations and the GDA's limits. All vehicles crossing the cordon line were counted. As such, the data here refer to vehicle movement in two directions across all gateways 1) inbound (into the urban center) and 2) outbound (out of the urban center), see Figure 6. In other words, this study does not capture vehicle movement after a vehicle crosses the cordon or vehicles moving inside the cordon.

Video footage was recorded between September 11 and November 1 with video data converted manually to traffic counts every 15 minutes for each selected gateway. Cameras recorded two consecutive days of video (Tuesday and Wednesday), 24 hours per day for every location. Additionally, 24/7 video footage was collected from three arterials to capture variations in the volume of commercial vehicles (CVs) by day of the week.

Importantly, while the study provides a comprehensive estimate of center city traffic composition, this effort cannot be considered a comprehensive count of all City traffic. Rather, the data is used to identify traffic patterns and vehicle types in established sites.

Figure 6. GDA cordon study methodology.



Gateway Selection

A total of 39 entries and exits were selected with the Seattle Department of Transportation (SDOT) based on:

a. The average annual daily traffic for roadways and waterways obtained from the Washington State Freight and Goods Transportation System framework *(11)*;

b. Seattle's Freight Network classification *(9)*; and

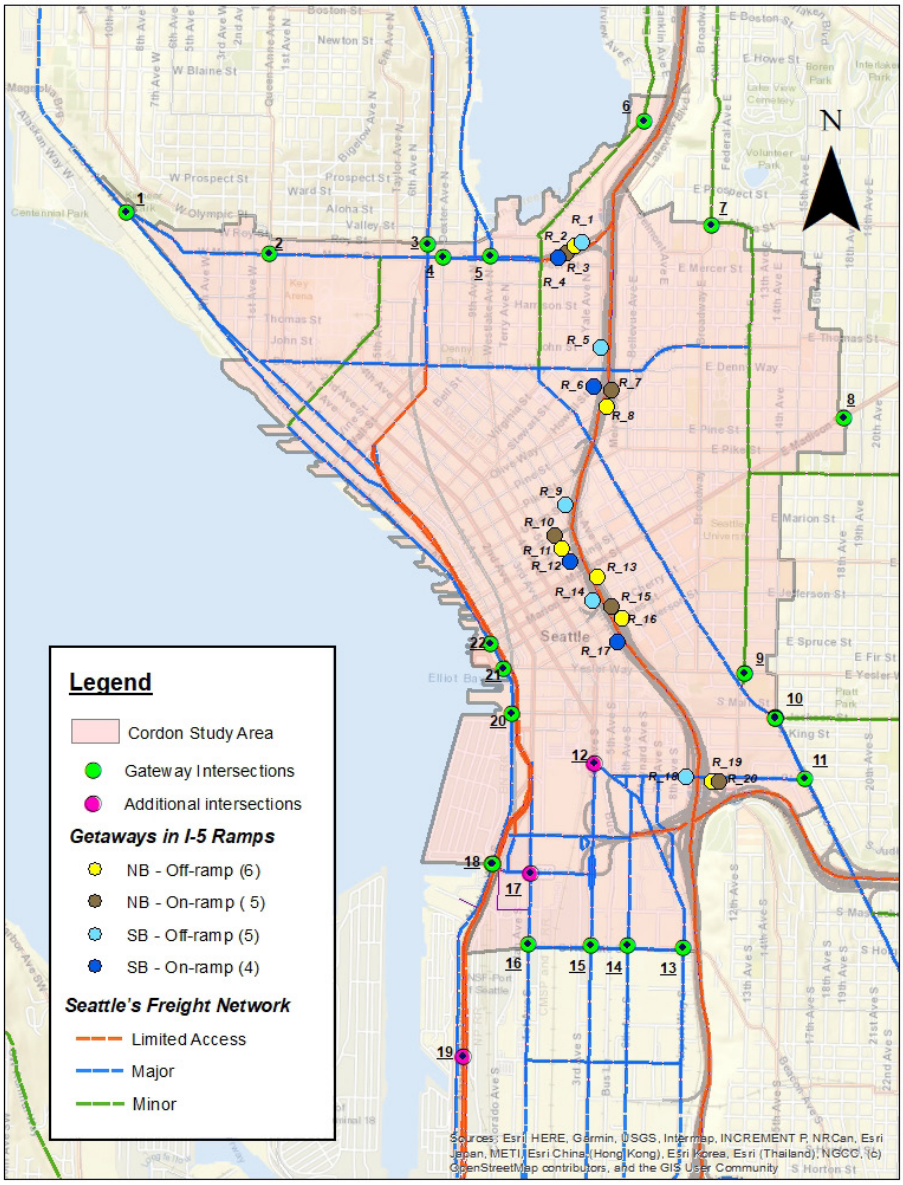
c. The location of existing traffic cameras in the GDA and along I-5.

These gateways include arterials, collectors, I-5 on/off ramps and ferry terminal entries/exits, comprehensively capturing all major commercial traffic routes. The study gateways are shown in Figure 7 and summarized in Table 2. Three additional intersections were selected with SDOT to collect count data: two inside the cordon and one outside. See the complete list of locations in Appendix B.

Table 2. GDA cordon count locations.

GATEWAY TYPE	NO.	DAYS	HOURS COLLECTED
Reference Intersection	3	Monday through Sunday	168 hrs *[120hrs (only CVs counted) + 48hrs (all vehicles counted]*
Intersections	15	Tuesday and Wednesday	48 hrs *(all vehicles counted)*
Additional Intersections* *(non-gateways outside or inside the cordon perimeter)*	3	Tuesday and Wednesday	48 hrs *(all vehicles counted)*
I-5 Highway On-Ramps	9	Tuesday and Wednesday	48 hrs *(all vehicles counted)*
I-5 Highway Off-Ramps	11	Tuesday and Wednesday	48 hrs *(all vehicles counted)*

Figure 7. GDA 42 count locations including the 39 gateways (intersection legs and I-5 ramps).



Data Sample

SDOT and WSDOT recorded video footage on 42 locations between September 2018 and November 2018. Table 3 shows all observed vehicles passing through the gateways located along the cordon perimeter (39 of 42 locations) in a 48-hour period.

Table 3: Data sample for the GDA cordon.

Activity Type		GDA Counts (veh)
Private		1,141,430
CVs	**Total CVs**	87,689
	Construction	*10,955*
	General CV	*22,056*
	Goods Transport	*26,555*
	Service	*26,323*
	Waste Management	*1,800*
Public Transit		13,611
Other Transit		10,186
Emergency		1,377
RVs		193
Unknown		1,684
TOTAL		1,256,170

Evaluation of Seattle's Freight Network

Figure 8 and 9 show the daily average truck volume and CV volume for all selected intersections' legs.

When evaluating the observed truck volumes for each location, we found that:

- four Major & Minor truck routes did not meet the 500+ trucks/day threshold defined in Seattle's Freight Master Plan:
  - **I_5. Mercer St & Westlake Ave N, north leg,**
  - **I_6. Fairview Ave E & Eastlake Ave E, northeast leg,**
  - **I_12. Seattle Blvd & 4th Ave S, east leg (inside cordon),**
  - **I_14. 6th Ave S & S Holgate St, north leg**
- two non-truck routes did meet the 500+ trucks/day threshold:
  - **I_12. Seattle Blvd S & 4th Ave S, north leg, and**
  - **I_18. Alaskan Way S & S Atlantic St, west leg (Terminal 46 entry/exit).**

But as Figure 9 shows, when considering all observed CVs (both small fleet and trucks) we found that:

- all Major truck routes met the 500+ CVs/day threshold,
- seven non-truck routes met the 500+ CVs/day threshold:
  - **I_4. Mercer St & Dexter Ave N, north leg,**
  - **I_8. 18th Ave E & E Madison St, west leg,**
  - **I_7.10th Ave E & E Aloha St, south leg,**
  - **I_2. W Mercer St & Queen Anne Ave N, north leg,** and
  - **I_9. E Yesler Way & 12th Ave, east leg.**
  - **I_12. Seattle Blvd S & 4th Ave S, north leg,** reported four times the volume (+ 2250 CVs/day) of the 500+ CVs/day traffic threshold.
  - **I_18. Alaskan Way S & S Atlantic St, west leg,** reported nearly twice the volume (849 CVs/day) of the 500+ CVs/day traffic threshold. Compared to others, this location saw low volum**es** of small fleet CVs (837 trucks and 12 small fleet).
- **I_6. Fairview Ave E & Eastlake Ave E, northeast leg,** the only Minor truck route of the selected count locations, met the 500+ CVs/day threshold.
- eleven Major truck routes reported at least four times the volume (+ 2250 CVs/day) of the 500+ CVs/day traffic threshold, with almost all located in the GDA south perimeter (connected to the Duwamish MIC). Two north perimeter exceptions are **Ref1. Elliot Ave W and W Mercer Pl, northwest leg** and **I_3. Aurora Ave N & Roy St, south leg,** highlighting the importance of both gateways as major entry/exit points for CVs.

Figure 8. Average daily truck traffic for the intersection legs.

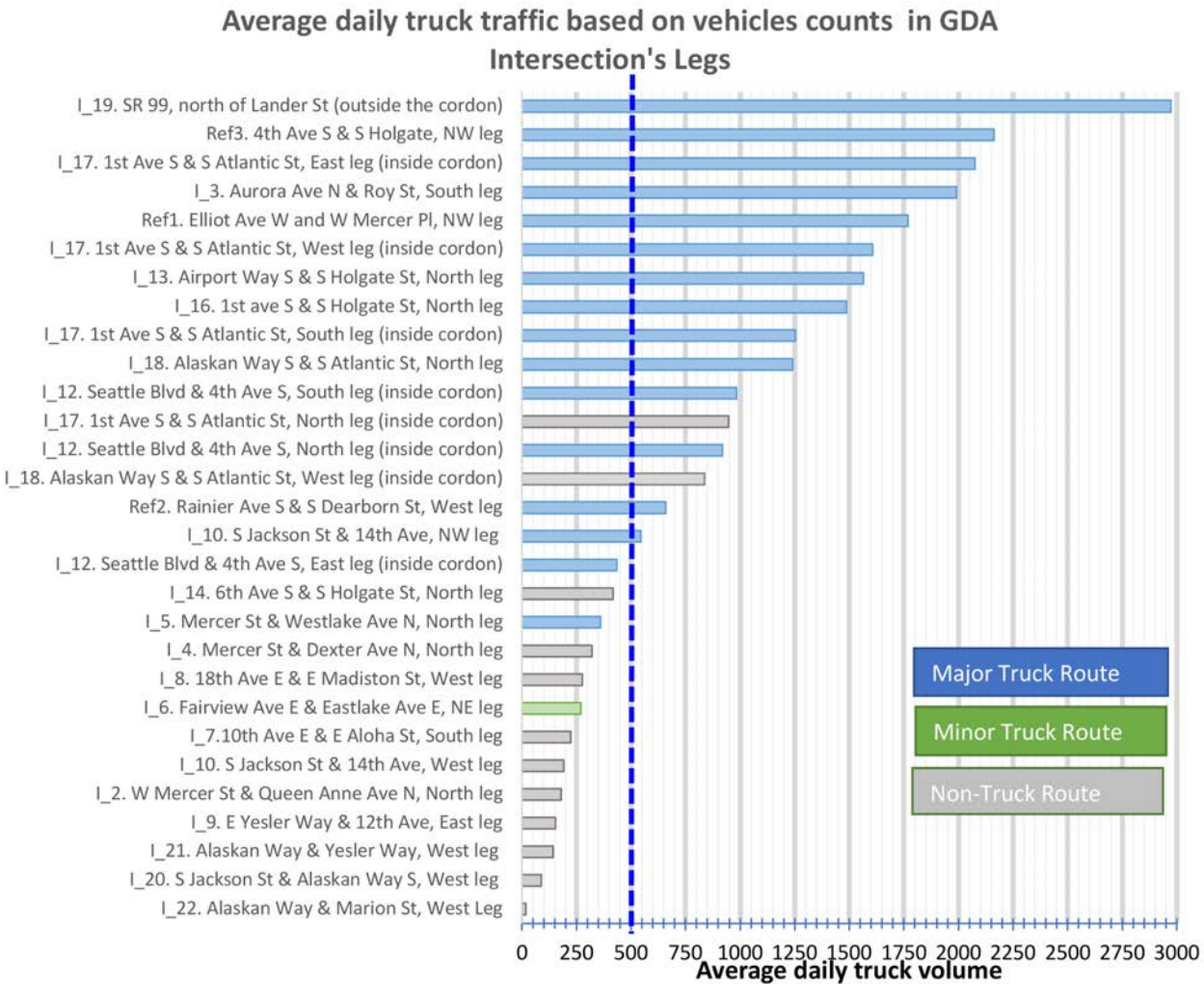


Figure 9. Average daily CV traffic for both small fleet and trucks for the intersection's leg.

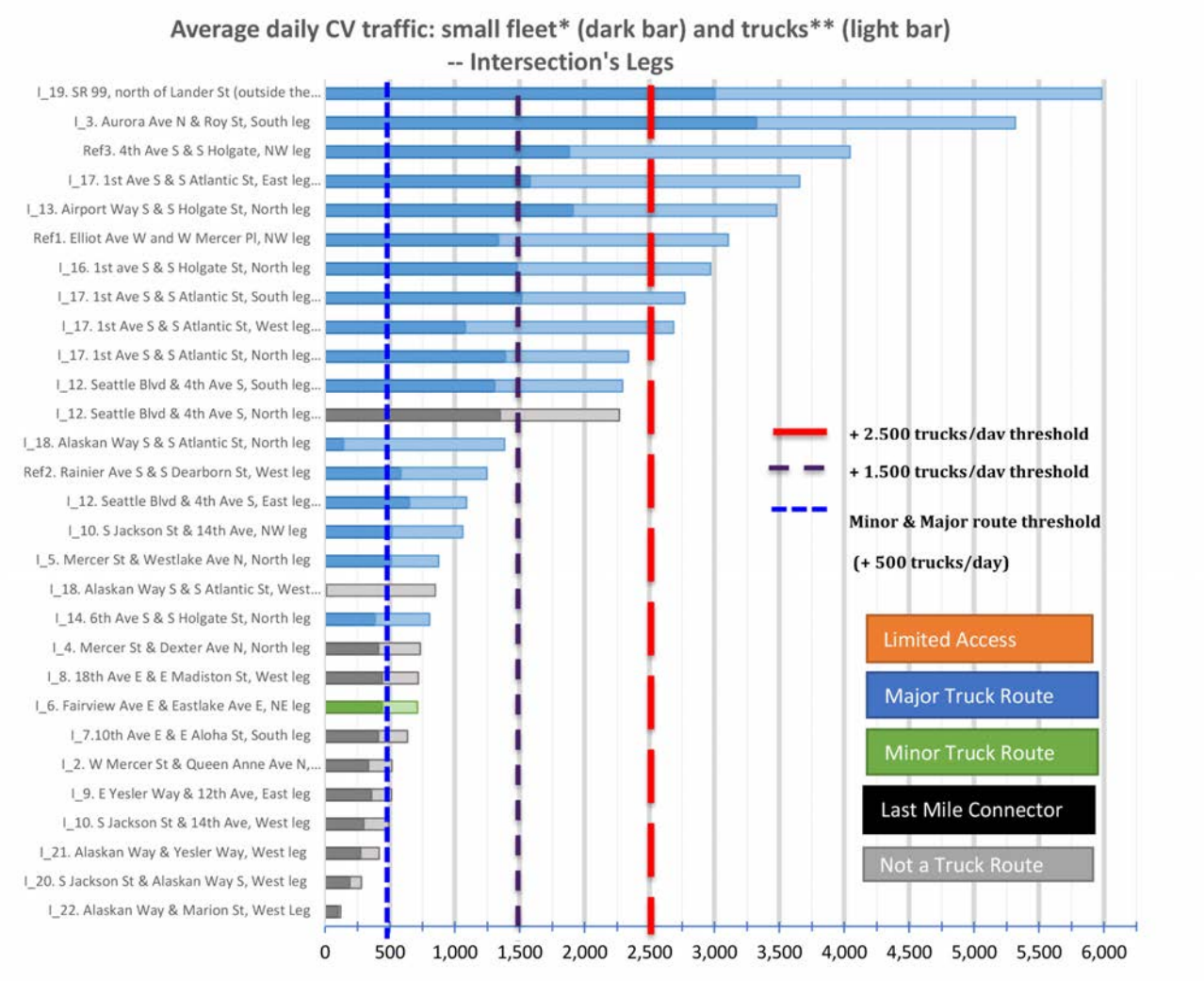


Figure 10 and 11 show the daily average truck volume and CV volume for all 20 I-5 on/off ramps in the study. Most ramps have not been designated as Freight Network elements. The four northernmost ramps, located at Mercer Street, are classified as Limited Access elements, a designation with no daily truck volume threshold.

When evaluating the observed truck volumes for each I-5 ramp, we found that:

- two ramps met the 500+ trucks/day threshold defined in Seattle's Freight Master Plan for Major & Minor elements:
  - **R2. Mercer St, I-5 northbound off-ramp, and**
  - **R4. Mercer St, I-5 southbound on-ramp.**

But Figure 11 shows that when considering all CVs (both small fleet and trucks):

- 65% of the I-5 ramps in the study met the 500+ CVs/day threshold defined in Seattle's Freight Master Plan for Major & Minor elements, including the four at Mercer Street **(R1, R2, R3 & R4)**.

This highlights the importance of the I-5 on/off ramps as commercial gateways in and out of the GDA.

Figure 10. Average daily truck traffic on the GDA ramp gateways.

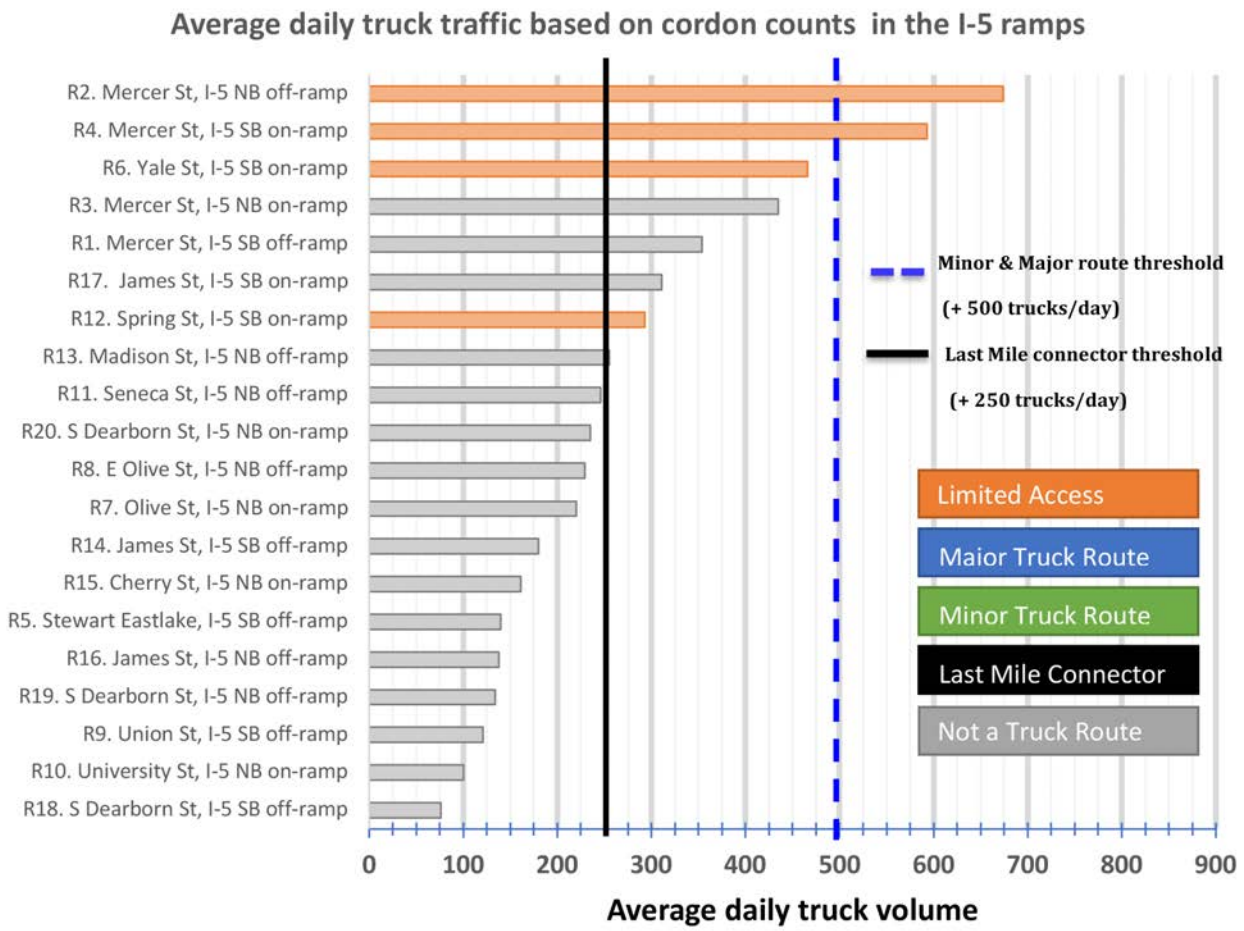
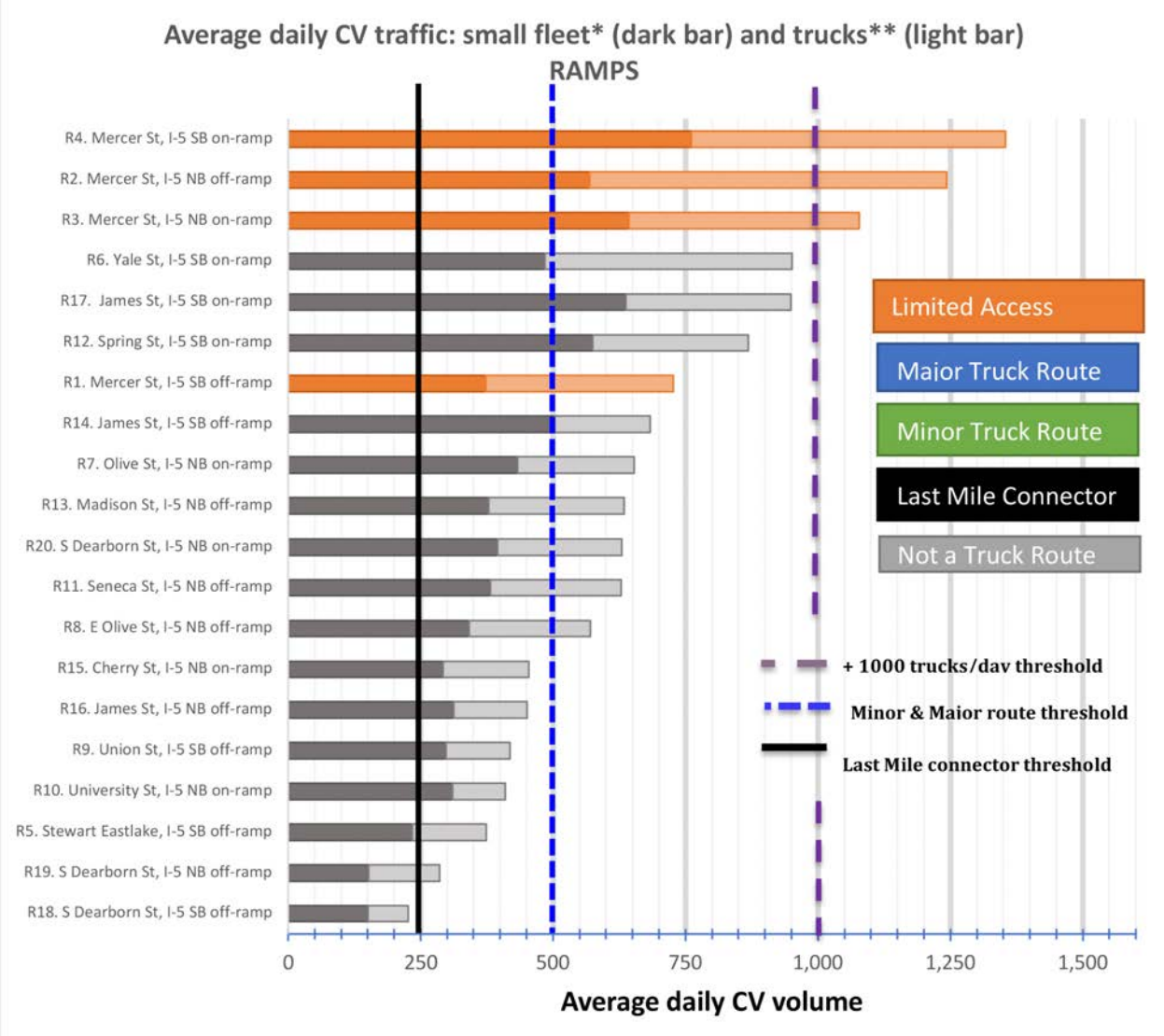


Figure 11. Average daily CV traffic for both small fleet and trucks on the GDA ramp gateways.



