# Appendix C
# Transportation Technical Report

*REVISED*

# TRANSPORTATION TECHNICAL REPORT FOR FINAL EIS

# TERMINAL 5 IMPROVEMENT PROJECT

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OCTOBER 6, 2016

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# GLOSSARY OF TERMS and ACRONYMS

**AWDT –** Average weekday daily traffic.

**Container** – The box used to transport goods by several modes, including truck, rail, and ship. Containers come in a range of sizes from 20-feet long to 48-feet long. The most common containers are 40-feet long.

**Container terminal –** Major transportation transfer points where import containers are unloaded from ships and transferred to trucks or rail for inland delivery to either intermodal rail hubs or regional businesses. Export cargo also passes through terminals in the reverse direction, arriving by truck or rail and loaded onto ships.

**DEIS –** Draft Environmental Impact Statement.

**Demurrage –** Ancillary cost that represents liquidated damages for delays.

**Dray –** The movement of cargo by truck. In the Port of Seattle area, a “dray trip” generally refers to the short truck trip between a marine terminal and an intermodal rail terminal. Containers that are moved by truck to local or regional businesses are simply referred to as truck trips.

**FGTS –** Freight and goods transportation system designated by the Washington State Department of Transportation.

**FEIS –** Final Environmental Impact Statement.

**Intermodal –** A transfer of cargo from one mode to another. In the shipping business, an “intermodal container” generally refers to one that will be transported from or to a ship by rail. Terminal 5 has an on-dock intermodal rail yard that allows the direct transfer of containers between rail and ship using yard equipment. However, it is expected that some containers will be trucked (see definition for “dray”) between the marine terminal and the near-dock rail yards operated by the BNSF Railway and Union Pacific (UP) Railroad.

**Near-Dock Intermodal Yard –** These include the BNSF SIG/North SIG Yard and the UP Argo Yard.

**NWSA –** Northwest Seaport Alliance, the partnership entity comprised of the Port of Seattle and Port of Tacoma charged with operating cargo terminal facilities in Elliott Bay and Commencement Bay.

**On-Dock Intermodal Yard –** The rail yard at Terminal 5.

**OCR –** Optical character recognition. OCR portals are positions at terminal entry and exit points to automatically read identification numbers on trucks, chassis (the trailer on which the container is transported) and containers.

**Panamax/Post-Panamax –** Panamax-class ships are limited by the size of the original Panama Canal, and are capable of carrying 5,000 TEUs. The existing berth and cranes at Terminal 5 have a reach that can accommodate up to 6,000 TEU vessels. Vessels capable of carrying 10,000 to 18,000 TEU capacities have started to be used on routes to other West Coast terminals. These are often referred to as Post-Panamax, Super Panamax, and Ultra Panamax vessels depending on the size. Vessels of that size would call on several ports during a West Coast circuit, and typically discharge only a portion of their capacity at one port. With upgrades to the berth, cranes, and uplands, Terminal 5 would be able to support 18,000 TEU vessels.

**RFID –** Radio frequency identification. These devices are used to track truck and container movements through the terminal gates.

**RMG –** Rail-mounted gantry crane. The largest type of equipment used to lift and stack containers. They are guided by fixed rails, and although not as mobile as top-picks or RTGs, allow the yard to be more densely stacked, which increases capacity.

**RTG –** Rubber-tired gantry crane. Yard equipment used to lift and stack containers in the yard. Will typically span over trucks, railcars and container stacks.

**SDOT –** Seattle Department of Transportation.

**Switch –** Movement of train segments when building or decoupling a full train. For example, when decoupling a train, the full train will pull into a storage track and drop a segment of the train on those tracks, and then pull forward and back into another storage track and drop another segment, and so on until the entire train is decoupled from the engine. Train building reverses this process.

**TEU –** Twenty-foot Equivalent Unit. A unit of measure used in the shipping industry. A 40-foot container equals two TEUs. In recent years, Port of Seattle shipments have averaged 1.74 TEUs per container.

**Throughput –** Volume of container cargo that passes through a terminal, generally measured in TEUs per year.

**Top Pick –** Yard equipment that is used to lift containers off or onto a truck or rail car, and also used to stack containers in the yard.

**TWIC -** Transportation Worker Identification Credential, which is issued by the U.S. Department of Homeland Security, and is required to access Terminal 5.

**WSDOT –** Washington State Department of Transportation.

# 1. INTRODUCTION

The Port of Seattle (Port) is proposing improvements to Terminal 5 that would rehabilitate the pier and deepen the berth to enable larger ships to utilize the terminal, and increase the terminal's capacity with crane and upland improvements. This Transportation Technical Report was prepared to support the project's Final Environmental Impact Statement (FEIS). It evaluates the transportation effects of potential terminal improvements, and compares those to conditions that would occur if the existing terminal configuration and facilities were to remain. Terminal 5 is currently vacant while the Port seeks a new tenant; information provided in this report based upon observed conditions through 2013, the most recent year in which the terminal was fully occupied. Figure 1 shows the site location and project vicinity.

## 1.1. Project Alternatives

The following summarizes the project alternatives evaluated in this report. Full descriptions are provided in the FEIS.

### 1.1.1. Alternative 1 – No Action

The No Action Alternative assumes that no improvements would be made to the existing 197-acre site other than routine maintenance and repair work. The Terminal 5 upland and waterfront area would continue as a cargo terminal transportation facility with cargo marshalling (sorting), cargo storage, cargo trans-shipments, and vessel moorage. The capacity of the terminal would be defined by the numbers and sizes of vessels capable of being serviced by the height and reach capability of the existing six cranes at the terminal. It is assumed that the No Action Alternative would accommodate 647,000 TEUs per year, which is about 95% of the 684,000 TEUs per year established by the *Southwest Harbor Cleanup and Redevelopment Project Environmental Impact Statement*[1] for the original Terminal 5 improvements.

Under the No Action Alternative, container storage and handling are assumed to be similar to prior operations with 70% to 80% of the container yard being used to store containers directly on road chassis (wheeled operation), and empty and rail cargo being grounded storage (containers stacked on the pavement) served by top picks. The terminal would also be capable of accommodating other marine cargo uses such as breakbulk or neo-bulk (goods that are loaded individually, and not in containers) and other general marine uses. The No Action Alternative would preclude super post-Panamax vessels from utilizing the site since they could not be accommodated by the existing wharf or cranes.

### 1.1.2. Alternative 2 – Wharf Improvements, Increased Cargo Handling

Alternative 2 would rehabilitate the existing Terminal 5 container cargo pier and deepen the existing navigational vessel berth access; it would also make crane and upland improvements required for the terminal to accommodate loading and unloading of two large vessels, each with a capacity of up to 18,000 TEUs. The upland container yard storage area would be changed from a wheeled operation to a grounded operation, served by a mixture of RTGs and top-picks. No substantial changes are proposed to the upland buildings, intermodal rail facilities, or truck gates. With the Alternative 2 improvements, the terminal's throughput is estimated at 1.3 million TEUs per year.

[1] Port of Seattle. Draft EIS published January 1994; Final EIS published November 1994.

Figure 1. Vicinity Map


*Source: Port of Seattle, August 2016.*

### 1.1.3. Alternative 3 – Wharf Improvements plus Upland Improvements

Alternative 3 proposes the cargo wharf and vessel berth improvements identified in Alternative 2 combined with substantial improvements to the upland cargo marshalling area to increase overall terminal throughput to 1.7 million TEUs per year. The wharf and crane improvements would allow simultaneous loading and unloading of two 18,000 TEU vessels. The container yard would be enlarged through relocation or demolition of the freight station, transit shed, maintenance, repair buildings, and operations buildings. The truck gate would be relocated, and the existing intermodal rail yard would be reconfigured with additional rail lines and concrete or rail runways for RTG or RMG equipment. The container yard capacity would be increased through use of grounded container storage served by RTG or RMG cranes.

## 1.2. Transportation-related Container Terminal Operations

This section provides an overview of various elements of container terminal operations that may affect the transportation system. The effects on these elements with each of the three alternatives are also described.

### 1.2.1. Throughput and Vessel Calls

The Northwest Seaport Alliance (NWSA), the new partnership between the Port of Seattle and Port of Tacoma, anticipates that larger vessels will dominate future ship calls to the Pacific Northwest. Improvements at Terminal 5 are proposed to accommodate the larger ships. If the Alternative 2 or 3 improvements are not made (No Action Alternative), Terminal 5 would not be able to accommodate larger ships because of limitations in the crane height and overreach. With the ability to serve larger ships, the number of vessel calls per week is estimated to decrease from six per week under the No Action Alternative to four per week with Alternatives 2 or 3.

An analysis was performed by Moffatt & Nichol to determine the potential throughput that could be accommodated by the terminal given the potential berth capacity, container yard area, storage density, peaking factors associated with larger ships, and container dwell time in the terminal. Alternative 1 (No Action Alternative) assumes an annual throughput at Terminal 5 of 647,000 TEUs. Alternative 1 assumes that existing cranes would continue to be used, and that the vessel calls would be similar to what occurred previously when an average of six vessels per week called at the terminal. The vessels reflected a mix of sizes, and only a portion of the vessel capacity was unloaded from or loaded onto each ship.

With Alternatives 2 or 3, the improved pier and deeper berth would allow larger ships to call at Terminal 5. For Alternative 2, which would have modest upland improvements, the throughput is estimated at 1.3 million TEUs per year. For Alternative 3, which would have increased container yard and intermodal yard capacities, the throughput is estimated to be 1.7 million TEUs per year.

The range of volumes proposed in Alternatives 2 and 3 could be achieved with various vessel service call scenarios. For the purpose of this analysis, a total of four ships per week were assumed: two 18,000 TEU ships and two 8,000 TEU ships. Table 1 summarizes the vessel calls and throughput assumed for each alternative.

Table 1. Terminal Throughput and Vessel Call Scenarios

| | Alternative 1 (No Action) No Improvements | | | Alternative 2 Wharf Improvements | | | Alternative 3 Wharf + Upland Improvements | | |
|---|---|---|---|---|---|---|---|---|---|
| Weekly Service | Vessel Capacity (TEUs) | % Discharged & Loaded | Annual TEUs [a] | Vessel Capacity (TEUs) | % Discharged & Loaded | Annual TEUs | Vessel Capacity (TEUs) | % Discharged & Loaded | Annual TEUs |
| Service 1 | 5,500 | 30% | 171,500 | 18,000 | 25% | 468,000 | 18,000 | 30% | 566,300 |
| Service 2 | 5,500 | 30% | 171,500 | 18,000 | 25% | 468,000 | 18,000 | 30% | 566,300 |
| Service 3 | 2,200 | 33% | 76,000 | 8,000 | 22% | 182,000 | 8,000 | 34% | 283,700 |
| Service 4 | 2,200 | 33% | 76,000 | 8,000 | 22% | 182,000 | 8,000 | 34% | 283,700 |
| Service 5 | 2,200 | 33% | 76,000 | | | - | | | - |
| Service 6 | 2,200 | 33% | 76,000 | | | - | | | - |
| Annual TEU's | | | 647,000 | | | 1,300,000 | | | 1,700,000 |

*Source: Heffron Transportation and Moffat & Nichol, January 2016.*
*a. Annual TEUs = (cargo discharged + cargo loaded) x 52 weeks per year.*
*Each service reflects an individual ship call with one discharge operation and one loading operation.*

The time that a ship spends in berth would vary based on size. The smaller ships anticipated for the No Action Alternative require about 16 to 20 hours at berth for loading and unloading. The larger ships anticipated for Alternatives 2 or 3 would require between 25 and 50 hours at berth.

### 1.2.2. Container Yard Operations

The container yard at a terminal functions as a surge pile—it provides space to quickly absorb containers unloaded from a ship before they are transported off terminal by rail or truck, and allows containers to be staged prior to ship loading. Both functions make the unloading and loading operations more efficient to reduce the time that a ship must stay at berth.

Terminal 5 has historically been a "wheeled operation," meaning that the majority of containers that enter or leave the terminal on truck are loaded directly from the ship to a chassis and then parked in a space on the terminal. This allows the truck driver to park or retrieve a container without the aid of a top-pick. With improvements and increased throughput, the container yard would be converted to a "grounded operation" in which containers are stored in stacks. Containers are unloaded from a ship to a specialized chassis, and then sorted into stacks. Containers are stacked according to destination. Some types of containers, such as refrigerated containers or hazardous materials would have separate areas.

The No Action Alternative assumes most loading, unloading, and stacking in the container yard would be performed by top-pick loaders, same as the existing condition. For Alternative 2, some RTGs would be used for loading trucks. For Alternative 3, it is expected that almost all loading functions in the container yard would be handled by RMG cranes in order to achieve the storage density required. RMGs have a fixed capacity, unlike top-picks where more equipment and staff can be added to increase capacity. As described later, the use of RMGs is likely to require that a second truck gate shift be added when 3,000 or more ship lifts per day are expected in order to meter the flow of truck loading and unloading to the capacity provided by the RMGs.

The crane and terminal crews often work two shifts when ships are in berth: the day shift, which typically occurs from 8:00 A.M. to 5:00 P.M., and the night shift, which typically occurs from 6:00 P.M. to 3:00 A.M. A "hoot shift" (typically from 3:00 to 7:00 A.M.) may be needed to unload or load a ship on rare occasions, which can occur if the ship is delayed by weather.

### 1.2.3. Rail and Intermodal Yard Operations

Terminal 5 has an on-dock intermodal rail yard that allows the direct transfer of containers between rail and ship within the terminal. This yard is primarily used to create or discharge unit trains where all containers have a common origin or destination. Intermodal containers with other origins or destinations are usually handled through one of the near-dock rail yards operated by the BNSF Railway and UP Railroad where a terminal's cargo is combined with cargo from other terminals to create either full unit trains or mixed-service trains that may drop or pick up segments at inland destinations. These containers are drayed (trucked) between Terminal 5 and the off-dock rail yards.

With the No Action Alternative, which would accommodate smaller ships, it is estimated that 55% of the terminal's throughput would be intermodal cargo. Just over half (30% out of 55%) is expected to be handled at the on-dock rail yard and the rest (25%) drayed to near-by off-dock rail yards. The remaining 45% of the total cargo would be trucked to local and regional businesses.

With increased throughput at Terminal 5, the percentage of containers transported by rail is expected to increase to 75%. This is because the regional market in the Pacific Northwest is not large enough to support higher demand for locally-trucked cargo. Of the containers transported by rail, two-thirds (or 50% of the intermodal total) are assumed to be handled at the on-dock intermodal yard and one-third (or 25% of the total) are assumed to be drayed to off-dock rail yards. The remaining 25% of the total cargo would be trucked to local and regional businesses. Table 2 presents the throughput and mode-of-travel assumptions for the three alternatives.

Table 2. Terminal 5 Throughput and Mode of Travel

| Condition | Throughput | Moved through On-Dock I/M [a] | Drayed to/from Off-Dock I/M | Trucked to/from Local/Region |
|---|---|---|---|---|
| Alternative 1 – No Action | | | | |
| Throughput (TEUs/Year) | 647,000 | 194,100 | 161,800 | 291,100 |
| Mode of Travel | | 30% | 25% | 45% |
| Alternative 2 – With Wharf Improvements | | | | |
| Throughput (TEUs/Year) | 1,300,000 | 650,000 | 325,000 | 325,000 |
| Mode of Travel | | 50% | 25% | 25% |
| Alternative 3 – With Wharf and Upland Improvements | | | | |
| Throughput (TEUs/Year) | 1,700,000 | 850,000 | 425,000 | 425,000 |
| Mode of Travel | | 50% | 25% | 25% |

*Source: Moffatt & Nichol, January 2016.*

*a. I/M = Intermodal containers moved between ship and rail.*

For the No Action Alternative and Alternative 2, the existing rail yard configuration and operation are expected to continue, and containers would be carried by yard equipment between a container yard stack and the intermodal yard, and loaded (or unloaded) from the train using a top pick. Once the segment of railcars on the loading tracks is filled, it is moved to the storage tracks until enough are ready to create a single unit train destined for a common location. The segments are then switched and connected to form a full unit train, which is typically 7,500 feet long, but can range from 5,000 to 8,600 feet long including locomotives. For Alternative 3, the configuration would be changed to accommodate RMG loaders, which would increase the capacity of the yard. The size of the unit train would remain 7,500 feet long.

### 1.2.4. Truck Gate Operations

The truck gate is where security checks occur and transaction information is exchanged for containers that enter or leave the terminal by road. This includes the dray movements between Terminal 5 and the near-dock intermodal yards. Trucks are allowed to deliver or retrieve a container within a designated window related to a ship's schedule. Export containers are usually required to arrive at the terminal a minimum of one and maximum of five working days prior to ship arrival. A container that arrives late must wait until the next ship call. Containers that arrive too early or are not picked up within the allotted time are charged a demurrage fee for on-terminal storage.

Arriving trucks proceed through the security Transportation Worker Identification Credential (TWIC) check point, then through an OCR portal that processes some of the transaction information regarding the container and truck identification, before arriving in the main gate queue. Once the truck reaches the processing station at the main gate, its container information is verified and matched to a pre-loaded booking. The driver is given directions to proceed to the designated container stack to drop off or retrieve their container. If the driver has a dual transaction (both dropping off and receiving a container), they would then proceed to their second container stack to be loaded prior to exiting the terminal. When exiting the terminal, the truck passes through an OCR portal and radiation detection portal prior to the exit gate. At the exit processing station, transaction information is verified and the driver is cleared to leave the terminal. If additional screening is required by US Customs and Border Protection, drivers are directed to that area before leaving the terminal.

For the No Action Alternative and Alternative 2, the truck gate is assumed to operate only during the day shift (8:00 A.M. to 5:00 P.M.) up to six days per week. On high-volume days, the gate may need to open one hour earlier. For Alternative 3, the gate may require a second shift (6:00 P.M. to 3:00 A.M.) due to the change to RMGs within the container terminal yard. If a second gate shift is required, then it is likely that a reservation system for gate access would also be implemented to meter the flow of trucks onto the terminal and improve on-terminal operations. Further detail about gate operations is provided in Section 5.3.

## 1.3. Study Area

The transportation study area for this report includes the north end of the Duwamish Manufacturing and Industrial Area (MIC), extending from Terminal 5 to Interstate 5 and from S Atlantic Street (SR 519) to SR 509 south of the 1$^{st}$ Avenue S Bridge. Within that area, the primary travel corridors serving Terminal 5 are SW Spokane Street between Harbor Avenue SW and East Marginal Way S, and East Marginal Way S between S Hanford Street and the North Argo Access. These corridors cover the primary travel routes between Terminal 5 and the near-dock intermodal rail yards, and between the terminal and the Spokane Street Viaduct, which is the primary route to the interstate freeway system. The following intersections were evaluated for this report, which are shown later on Figure 3.

- SW Spokane Street/Harbor Avenue NW
- SW Spokane Street/West Marginal Way SW/Chelan Avenue SW
- SW Spokane Street/Terminal 5 Access
- SW Spokane Street/11$^{th}$ Avenue SW
- S Spokane Street/East Marginal Way S
- S Hanford Street/East Marginal Way S
- East Marginal Way S/North Argo Access Road

# 2. AFFECTED ENVIRONMENT

This section of the report discusses the existing transportation conditions in the project study area, including roadways, rail, transit and non-motorized traffic, operational characteristics of Port-generated and general background vehicle traffic, safety conditions, and parking characteristics.

## 2.1. Transportation Network

### 2.1.1. Existing Roadway Network

The near-site roadway network that serves Terminal 5 is shown on Figure 2. Terminal 5 has two vehicle access points. The primary (overpass) access is via the Terminal 5 Access Bridge that connects to SW Spokane Street just west of the Spokane Street Swing Bridge over the West Duwamish Waterway. This access bridge is grade-separated from the Terminal 5 lead railroad tracks. A secondary (surface) access is located at-grade via West Marginal Way SW and connects to the SW Spokane Street/West Marginal Way SW/Chelan Avenue SW intersection as its northern leg. This access points crosses the Terminal 5 lead railroad tracks at grade, which can be blocked for train movements. The surface route and overpass connect south of the Terminal 5 gate, and either route can be used to access the Terminal 5 office and businesses located southeast the terminal at privately-owned sites known as Terminals 7A, 7B, and 7C. In the past, at times of high truck activity for Terminal 5, trucks were discouraged (and even prohibited by the terminal operator) from short-cutting the queue line by using the surface access, and were directed to enter the terminal via the Terminal 5 Access Bridge. Trucks that exit the terminal could use either route.

Connections between the terminal and the regional highway network are provided by S/SW Spokane Street, West Marginal Way SW, East Marginal Way S, and the West Seattle Bridge/Spokane Street Viaduct. All of these roadways are part of WSDOT's *Freight and Goods Transportation System* (FGTS). The West Seattle Bridge, SR 99, East Marginal Way and West Marginal Way are classified as FGTS T-1 roadways, the highest classification, and SW Spokane Street is classified as a T-2 roadway. All of these connecting streets are also part of the City's new Heavy Haul Network that allows increased axle loads and gross tonnage for specially-permitted trucks. The Heavy Haul Networks and FGTS are described further in Sections 2.1.2 and 2.1.5, respectively.

**S / SW Spokane Street** is a surface arterial that connects from Harbor Avenue SW in West Seattle to Airport Way S near Interstate 5 (I-5). For most of its length, it is classified by the Seattle Department of Transportation (SDOT) as a Minor Arterial[2], except for the portion between East Marginal Way S and West Marginal Way SW (across Harbor Island), which is classified as a Collector Arterial. The arterial crosses the Duwamish West Waterway on a two-lane swing-bridge, which opens for marine vessel traffic. It then widens to five lanes (three westbound and two eastbound) as it crosses the fixed Duwamish East Waterway bridge. Two of the westbound lanes and one of the eastbound lanes provide exclusive access to Harbor Island. Just east of the East Waterway Bridge are ramps to and from the Spokane Street Viaduct, which can be used to access I-5.

2 All City of Seattle street classifications are from the *Seattle Arterial Classifications Planning Map, December 11, 2003;* http://www.seattle.gov/transportation/streetclassmaps/planweb.pdf; accessed January 26, 2015.

Figure 2. Near-site Roadway Network


*Source: Port of Seattle, August 2016.*

**West Marginal Way SW** connects from SW Spokane Street to State Route 99 (SR 99) near the First Avenue S Bridge. It is classified as a Principal Arterial. Along much of its length, it is a five-lane roadway (two lanes in each direction plus a center two-way left turn lane). North of the intersection with SW Spokane Street, West Marginal Way SW crosses the lead railroad tracks that serve Terminal 5 at grade, and passes under the Terminal 5 Access Bridge. This street provides an at-grade connection to Terminal 5 and other local businesses that front the Duwamish River.

**East Marginal Way S**, between S Atlantic Street and Duwamish Avenue S, is a Minor Arterial that connects the downtown Seattle waterfront to SR 99 south of the Spokane Street Viaduct. This roadway provides access to BNSF Railway's Seattle International Gateway (SIG) Intermodal Yard via S Hanford Street, and also connects to I-5 and Interstate 90 (I-90) via S Atlantic Street. Just south of the intersection with S Spokane Street are two railroad crossings—one operated by the BNSF Railway and the other by the UP Railroad—that link the West Seattle and Harbor Island rail yards in to the mainline tracks and support yards. The Port recently completed the **East Marginal Way Grade-Separation Project** that vertically separates the roadway from the main railroad crossings. Trucks can access SR 99 just south of the grade-separated structure. This route also provides a connection to the North Argo Access, a Port-owned truck access roadway located along the south edge of the Argo Yard lead tracks (see description below).

**West Seattle Freeway/Spokane Street Viaduct** is an elevated Principal Arterial that connects West Seattle to State Route (SR) 99, I-5, and Beacon Hill to the east. Ramps connect this elevated roadway to surface Spokane Street at several locations, including ramps to and from SW Chelan Street just west of Terminal 5 and ramps to and from Harbor Island to the east. Ramps also provide an eastbound exit to 1$^{st}$ Avenue S and 4$^{th}$ Avenue S, and a westbound entry from 1$^{st}$ Avenue S.

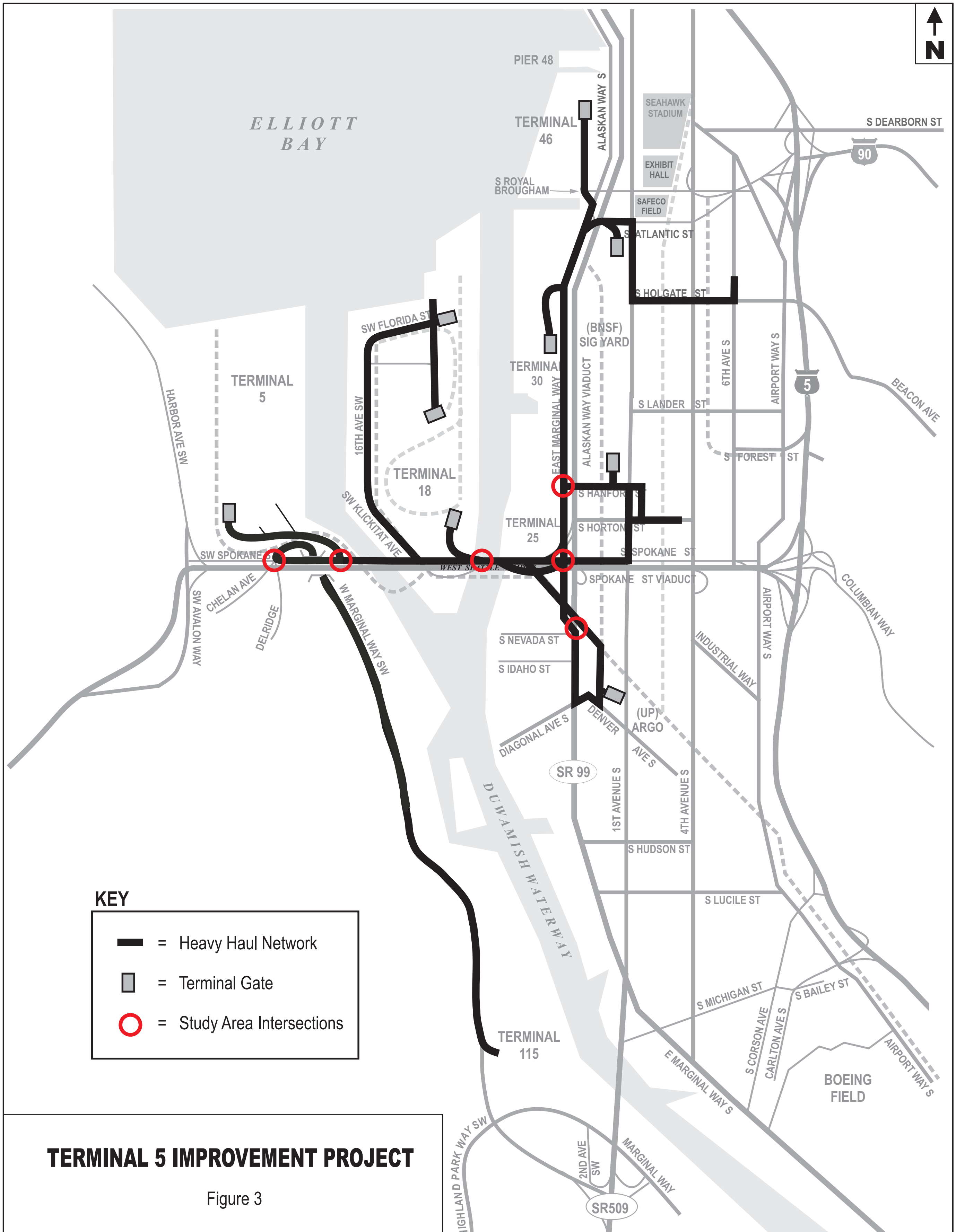
**North Argo Access** provides a one-way southbound truck connection between East Marginal Way S and the UP Argo Yard for intermodal transfers. The access route connects under SR 99 just south of the new East Marginal Way grade-separated structure. It was recently constructed to eliminate the need for trucks to weave across SR 99 in the southbound direction between the existing on-ramp and Diagonal Avenue S. Trucks returning to the container terminals exit the Argo Yard via Diagonal Avenue S and East Marginal Way S.

### 2.1.2. Heavy Haul Network

In October 2015, the City Council unanimously adopted legislation to create a Heavy Haul Network on a limited number of city streets to allow for the efficient drayage of sealed, ocean-going containers between the Port of Seattle and nearby intermodal facilities (Ordinance No. 124890). The new maximum allowable tandem drive axle weight of 43,000 pounds and maximum of gross vehicle weight of 98,000 pounds will be administered and enforced under a new permitting system. The adopted Heavy Haul Network, shown on Figure 3, includes the street system connecting Terminal 5 to the railyards; the upper level of the West Seattle Bridge and Spokane Street Viaduct are excluded from the Heavy Haul Network.[3]

Among the conditions of the permit is a requirement for twice-yearly inspections for permitted vehicles. In addition, the legislation establishes a new Commercial Vehicle Enforcement Officer (CVEO) position in SDOT devoted to enforcing truck-related rules and regulations in the Heavy Haul Network area.

[3] SDOT, *Summary – Adopted Heavy Haul Network Legislation*, October 27, 2015.




# TERMINAL 5 IMPROVEMENT PROJECT

Figure 3

**HEAVY HAUL NETWORK AND STUDY AREA INTERSECTIONS**

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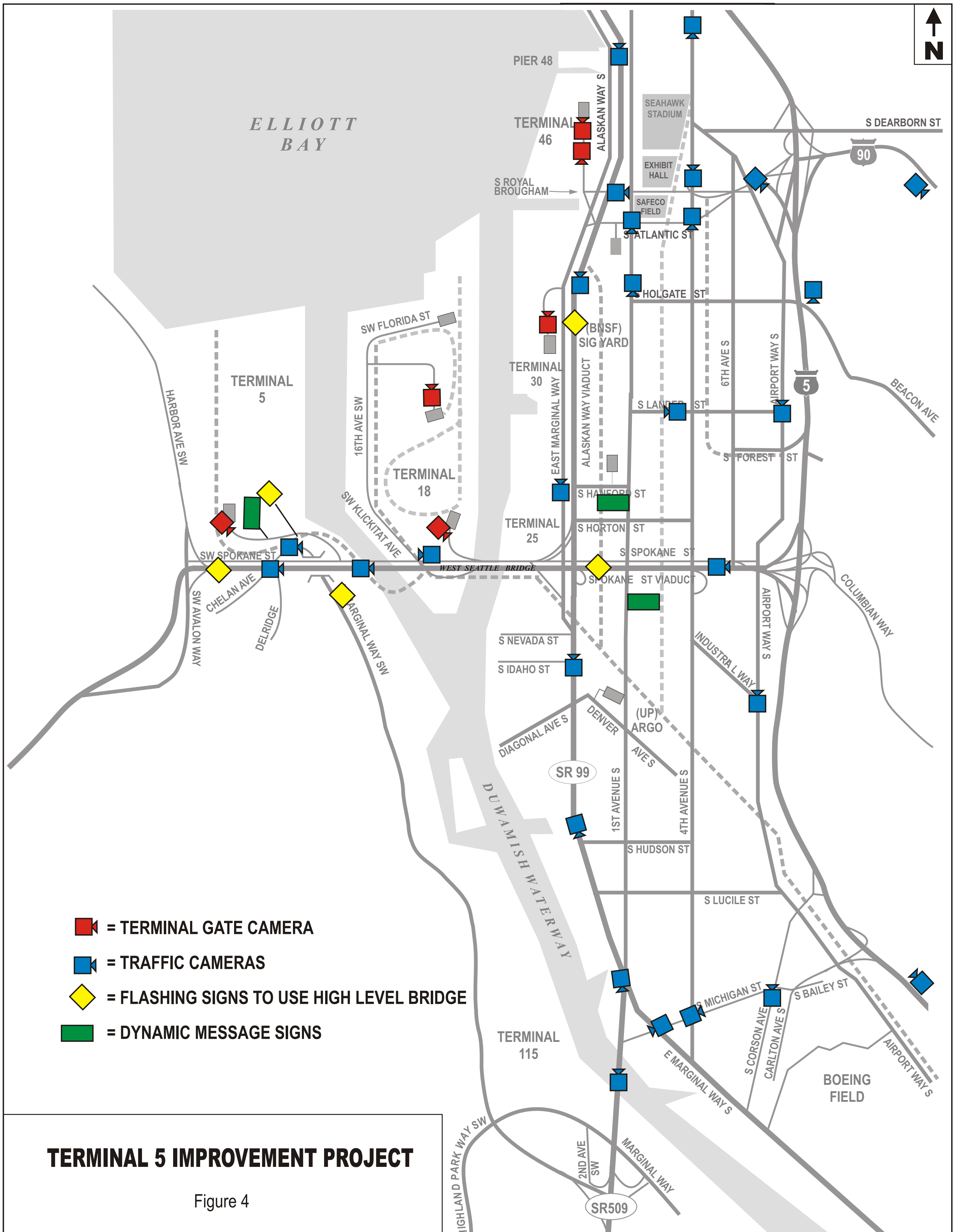
As part of the legislation, the Port and City have entered into a Memorandum of Understanding (MOU), detailing the Port's commitment to the program. It states that the Port will pay up to $250,000 to support the implementation and operation of the Heavy Haul program through at least the end of 2017. As a second component of the MOU, the Port has agreed to contribute between $10 million and $20 million over the next 20 years to pavement rehabilitation and restoration projects on heavy haul network roadways. Project-specific Port funding would be directly tied to the estimated cost of accelerated deterioration of pavement due to heavy vehicles on the roadway, in addition to the estimated additional layer of paving needed to support more frequent use by heavy vehicles.

