heffron transportation, inc.

# TECHNICAL MEMORANDUM

To: Wastewater Treatment Division, King County

From: Jennifer Barnes, P.E. JAB
Tod McBryan, P.E.
Heffron Transportation, Inc.

Project: Lower Duwamish Waterway Cleanup Project

Subject: Truck Trip Analysis

Date: January 10, 2014

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The Environmental Protection Agency's (EPA's) *Lower Duwamish Waterway Feasibility Study* evaluated cleanup alternative effects from construction in a way that allowed direct comparisons between alternatives. That analysis used one simplifying set of assumptions for construction-related transportation. King County wanted to look at a range of possible transportation alternatives to allow for a more informed discussion of potential project impacts with the affected community. This memorandum summarizes transportation estimates associated with that range of potential transportation options for the Lower Duwamish Waterway (LDW) Cleanup Project. It includes a description of three cleanup alternatives and three transport scenarios. For this analysis, we have developed estimates of average daily and hourly truck trips under three transport and transload facility scenarios, and identified the potential future truck haul routes to which those trips could be added. This analysis of potential transport impacts is intended for discussion only and does not constitute recommendations. It is anticipated that a much more detailed analysis of transport alternatives and impacts would be prepared as part of preliminary design and environmental review.

## 1. Description of Cleanup Alternatives and Transport Options

Cleanup alternatives analyzed comprise a combination of cleanup activities including enhanced natural recovery, capping, and dredging. Of these activities, dredging triggers the highest need for transport, as loads of excavated material would need to be hauled away from the site for disposal at a landfill. Three cleanup alternatives that would result in varying amounts of dredged sediment needing to be transported for disposal are summarized in Table 1. The three alternatives were chosen to help bracket and illustrate the range of potential transport impacts. The Key Elements Alternative has the lowest amount of dredging and transport, the EPA Proposed Alternative has a somewhat higher amount, and the Mostly Dredging (5R) Alternative has the highest amount.

The EPA's feasibility study analysis used the same daily rate of dredging (and number of trucks per day) for all cleanup alternatives. The difference in traffic impact between the cleanup alternatives is therefore the total number of days (and years) over which the dredging and hauling would take place. The cleanup alternatives considered in this transport analysis range in duration from approximately 5 years to 17 years. Therefore, while the differences in dredged volumes are not expected to significantly affect the number of truck trips generated on a single day, they would affect the number of years over which truck trips would be generated. This is described in more detail later in this memorandum.

Table 1. Summary of Cleanup Alternatives Used in Traffic Analysis

| | Cleanup Actions Considered for Traffic Analysis | | |
|---|---|---|---|
| | Key Elements | EPA Proposed | Mostly Dredging (5R) |
| Cleanup Action Components | | | |
| Enhanced Natural Recovery | 48% | 31% | 0% |
| Capping | 25% | 28% | 9% |
| Dredging | 27% | 41% | 91% |
| Estimated Dredged Volume (cubic yards) | 620,000 | 790,000 | 1,600,000 |
| Estimated Dredged Truck Loads | 33,000 | 42,000 | 86,000 |

*Sources: EPA 2013; LDW FS 2012; LDWG 2012.*

For each cleanup alternative, dredging and removal (transport) of the contaminated waste material can be accomplished in three different ways:

- **Nearshore** – For locations where dredging needs to be accessed from the land, contaminated sediment would be removed using equipment placed near the shore and loaded directly into containers that would be trucked to an offsite facility, where the containers would then be loaded onto a train that would carry the material to a landfill for disposal. Based on the topography and access characteristics of the LDW, the EPA feasibility analysis determined that 22% of the total dredged volume would be removed this way.

- **Transload (Barge-to-Truck)** – Contaminated sediment would be removed using equipment placed on a barge in the LDW. The excavated material would be transferred from barge to a container at a designated transload facility located at the LDW site. A truck would then carry the container to an offsite facility for transfer to rail.

- **Direct-to-Rail** – Contaminated sediment would be removed using equipment placed on a barge in the LDW, and the barge would then carry it directly to a shoreline facility where it would be transferred directly to containers on rail cars. With this option, no truck haul trips would be generated at the direct-to-rail LDW site. (Note, this is also a type of transload operation but for the purpose of this memorandum, in order to differentiate it from the barge-to-truck transload operation described above, it is referred to only as direct-to-rail.)

This analysis focuses on the degree to which each of these transport methods could be used. Note that for purposes of comparison between alternatives, EPA's feasibility analysis defined all dredged material as being trucked since a direct-to-rail facility would not necessarily be available at the time of the project. However, it acknowledged that trucking could be reduced if such facilities were used.