General Trends

For the following sections, only the 39 entry/exit gateway locations on the cordon perimeter were used to evaluate inbound/outbound CV traffic patterns. The general trends analysis excludes these three locations:

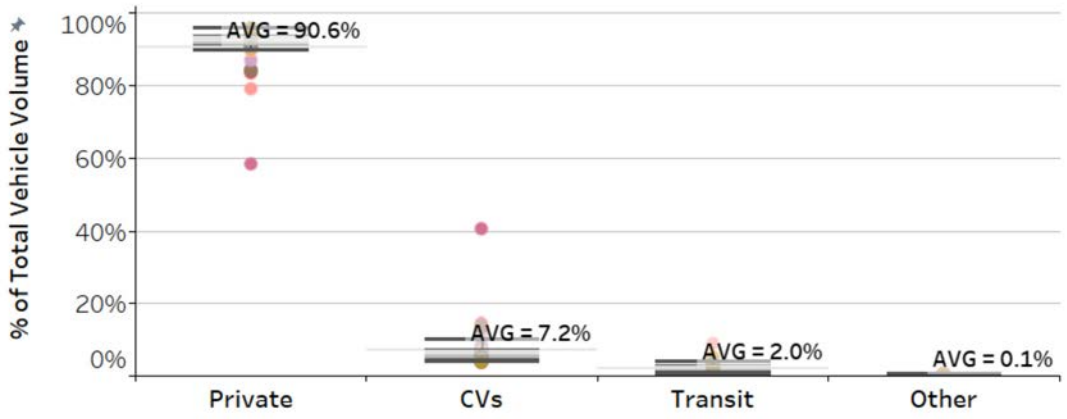
- **I_12. Seattle Blvd S & 4th Ave S**, which is inside the cordon area;
- **I_17. S Atlantic St & 1st Ave S**, which is inside the cordon area;
- **I_19. SR 99, west of S Lander St**, which is south of the cordon.

CV Share of Traffic Volumes

Figure 12 shows the percentage by vehicle usage by mode. As Figure 13 shows, in the GDA:

- The average CV share of total traffic volume is 7%. This percentage drops to 5% when considering only the I-5 ramps; it rises to 9%, when considering the intersections.
- The CV share per location generally varies from 3.6% to 10%. Five locations (all on the south boundary of the cordon) showed a CV share greater than 10% :
  - **I_16. S Holgate St & 1st Ave S** (13%)
  - **Ref 3. S Holgate St & 4th Ave S** (14%)
  - **I_13. S Holgate St & Airport Way S** (14%)
  - **I_18. Atlantic St & Alaskan Way S** with the highest share of CVs (40%).

Figure 12. Traffic composition per location. Note: Transit includes both (1) "Public Transit" and (2) "Other Transit" categories.



CV Volume by Day-of-Week

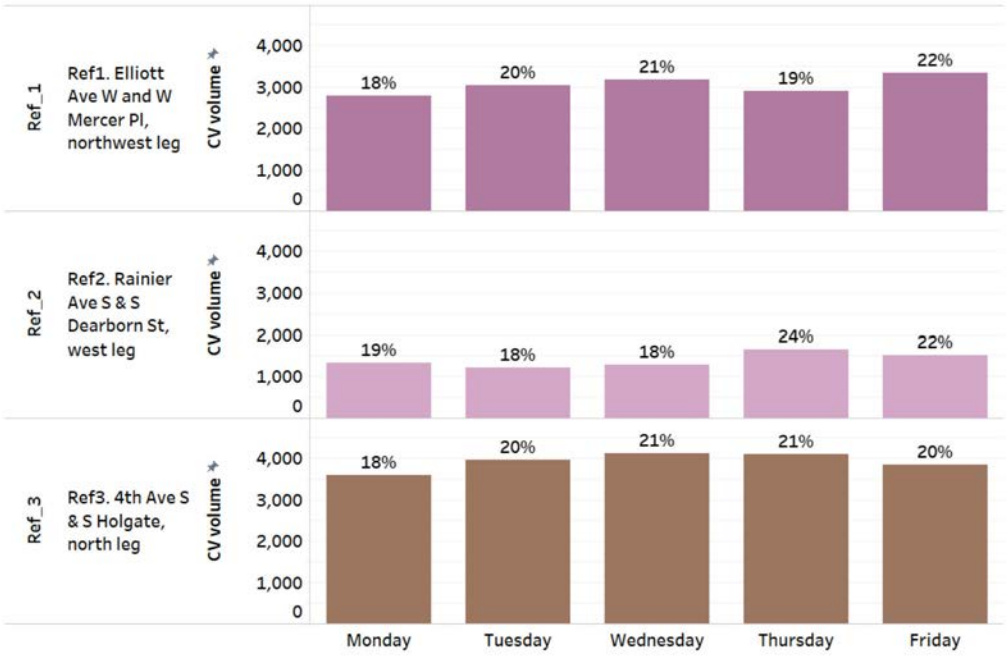
The analysis of traffic volume by day-of-week considers seven-day counts from three gateways. Table 4 summarizes the day-of-week adjustment factor and CV volume for each reference location. This analysis illustrated differences between locations and day of the week:

- For all locations, weekends showed the lowest volume of CVs, with Sunday having the lowest share for all locations (with day-of-week adjustment factors varying between 2.7 and 5.6).
- Mondays (**Ref 1** & **Ref 3**) and Tuesdays (**Ref 2**) had lower volumes than other weekdays with a difference of at least 400 CVs compared to the maximum weekday volume or at least 170 CVs more than the average weekday volume per location.
- Peak weekday volume occurred between Wednesday and Friday, see Figure 13.
- However, weekday CV volume differences between Wednesday, Thursday and Friday were not statistically significant (at a 5% level based on a chi-squared test.)

Table 4. Day-of-week adjustment factors for each reference location in the GDA.

GATE ID	INTERSECTION NAME	LEG INSIDE THE CORDON	M	T	W	TH	F	SAT	S	TOTAL CV VOLUME	WEEKDAY AVERAGE
Ref 1	Elliott Ave W & Mercer Pl	NW	0.869	0.795	0.761	0.838	0.724	2.052	4.592	15233	3047
Ref 2	Rainier Ave S & S Dearborn St	W	0.861	0.932	0.893	0.691	0.757	1.979	2.691	6954	1391
Ref 3	4th Ave S & S Holgate	NW	0.840	0.762	0.732	0.738	0.786	3.100	5.561	19619	3924

Figure 13. Share of CV volume per day of the week.



CV Fleet Composition

In general, the most common CV body types in the traffic volume were commercial pick-ups and work-vans, at 54% of all recorded CVs (see Figure 14).

The second-highest proportion of CV was single-unit 2-axle vehicles, at nearly 30% of all recorded CVs.

As shown in Figure 15, when considering only the I-5 ramps, the share of smaller CV fleet rises to 60% and the volume for all truck categories drops (except for 2 axle single-unit trucks), which is a reasonable finding since the ramps are not elements of the over-legal and heavy haul networks. Both findings are consistent inbound and outbound.

Figure 14. Distribution of all observed CV by body type in the GDA gateways.

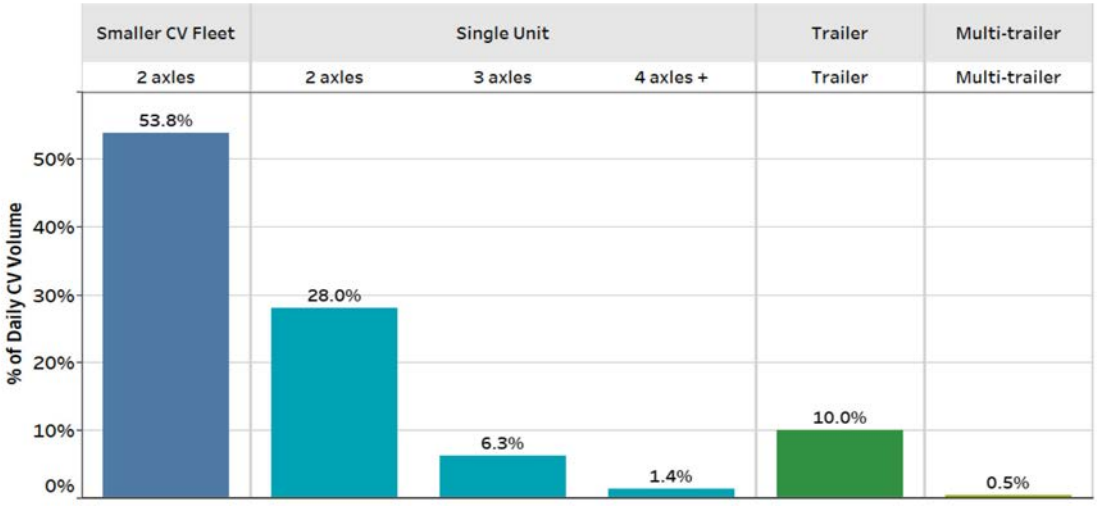
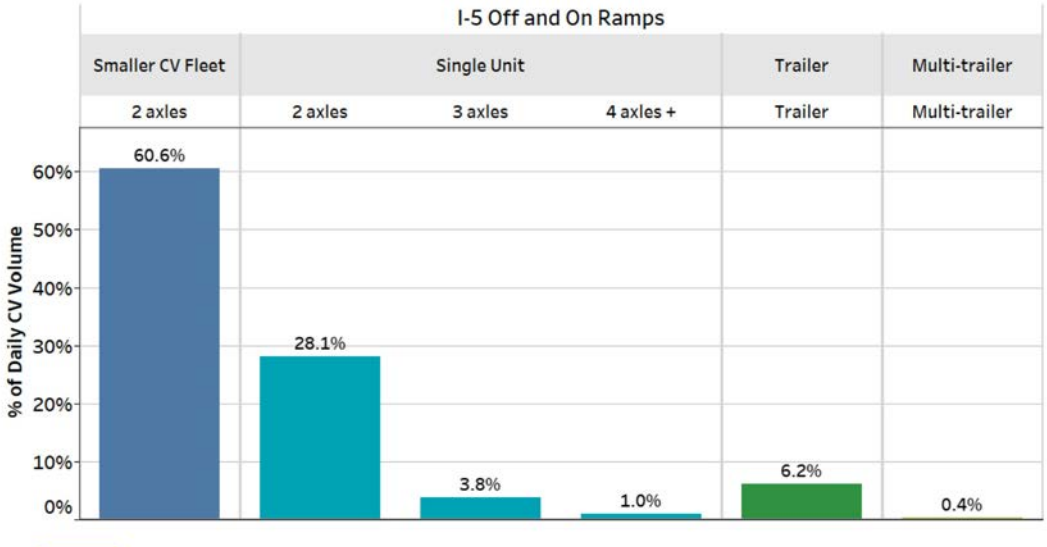


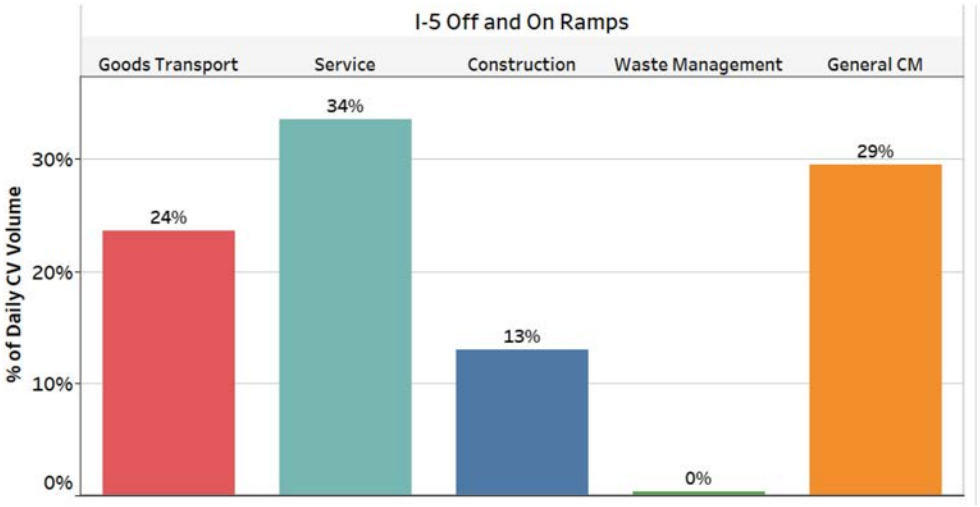
Figure 15. Distribution of observed CV in the I-5 ramps by body type in the GDA.



As indicated in Figure 16, goods transport and service vehicles constituted the highest share, each accounting for 30% of all CV traffic. This finding highlights the importance of service movement in the urban core. It is notable when viewed in light of the findings of the earlier GDA curb occupancy study *(1)*, which found service vehicles tend to have longer dwell times, with 44% of all observed service vehicles parked for more than 30 minutes and 27% parked for an hour or more. Given this study's finding of service vehicles representing a significant share of commercial traffic volume, these vehicles may have a disproportionate impact on parking space rates at the curb. I-5 ramps also showed a high percentage of service vehicles, accounting for 34% of all CV traffic, both inbound and outbound (see Figure 17).

Figure 16. Distribution of all observed CV by vehicle use in the GDA gateways.

Figure 17. Distribution of observed CV in the I-5 ramps by vehicle use in the GDA.



Local conditions and/or the street element purpose (e.g., through trips, regional trips, to/from trips, last/first mile trips) likely make for variations on the CV fleet configuration observed in specific locations. Specifically, we highlight the following GDA gateways with significant volumes of CV (500+ CVs/day) that diverge from the previously described general trend regarding CV activity share or CV body share:

- **R14. James St, I-5 SB off-ramp** was the ramp with 500+ CVs/day that reported the highest share of service vehicles (48%);
- **I_3. Aurora Ave N & Roy St, south leg,** and **I_7.10th Ave E & E Aloha St, south leg** were the gateways with a volume of 500+ CVs/day that showed a +10% variation of the average GDA service vehicle share (40% and 42%, respectively);
- **Ref2. Rainier Ave S & S Dearborn St, west leg** showed the second-highest share of goods transport vehicles (38%) and the highest share of multi-trailers (3%).

- **I_18. Alaskan Way S & S Atlantic St, north leg** showed the biggest share of goods transport vehicles (76%) and the highest share of trailer trucks (59%); notably, the west leg of this intersection functions as Terminal 46's entry/exit.
- Four additional gateways had the highest percentage of trailer trucks share (between 13% and 18%) : **(I_14. 6th Ave S & S Holgate St, north leg; I_16. 1st ave S & S Holgate St, north leg, I_10. S Jackson St & 14th Ave**, **northwest leg**; and **R2. Mercer St, I-5 NB off-ramp**);
- **Ref1. Elliot Ave W and W Mercer Pl, northwest leg** and **Ref3. 4th Ave S & S Holgate, northwest leg** showed the highest share of single-unit trucks (46% and 45%).

Daytime and Nighttime Comparison

Since the counts were collected in a 24-hour period, it was possible to examine and compare traffic between 'daytime' (defined as 06:00-17:59) and 'nighttime' (defined as 18:00-23:59 and 00:00-05:59). As indicated in Figure 18, only 15% of all CV traffic was recorded during nighttime hours, suggesting no considerable travel demand in off-peak hours. In contrast, nearly twice as much private traffic volume was at nighttime (28%).

Figure 18. Comparison of daytime and nighttime traffic counts.

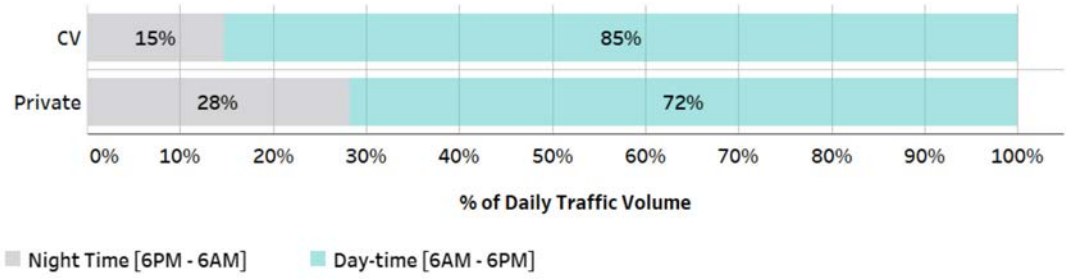


Figure 18. Comparison of daytime and nighttime traffic counts.

Vehicle Counts by Time of Day (Time Profile)

The vehicle counts were accumulated for each hour, with each hour averaged over the 48-hour period to obtain the study area time profile. Figure 19 shows that CV volumes throughout the day are significantly smaller than private vehicle volume. Private vehicle traffic has very distinct peaks during the commuter AM/PM peak periods, reflecting passenger vehicles' general profile across Seattle.

The vast majority of CVs were observed during business hours (6 AM and 6 PM). In contrast to the private vehicle pattern, CV time-of-day pattern has only one "hump," peaking during the morning and early afternoon, and steadily declining over the day. The 'spare' capacity freed up by the decline in Private vehicles between commuter peaks was utilized by the number of CVs observed in the selected gateways.

Figure 19. Average daily CV and private vehicle volume (veh/hr).

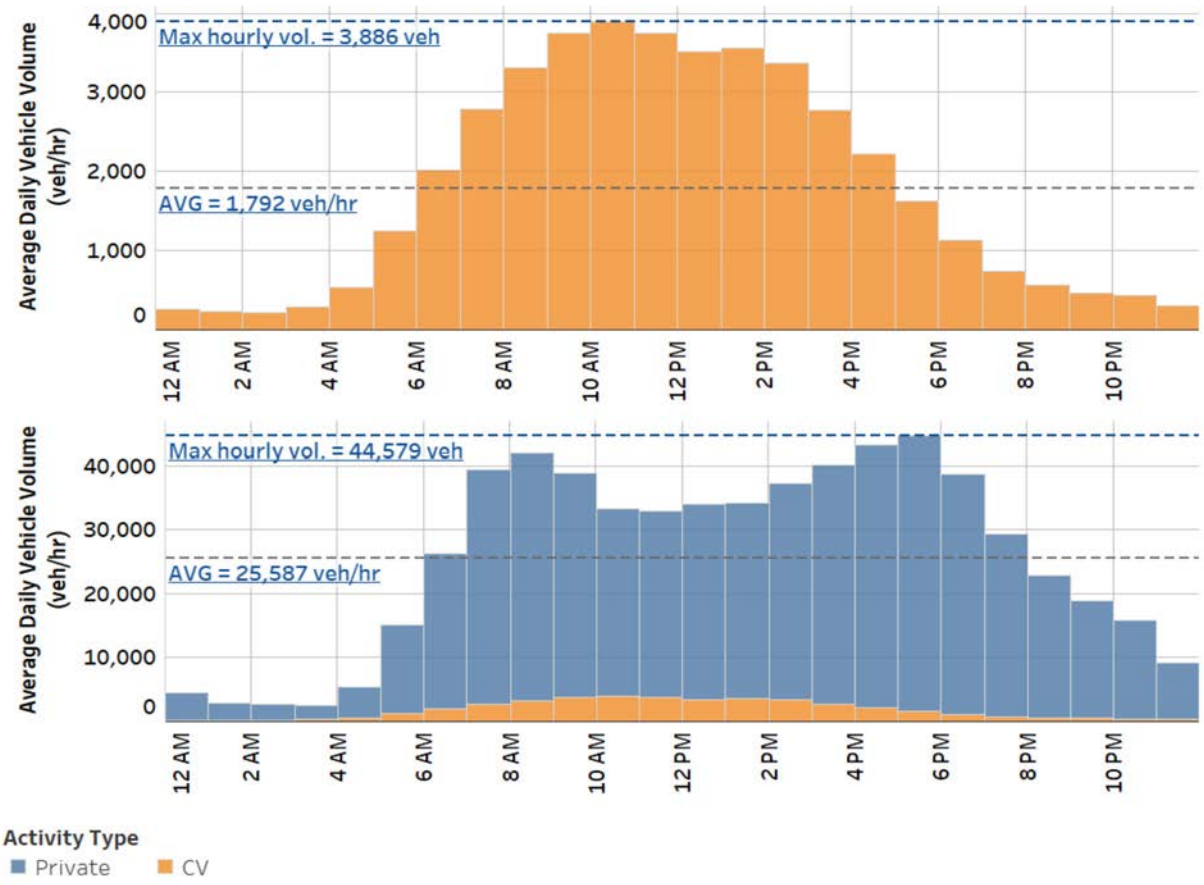
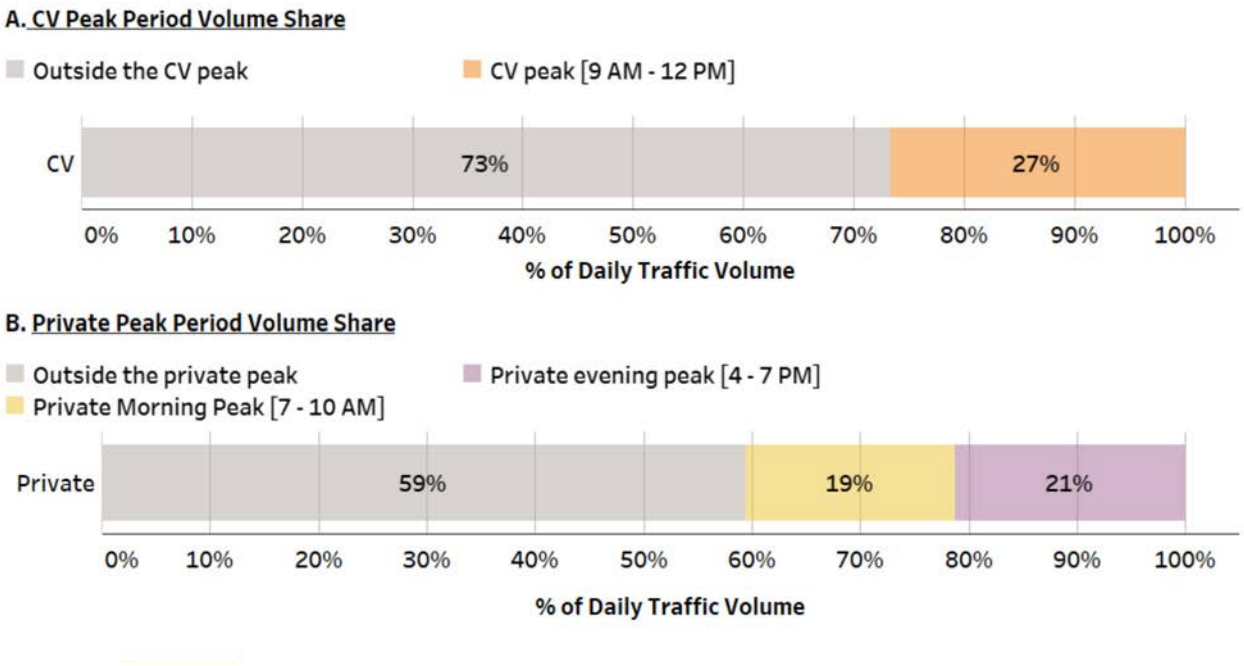


Figure 20 shows the vehicle volume share during the three hours with the highest volume for CV, the private vehicle AM peak, and the private vehicle PM Peak. The three most intense hours for CV traffic [9 AM – 12 PM] hold 27% of the CV traffic based on the vehicle count data. In contrast, 19% of private vehicles were observed during the AM peak period [7:00 – 10:00 AM] and 21% during the PM peak period [4:00 PM – 7 PM]. This finding suggests that CVs have a more intense peak than private vehicles.