Based on analysis, City and Port staff recommend that pavement investments be targeted to three principal corridors: 1) SW Spokane Street between Terminal 5 and East Marginal Way S, 2) East Marginal Way S between Terminal 46 and the North Access Road, and 3) S Hanford Street between East Marginal Way S and the BNSF SIG Yard.

### 2.1.3. Driver Information Infrastructure

SDOT, Port of Seattle and WSDOT jointly developed a good network of traffic cameras, dynamic message signs, and signs with flashing beacons to alert motorist about bridge openings in the Duwamish Industrial Area. There are City and State-owned cameras along most arterial routes and state highways in the neighborhood that can be viewed from various web sites. In addition, all of the Port of Seattle's terminal gates have cameras (some from multiple angles) that show the length of the gate queues. There are several flashing beacon signs that are triggered when the Spokane Street Swing Bridge opens for marine traffic to alert motorists to "Use High Bridge When Flashing." Finally, there are dynamic message signs along 1st Avenue S on which the message can be set at SDOT's Transportation Operations Center (TOC). The location of various driver information infrastructure is shown on Figure 4.

In addition to these efforts, the NWSA is in the process of deploying the data collection, sharing and communications infrastructure that will enable the NWSA's Operations Service Center to measure truck traffic congestion on, at and near container terminals and reduce it by providing real-time truck wait and queuing information to the trucking community. This will enable drivers to make informed routing decisions. The project is part of FHWA's *Freight Advanced Traveler Information System* (FRATIS) program and supported by an initial FRATIS grant. In addition, the NWSA has been awarded a federal grant through the federal Congestion Mitigation and Air Quality Improvement (CMAQ) Program to expand on an FHWA pilot-project current underway at the NWSA South Harbor (Tacoma terminals). Both applications are expected to reduce wait times at the terminal gates. This uses a new smartphone application—Dray Q—that provides terminal wait time information to a driver through mobile phones. An extension application, Dray Link, is also being offered that will provide a more robust set of logistics tools including providing drivers with the ability to manage pick-up and delivery information. Experience with pilot projects in locations such as the Ports of Los Angeles and Long Beach has shown that queuing and wait time reductions will result in reductions of diesel and greenhouse gas emissions.




**TERMINAL 5 IMPROVEMENT PROJECT**

Figure 4

EXISTING DRIVER INFORMATION INFRASTRUCTURE

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### 2.1.4. Infrastructure Improvements since Construction of Terminal 5

Many infrastructure improvements were made when the current configuration of Terminal 5 was constructed in 1997. The major transportation-related improvements included:

- Constructing the Terminal 5 Access Bridge to grade-separate the terminal's vehicular traffic from its lead railroad tracks, and minimize truck queues on city streets;
- Rebuilding Harbor Avenue SW to include new curb, gutter, sidewalk and a landscape berm;
- Constructing the on-dock intermodal yard, storage tracks and lead railroad tracks;
- Installing a second lead track across Harbor Island to increase rail capacity; and
- Constructing a new emergency-access bridge between the south end of Harbor Island and the mainland that can be used if this area is blocked by a train.

Since Terminal 5 opened in 1997, both the Port and City of Seattle have made the following additional infrastructure improvements in the area.

- Rebuilding the Harbor Island roadway network as part of the Terminal 18 expansion in 1999, which relocated the lead railroad tracks to Harbor Island and Terminal 18 under the SW Spokane Street Bridge (these trains previously crossed Spokane Street at grade near 11th Avenue SW). The Terminal 18 project also reconfigured SW Spokane Street to create the frontage road system, which simplified the intersection at 11th Avenue SW.
- Constructing the East Marginal Way Grade Separation described previously, which allows Port trucks and other vehicular traffic to bypass train movements in the corridor.
- Widening the Spokane Street Viaduct, constructing a new eastbound off-ramp to 4th Avenue S, and rebuilding the westbound on and off-ramps at 1st Avenue S.
- Rebuilding surface Spokane Street under the viaduct. This project provided wider lanes, better U-turn facilities, new pavement, and improved traffic signal systems.
- Rebuilding the SW Spokane Street fixed bridge over the East Duwamish Waterway.
- Constructing the North Argo Access Road, which eliminated the need for trucks to weave across SR 99 in the southbound direction between the existing on-ramp at East Marginal Way and Diagonal Avenue S.

All of these improvements were constructed in part to accommodate future growth at the Port's container terminals, and were designed for large trucks.

### 2.1.5. Future Plans and Policies

The City's adopted modal transportation plans and programs were reviewed to identify goals, policies and planned future improvements to vehicular and non-motorized travel to and through the Terminal 5 study area.

## Regional and State Freight Designations

The Port of Seattle marine facilities, including Terminal 5, are located within the Duwamish Manufacturing/Industrial Center (MIC), designated by the Puget Sound Regional Council (PSRC) as part of *VISION 2040*.[4] MICs are employment areas with intensive, concentrated manufacturing and industrial land uses that cannot be easily mixed with other activities. They are characterized as areas of large contiguous blocks served by the region's major transportation infrastructure, including roads, rail, and port facilities. The Duwamish MIC is one of the largest and most intensely developed industrial and manufacturing areas in the Pacific Northwest.[5] *Transportation 2040* is the region's long-range transportation plan that implements VISION 2040. Transportation 2040 presents the *Regional Freight Strategy*, which provides background on many of the bigger issues regarding the region's freight and goods movement and presents recommendations for a long-term regional freight strategy. Policies in the Regional Freight Strategy recognize that MICs are located to have ready access to transportation systems, to reduce the time and cost of transporting goods as well as pressure on the regional transportation system. Transportation policies identified in the City's *Comprehensive Plan*[6] for MICs in Seattle include maintaining land that is uniquely accessible to water, rail, and regional highways for continued industrial use, and promoting an intermodal freight transportation strategy that improves freight and goods movement within and between these modes.

WSDOT has established the Washington State *Freight and Goods Transportation System* (FGTS) to classify roadways, railways and waterways according to their annual freight tonnage. Each facility is categorized 1 through 5, with 1 reflected the highest annual freight tonnage and 5 reflecting the lowest. In the vicinity of Terminal 5, T-1 roadways (carrying more than 10 million tons of freight per year) include the West Seattle Bridge/Spokane Street Viaduct, SR 99, and West Marginal Way S. T-2 roadways (carrying 4 million to 10 million tons of freight per year) include 11th Avenue SW and 16th Avenue SW on Harbor Island and SW Spokane Street. The Puget Sound Marine Waterway has a W-1 classification (carrying more than 25 tons of freight per year), and the railroads serving the area are classified as R-1 (carrying more than 5 million tons per year). WSDOT has identified T-1 and T-2 roadways, as well as FGTS railroads and waterways, as freight economic corridors in Washington State.[7]

WSDOT is currently working to identify and designate Critical Urban and Rural Freight Corridors throughout the state. Although still in draft form, the designated corridors are expected to be submitted to the Federal Highway Administration (FHWA) by the end of 2016.[8] Criteria for Critical Urban Freight Corridors include high truck volume/tonnage, and close connectivity to the National Freight Highway Network, major freight intermodal facilities, and large industrial/warehouse centers. If approved, there will be a new Critical Urban Freight Corridor in the Duwamish that will include East Marginal Way S between Diagonal Avenue S and S Atlantic Street, as well as S Hanford Street between East Marginal Way S and 1st Avenue S. In the vicinity of the Terminal 5 site, SW Spokane Street (between Terminal 5 and I-5) is already designated as an Intermodal Connector, and is part of the Primary Highway Freight Network.[9]

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4 Puget Sound Regional Council, VISION 2040, 2009.
5 Puget Sound Regional Council, Regional Centers Monitoring Report, 2013.
6 City of Seattle, Seattle's Comprehensive Plan: Toward a Sustainable Seattle, January 2005.
7 Washington State Department of Transportation, Washington State Freight and Goods Transportation System, 2015 Update, March 2016.
8 Washington State Department of Transportation, Designation of Critical Urban and Rural Freight Corridors, May 2016.
9 Washington State Department of Transportation, Draft Candidate Urban and Rural Freight Corridors Map, *http://wsdot.maps.arcgis.com/home/webmap/viewer.html?webmap=0fe90fe7cd324ed9a9a9586866aa9b04*, Accessed August 15, 2016.

## Seattle Comprehensive Plan

Land use and transportation policies in the City of Seattle are guided by the *2005 Comprehensive Plan, Toward a Sustainable Seattle*. The Comprehensive Plan is currently undergoing a major update, which has been in process since 2012 and is planned to be completed in 2016. However, until the update is adopted, the City's adopted goals and policies remain those identified in the 2005 Comprehensive Plan. Freight goals identified in the Comprehensive Plan include preservation and improvement of mobility and access for the transport of goods and services (TG19) and maintenance of Seattle as the hub for regional goods movement and as a gateway to national and international suppliers and markets (TG20). The Terminal 5 project is consistent with these goals, and is particularly relevant to TG20, as the proposed improvements to accommodate larger ships have been identified to support changes to marine freight movement on a national and international scale. The Terminal 5 project is also consistent with adopted Comprehensive Plan freight transportation policies that support efficient and safe movement of goods by rail where appropriate (Policy T49) and encourage intermodal freight transportation improvements (Policy T50). Evaluation of the Terminal 5 project's potential impacts on all modes and integration of proposed improvements with non-freight improvements is consistent with Policy T48, which indicates that improvements supporting freight mobility on Major Truck streets may be integrated with improvements supporting other modes of travel.

The in-process update to the Comprehensive Plan includes policies that are consistent with the 2005 Plan but more detailed. It should be noted, however, that until the updated Comprehensive Plan is adopted by the City, policy updates are still draft and potentially subject to revision. The Transportation Elements of the Mayor's Draft Plan, which was issued in May 2016, maintains the goal (TG5) of improving mobility and access for the movement of goods and services to enhance and promote economic opportunity throughout the city. Transportation policies supporting this goal in the Mayor's Draft Plan relate to freight access and mobility in the Duwamish MIC. Key provisions of the draft Plan include:

- T4.6 – Improve mobility and access for freight in order to reduce truck idling, improve air quality, and minimize the impacts of truck parking and movement in residential areas.

- T 5.1 - Enhance Seattle's role as the hub for regional goods movement and as a gateway to national and international suppliers and markets.

- T5.2 - Develop a freight network in the Freight Master Plan that connects the city's manufacturing/industrial centers, enhances freight mobility and operational efficiencies, and promotes the city's economic health.

- T5.3 - Ensure that freight corridors are designed, maintained and operated to provide efficient movement of truck traffic.

- T5.6 - Work with freight stakeholders and the Port of Seattle and others to improve intermodal freight connections involving Port container terminals, rail yards, industrial areas, airports and regional highways.

- T5.7 – Support efficient and safe movement of goods by rail where appropriate, and promote efficient operation of freight rail lines and intermodal yards.

- T6.5 – Improve safety for all modes of transportation on streets heavily used by trucks.

The Container Port Element of the Comprehensive Plan recognizes the importance of the Port of Seattle as a vital economic development entity and cargo gateway. The Draft Container Port Element contains several goals and policies that support retention of this function; the updated Container Port polices reflect minimal changes to those in the current adopted plan. Key transportation provisions in the Container Port Element of the Mayor's Draft Plan include:

- CP1.6 - Monitor, maintain and improve key freight corridors, networks and intermodal connections that provide access to cargo-container facilities and the industrial areas around them to address bottlenecks and other access constraints.
- CP1.7 - Provide safe, reliable, efficient and direct access between Port marine facilities and the state highway or interstate system, and between Port terminals and railroad intermodal facilities, recognizing that Port operations must address other transportation needs, such as pedestrian safety.
- CP1.8 - Make operational, design, access and capital investments to accommodate trucks and railroad operations and preserve mobility of goods and services. Improvements may include improvement of pavement conditions, commute trip reduction strategies, roadway rechannelization to minimize modal conflicts, use of intelligent transportation systems, construction of critical facility links, and grade separation of modes, especially at heavily used railroad crossings.
- CP1.9 - Maintain a City classification for freight routes to indicate routes where freight will be the major priority. Street improvements that are consistent with freight mobility but also support other modes may be considered in these streets.
- CP1.10 - Continue joint City and Port efforts to implement relevant Port recommendations, such as recommendations contained in the Container Terminal Access Study.
- CP1.12 - Given the importance of cargo container terminal operations to the state and regional economies, develop partnerships within the City, the Port, the region and the State to advocate for project prioritization and timely funding to improve and maintain freight infrastructure, and explore funding partnerships.

## Complete Streets Ordinance

In 2007, the Seattle City Council passed Ordinance 122386, known as the Complete Streets ordinance, which directs SDOT to design streets for pedestrians, bicyclists, transit riders, and persons of all abilities, while promoting safe operation for all users, including freight. Section 3 of the ordinance states, "*Because freight is important to the basic economy of the City and has unique right-of-way needs to support that role, freight will be the major priority on streets classified as Major Truck Streets. Complete Street improvements that are consistent with freight mobility but also support other modes may be considered on these streets.*"

The Complete Streets ordinance is the lens through which SDOT views all major maintenance and construction projects. The Complete Streets checklist is the tool SDOT uses to collect data and information about the status of the street and surroundings, as well as the details of the project, with a goal of identifying specific improvements that can be incorporated into the project to balance the needs of all users. Although Complete Streets evaluation is not a tool implemented at the development project level, it is important to note that it is a planning-level tool SDOT applies identify the appropriate transportation network and improvement priorities needed to accommodate all modes of travel, and it guides implementation of the modal plans and projects described in the following sections.

## Seattle Freight Master Plan and Freight Access Project

The City of Seattle is developing a *Freight Master Plan* (FMP)[10] to address the unique characteristics, needs, and impacts of freight mobility. The public review draft of the FMP was issued in May 2016. The draft FMP designates a citywide freight network. In the Terminal 5 study area, it identifies SR 99 as a Limited Access Truck Street; S Spokane Street, West Marginal Way S, East Marginal Way, and the West Seattle Bridge as Major Truck Streets; Delridge Way SW as a Minor Truck Street; and the West Marginal Way access to Terminal 5 as a First/Last Mile Connector. The FMP outlines the critical role that freight movement has on meeting the City's goals for social equity, economic productivity, sustainability, and livable neighborhoods. It includes information about existing conditions, policies, future conditions assessment, identification of near- and long-term improvements, design guidelines, and the creation of an implementation strategy (recommended projects in the Terminal 5 study area are described below).[11] It is expected that the FMP will be adopted by the end of 2016.

The *Freight Access Project*[12], which was a joint effort between the City of Seattle and Port of Seattle, identifies truck-freight transportation investments needed over the next 20 years to support Seattle's industrial lands and keep freight traffic moving. The *Freight Access Project* identifies numerous projects to improve freight mobility, safety, and accessibility in the Duwamish MIC, which are also identified in the Draft FMP. In the vicinity of Terminal 5, recommended projects include heavy haul upgrades and other improvements to East Marginal Way (described in more detail in a section below) between the Port and rail yards, access improvements to the Main Seattle International Gateway (SIG) Yard via S Hanford Street, grade separation of S Lander Street over the BNSF railroad tracks, study of additional SODO railroad grade separations, and freight access and Intelligent Transportation System (ITS) improvements to S Spokane Street. The recommendations include the following projects in the Terminal 5 study area that would address capacity and access needs:

- **East Marginal Way Corridor (S Royal Brougham St to Idaho St.) –** This project would reconstruct a core freight route to heavy haul standards and offer safety and operational improvements for all modes.

- **East Marginal Way / S Hanford Street Intersection** - This project would upgrade the signal, lengthen the northbound right-turn lane, improve the railroad crossing pavement, and evaluate the need for railroad crossing gates at the Whatcom track crossings. The project also includes rebuilding the intersection and its approaches to Heavy Haul route requirements.

- **Hanford Street and Main SIG Access Improvements (East Marginal Way S to 1st Avenue S) -** This project evaluate the feasibility of installing a traffic signal at the Main SIG entrance. It would also rebuild the segment of Hanford Street between the E Marginal Way S and 1st Avenue S to Heavy Haul route standards, including new pavement at railroad crossings. It may include rail crossing gates or other devices, if needed.

- **South Spokane Street ITS Upgrades (Chelan Avenue to Airport Way South)** – Described in the following section.

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[10] Seattle Department of Transportation, Freight Master Plan, Public Review Draft, May 2016.
[11] Seattle Department of Transportation website: http://www.seattle.gov/transportation/freight_fmp.htm, Accessed April 18, 2016.
[12] Seattle Department of Transportation and Port of Seattle, Seattle Industrial Areas Freight Access Project, May 2015.

The *Freight Access Project* also recommends the following evaluation project:

- **Lower Spokane Street Freight Only Lanes Pilot Project (Harbor Island to Airport Way S) -** This pilot project would design, implement, and evaluate freight-only lanes on the corridor. It would modify roadway channelization for truck-only lanes, install signal and signage upgrades, and provide ITS equipment such as variable message signs and detection equipment. The project would evaluate time-of-day operations, while providing a contingency for allowing all traffic to use the lanes in the event of an incident on the upper bridge.

The Port would contribute to freight improvement projects identified in the FMP and FAP at locations affected by the Terminal 5 project.

### West Seattle Bridge / Duwamish Waterway Corridor

SDOT prepared the *West Seattle Bridge / Duwamish Waterway Corridor Whitepaper and Priority Investment List*[13] in September 2015 at the request of Councilmember Tom Rasmussen and Mayor Ed Murray. This whitepaper compiled a list of investment strategies to address congestion in the corridor. Almost all of the project recommendations are part of prior studies and plans. Key high-priority projects related to the segments near Terminal 5 include the following:

- **South Spokane Street Intelligent Transportation System (ITS) Upgrades** – This project, which was part of SDOT's *2014 Next Generation ITS Implementation Plan*, would install ITS equipment along Lower Spokane Street corridor between Terminal 5 and Airport Way S to collect and display real-time travel time information to truck drivers and other motorists. Traffic signal system improvements at the intersection of Chelan Avenue could also be included in the project scope.

- **Bridge opening coordination –** SDOT will work with the Coast Guard and marine vessel operators to voluntarily avoid bridge openings if there is an incident that blocks traffic on the West Seattle High-Level Bridge or Spokane Street Viaduct. Bridge opening protocols are described later in Section 2.4.

- **Traffic management** – Several projects were listed to reduce delay related to openings of the Lower Spokane Street Swing Bridge, rail crossings, and truck queues at Terminals 5 and 18. Management measures could include advance notification, and coordination of systems to reduce delay after a bridge opening or train crossing.

In April 2016, SDOT prepared a written progress report to the City Council related to the implementation of these initiatives. SDOT's accomplishments in 2015 and 2016 include: [14]

- Painted eastbound red bus lane and increased police enforcement on the West Seattle Bridge.
- Coordinated with Coast Guard and marine vessel operators to obtain cooperation with voluntary avoidance of openings during road traffic peak periods.
- Revised mechanical opening sequence of the Swing Bridge to reduce the time it takes to open and close it.

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13 Seattle Department of Transportation, September 22, 2015.
14 SDOT, *West Seattle Bridge Corridor Improvements, Update on White Paper and Investment List Report*, April 15, 2016.

- Added enhanced markings of at-grade crossing of Alki Trail at five-way intersection (West Marginal Way SW/SW Spokane Street/Chelan Avenue SW).
- Revised RapidRide C Line Service.

### Duwamish Freight Spot Improvement Program

SDOT prepared a summary report of spot improvements that it proposed for State of Washington's Freight Mobility Strategic Investment Board (FMSIB).[15] The list included pavement, turn radius, signal, and signage/wayfinding improvements. Near the Terminal 5 site it recommended:

- Railroad crossing reconstruction on SW Spokane Street at the 11th Avenue SW rail crossing and on East Marginal Way at the T-30 rail crossing.
- Pavement rehabilitation on S/SW Spokane Street.
- Port terminal wayfinding signs at various locations.

### Multimodal Plans and Projects

*Move Seattle*,[16] approved by voters in November 2015, is a multimodal transportation package that integrates recommendations developed in the City's various modal plans, and includes a list of high-priority projects that are intended to be implemented within the next 10 years. Two high priority *Move Seattle* projects include elements also identified as part of the FMP and *Freight Access Project*: the South Lander Grade Separation and the East Marginal Way Corridor. The East Marginal Way Corridor Improvements Project seeks to implement the heavy haul and other freight improvement projects described above, while also providing facilities to improve safety and mobility for people who walk or bike through the corridor. The Delridge Complete Street Project, which seeks to streamline traffic operations and improve multimodal connections between transit, freight, pedestrians, and general-purpose vehicles, is also identified as a high priority *Move Seattle* project. Both the East Marginal Way and Delridge corridor projects recognize the Port as a critical freight generator in their respective study areas and include improvement of freight movement as part of their multimodal objectives. Terminal 5 is compatible with the freight objectives of these projects. However, these multimodal projects also seek to improve safety and mobility for other travelers in these corridors, including people who walk, bike, take transit, or drive personal vehicles. Any transportation improvements identified to support the Terminal 5 project should be compatible with the multimodal objectives of the East Marginal Way and Delridge Way corridor studies. Both corridor studies are currently underway so the timeline for project implementation is not yet known; however, it is possible that construction of the corridor projects could overlap with construction of Terminal 5 improvements, requiring construction coordination between the Port and the City.

The City's *Bicycle Master Plan (BMP)*[17] sets forth a vision that riding a bicycle be a comfortable and integral part of daily life in Seattle for people of all ages and abilities, and provides a blueprint to make it easier to decide to ride a bike. In the Terminal 5 vicinity, the BMP recommends an off-street trail connection between the West Seattle Bridge Trail and Duwamish River Trail. Non-motorized crossing of the SW Spokane Street/West Marginal Way SW/Chelan Avenue SW intersection—which connects the West Seattle Bridge Trail to the east and Alki Trail to the west—is identified as a "catalyst" project, defined as being located at a significant choke point that poses implementation challenges due to physical constraints. Further information about this project is presented in Section 2.8. The BMP also

[15] SDOT, *Duwamish Freight Spot Improvement Program, Proposed Projects for Partnership with Freight Mobility Strategic Investment Board,* September 2015.
[16] Seattle Department of Transportation, Move Seattle: 10-Year Strategic Vision for Transportation, Spring 2015.
[17] Seattle Department of Transportation, Bike Master Plan, April 2014.

recommends protected bike lanes along Delridge Way SW to the southwest of the project site, and along East Marginal Way S to the east of the site. None of the BMP-recommended projects located in the vicinity of Terminal 5 are included in the current BMP Implementation Plan;[18] however, bicycle facility recommendations are being developed as part of the *Move Seattle* Delridge Way and East Marginal Way multimodal corridor projects described above.

The City's *Pedestrian Master Plan (PMP)*[19] sets forth a mission to make Seattle the most walkable city in the nation. None of the PMP's Tier 1 (high priority) improvements are located near Terminal 5. However, pedestrian facility recommendations are being developed in the vicinity of the Terminal 5 site as part of the *Move Seattle* Delridge Way and East Marginal Way multimodal corridor projects described above.

The *Transit Master Plan (TMP*[20]*)* defines the critical role that transit plays in meeting the City's goals related to sustainability, equity, economic productivity, and livability. Developed with feedback from King County Metro and Sound Transit, the *TMP* identifies the types of transit facilities, services, programs, and system features that will be required to meet Seattle's transit needs through 2030, based upon market analysis, review of future growth patterns, and evaluation of transit needs. In the vicinity of Terminal 5, the *TMP* identifies the West Seattle Bridge as part of Seattle's Frequent Transit Network (FTN), which is a vision for a network of transit corridors that connect the city's urban centers and villages with high-quality transit service within a short walk for most residents. It identifies the service level of the corridor connecting West Seattle and Downtown as "frequent" to "very frequent." It also identifies Delridge Way SW as a priority bus corridor; transit facility recommendations are being developed as part of the *Move Seattle* Delridge Way multimodal corridor project described above.

The *Sound Transit 3 (ST3)*[21] ballot measure that voters will consider in November 2016 will build upon the existing mass transit system of light rail, commuter rail and bus service to destinations throughout King, Snohomish and Pierce counties. The *ST3* package includes extension of light rail from Downtown to West Seattle, which is part of the City's FTN described above. If the ST3 package passes, this project would build light rail from the stadium district in downtown Seattle to the vicinity of Alaska Junction in West Seattle, with an alignment primarily on an elevated guideway and a new rail-only fixed span crossing the Duwamish River. The project would provide five new or expanded stations, including a new station on Delridge Way SW south of the Terminal 5 site.  ST3 plans are conceptual at this time and exact locations of stations and support structures for the elevated line are not known. Nevertheless, the proposed light rail corridor and station are located to the south of the West Seattle Bridge, so they would not overlap with the Terminal 5 project footprint, which is located to the north of the West Seattle Bridge. However, the proposed Delridge station could be located within one-quarter mile of Terminal 5, which would greatly improve transit service for Port employees. Therefore, any transportation improvements proposed to support the Terminal 5 project should also be designed to accommodate pedestrian access between the site and Delridge Way SW. The proximity of the light rail extension and would also require coordination if construction activities for both the Terminal 5 and light rail projects were to overlap.

## Capital Improvement Program

Every year during the annual budget process, the City adopts a six-year Capital Improvement Program (CIP) that outlines anticipated investments over that timeframe. While the CIP identifies near-term high priority projects, some may be fully funded while others are not. The *2016-2021 Proposed Capital Improvement Program*[22] includes transportation projects in the Terminal 5 vicinity. Funded pro-

18 Seattle Department of Transportation, Bike Master Plan, 2016-2020 Implementation Plan, March 2016.
19 Seattle Department of Transportation, Seattle Pedestrian Master Plan, September 2009.
20 Seattle Department of Transportation, Transit Master Plan, April 2012.
21 Sound Transit, Sound Transit 3, http://soundtransit3.org/, Accessed August 2016.
22 City of Seattle, 2016-2021 Proposed Capital Improvement Program, September 23, 2015.

jects include design of the Lander Street Grade Separation and the multi-modal corridor studies of East Marginal Way and Delridge Way SW; the City portion of the Heavy Haul Corridor Project on East Marginal Way is currently listed as an unfunded project in the CIP, but it indicates that this project will be implemented in partnership with the Port.

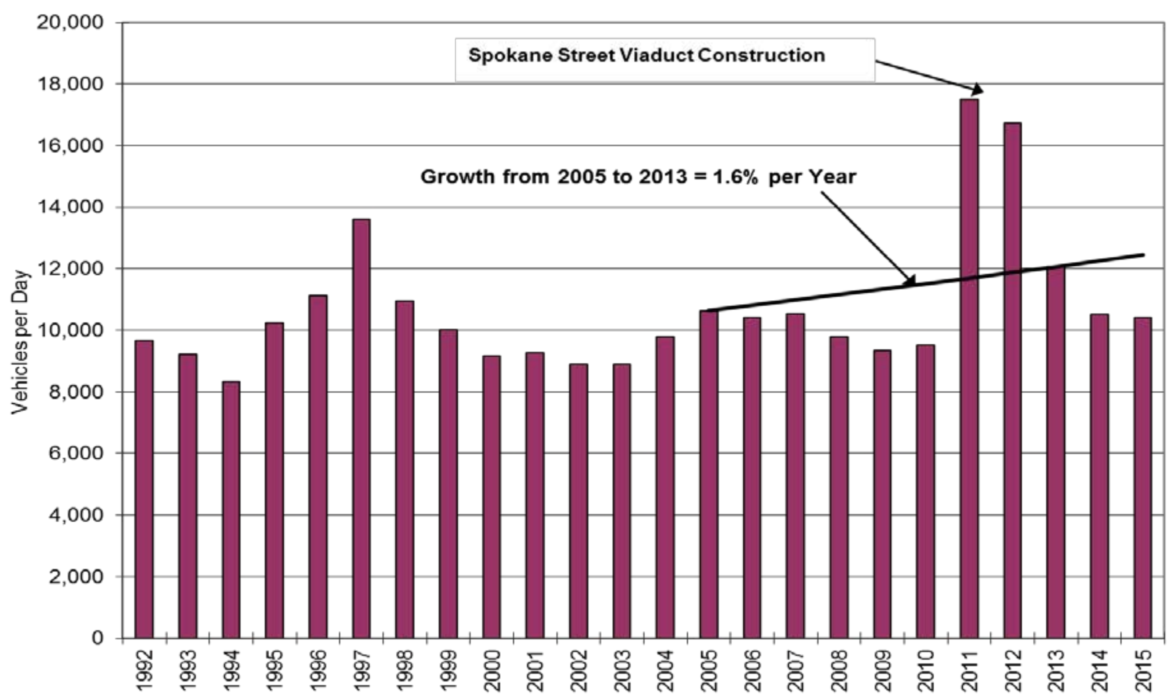
## 2.2. Traffic Volumes

### 2.2.1. Historic Traffic Volumes on SW Spokane Street

Traffic volumes along the Spokane Street corridor have fluctuated in the past decade. The City maintains a permanent traffic recording station on the Spokane Street Swing Bridge. Since 1992, traffic counts have been performed on the bridge for a seven-day period during every month of the year. These data were collected and compiled to show how traffic volumes have changed since 1992 and how the volumes vary from month to month.

Figure 5 shows the average weekday daily traffic (AWDT) volumes by year on the Spokane Street Swing Bridge. The peak volumes occurred in 2011 and 2012, coinciding with construction work that was occurring on the Spokane Street Viaduct and the Alaskan Way Viaduct. Additional traffic may have utilized surface routes that included Spokane Street to avoid construction-related congestion. The lowest volumes occurred in 2009 and 2010, coinciding with the economic recession. Year 2013 was the last full year with Terminal 5 operating as a container terminal, and existing conditions documented in this report reflect that year. Between 2005 (pre-recession) and 2013, and excluding the construction-related peaks in 2011 and 2012, traffic volumes grew at an average rate of about 1.6% per year.