This analysis considers three transport scenarios for each cleanup alternative that would include varying proportions of the removal transportation methods described above. The three transport scenarios are summarized in Table 2. As shown, Transport Scenario A (100% by Trucks) would result in the highest number of truck trips because it would include no direct-to-rail operation and all dredged material would be hauled by truck from the site either as part of nearshore or transload operations. Transport Scenario C (22% by Trucks) represents the lowest percentage of truck usage available due to the use of nearshore operations. Under Scenario C, all other sediment placed onto barges would be direct-to-rail and therefore would not generate truck trips. The number of truck trips resulting from Transport Scenario B (60% by Trucks) was selected to be a middle scenario in-between the other transport scenarios with part of the sediment placed on barges transferred to trucks, and part carried direct-to-rail. This last scenario would occur if a direct–to-rail facility was available to handle part of the sediment dredged daily (based on a current facility's capacity). The resulting estimates of average daily and hourly truck trips are described in the following section.

Table 2. Dredging and Transportation Scenarios [1]

| | Percentage of Operation | | |
|---|---|---|---|
| Dredging and Transportation Operation | Transport Scenario A 100% by Trucks | Transport Scenario B 60% by Trucks | Transport Scenario C 22% by Trucks |
| Nearshore | 22% | 22% | 22% |
| Transload | 78% | 38% | 0% |
| Direct-to-Rail | 0% | 40% | 78% |
| Total | 100% | 100% | 100% |

*Source: King County 2013.*
*1. Applicable to any cleanup alternative.*

## 2. Truck Trip Estimates

In order to estimate the average numbers of daily and hourly truck trips that could result from the three cleanup alternatives with the three dredging and transportation scenarios described above, the following additional parameters defined in EPA's feasibility analysis were assumed for this evaluation:

- **Number of operating days per year** – The expected annual work window for this operation would be October 1 to February 15. This reflects 138 calendar days. After accounting for weekends, holidays and equipment downtime, EPA's analysis used 88 dredging work days within this period. Therefore, depending on how many days per week the transportation would occur, the number of operating days per year is expected to range from 88 to 138. This analysis assumed the hauling would occur concurrently with the dredging over 88 operating days.

- **Number of operating hours per day** – Dredging operations could occur from 12 to 24 hours per day. However, the hours in which truck trips occur could also be constrained by the operating hours of the facility to which they are hauling the dredged loads. The posted service hours for both potential facilities are 7 A.M. to 6 P.M., which would provide an 11-hour transportation window. However, at least one facility indicates that it allows 24-hour access for contracted customers. Therefore, depending on the number of hours in which dredging would occur and the operating hours at the receiving facility, the number of operating hours per day is expected to range from 11 to 24. For purposes of comparison, this analysis assumed the hauling would occur during over the 11 facility operating hours. Actual hauling hours would be subject to permit conditions, receiving facility operations capacity, and other factors that would be determined at the time of construction.

When reviewing truck trip estimates, it is also important to note that hauling of one dredged load from the site would generate two truck trips. An unloaded truck would travel from the rail transfer facility to the transload site in the LDW area, and a truck with a full container would travel from the site to the rail transfer facility.

Table A-1 in Attachment A includes summary tables of trip estimates for the three cleanup alternatives, with each of the three transport scenarios. As shown, Transport Scenario A (100% trucks) is projected to average about 112 truck trips per day (about 11 truck trips per hour). Transport Scenario B (60% trucks) is projected to average about 66 truck trips per day (about 7 truck trips per hour), and Transport Scenario C (22% trucks) is projected to average about 24 truck trips per day (about 3 truck trips per hour).

While the number of trucks per day varies depending on the transport scenarios, the average daily and hourly truck trips for any particular transport scenario are similar for each cleanup alternative (Table A-1). Since the amount dredged each day would be constant, as the total volume dredged increases, the duration of the dredging would also increase. Therefore, the project's total number of truck trips is directly correlated to the dredging volume required to complete the cleanup alternative – regardless of the transport scenario (Table A-2). The shortest duration would occur with the Key Elements Alternative and the longest duration would occur with the Mostly Dredging (5R) Alternative.

Under all transport scenarios, about 24 daily trips (about 3 trips per hour) would be generated by nearshore operations. These trips would travel to and from various locations along the LDW where the localized nearshore dredging would occur. The remaining trips, if any, would be generated by the transload operations, so would travel to and from one or two transload facilities at specific locations.

The trip projections shown in Attachment A reflect the assumptions described above; operations over more days per year and/or hours per day would result in a lower number of trucks per day and per hour. For example, if transload operations stockpiled dredged material and had trucks continuously haul that dredged material more than 11 hours per day or over more than 88 days within the operating window, the average truck trips per hour or day would decrease for the three cleanup alternatives. Note that the total years in which truck trips occur would not change.