Figure 20. Comparison of peak vs non-peak traffic counts for commercial and private.



Peak Hour and Directionality

Overall, CV traffic peaks at 9:45 AM, two hours after the private vehicle AM peak (7:45 AM) and 7 hours before the private vehicle PM peak (5:00 PM). Looking across gateways, CV peak took place between 7:00 AM and 1:45 PM with 54% of the GDA gateways peaking during the 3 hours of maximum CV volume [9 AM to 12 PM], except:

- five I-5 off ramps peaked between 5:30 AM - 5:45 AM:

  R5. Stewart Eastlake, I-5 SB off-ramp,

  R9. Union St, I-5 SB off-ramp,

  R11. Seneca St, I-5 NB off-ramp,

  R13. Madison St, I-5 NB off-ramp, and

  R16. James St, I-5 NB off-ramp

- **I_20. S Jackson St & Alaskan Way S, west leg** (a Seattle ferry terminal entry) peaked at 3:00 PM, with 95% of CV traffic entering the ferry terminal and only 5% entering the GDA.
- **I_22. Alaskan Way & Marion St, west leg** (a Seattle ferry terminal exit) peaked at 7:00 AM, close to the same time as the private vehicle peak.

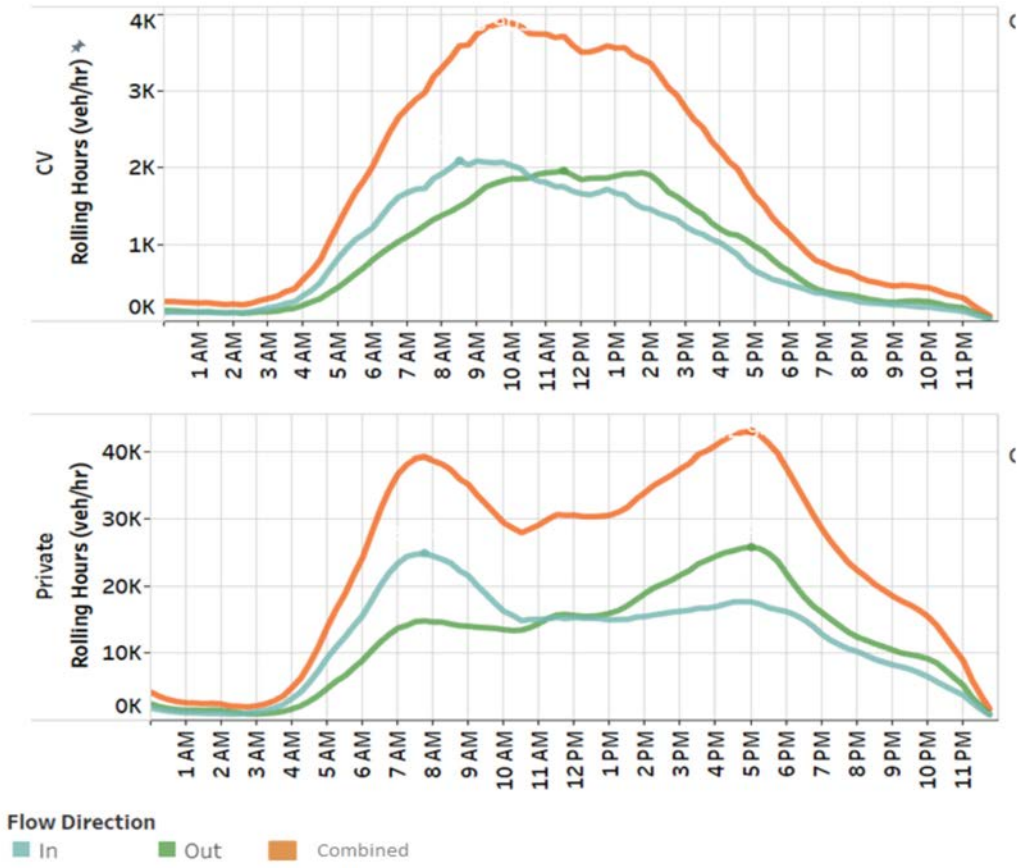
Regarding directionality, overall inbound and outbound CV volume both peaked in the morning: inbound at 8:30 AM and outbound at 11:30 AM, see Figure 21. In contrast, private inbound volume peaked at 7:45 AM and outbound volume peaked at 5:00 PM. Additionally, daily average inbound and outbound CV volumes are balanced with a daily hourly volume of 459 CVs/hr and 463 CVs/hr, respectively. All but three of the 39 gateways have a single leg; the remaining three have two legs. When evaluating directional CV traffic per gateway leg:

- traffic in 78% of legs peaked between 7:00 AM – 1:45 PM
- traffic in 58% of legs peaked between 9 AM – 12 PM
- traffic in all legs in the northern boundary and northeast corner had similar peaks for both inbound and outbound volumes (± 2:00:00 hrs difference) between 9:00 AM - 1:00 PM:

  Ref1. Elliot Ave W and W Mercer Pl, northwest leg,

  - **I_2. W Mercer St & Queen Anne Ave N, north leg,**
  - **I_4. Mercer St & Dexter Ave N, north leg,**
  - **I_5. Mercer St & Westlake Ave N, north leg,**
  - **I_6. Fairview Ave E & Eastlake Ave E, northeast leg,**
  - **I_7.10th Ave E & E Aloha St, south leg,** and
  - **I_8. 18th Ave E & E Madiston St, west leg.**
- Both gateways that access the Seattle Ferry Terminal **(I_20. S Jackson St & Alaskan Way S, west leg and I_21. Alaskan Way & Yesler Way, west leg**) showed simultaneous peaks for CV GDA outbound volumes at 3:00 PM, not significantly different from the private vehicle peak. But while the private traffic pattern showed a clear afternoon peak, **I_20** outbound volume and **I_21** inbound/outbound CV volume peaked between 4:45 AM and 5:15 AM, with volumes staying almost constant throughout the day with a sharp decrease between 3:30 and 4:30 PM.

Figure 21. Private and commercial vehicle rolling hour by time of day *(different scales used)*.



Time Profiles by CV category

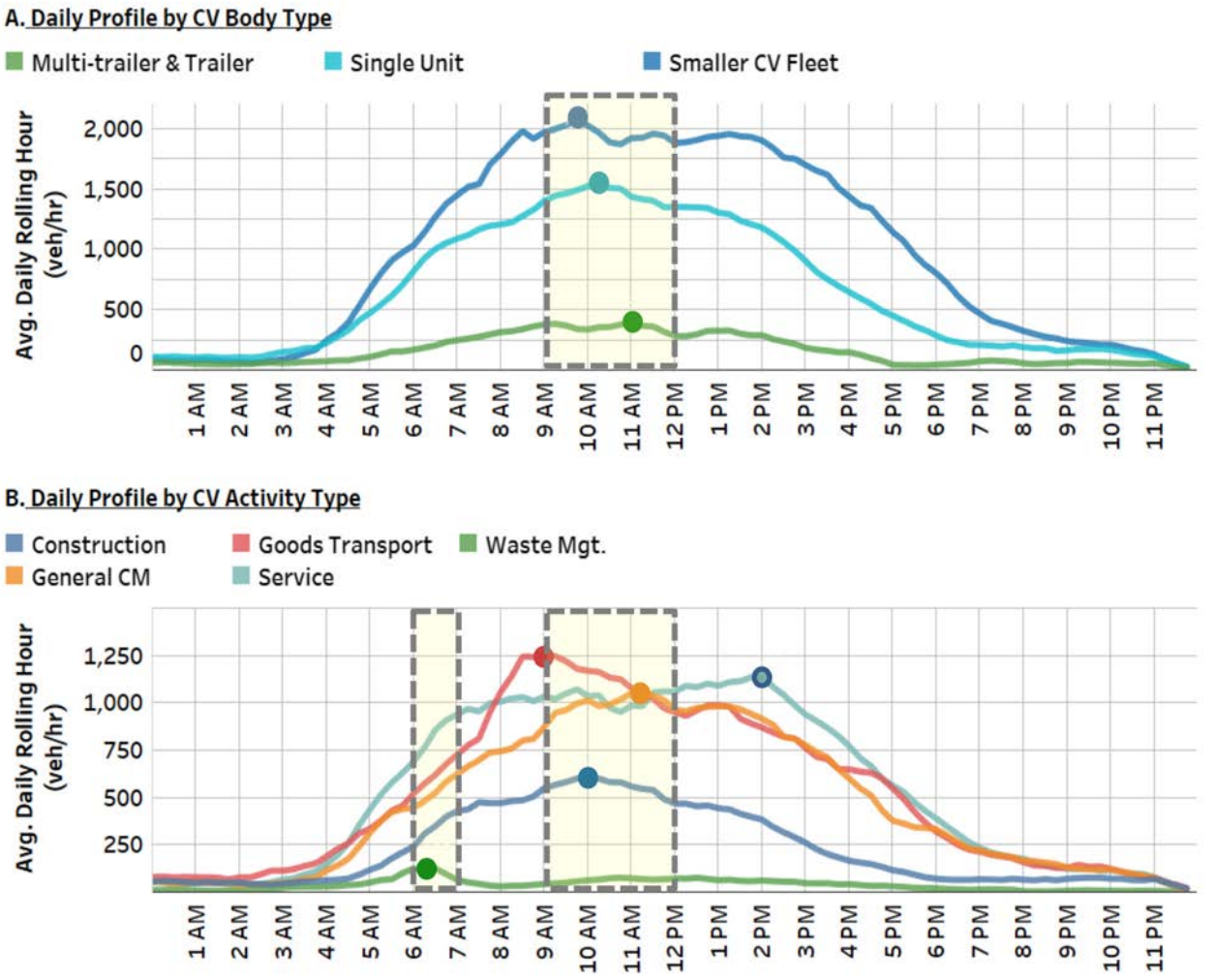
When evaluating CV activity, each vehicle category peaked at different times:

- Waste Management (WM) peaked at 6:15 AM. However, this category is highly sensitive to changes in trends due to the small share of WM vehicles;
- Goods Transport peaked at 9:00 AM;
- Construction and General CM were consistent with overall trends, peaking at 10:00 AM and 11:15 AM, respectively;

Service is the only CV category that peaked in the early afternoon, at 2:00 PM.

While there are peak differences in each CV category, overall CVs across body type peaked between 9:45 AM – 11:00 AM, as indicated in Figure 22 and consistent with the overall trend findings described earlier.

Figure 22. Daily profiles by: (a) CV body type, and (b) activity type.



Geographical Differences

While the previous section discusses key findings based on aggregated daily traffic patterns found across all cordon perimeter locations, this section examines the reference gateways, where seven days of CV counts were collected. This analysis explores traffic pattern spatial variations, as daily patterns of specific vehicle classes and directions can be easily affected by local conditions.

These three locations provide a snapshot of the different sides of the cordon perimeter:

- **Ref 1. Elliott Ave W & W Mercer PI** - northwest corner,
- **Ref 2. Rainier Ave S & S Dearborn St** - southeast corner, east of I-5,
- **Ref 3. S Holgate St & 4th Ave S** -- south boundary, west of I-5.

These three case studies give greater detail and understanding of GDA inbound/outbound commercial traffic patterns, as well as describe who is using these transportation elements. The three examples clearly illustrate how the adjacent land, proximity to freight facilities, street type and network connectivity impact network elements' use patterns.

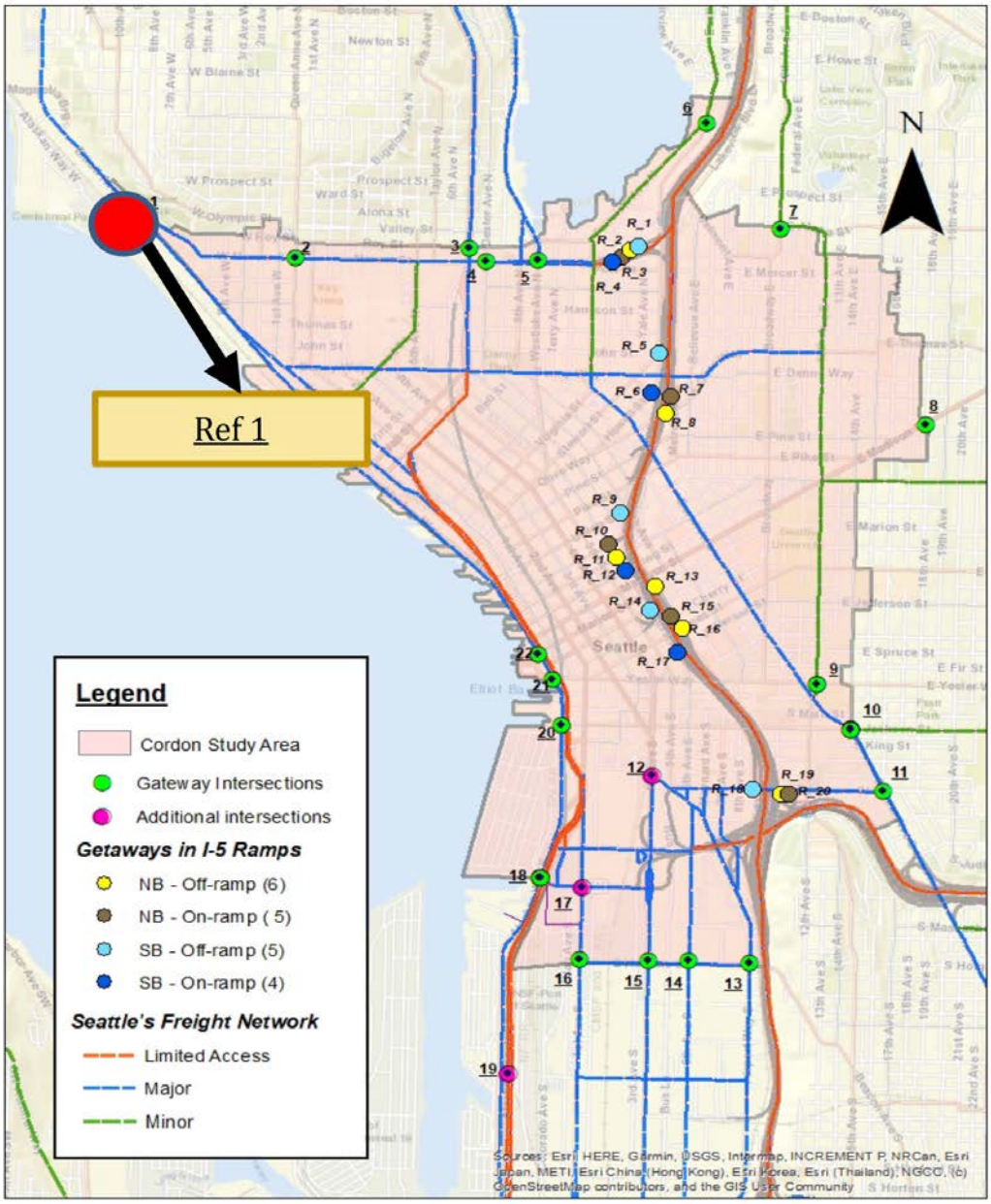
Ref 1. Elliott Ave W & W Mercer PI

This gateway only includes the northwest leg of the intersection located in the northwest corner of the GDA cordon, as it can be observed in Figure 23. A total sample of 16,939 CVs were observed in a 24-hour period for 7 consecutive days with 10% of all CV volume during the weekend (see Table 5).

Table 5. Data sample for Ref 1. Elliott Ave W & W Mercer PI.

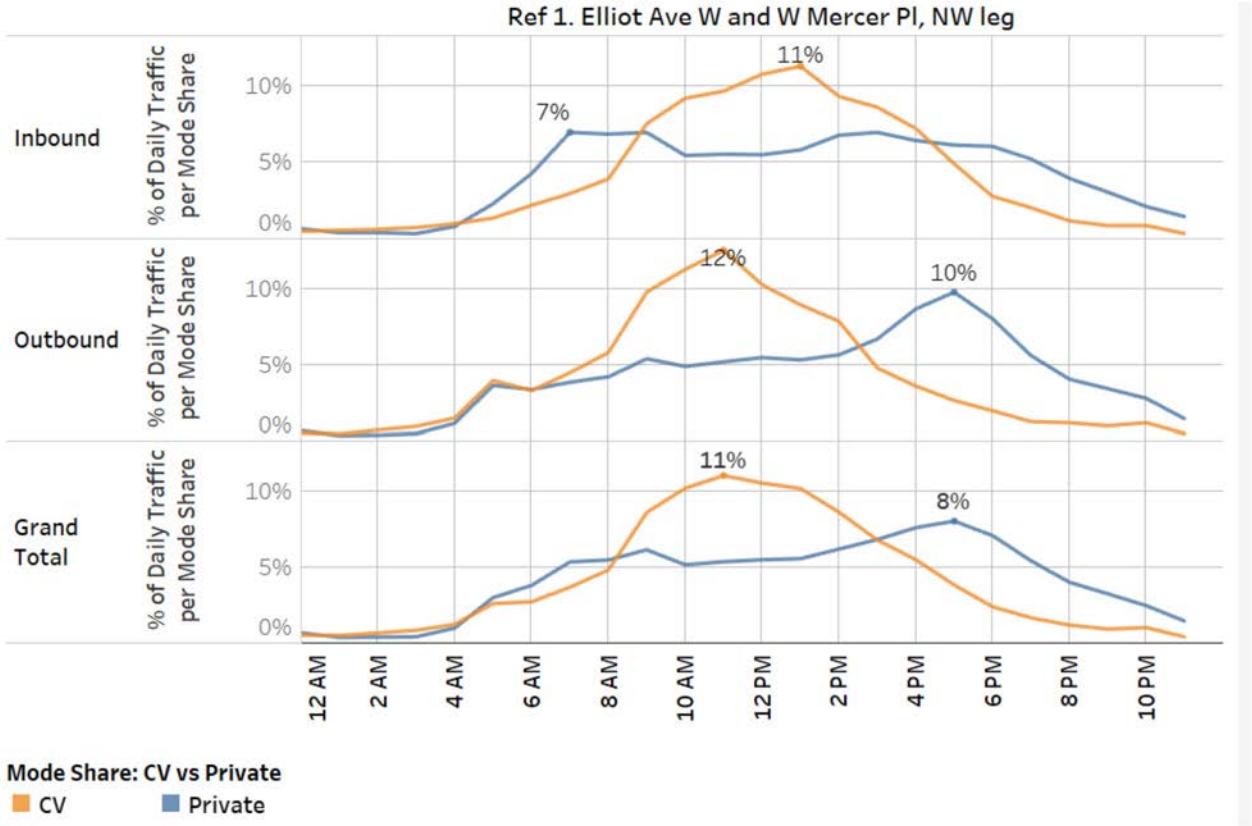
	WEEKDAYS (VEH)	WEEKEND (VEH)
Number of CVs	15,233 (90%)	1,706 (10%)
Avg. number of CVs per day	3,046	853

Figure 23. Reference 1 Elliott Ave W & W Mercer Pl location.



Outbound and inbound flows were balanced. Unlike private vehicle flow, CV outbound flows had a late morning peak and inbound peaked in early afternoon. CVs peaked in the 'spare' capacity left between the private vehicle peaks. These findings are consistent with the overall traffic pattern observed in the gateways along the north boundary of the cordon (between Elliot Avenue W & Fairview Avenue N). See Figure 24 for outbound and inbound flows daily profiles by percentage of total vehicle volume by mode share (private and CV).

Figure 24. Share of Traffic Volume per Mode Share for Reference location 1.



A higher than average percentage of trailers (11%) and 2-axle single-unit trucks (35%) were observed in this gateway, which may be explained by Elliot Ave W's connectivity to the industrial facilities along Alaskan Way.

This location had one of the lowest shares of service vehicles (19%), but relatively high shares of goods transport and construction vehicles across the GDA gateways. This may be explained by the Port terminals and the many construction projects along Alaskan Way.

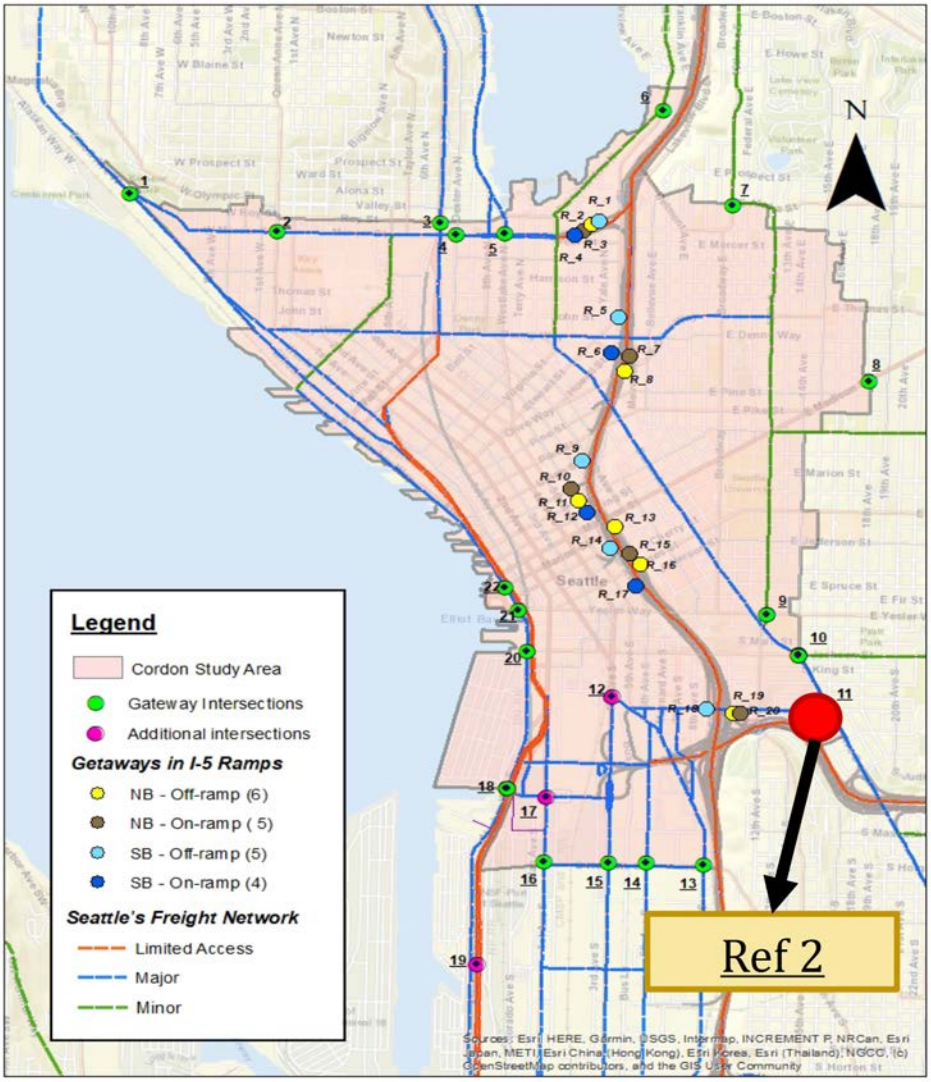
Ref 2. Rainier Ave S & S Dearborn St

This gateway only includes the west leg of the intersection in the southeast corner of the GDA cordon (see Figure 25). A total sample of 7,950 CVs were observed in a 24-hour period for seven consecutive days. This gateway had the highest share of weekend traffic (13%) of the three reference locations (see Table 6).