Figure 5. Average Weekday Daily Traffic (AWDT) on Spokane Street – 1992 through 2015

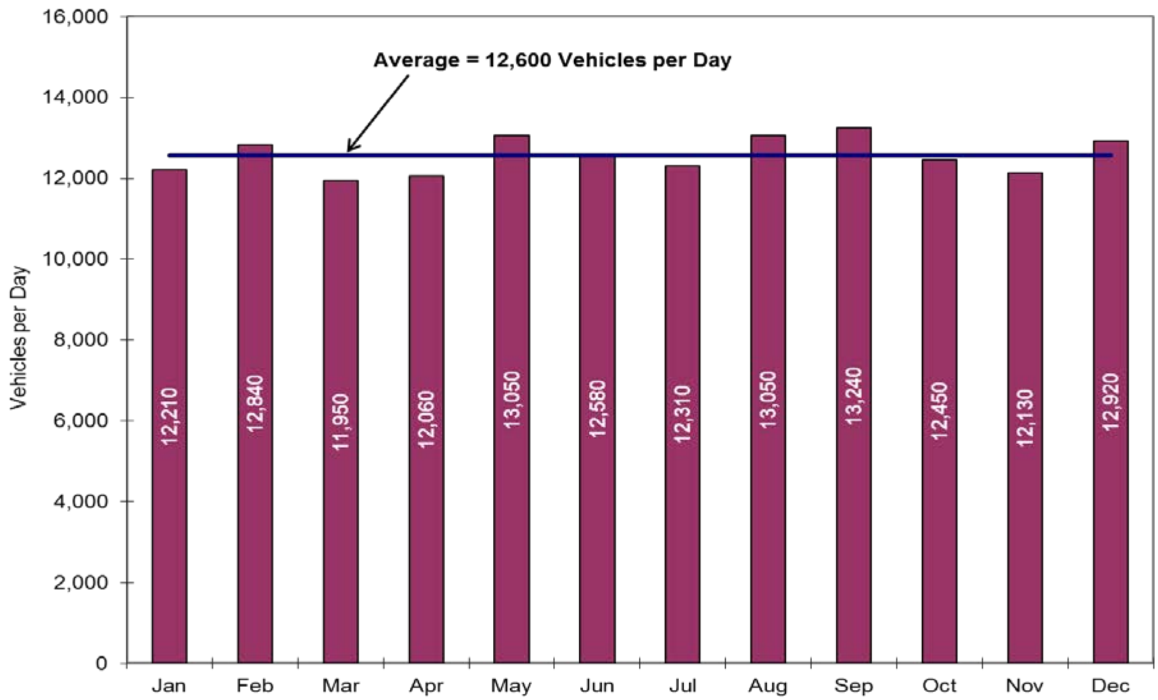



*Source: Seattle Department of Transportation. Counts on Spokane Street at "Point A" which is the Lower Spokane Street (Swing) Bridge. Values reflect counts performed in the spring of each year (March or April).*

Figure 6 shows the AWDT on the Spokane Street Swing Bridge for each month in 2013, which is the last full year with Terminal 5 operating as a container terminal. The annual average volume from 2013 was 12,600 vehicles per day with slightly more than half traveling the bridge in the eastbound direction. This unbalanced flow likely occurs as vehicles use the surface route in order to avoid eastbound congestion on the West Seattle Freeway and Spokane Street Viaduct approaching SR 99, 1st Avenue S, and I-5. As shown, average volumes vary only slightly from month to month.

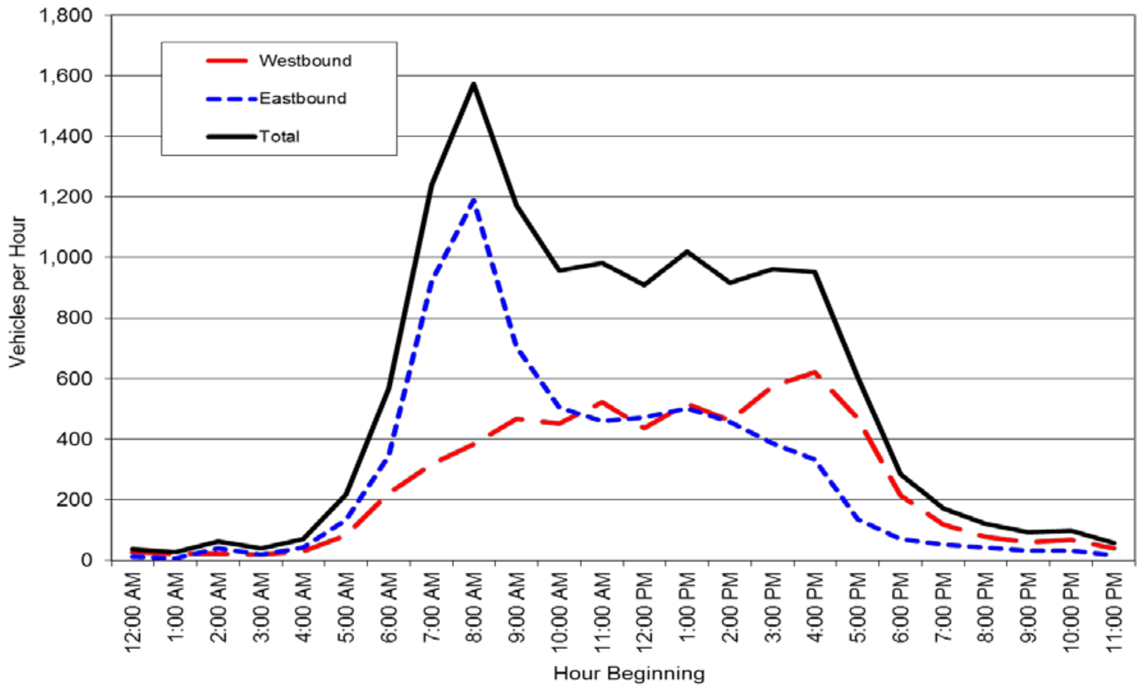
Hourly traffic volumes for June 2013, which Figure 6 shows most closely represents the average month, were plotted to show how traffic volumes fluctuate by time of day. Figure 7 shows that the highest volumes occur during the morning commuter peak hour, with the predominant flow in the eastbound direction. As previously discussed, Lower Spokane Street is often used as a bypass by commuters who look to avoid morning congestion on the West Seattle Freeway and Spokane Street Viaduct. Westbound flow across the Swing Bridge is highest during the commuter PM peak hour.

Figure 6. Average Weekday Traffic (AWDT) on Spokane Street Bridge by Month – 2013




*Source: Seattle Department of Transportation. Counts on Spokane Street at "Point A" which is the Lower Spokane Street (Swing) Bridge. Values reflect counts performed one week each month in 2013.*

Figure 7. Hourly Volumes on Spokane Street Bridge – Average Weekday in June 2013




*Source: Seattle Department of Transportation. Counts on SW Spokane Street Bridge for one week in June 2013. Counts reflect the average of Tuesday, Wednesday and Thursday volumes.*

### 2.2.2. Existing Intersection Traffic Volumes

Peak period intersection turning-movement counts (which show the volume for each movement at an intersection) were compiled from various sources for the AM and PM peak hours. As shown on Figure 4, peak traffic in the Spokane Street Bridge corridor occurs during the AM peak hour, which as described later in this report, is also when peak volumes generated by Terminal 5 are expected to occur. The PM peak hour condition was also evaluated since it is when reverse-direction traffic is highest, which can affect intersection operations. The traffic volume data were obtained for dates prior to June 2014 to reflect conditions when Terminal 5 was operational. Table 3 lists the intersections for which data were obtained. No recent turning movement counts were available for the SW Spokane Street/Terminal 5 Access Bridge or SW Spokane Street/11th Avenue SW intersections prior to the terminal closing. Therefore, traffic volumes for those intersections were derived based on counts at adjacent intersections, historic counts from SDOT's database for the Swing Bridge and Harbor Island roadways, and Terminal 5 gate volumes.

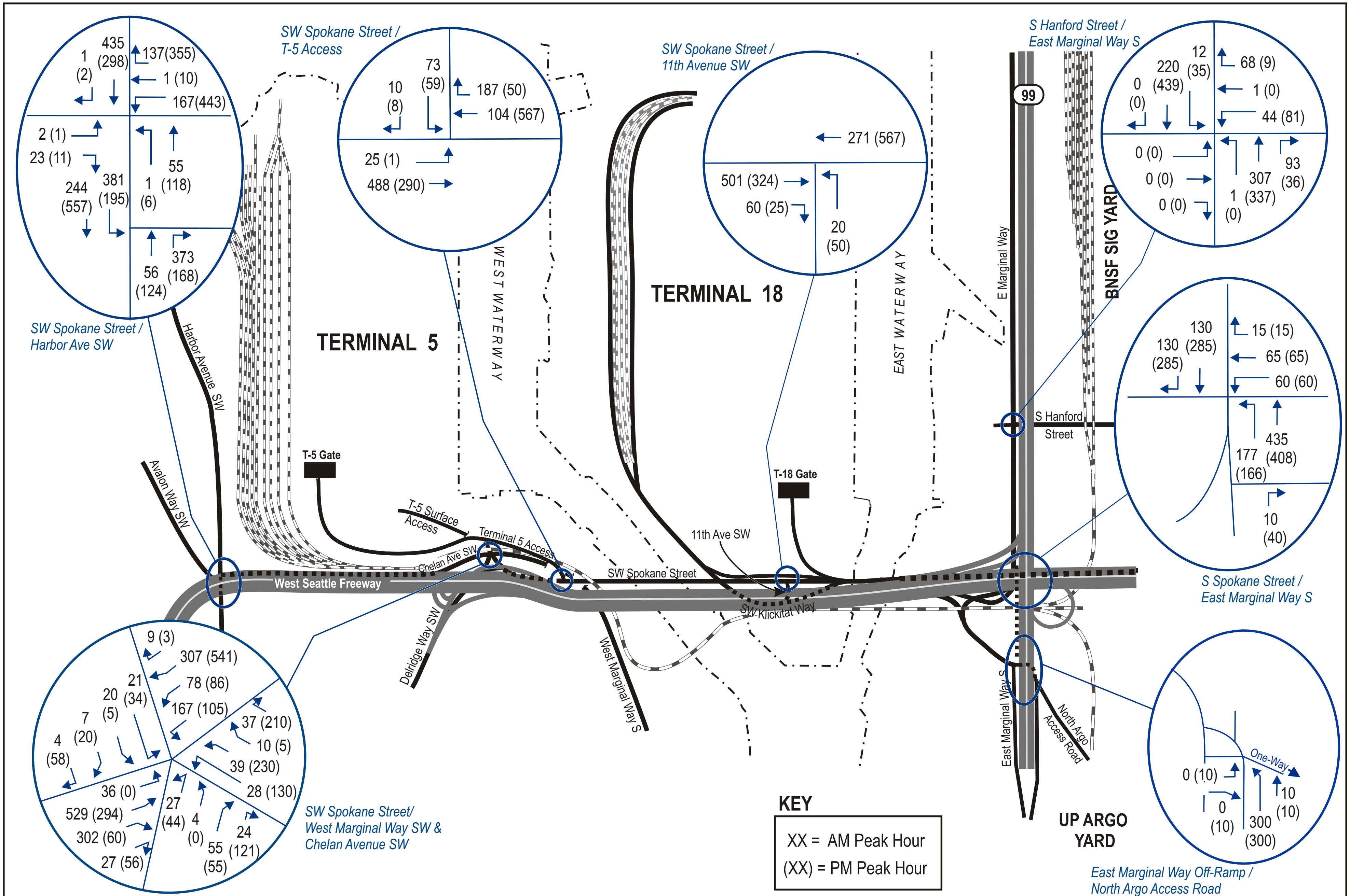
Table 3. Existing Intersection Traffic Counts

| Intersection | Data source | Date of count(s) | Count Type [a] |
|---|---|---|---|
| SW Spokane Street/West Marginal Way SW/Chelan Ave SW | SDOT | April 2014 | Intersection Count |
| SW Spokane St/ Harbor Avenue SW | SDOT | July 2013 | Intersection Count |
| East Marginal Way S / SR 99 Ramps (at North Argo Access) | Heffron [b] | October 2012 | Machine Counts |
| S Spokane Street/East Marginal Way S | SDOT | Dec 2009 | Machine Counts |
| East Marginal Way S/S Hanford Street | SDOT | May 2013 | Intersection Count |

*a. Intersection counts include volumes by turning movement and are usually performed using a camera; Machine counts are performed along roadway segments using pneumatic tubes and counting machine.*

*b. Counts commission by Heffron Transportation, Inc., and performed by All Traffic Data, Inc. on the new East Marginal Way Grade-Separated structure.*

Intersection counts were adjusted to reflect the average month in 2013 based on data from the Spokane Street Swing Bridge described above. In addition, the volumes were increased to reflect the existing Design Day condition for Terminal 5, which is described in Section 2.2.4. Figure 8 shows the existing AM and PM peak hour traffic volumes for the study area intersections.




**TERMINAL 5**
Improvement Project

Figure 8
**Existing (2013) Traffic Volumes**
**AM and PM Peak Hours**

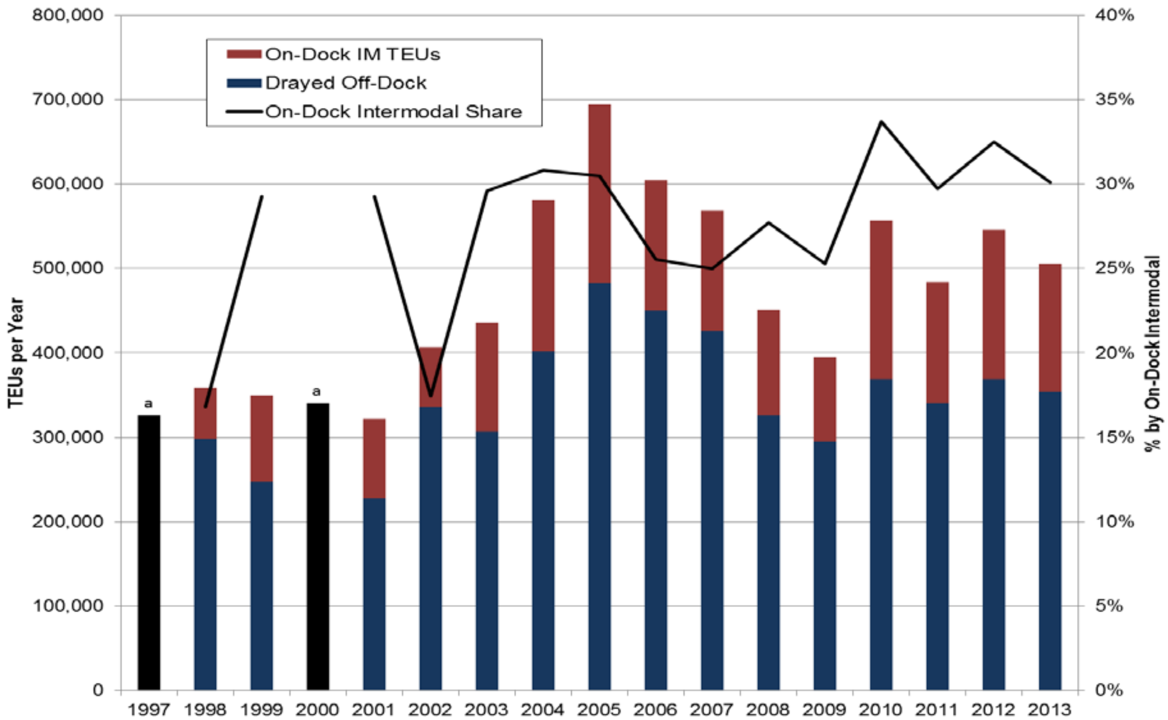
heffron transportation, inc.

09.15.16

### 2.2.3. Terminal 5 Throughput and On-Dock Intermodal Volumes

Since Terminal 5 reopened in its present configuration, the terminal throughput has averaged about 466,000 TEUs per year, with a peak throughput of about 695,000 TEUs in 2005 (a year that experienced increased traffic due to diversions from Southern California ports). The historic annual throughput and intermodal volumes are shown on Figure 9. In the past decade, the share of containers loaded directly to rail at Terminal 5's on-dock intermodal yard ranged from about 25% to 35%.

Figure 9. Annual Throughput and Intermodal Volumes at Terminal 5 – 1997 to 2013



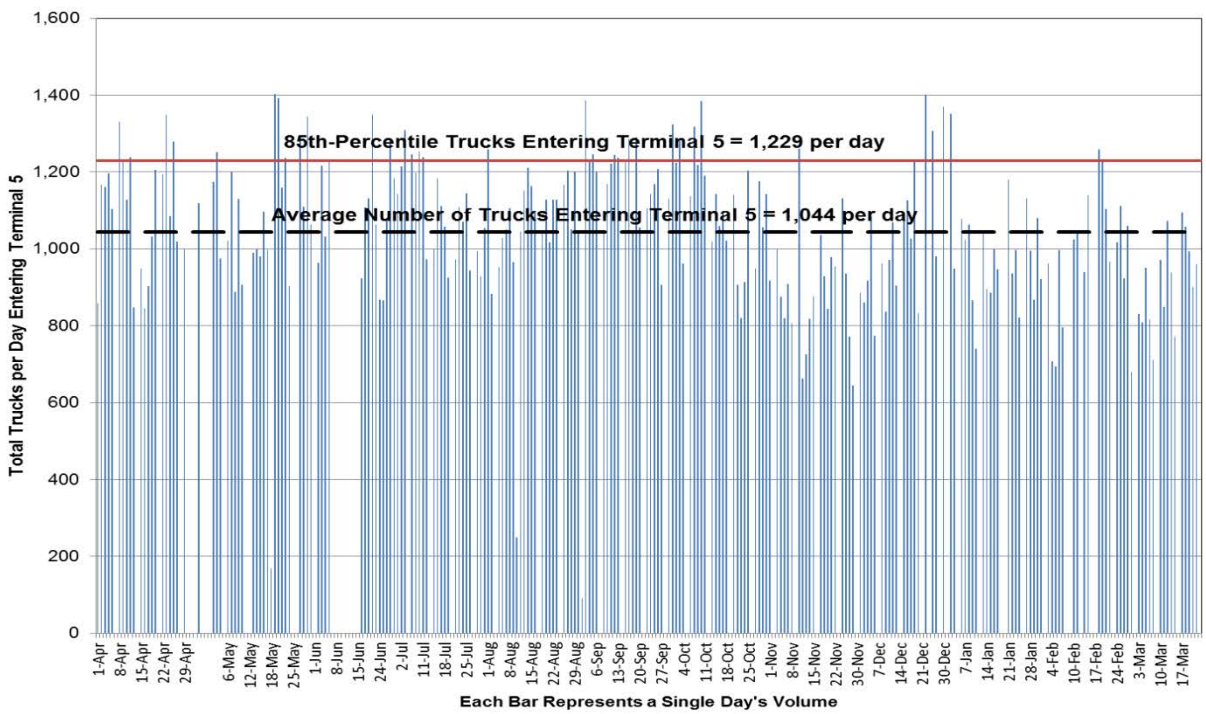

*Source: Port of Seattle, 2015.*

*a. Data regarding intermodal traffic are not available.*

## 2.2.4. Truck Volumes

RFID readers have been installed at all of the Port's container terminals and began recording trucks entering those terminals on April 1, 2013. Data for the nearly full-year period from April 1, 2013 through March 22, 2014 were compiled for Terminal 5. This period reflects full operation of the terminal before the former tenant moved to Terminal 18, and reflects all truck movements regardless of whether the truck carried an empty chassis or a container. Figure 10 presents the daily truck trips that entered Terminal 5 during this period. The figure shows that an average of 1,044 trucks per day entered Terminal 5, reflecting a total of 2,088 truck trips per day (one trip entering and one trip exiting the terminal). The 85th-percentile volume was approximately 1,230 entering trucks per day, or 2,460 total truck trips per day. On peak days, the volume approached 1,400 trucks entering the terminal each day (2,800 total truck trips). The 85th-percentile volumes were assumed to represent the Design Day condition for Terminal 5.

Figure 10. Trucks Entering Terminal 5 Each Day (April 1, 2013 thru March 22, 2014)




*Source: RFID data from Port of Seattle for the period from April 1, 2013 through March 22, 2014. Data compiled by Heffron Transportation, Inc.*

As described later in Section 4.1.4, an average of 12% of the daily truck trips occur during the commuter AM peak hour and 3% occur during the PM peak hour. The Design Day for existing conditions (in 2013) included 295 AM peak hour truck trips and 74 PM peak hour truck trips.

## 2.3. Level of Service

Level of service (LOS) is a qualitative measure used to characterize traffic operating conditions. Six letter designations, "A" through "F," are used to define level of service. LOS A is the best and represents good traffic operations with little or no delay to motorists. LOS F is the worst and indicates poor traffic operations with long delays. LOS D is acceptable to the City.

Level of service is defined in terms of delay. For signalized intersections, delay is dependent on a number of variables, including traffic volumes by turning movement, intersection lane geometry, percentage of heavy vehicles, signal timing, and signal phasing. Complete descriptions of level of service criteria are included in Appendix A.

Level of service for the study area intersections was determined using methodologies presented in the Highway Capacity Manual (HCM)[23] and calculated with the *Synchro 9.1* traffic operations analysis software. Existing intersection lane configurations and signal operations data, which were obtained from SDOT, were field verified. The model was also coded to account for the high volumes of trucks in the area with percentages that range up to 100% for some movements based on existing counts. Levels of service are reported using the *Synchro* module for signalized intersections and the *HCM 2010* module for the all-way stop intersection at East Marginal Way S/North Argo Access. Table 4 summarizes the existing levels of service for the study area intersections.

The analysis shows that almost all of the study area intersections now operate at LOS D or better. The exception is the five-legged intersection at SW Spokane Street/West Marginal Way SW/Chelan Avenue SW, which currently operates at LOS F during the PM peak hour. Operations at this intersection are affected by the need for each of the five streets that approach the intersection to be served with a separate signal phase. This level of service reflects typical operation without any pre-emption of signal phases due to train crossings of West Marginal Way SW just north of the intersection or openings of the Spokane Street Swing Bridge. Such pre-emptions exacerbate congestion at the intersection since some movements are not served to reduce potential vehicle-train conflicts at the crossing. Swing Bridge openings affect both the five-legged intersection and Terminal 5 Access Bridge operations due to vehicles that queue while waiting for vessels. Further information about the frequency and duration of Spokane Street Swing Bridge openings is provided in the next section.

23 HCM 2010, Transportation Research Board. 2010.

Table 4. Level of Service Summary - Existing (2013) Conditions

| Signalized Intersections | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|
| | LOS[1] | Delay[2] | LOS | Delay |
| SW Spokane St / Harbor Ave SW | C | 24.7 | C | 20.4 |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | D | 51.0 | F | 80.1 |
| SW Spokane St / Terminal 5 Access | A | 9.8 | B | 13.4 |
| SW Spokane St / 11th Avenue SW | A | 2.0 | A | 4.1 |
| S Spokane St / East Marginal Way S | B | 15.9 | B | 25.2 |
| S Hanford St / East Marginal Way S | B | 17.7 | C | 21.5 |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 11.1 | B | 11.9 |

*Source: Synchro model developed by Concord Engineering and Heffron Transportation, Inc., January 2015. Levels of service for signalized intersections were calculated using the Synchro 9.1 methodology. The all-way stop intersection level of service was determined using the 2010 HCM methodology.*

1. *Level of service.*
2. *Average seconds of delay per vehicle.*
3. *All-way stop controlled intersection*

## 2.4. Spokane Street Swing Bridge Operations

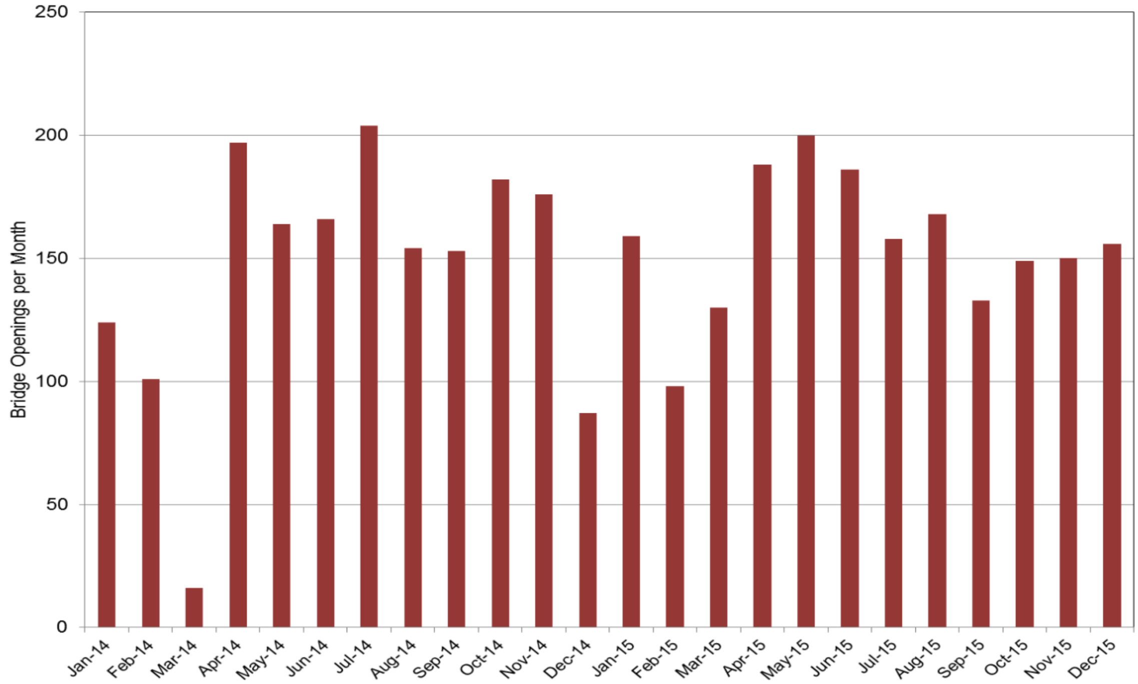
The Spokane Street Swing Bridge is located on lower SW Spokane Street and connects West Marginal Way and Terminal 5 to Harbor Island. This bridge pivots (“swings”) to open for marine traffic on the Duwamish River’s West Waterway. Many large commercial vessels and barges require the bridge to open when transiting to up-river industrial areas. Because the depth of the river is affected by tides, larger vessels must time their trips with accommodating tides. The Swing Bridge has no black-out periods that restrict marine traffic at certain hours of the day, and there is a parallel alternative route on the West Seattle Freeway that most traffic can use when the bridge is open. There are some static message signs with a flashing beacon that alert drivers to use alternative routes when the Swing Bridge is open (locations are shown on Figure 4).

Data related to the frequency and duration of bridge openings were obtained for a two-year period from January 1, 2014 through December 31, 2015. During this period, there were 3,599 bridge openings, an average of 150 per month. Openings tended to occur more frequently during the summer months, with a peak of about 200 openings per month, as shown on Figure 11.

The bridge data were also compiled to determine the duration for each bridge opening. As shown on Figure 12, the average opening was 11.8 minutes long, and the 85th-percentile was 14.0 minutes long. There were a handful of openings that lasted longer than 35 minutes, which included three openings that exceeded 100 minutes.

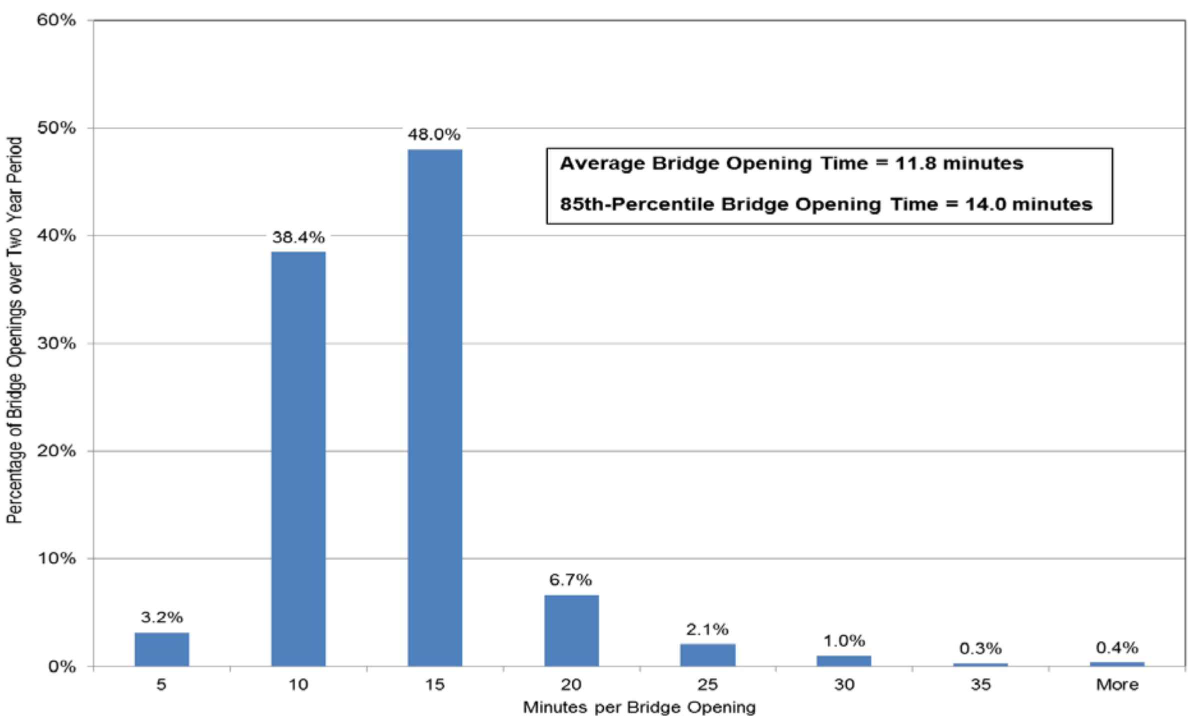
The time of day that openings occur was reviewed. The majority (64%) occurred during daytime business hours between 7:00 A.M. and 5:00 P.M.