At the high end of the estimated range in Table A-1, 11 trips per hour would likely be noticeable to someone living or working adjacent to the transload facility (unless it were a site that already generates a high level of truck traffic), but may not be noticeable farther from the site on the major arterials used to access the site and the rail transfer facility. Traffic counts at key intersections along potential haul routes were conducted to provide additional information about the added increment of truck traffic and its likely impact on traffic operations, described later in this memorandum.

Table A-2 in Attachment A shows the total estimated truck trips projected for each cleanup alternative with each transport scenario over the duration of the project. As shown, the highest total truck trips would occur, about 172,000, with the Mostly Dredging (5R) Alternative under the "100% by Trucks" scenario. The lowest total trucks, about 14,500, would occur with the Key Elements Alternative under the "22% by Trucks" scenario. The other combinations of cleanup alternatives and transport scenarios would have total truck trips that range between those two estimates.

# 3. Potential Truck Haul Routes

Attachment B includes maps (Figures 1 through 5) showing potential truck routes that have been projected based upon potential locations for barge-to-truck transload facilities, the locations where nearshore operations are expected to occur as identified in EPA's feasibility study, and the locations of facilities where material can be transferred from truck to rail for ultimate disposal at a landfill.

Trucks hauling dredged material are expected to travel to and from one of two facilities that can accommodate truck-to-rail transfer of material, both located in south Seattle. These facilities are Republic Services (located at 2733 – 3rd Avenue S) and Waste Management (located at 70 Alaska Street S). Routes to and from each facility are shown on Figures 1 through 5 in Attachment B.

Truck trips generated by transload operation would travel to and from one or two transload facilities, where dredged material would be transferred from barge to containers and loaded onto trucks. The exact location of the transload facility (or facilities) is unknown at this time. Therefore, for the purpose of this analysis and to reflect the range of potential travel routes that could be used by trucks, the County identified four potential locations that could be used for transload activity. Two were identified on the west side of the LDW and two were identified on the east side. The potential west side locations are labeled as W-1 and W-2 on Figures 1 and 2, respectively, and the east side locations are labeled as E-1 and E-2 on Figures 3 and 4, respectively. Of the high-end estimated 11 truck trips per hour projected with Transport Scenario A (100% by trucks), 8 truck trips (4 inbound, 4 outbound) would be generated by transload operations; these trips would travel to and from one selected transload facility or could potentially be split between two transload facilities. The remaining 3 truck trips per hour with Transport Scenario A are projected to be generated by nearshore operations described in the EPA feasibility study. These trips could be generated at one of any of the locations where nearshore cleanup actions are expected to occur, labeled as NS-1 through NS-11 on Figure 5 in Attachment B.

The figures in Attachment B show that the majority of truck haul trips generated by LDW cleanup activities would be expected to occur on principal arterial routes: West Marginal Way, East Marginal Way, the West Seattle Bridge, 1st Avenue S and/or 4th Avenue S. Additionally, more than one viable route utilizing these major roadways exists between most points in the LDW project area and the potential rail transfer facilities. However, to access these major streets from the transload and nearshore loading locations adjacent to the LDW, some trips would likely occur on local streets. The local streets that provide access to the four potential transload sites (where the highest volume of truck trips would originate) are located in industrial areas (some with residences) that already have regular truck and heavy vehicle activity. Similarly, most of the local streets that provide access to the largest nearshore areas that could generate truck trips are in industrial areas (some with residences) with regular truck and heavy vehicle activity.

It should be noted that the analysis of potential routes assumed that the South Park Bridge would be reopened by the time truck trips begin occurring. However, based on the location of the likely transload sites and the areas where nearshore activity is likely to occur, no truck trips are expected to use the South Park Bridge as part of the access route to either of the rail transfer facilities. However, this assumption is dependent on the actual location of nearshore dredging operations.

It should also be noted that all the cleanup alternatives will generate an average of at least 2 trains of dredged material each day, resulting in 4 additional train trips through the area; passing of these trains through at-grade rail crossings would also affect vehicle traffic operations. These traffic effects were not evaluated as part of this study. Trains from the direct-to-rail facilities would need to access the main line and would have to cross more local roads than the trains originating from either of the two truck-to-rail transfer facilities located on the main lines.

# 4. Effect of Additional Truck Trips on Traffic Operations

To determine the potential level of traffic impact that could result from trucks generated by the project, operations at five intersections located along the potential haul routes were evaluated without and with the project-related truck trips. The five intersections, shown in the Attachment C figures and listed in Table 3 below, reflect representative locations along the potential truck haul routes through which truck trips would be expected to travel, depending on the location chosen for the transload facility, the location where a nearshore operation is taking place, and which truck-to-rail transfer facility is used. Conditions were evaluated for year 2018, which would be near the beginning of the construction period.