Table 6. Data sample for Ref 3. S Holgate St & 4th Ave S.

	WEEKDAYS (VEH)	WEEKEND (VEH)
Number of CVs	6,954 (87%)	996 (13%)
Avg. number of CVs per day	1,390	498

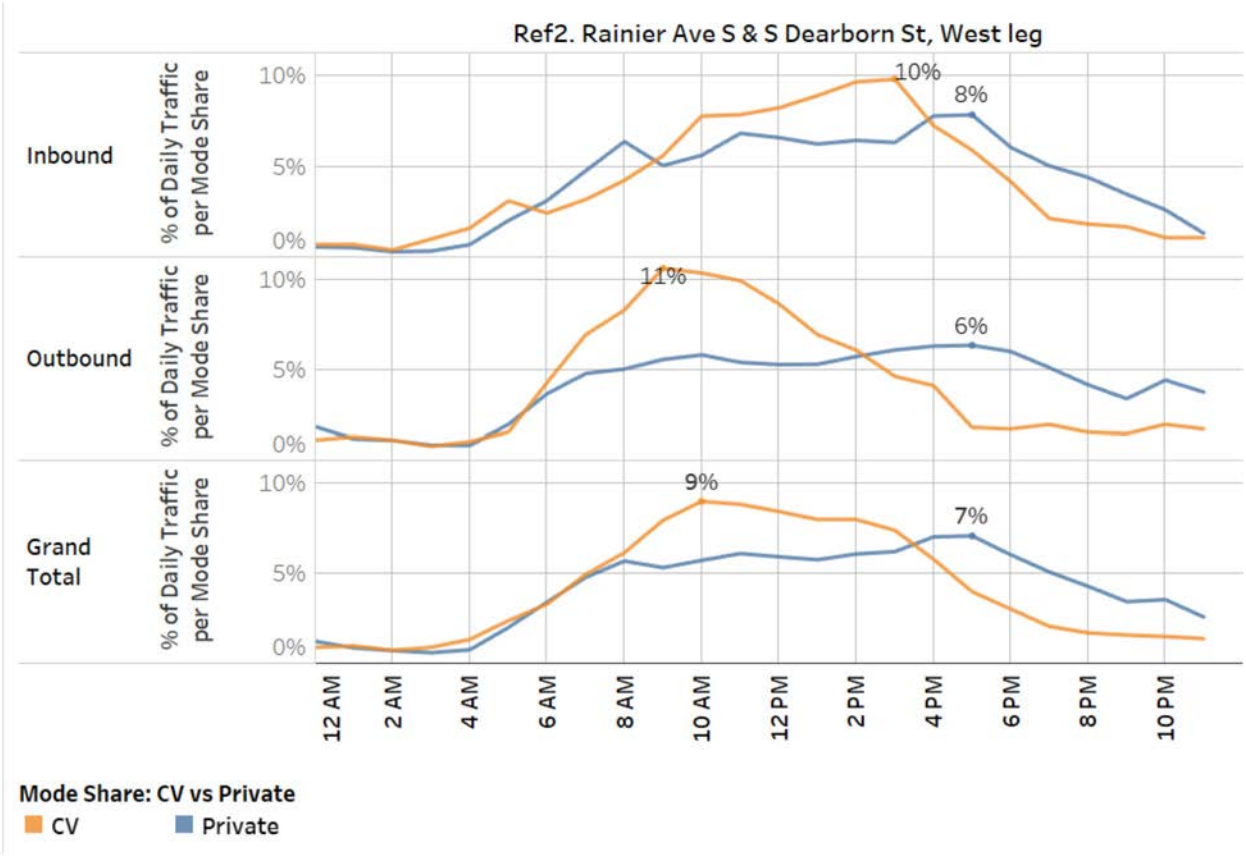
Figure 25. Ref 2. Rainier Ave S & S Dearborn St location.



The CV fleet included a higher than average share for all truck categories and one of the highest shares of multi-trailers (4%), as well as the GDA study area's largest share of goods transport vehicles (38%). Conversely, it also had one of the lowest shares of service vehicles (17%). The parcels adjacent to this gateway have a mix of industrial, commercial, and midrise residential buildings, including Public Storage, Goodwill, and Franz Bakery facilities.

Outbound and inbound flows were balanced. However, CV outbound flows showed a more pronounced peak earlier than the inbound flows, which steadily increased from late morning through mid-afternoon. See Figure 26 for outbound and inbound flows daily profiles by percentage of total vehicle volume by mode share (private and CV). Similar patterns were observed in other west/east legs of the gateways in the southeast corner of the GDA cordon. These legs in the southeast corner also showed variations between private and CV daily traffic patterns, where the private flows had late afternoon peaks in both directions. Finally, the locations in the southeast corner (Ref 1, Locations 10 and 11) had the most variations in daily CV traffic patterns among adjacent getaways.

Figure 26. Share of Traffic Volume per Mode Share for Reference location 2.



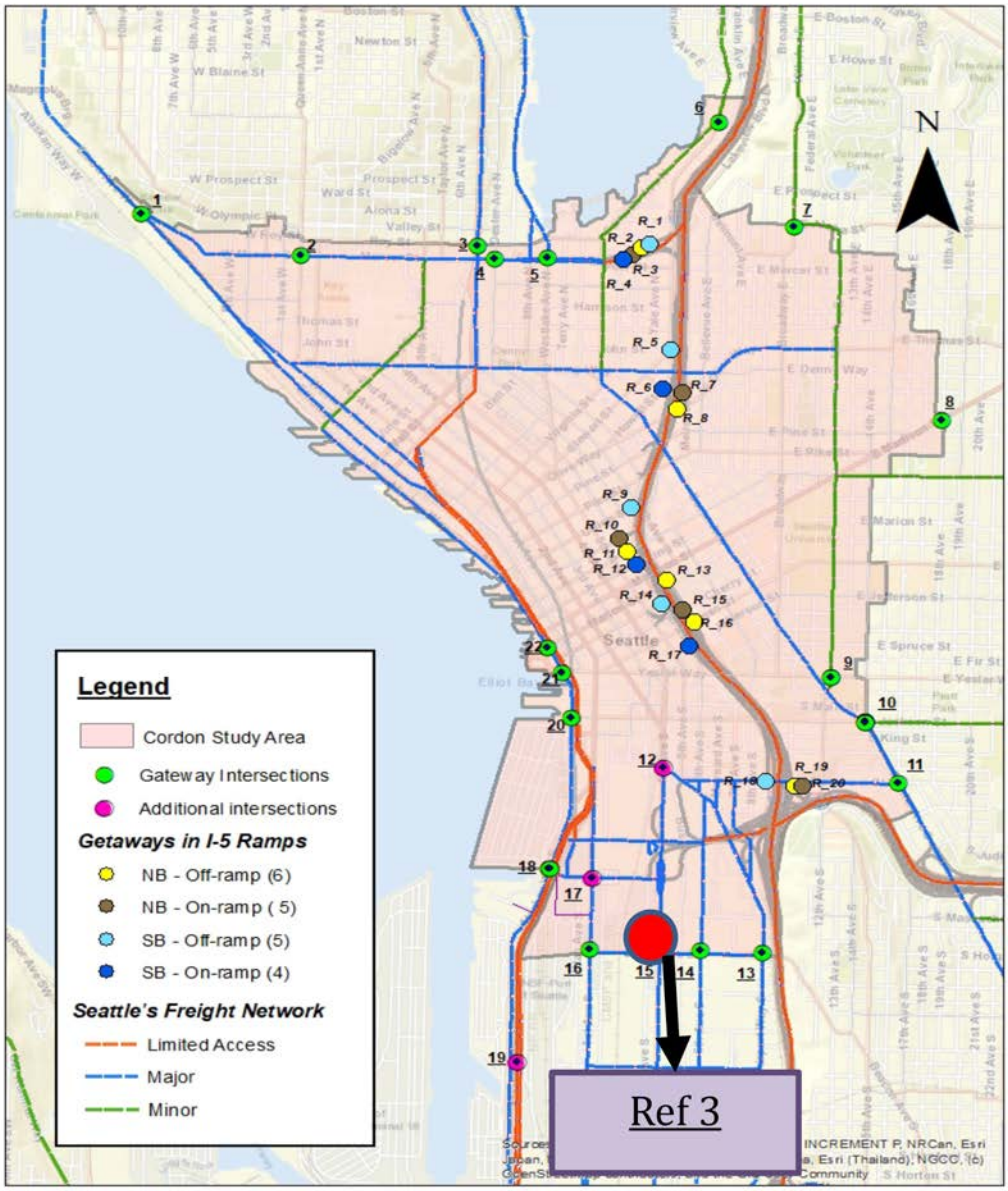
Ref 3. S Holgate St & 4th Ave S

This gateway only includes the north leg of the intersection and is on the south boundary of the GDA cordon as shown in Figure 27. A total sample of 21,163 CVs were observed in a 24-hour period for seven consecutive days with only 7% of all CV volume during the weekend (see Table 7).

Table 7. Data Sample for Ref 3. S Holgate St & 4th Ave S

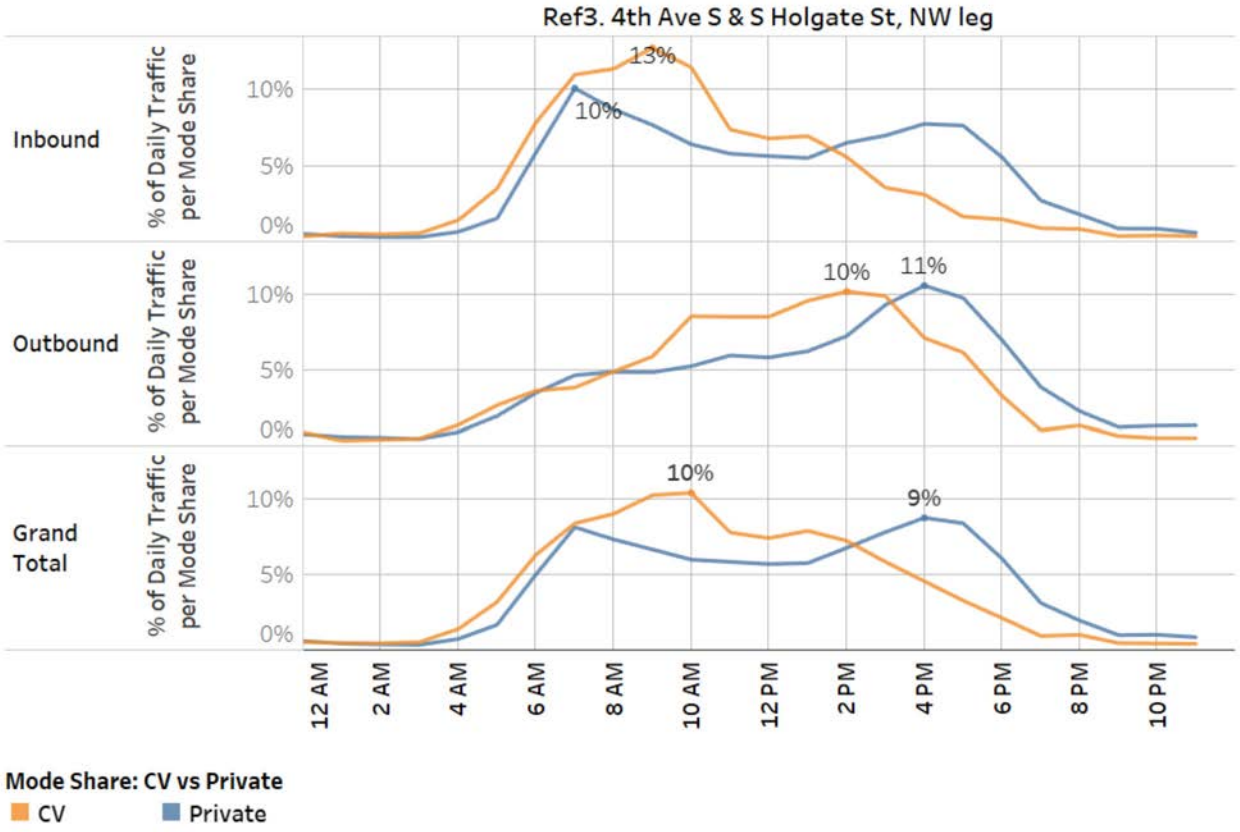
	WEEKDAYS (VEH)	WEEKEND (VEH)
Number of CVs	**19,619 (93%)**	**1,517 (7%)**
Avg. number of CVs per day	**3,924**	**758**

Figure 27. Ref 3. S Holgate St & 4th Ave S location.



CV volume has a directional split with an early morning inbound peak and early afternoon outbound peak. Unlike Ref 1, commercial travel peaked similar to private vehicles: morning for inbound flows and afternoon for outbound flows. See Figure 28 for outbound and inbound flows daily profiles by percentage of total vehicle volume by mode share (private and CV). This finding is consistent with the overall traffic pattern observed in the gateways along the south boundary (between Alaskan Way S & Airport Way S) with the exception of **I_16. 1st ave S & S Holgate St, north leg**, which reported an early outbound peak at 10:30 AM. Inbound peak volume (328 CVs/hr) was twice that of the outbound peak volume (152 CVs/hr). These south boundary gateways are in the Duwamish MIC, Seattle's biggest logistics hub, where much land is devoted to warehousing, maritime, and industrial purposes including Port terminals, UPS, and Fedex distribution centers.

Figure 28. Share of Traffic Volume per Mode Share for Reference location 3.



Manufacturing may explain why this gateway has one of the highest CV shares of total traffic (14%, twice the GDA study area average). The commercial fleet showed a higher than average share of single-unit trucks, particularly 3-axle single-unit trucks (11.5%, twice the average for the GDA study area). Compared to other reference locations, this one has one of the lowest shares of service vehicles (19%).

Finally, this location has the study area's highest share of waste management vehicles (9%), which may be explained by the Republic Services recycling facility at S Lander St, west of 3rd Ave S.

BALLARD-INTERBAY VEHICLE COUNT

Overview

This chapter presents the findings and analysis of vehicle counts collected in the Ballard, Interbay, and Fremont area (subsequently referred to as Ballard-Interbay). The Seattle Department of Transportation (SDOT) provided the counts, which were collected based on the vehicle typology the SCTL Center research team developed for the Seattle Greater Downtown Area (GDA) Vehicle Cordon Study.

As with the cordon study, these counts were collected through manual video processing for 29 selected locations between December 18, 2019 and January 2, 2020. For this study, each site represents an intersection roadway leg in which a screen-line count was performed. Street cameras recorded two days of video during midweek (Tuesday, Wednesday, or Thursday) 24 hours per day for each of the 29 gateways between December 2019 and January 2020. The video footage processing captured granular data about the day of the week, time of day, vehicle body type, vehicle use, number of axles, and directionality. Unlike the GDA cordon project, directionality in the Ballard-Interbay study does not refer to inbound/outbound flows, as there is no cordon with which to measure this. Instead, directionality in the Ballard-Interbay study refers to (and captures) compass directions: North, East, South, West.

Key Findings

- Measured by activity type, Service vehicles make up the study area's biggest share of commercial vehicle (CV) traffic (40%).
- Measured by vehicle body type, smaller vehicles (i.e., pick-ups, vans, and step vans) represent the most significant share (60%) of all CV traffic.
- On average, daily CV traffic is not significant during the nighttime period [7 PM – 7 AM] (9%) with a higher-volume share during the three hours of maximum volume [9 AM -12 PM] (31%).
- Overall study area CV traffic peaked at 10:15 AM.
- In all locations, CV traffic peaked between 7:45 AM – 1 PM, with 80% peaking in the 9 AM – 12 PM period.
- When considering both small CV fleets and trucks, approximately 40% of the Minor & Major truck routes showed more than double (1,000+ CVs/day) of the 500+ daily truck volume threshold set in the Seattle Freight Master Plan.
- Most locations with the highest CV volumes are found along the three N/S corridors (15th Ave NW, Fremont Bridge and Aurora Avenue N) and the two E/W corridors (NW Market and Leary Way NW).

Gateway Selection

A total of 29 locations were selected in coordination with the Seattle Department of Transportation (SDOT) based on (see Figure 29):

(a) Seattle's freight network designation system *(9)*, and

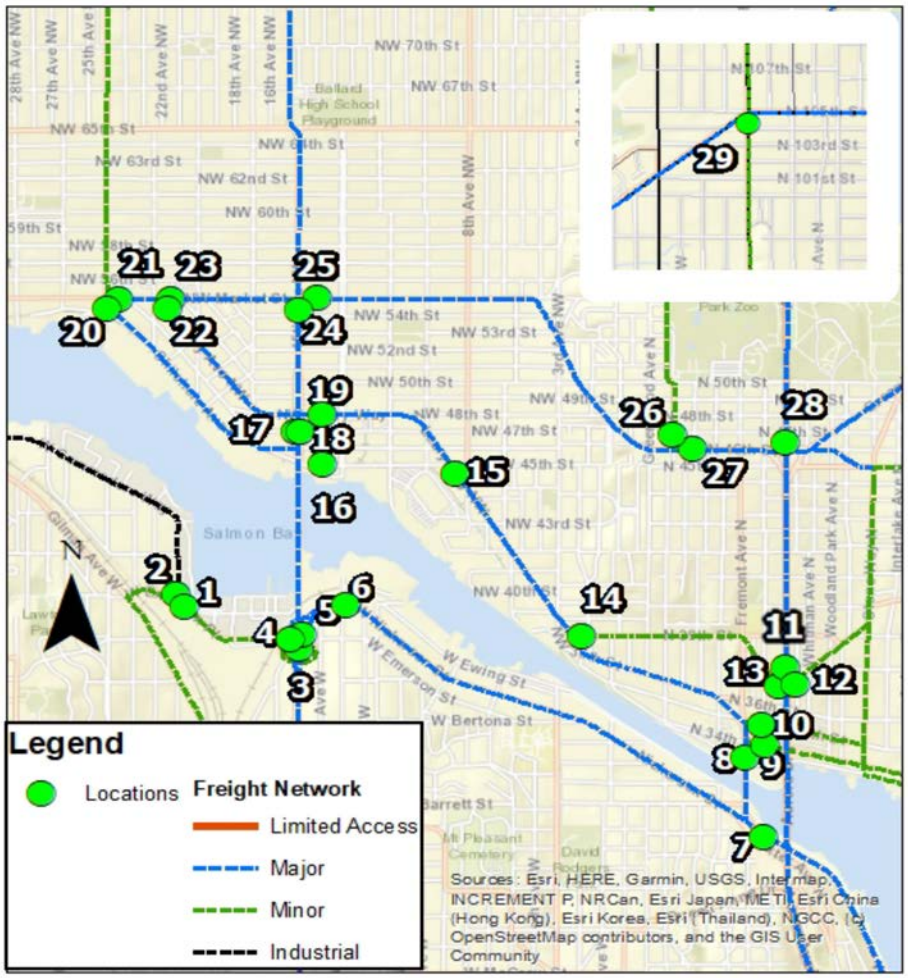
(b) the location of existing traffic cameras in the study area.

For this study, each location represents a roadway leg in which a screen-line was done. These locations comprehensively capture all major commercial traffic routes in the study area, including arterials, collector arterials and the ramps for the Ballard, Fremont, and Aurora bridges. The selected roadways also capture CV volumes along the study area's major corridors:

- North-South:
  - **15th Ave W/NW,**
  - **Fremont Ave N, and**
  - **Aurora Avenue N.**
- East-West between the N-S corridors:
  - **NW Market St, and**
  - **NW Leary Way.**

See the complete list of locations in Appendix C.

Figure 29. Ballard/Interbay 29 count locations.



Study Area

The vehicle counts were collected in five of Seattle's neighborhoods: Interbay, Fremont, West Woodland (Ballard District), Adams (Ballard District), Queen Anne (northern and eastern areas), and Greenwood. This area consists of maritime, industrial, commercial, and residential land uses with critical local and regional freight routes, see Figure 30.

Over the past 15 years, the Ballard-Interbay area has seen rapid development and residential growth—growth likely to continue with the implementation of key infrastructure projects, including three future Sound Transit light rail stations. The area also has maritime and industrial uses, local and regional freight routes, and an important Manufacturing Industrial Center (MIC).

At 932 acres, the Ballard-Interbay-Northend Manufacturing and Industrial Center (BINMIC), as identified in Seattle's Comprehensive Plan, is the region's smallest MIC. Compared to other MICs, it has a smaller parcel size with a mix of diverse uses, spanning light manufacturing, maritime, food processing, warehouse uses, a rail yard, and several Port of Seattle facilities. Port facilities in the BINMIC include Fishermen's Terminal, the city's largest cruise ship terminal, and a grain elevator, among others.

The study area also includes two HUB urban villages as identified in the Seattle 2035 Comprehensive Plan: Fremont and Ballard. Ballard, in particular, is a fast-growing and fast-changing neighborhood that includes commercial and residential uses adjacent to deep-rooted manufacturing and industrial uses, see Figure 31. It has recently experienced rapid residential growth and office and retail development. This growth has intensified conflicts for limited street space as on-street parking and loading zone availability become increasingly scarce and travel congestion worsens.

Figure 30. Land use in the Ballard/Interbay study area.