Figure 11. Swing Bridge Openings per Month




*Source: Seattle Department of Transportation, bridge tender data for period from January 1, 2014 through December 31, 2015.*

Figure 12. Duration of Swing Bridge Openings




*Source: Seattle Department of Transportation, bridge tender data for period from January 1, 2014 through December 31, 2015.*

SDOT has evaluated the bridge opening protocols for the Swing Bridge. The *West Seattle Bridge / Duwamish Waterway Corridor Whitepaper and Priority Investment List*[24] included the following detail related to these protocols:

> *The Spokane St Swing Bridge crosses the West Duwamish Waterway. The waterway existed long before a bridge was installed. The U.S Coast Guard is charged with managing navigable waterways within the United States. Federal law CFR 33 Chapter 11, enacted in 1894, requires bridges to be permitted and, in general, not restrict navigation. The permit for the Swing Bridge requires that bridge openings must occur, without delay, when requested by a vessel captain. In the past, SDOT requested that the Coast Guard grant a deviation from this requirement and allow "closed periods" during peak commute times. Similar to the permit for the Lake Washington Ship Canal bridges, a closed period would restrict bridge openings and avoid vehicle delays during peak commute times. The Coast Guard has denied SDOT's request stating the significant hardship delaying vessel sailing would have on the waterway users. Waterway users argue that sailings are scheduled around tides and currents. A peak period delay of only a few hours could result in many hours of delay until sailing conditions are again favorable. The Coast Guard and federal courts have ruled that, although navigation may have a higher standing than vehicle travel, it is not absolute.*
>
> *SDOT requested that vessel openings be delayed during time of extreme congestion due to a blocking incident on the West Seattle High-Level Bridge. The Coast Guard has specifically ruled that "a bridge opening cannot be delayed due to an incident on a parallel route." They have agreed to broadcast a request that vessels "volunteer" delaying their sailing should SDOT report a blocking incident on the High-level Bridge.*

SDOT has proposed ITS improvements along SW Spokane Street to better coordinate signal operations with bridge openings and to alert users of potential bridge-opening delays. These were previously described in Section 2.1.5 above. In addition, SDOT recommended improvements to the Swing Bridge control system, which is the computer-based program that opens and closes the bridge. It may be possible to reduce the time that SW Spokane Street is closed to traffic by about 30 seconds for each bridge event by changing the electrical/mechanical functional time. In addition, SDOT has worked with the Coast Guard and marine vessel operators to voluntarily avoid bridge openings if there is an incident that blocks traffic on the West Seattle High-Level Bridge or Spokane Street Viaduct.

24 Seattle Department of Transportation, September 22, 2015.

## 2.5. Traffic Safety

Historical collision data were obtained from the City to determine if there are any unusual traffic safety conditions in the vicinity of Terminal 5. Signalized intersections with 10 or more collisions per year and unsignalized intersections with five or more collisions per year are typically considered high-collision locations by the City. Four years of data were obtained from the City, which includes the period from January 1, 2011 through December 31, 2014. Data specific to bicycle collisions along SW Spokane Street between East Marginal Way S and Terminal 5 were also requested. The reported collisions are summarized in Table 5.

During the four-year period, none of the intersections met the City's threshold for a high collision intersection, and there were no reported collisions involving trains. The highest number of collisions occurred at the S Spokane Street North Road/East Marginal Way S intersection. Of the 12 total collisions, one collision resulted in a fatality (discussed below) and five collisions resulted in six injuries. The second highest number of collisions occurred at the SW Spokane Street/Harbor Ave SW intersection. Two of the seven collisions resulted in a total of four injuries.

There were four recorded bicyclist collisions near the SW Spokane Street/11$^{th}$ Avenue SW intersection, which is where the West Seattle Trail crosses from the north side to the south side of SW Spokane Street. Two of the bicycle collisions occurred in 2011, one in 2012 and one in 2014. There was also one bicycle/bicycle collision on SW Spokane Street between SW Klickitat Way and 11th Avenue SW in 2013. None of the bicycle collisions resulted in a fatality.

There were two fatalities reported within the study area during the four-year analysis time period. One fatality occurred at the S Spokane Street /East Marginal Way S intersection in 2013 during daylight hours. This collision involved two vehicles caused by one vehicle changing lanes. The other fatality occurred at the intersection of S Hanford Street/East Marginal Way S. It involved a semi-truck and bicyclist and occurred in 2013 during daylight hours. After the bicyclist fatality, the City installed a flashing beacon north of S Horton Street to improve the visibility of pedestrians and bicyclists in the corridor. Future improvements are also proposed as part of the *Seattle Bicycle Master Plan*[25], recommends a protected bicycle lane along this segment of the corridor.

[25] Seattle Department of Transportation, *Bike Master Plan Implementation Plan 2015-2019*, October 17, 2014.

Table 5. Intersection Collision Summary

| Intersection | Type of Collisions (Totals for 4 Years) | | | | | | | Severity [a] | | Collisions by Year | | | | Summary | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rear End | Side-Swp | Left Turn | Right Turn | Right Angle | Ped/ Bicycle | Other | # of Injuries | # of Fatalities | 2011 | 2012 | 2013 | 2014 | Total for 4 Years | Average per Year |
| S Spokane NR (north road) St / East Marginal Way S | 2 | 2 | 0 | 1 | 3 | 0 | 4 | 6 | 1 | 3 | 5 | 1 | 3 | 12 | 3.0 |
| SW Spokane St / Harbor Ave SW | 1 | 2 | 0 | 2 | 1 | 0 | 1 | 4 | 0 | 1 | 2 | 1 | 3 | 7 | 1.8 |
| S Spokane SR (south road) St / East Marginal Way S | 1 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 3 | 3 | 0 | 0 | 6 | 1.5 |
| SW Spokane St / 11th Ave SW | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 4 | 1 | 0 | 1 | 6 | 1.5 |
| SW Spokane St / WSF off-ramp | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 4 | 0 | 4 | 1.0 |
| SW Spokane St / West Marg Way SW / Chelan Ave SW | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0.5 |
| S Hanford St/East Marginal Wy S | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 2 | 0.5 |
| SW Spokane St / T-5 Access | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| SW Spokane St / Klickitat Ave SW | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| SW Spokane St / T-18 Access | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |

*Source: City of Seattle, January 2015. Summarizes collision data for the four-year period from January 1, 2011 through December 31, 2014.*
*a. Injuries are not recorded for every collision in the report from the City.*

## 2.6. Rail

Terminal 5 has an existing intermodal rail yard that has six 3,000-foot long loading tracks and about 40,000 linear feet of storage tracks. An intermodal unit train is typically made up of 24 to 28 double-stack rail cars, and each car can accommodate 10 intermodal boxes (containers). A full train's length, including locomotives, can range from 5,000 to 8,600 feet, and is typically 7,500 feet long. When a train arrives at the terminal, it is split into segments by switching each part into the loading tracks and/or storage tracks. The segments are reconnected, attached to locomotives, and undergo break tests before a full unit train leaves the terminal destined for the mainline. During both the arrival and departure switching maneuvers, the trains block the at-grade crossing of West Marginal Way SW just north of SW Spokane Street.

It is estimated that the existing intermodal rail yard has the capacity to handle about 530,000 TEUs per year, which averages to about 18 full unit trains per week. Historically, Terminal 5 generated about nine trains per week, about half of the yard's capacity. Further information about existing rail operations beyond the terminal is provided in the *T-5 Rail Infrastructure and Grade-Crossing Analysis* (Moffatt & Nichol, April 2016).

## 2.7. Transit

Two King County Metro routes provide bus transit service along SW Spokane Street adjacent to the site. Route 21 provides all-day service between Arbor Heights, West Seattle and Downtown Seattle. The buses operate from 4:45 A.M. to 1:00 A.M. at about 15-minute headways (time between consecutive buses) during most of its operating hours. Route 37 connects between Alaska Junction and Downtown Seattle via Alki Avenue SW, but only operates during the morning and afternoon peak periods. This route has four buses destined to downtown in the morning and four returning buses in the afternoon. Both routes have bus stops on SW Spokane Street just west of Chelan Avenue SW.

Sound Transit's ST3 package will be on the November 2016 ballot. If the ST3 package passes, this project would build light rail from the stadium district in downtown Seattle to the vicinity of Alaska Junction in West Seattle, with an alignment primarily on an elevated guideway and a new rail-only fixed span crossing the Duwamish River. The project would provide five new or expanded stations, including a new station on Delridge Way SW, south of the Terminal 5 site. Further information about the ST3 plans was provided in Section 2.1.5.

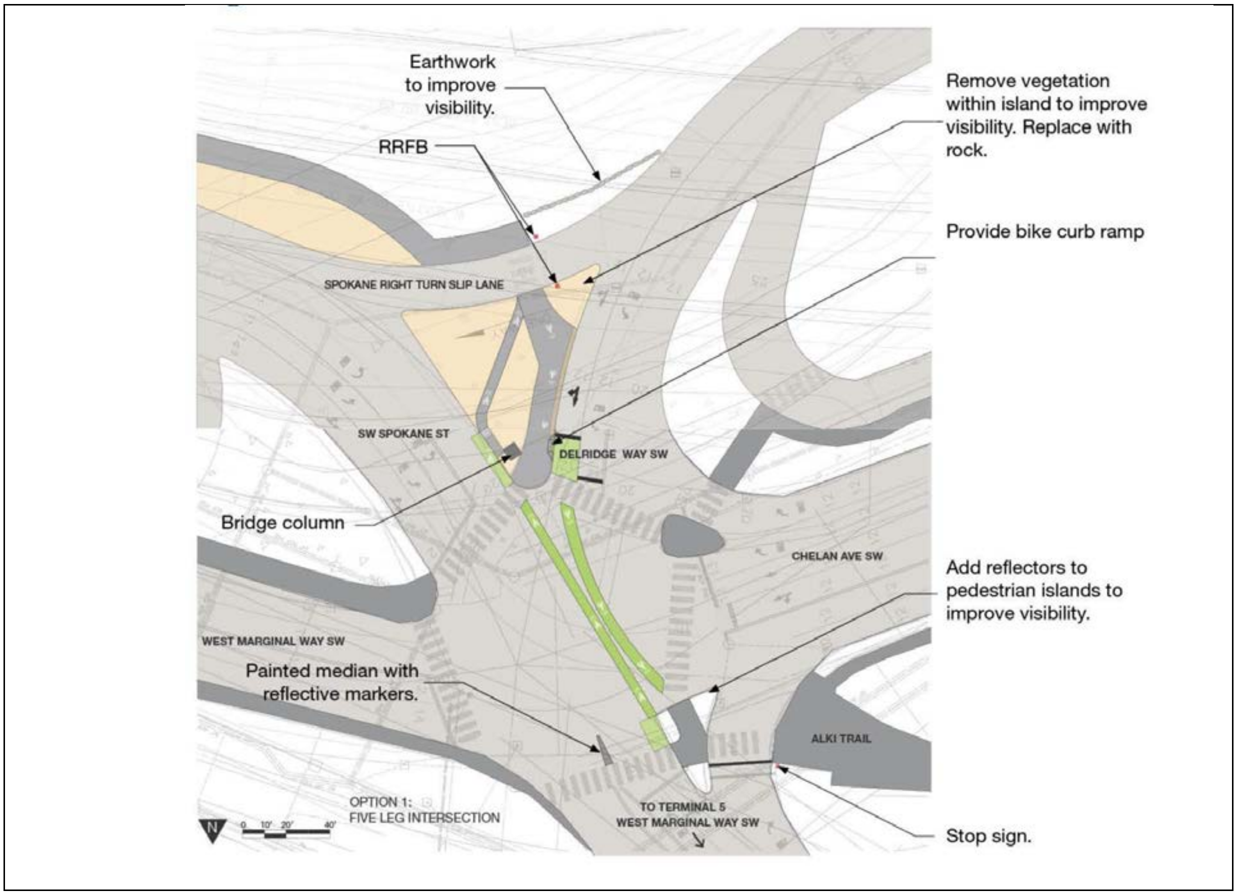
## 2.8. Non-Motorized Facilities

Most streets in the site vicinity have sidewalks on at least one side of the street. The Terminal 5 Access Bridge has no sidewalks, but does have shoulders (including a very wide shoulder on the west side of the structure) that could be used by pedestrians in an emergency. There is no sidewalk along the north/east side West Marginal Way SW south of Chelan Avenue SW due to the proximity of the railroad tracks along this corridor. There are wide gravel and dirt areas between the curb and railroad tracks that are used by pedestrians.

The West Seattle Trail crosses the Duwamish River on the south side of the Spokane Street Swing Bridge. The trail splits just west of the bridge with a trail continuing high on the slope under the West Seattle Freeway to the Delridge neighborhood, and a secondary connection descending to grade and along sidewalks at the SW Spokane Street/West Marginal Way SW/Chelan Avenue SW intersection. The bike path crosses the Duwamish West Waterway on the south side of the Swing Bridge, and crosses to the north side of SW Spokane Street at 11th Avenue SW, which provides a signalized crossing. The path crosses the Harbor Island Access Road (surface SW Spokane Street), 11th Avenue SW, and the Terminal 18 truck gate driveway at unsignalized crossings. Further east, the West Seattle Trail connects to East Marginal Way, which has a sidewalk on its west side and painted bicycle lanes on both sides.

In 2015, SDOT enhanced the existing surface bicycle travel routes through the intersection with green bike boxes and green bike lanes as shown on Figure 13. These "short-term" improvements are intended to be the first phase of bicycle improvements at the intersection.

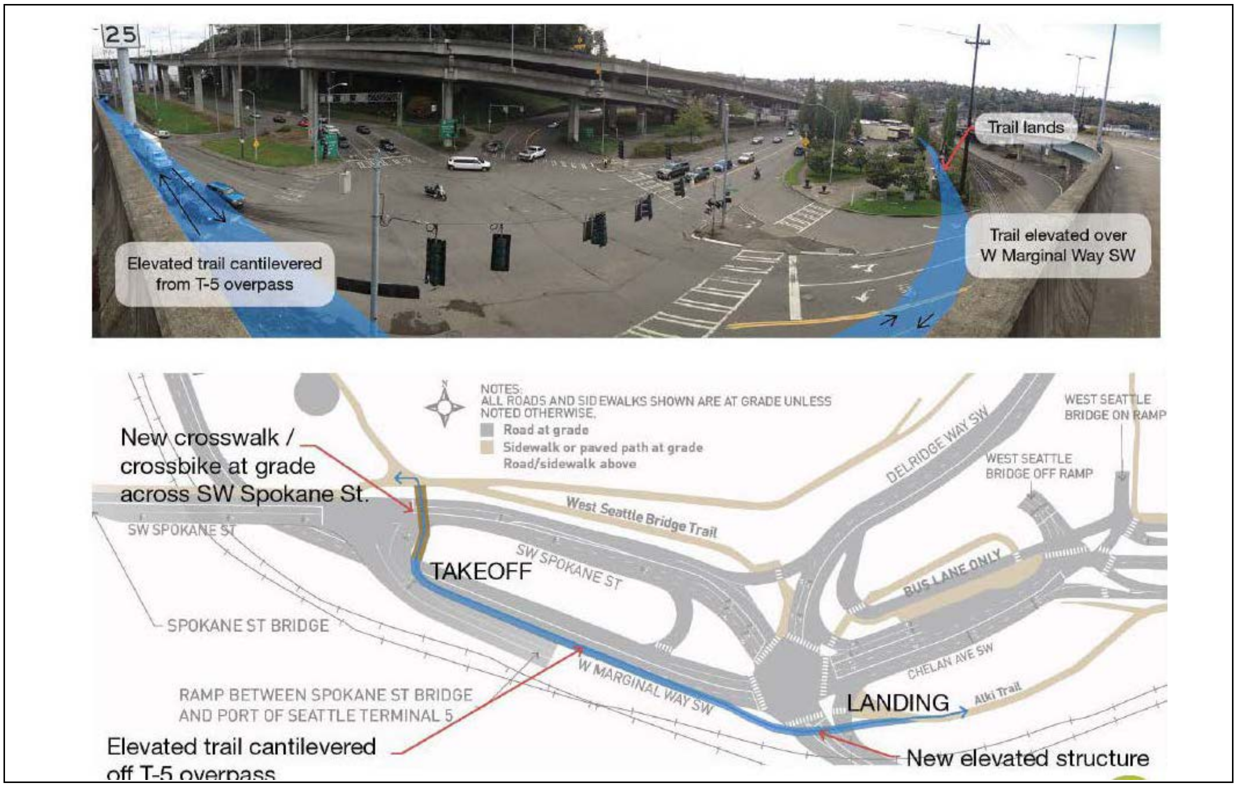
Figure 13. Short-Term Bicycle Improvements at Five-Legged Intersection




*Source: SDOT, Presentation to the Seattle Bicycle Advisory Board, January 7, 2015. The green bicycle lanes were added to the intersection in 2015.*

In the long-term, SDOT recommends a grade-separated structure for bicyclists (and pedestrians) that would connect from the existing Terminal 5 Access Bridge to SW Spokane Street west of Chelan Avenue SW. The potential new crosswalk on the west side of the SW Spokane St/T-5 Access would also be accompanied with bike and pedestrian signal heads and detection. That option is depicted in Figure 14. Additional structural analysis and design would be needed to determine if it is possible to cantilever the pedestrian/bicycle facility off of the existing T-5 Access Bridge. SDOT has also suggested a potential mid-term solution that would create a trail parallel to West Marginal Way SW and connect to the SW Spokane Street Bridge via streets located south of the bridge. SDOT will continue to evaluate the mid-term and long-term options, and no timetable for implementation has been proposed. SDOT has no plans or funding to implement mid- or long- term improvements at the intersection of Chelan Ave SW, W Marginal Way SW, SW Spokane St, and the Alki Trail.

Figure 14. Potential Long-Term Bicycle Improvements at Five-Legged Intersection




*Source: SDOT, Presentation to the Seattle Bicycle Advisory Board, January 7, 2015.*

## 2.9. Parking

Terminal 5 has about 540 parking spaces that are located in various lots around the terminal. The largest parking lots are located adjacent to the Administration Building (183 spaces), transit shed (143 spaces), and gate house (155 spaces). There are about 40 other spaces located near the maintenance facilities, intermodal yard, and security gate.

On-street parking is not allowed along most streets in the site vicinity. The exception is Harbor Avenue SW, but the parking is separated from the main areas of the terminal by the intermodal rail yard, a fence, and a landscaped berm.

In 2008, the City of Seattle and Port of Seattle convened the *South Harbor Truck Parking* workgroup in response to community concerns about heavy-duty trucks parking along residential streets in the Georgetown and South Park neighborhoods (truck parking is allowed on industrial streets). The work group recommended many measures to address truck parking.[26] The key elements that were implemented included:

- The Port of Seattle implemented a free truck parking lot for about 120 trucks (power only, no trailers) on the south end of T-25. That parking lot is still in operation.
- City and Port jointly developed outreach materials to inform truck drivers about parking regulations and show on a map where truck parking and overnight parking is prohibited.
- City installed additional signage where truck parking is prohibited (per SMC 11.72.070).
- City would increase enforcement of truck parking regulations.

The actions did help reduce truck parking impacts; however, ongoing education and enforcement may be needed.

[26] Port of Seattle, *South Harbor Truck Parking: Work Group Recommendations*, April 2009.

# 3. CONSTRUCTION-RELATED IMPACTS OF ACTION ALTERNATIVES

Alternatives 2 and 3 would generate temporary increases in vehicular, truck, train, and barge traffic associated with construction activities to rehabilitate the wharf, deepen the berth, and reconstruct upland facilities including the container yard, intermodal yard, and support facilities. The potential transportation-related elements of this work include:

- Transport of construction debris and dredge spoils away from the project site;
- Transport of construction materials and equipment to the site; and
- Travel and parking demand generated by construction workers.

In addition, the Action Alternatives would construct a new substation on the site, which would eliminate some existing parking. This section describes the transportation impacts associated with the construction elements of the Action Alternatives.

Details about how the Terminal 5 berth improvements would be constructed are presented in the *Biological Assessment Terminal 5 Cargo Wharf Rehabilitation and Berth Deepening*[27] report. The work is expected to be completed over two years, with in-water work limited to a period between mid-August and mid-February. The elements that could affect transportation would be demolition, transportation of piles and other materials, and dredging. Each of these is described below.

**Wharf Demolition:** The project would demolish older wharf and structural systems as needed. This includes removing piles, overwater structures, and asphalt paving. Materials removed during demolition are expected to be trucked off site. At the peak, demolition activities may generate up to ten double dump truck loads per hour, resulting in 20 truck trips per hour (10 trucks arriving and 10 trucks departing).

**Transport of Piles:** Upgrading the berth is expected to require about 4,400 piles, which includes a combination of H-piles, sheet piles, concrete piles, and pinch piles. Given the various installation methods, it is expected that six sheet or concrete piles could be installed per day, and 7 pinch piles could be installed per day. The piles would be delivered to the terminal on trucks, with up to two truck deliveries per day.

**Dredging:** Dredge spoils are expected to be loaded onto a barge, and disposed of according to strict requirements of the U.S. Environmental Protection Agency (EPA), Department of Natural Resources (DNR), and Washington Department of Ecology (DOE). Dredge sediments unsuitable for open water disposal would be barged to a contractor-provided upland offloading facility. Therefore, none of the dredged material is expected to generate truck traffic from Terminal 5.

**Upland Improvements:** Alternative 3 would include improvements to the upland areas and railyard to increase terminal storage and handling capacity. The container marshalling area would be enlarged by demolishing and/or relocating the existing entrance gate, freight station, transit shed, maintenance and repair facilities. The existing intermodal rail yard would be reconfigured with additional rail lines and concrete or rail runways for RTG or RMG equipment. These construction activities would generate truck and construction worker trips.

[27] Hart Crower, March 19, 2015.

The highest volume of trucks during uplands construction would occur during demolition. It is estimated that all of the demolition materials (e.g., pavement, structures) could generate 2,200 to 2,800 truckloads of material, and each load would generate two truck trips (one empty truck entering the site and one full truck leaving). If the material is stock-piled, then the number of trucks would be generated at the rate that they can be loaded, which with two loaders is estimated to be limited to about 20 loads per hour and 160 loads per day. This could generate up to 40 truck trips per hour and 320 truck trips per day. If the material is not stock-piled, trucks would be loaded at a slower rate that accounts for the time to remove materials and load them directly.

Concrete and pavement installation for the uplands is likely to occur in phases, with half of the pavement being completed during the non-in-water work months of one year, and half being completed in the next year. The total paved area is estimated to require 2,650 truckloads of surface course, concrete, and asphalt, which relates to 1,325 truckloads per year. Concrete and asphalt work would likely be done at different times, and each is estimated to generate a maximum of 10 truckloads per hour, and 80 truckloads per day.

Construction worker trips would vary by stage of work, and typically the peak construction worker load occurs during building construction when many different trades can be on the site simultaneously (e.g., carpenters, electricians, plumbers, etc.). These peak phases for construction workers would not overlap with the peak truck activity described above.

**Substation:** Alternatives 2 and 3 include upgrading the power supply to the terminal and constructing a new substation near the Administration Building, the footprint of which would eliminate 29 parking spaces.

For all stages of construction, the number of construction workers at the site would be less than the terminal employs when operational, and the number of truck trips generated would be less than the container terminal would generate. Therefore, the level of traffic and parking demand would also be less. The vicinity roadways and the on-site parking supply could accommodate traffic and parking demand generated by construction activities. No adverse impacts associated with construction traffic or parking are expected.

Prior to beginning construction work that could impact SDOT right-of-way; the contractor would be required to submit the following information to SDOT for review and approval of necessary permits:

- Haul Route Plan;
- Traffic control plan for work on or adjacent to an arterial street;

In addition, the Port and NWSA would commit to being part of SDOT's ongoing construction coordination program to ensure coordination of project timelines, construction sequencing, traffic control plans and construction staging.

# 4. TRAVEL DEMAND ESTIMATES FOR ALL PROJECT ALTERNATIVES

This section presents the travel demand estimates for all of the project alternatives, including the No Action Alternative. The historic travel demand for Terminal 5 was previously presented (see Section 2.2.3) to provide context and establish the Design Day trip generation for the existing condition. Information is then presented (Section 4.2) to estimate how those volumes would change with larger ship sizes and increased throughput. The travel routes and trip assignments are then presented (Section 4.3) to estimate each alternative's trips on study area roadways.

## 4.1. Parameters for Estimating Truck Trips

Over the past two decades, trucking logistics have improved with enhancements to fleet management systems and trip planning processes. One recent industry trend has seen shipping lines adding vessels to service routes while maintaining the same number of ports of call. This allows vessels to sail at reduced speeds, which saves significant costs by reducing fuel use. This also results in increased time in port, which spreads out discharge and load activities, and reduces the need to staff terminals during the more expensive hoot shifts.[28] These industry changes have affected truck traffic at the port by reducing seasonal and daily peaks in traffic. The following sections present the primary factors used to derive truck trip generation estimates for the increased capacity conditions that could occur at Terminal 5.

### 4.1.1. Average Container Size

The Port tracks throughput at each terminal by both the numbers of containers and TEUs, a twenty-foot equivalent unit, which is the standard unit of measure for the shipping industry. A 40-foot container is equivalent to 2.0 TEUs. In the past 10 years, the average number of TEUs per container for all Port terminals has been relatively steady at 1.74. Over 70% of containers are 40-foot or larger. This factor was used to convert TEU forecasts to containers for use in the truck trip forecasts.

### 4.1.2. Average Day and Design Day

RFID data described previously were compiled for all of the Port terminals. The number of days per year that truck gates were open at the Port's three largest terminals ranged from 245 days at Terminal 5 to 293 days at Terminal 18. The average was 260 days per year, which indicates that the terminal gates are open on some weekend days and some holidays. Many Saturdays experienced truck volumes that were close to the average day; Sunday volumes were the lowest of the week. It was assumed that the upgraded Terminal 5 would be open for 260 days per year to reflect an Average Day condition.

Traffic analysis is often performed for an $85^{th}$-percentile condition, which will be referred to as the Design Day. Based on RFID data for the entire port, the $85^{th}$-percentile volumes were 18% to 40% higher than the average day volumes through each terminal. The lowest peak condition occurred at Terminal 5, which had many smaller ship calls; the highest peak condition occurred at Terminal 18, which accommodated larger ships. To be conservative, and to account for the potential for larger ships at Terminal 5, the Design Day truck volumes were assumed to be 40% higher than an average day. As described later, the 40% increase accounts for the potential increase in truck activity associated with large ship loading and unloading events. Based on analysis of throughput at Terminal 18 during large-ship events, which is described in Section 4.1.5, this factor results in a conservatively high estimate of trips.

[28] Moffatt & Nichol, December 2014.

### 4.1.3. Truck Trips per Ship Lift

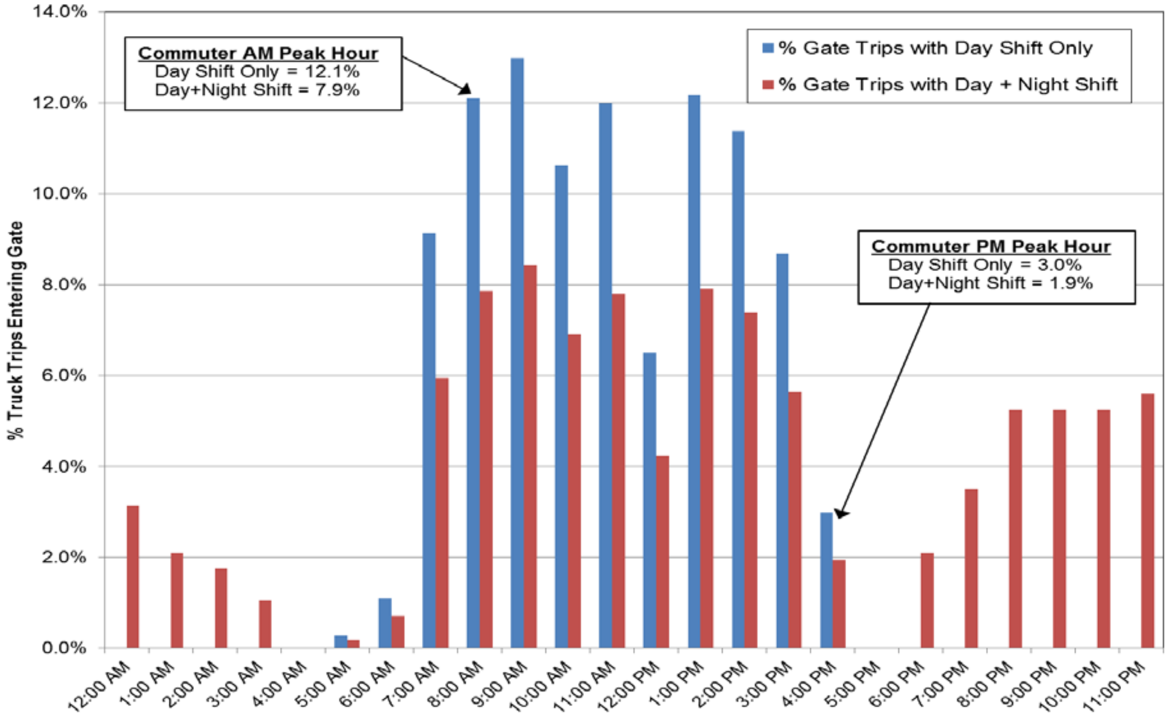
Two months of detailed RFID data and ship lift data for the Terminal 18 gate were compared to determine a truck trip factor per gate move. A ship lift is counted every time a container is either loaded or unloaded from a ship at the terminal. Overall, the terminal generated approximately 1.77 truck trips for every ship lift of a container not moved by on-dock rail. Trips are defined as one-way movements. Since the value is less than two, it means that some trucks drop off one container and pick up a second during the same trip through the terminal. This type of increased efficiency would likely be required for Terminal 5 to achieve the increased throughput target. The factor of 1.77 truck trips per ship lift was applied to all containers projected to enter or leave the terminal through the truck gate (excluding those moved through the terminal's on-dock rail yard).

### 4.1.4. Truck Trips by Time of Day

The port-wide RFID data for the period from April 1, 2013 through March 22, 2014 were compiled to determine the arrival patterns for trucks at all of the Port terminals. This average arrival pattern is presented in Figure 15. Based on these truck arrival data, peak hour traffic analysis assumed that 12% of each day's trips would occur during the AM peak hour of the nearby street system, which is the highest one-hour volume between 7:00 and 9:00 A.M. During the street system's PM peak hour (the highest one-hour volume between 4:00 and 6:00 P.M.), the terminal would generate 3% of the day's traffic. These data also show a lower arrival rate during the lunch hour, which reflects the anticipated change to a grounded container operation by which truck drivers cannot fetch or deliver their own load without longshore support. Under these conditions, the gates would likely close or operate at reduced capacity during the longshore lunch hour. It is noted that this pattern reflects a conservatively high condition where the terminal gates are open for the standard day shift from 8:00 A.M. to 5:00 P.M.. If gates are opened earlier or during lunch, a lower percentage of traffic would likely occur during the peak hours. The pattern with only a daytime shift was assumed for the No Action and Alternative 2 conditions.

For Alternative 3, capacity limitations of the RMGs within the terminal to load trucks would likely require that a second shift be added to the gate on peak days. Under this condition, a reservation system would also be implemented to spread truck traffic out over the course of the two shifts. The potential effect on traffic through the gate was estimated, assuming that 50% of the intermodal dray trips would be moved during the night shift, and that 25% of the local/regional trucks would be moved during the night shift. The potential effect on traffic through the gate is also shown on Figure 15. With a second shift, the percentage of daily trucks that would arrive during the AM peak hour would decrease from about 12% to 8%, and truck arrivals during the PM peak hour would decrease from 3% to 2%. The estimated daily and peak hour volumes for each alternative are presented later in this section.