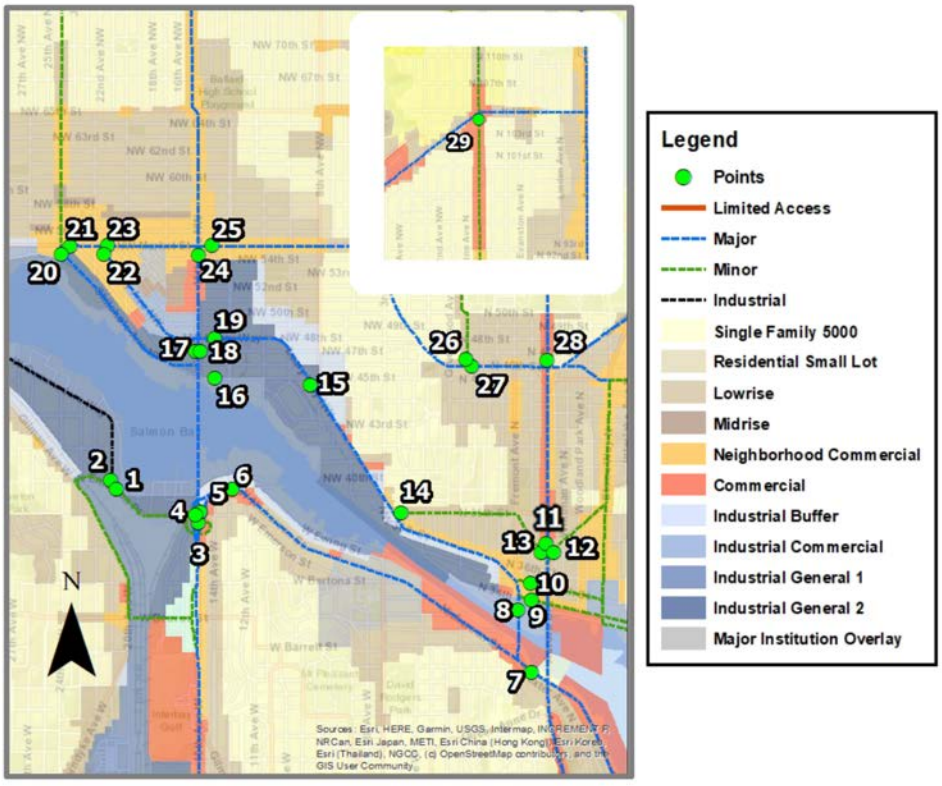
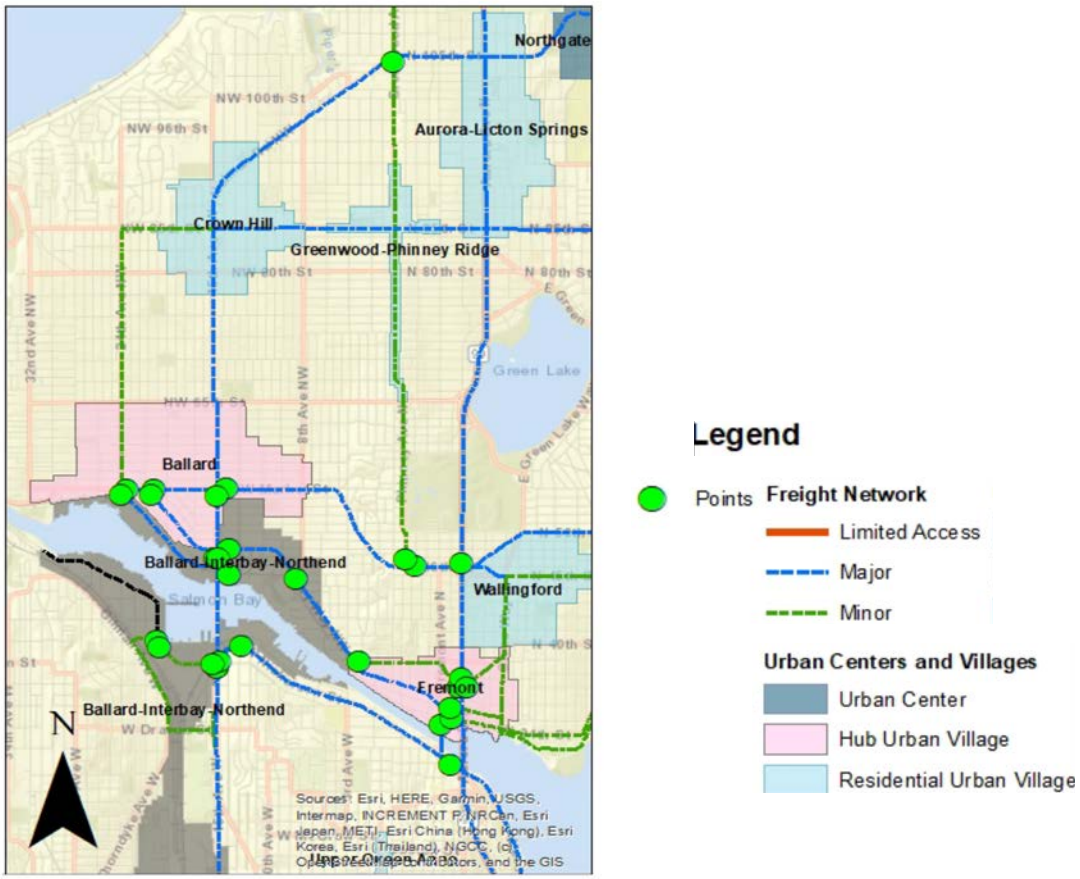


Figure 31. Land use in the Ballard/Interbay study area.



Data Sample

SDOT recorded video footage on 29 selected locations between December 2019 and January 2020. Table 8 shows all observed vehicles passing through all the locations in a 48-hour period.

Table 8. Ballard/Interbay data sample.

Activity Type		Ballard Counts (veh)
Private		907,393
CVs	Total CVs	58,823
	Construction	6,802
	General CV	16,776
	Goods Transport	9,768
	Service	24,182
	Waste Management	1,295
Public Transit		11,733
Other Transit		4,737
Emergency		483
RVs		116
TOTAL		983,285

Evaluation of Seattle's Freight Network

Figure 32 and 33 show the daily average truck volume and CV volume for each selected location.

When analyzing the observed truck volumes for each location, we found that:

- 70% of the Major & Minor truck routes did not meet the 500+ truck/day threshold defined in Seattle's Freight Master Plan.
- **Location 1 – W Emerson PL**, a BINMIC industrial access street in the Interbay neighborhood, was the Minor truck route with the highest daily truck volume (1665+ truck/day) and one of the eight locations that met the 500+ truck/day threshold.

But Figure 33 shows that when considering all CVs (both small fleet and trucks):

- around 90% of Minor & Major truck routes did meet the 500+ CV/day threshold,
- **Location 1 – W Emerson PL** remained the Minor truck route with the highest daily CV volume**.** Including the smaller fleet takes this location from seventh-most-significant daily CV volume to fifth-most-significant daily CV volume.
- Approximately 40% of the Minor & Major truck routes showed CV daily traffic volume that was more than double the volume (+1,000 CV/day) of the 500+ volume threshold.
- The study area's only first/last mile connector (**Location 2 – 21st Ave W**), a BINMIC industrial access street connected to **Location 1**, reported three times the volume (750+ CV/day) of the 250+ truck/day threshold set for first/last mile connectors.

These findings seem to indicate that the commercial traffic in this area diverges from what the Seattle's Freight Master Plan outlines for the area. In general, truck volumes are lower than the defined threshold of 500+ truck/day. But when considering all commercial flow for this area, most locations not only met the threshold, a full 40% of locations reported more than double the volume threshold.

The 10 roadway links that reported the highest CV volume carried 60% of all commercial traffic observed in the Ballard-Interbay study area. Nine of the 10 are classified as Major Truck Routes and are located along the major North-South and East-West corridors. The exception is **Location 1 – W Emerson PL, a** Minor truck route adjacent to the Interbay industrial area that connects to Fishermen's Terminal.

It is important to acknowledge that video quality limitations made it impossible to distinguish between a Class 3 (single-axle) or Class 5 (double-axle) step van. This means that all unibody vehicles (same frame from rear to end) were classified as CV small fleet and not included in the average daily truck traffic chart below. Therefore, there is a mismatch in the classification of Class 5 vehicles (single-unit 2-axle truck) between previous SDOT counts and this data- collection effort.

Figure 32. Average daily truck traffic for the count locations in the Ballard/Interbay study area.

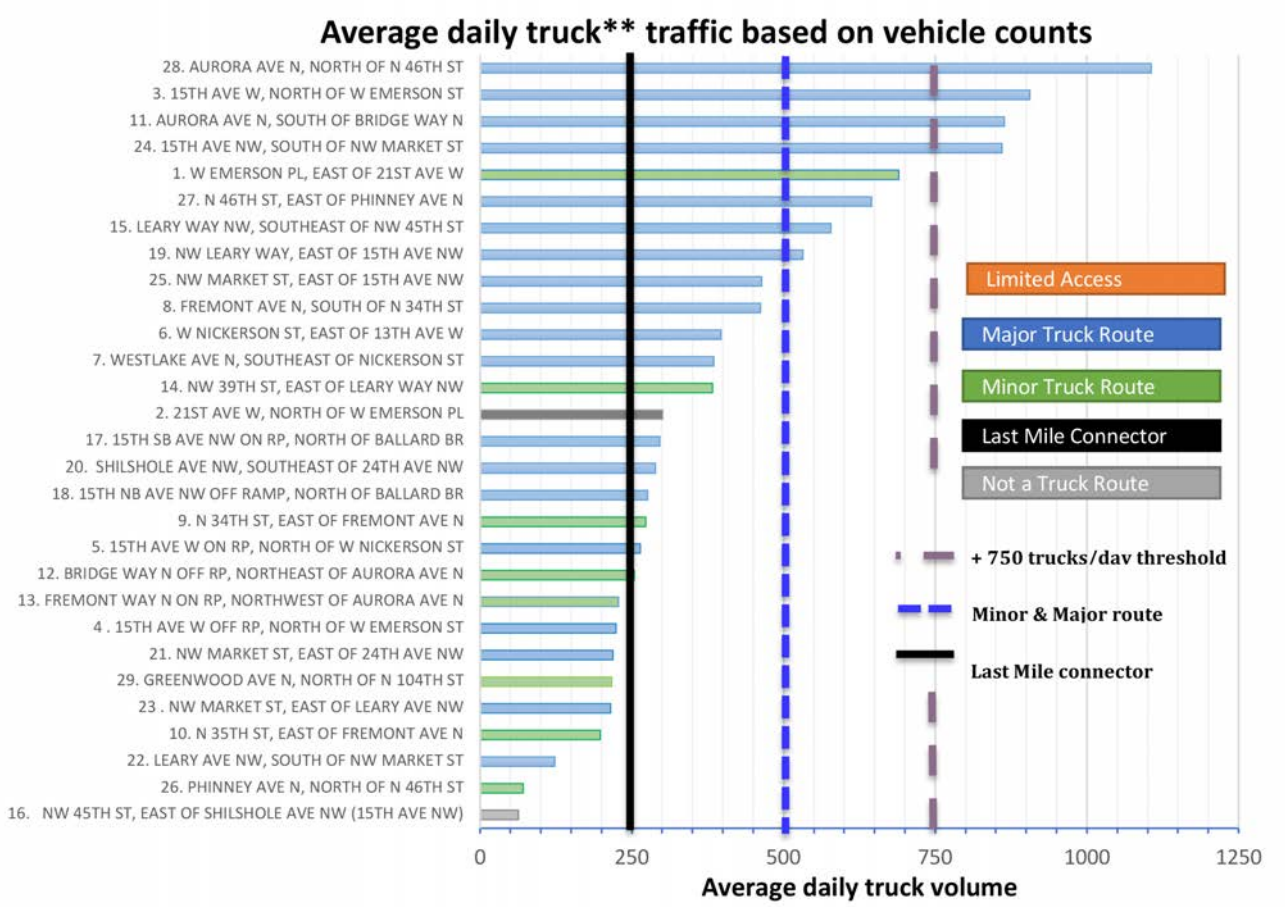
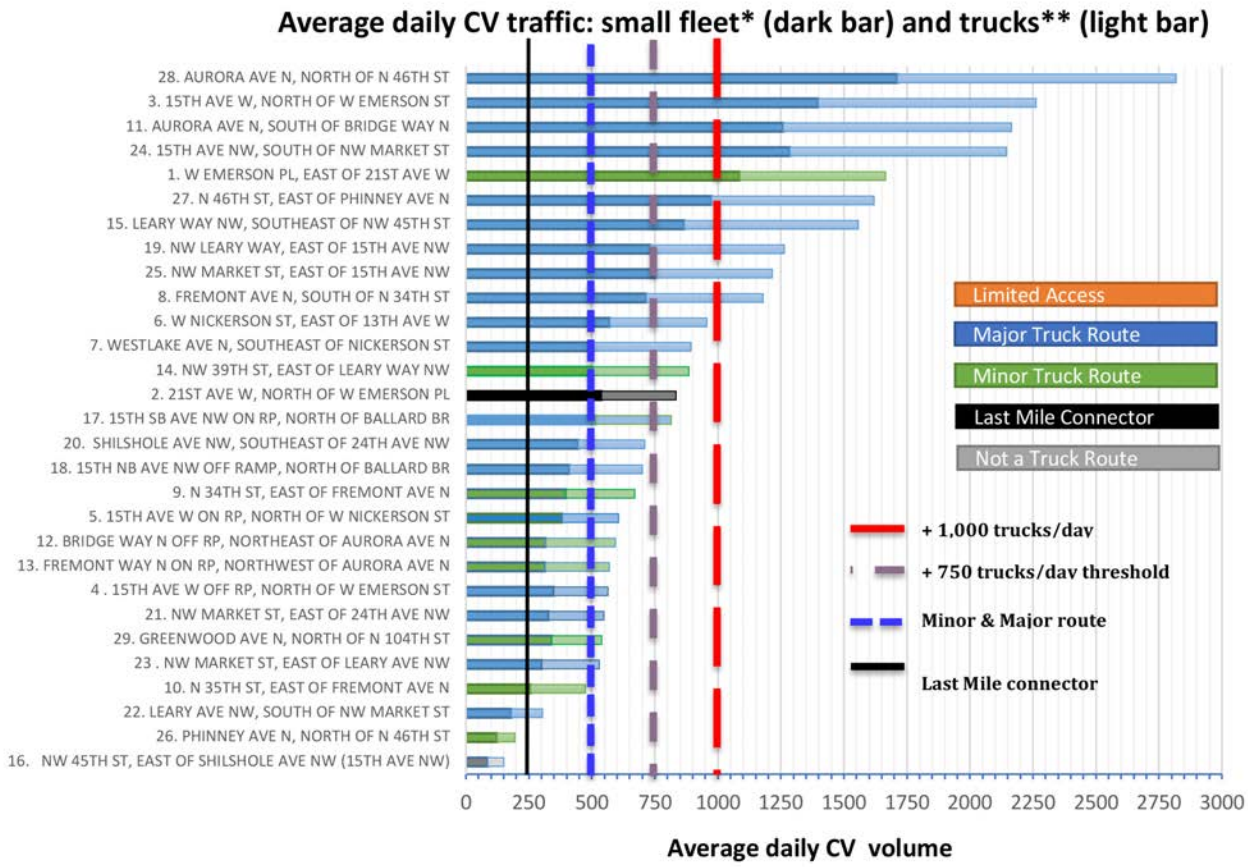


Figure 33. Average daily truck traffic for the count locations in the Ballard/Interbay study area.



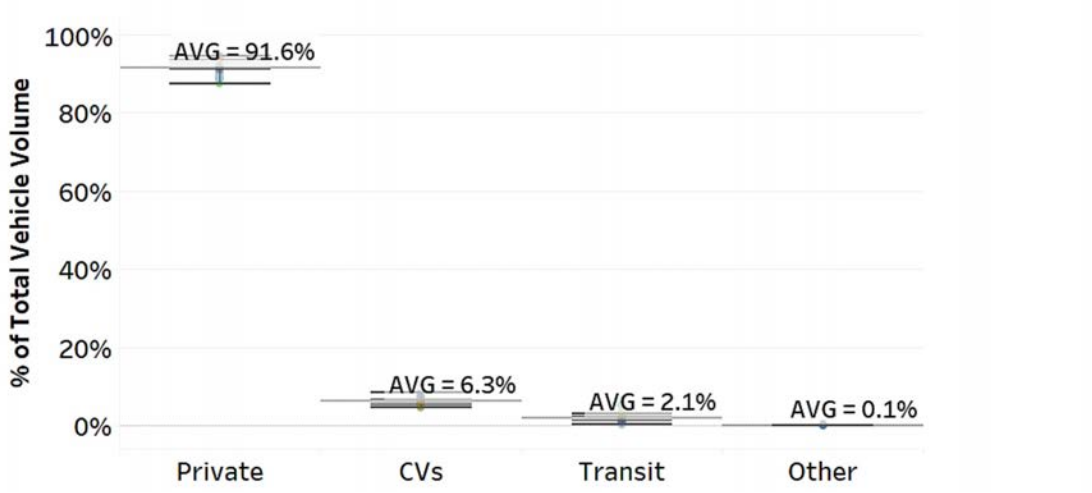
General Trends

CV Share of Traffic Volumes

Figure 34 shows the daily average percentage of traffic volume by vehicle usage and location. As shown in Figure 33, for the Ballard-Interbay area:

- The daily average CV share of total traffic volume is 6%.
- The daily average CV share per location varies between 8.4% and 4.7%, with just two locations above 10%:
  - **2. 21st Ave W, north of W Emerson PL, and**
  - **16. NW 45th St, East of Shilshole Ave NW (15th Ave NW).**

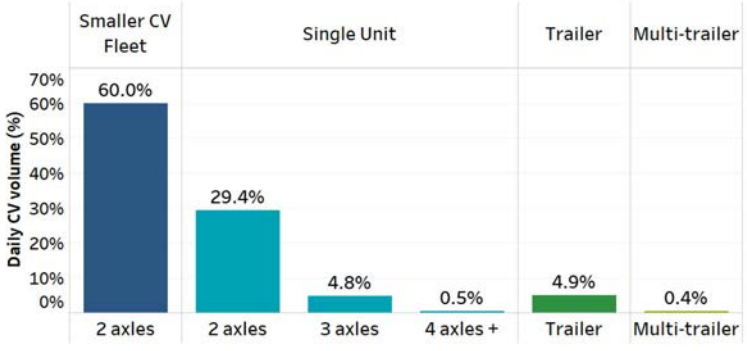
Figure 34. Average Daily Traffic Composition per Location. Note: Transit includes both (1) "Public Transit" and (2) "Other Transit" categories.



CV Fleet Composition

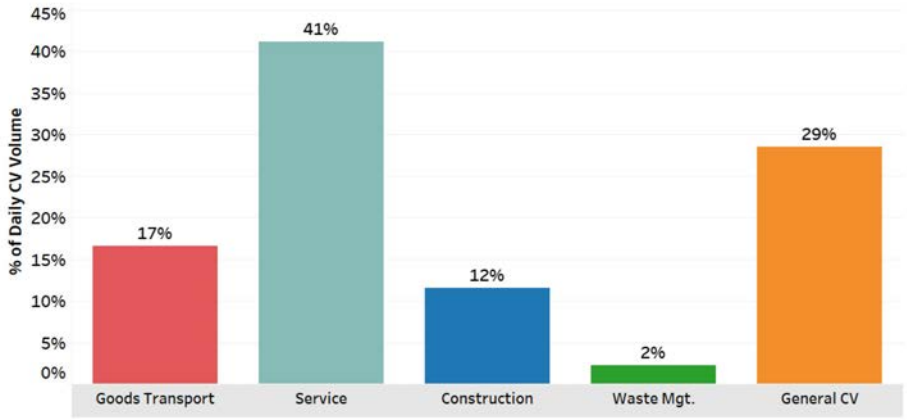
Overall, commercial pick-ups and work-vans made up the biggest share of CV body types, constituting 60% of all recorded CVs over the study period. Single-unit 2-axle vehicles made up the second-largest share, comprising nearly 30% of all recorded CVs, see Figure 35.

Figure 35. Distribution of all observed CV by body type.



Service vehicles had far higher volumes than any other CV category, accounting for 41% of all CV traffic. This share is significantly larger (10% larger) than what was observed in the GDA, highlighting the importance of Service movements in the Ballard-Interbay area, see Figure 36.

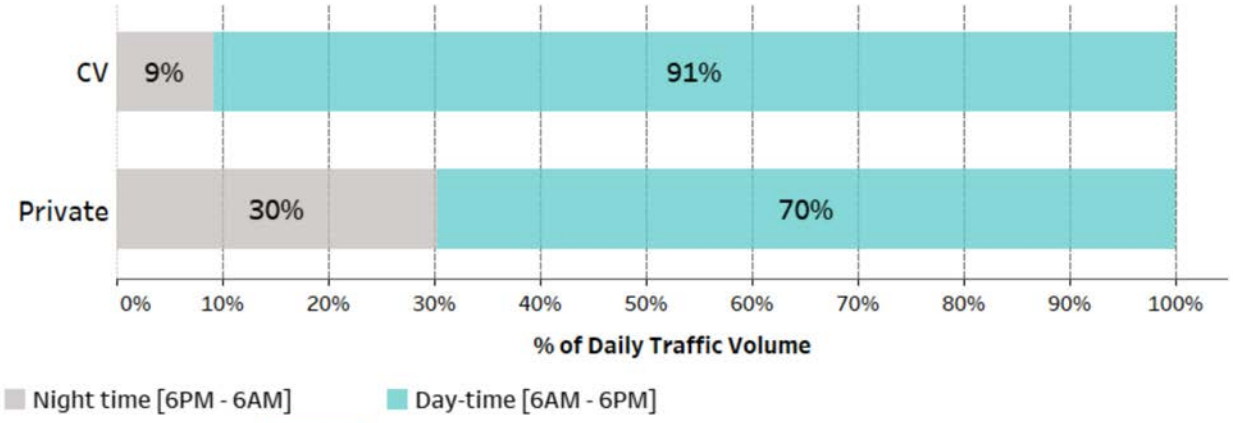
Figure 36. Distribution of all observed CV by activity type.



Daytime and Nighttime Comparison

Since the counts were collected in a 24-hour period, it was possible to examine and compare traffic in 'daytime' (defined as 06:00-18:59) and 'nighttime' (defined as 18:00-23:59 and 00:00-05:59) periods. As indicated in Figure 37, only 9% of all CV traffic was recorded during nighttime hours (6% less than the nighttime volume observed in the GDA), suggesting no considerable travel demand in off-peak hours. In contrast, Private vehicles made up a bigger share of nighttime traffic at 27%, three times that of CVs.

Figure 37. Comparison of daytime and nighttime traffic counts.



Vehicle Counts by Time of Day (Time Profile)

The vehicle counts were accumulated for each hour, with each hour averaged over the 48-hour period to obtain the study area time profile. Figure 38 shows that CV volumes throughout the day are significantly smaller than Private vehicle volume. Private vehicle traffic has very distinct peaks during the commuter AM/PM peak periods, reflecting passenger vehicles' general profile across Seattle.

The vast majority of CVs were observed during business hours (6 AM and 6 PM). In contrast to the private vehicle pattern, CV time-of-day pattern has only one "hump," peaking during the morning and early afternoon, and steadily declining over the day. The "spare" capacity freed up by the decline in private vehicles between commuter peaks was utilized by the number of CVs observed on the study area streets.

Figure 38. Private and commercial daily average vehicle counts by time of day (different scales used)

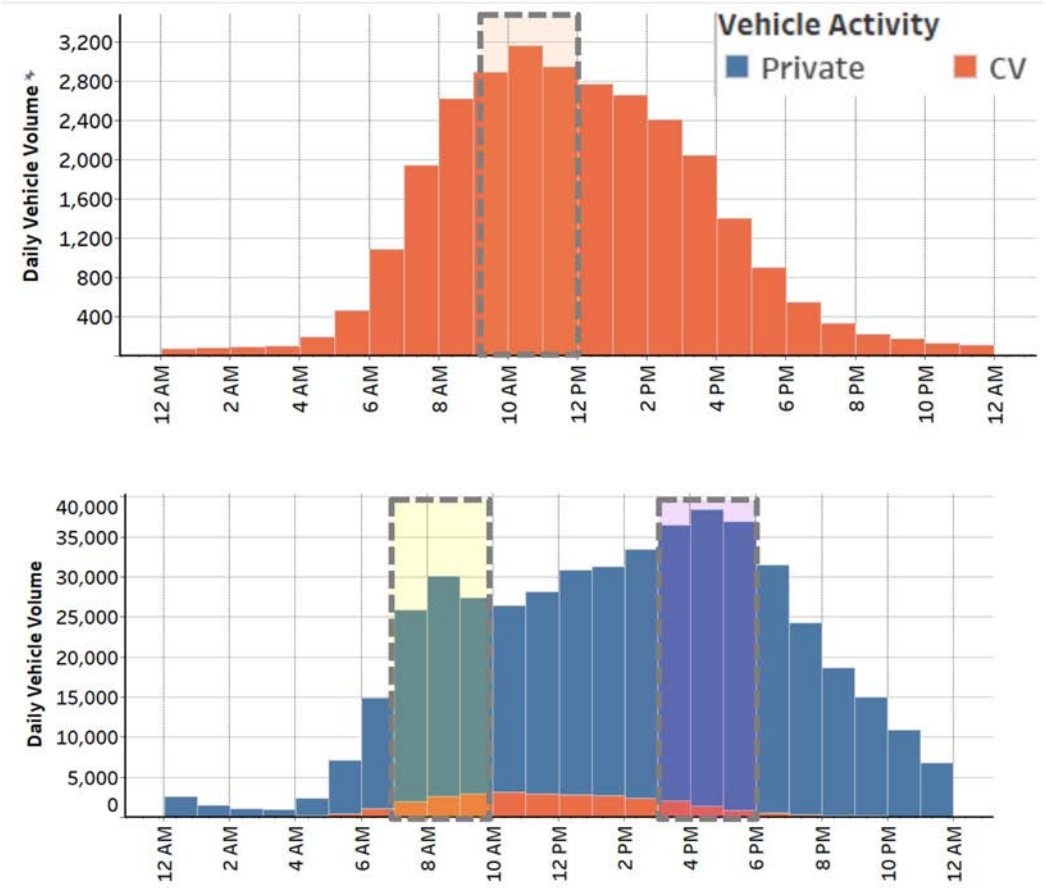
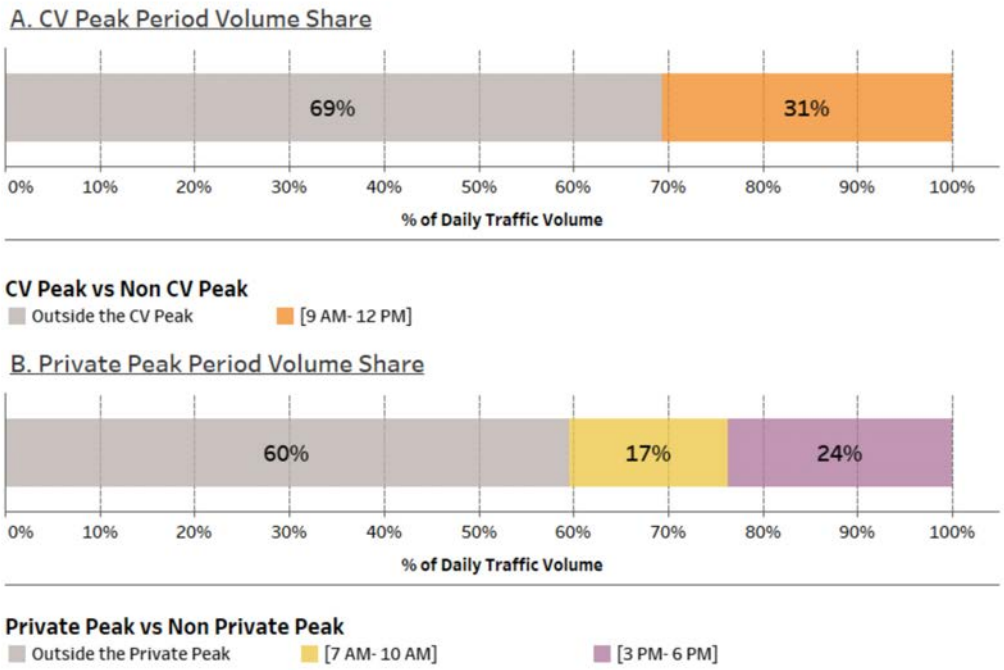


Figure 39 shows the vehicle volume share during the three hours with the highest volume for CV, the private AM peak, and the private PM Peak. The three most intense hours for CV traffic [9 AM – 12 PM] hold 31% of the CV traffic based on the vehicle count data. In contrast, 17% of private vehicles were observed during the peak period [7 AM – 10 AM] and 24% during the PM peak period [3 PM – 6 PM]. This finding suggests that CVs have a more intense peak than private vehicles.

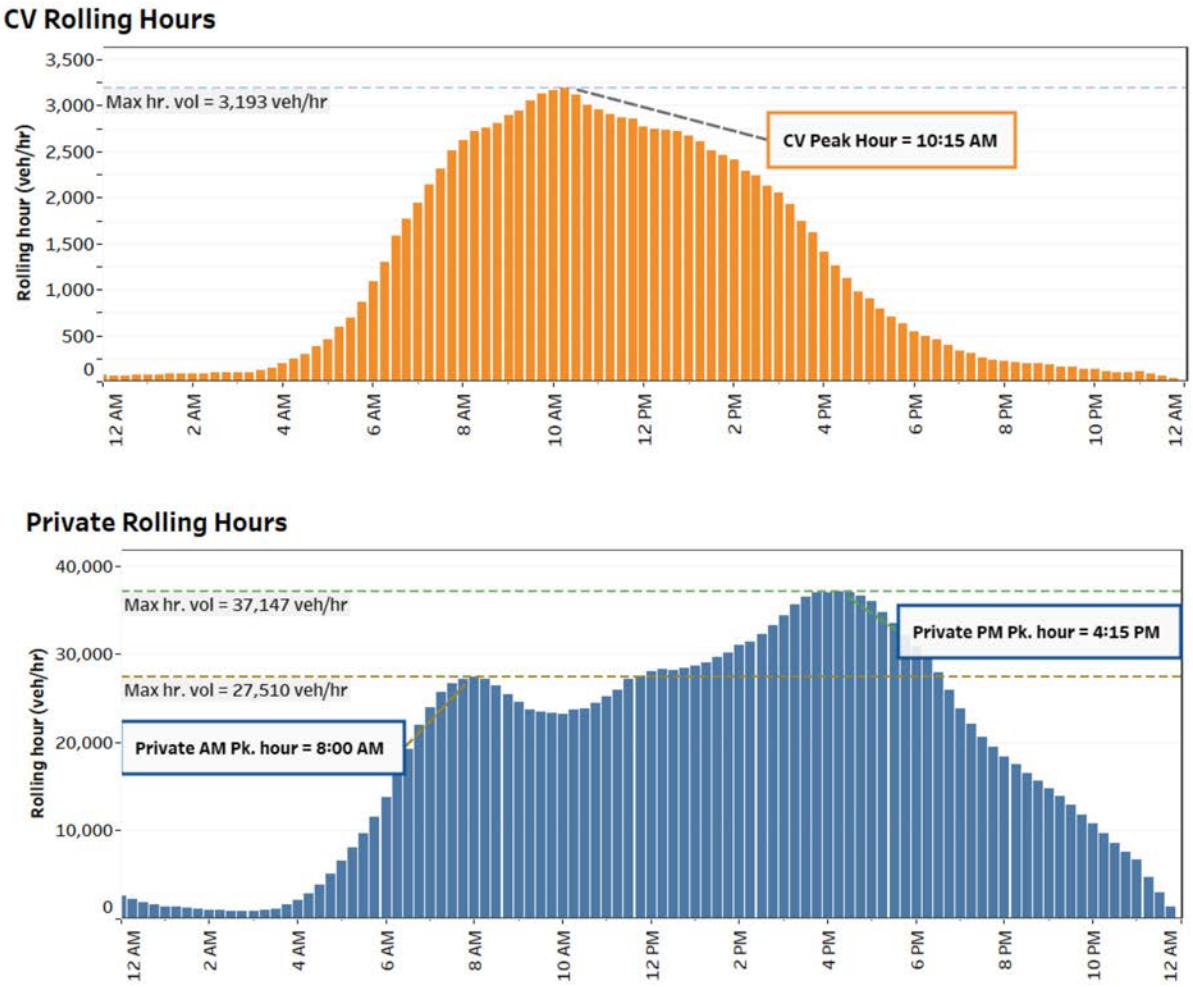
Figure 39. Comparison of peak vs non-peak traffic counts for commercial and private.



Peak Hour

Overall, CV traffic peaked at 10:15 AM, roughly 2 hours after the private vehicle 8 AM peak and 6 hours before the private vehicle 4:15 PM peak. Looking across locations, CV peak occurred between 8:45 AM and 1 PM, except for Location **29 - Greenwood Ave N, north of N 104th St** (the study area's northernmost location), where the peak hour was 7:45 AM, see Figure 40.

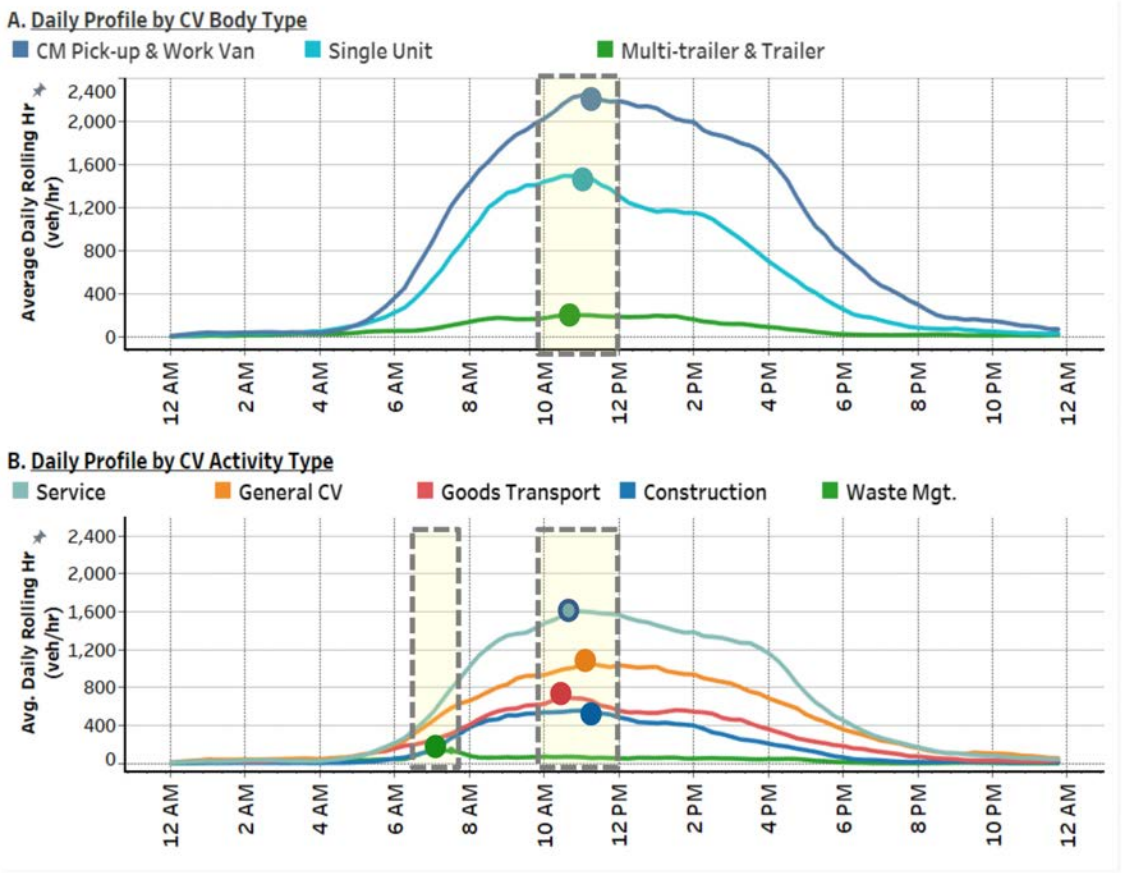
Figure 40. Private and commercial rolling hour by time of day (different scales used)



Time Profiles by CV Category

Each CV activity type and CV body type peaked between 10 AM – 12 noon, as indicated in Figure 41 and consistent with the prior section findings. The only exception was the Waste Management (WM) category, which peaked at 7 AM. Notably, this category is highly sensitive to changes in trends due to the small share of WM vehicles.

Figure 41. Daily profiles by: (a) CV body type, and (b) activity type.



Pocket Case Studies

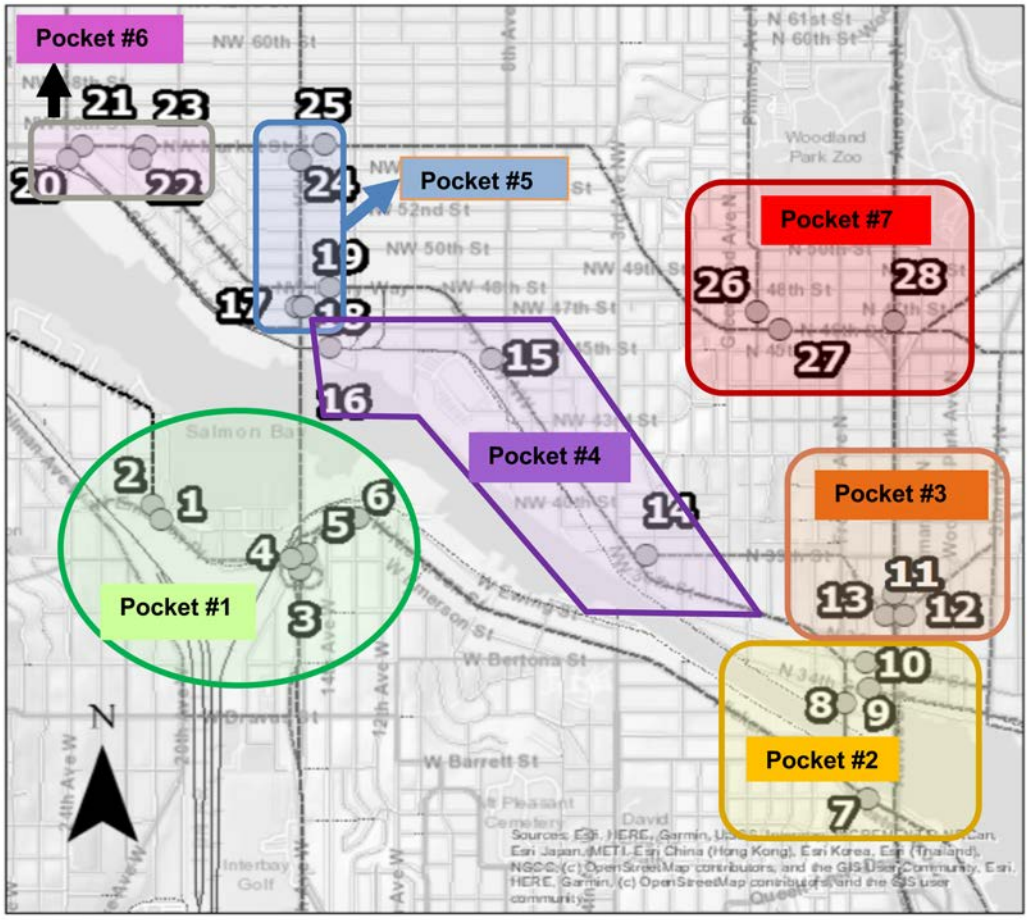
Here the research team departs from discussing key findings based on traffic patterns found across all 29 study area locations to instead explore in more detail CV fleet configurations and daily CV traffic patterns in smaller sub-areas called 'pockets'. This analysis allowed the research team to study more deeply the relationship between land use, street network configuration, and the way various street network elements connect. Although some of the pockets that the research team analyzed followed general trends, some did not, due to granular details related to street network and/or land use connections that can impact traffic patterns. The four pockets discussed in depth here are those that illustrated deviations from the already-identified overall trends in CV fleet configuration and/or daily CV traffic patterns.

Table 9 shows the average CV daily traffic and overall land use in each pocket during the data-collection effort. Figure 42 shows the location of each pocket.

Table 9. Average CV daily traffic and overall land Use by pocket area.

POCKET #	POCKET NAME	# OF ROADWAY SEGMENTS	AVE. CV DAILY VOLUME	OVERALL USE	URBAN VILLAGE STRATEGY	INDUSTRIAL OR COMMERCIAL FACILITIES	CORRIDORS
#1	Interbay	6	6,885	Industrial	BINMIC	Fishermen's Terminal, Foss Maritime Co. shipyard	15th Ave W (N-B Corridor): Ballard Bridge and its SB off and NB on ramps.
#2	Fremont Bridge	4	3,214	Light industrial, mix commercial and low rise residential .	Fremont HUB Urban Village	Fremont Commercial core	Fremont Ave N (N-B Corridor)
#3	Aurora Bridge	3	3,325	Commercial low rise residential.	Fremont HUB Urban Village	None.	Aurora Ave N (N-B corridor): Aurora Bridge and its NB off and SB on ramps.
#4	Northern BINMIC	3	2,591	Industrial land with some low rise residential in the northeast.	BINMIC	Warehouses, marinas, asphalt plant, towbow terminal	Leary Way NW (E-W corridor)
#5	15th Ave NW Corridor	4	4,924	Industrial land in the South and the East, with commercial uses in the North.	BINMIC, Ballard HUB Urban Village	Warehouses, shipyard and marina.	15th Ave NW N-B Corridor
#6	Ballard Commercial Area	5	3,304	Mostly commercial with some industrial land in the south area.	Ballard HUB Urban Village	Historic district, Ballard commercial core, Stimson industrial park	NW Market St (E-W corridor)
#7	Northern Fremont	3	4,631	Mostly low rise residential with some commercial land.	None.	None.	N 46th St (E-W corridor)

Figure 42. Map of the seven case study pockets in the Ballard-Interbay area.



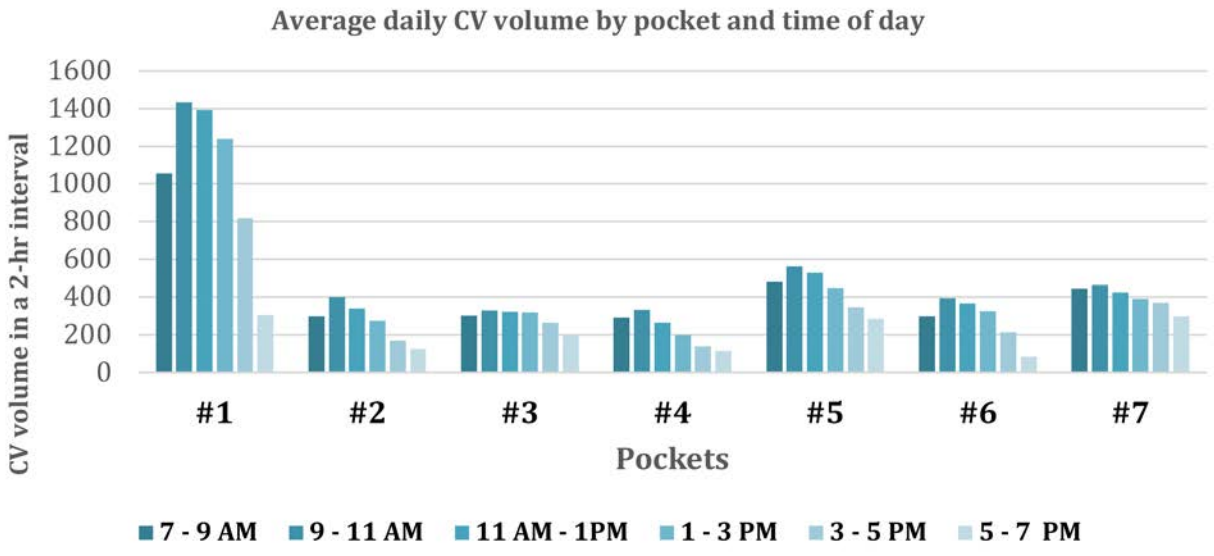
Differences in CV Volume by Pocket Location

Table 10 and Figure 43 below provide a pocket-by-pocket average of daily CV volume observed in each two-hour daytime period from 7 AM to 7 PM. CV volume peaked in all pockets during the 9 AM - 11 AM period with a steady decline after 3 PM. The research team operated on the null hypothesis, which assumes that there is no association between pocket areas and time of day. To test this hypothesis, the research team conducted a chi-square analysis (using a 0.05 level of significance) to evaluate the association.

Table 10. Differences in daily CV volume by pocket and time of day.

	NO. OF LINKS	AVG. CV VEHICLE VOLUME	7 - 9 AM	9 - 11 AM	11 AM - 1PM	1 - 3 PM	3 - 5 PM	5 - 7 PM
#1	6	6885	1054	1434	1392	1241	816	306
#2	4	3214	299	402	341	275	170	126
#3	3	3325	301	329	324	318	265	201
#4	3	2591	292	334	265	200	140	115
#5	4	4924	480	563	527	450	348	284
#6	5	3304	300	396	367	325	214	86
#7	3	4631	444	462	426	392	369	299

Figure 43. Average daily CV volume by pocket and time of day.



Since P-value is well below the significant level of (0.05), the null hypothesis is not approved (see Table 11). Thus, the research team can conclude that there does exist a relationship between pocket area and time of day; and that the pocket location may help explain the CV volume distribution.

Table 11. Results of chi-squared test for daily CV volumes: pockets vs 2-hour CV volume.

AREA	TEST STATISTICS	P-VALUE
Ballard-Interbay	334.6	3.69E-53

Additionally, the research team used a chi-squared statistical test to evaluate the statistical significance of this time-of-day analysis. The test performed a goodness-of-fit analysis between the observed data and an expected value. For this test, the expected CV volume would equal the total volume in the daytime period [7AM – 7PM] divided by 6 for each two-hour period. The chi-squared test compared the observed distribution to the expected distribution and determined the statistical significance of the difference between the two. The test results are shown in Table 12 and proved a significant relationship does exist between the time of day and the CV volume in the pocket location.

Table 12. Results of chi-squared test for daily CV volumes in the pocket areas.

POCKET NO.	POCKET NAME	TEST STATISTICS	P-VALUE
#1	Interbay	874	1.35E-186
#2	Fremont Bridge	201	1.66E-41
#3	Aurora Bridge	42	6.27E-08
#4	Northern BINMIC	169	1.18E-34
#5	15th Ave NW Corridor (Ballard Bridge)	129	3.26E-26
#6	Ballard Commercial Area	233	2.06E-48
#7	Northern Fremont	44	1.99E-08

Pocket #1- Interbay area

The Interbay pocket is located south of the Ship Canal within the BINMIC, see Figure 44. The freight facilities in this pocket include the Fishermen's Terminal (a Port of Seattle facility), Foss Maritime Company shipyard, and two at-grade rail crossings. All six locations in this pocket are classified as industrial access streets (designed to accommodate significant volumes of large CVs) including the 15th Ave NW N-S corridor and its NB on-ramp and SB off-ramp south of the Ballard Bridge. See Table 13 for the pocket's data sample.

Figure 44. Pocket #1 locations.

Table 13. Pocket# 1 – Interbay area data sample.