Figure 15. Truck Arrivals at Port Terminals by Time of Day

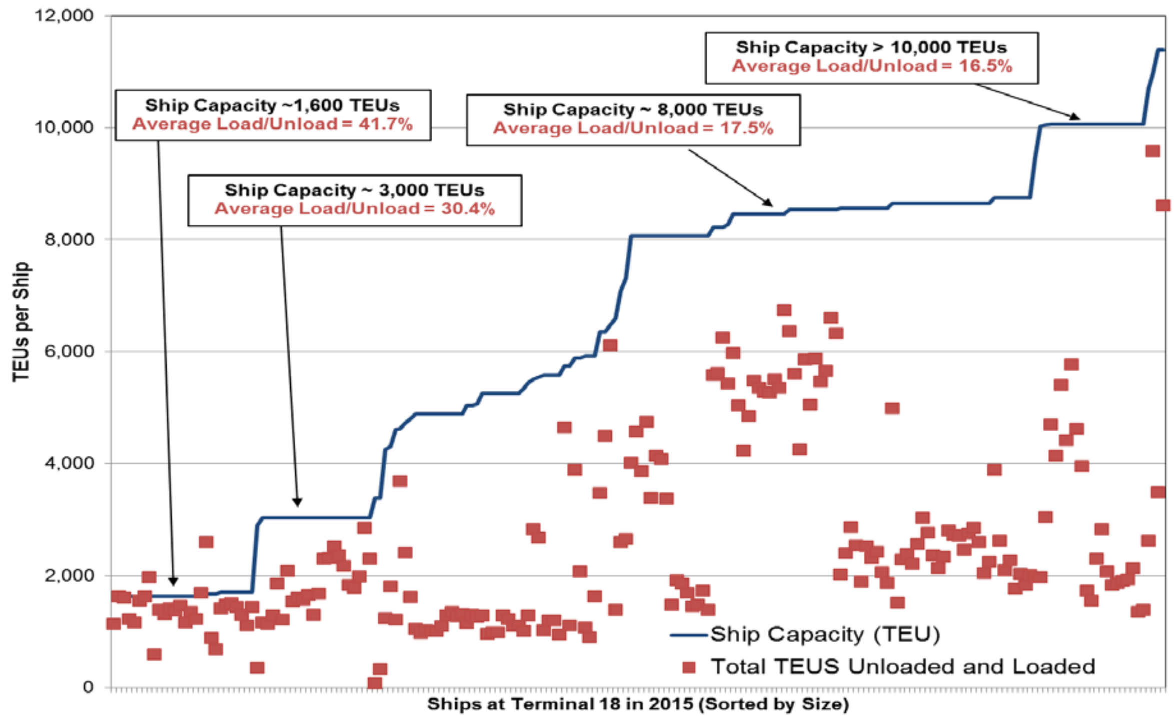



*Source: RFID data from Port of Seattle for all terminals for the period from April 1, 2013 through March 22, 2014. Data compiled by Heffron Transportation, Inc.*

## 4.1.5. Effect of Larger Vessels on Traffic Peaks

With the Alternative 2 or 3 improvements, larger vessels are expected to call at Terminal 5 than could be accommodated by the existing cranes. To better understand how larger ships could affect truck traffic entering and exiting the terminal, detailed analysis was performed for Terminal 18, which currently accommodates larger ships. For Seattle, which has a more limited local market for goods compared to other large ports such as Los Angeles or Long Beach, a larger ship does not necessarily relate to more containers per call. To illustrate this, 11 months of vessel calls were tracked for Terminal 18 and compared to the number of containers that were unloaded or loaded from each vessel. Figure 16 illustrates the relationship between vessel size and throughput. As shown, smaller ships have a higher percentage of cargo unloaded or loaded. The data reflected many calls of ships larger than 10,000 TEUs with fewer containers moved through the terminal than the containers moved for much smaller ships.

Figure 16. Vessel Size vs. Throughput at Terminal 18 – Year 2015



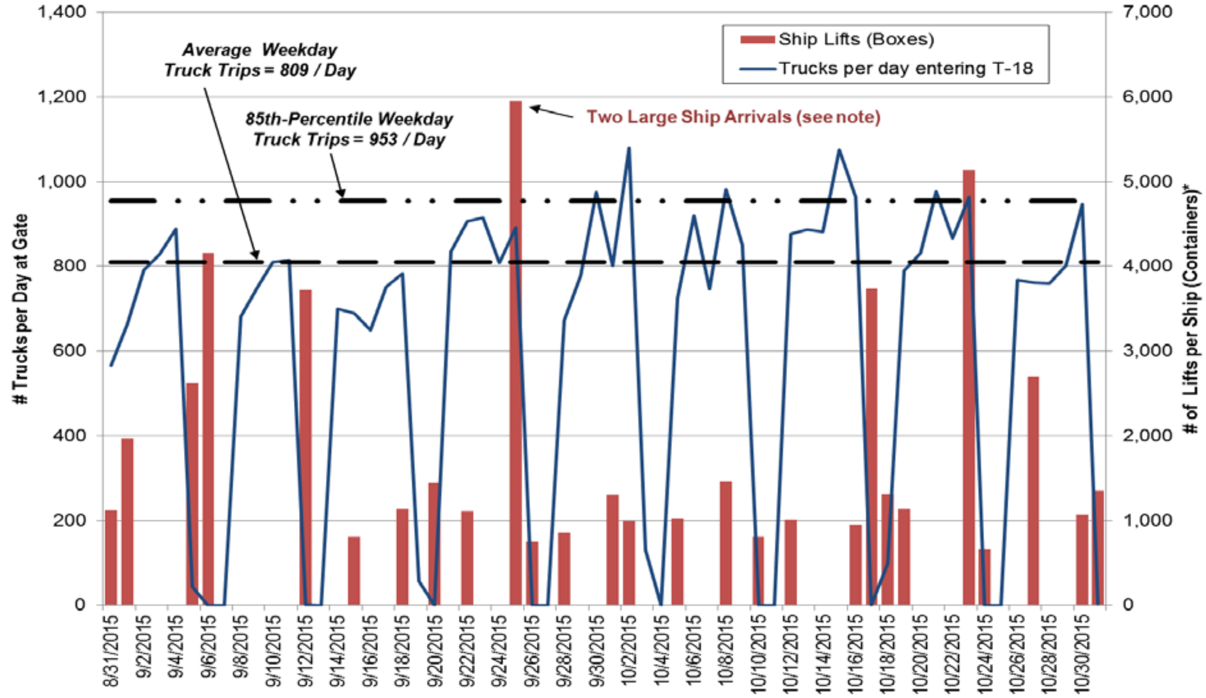

*Source: Data from Port of Seattle, compiled by Heffron Transportation, Inc.,*
*Total TEUs loaded or unloaded per ship for the period from January 1, 2015 through November 30, 2015.*

Ship activity at the various terminals usually follows a regular pattern, with weekly or biweekly service to and from various foreign ports. To understand how ship arrivals and the sizes of those ships could affect truck movements through the terminal gates, two months of ship lift and truck RFID data were reviewed for Terminal 18 (September and October 2015). Figure 17 shows the number of daily truck trips that entered Terminal 18 for each day of the period, overlaid with lifts from individual ships. Sundays are the days with no traffic through the gate. The ship lifts are shown for the day that the ship arrived, even though those lifts may have occurred over a number of days. This allows the truck gate effect to be related to the size and throughput for each ship.

The chart shows a relatively constant pulse of activity in each week, which typically included one large ship plus several smaller ones. The peak day for ship activity occurred on September 25, 2015 when two ships arrived at the terminal with respective capacities of 11,388 TEUs and 8,566 TEUs. A total of 5,956 containers (10,924 TEUs) were unloaded/loaded for these two ships, which is about 27% of the combined capacity. Truck volumes entering the terminal remained relatively constant, and while there was a slight increase in daily volumes about four days after the peak ship arrivals, it was not much higher than daily trips generated two weeks later when there were smaller ships at the terminal. On the average weekday during the two-month period, 809 trucks entered the terminal. This increased to 953 trucks per day on the 85$^{th}$-percentile day (18% higher than average), and 1,081 trucks per day on the peak day (34% higher than average).

The Design Day for Terminal 5 assumes that truck volumes will be 40% higher than the average day. Based on the observations at Terminal 18, this factor reflects a conservatively high estimate of truck trips, and captures the potential increase in truck traffic associated with a larger ship or expedited load/unload event.

Figure 17. Trucks Entering Gate vs. Ship Lifts at Terminal 18




*Source: Port of Seattle RFID Data at Terminal 18 inbound gate and ship lift data for Terminal 18. Notes: Two Ship Arrivals on 9/25/15 with capacity of 11,388 TEUs and 8,566 TEUs, respectively. A total of 5,956 boxes (10,924 TEUs) were unloaded/loaded for these two ships.*
*Red lines indicate the day that the ship arrived. Containers may have been loaded or unloaded over more than 1 day.*

## 4.2. Future Throughput and Truck Volumes

Cranes at the current Terminal 5 facility are each capable of serving 6,000 TEU ships.. Shippers have been using larger and larger vessels to reduce costs. Vessels capable of carrying 10,000 to 18,000 TEU capacities are starting to be used on routes to other West Coast terminals. Vessels of that size would typically call on several ports during a West Coast circuit, discharging only a portion of their capacity at one port. Alternative 1, the No Action Alternative, assumes that Terminal 5 would resume operating as it had in the past with Panamax-class vessels. Alternatives 2 and 3 assume that vessels carrying up to 18,000 TEUs would call at Terminal 5, which would increase the throughput. The potential effects of these changes and the resulting truck and rail trip generation are described in the following sections.

### 4.2.1. Terminal Throughput and Vessel Calls

The estimated vessel call and discharge rates for Alternatives 1 through 3 were previously presented in Table 1 of this report.

Alternative 1 (No Action Alternative) assumes an annual throughput at Terminal 5 of 647,000 TEUs. Alternative 1 assumes that existing cranes would continue to be used, and that the vessel calls would be similar to what occurred previously when an average of six vessels per week called at the terminal. The vessels reflected a mix of sizes, and only a portion of the vessel capacity was unloaded from or loaded onto each ship.

With Alternatives 2 or 3, the improved pier and deeper berth would allow larger ships to call at Terminal 5. An analysis was performed by Moffatt & Nichol to determine the potential throughput that could be accommodated by the terminal given the potential berth capacity, container yard area, storage density, peaking factors associated with larger ships, and container dwell time in the terminal. For Alternative 2, which would have modest upland improvements, the throughput is estimated at 1.3 million TEUs per year. For Alternative 3, which would have increased container yard and intermodal yard capacities, the throughput is estimated to be 1.7 million TEUs per year.

### 4.2.2. Intermodal Share

The majority of containers that move through the Port are transported by rail between their landside connections and inland origins or destinations. At Terminal 5, most would be transferred to and from rail through the on-dock intermodal rail yard; some would be drayed to the off-dock rail yards. The percentages of containers via each mode of travel were previously presented in Table 2. For the No Action Alternative, an estimated 55% of the containers would be intermodal. With increased throughput at Terminal 5 with Alternatives 2 or 3, the percentage of containers transported by rail is expected to increase to 75%, with two-thirds (or 50% of the total throughput) assumed to be handled at the on-dock intermodal yard and one-third (or 25% of the total) assumed to be drayed to off-dock rail yards. The remaining 25% of the total cargo would be trucked to local and regional businesses.

### 4.2.3. Truck Trips

The factors described above were used to estimate truck trips for the increased throughput scenarios, which are presented in Table 6. As shown, with the increased throughput volumes, the upgraded Terminal 5 is expected to generate 3,560 to 4,660 truck trips on the Design Day for Alternatives 2 and 3, respectively. It is noted that truck trips are reported as one-way trips (e.g. 4,660 truck trips per day reflects 2,330 trucks entering the terminal and 2,330 trucks exiting the terminal). The table also shows the estimated net change in trips for the Action alternatives as compared to the No Action Alternative, projected at 1,080 additional Design Day truck trips for Alternative 2 and 2,180 additional Design Day truck trips for Alternative 3.

The table also summarizes projected peak hour trips. As previously described, Alternative 1 and 2 are assumed to operate with only a daytime shift at the truck gate. Alternative 3, however, would require a second gate shift on peak days. Therefore, Alternative 2 would have the highest peak hour truck trips, and is estimated to generate an additional 130 truck trips during the AM peak hour and 31 truck trips during the PM peak hour on the Design Day.

Table 6. Terminal 5 Truck Trip Generation Estimates – All Alternatives

| | Average Day Truck Trips | | | Design Day Truck Trips | | |
|---|---|---|---|---|---|---|
| Condition | Daily | AM Peak Hour | PM Peak Hour | Daily | AM Peak Hour | PM Peak Hour |
| Alternative 1 - No Action [a] | | | | | | |
| Drayed to Off-Dock Rail Yard | 630 | 76 | 19 | 890 | 107 | 27 |
| Trucked to local/regional businesses | 1,140 | 137 | 34 | 1,590 | 191 | 48 |
| Total | 1,770 | 213 | 53 | 2,480 | 298 | 75 |
| Alternative 2 – 1.3 Million TEUs/Year [a] | | | | | | |
| Drayed to Off-Dock Rail Yard | 1,270 | 152 | 38 | 1,780 | 214 | 53 |
| Trucked to local/regional businesses | 1,270 | 152 | 38 | 1,780 | 214 | 53 |
| Total | 2,540 | 304 | 76 | 3,560 | 428 | 106 |
| Alternative 3 – 1.7 Million TEUs/Year [b] | | | | | | |
| Drayed to Off-Dock Rail Yard | 1,660 | 133 | 33 | 2,330 | 186 | 47 |
| Trucked to local/regional businesses | 1,660 | 133 | 33 | 2,330 | 186 | 47 |
| Total | 3,320 | 266 | 66 | 4,660 | 372 | 94 |
| Net Change in Trips for Alternative 2 | 770 | 91 | 23 | 1,080 | 130 | 31 |
| Net Change in Trips for Alternative 3 | 1,550 | 53 | 13 | 2,180 | 74 | 19 |

*Source: Derived by Heffron Transportation, Inc. January 2016.*

*a. Terminal gate for Alternatives 1 and 2 assumed to be open during day shift only. With that condition, 12% of the daily trips would occur in the AM peak hour, and 3% would occur in the PM peak hour.*

*b. Terminal gate for Alternative 3 assumed to be open during both day and night shift. With that condition, 8% of the daily trips would occur in the AM peak hour and 2% would occur in the PM peak hour.*

### 4.2.4. Employee Trips

The numbers of employees needed to staff the terminal during various ship unload/load events was estimated for each alternative. When the terminal is operating at peak capacity, it is likely to have all cranes staffed. This in turn increases the yard equipment needed, as well as staffing at the terminal's on-dock intermodal yard and truck gates. The Average Day conditions assume that a single ship would call at the terminal; the Design Day assumes two ship calls. The following assumptions were made related to terminal staffing.

- **Crane/Yard Gangs –** Each crane is typically operated by a crew (referred to as a "gang") of 22 persons, which includes the crane personnel as well as ground crews to position containers inside the terminal. Terminal 5 currently has six cranes, which can be configured to service two smaller ships or one larger ship. With the Alternative 2 or 3 pier and berth improvements, the terminal could have up to 12 cranes operating for two large ships. When the terminal is operating at peak berth capacity, a second crane shift would be needed for all alternatives.

- **Gate Clerks and Supervisors –** The existing truck gate, which has 13 lanes (10 inbound and 3 outbound) would remain for the No Action Alternative and Alternative 2, and would be operated with remote clerks in a single office (also called "the kitchen"). When the terminal is operating at capacity, it is assumed to require 24 staff (clerks and supervisors). For Alternative 3, capacity limitations of the RMGs within the terminal to load and unload trucks would likely require that a second shift be added to the gate on peak days. Under this condition, a reservation system would also be implemented to spread truck traffic out over the course of the two shifts. The gate would require fewer staff for the day shift, but would add staff for a second gate shift.

- **Yard Staff –** Terminal 5's on-dock intermodal yard is assumed to operate during two shifts, and would be staffed by up to 30 people for the No Action Alternative and Alternative 2. Alternative 3 would increase the capacity of the yard, and yard staff could increase to 54 people for each of two shifts.

- **Mechanics/Service Personnel –** Staff needed to maintain yard equipment would increase with throughput and amount of equipment used. The highest staffing need would be for Alternative 2, which assumes use of top picks for many operations.

- **Management –** Five to eight managers are assumed to be on terminal for a day shift with one to two during a night shift.

Table 7 summarizes the assumed staffing needs for both the existing and improved conditions.

Table 7. Terminal 5 Employee Estimate – All Alternatives

| | | Average Day (1 ship) | | Design Day (2 ships) | |
|---|---|---|---|---|---|
| Personnel | Throughput | Day Shift | Night Shift | Day Shift | Night Shift |
| Alternative 1 (No Action) | 647,000 TEUs/year | 4 cranes / 9 gate lanes | | 6 cranes / 13 gate lanes | |
| Crane/Yard Gangs | | 88 | 0 | 132 | 132 |
| Gate Clerks & Supervisors | | 5 | 0 | 7 | 0 |
| Rail Yard Staff | | 20 | 0 | 30 | 30 |
| Management | | 5 | 0 | 5 | 1 |
| Mechanics | | 16 | 0 | 16 | 8 |
| Total | | 134 | 0 | 190 | 171 |
| Alternative 2 (Wharf Improvements) | 1.3M TEUs/year | 6 cranes / 13 gate lanes | | 10 cranes/13 gate lanes | |
| Crane/Yard Gangs | | 132 | 0 | 220 | 220 |
| Gate Clerks & Supervisors | | 24 | 0 | 24 | 0 |
| Rail Yard Staff | | 30 | 0 | 30 | 30 |
| Management | | 5 | 0 | 5 | 1 |
| Mechanics | | 16 | 0 | 27 | 14 |
| Total | | 207 | 0 | 306 | 265 |
| Alternative 3 (Wharf + Uplands) | 1.7 M TEUs/year | 6 cranes / 13 gate lanes | | 12 cranes/13 gate lanes | |
| Crane/Yard Gangs | | 132 | 138 | 258 | 258 |
| Gate Clerks & Supervisors | | 18 | 16 | 18 | 16 |
| Rail Yard Staff | | 54 | 54 | 54 | 54 |
| Management | | 8 | 2 | 8 | 2 |
| Mechanics | | 26 | 13 | 23 | 13 |
| Total | | 244 | 223 | 364 | 343 |

*Source: Heffron Transportation and Moffatt & Nichol, January 2016.*

Some of the employees who work the day shift could take transit, walk or bike to work. However, those options are limited by the fact that many employees are dispatched from the labor hall and do not arrive directly from home. In addition, transit may not be available to night shift employees since none of the bus routes that serve the near-site area operate after 2:00 A.M. when the night shift typically ends. Employee modes of travel were derived from 'Journey-to-Work' survey results from the year 2010 Census.[29] No data were reported for the Transportation Analysis Zone (TAZ) where Terminal 5 is located; therefore, data for the two TAZs just south of Terminal 5 (TAZs 176 and 179), which have industrial uses and similar transit service, were reviewed. The data showed that 96% of the employees commuted by personal vehicle (77% by single-occupant vehicle and 19% by carpool), 1% walked or biked to work, and 3% used transit. These results are similar to the year 2000 Census data reported for the census tract where Terminal 5 is located that also determined that 96% of the employee trips were made by personal vehicle. The modes of travel are reasonable given the limitations described above.

[29] Compiled by the Puget Sound Regional Council.

Trip generation rates used to estimate Terminal 5 employee trips assume that each employee travels to the site before the shift, leaves just after the shift, and that very few employees leave the site during the shift. Therefore, a daily trip generation rate of 2.10 trips per employee was used. For the morning and afternoon peak hours, a trip generation rate of 0.65 trips per employee was assumed, which reflects 65% of the employees entering or leaving the site during the peak hour. The employee trips were then adjusted to reflect the mode of travel characteristics described above in which 4% of the trips occur by non-vehicular modes, and the average vehicle carried 1.2 persons. The transit trip reduction was not applied to inbound trips during the PM peak hour since few transit routes are in service at 2:00 A.M. when the night shift ends. The employee trip generation for each alternative is summarized in Table 8.

Based on the estimated staffing levels, the highest number of employee trips would occur in the PM peak hour, when employees who work the day shift leave the terminal and those who work the night shift arrive at the terminal.

Table 8. Terminal 5 Employee Vehicle Trip Estimates – All Alternatives

| | Daily [a] | | | AM Peak Hour | | | PM Peak Hour | | |
|---|---|---|---|---|---|---|---|---|---|
| | In | Out | Total | In | Out | Total | In [b] | Out | Total |
| Average Day Condition | | | | | | | | | |
| No Action (Alternative 1) | 113 | 113 | 226 | 70 | 0 | 70 | 0 | 70 | 70 |
| Alternative 2 | 174 | 174 | 348 | 108 | 0 | 108 | 0 | 108 | 108 |
| Alternative 3 | 392 | 392 | 784 | 127 | 0 | 127 | 121 | 127 | 248 |
| Net Change - Alt 2 | 61 | 61 | 122 | 38 | 0 | 38 | 0 | 38 | 38 |
| Net Change - Alt 3 | 279 | 279 | 558 | 57 | 0 | 57 | 121 | 57 | 178 |
| Design Day Condition | | | | | | | | | |
| No Action (Alternative 1) | 303 | 303 | 606 | 99 | 0 | 99 | 93 | 99 | 192 |
| Alternative 2 | 480 | 480 | 960 | 159 | 0 | 159 | 144 | 159 | 303 |
| Alternative 3 | 594 | 594 | 1,188 | 189 | 0 | 189 | 186 | 189 | 375 |
| Net Change - Alt 2 | 177 | 177 | 354 | 60 | 0 | 60 | 51 | 60 | 111 |
| Net Change - Alt 3 | 291 | 291 | 582 | 90 | 0 | 90 | 93 | 90 | 183 |

*Source: Heffron Transportation, Inc., August 2016.*

a. *Daily trips assume that each employee generated 2.10 trips per day, and that 65% of the employees commute during the peak one hour period in the morning and afternoon. Vehicle trips assume that 96% of the trips occur by vehicle with an average vehicle occupancy of 1.2 persons per vehicle.*

b. *Account for 2nd shift employees arriving during PM peak hour. All inbound trips during the PM peak hour are assumed to be by vehicle (single occupant and carpool) since most transit service does not operate at 2:00 A.M. when the night shift ends.*

The number of walk/bike and transit trips was also estimated based on the mode of travel experience for the site area. These are summarized in Table 9. At peak employment (Alternative 3 during a Design Day), the Terminal 5 project is expected to generate a net increase of 4 walk/bike trips per day (2 in and 2 out) and 10 transit trips per day (5 in and 5 out).

Table 9. Terminal 5 Employee Walk/Bike and Transit Trip Estimates – All Alternatives

| | Daily Walk/Bike Trips [a] | | | Daily Transit Trips [b] | | |
|---|---|---|---|---|---|---|
| | In | Out | Total | In | Out | Total |
| Average Day Condition | | | | | | |
| No Action (Alternative 1) | 1 | 1 | 2 | 4 | 4 | 8 |
| Alternative 2 | 2 | 2 | 4 | 6 | 6 | 12 |
| Alternative 3 | 2 | 2 | 4 | 7 | 7 | 14 |
| Net Change - Alt 2 | 1 | 1 | 2 | 2 | 2 | 4 |
| Net Change - Alt 3 | 1 | 1 | 2 | 3 | 3 | 6 |
| Design Day Condition | | | | | | |
| No Action (Alternative 1) | 2 | 2 | 4 | 6 | 6 | 12 |
| Alternative 2 | 3 | 3 | 6 | 9 | 9 | 18 |
| Alternative 3 | 4 | 4 | 8 | 11 | 11 | 22 |
| Net Change - Alt 2 | 1 | 1 | 2 | 3 | 3 | 6 |
| Net Change - Alt 3 | 2 | 2 | 4 | 5 | 5 | 10 |

*Source: Heffron Transportation, Inc., August 2016.*

*a. Based on 2010 Census results that 1% of employees in the site vicinity commute by walk or bike modes of travel.*

*b. Based on 2010 Census results that 3% of employees in the site vicinity commute by transit.*

## 4.3. Trip Distribution Pattern and Trip Assignment

### 4.3.1. Truck Trips

The truck trip distribution pattern for Terminal 5 was based on detailed origin-destination studies performed in February 2014 to develop the *Container Terminal Area Traffic Analysis Tool.*[30] These studies used Bluetooth readers that were placed at the terminal entrances and along regional roadways to capture unique addresses emitted from vehicles containing Bluetooth-enabled devices. Data at points along major travel routes were then paired with the terminal data to derive an origin-destination pattern for each terminal at the Port. The data were further augmented with information from local warehouse and consolidation businesses to determine local truck trip patterns.

Data collected from the Bluetooth readers determined that nearly all Terminal 5 trucks (about 92%) arrived and departed the terminal via SW Spokane Street east of the terminal, crossing the Swing Bridge. About half of these trucks used the ramps to and from the Spokane Street Viaduct that connect to Harbor Island, east of the site. The rest stayed on surface streets to access the near-dock intermodal yards as well as local connections to SR 99 and I-90 (via East Marginal Way S and S Atlantic Street). None of the trucks arrived or departed using the West Seattle Freeway ramps that connect direct to Chelan Avenue SW west of the terminal.

With larger ships at Terminal 5, more trucks (25%) are expected to travel to and from the near-dock rail yards, resulting in more concentrated truck increases on surface SW Spokane Street and East Marginal Way between S Hanford Street and the Argo Yard. The new North Argo Access allows trucks destined to that railyard to avoid the merge across SR 99. The new access route passes under SR 99 just south of the

30 The Transpo Group, July 2015.

East Marginal Way grade-separated structure. Trucks returning from the Argo Yard use northbound East Marginal Way S north of Diagonal Avenue S. One change expected within the 10-year horizon is the extension of SR 509 from its current terminus near SeaTac Airport to I-5. In the future, this new highway connection is expected to attract more truck traffic to West Marginal Way SW and SR 509, reducing the number of trucks that may now use I-5 south of Spokane Street. That change is expected to result in decreased truck traffic on the Spokane Street Viaduct compared to existing conditions. Table 10 summarizes the truck trip pattern assumed for future conditions, which reflects the existing travel patterns for all of the Port's terminals and the planned changes to the roadway system described above.

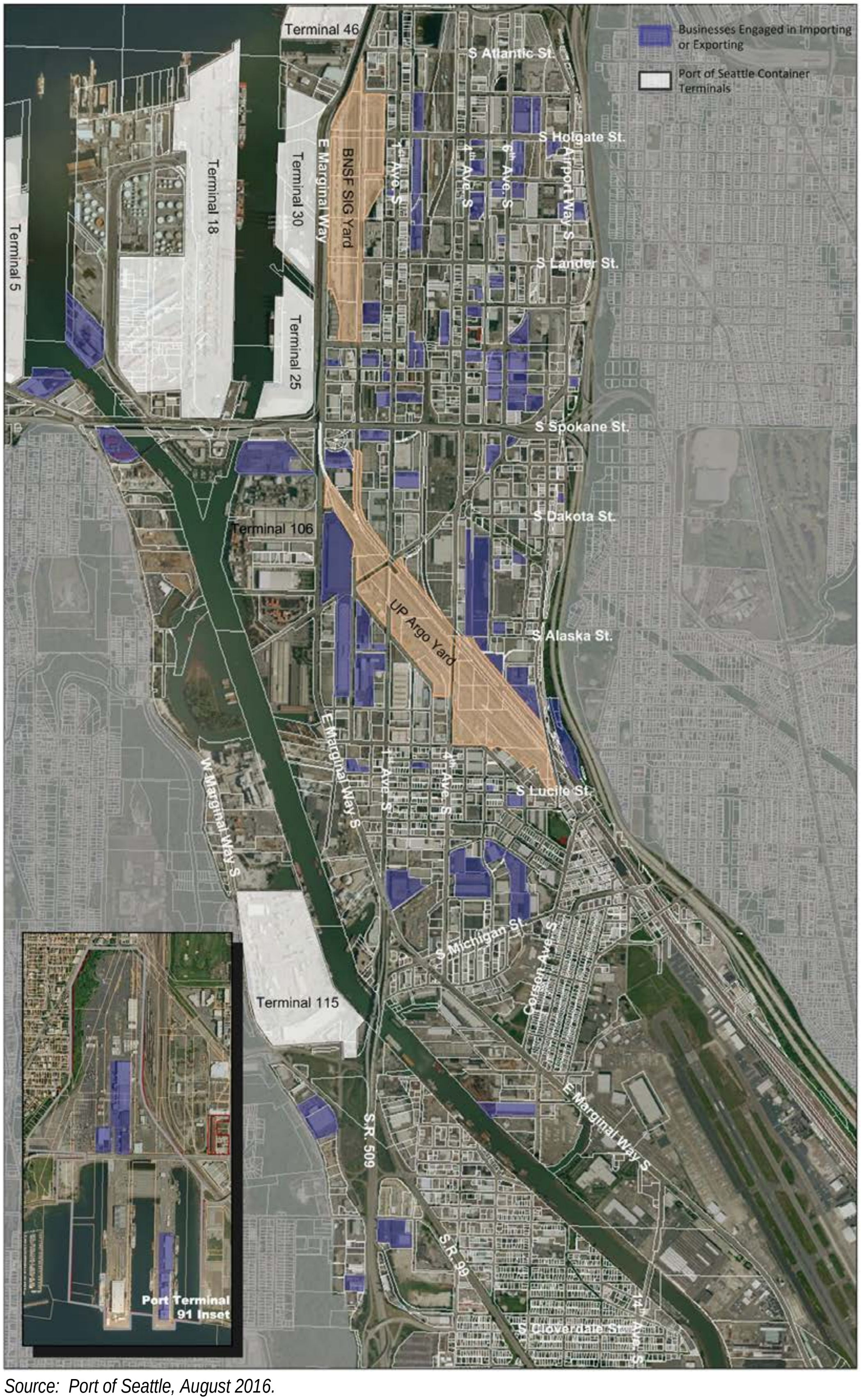
Table 10. Truck Trip Distribution Pattern for Terminal 5

| | SIG Yard | Argo Yard | I-5 North | I-90 East | I-5 South | SR 99 | SR 509 | Local | Total |
|---|---|---|---|---|---|---|---|---|---|
| Existing | <1% | 4% | 15% | 20% | 29% | 11% | 9% | 12% | 100% |
| Future | 15% | 10% | 7% | 12% | 18% | 13% | 13% | 12% | 100% |

*Source: The Transpo Group, February 2014. Patterns derived from Bluetooth data at terminals and along primary travel routes.*
*Note: Existing conditions based on current travel patterns for Terminal 5; the future condition based on existing travel patterns for all of the Port's terminals.*

"Local" trips are those that travel between the terminal and local distribution and logistics facilities in the Duwamish neighborhood. Figure 18 shows the location of these businesses. Travel patterns would change by day depending on the customer and origin of the ship. The trip pattern assumed for the local trips was based on the port-wide average of local trips from all of the terminals.