FREIGHT NETWORK CLASSIFICATION	STREET NETWORK CLASSIFICATION	LOCATION NAME	FLOW DIR	AVG. DAILY CV VOL	DIRECTIONALITY
Major Truck Street	Industrial Access	3. 15th Ave W, north of W Emerson St	NB	1127	49.80%
			SB	1136	50.20%
			Total	**2,263**	**100.00%**
		4. [SB off-rp] & 5 [NB on-rp] - 15th Ave W, north of W Emerson St.	Ramp:: NB	605	51.80%
			Ramp:: SB	564	48.20%
			Total	**1,169**	**100.00%**
		6. Nickerson St, east of 13th Ave W	EB	518	54.20%
			WB	438	45.80%
			Total	**956**	**100.00%**
Minor Truck Street	Industrial Access	1. W Emerson PL, east of 21st Ave W	NWB	865	52.00%
			SEB	800	48.00%
			Total	**1,665**	**100.00%**
First/Last Mile Conector	Industrial Access	2. 21st Ave W, North of W Emerson PL	NB	386	46.30%
			SB	447	53.70%
			Total	**833**	**100.00%**
Grand Total			Total	6,885	100.00%

This pocket accommodates a large amount of travel through the study area. See Table 13 for the total sample of CV at this pocket. All six locations reported an average daily volume of at least 833 CV/day, exceeding the Seattle Freight Master Plan threshold of 500+ CVs/day, even at **Location 2. 21st Ave W, North of W Emerson PL**, a First/Last Mile connector. As cited earlier in the truck volume analysis, **Location 1. W Emerson PL, east of 21st Ave W** reported one of the study area's highest CV daily volumes, despite being designated a Minor truck route in the master plan. **Location. 3 15th AVE NW, north of W Emerson St** also serves a substantial CV volume with an average of 2,263 CV/day. This represents the study area's highest daily volume and is almost three times the study area average. This principal arterial is one of the city's most important NB Corridors, accommodating a substantial number of private and commercial vehicles.

The locations also reported a balanced directionality (difference of ± 5%) of the total observed CV traffic, including a balanced volume of CV traffic between the SB off-ramp and the NB off-ramp. The study area's only First/Last Mile connector, **Location 2. 21st Ave W, north of W Emerson PL**, showed the highest CV share volumes (almost 11%) of the whole study area, highlighting its role as an industrial access road.

This area followed the general trend with peak volumes between the 9 AM - 12 PM period for both location and directional analysis. **Location 2. 21st Ave W, north of W Emerson PL** was the only exception, reporting constant CV volume throughout the day (8 AM - 3 PM) with the SB direction peak hour at 8 AM and the NB at 3 PM.

Pocket #2 - Fremont Bridge

This pocket has count locations on both sides of the shoreline (Lake Union and the Ship Canal), see Figure 45. Three locations track E-W movements east of Fremont Ave N; one location is on Fremont Ave N north of the Fremont Bridge. South of the ship canal, the zoning consists of a mix of residential and commercial uses. The Fremont HUB urban village is located north of the ship canal with light industrial and commercial land on the shoreline and in the Fremont commercial core, north of N 34th St. See Table 14 for the pocket's data sample.

While three locations (7, 8 and 9) are among the study area's lowest CV share of total daily volume, two of the three met the threshold of 500+ CVs/day. The one exception was **Location 10. N 35th St, east of Fremont**, a Minor truck route with 473 CVs/day.

Figure 45. Pocket #2 vehicle counts locations.

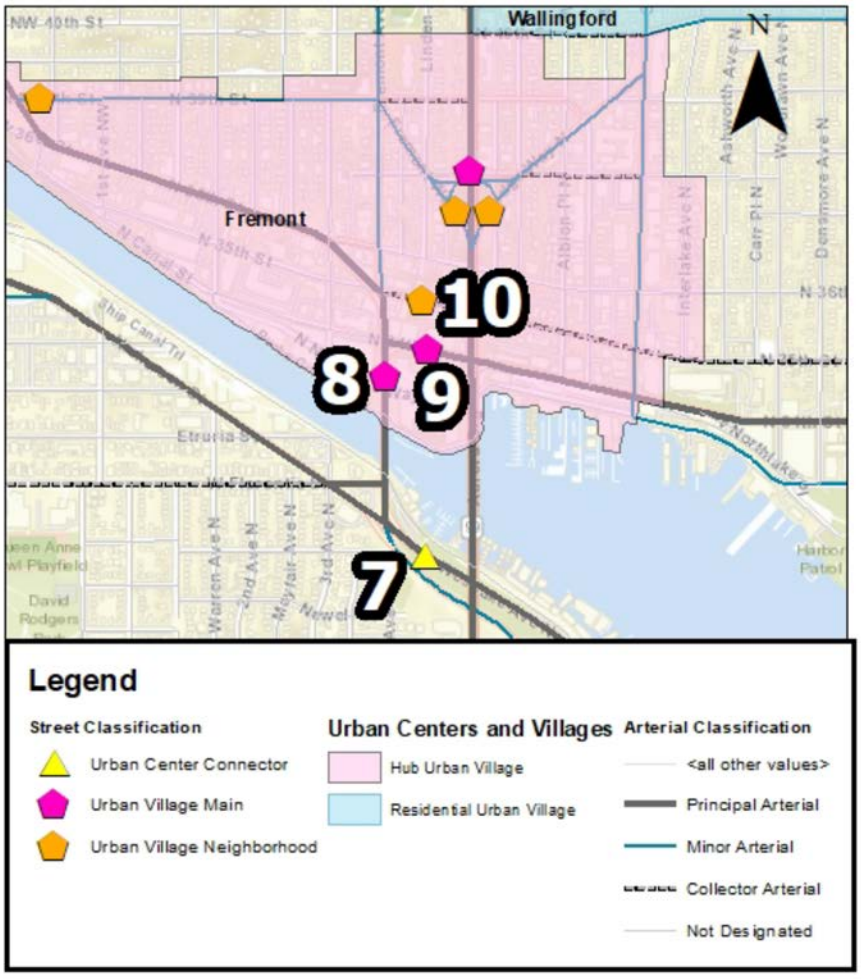


Table 14. Pocket# 1 – Interbay area data sample.

FREIGHT NETWORK CLASSIFICATION	STREET NETWORK CLASSIFICATION	LOCATION NAME	FLOW DIR	AVG. DAILY CV VOL	DIRECTIONALITY
Major Truck Street	Urban Center Connector	7. Westlake Ave N, southeast of Nickerson St	NWB	432	48.30%
			SEB	462	51.70%
			Total	**893**	**100.00%**
	Urban Village Main	8. Fremont Ave N, south of N 34th St	NB	651	55.20%
			SB	528	44.80%
			Total	**1,179**	**100.00%**
Minor Truck Street		9. N 34th St, east of Fremont Ave N	EB	273	40.80%
			WB	396	59.20%
			Total	**669**	**100.00%**
	Urban Village Neighborhood	10. N 35th St, east of Fremont Ave N	EB	335	70.70%
			WB	139	29.30%
			Total	**473**	**100.00%**
Grand Total	Total	Total	Total	3,214	100.00%

This pocket registered a slightly higher nighttime volume, with **Location 7. Westlake Ave N, southeast of Nickerson St** (a Major truck route and urban connector) and **Location 8. Fremont Ave N, south of N 34th St** reporting the highest share of the average nighttime observed CVs in the whole study area (14% and 13%, respectively). Additionally, **Location 7** had twice the average single trailer and multi-trailer share of daily CV for the whole Ballard-Interbay study area, at 10%.

Directionality in the form of EB-WB movements was captured for daily CV traffic in both **Location 9. N 34th St, east of Fremont Ave N** (40% EB/60% WB of daily CV traffic, highest share toward Fremont Ave N) and **Location 10. N 35th St, east of Fremont Ave N** (70% EB/30% WB of daily CV traffic, highest share toward Aurora Ave N).

Pocket #3 - Aurora Bridge

The Aurora Bridge pocket includes three locations along the main N-S corridor (Aurora Ave N), the north end of the Aurora Bridge, and its two corresponding ramps, see Figure 46. This pocket falls within the Fremont HUB villages, adjacent to a mix of low-rise residential land and a commercial corridor along Aurora Ave N. See Table 15 for the pocket's data sample.

Figure 46. Pocket #3 vehicle counts locations.

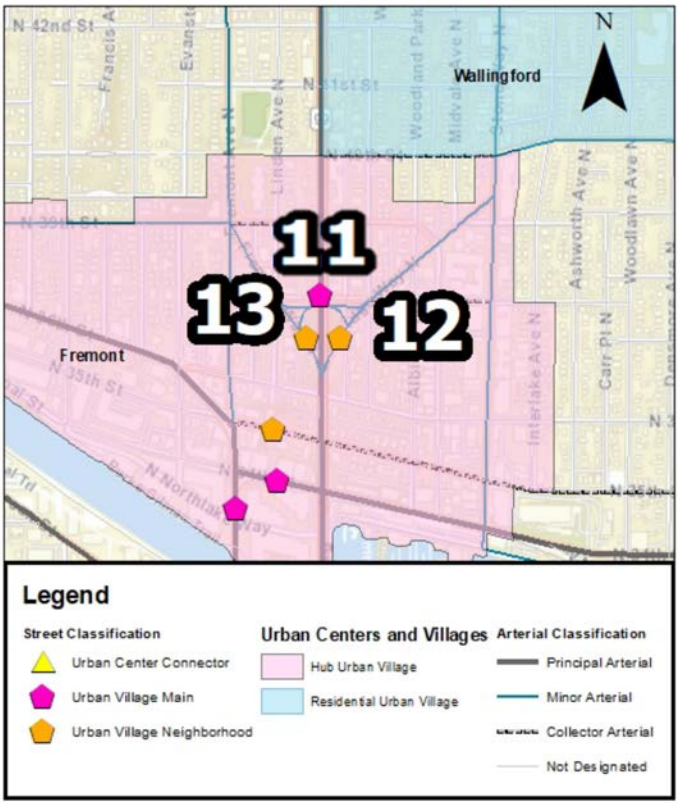


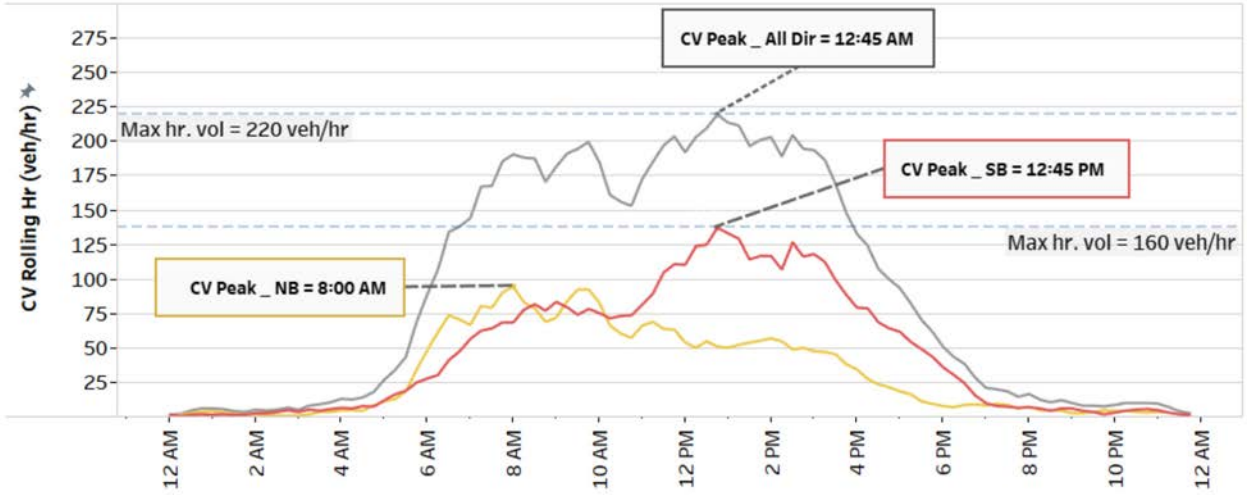
Table 15. Pocket# 3 – Aurora Bridge data sample.

FREIGHT NETWORK CLASSIFICATION	STREET NETWORK CLASSIFICATION	LOCATION NAME	FLOW DIR	AVG. DAILY CV VOL	DIRECTIONALITY
Major Truck Street	Urban Village Main	11. Aurora Ave N, south of Bridge Way N	NB	874	40.40%
			SB	1291	59.60%
			Total	**2,165**	**100.00%**
Minor Truck Street	Urban Village Neighborhood	12. Bridge Way N NB off rp, northeast of Aurora Ave N	Ramp:: NB	593	100.00%
			Total	**593**	**100.00%**
		13. Fremont Way N SB on-rp, northwest of aurora Ave N	Ramp:: SB	568	100.00%
			Total	**568**	**100.00%**
Grand Total	Total	Total	Total	3,325	100.00%

Location 11. Aurora Ave N, south of Bridge Way N served a substantial volume of daily CV traffic with an average of 2,165 CVs/day. Despite having some of the highest daily CV traffic of the whole Ballard-Interbay study area, this location's CV share of total daily volume fell below the median. This reinforces its importance as one of the city's most important NB Corridors, accommodating substantial flow of both private and commercial vehicles.

The Aurora Bridge ramps (**Locations 12. Bridge Way N off-ramp, north of Aurora Ave** and 1**3. Fremont Way N on-ramp northwest of Aurora Ave N**) showed balanced volume and simultaneous peak hours. **Location 11. Aurora Ave N, south of Bridge Way N**, on the other hand, reported the highest share of CV volume in the SB direction (60%), moving south of the ship canal. Additionally, the directionality by time of day in **Location 11** did not follow the general trend, showing a directional split with a NB peak in the early morning and a SB peak in the early afternoon, see Figure 47.

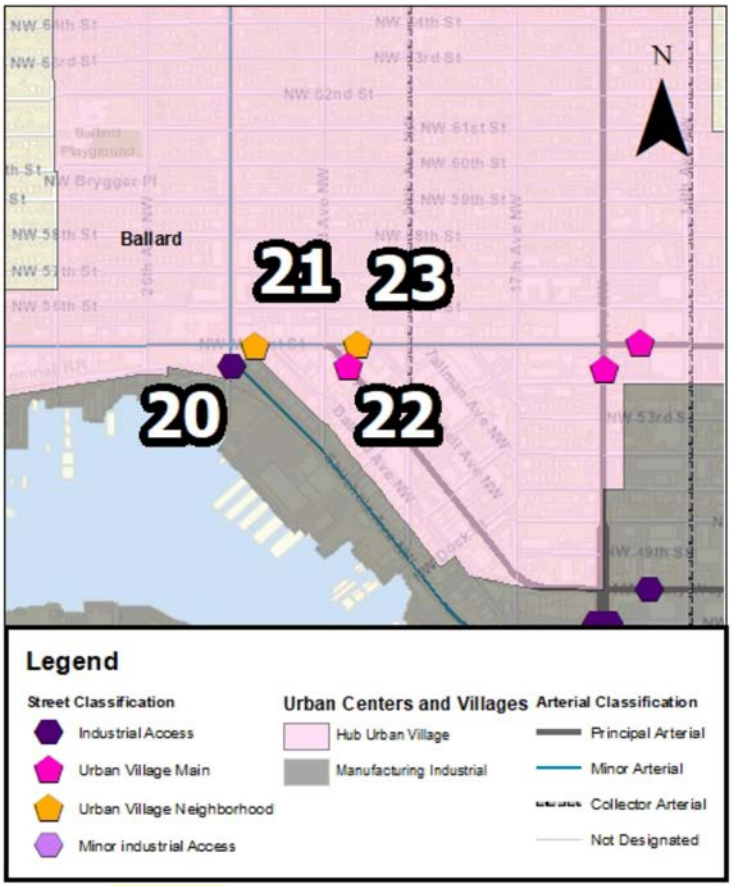
Figure 47. CV total and directional daily profiles observed in Location 11. Aurora Ave N, south of Bridge Way N.



Pocket #6 - Ballard Commercial District

Most of this pocket is located within the Ballard HUB village, but it also includes the northwest corner of the BINMIC, see Figure 48. Freight facilities include Stimson Industrial Park and Ballard Oil Company. This pocket had the biggest share of goods transport (22%) and the smallest share of construction vehicles (7%). This finding may be explained by this pocket being located within the Ballard commercial core. See Table 16 for the pocket's data sample.

Figure 48. Pocket #6 vehicle counts locations.



Despite being designated as Major truck routes in the Seattle Freight Master Plan, all locations in this pocket reported both CV volume and CV traffic share below the general trend (median equal to 6%). **Location 22. Leary Ave NW, south of NW Market St** only reported 303 CVs/day, which does not meet the master plan threshold of 500+ CVs/day.

Table 16. Pocket# 6 – Ballard Commercial District data sample.

FREIGHT NETWORK CLASSIFICATION	STREET NETWORK CLASSIFICATION	LOCATION NAME	FLOW DIR	AVG. DAILY CV VOL	DIRECTIONALITY
Major Truck Street	Industrial Access	20. Shilshole Ave NW, Southeast of 24th Ave NW	NWB	314	44.20%
			SEB	397	55.80%
			Total	**710**	**100.00%**
	Urban Village Main	22. Leary Ave NW, South of NW Market St	NWB	171	56.40%
			SEB	132	43.60%
			Total	**303**	**100.00%**
	Urban Village Neighborhood	21. NW Market St, east of 24th Ave NW	EB	252	46.10%
			WB	295	53.90%
			Total	**547**	**100.00%**
		23. NW Market St, east of Leary Ave NW	EB	292	55.20%
			WB	237	44.80%
			Total	**529**	**100.00%**
Grand Total	Total	Total	Total	2,089	100.00%

All locations showed constant volumes throughout the day and peaked between 12:45 PM and 1:00 PM, contrary to the study area general trend. The only exception is also this pocket's only industrial access street, **Location 20. Shilshole Ave NW**, **southeast of 24th Ave NW,** which had this pocket's highest CV volume (710 CVs/day). **Location 20** reported a sharp morning peak at 10:15 AM. All locations in this pocket showed similar average daily traffic patterns between directions (peak hours and hourly CV volume).

CONCLUSION

This timely research from the University of Washington's Supply Chain Transportation and Logistics Center on behalf of the Seattle Department of Transportation produces Seattle's first complete estimate of Greater Downtown area traffic volumes. And it offers a detailed analysis of commercial vehicle traffic in and around one of the city's two major industrial centers, the Ballard-Interbay Northern Manufacturing Industrial Center. These efforts are significant because the city has lacked a comprehensive estimate of commercial vehicle volumes—until now. Across both the Greater Downtown area (GDA) and Ballard-Interbay area, we find the following:

- Smaller vehicles (such as pick-ups, vans, and step vans) make up the largest share of all CV traffic, representing 54% in the GDA and 60% in Ballard-Interbay.
- Service vehicles are an important share of CV traffic, representing 30% in the GDA and 40% in Ballard-Interbay (constituting the largest single category share identified in that area.)
- Evaluation of the selected gateways and roadway legs suggests the need to update some of the freight network element categories defined in SDOT's current freight master plan.
- On average, daily CV traffic is low in the evening and night and high during peak volume hours of 9 AM-12 PM. Over the course of 24 hours, just 15% of CV traffic on average flows from 6 PM – 6 AM in the GDA and just 9% in Ballard-Interbay. Conversely, 27% of CV traffic on average flows in the three hours of maximum volume [9 AM -12 PM] in the GDA and 31% in Ballard-Interbay.
- The vast majority of CVs were observed during regular business hours, 6 AM – 6 PM. Therefore, unlike the passenger vehicle pattern, CV time-of-day pattern has only one "hump," peaking in the morning and early afternoon and declining steadily over the day. CVs appear to utilize the 'spare' capacity freed up by the decline in private vehicles between AM and PM commuter peaks.
- Overall, CV traffic peaked at 9:15 AM in the GDA and 10:15 AM in Ballard-Interbay with observed variations between locations inside each study area. GDA gateways showed both inbound and outbound flows peaked during the morning period: at 8:30 AM and 11:30 AM, respectively.
- Although all locations showed the typical CV daily pattern for the aggregated volume, some locations in both study areas had directionality oriented traffic patterns, with CV movement in one direction during some parts of the day and in the opposite direction during others. These patterns may be explained by the temporal distribution of activities in the area, for example, where specific fleets may be leaving or returning to a warehouse, commercial area, or the port terminal.
- We observe significant variation in traffic patterns (peak hours, CV share of total traffic, CV volume, directionality) due to local conditions within and surrounding each study area, such as land use and street classification.
- In the Greater Downtown area only, with regard to the cordon entry/exit points (an analysis not performed for Ballard-Interbay), we find that nearby gateways show similar commercial traffic patterns, including:
  - peak hours for overall CV traffic
  - inbound and outbound CV peak hours
  - inbound/outbound volume ratio

- time of day factors for overall CV traffic and by direction.

No existing collection effort by SDOT, WSDOT or Puget Sound Regional Council produces enough detail to understand Seattle's vehicle movements or connect them with economic activity. To fill the gap, Seattle could consider adopting a standard freight-data reporting system that would emphasize collecting and distributing richer and better data for time-series analysis and other freight forecasting, similar to systems used in cities like Toronto and London.

Seattle is a national leader when it comes to freight master plans. This study offers a critical snapshot of the detailed data needed for effective policy and planning, potentially informing everything from road maintenance and traffic signals to electric vehicle charging station sites and possible proposals for congestion pricing. That said, going forward, Seattle could consider the myriad benefits of sustained, ongoing detailed data reporting to aid effective, comprehensive policy making and planning. Such ongoing data reporting could help Seattle make good on its master plan vision of "a vibrant city and thriving economy connecting people and products within Seattle and to regional and international markets."

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APPENDIX A

Table A: Vehicle Typology for both Seattle's Greater Downtown cordon and Ballard/Interbay studies.

NO	CV	GENERAL BODY TYPE	ACTIVITY TYPE	VEHICLE BODY	NO. OF AXLES	FHW CLASS
1	Non-commercial	Motorcycle	Private	Motorcycles	2 axles	Class 1
2	Non-commercial	Car	Private	Passenger vehicle	2 axles	Class 2
3	Non-commercial	Car	Emergency	Passenger vehicle	2 axles	Class 2
4	Non-commercial	Transit	Public Transit	Bus	2 axles +	Class 4
5	Non-commercial	Transit	Other Transit	Bus/other transit	2 axles +	Class 3 & Class 4
6	Non-commercial	Recreational	Recreational	RVs	Unknown	Unknown
7	Non-commercial	Emergency van	Emergency	Work Van	2 axles	Class 3 & Class 5
8	Commercial	CM smaller fleet	Goods Transport	Work Van	2 axles	Class 3 & Class 5
9	Commercial	CM smaller fleet	Service	Work Van	2 axles	Class 3 & Class 5
10	Commercial	CM smaller fleet	Service	CM Pick-Up	2 axles	Class 3 & Class 5
11	Commercial	CM smaller fleet	General CM	Work Van	2 axles	Class 3 & Class 5
12	Commercial	Truck	Goods Transport	Single Unit	2 axles	Class 3 & Class 5
13	Commercial	Truck	Goods Transport	Single Unit	3 axles	Class 6
14	Commercial	Truck	Goods Transport	Single Unit	4 axles +	Class 7
15	Commercial	Truck	Goods Transport	Trailer	3 or 4 axles	Class 8
16	Commercial	Truck	Goods Transport	Trailer	5 axles	Class 9
17	Commercial	Truck	Goods Transport	Trailer	6 axles +	Class 10
18	Commercial	Truck	Goods Transport	Multi-trailer	5 or less axles	Class 11
19	Commercial	Truck	Goods Transport	Multi-trailer	6 axles	Class 12
20	Commercial	Truck	Goods Transport	Multi-trailer	7 axles +	Class 13
21	Commercial	Truck	Goods Transport	Unknown	Unknown	Unknown
22	Commercial	Truck	Service	Single Unit	2 axles	Class 3 & Class 5
23	Commercial	Truck	Service	Single Unit	3 axles	Class 6
24	Commercial	Truck	Service	Single Unit	4 axles +	Class 7
25	Commercial	Truck	Service	Trailer	3 or 4 axles	Class 8
26	Commercial	Truck	Service	Trailer	5 axles	Class 9
27	Commercial	Truck	Service	Trailer	6 axles +	Class 10

Table A Continued

NO	CV	GENERAL BODY TYPE	ACTIVITY TYPE	VEHICLE BODY	NO. OF AXLES	FHW CLASS
28	Commercial	Truck	Service	Multi-trailer	5 or less axles	Class 11
29	Commercial	Truck	Service	Multi-trailer	6 axles	Class 12
30	Commercial	Truck	Service	Multi-trailer	7 axles +	Class 13
31	Commercial	Truck	Service	Unknown	Unknown	Unknown
32	Commercial	Truck	Waste Management	Single Unit	2 axles	Class 3 & Class 5
33	Commercial	Truck	Waste Management	Single Unit	3 axles	Class 6
34	Commercial	Truck	Waste Management	Single Unit	4 axles +	Class 7
35	Commercial	Truck	Waste Management	Trailer	3 or 4 axles	Class 8
36	Commercial	Truck	Waste Management	Trailer	5 axles	Class 9
37	Commercial	Truck	Waste Management	Trailer	6 axles +	Class 10
38	Commercial	Truck	Waste Management	Multi-trailer	5 or less axles	Class 11
39	Commercial	Truck	Waste Management	Multi-trailer	6 axles	Class 12
40	Commercial	Truck	Waste Management	Multi-trailer	7 axles +	Class 13
41	Commercial	Truck	Waste Management	Unknown	Unknown	Unknown
42	Commercial	Truck	Construction	Single Unit	2 axles	Class 3 & Class 5
43	Commercial	Truck	Construction	Single Unit	3 axles	Class 6
44	Commercial	Truck	Construction	Single Unit	4 axles +	Class 7
45	Commercial	Truck	Construction	Trailer	3 or 4 axles	Class 8
46	Commercial	Truck	Construction	Trailer	5 axles	Class 9
47	Commercial	Truck	Construction	Trailer	6 axles +	Class 10
48	Commercial	Truck	Construction	Multi-trailer	5 or less axles	Class 11
49	Commercial	Truck	Construction	Multi-trailer	6 axles	Class 12
50	Commercial	Truck	Construction	Multi-trailer	7 axles +	Class 13
51	Commercial	Truck	Construction	Unknown	Unknown	Unknown
52	Non-commercial	Truck	Emergency	Single Unit	2 axles	Class 3 & Class 5
53	Non-commercial	Truck	Emergency	Single Unit	3 axles	Class 6
54	Non-commercial	Truck	Emergency	Single Unit	4 axles +	Class 7
55	Non-commercial	Truck	Emergency	Trailer	3 or 4 axles	Class 8
56	Non-commercial	Truck	Emergency	Trailer	5 axles	Class 9
57	Non-commercial	Truck	Emergency	Trailer	6 axles +	Class 10
58	Non-commercial	Truck	Emergency	Multi-trailer	5 or less axles	Class 11
59	Non-commercial	Truck	Emergency	Multi-trailer	6 axles	Class 12

Table A Continued

NO	CV	GENERAL BODY TYPE	ACTIVITY TYPE	VEHICLE BODY	NO. OF AXLES	FHW CLASS
60	Non-commercial	Truck	Emergency	Multi-trailer	7 axles +	Class 13
61	Non-commercial	Truck	Emergency	Unknown	Unknown	Unknown
62	Commercial	Truck	General CM	Single Unit	2 axles	Class 3 & Class 5
63	Commercial	Truck	General CM	Single Unit	3 axles	Class 6
64	Commercial	Truck	General CM	Single Unit	4 axles +	Class 7
65	Commercial	Truck	General CM	Trailer	3 or 4 axles	Class 8
66	Commercial	Truck	General CM	Trailer	5 axles	Class 9
67	Commercial	Truck	General CM	Trailer	6 axles +	Class 10
68	Commercial	Truck	General CM	Multi-trailer	5 or less axles	Class 11
69	Commercial	Truck	General CM	Multi-trailer	6 axles	Class 12
70	Commercial	Truck	General CM	Multi-trailer	7 axles +	Class 13
71	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Table B: Vehicle Typology metadata.

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
VEH_ID	Text	Vehicle's category unique identifier.
CV_TYP	Non-commercial, Commercial	Indicates if the vehicle is used for commercial or non-commercial activity.
ACT_TYP	Private, Public Transit, Other Transit, Recreational, Emergency, Freight, Service, Construction, Waste Management	Indicate the primarily purpose for which the vehicle was manufactured or is primarily usage purpose. . **If CV_TYP = 'Non-Commercial'**, **Private:** Vehicles manufactured primarily for the purpose of carrying passengers for private or business needs with maximum seating capacity of eight people. **Emergency:** Vehicles used by emergency responses teams (e.g., fire trucks, ambulances and police cars). **Recreational:** Vehicles designed or modified for recreation or camping. Public Transit: Vehicles manufactured primarily for the purpose of carrying passenger with a minimum seating capacity of 10 people. Only included those vehicles owned by local agencies to provide transit services by public conveyance with established routes, schedules and transit fee. **Other Transit:** School; public; private; or commercial passenger-carrying buses and vans excluding public transit. **If CV_TYP = 'Commercial'**, **Goods Transport:** Vehicles design for carrying commodities (e.g.., carrier and shipper's work van; autotransporters, cargo tanks, box trucks, containers, and tankers). Only work-vans with either readable and/or recognizable carrier or shipper logo are considered in this category. **Service:** Vehicles designed typically to be use by maintenance or service providers (e.g., electricity, plumbing, internet telecommunication, catering, public utilities, pest control); including food trucks, buckets trucks, service providers' pick-ups or work vans, and any other service-body truck. Only work-vans working as food-trucks or with either readable and/or recognizable service providers; racks and/or service equipment are considered in this category. **Waste Management:** Vehicles manufactured primarily for the purpose of collection, transportation, disposal or recycling, and monitoring of waste; including street sweepers and sewage waste trucks. Only trucks are considered in this category. **Construction:** Vehicles primarily sold by manufactures for building, civil engineering or engineering work. (e.g.., rack trucks; stake trucks; concrete mixers; dumpers; empty flatbeds; and flatbeds carrying construction materials or equipment). Only trucks are considered in this category. **General CV:** When a commercial vehicle can't be classified in any of the commercial ACT_TYP described below it will follow this category. This can be attributed to low resolution; occlusion; or absence of logo; and/or lack of equipment. Otherwise, "**Unknown**".

Table B Continued

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
BODY_TYP	Motorcycle, Passenger vehicle, Bus, Bus/other transit, RVs, Work Van, CM Pick-up, Bus, Single Unit, Trailer, Multi-trailer.	Indicate the vehicle's body type. The relationship between this attribute and **ACT_TYP** is also described below. **If ACTY_TYP = "Private"**, **Motorcycle:** All two-or three wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and ae steered by handlebars rather than steering wheels. Includes motorcycles, motor scooters, and 3-wheel motorcycles. Due to low video resolution is not possible to accurately distinguish between private and emergency motorcycles. Therefore, for this project, all motorcycles are classified as "**Private**". **Passenger vehicle:** Sedan, coupes, SUVs, mini-van, passenger-vans and pick-ups manufactured primarily for the purpose of carrying passengers with maximum seating capacity of 8 people. It includes those pulling recreational or other light trailers. Please see **CM Pick-up** and **Bus/Van**'s description for exceptions to this category. This category can also be classified as **ACT_TYP = "Emergency"** (e.g., police cars). **If ACT_TYP = "Recreational"**, **RVs:** Vehicle designed or modified for recreation or camping, including campervans, motor-house, campervans and truck campers. **If ACT_TYP = "Public Transit"**, **Bus**: Vehicles manufactured as traditional bus passenger-carrying buses with two axles and six tires; or three or more axles. **If ACT_TYP = "Other Transit",** **Bus/vans:** Vehicles manufactured as traditional bus passenger-carrying buses (e.g., chatter bus, coach bus, school bus, short bus) with a minimum seating capacity of ten people; including passenger vans (FHWY - Class 3). Pick-ups used for commercial purposes follow the category "**Service**" of the **ACT_TYP** attribute. For this project **ACT_TYP = "Construction"** was not considered due to low resolution of the video footage., **CM Pick-up:** This category is limited to pick-ups that meet at least one of the following conditions: a. Pick-up with covered cargo area higher than the cabin roof; b. Pick-up carrying service equipment, barricades and road signs; c. Pick-up with two or more of the following features: i. rails for mounting with or without ladders, ii. covered cargo area with same height as the cabin, iii. roof clearance lights, iv. Company logo, v. truck tool boxes, and vi. side Boards. **Work-Van:** Unibody vehicle which includes mini-vans, vans and step-vans, with partial or without windows in the rear, manufactured primarily for the purpose of commercial or emergency (e.g., ambulances). Some are similar in size and design as passenger vans and passenger mini-vans; others are much larger, often having roll-up rear doors. Depending on the company or/and presence of service equipment follow one of the following ACT_TYP categories: "Freight", "Service" or "General CM". Truck categories depending on their configuration follow on of the following **ACT_TYP** categories: "**Freight**", "**Service**", "**Waste Management**", "**Construction**" or "**Emergency**": **Single unit**: Truck on a single frame, including truck tractor units traveling without a trailer. **Trailer**: Truck consisting on two units in which the pulling unit is tractor (i.e., semi-trailer unit trucks) or single unit truck (i.e., single trailer). **Multi-trailer**: Truck consisting on three or more units in which the pulling unit is tractor or single unit truck. Otherwise, "**Unknown**"

Table B Continued

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
FHWA_ CLASS	Class 1, Class 2, Class 3 & Class 4, Class 4, Class 3 & Class 5, Class 6, Class 7, Class 8, Class 9, Class 10, Class 11, Class 12, Class 13.	Indicate vehicle class according to the Federal Highway (FHWA) classification's system. The relationship between this attribute (**FHWA_CLASS**) and **BODY_TYP** is also described below. **If BODY_TYP = "Motorcycle"**, **Class 1:** All two- or three-wheeled motorized vehicles. **If BODY_TYP = "Passenger vehicles"**, **Class 2:** Two-axle and four-tire vehicle. Due to low visibility and occlusion, Class 3 and Class 2 are combined for passenger vehicles recommended by the FHWA. **If BODY_TYP = "Bus"**, **Class 4:** All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. **If BODY_TYP = "Bus/other transit"**, **Class 3 & Class 4:** Traditional passenger-carrying buses and two-axles with four-tire vehicles (Class 3). **If BODY_TYP = "CM Pick-up" or "Work-Van"**, **Class 3 & Class 5:** Two-axle single unit vehicles with four (Class 3) or six -tires (Class 5). **If BODY_TYP = "Single Unit"**, **Class 5**: Truck on a single unit frame with two axles and dual rear wheels. **Class 6**: Truck on a single unit frame with three axles and dual rear wheels. **Class 7**: All trucks on a single frame with four or more axles. **If BODY_TYP = "Trailer",** **Class 8**: All vehicles with four or fewer axles consisting of two units, one of which is a tractor or a straight truck power unit. **Class 9**: All vehicles with five axles consisting of two units, one of which is a tractor or a straight truck power unit. **Class 10**: All vehicles with six or more axles consisting of two units, one of which is a tractor or a straight truck power unit. **If BODY_TYP = "Multi-trailer"**, **Class 11**: All vehicles with five or fewer axles consisting of three or more units, one of which is a tractor or a straight truck power unit. **Class 12**: All vehicles with six axles consisting of three or more units, one of which is a tractor or a straight truck power unit. **Class 13**: All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or a straight truck power unit. Otherwise, "**Unknown**"
NO_AXLES	2 axles, 2 axles +, 3 axles, 4 axles +, 3 or 4 axles, 5 axles, 6 axles +, 5 axles or less, 6 axles, 7 axles +	Finally, data collectors will classify each vehicle by the number of axles touching the ground, without considering recreational or other light trailers, based on the Federal Highway Administration (FHWA) vehicle's classification system.

APPENDIX B:
SEATTLE GREATER DOWNTOWN AREA GATEWAYS

Table A: Gateway metadata for the Seattle's Greater Downtown area cordon study.

ATTRIBUTE	CODE DOMAIN	DESCRIPTION
GATE_ID	Text	Gateway's unique identifier.
GATE_LOC	Text	Location of the cordon's gateway
GATE_TYPE	Ref, Int, On-Ramp, Off-Ramp	Type of gateway based on its roadway classification and the amount of video processed. The types are described as: **Ref:** Intersection selected as a reference location. 24/7 video was collected. **Int:** Intersection. **On-Ramp:** I-5 entrance ramp. **Off-Ramp:** I-5 exit ramp. **NA:** all intersection legs are located outside/inside the cordon area.
NBHD	Uptown, South Lake Union, Capitol Hill/First Hill, Downtown.	**If GATE_TYP = "Ref" or "Int"**, neighborhood in which the intersection is located. Otherwise, "**NA**"
INT_LEG	Text	**If GATE_TYP = "Ref"** or "**Int**", Intersection leg inside Seattle's Greater Downtown Area. Otherwise, "**NA**"
RAMP_DIR	NB, SB	**If GATE_TYP = "Off-Ramp" or "On-Ramp"**, direction of traffic on the I-5 to which the ramp is associated to. Otherwise, "**NA**"
SOURCE	WSDOT, SDOT	Indicates the agency that collected the video footage. **WSDOT**: Washington Department of Transportation. **SDOT**: Seattle Department of Transportation.
VIDEO_DATE	Text	Date interval when the video was collected.
DAY_WEEK	Text	Indicates the day of the week when the video footage was recorded.

Table B: Seattle's Greater Downtown area gateway database.

GATE_ID	GATE_LOC	GATE_TYPE	NBHD	INT_LEG	RAMP_DIR	SOURCE	VIDEO_DATE	DAY_WEEK
Ref_1	Elliott Ave W & W Mercer Pl	Ref	Uptown	NW Leg	NA	SDOT	10/02/18 - 10/08/18	M - S
I_2	W Mercer St and Queen Anne Ave N	Int	Uptown	North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_3	Aurora Ave N-SR99 & Roy St	Int	South Lake Union	South Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_4	Mercer St & Dexter Ave N	Int	South Lake Union	North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_5	Mercer St & Westlake Ave N	Int	South Lake Union	North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_6	Fairview Ave E & Eastlake Ave E	Int	South Lake Union	NE Leg	NA	SDOT	10/31/18 - 11/01/18	W, Th
I_7	10th Ave E & E Aloha St	Int	Capitol Hill / First Hill	South Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_8	18th Ave & E Madison St	Int	Capitol Hill / First Hill	West Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_9	E Yesler Way & 12th Ave	Int	Capitol Hill / First Hill	East Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_10	S Jackson St & 14th Ave	Int	Capitol Hill / First Hill	West Leg, NW Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
Ref_2	Rainier Ave S & S Dearborn St	Ref	Downtown	West Leg	NA	SDOT	10/02/18 - 10/08/18	M - S
I_12	Seattle Blvd S & 4th Ave S	N/A – inside the cordon	Downtown	NA	NA	SDOT	10/02/18 - 10/03/18	T, W
I_13	Airport Way S & S Holgate St	Int	Downtown	North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_14	6th Ave S & S Holgate	Int	Downtown	North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
Ref_3	4th Ave S & S Holgate St	Ref	Downtown	North Leg	NA	SDOT	10/02/18 - 10/08/18	M - S
I_16	1st Ave S & S Holgate St	Int	Downtown	North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_17	1st Ave S & S Atlantic St	N/A - inside the cordon	Downtown	NA	NA	SDOT	10/02/18 - 10/03/18	T, W
I_18	Alaskan Way S & S Atlantic St	Int	Downtown	West Leg, North Leg	NA	SDOT	10/02/18 - 10/03/18	T, W

Table B Continued

GATE_ID	GATE_LOC	GATE_TYPE	NBHD	INT_LEG	RAMP_DIR	SOURCE	VIDEO_DATE	DAY_WEEK
I_19	SR99 and Lander St	N/A - outside the cordon	Downtown	NA	NA	SDOT	10/02/18 - 10/03/18	T, W
I_20	S Jackson St & Alaskan Way S (Ferry -inbound)	Int	Downtown	West Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_21	Alaskan Way & Yesler Way (Ferry - outbound)	Int	Downtown	West Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
I_22	Alaskan Way & Marion St (Ferry - outbound)	Int	Downtown	West Leg	NA	SDOT	10/02/18 - 10/03/18	T, W
R_1	Mercer St off-ramp - SB	Off-Ramp	NA	NA	SB	WSDOT	09/18/18 - 09/19/18	T, W
R_2	Mercer St off-ramp - NB	Off-Ramp	NA	NA	NB	WSDOT	09/18/18 - 09/19/18	T, W
R_3	Mercer St on-ramp - NB	On-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W
R_4	Mercer St on-ramp - SB	On-Ramp	NA	NA	SB	WSDOT	09/11/18 - 09/12/18	T, W
R_5	Stewart/ Eastlake off-ramp (Denny)	Off-Ramp	NA	NA	SB	WSDOT	09/11/18 - 09/12/18	T, W
R_6	Yale St on-ramp (Howell)	On-Ramp	NA	NA	SB	WSDOT	09/18/18 - 09/19/18	T, W
R_7	Olive St on-ramp	On-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W
R_8	E Olive St off-ramp	Off-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W
R_9	Union St off-ramp	Off-Ramp	NA	NA	SB	WSDOT	09/11/18 - 09/12/18	T, W
R_10	University St on-ramp	On-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W
R_11	Seneca St off-ramp	Off-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W
R_12	Spring St on-ramp	On-Ramp	NA	NA	SB	WSDOT	09/25/18 - 09/26/18	T, W
R_13	Madison St off-ramp	Off-Ramp	NA	NA	NB	WSDOT	09/18/18 - 09/19/18	T, W
R_14	James St off-ramp (Columbia / Cherry St)	Off-Ramp	NA	NA	SB	WSDOT	09/11/18 - 09/12/18	T, W

Table B Continued

GATE_ID	GATE_LOC	GATE_TYPE	NBHD	INT_LEG	RAMP_DIR	SOURCE	VIDEO_DATE	DAY_WEEK
R_15	Cherry on-ramp	On-Ramp	NA	NA	NB	WSDOT	09/18/18 - 09/19/18	T, W
R_16	James St off-ramp	Off-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W
R_17	James St on-ramp	On-Ramp	NA	NA	SB	WSDOT	09/18/18 - 09/19/18	T, W
R_18	S Dearborn St off-ramp	Off-Ramp	NA	NA	SB	WSDOT	10/02/18 - 10/03/18	T, W
R_19	S Dearborn St off-ramp	Off-Ramp	NA	NA	NB	WSDOT	10/02/18 - 10/03/18	T, W
R_20	S Dearborn St on-ramp	On-Ramp	NA	NA	NB	WSDOT	09/11/18 - 09/12/18	T, W

APPENDIX C:
BALLARD/INTERBAY AREA LOCATIONS

Table A: Gateway metadata for the Ballard/Interbay vehicle count study.

LOCATION	FREIGHT NETWORK CLASSIFICATION	STREET NETWORK CLASSIFICATION	VIDEO_DATE	DAY_WEEK
1. W Emerson PL, east of 21st Ave W	Minor Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
2. 21st Ave W, North of W Emerson PL	First/Last Mile Connector	Industrial Access	12/17/19 - 12/18/19	T - W
3. 15th Ave W, north of W Emerson St	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
4. [SB off-rp] 15th Ave W, north of W Emerson St.	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
5. [NB on-rp] - 15th Ave W, north of W Emerson St.	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
6. Nickerson St, east of 13th Ave W	Major Truck Street	Industrial Access	12/31/19- 01/2/20	T- Th
7. Westlake Ave N, southeast of Nickerson St	Major Truck Street	Urban Center Connector	12/31/19- 01/2/20	T- Th
8. Fremont Ave N, south of N 34th St	Major Truck Street	Urban Village Main	12/31/19- 01/2/20	T- Th
9. N 34th St, east of Fremont Ave N	Minor Truck Street	Urban Village Main	12/31/19- 01/2/20	T- Th
10. N 35th St, east of Fremont Ave N	Minor Truck Street	Urban Village Neighborhood	12/31/19- 01/2/20	T- Th
11. Aurora Ave N, south of Bridge Way N	Major Truck Street	Urban Village Main	12/31/19- 01/2/20	T- Th
12. Bridge Way N NB off rp, northeast of Aurora Ave N	Minor Truck Street	Urban Village Neighborhood	12/31/19- 01/2/20	T- Th
13. Fremont Way N SB on-rp, northwest of aurora Ave N	Minor Truck Street	Urban Village Neighborhood	12/31/19- 01/2/20	T- Th
14, NW 39th St, east of Leary Way NW	Minor Truck Street	Urban Village Neighborhood	12/31/19- 01/2/20	T- Th
15. Leary Way NW, southeast of NW 45th St	Major Truck Street	Industrial Access	12/31/19- 01/2/20	T- Th
16. NW 45th St, east of Shilshole Ave NW	Non-Truck Street	Minor Industrial Access	12/17/19 - 12/18/19	T - W
17. [SB on-rp] 15th Ave NW, north of Ballard Bridge	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
17. [SB on-rp] 15th Ave NW, north of Ballard Bridge	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
19. NW Leary Way, east of 15th Ave NW	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
20. Shilshole Ave NW, Southeast of 24th Ave NW	Major Truck Street	Industrial Access	12/17/19 - 12/18/19	T - W
21. NW Market St, east of 24th Ave NW	Major Truck Street	Urban Village Neighborhood	12/17/19 - 12/18/19	T - W
22. Leary Ave NW, South of NW Market St	Major Truck Street	Urban Village Main	12/17/19 - 12/18/19	T - W

Table A Continued

LOCATION	FREIGHT NETWORK CLASSIFICATION	STREET NETWORK CLASSIFICATION	VIDEO_DATE	DAY_WEEK
23. NW Market St, east of Leary Ave NW	Major Truck Street	Urban Village Neighborhood	12/18/19 - 12/19/19	W- Th
24. 15th Ave NW, south of NW Market St	Major Truck Street	Urban Village Main	12/17/19 - 12/18/19	T - W
25. NW Market St, east of 15th Ave NW	Major Truck Street	Urban Village Main	12/17/19 - 12/18/19	T - W
26. Phinney Ave N, north of N 46th St	Minor Truck Street	Urban Center Connector	12/17/19 - 12/18/19	T - W
27. N 46th St, east of Phinney Ave N	Major Truck Street	Urban Center Connector	12/17/19 - 12/18/19	T - W
28. Aurora Ave N, north of N 46th St	Major Truck Street	Urban Center Connector	12/17/19 - 12/18/19	T - W
29. Greenwood Ave N, north of N 104th St	Minor Truck Street	Urban Center Connector	12/17/19 - 12/18/19	T - W

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