Figure 18. Local Import/Export Businesses in Duwamish



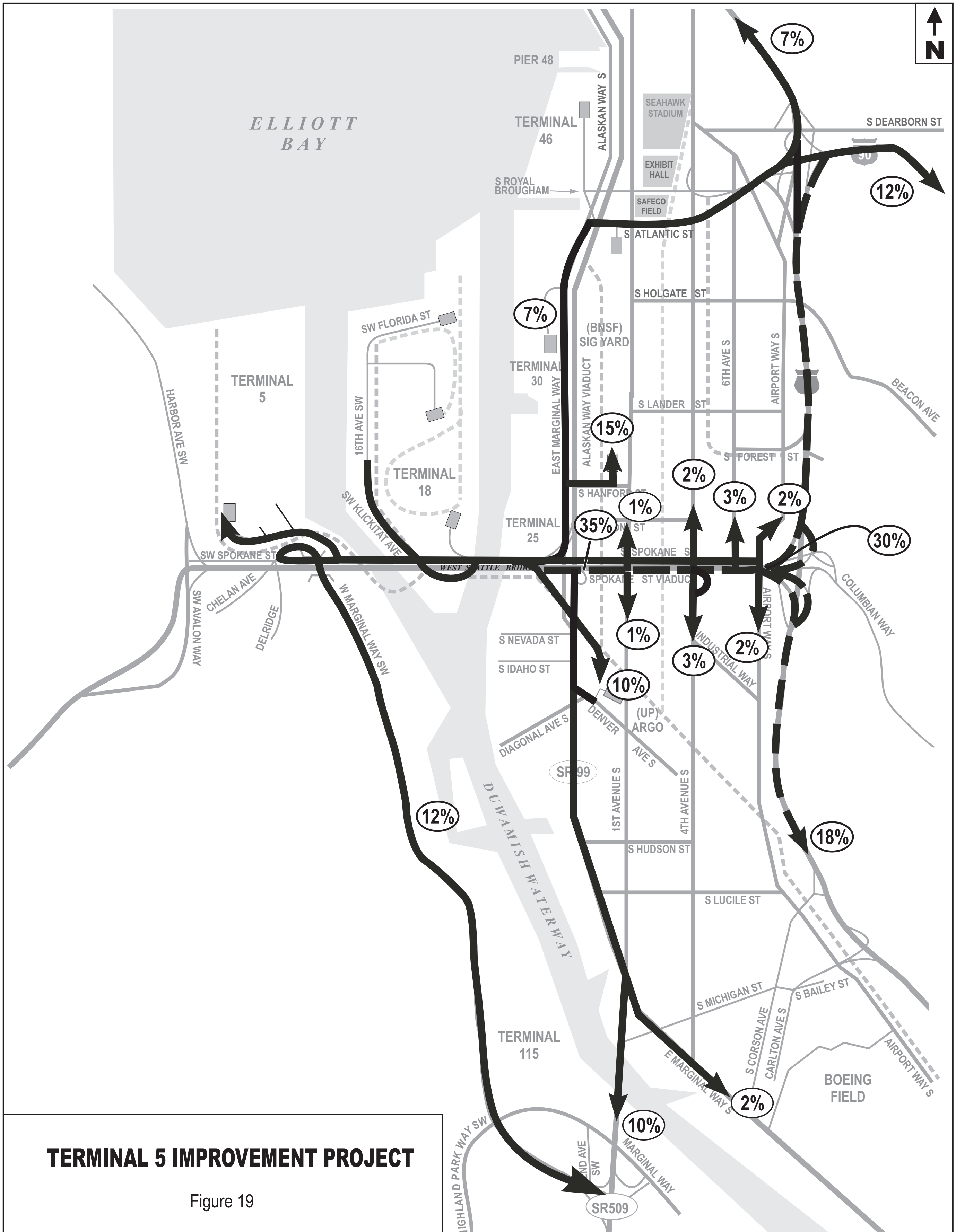

*Source: Port of Seattle, August 2016.*

Figure 19 shows the truck trip distribution pattern based on regional and local destinations. Figure 20 shows the truck trips for all three alternatives on the near site network. The net change in truck trips for Alternative 2, which has the highest number of peak hour truck trips, is shown on Figure 21.

### 4.3.2. Employee Trips

The travel pattern for employee trips was derived using information from the City of Seattle's Concurrency Director's Rule 5-2009.[31] The City's materials for this Directors Rule include a database that provides vehicle trip patterns for various types of land uses for each Transportation Analysis Zone (TAZ) in the city. The data were compiled to determine inbound and outbound patterns during the peak hours. Based on this information, about 70% of the employees are expected to use the West Seattle Freeway to access SR 99 North or I-5 (25% to SR 99 north of Spokane Street, 20% to I-5 north of downtown, 10% to I-90, 10% south on I-5, and 5% to Beacon Hill). About 17% are expected to use West Marginal Way SW to access SR 509 or SR 599 and destinations south of Seattle, while another 15% would use local streets (including Harbor Avenue SW and Delridge Way SW) to access West Seattle. Figure 22 shows the employee trips for the AM and PM peak hours.

[31] City of Seattle Department of Transportation, *Transportation Concurrency Project Review System, Director's Rule 5-2009*, Effective April 13, 2009.




**TERMINAL 5 IMPROVEMENT PROJECT**

Figure 19

**FUTURE TRUCK TRIP DISTRIBUTION PATTERN**

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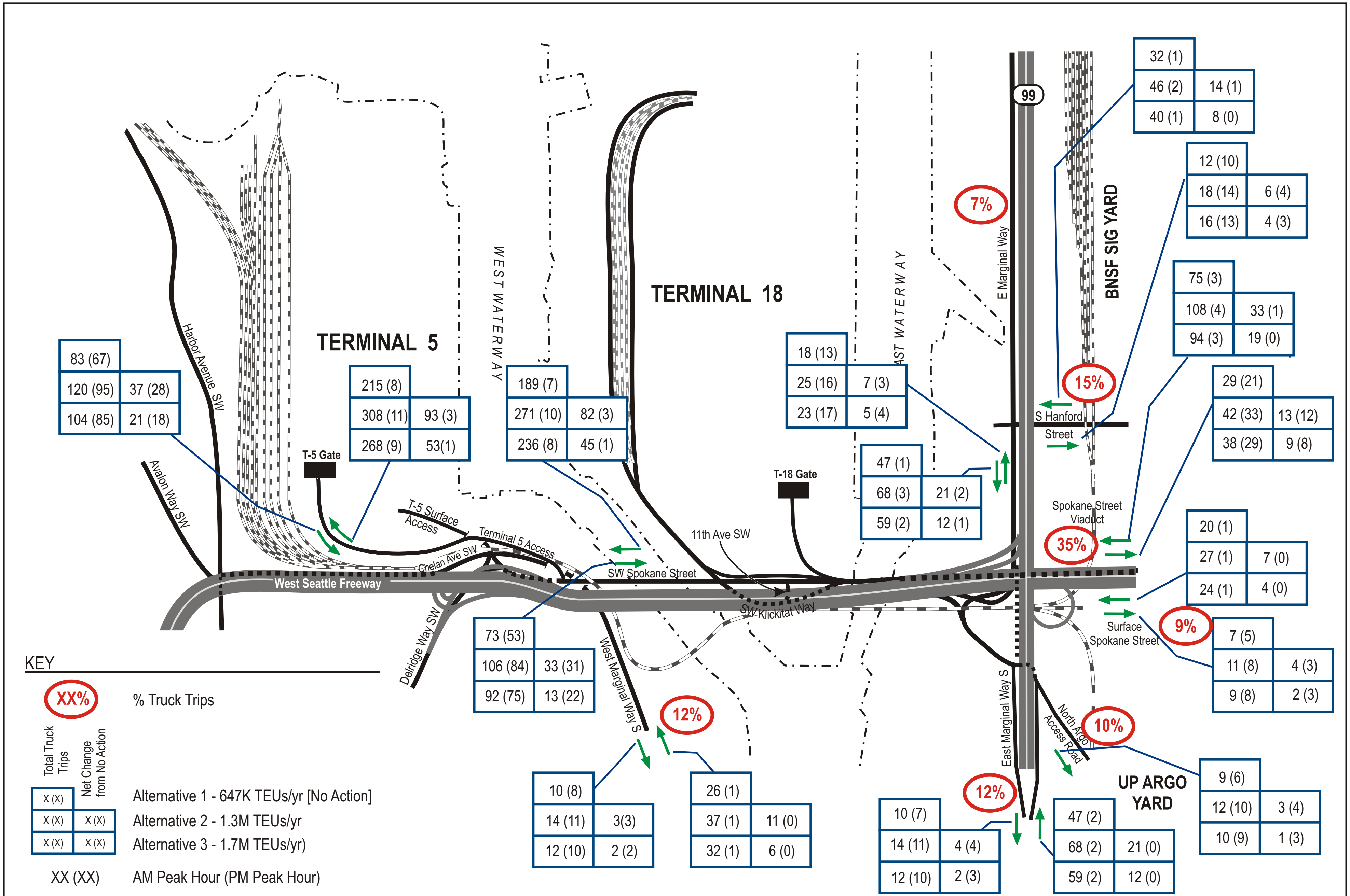
09.15.16

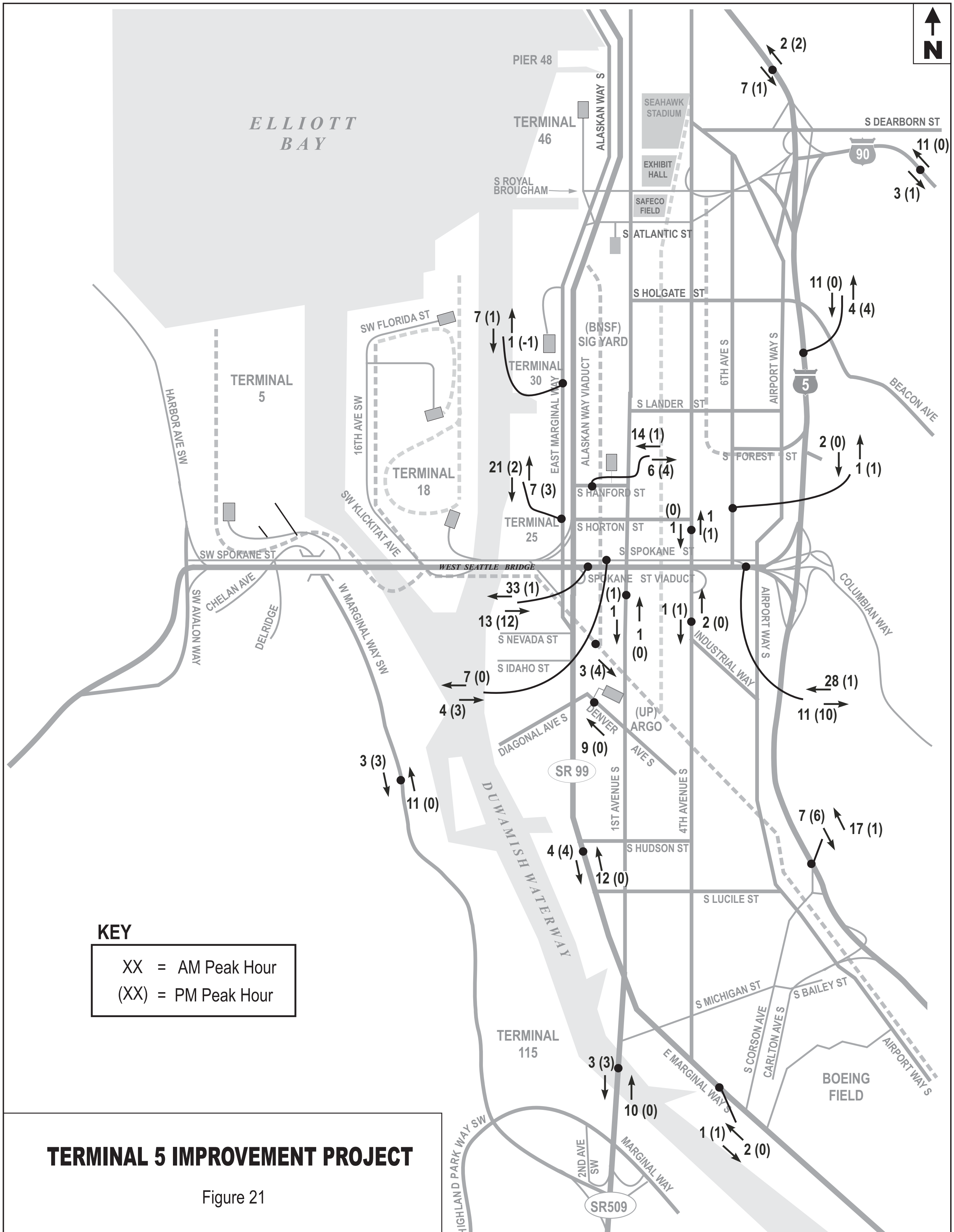



**TERMINAL 5**
Improvement Project

Figure 20
**Terminal 5 Truck Trips (Design Day)**
**AM and PM Peak Hours**

heffron transportation, inc.

09.15.16



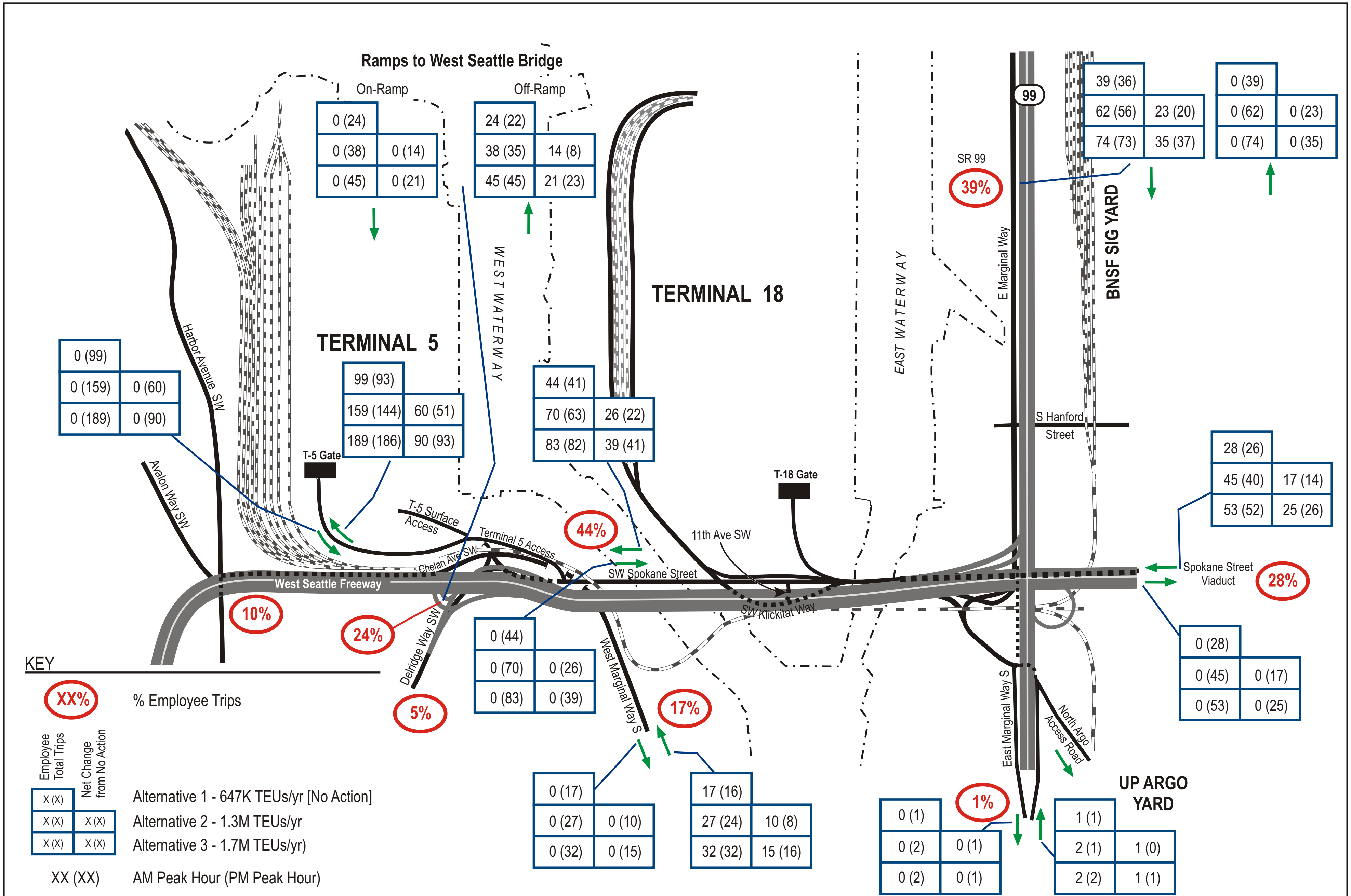

**TERMINAL 5 IMPROVEMENT PROJECT**

Figure 21

**NET CHANGE IN TRUCK TRIPS**
**ALTERNATIVE 2 - DESIGN DAY**

heffron transportation, inc.

09.15.16




**TERMINAL 5**
Improvement Project

Figure 22
**Terminal 5 Employee Trips (Design Day)**
**AM and PM Peak Hours**

heffron transportation, inc.

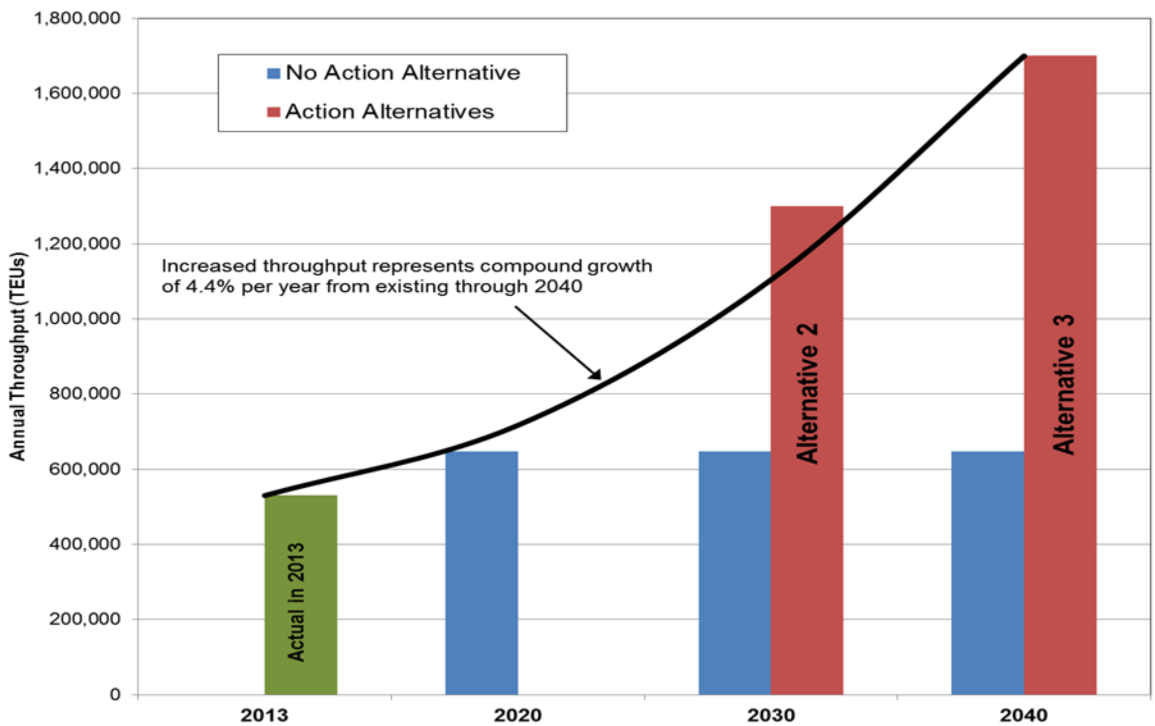
09.15.16

# 5. PROJECT IMPACTS

## 5.1. Future Traffic Volumes

Three future years—2020, 2030, and 2040—were evaluated to capture the potential growth in terminal throughput over time. The No Action volumes for Terminal 5 were evaluated for each of these horizon years to provide a basis for comparison. Under these conditions, container operations could continue with existing terminal infrastructure. Alternative 2 was evaluated for year 2030 conditions, and Alternative 3 was evaluated for year 2040 conditions. Figure 23 illustrates the analysis conditions evaluated for this report. It also shows the growth trend line between the actual conditions in 2013 and the Alternative 3 conditions in the year 2040. This shows that the compound growth would be 4.4% per year, a conservatively high assumption for container growth.

Figure 23. Analysis Conditions




*Source: Heffron Transportation, Inc., January 2016.*

Traffic volumes for the 2020, 2030, and 2040 No Action Alternative were derived by applying an annual growth rate of 1.6% per year to existing non-Terminal 5 traffic volumes. This is the historic growth rate for traffic on the Spokane Street Swing Bridge observed from 2005 through 2013, which accounts for the economic recovery since the 2008/2009 recession as well as increased traffic due to growth in West Seattle, and is similar to growth rates expected elsewhere in Seattle. This growth rate exceeds the growth rate predicted by the *Container Terminal Area Traffic Analysis Tool*[32], which used regional forecasts prepared by the Puget Sound Regional Council. The tool estimated a future growth rate for the Lower Spokane Street Swing Bridge of 0.3% per year.

32 The Transpo Group, July 2015.

Traffic forecasts developed for the City's proposed *2035 Comprehensive Plan*[33] were reviewed for consistency with the background traffic growth assumptions described above. The Comprehensive Plan analysis forecasts 2035 traffic conditions with buildout of the City's preferred future land use plan, focusing on projected PM peak hour volume-to-capacity ratios (V/Cs) of vehicular traffic on arterials crossing screenlines defined throughout the City. The existing and projected future V/Cs across the screenlines closest to the Terminal 5 study area, as well as the resulting projected annual growth between them, is summarized as follows:

**3.11 Duwamish River, West Seattle Freeway – S Spokane Street:**
EB – 2013 V/C = 0.61; 2035 V/C = 0.69; annual growth = 0.6%
WB – 2013 V/C = 0.87; 2035 V/C = 1.15; annual growth = 1.3%

**9.12 South of Spokane Street, East Marginal Way S – Airport Way S:**
NB – 2013 V/C = 0.47; 2035 V/C = 0.60; annual growth = 1.1%
SB – 2013 V/C = 0.52; 2035 V/C = 0.70; annual growth = 1.4%

In addition, the Draft Comprehensive Plan analysis provides existing and projected future Average Weekday Daily Traffic (AWDT) vehicle volume forecasts for state highways throughout Seattle. The existing and projected volumes for the state highway nearest the Terminal 5 study area, as well as the resulting projected annual growth between them, is summarized as follows:

**SR 99, East Marginal Way to West Seattle Bridge:**
2013 AWDT = 43,000; 2035 AWDT = 61,300; annual growth = 1.6%

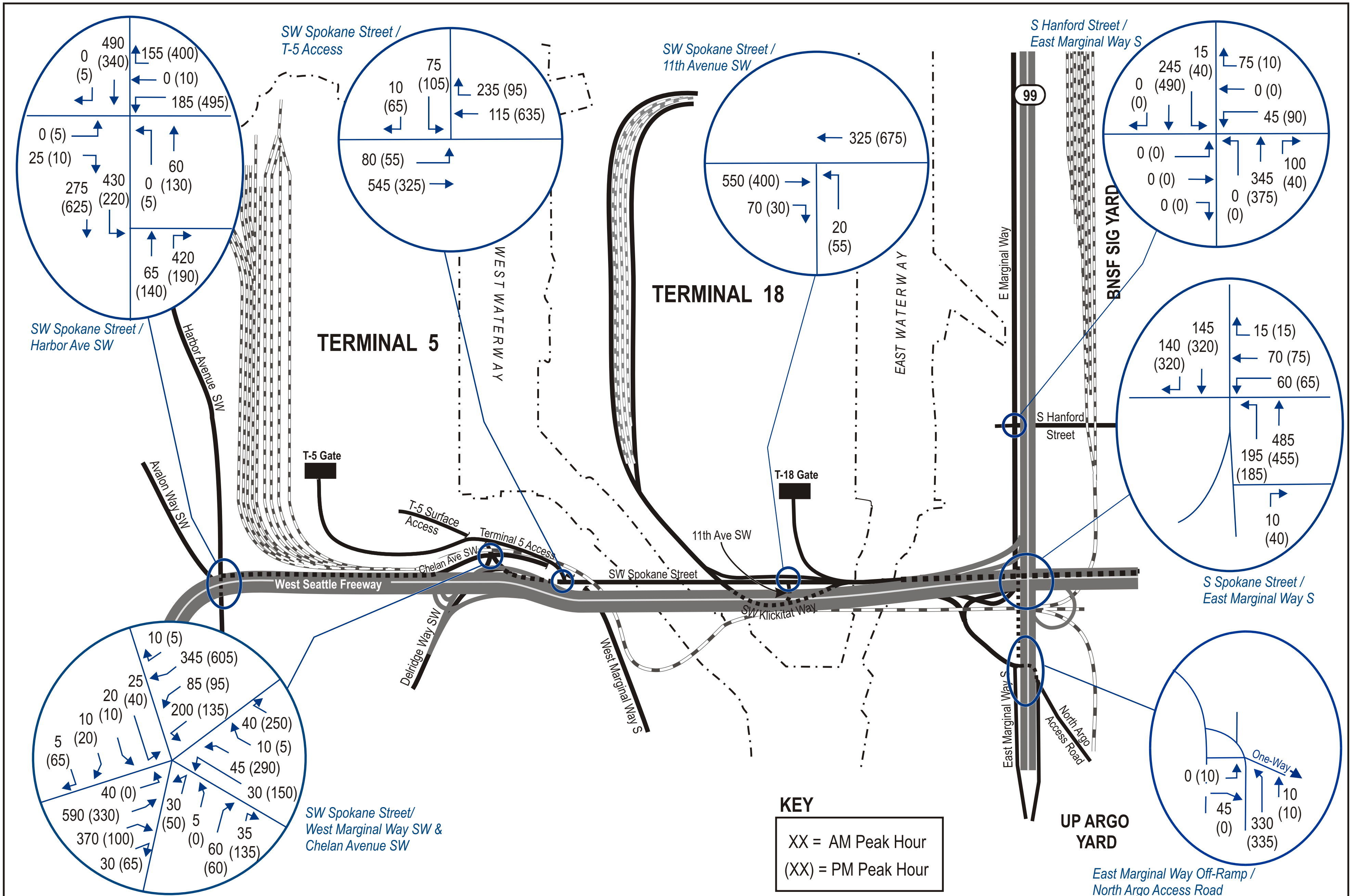
These Draft Comprehensive Plan projections indicate that the Terminal 5 background annual traffic growth assumption of 1.6% is conservatively higher than the projected annual growth on arterials crossing the screenlines nearest the study area, and is consistent with the projected annual growth on the state highway segment nearest the study area.

Existing non-terminal traffic was increased by 1.6% per year, and then Terminal 5 No Action truck and employee trips were added to the network. The No Action Traffic Volumes are shown on Figures 24 through 26 for the 2020, 2030, and 2040 conditions, respectively.

### 5.1.1. Future Traffic Volumes at Study Area Intersections

The net change in truck trips and employee trips generated by Alternatives 2 and 3 were added to the No Action Volumes to estimate the future Action Alternative volumes; Figure 27 shows for year 2030 with Alternative 2, and Figure 28 shows year 2040 with Alternative 3.

[33] Traffic forecasts developed for the *Mayor's Recommended Draft Plan, Transportation Appendix*, May 2016.

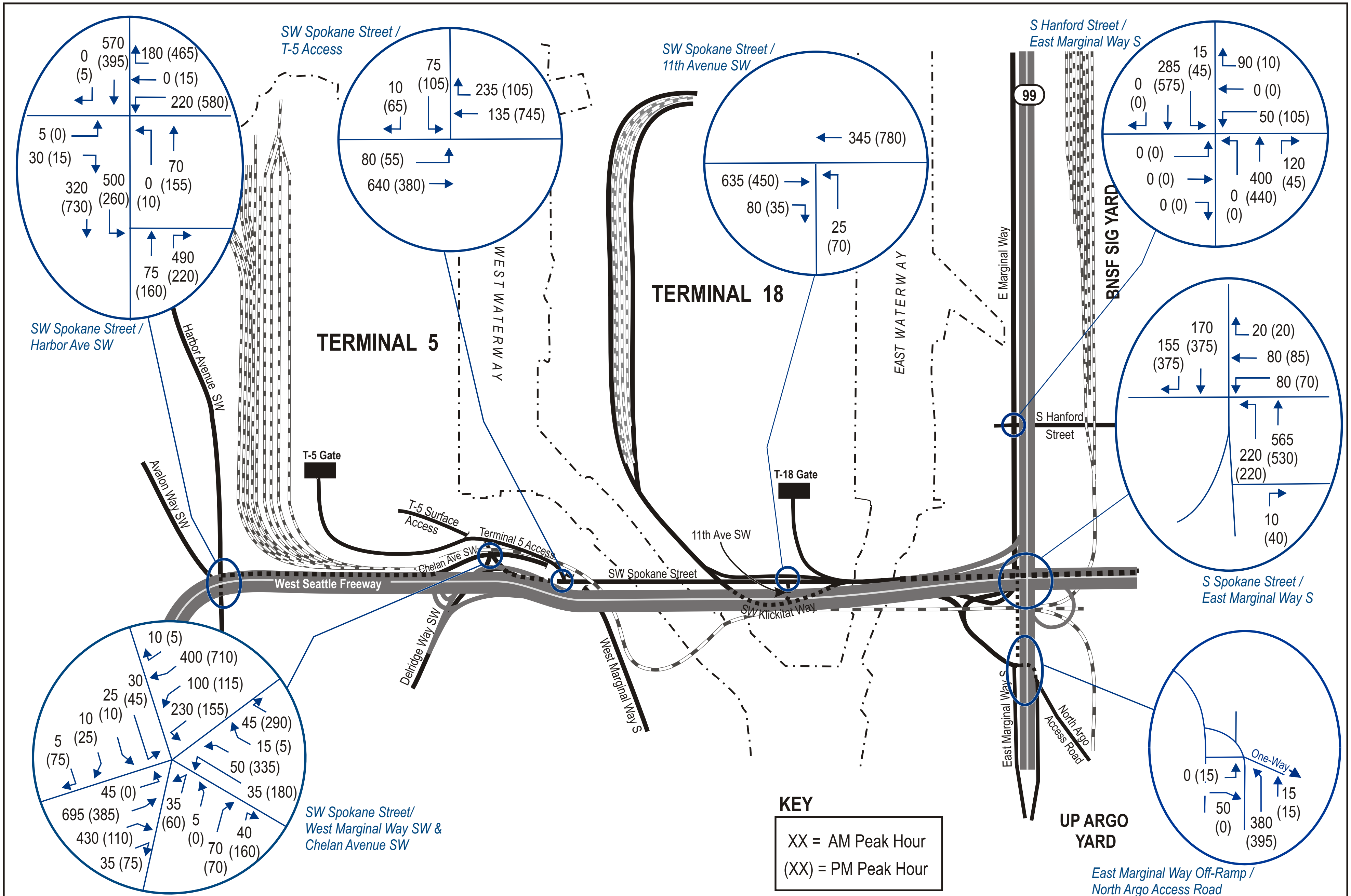



**TERMINAL 5**
Improvement Project

Figure 24
**Year 2020 No Action Traffic Volumes**
**AM and PM Peak Hours**

heffron transportation, inc.

09.15.16

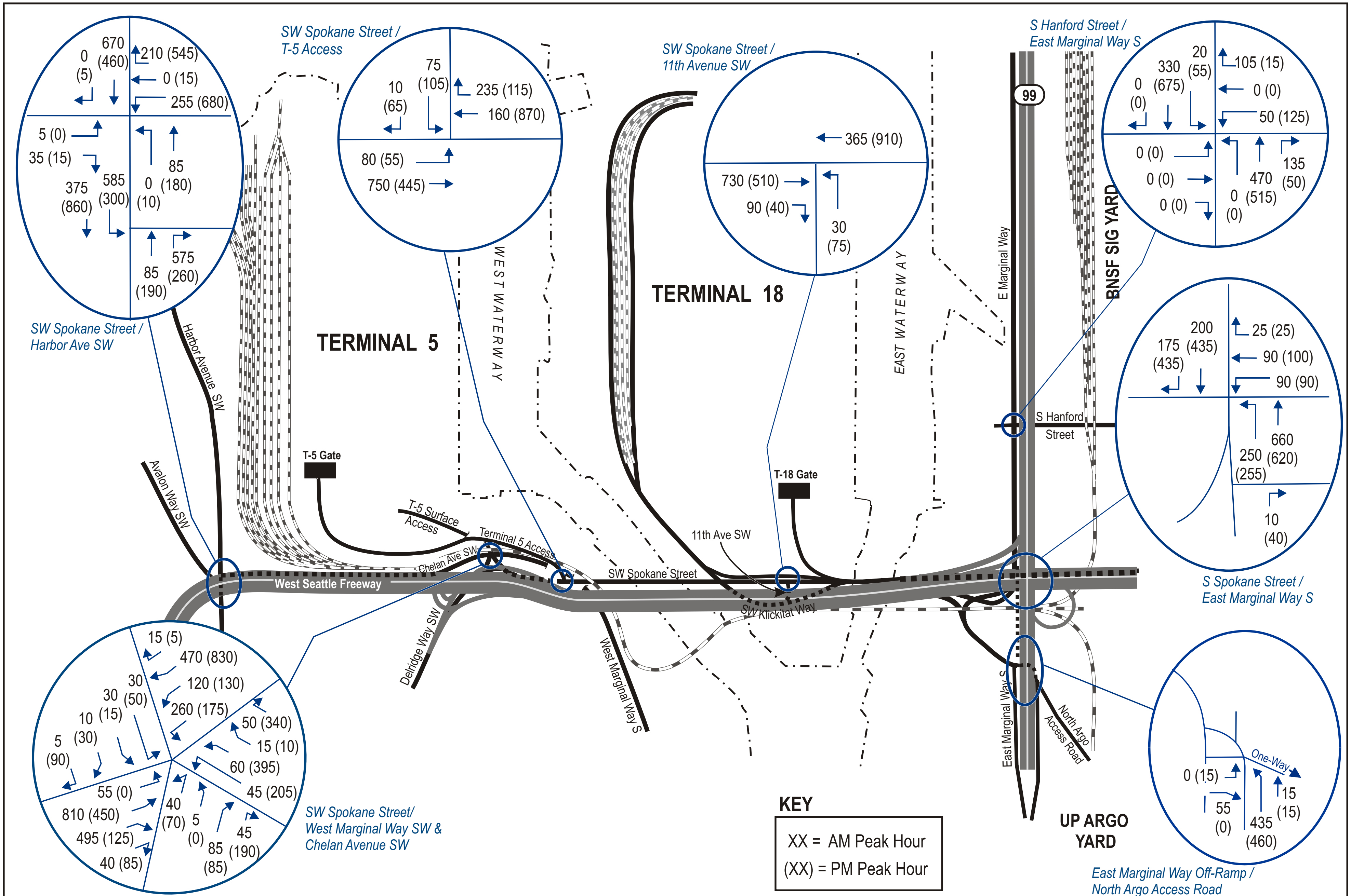



**TERMINAL 5**
Improvement Project

Figure 25
**Year 2030 No Action Traffic Volumes**
**AM and PM Peak Hours**

heffron transportation, inc.

09.15.16

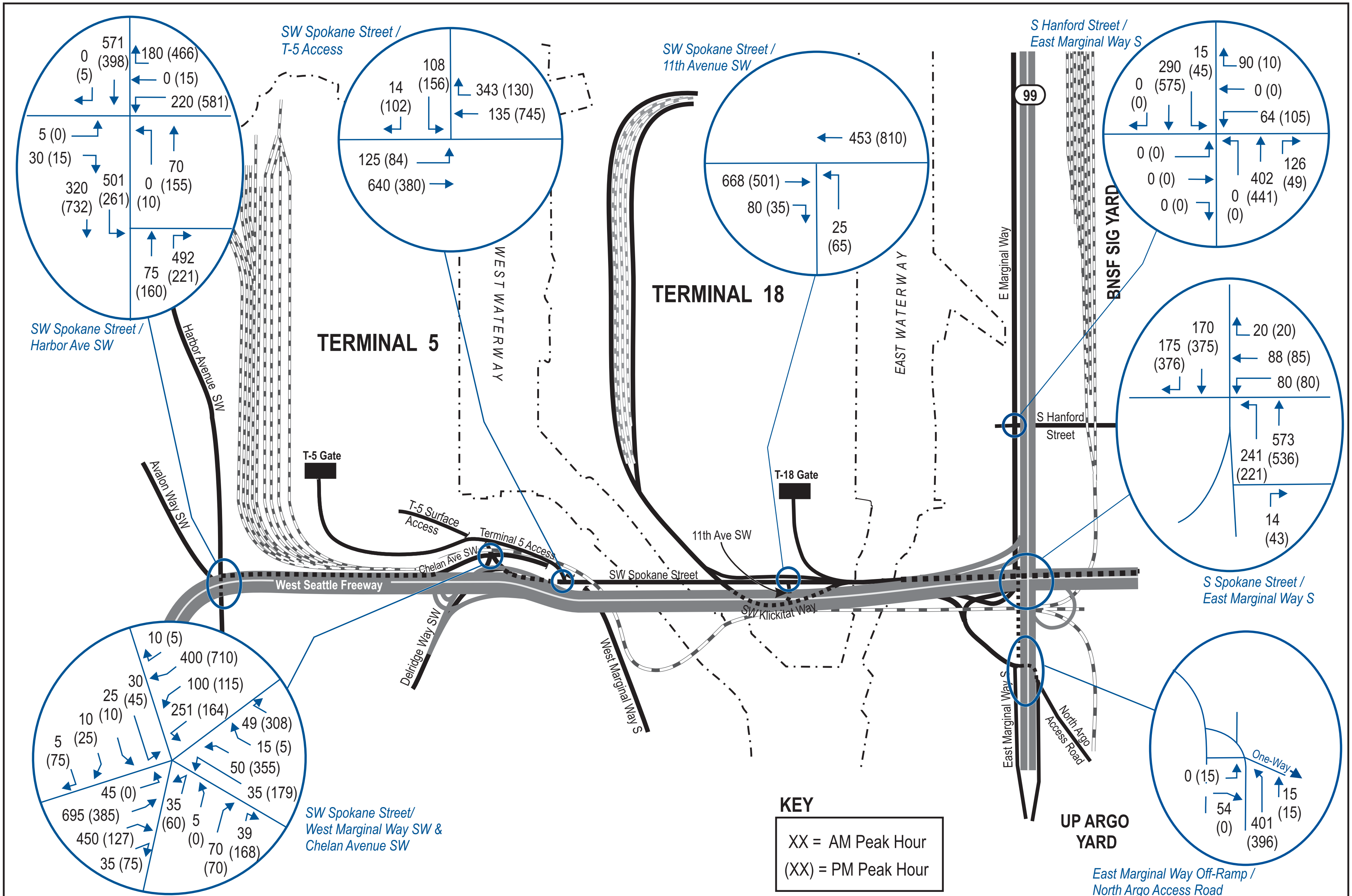



**TERMINAL 5**
Improvement Project

Figure 26
**Year 2040 No Action Traffic Volumes**
**AM and PM Peak Hours**

heffron transportation, inc.

09.15.16

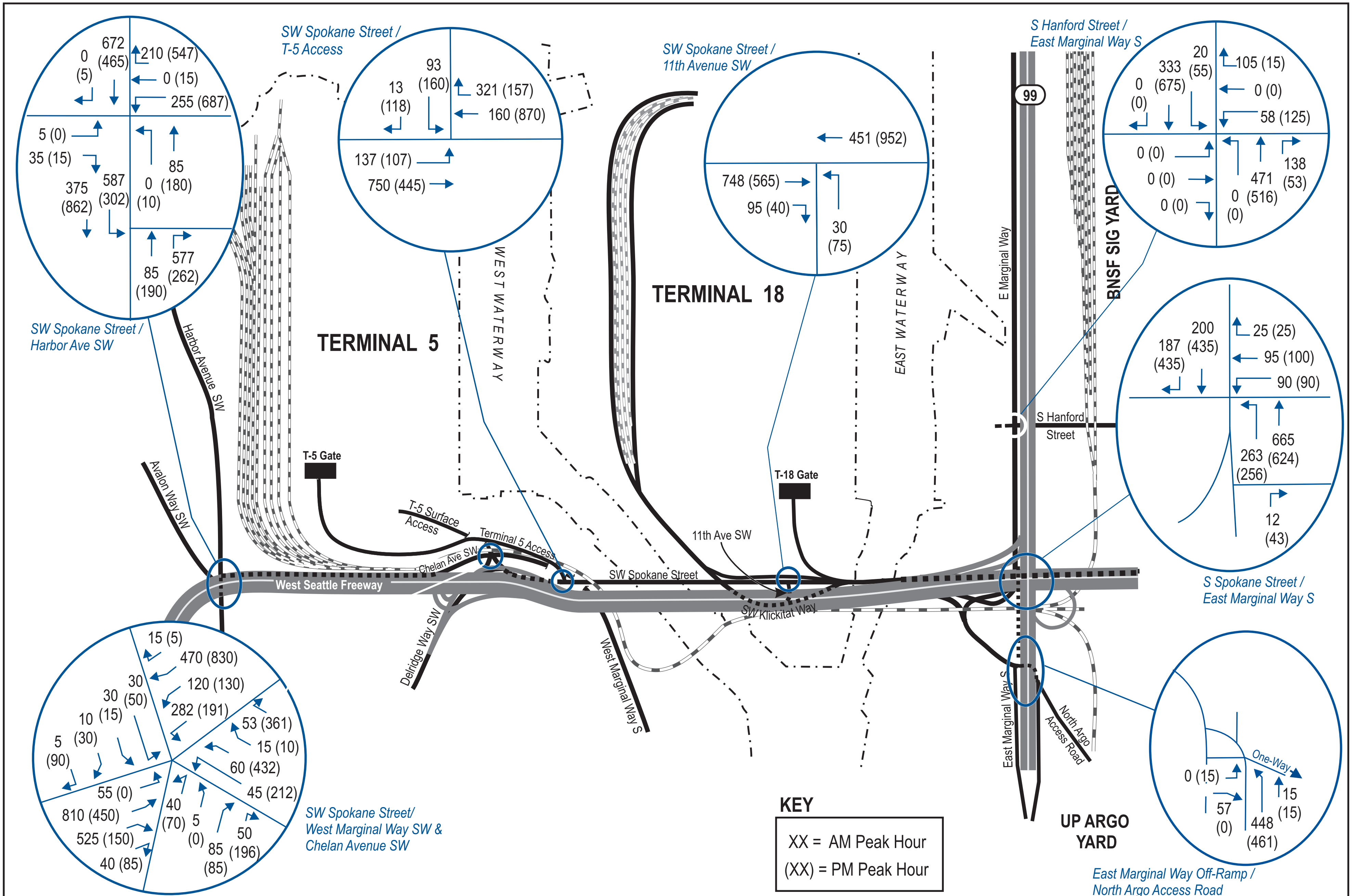



**TERMINAL 5**
Improvement Project

Figure 27
**Year 2030 Traffic Volumes with Terminal 5 Alternative 2 (1.3 M TEUs/Year) AM and PM Peak Hours**

heffron transportation, inc.

09.15.16




**TERMINAL 5**
Improvement Project

Figure 28
**Year 2040 Traffic Volumes**
**with Terminal 5 Alternative 3 (1.7 M TEUs/Year)**
**AM and PM Peak Hours**

heffron transportation, inc.

09.15.16

### 5.1.2. Traffic Volumes on State Highways

Traffic forecasts developed for the City's proposed *2035 Comprehensive Plan*[34] included forecasts for state highways in the area. These forecasts, which were built off of the PSRC's regional model included growth in Port of Seattle container terminal throughput to 3.5 million TEUs per year. Therefore, the forecasts did include Terminal 5 as part of the overall Port growth target. Forecasts for several state highways in the vicinity of Terminal 5 are summarized in Table 11. The net change in truck and employee trips generated by the terminal are then compared to the total volumes to show the magnitude of the project's impact. As shown, the project would represent a small percentage of the traffic on these routes. Alternative 2 would represent 0.03% to 0.11% of the year 2035 traffic, and Alternative 3 would represent between 0.07% and 0.29% of the 2035 traffic.

Table 11. Terminal 5 Traffic versus Future Traffic Volumes on State Highways

| | Average Weekday Traffic [a] | | Net Change in Terminal 5 Traffic [b] | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Alternative 2 | | | Alternative 3 | | |
| State Highway/Interstate | Year 2013 | Year 2035 | Truck Trips | Emp. Trips | T-5 % of 2035 Traffic | Truck Trips | Emp. Trips | T-5 % of 2035 Traffic |
| Interstate 5 North of West Seattle Freeway | 235,700 | 266,500 | 30 | 160 | 0.07% | 90 | 260 | 0.13% |
| Interstate 5 South of West Seattle Freeway | 235,700 | 266,500 | 50 | 35 | 0.03% | 130 | 60 | 0.07% |
| Interstate 90 across Lake Washington | 142,800 | 185,100 | 30 | 35 | 0.04% | 90 | 60 | 0.08% |
| SR 99 north of First Avenue S Bridge | 43,000 | 61,300 | 20 | 0 | 0.03% | 90 | 0 | 0.15% |
| SR 99 at Yesler Way | 77,200 | 66,200 | 0 | 90 | 0.14% | 0 | 150 | 0.23% |
| SR 509 at Cloverdale | 38,900 | 51,800 | 25 | 30 | 0.11% | 100 | 50 | 0.29% |

a. *Traffic forecasts developed by Fehr & Peers, for the* Mayor's Recommended Draft 2035 Comprehensive Plan, Transportation Appendix, *May 2016.*
b. *Derived by Heffron Transportation, Inc. per methodology described in this report.*

## 5.2. Level of Service

Traffic operating conditions for the study area intersections were evaluated for each of the future year conditions described in the previous section. The analysis assumed that the existing intersection lane configurations would remain the same in the future; traffic signal timings were optimized since they are likely to be adjusted by the future 2030 and 2040 horizon years. In addition, truck percentages for each movement were adjusted to reflect changes in truck volumes relative to total volumes, which accounts for the changes in Terminal 5 truck trips. The methodology to determine intersection level of service was previously described in Section 2.3. Table 12 summarizes the projected future AM peak hour conditions for all alternatives, and Table 13 shows the projected future PM peak hour conditions.

The analysis indicated that the following three intersections along the Spokane Street corridor would operate at poor levels of service in the future:

34 Traffic forecasts developed for the *Mayor's Recommended Draft Plan, Transportation Appendix*, May 2016.

**SW Spokane Street/West Marginal Way/Chelan Avenue SW –** This intersection is forecast to operate at LOS F for the 2020 No Action conditions during both the AM and PM peak hours. Conditions would get progressively worse in the subsequent decades due to background traffic growth in the corridor, with average PM peak hour vehicle delay of nearly 280 seconds per vehicle by 2040. Traffic generated by the Terminal 5 improvements is projected to add up to about 15 seconds of average delay per vehicle. As described later in the *Mitigation* section of this report, increased train traffic associated with the terminal could block the north leg of the five-legged intersection (the at-grade connection to Terminal 5) for much of the day, and at full operation, it is recommended that the north leg of the intersection be closed to vehicle traffic. Eliminating this leg of the intersection would dramatically improve traffic operations by eliminating one phase of the sequential-phase signal operation, and allowing some movements to operate concurrently. With closure of the north leg, it is estimated that in 2040 with Alternative 3, the intersection would operate at LOS E during the AM peak hour (68.5 seconds of delay per vehicle) and at LOS F in the PM peak hour, but with substantially reduced delay (97.3 seconds per vehicle) compared to the No Action Alternative. Closing the north leg of the intersection would also eliminate the at-grade railroad crossing and the signal pre-emption associated with train movements adjacent to the intersection. All traffic to and from Terminal 5, as well as local businesses at Terminal 7A, 7B, and 7C should be directed to use the Terminal 5 Access Bridge, which would operate at LOS C or better during the peak hours with this diverted traffic.

Until train movements across the surface access at West Marginal Way S warrant, other measures should be considered to improve operations. One alternative would be to convert the north leg of the five-legged intersection into a one-way northbound roadway and eliminate the ability to exit at this location. That would eliminate the signal phase associated with outbound movements and improve traffic operations at the intersection.

**SW Spokane Street/Harbor Avenue SW –** This intersection is forecast to operate at LOS F during the AM peak hour in 2040, without or with the proposed Terminal 5 project. This condition is related to the existing signal phasing that will not be able to accommodate growth in background traffic and the high volume of southbound left turns projected from Harbor Avenue SW onto the Spokane Street connector ramp. To mitigate this condition, it is recommended that the signal phasing be changed, which could improve operations to LOS E (63.1 seconds of delay) in 2040 with Alternative 3. Further detail about recommended signal improvements for the Spokane Street corridor are presented in the *Mitigation* section.

**S Spokane Street/East Marginal Way S –** This intersection is expected to operate at LOS E during the PM peak hour by 2030, and during both peak hours by 2040 without or with the proposed Terminal 5 project. The increase in traffic generated by Terminal 5 would add fewer than 2.0 seconds of delay to the intersection. Signal improvements described in the *Mitigation* section would include this intersection.

**S Hanford Street/East Marginal Way S –** This intersection would operate at LOS D or better until 2040, when it is forecast to operate at LOS F during the PM peak hour with Alternative 3. Although the project is expected to add little average delay to the intersection (less than 2 seconds per vehicle), operations could be improved by having all east-west pedestrian/bicycle movements served by a separate signal phase. Further detail about recommended signal improvements for the corridor are presented in the *Mitigation* section.

Table 12. Level of Service Summary - Future Conditions with All Alternatives – AM Peak Hour

| Signalized Intersections | No Action Alternative | | With T-5 Improvements | |
|---|---|---|---|---|
| | LOS[1] | Delay[2] | LOS | Delay |
| YEAR 2020 | No Action (647,000 TEUs/Yr) | | | |
| SW Spokane St / Harbor Ave SW | D | 44.9 | | |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | F | 77.4 | | |
| SW Spokane St / Terminal 5 Access | B | 10.6 | | |
| SW Spokane St / 11th Avenue SW | A | 2.1 | | |
| S Spokane St / East Marginal Way S | B | 17.2 | | |
| S Hanford St / East Marginal Way S | B | 17.9 | | |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 12.0 | | |
| YEAR 2030 | No Action (647,000 TEUs/Yr) | | With 1.3 Million TEUs/Year | |
| SW Spokane St / Harbor Ave SW | E | 58.3 | E | 58.8 |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | F | 129.3 | F | 142.2 |
| SW Spokane St / Terminal 5 Access | B | 12.7 | B | 14.7 |
| SW Spokane St / 11th Avenue SW | A | 2.3 | A | 2.7 |
| S Spokane St / East Marginal Way S | C | 22.3 | C | 26.7 |
| S Hanford St / East Marginal Way S | B | 19.3 | C | 20.7 |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 13.4 | B | 14.6 |
| YEAR 2040 | No Action (647,000 TEUs/Yr) | | With 1.7 Million TEUs/Year | |
| SW Spokane St / Harbor Ave SW | F | 84.5 | F | 85.7 |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | F | 200.2 | F | 215.8 |
| SW Spokane St / Terminal 5 Access | B | 13.8 | B | 16.0 |
| SW Spokane St / 11th Avenue SW | A | 2.5 | A | 3.0 |
| S Spokane St / East Marginal Way S | E | 56.0 | E | 57.6 |
| S Hanford St / East Marginal Way S | C | 24.4 | C | 26.8 |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 15.5 | B | 16.4 |

*Source: Synchro model developed by Concord Engineering and Heffron Transportation, Inc., January 2016. Levels of service for signalized intersections were calculated using the Synchro 9.1 methodology. The all-way stop intersection level of service was determined using the 2010 HCM methodology.*

1. *Level of service.*
2. *Average seconds of delay per vehicle.*
3. *All-way stop controlled intersection*

Table 13. Level of Service Summary - Future Conditions with All Alternatives – PM Peak Hour

| | No Action Alternative | | With T-5 Improvements | |
|---|---|---|---|---|
| Signalized Intersections | LOS[1] | Delay[2] | LOS | Delay |
| YEAR 2020 | No Action (647,000 TEUs/Yr) | | | |
| SW Spokane St / Harbor Ave SW | C | 21.5 | | |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | F | 121.4 | | |
| SW Spokane St / Terminal 5 Access | B | 17.5 | | |
| SW Spokane St / 11th Avenue SW | A | 4.8 | | |
| S Spokane St / East Marginal Way S | C | 26.2 | | |
| S Hanford St / East Marginal Way S | C | 30.6 | | |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 12.9 | | |
| YEAR 2030 | No Action (647,000 TEUs/Yr) | | With 1.3 Million TEUs/Year | |
| SW Spokane St / Harbor Ave SW | D | 34.6 | D | 38.3 |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | F | 188.3 | F | 199.0 |
| SW Spokane St / Terminal 5 Access | C | 24.3 | C | 32.3 |
| SW Spokane St / 11th Avenue SW | A | 6.5 | A | 7.2 |
| S Spokane St / East Marginal Way S | E | 56.8 | E | 57.0 |
| S Hanford St / East Marginal Way S | D | 42.6 | D | 42.6 |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 15.1 | B | 15.2 |
| YEAR 2040 | No Action (647,000 TEUs/Yr) | | With 1.7 Million TEUs/Year | |
| SW Spokane St / Harbor Ave SW | D | 49.0 | D | 42.8 |
| SW Spokane St / West Marginal Way SW / Chelan Ave SW | F | 277.4 | F | 291.3 |
| SW Spokane St / Terminal 5 Access | D | 40.4 | D | 50.0 |
| SW Spokane St / 11th Avenue SW | A | 8.8 | A | 9.6 |
| S Spokane St / East Marginal Way S | E | 65.5 | E | 65.8 |
| S Hanford St / East Marginal Way S | E | 79.8 | F | 81.2 |
| East Marginal Way NB Ramp / North Argo Access Road [3] | B | 18.7 | B | 18.8 |

*Source: Synchro model developed by Concord Engineering and Heffron Transportation, Inc., August 2016. Levels of service for signalized intersections were calculated using the Synchro 9.1 methodology. The all-way stop intersection level of service was determined using the 2010 HCM methodology.*

1. *Level of service.*
2. *Average seconds of delay per vehicle.*
3. *All-way stop controlled intersection*

## 5.3. Gate Queue Analysis

This section details the methodology used to estimate queue lengths at the Terminal 5 inbound truck gate. This queuing analysis was performed to determine the number of gate lanes or service check points that may be required to accommodate the peak truck queue and prevent it from backing up to SW Spokane Street. There are two elements of the gate system that could cause truck queuing off of the terminal:

- **Pre-check** – This is where truck drivers must show security identification in order to access the terminal. The analysis was used to determine whether the existing single checkpoint would suffice or whether two check points would be needed under certain circumstances.

- **Main Gate –** Terminal 5's main gate operates with a "kitchen counter" system meaning that remote clerks can serve multiple lanes. There are 14 inbound truck lanes (13 queue lanes and one bypass lane) in advance of the gate, but trucks are usually only allowed to queue in lanes that correspond to an open gate. To be conservative, the analysis was performed assuming that only eight of the gate lanes and corresponding truck queue lanes would be used for the improved terminal. If needed, two additional inbound lanes could be opened to address queues.

### 5.3.1. Queue Model and Methodology

For queuing at the pre-check and main truck gate, a **M/M/s** model was applied. The M/M/s label refers to the key input elements of the queuing model. The first "M" is the symbol that defines an exponential distribution of inter-arrival times (times between each vehicle arrival at the transfer station) known as "Markovian." This distribution of arrivals is also described as a Poisson distribution. The second "M," also refers to an exponential distribution, but applies to service times in the queuing system. This assumption implies that the transaction times for each truck will vary and will also follow an exponential pattern. For example, many of the service times are expected to be less than the average, but will occasionally be much longer (e.g., a truck driver that cannot find or does not have the proper identification). It is important to note that the assumption that service times are exponentially distributed implies a somewhat large amount of variability and reflects a worst-case condition. Finally, the "s" label in the queuing model description refers to the number of service points. For the inbound flows at the pre-check gate, the model tested both a single and a double service point. For the main truck gate, the model tested queues assuming that 8 of the existing 13 service lanes would be used to process inbound truck movements.

Truck trips generated for each of the three alternatives, and previously described in Section 4 were used for this analysis. Inbound trips for each hour of the day were determined using the arrival rates shown on Figure 15. As previously described, a second gate shift is expected to be added for Alternative 3. However, for the purpose of understanding the resiliency of the gate, that alternative was evaluated for both a single shift and double shift condition.

### 5.3.2. Service Rates

#### Pre-Check Gate

Service rates for the pre-check gate were determined from observations at the Terminal 18 gate in 2012. The service rate was measured as the time between consecutive trucks arriving at the pre-check gate, with 66 arrivals observed during the morning peak period. The service times ranged from 6.4 seconds to 26.9 seconds with an average service time of 17.7 seconds.

If two pre-check lanes are provided, they could either be serviced by one or two security guards. It was assumed that if one guard has to serve both lanes, the service rate per truck would increase by about 5 seconds (to 22.7 seconds per truck) to account for additional time needed for the guard to move between the gate lanes. If a second guard is added, the average service time is assumed to remain at 17.7 seconds per truck per lane.

### Main Gate

Service rates for the main gate were assumed to be 1.2 minutes (72 seconds) per truck. This rate is based on information provided by SSA Marine when Terminal 30 was being reactivated as a container terminal with a new truck gate.[35] The existing gate has 14 storage lanes; however, only 8 of those lanes were assumed to be used for inbound storage. Those 8 lanes have a capacity to hold 80 to 90 trucks. This configuration was assumed for the No Action and Alternative 2 conditions.

Alternative 3 would replace the existing gate. The proposed gate would have a similar capacity to the existing gate, with 80 to 90 trucks.

## 5.3.3. Queue Analysis Results

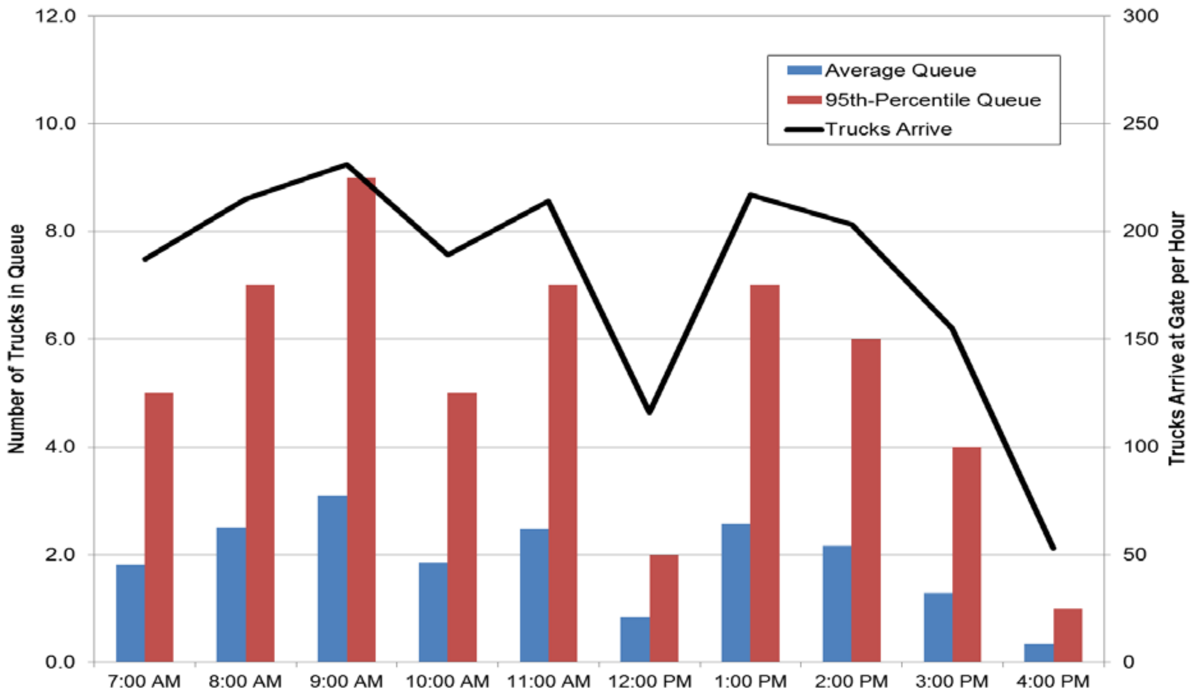
### Pre-Check Gate

The analysis determined that the pre-check gate is the constraint in the system. Currently, the pre-check gate facility is located about 1,900 feet from SW Spokane Street. This distance is estimated to accommodate about 24 trucks, assuming an average of 80 feet per truck, which allows extra space given that this queue is continually moving. A single-lane gate with one security guard could accommodate hourly volumes up to about 180 trucks per hour before the truck queue would extend to SW Spokane Street. With two gate lanes for trucks, a single guard could accommodate hourly volumes up to about 280 trucks per hour. Beyond that volume, two security guards would be needed, one for each lane. To reduce the potential that queues would reach SW Spokane Street, it is recommended that Terminal 5 provide two pre-check gate lanes, and that the pre-check gate open at least 30 minutes before the main gate to accommodate early-arriving trucks. As noted below, the main gate would need to open one hour early on days when more than 1,500 truck arrivals are expected, in which case the pre-check gate hours would also need to open one-hour earlier than a typical day. The analysis also determined that the pre-check gate(s) would need to remain open for the entire workday (i.e., a security guard would staff the pre-check gate during morning, lunch, and afternoon breaks).

Queues by time of day for the Alternative 2 Design Day were determined using the queue model with two pre-check gates and a single security guard, shown on Figure 29. The average and 95$^{th}$-percentile queues were evaluated, the latter is defined as the queue length that could be exceeded for 5% of the evaluated peak hour and is typically the basis used for facility design. Under this operating condition, the 95$^{th}$-percentile queue length is estimated to be 9 trucks, and would occur during the 9:00 A.M. hour.

[35] Heffron Transportation, Inc. *Transportation Technical Report for Terminal 30 Cargo Reactivation*, September 18, 2006.

Figure 29. Queues at Pre-Check Gate for Alternative 2 – Design Day




*Source: Heffron Transportation, Inc., January 2016. Assumes two pre-check lanes with one security guard*

Arrivals that exceed 330 trucks per hour could create queues that extend to Spokane Street. That relates to a daily volume of about 2,700 trucks entering the gate per day, which is 50% higher than Alternative 2 Design Day Volume. (It is noted that trucks entering the terminal are one-half of the total daily trips generated, which includes both entering and exiting trucks.) The pre-check gate should open one-hour earlier than normal on days when the entering truck volume is expected to exceed 1,500 trucks to reduce the potential for queues to extend onto SW Spokane Street.

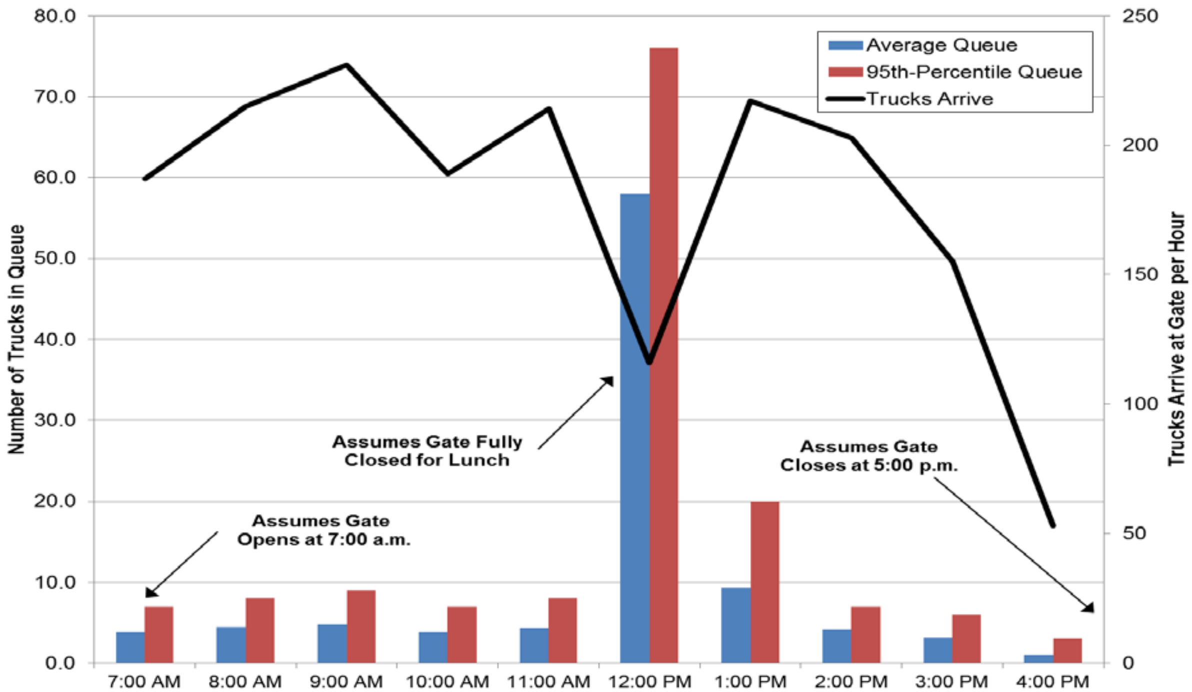
As previously described, if RMGs are installed within the terminal (Alternative 3), the number of trucks that can be served by the terminal's yard equipment would be constrained. Under that condition a second gate shift and a reservation system would be needed to meter the number of trucks that enter the terminal during each hour. Therefore, although the Design Day volumes would be higher for Alternative 3, hourly queues are expected to be lower.

Recommended physical features and operating protocols for the pre-check gate are described in the *Mitigation* section later in this report.

## Main Gate

This analysis assumes that 8 of the existing 13 gate lanes would be used for inbound trucks, and would have a total queue capacity of 80 to 90 trucks. The analysis determined that the main gate would need to open one hour early (at 7:00 A.M.) when daily volumes are expected to exceed 1,500 trucks entering the terminal per day. The model also assumed that the gate would be closed during the one-hour lunch break. Figure 30 shows the Design Day queue by hour for Alternative 2 at the main gate. As shown, with the early gate hours, the main gate would accommodate the Alternative 2 Design Day volumes. The peak queue is expected to occur during the noon hour due to the lunch-time closure. However, the queued trucks would be accommodated by the available storage space and no overflow is expected.

Figure 30. Queues at Main Gate With Lunch Break




*Source: Heffron Transportation, Inc., February 2015. Assumes 8 entry lanes and "kitchen counter" system. Gate would be closed during one-hour lunch break.*

## Incidents that Affect Gate Operations

It is recognized that incidents and labor conditions can affect gate operations and queuing conditions. In the past, computer malfunctions have occurred that either dramatically slow processing times or cease processing altogether. Labor issues have also affected gate processing. Protocols to manage the queue should be established if such conditions were to occur in the future. Operational protocols could include:

- Open up additional queuing space at the main terminal gate to process trucks through the pre-check lane.
- Notify truck drivers and dispatchers (using radio, cell phone and/or internet communications) to avoid Terminal 5 until the queue has cleared.
- Notify SDOT and WSDOT traffic operations personnel about closures, so that messages alerting drivers can be posted on select Dynamic Message signs along travel routes to the terminal.
- Pay the cost of locating a Police Officer at the intersection of SW Spokane Street and the Terminal 5 ramp to redirect truck traffic and prevent the queue from blocking through-traffic on SW Spokane Street.

It is recommended that the Port of Seattle and NWSA develop a Gate Queue Management Plan that defines the terminal operator's responsibilities related to gate infrastructure and operating protocols to prevent the truck queue from extending to SW Spokane Street. The Plan is presented in the *Mitigation* section later in this report.

## 5.4. Traffic Safety

Increased throughput at the terminal would add traffic to the surrounding street network, which could increase the potential for conflicts. Historic collision data for the study area do not indicate any unusual safety issues, and the data include truck traffic generated by the existing terminal along the same travel routes that will be used in the future. Therefore, the Terminal 5 improvements are not expected to adversely affect safety on the roadway network.

Increased throughput could increase the number of train crossings of West Marginal Way SW. The *Mitigation* measures section later in this report recommends that the north leg of the SW Spokane Street/West Marginal Way SW/Chelan Avenue SW intersection be closed to all but emergency vehicle traffic with Alternative 2 or 3. This would eliminate the potential conflict at this intersection.

## 5.5. Rail

The No Action Alternative is estimated to generate about 9 trains during a peak week; Alternative 2 is expected to generate up to 18 trains in a peak week, and Alternative 3 is expected to generate 24 trains in a peak week. Each train would typically be 7,500 feet in length, but could range up to 8,600 feet in length.

As described in the *Mitigation* section of this report, it is recommended that with Alternative 2 or 3 that surface West Marginal Way SW north of SW Spokane Street be closed to all traffic except emergency vehicles. With this change, any additional rail crossing delays created by the increased train activity at this location would be eliminated, and the traffic signal at the five-legged intersection of SW Spokane Street/ West Marginal Way SW/Chelan Avenue SW would no longer need to have a railroad pre-emption phase.

Three existing surface crossings of the Terminal 5 lead tracks, which are located off West Marginal Way SW southeast of the five-legged intersection would experience increased train blockages. This traffic could be accommodated by the Terminal 5 Access Bridge, which crosses over the rail tracks and provides access to Terminals 7A, 7B, and 7C. Measures to improve local business access are also suggested in the *Mitigation* section.

Further analysis of off-terminal rail impacts is described in the *T-5 Rail Infrastructure and Grade-Crossing Analysis* (Moffatt & Nichol, April 2016).

## 5.6. Transit

The proposed project is expected to generate about ten transit trips per day. As discussed in *Section 2.1.5. Future Plans and Policies,* Delridge Way SW has been designated as a high priority bus corridor (with improvements currently being studied as part of the Delridge Way Complete Streets Project) and Sound Transit's ST3 package includes extension of light rail between downtown Seattle and West Seattle, with a station proposed on Delridge Way SW to the south of the West Seattle Bridge. Implementation of these projects would improve transit service for Port employees. Measures to improve pedestrian access between the transit stops/station and Terminal 5 are described in the next section.

## 5.7. Non-Motorized Facilities

Terminal 5 would generate little, if any, pedestrian or bicycle traffic. As described in Section 4.2.4, at peak employment (Alternative 3 during a Design Day), the Terminal 5 project is expected to generate a net increase of 4 pedestrian/bicycle trips (2 in and 2 out) and 10 transit trips (5 in and 5 out) per day. Those who commute by transit would be pedestrian trips between transit stops and the terminal.

The Terminal 5 project would increase train activity across West Marginal Way SW north of SW Spokane Street. The amount of delay associated with each train crossing event would be the same for the No Action Alternative or Alternatives 2 or 3; however, the frequency of movements, and hence the chance for delay, would increase with the project. The delay would affect pedestrians and bicyclists travelling to or from Terminal 5 or businesses at Terminal 7 north of these tracks. As described in the *Mitigation* section of this report, at some point, the duration of total blockage time would likely warrant closing this surface crossing to all traffic except emergency vehicles. While this change would improve overall intersection operations, it would eliminate the pedestrian and bicycle access to Terminal 5. If and when that happens, an alternative pedestrian and bicycle access would need to be provided, which could be a bridge over the tracks, provision of a shuttle, or another measure. It is noted that on-terminal shuttles are typically provided to transport employees from the main office to their post on the terminal, and the route could be extended to pick up employees at off-site locations, including nearby transit stops or the future light rail station.

SDOT recently completed short-term bicycle improvements at and near the five-legged intersection of SW Spokane Street/West Marginal Way SW/Chelan Avenue SW, and is considering additional improvements. Closing West Marginal Way at the railroad crossing would improve conditions for the potential medium-term project with a surface bicycle trail along the east and north side of West Marginal Way SW. If the street crossing is closed, the potential at-grade trail would not need to cross vehicular movements, and bicyclists could flow freely across that leg of the intersection.

The City's potential long-term bicycle improvement proposes to cantilever a new bicycle facility off of the Terminal 5 Access Bridge. It would also add a new pedestrian/bicycle crosswalk on the west side of the SW Spokane Street/Terminal 5 Access intersection. This additional crosswalk would require a pedestrian crossing phase, but it could run concurrent with traffic from the Terminal 5 Access Bridge, and would not affect the overall intersection level of service even with the Terminal 5 improvements and closure of the West Marginal Way SW grade-crossing, which would add more traffic to the intersection. Additional structural analysis and design for the long-term bicycle improvement is necessary to determine the feasibility of cantilevering a bicycle/pedestrian path off the side of the existing Terminal 5 Access Bridge.

There is no "through" bicycle or pedestrian access allowed at Terminal 5. The proposed project is not expected to adversely affect the travel time or safety of pedestrians or bicycles who walk or ride near Terminal 5 since the Terminal 5 Access Bridge is located on the opposite side of the street from the bike trail/sidewalk across the SW Spokane Street Swing Bridge, and the new corner-to-corner bike crossing at the West Marginal Way SW/Chelan Avenue SW/Delridge Way/Spokane Street intersection does not cross concurrently with any of the major movements that serve the terminal's trucks or employees. To the east, the West Seattle Trail crosses SW Spokane Street at 11th Avenue SW, which provides a signalized crossing. While the project would increase truck and employee trips on SW Spokane Street, it would not affect the timing or operation of the bicycle crossing.

## 5.8. Parking

There are currently 481 parking spaces near the Terminal 5 Administration Building, which would remain for Alternative 1 (No Action). Parking would be reduced to 452 spaces with Alternative 2 due to construction of the substation, which would eliminate some parking near the Administration Building. Alternative 3 would reconfigure the yard, buildings, and parking lots. This alternative would have approximately 530 parking spaces.

The number of employees at the terminal on a peak day was detailed previously in Table 7. It is possible that some employees from the day shift would still be parked at the site when employee arrive for the night shift, and the peak parking demand for the terminal would occur during this overlap period. The parking supply described above reflects the potential worst-case condition assuming some overlap. Fewer parking spaces would be needed if the shifts are spread out enough to allow the day shift employees to leave the site before the night shift employees arrive. The parking supply will be refined once the terminal has a tenant and the actual shift times are known.

The proposed Terminal 5 project would increase the number of daily truck trips generated by the terminal, which could increase the number of trucks that serve the port and the potential truck parking demand. However, trucks that serve Terminal 5 also serve other terminals, including those in Tacoma, and are related to the peak loads of the cumulative NSWA terminals. Therefore, it is not possible to isolate the truck parking demand that would be associated with Terminal 5 alone. The Port of Seattle has partnered with the City of Seattle to reduce truck parking in Georgetown and South Park with measures describe previously in Section 0. The Port would continue to distribute outreach materials developed by the City of Seattle, including a map that indicates areas where truck parking and overnight parking is prohibited, to truck drivers who serve Terminal 5.

## 5.9. Transportation Concurrency

The City of Seattle developed a Transportation Concurrency policy as part of its *Comprehensive Plan* (City of Seattle, 1994). The Transportation Concurrency was updated with the *Transportation Concurrency Project Review System, Director's Rule 5-2009* (City of Seattle, Effective 4/13/09). Within the transportation concurrency policy, the City has adopted level-of-service standards for 30 screenlines, each of which encompasses one or more arterials in the City. Screenline analysis is a transportation-planning tool that groups key arterials of a transportation network together to measure the operating conditions of a corridor. For example, the Ship Canal functions as a screenline to measure north-south travel north of downtown Seattle. Up to four (4) of the City's screenlines that would be crossed by the greatest number of project trips are reviewed for concurrency.

The City has established a level of service (LOS) standard for each screenline, which is measured by the volume-to-capacity (v/c) ratio. A project would meet the concurrency standard if the v/c ratio with the addition of a proposed project's traffic is lower than or equal to the LOS standard for the screenline. However, if the new v/c ratio is greater than the LOS standard for the screenline, the proposed project would either fail concurrency or be allowed to propose alternative solutions.

Three screenlines were evaluated for this project:

1. Duwamish River between W Seattle Freeway and Spokane Street (Screenline 3.11),
2. South City limit from SR 99 to Airport Way S (Screenline 4.13), and
3. South of Spokane Street from East Marginal Way S to Airport Way S (Screenline 9.12).

The level of service standards and the volume-to-capacity (v/c) ratios are presented in Table 14.

Table 14. Concurrency Analysis for Terminal 5 Alternative 2

| Screenline Number | Location | Direction | 2008 Capacity | 2008 Traffic Count [a] | Project Trips | Total Volume across screenline | With Project v/c ratio [b] | LOS Standard [c] |
|---|---|---|---|---|---|---|---|---|
| 3.11 | Duwamish River | | | | | | | |
| | W Seattle Freeway and | EB | 4,950 | 3,281 | 57 | 3,338 | 0.67 | 1.20 |
| | Spokane Street | WB | 4,950 | 5,712 | 25 | 5,737 | 1.16 | 1.20 |
| 4.13 | South City limit | NB | 11,800 | 3,179 | 1 | 3,180 | 0.27 | 1.00 |
| | SR 99 to Airport Way S | SB | 11,800 | 3,788 | 2 | 3,790 | 0.32 | 1.00 |
| 9.12 | South of Spokane St | | | | | | | |
| | E Marginal Way to | NB | 9,600 | 5,138 | 0 | 5,138 | 0.54 | 1.00 |
| | Airport Way S | SB | 9,600 | 6,194 | 7 | 6,201 | 0.65 | 1.00 |

*Source: City of Seattle DPD Director's Rule 5-2009, Approved 4/10/09. Attachment C.*

*a Data reflect most recent official measurement of screenline volumes and capacities from 2008. Reflect PM peak hour volumes.*

*b v/c = volume-to-capacity ratio. It equals the 2008 traffic count+ project trips, divided by the 2008 capacity.*

*c Level of service standard, reported as a v/c ratio, which was established by the City of Seattle Ordinance #117383.*

The analysis shows that the v/c ratios for all screenlines would be less than the LOS standards; therefore, transportation concurrency would be met for the project. It should be noted, Screenline 3.11 in the westbound direction is approaching its LOS threshold standard. It is also noted that the City is in the process of updating its Concurrency process to account for multiple transportation modes.

# 6. MITIGATION

## 6.1. During Terminal Construction

No transportation or parking impacts are expected from construction of the Terminal 5 pier improvements or deepening the berth. The terminal would generate fewer truck and employee trips during the construction period than the No Action operations would generate.

Prior to beginning construction work that could impact SDOT right-of-way; the contractor would be required to submit the following information to SDOT for review and approval of necessary permits:

- Haul Route Plan; and
- Traffic Control Plan for work on or adjacent to an arterial street.

In addition, the Port and NWSA would commit to being part of SDOT's ongoing construction coordination program to ensure coordination of project timelines, construction sequencing, traffic control plans and construction staging with other projects with overlapping construction timelines. The Port would also be part of any coordination program established by Sound Transit if it proceeds with construction of the light rail line to West Seattle and a new station at Delridge.

## 6.2. Long-term Mitigation with Terminal 5 Improvements

The following describes measures recommended to mitigate the long-term transportation impacts of the proposed Terminal 5 Improvements. This includes both infrastructure improvements as well as operational protocols.

### 6.2.1. Off-site Intersection Improvements

**Intersection of SW Spokane Street/West Marginal Way/Chelan Avenue SW.** The analysis determined that increased vehicular traffic associated with either Alternative 2 or 3 would adversely affect operations at the five-legged intersection of SW Spokane Street/West Marginal Way SW/Chelan Avenue SW. In addition, increased train crossings of surface West Marginal Way SW, which is the north leg of this intersection, would exacerbate delay and congestion by increasing the number of signal preemptions of the intersection. Ultimately, when the terminal generates a high volume of trains (12 to 15 per week), it is recommended that the north leg of the intersection (West Marginal Way) be closed to all vehicular traffic except emergency vehicles. All traffic to and from Terminal 5, as well as local businesses at Terminal 7A, 7B, and 7C would then be directed to use the Terminal 5 Access Bridge, which has capacity to accommodate this diverted traffic.

In the interim, other measures should be considered to improve operations. One alternative would be to convert the north leg of the five-legged intersection into a one-way northbound roadway and eliminate the ability to exit at this location. That would eliminate the signal phase associated with outbound movements. Advance signage notifying drivers on northbound West Marginal Way to use left lane if the crossing is blocked by a train would be re-installed (see *Driver Information System Improvements* below). In addition, several measures are proposed to improve local access to businesses at Terminal 7 (see *Local Access Improvements* below). The Port should work with SDOT to determine the most desirable configuration for the five-way intersection and triggers for implementation.

**Signal Upgrades on Spokane Street Corridor.** With the closure of the north leg of the five-legged intersection (described above), the traffic signal operation and pre-emption protocols for that intersection would change. Railroad pre-emption would no longer be required when a train crosses the north leg of the intersection. Signal timing changes should also be made at the intersections of SW Spokane Street/Harbor Avenue SW and S Hanford Street/East Marginal Way to accommodate future background traffic growth. In addition, the manner in which signals operate following an opening of the lower Spokane Street Swing Bridge should be updated. Therefore, it is recommended that a comprehensive signal improvement project for the Spokane Street corridor be implemented as part of the Terminal 5 project that would reprogram signals along Spokane Street from Harbor Avenue SW to East Marginal Way S, and include the signal at East Marginal Way/S Hanford Street. This project should include upgrading the signal controller at the five-legged intersection and improving interconnection equipment, if needed. These upgrades are consistent with recommendations in the City's *Freight Access Project* and *Freight Master Plan* described previously in Section 2.1.5.

### 6.2.2. Driver Information System Improvements

The Port should improve systems that provide information to drivers. This includes:

- Replacing the Flashing Alert Sign located on northbound West Marginal Way that notifies motorists approaching Terminal 5 (and local businesses) that the railroad tracks are blocked by a train. This would allow them time to move from the right turn lane to the left turn lane so they can access the terminal and local businesses via the Terminal 5 Access Bridge. (It is noted that the foundation and conduit for the sign still exist, but the sign was damaged by a collision and removed.) The alert sign should be maintained until the surface access via W Marginal Way is closed to vehicular traffic.

- Connecting Terminal 5 to the NWSA's *Gate Wait Time Awareness System* or a similar system, which provides real-time information to truck drivers and dispatchers about the time it will take to get through a terminal gate and the terminal.

### 6.2.3. Local Business Access and Pedestrian Access

To improve access for local businesses at Terminal 7, the Port should:

- Reconfigure the Terminal 5 Access Bridge (if approved by SDOT and the Seattle Fire Department) to provide two inbound (westbound) lanes, with one of the lanes being signed for Terminal 5 only and the other being striped and signed for "Right Turn Only" onto 26th Avenue SW in order to provide a bypass lane for local businesses.

- Work with the Terminal 7 businesses to re-establish lane striping and No Parking signage to maintain the surface route that connects to West Marginal Way at the south end of Terminal 7 (near the West Seattle Bridge abutments).

- Work with the tenant to allow trucks from Terminal 7 to enter the Terminal 5 queue line from 26th Avenue SW. In the past, these locally-generated trucks were required to exit the terminal via the surface route and re-enter the queue line via the Terminal 5 Access Bridge.

If the surface access to Terminal 5 at West Marginal Way S is closed as described in Section 6.2.1, an alternative pedestrian and bicycle access should be provided, which could be a bridge over the tracks, provision of a shuttle, or other measure.

### 6.2.4. Gate Queue Management Plan

Increased truck traffic associated with Alternative 2 and 3 would require improvements and operational protocols at the truck gates. A *Gate Queue Management Plan* has been developed for Terminal 5, and is presented in Appendix B of this report. The plan identifies various elements that would be implemented to reduce the potential for truck queues to reach SW Spokane Street. It includes detail related to gate infrastructure, gate operations, incident management, monitoring, and remedies. The NWSA and Port of Seattle would make the terminal operator responsible for managing the queue.

Three key elements of the plan relate to the infrastructure that should be provided at the gate, the operating protocols that should then be implemented for various throughput conditions, and protocols if there is an incident or event that closes the gate or reduces its capacity. These are outlined below.

#### Gate Infrastructure

If the existing Terminal 5 Main Gate and queue storage capacity remains, then the following infrastructure will be provided at and approaching the Terminal 5 inbound gate prior to terminal occupancy and operation.

- Retain the Main Gate with at least eight (8) inbound truck lanes and storage for at least 80 trucks (total for all lanes).
- Reconfigure the Terminal 5 Access Bridge (if approved by SDOT and the Seattle Fire Department) to provide two inbound (westbound) lanes and one outbound (eastbound) lane. The southernmost inbound lane should be striped and signed for "Terminal 5 Access Only" and the northernmost inbound lane should be striped for "Right Turn Only" to provide for local access to local businesses and warehouses.
- Provide two inbound pre-check (TWIC security check) lanes entering Terminal 5 with a minimum storage length for two trucks each (150 feet) between the checkpoint and 26th Avenue SW (the road at the west end of the Terminal 5 Access Bridge).
- Provide a single security booth with foot access to each of the inbound pre-check lanes.
- Provide gate processing technologies, including equipment identification, to reduce gate transaction times. Equipment identification should occur at a location that does not affect the ability to queue at the main gate prior to opening.
- Terminal shall be connected to the NWSA's Wait Time Awareness System or similar application that distributes information about gate and terminal wait times to truck drivers and dispatchers through a mobile phone application or web-based interface.
- Maintain and/or update the existing video equipment (or replacement technology) that provides real-time view of Terminal 5 queue lengths.

If the Terminal 5 Main Gate and Security Gate are relocated to extend the queue storage capacity, then the first four elements above may be altered or eliminated as requirements based on the capacity provided. The required features would be coordinated with SDOT and SDCI staff as part of the permit process for the new gate structures.

### Gate Management Protocols

The terminal operator would operate the pre-check and main gate in a manner to prevent the truck queue from extending onto SW Spokane Street. The operation is expected to change daily based on the expected gate volume. The following lists a menu of potential operations that could be implemented to reduce the potential queue:

- Open the pre-check gate at least 30 minutes prior to main gate opening and allow trucks to queue at the main gate. On days when the daily throughput is expected to generate more than 1,500 inbound truck moves, the pre-check gate may need to be opened 1 hour prior to opening the main gate unless other flow management strategies are implemented.
- Keep the pre-check gate open and staffed during morning, lunch, and afternoon break periods.
- Provide a second security guard at the inbound pre-check lanes.
- Extend main gate hours for specific customers.
- Extend main gate hours for all movements.

### Protocols during Gate Incidents/Events

It is recognized that incidents or events could occur that could reduce capacity of the gate or close it altogether. Under such conditions, the terminal operator would:

- Open up additional queuing space at the main terminal gate to process trucks through the pre-check lane.
- Notify truck drivers and dispatchers (using radio, cell phone and/or internet communications) to avoid Terminal 5 until the queue has cleared.
- Notify SDOT and WSDOT traffic operations personnel about closures, so that messages alerting drivers can be posted on select Dynamic Message signs along travel routes to the terminal.
- Pay the cost of locating a police officer at the intersection of SW Spokane Street and the Terminal 5 ramp to redirect truck traffic and prevent the queue from blocking through-traffic on SW Spokane Street.

In addition, the NWSA would monitor gate queue conditions and issue a bi-annual report. If queues do extend onto SW Spokane Street, the plan prescribes remedy and enforcement actions that could be taken against the terminal operator.

## 6.2.5. Truck Parking

The Port of Seattle and NWSA should continue to work with the City of Seattle to develop brochures and web-based information related to truck parking, and distribute the information to truck drivers who serve Terminal 5. The materials should include a map of the Sodo, Georgetown, South Park and Delridge neighborhoods, show where truck parking and overnight parking is prohibited, and provide information about off-street parking locations.

# APPENDIX A

# LEVEL OF SERVICE DEFINITIONS

Levels of service (LOS) are qualitative descriptions of traffic operating conditions. These levels of service are designated with letters ranging from LOS A, which is indicative of good operating conditions with little or no delay, to LOS F, which is indicative of stop-and-go conditions with frequent and lengthy delays. Levels of service for this analysis were developed using procedures presented in the *Highway Capacity Manual* (Transportation Research Board, 2010).

Level of service for signalized intersections is defined in terms of delay. Delay can be a cause of driver discomfort, frustration, inefficient fuel consumption, and lost travel time. Specifically, level of service criteria are stated in terms of the average delay per vehicle in seconds. Delay is a complex measure and is dependent on a number of variables including: the quality of progression, cycle length, green ratio, and a volume-to-capacity ratio for the lane group or approach in question. Table B-1 shows the level of service criteria for signalized intersections from the *Highway Capacity Manual*.

Table B-1. Level of Service Criteria

| Level of Service | Average Delay Per Vehicle | General Description |
|---|---|---|
| A | Less than 10.0 Seconds | Free flow |
| B | 10.1 to 20.0 seconds | Stable flow (slight delays) |
| C | 20.1 to 35.0 seconds | Stable flow (acceptable delays) |
| D | 35.1 to 55.0 seconds | Approaching unstable flow (tolerable delay—occasionally wait through more than one signal cycle before proceeding. |
| E | 55.1 to 80.0 seconds | Unstable flow (approaching intolerable delay) |
| F | Greater than 80.0 seconds | Forced flow (jammed) |

*Source: Transportation Research Board, Highway Capacity Manual, 2010.*

For unsignalized two-way-stop-controlled, all-way-stop-controlled, and roundabout intersections, level of service is based on the average delay per vehicle. The level of service for a two-way, stop-controlled intersection is determined by the computed or measured control delay and is defined for each minor movement. Delay is related to the availability of gaps in the main street's traffic flow, and the ability of a driver to enter or pass through those gaps. The delay at an all-way, stop-sign (AWSC) controlled intersection is based on saturation headways, departure headways, and service times. Delay at roundabouts is based on entry flow rates and flow rate capacity. Table B-2 shows the level of service criteria for unsignalized intersections from the *Highway Capacity Manual*.

Table B-2. Level of Service Criteria for Unsignalized Intersections

| Level of Service | Average Delay (seconds per vehicle) |
|---|---|
| A | Less than 10.0 |
| B | 10.1 to 15.0 |
| C | 15.1 to 25.0 |
| D | 25.1 to 35.0 |
| E | 35.1 to 50.0 |
| F | Greater than 50.0 |

*Source: Transportation Research Board, Highway Capacity Manual, 2010.*

# APPENDIX B

# GATE QUEUE MANAGEMENT PLAN

# Terminal 5
# Gate Queue Management Plan

## A. Purpose

The Northwest Seaport Alliance (NWSA), the Port Development Authority responsible for managing marine cargo facilities within the Puget Sound gateway including the planned re-opening of Terminal 5 within the North Harbor (Seattle), will require that the Terminal Operator (lessee) for Terminal 5 implement measures to avoid, reduce, and manage queues at the inbound terminal gate. The intent of these measures is to prevent truck queues from extending onto SW Spokane Street.

## B. Gate Infrastructure

If the existing Terminal 5 Main Gate and queue storage capacity remains, then the following infrastructure will be provided at and approaching the Terminal 5 inbound gate prior to terminal occupancy and operation.

1. Retain the Main Gate with at least eight (8) inbound truck lanes and storage for at least 80 trucks (total for all lanes).

2. Reconfigure the Terminal 5 Access Bridge (if approved by the Seattle Department of Transportation [SDOT] and the Seattle Fire Department) to provide two inbound (westbound) lanes and one outbound (eastbound) lane. The southernmost inbound lane should be striped and signed for “Terminal 5 Access Only” and the northernmost inbound lane should be striped for “Right Turn Only” to provide for local access to local businesses and warehouses.

3. Provide two inbound pre-check (Transportation Worker Identification Credential [TWIC] security check) lanes entering Terminal 5 with a minimum storage length for two trucks each (150 feet) between the checkpoint and 26$^{th}$ Avenue SW (the road at the west end of the Terminal 5 Access Bridge).

4. Provide a single security booth with foot access to each of the inbound pre-check lanes.

5. Provide gate processing technologies, including equipment identification, to reduce gate transaction times. Equipment identification should occur at a location that does not affect the ability to queue at the main gate prior to opening.

6. Terminal shall be connected to the NWSA’s *Wait Time Awareness System* or similar application that distributes information about gate and terminal wait times to truck drivers and dispatchers through a mobile phone application or web-based interface.

7. Maintain and/or update the existing video equipment (or replacement technology) that provides real-time view of Terminal 5 queue lengths.

If the Terminal 5 Main Gate and Security Gate are relocated to extend the queue storage capacity, then Elements B1 through B4 above may be altered or eliminated as requirements based on the capacity provided. The required features would be coordinated with SDOT and SDCI staff as part of the permit process for the new gate structures.

## C. Gate Management Protocols

The terminal operator shall operate the pre-check and main gate in a manner to prevent the truck queue from extending onto SW Spokane Street. The operation is expected to change daily based on the expected gate volume. The following lists a menu of potential operations that could be implemented to reduce the potential queue:

1. Open the pre-check gate at least 30 minutes prior to main gate opening and allow trucks to queue at the main gate. On days when the daily throughput is expected to generate more than 1,500 inbound truck moves, the pre-check gate may need to be opened 1 hour prior to opening the main gate unless other flow management strategies are implemented.

2. Keep the pre-check gate open and staffed during morning, lunch, and afternoon break periods.

3. Provide a second security guard at the inbound pre-check lanes.

4. Extend main gate hours for specific customers.

5. Extend main gate hours for all movements.

## D. Protocols during Gate Incidents/Events

It is recognized that incidents or events could occur that could reduce capacity of the gate or close it altogether. Under such conditions, the terminal operator shall:

1. Open up additional queuing space at the main terminal gate to process trucks through the pre-check lane.

2. Notify truck drivers and dispatchers (using radio, cell phone and/or internet communications) to avoid Terminal 5 until the queue has cleared.

3. Notify SDOT and Washington State Department of Transportation (WSDOT) traffic operations personnel about closures, so that messages alerting drivers can be posted on select Dynamic Message signs along travel routes to the terminal.

4. Pay the cost of locating a police officer at the intersection of SW Spokane Street and the Terminal 5 ramp to redirect truck traffic and prevent the queue from blocking through-traffic on SW Spokane Street.

## E. Monitoring

The NWSA shall perform bi-annual monitoring of the Terminal 5 gate volumes and queue conditions. The monitoring shall be performed in the 3$^{rd}$ Quarter (July 1 to September 30) and evaluate the following metrics:

1. Inbound truck volumes by day for at least a one-month period;
2. Hourly truck volumes for at least a one-week period;
3. Peak truck queues by time of day for at least a one-week period; and
4. Operational measures that were in effect during the queue survey period, including at a minimum operating hours for pre-check and main gate, number of security guards at the pre-check gate, number of clerks at the main gate, and description of gate processing technology used.

The information above will be compiled into a report that would be publically available.

## F. Remedy and Enforcement

If the truck queue extends onto SW Spokane Street, which shall be defined as one truck that moves less than 30 feet in a five-minute period due to a truck blockage that emanates from the pre-check or the main gate, then the terminal operator shall implement additional measures to ameliorate the gate queue. These could include:

1. Implement truck flow management system to reduce the truck movements during the peak periods.
2. Pay the cost of locating traffic control personnel at the intersection of SW Spokane Street and the Terminal 5 ramp to redirect truck traffic and prevent the queue from blocking through traffic on SW Spokane Street.
3. Participate in a working group that includes representatives from the NWSA, Port of Seattle, and Seattle Department of Transportation to evaluate queue solutions.
4. Perform the monitoring prescribed in Section E up to three additional times in a two-year period.

If the queue length continues to extend onto SW Spokane Street, then the terminal operator would be responsible for any City enforcement action including civil penalties as provided by the SMC 23.90.018.