For the operational analysis, truck trips generated in Transport Scenario A (100% by trucks) were evaluated because they reflect the highest number of trucks that could potentially be generated by the project, and thus would have the highest level of potential impact of the three transport scenarios. Trucks generated with Transport Scenarios B or C would have an even lower effect than the results presented in the sections below. The weekday PM peak hour was evaluated because this is period in which the highest traffic volumes typically occur, so it reflects worst-case traffic operating conditions. It is typical in transportation analysis to evaluate the high end of the range of traffic volumes that could potentially occur without and with the project, in order to determine the worst-case traffic operating conditions that could result. However, it should be noted that at other non-peak times of day, background traffic volumes would be lower, and traffic operating conditions with or without the project would be expected to have lower average vehicle delay than what is presented below.

## 4.1. Intersection Traffic Volumes

Intersection traffic volumes are based upon new PM peak hour turning movement counts that were conducted on Tuesday, November 19, 2013. The count data include a breakdown of how many of the vehicles traveling through the intersection were heavy vehicles (including trucks and buses). Existing traffic volumes at the five study intersections are shown on Figure 6 in Attachment C.

Historical traffic counts conducted by the Seattle Department of Transportation (SDOT) [1] along the potential truck haul routes were reviewed to determine the traffic growth rates that have occurred in the area over the past 5 to 10 years. The data indicated that changes in traffic volumes have been variable. In some locations, traffic has grown with average increases of about 1% per year. In other locations, volumes have declined. Declines in volumes have been common over the past several years as a result of the economic recession. To provide a conservative estimate for future analyses, a 1% compound annual growth rate was applied to the existing counts to estimate 2018 volumes. This growth rate is intended to account for potential increases in traffic that may occur in the area as the economy continues to recover.

Projected PM peak hour traffic volumes are shown in the figures in Attachment C. Figure 7 shows projected 2018 PM peak hour intersection volumes without the proposed project-related truck traffic.

Figure 8 shows the highest average number of truck trips per hour expected to be added to each intersection by the project (with Transport Scenario A, 100% by Trucks). It should be noted that the

[1] Seattle Department of Transportation (SDOT), 2013, Annual Traffic Count Data, 2005 – 2012.

five intersections would not experience project-generated truck trips all at the same time. As described above, the actual truck trips would depend on the location chosen for the transload facility, the location where a nearshore operation is taking place, and which truck-to-rail transfer facility is used. The trips shown on Figure 8 represent the highest average trips per hour expected to potentially occur at any one of the intersections, if the relative locations of the transload operation, nearshore operation, and transfer facility (based upon the haul routes shown in Attachment B) were lined up for maximum usage of the intersection.

To estimate the 2018 "with project" intersection volumes, the project-generated truck trips were added to the "without project" traffic volumes. Figure 9 shows the projected 2018 "with project" PM peak hour intersection volumes.

## 4.2. Percent of Heavy Vehicles

Table 3 shows the percentages of heavy vehicles (trucks and buses) traveling through each intersection under existing conditions, and in 2018 without and with the trucks that would potentially be added by the LDW project. The "2018 without project" percentages are based upon the existing traffic counts that were conducted at the intersections. As shown, intersections along the expected truck haul routes already experience a fairly high level of truck traffic, ranging between 5% and 12% of total vehicles traveling through each intersection during the PM peak hour. This is not unexpected, due to the predominance of industrial development located along the potential truck haul routes. The largest increase in heavy vehicle percentage due to project-related truck trips among the five intersections is projected to occur at the East Marginal Way S/ Carleton Avenue S. At this location, the percentage is estimated to change from 12.0% to 12.7%. This and the other relatively small changes in the heavy-vehicle percentages resulting from the project would not likely be noticeable to drivers.

Table 3. Summary of Heavy Vehicle Percentages – PM Peak Hour

| | Heavy Vehicle Percentage at Intersections [1] | | |
|---|---|---|---|
| Intersection | Existing (2013) | 2018 without Project | 2018 with Project [2] |
| 4th Avenue S / S Spokane Street | 6.5% | 6.5% | 6.9% |
| East Marginal Way S / Diagonal Avenue S | 5.3% | 5.3% | 5.6% |
| 4th Avenue S / S Michigan Street | 6.0% | 6.0% | 6.4% |
| East Marginal Way S / Carleton Avenue S | 12.0% | 12.0% | 12.7% |
| West Marginal Way S / S Holden Street | 8.5% | 8.5% | 8.8% |

*Source: Idax Data Solutions, November 2013; Heffron Transportation, Inc., December 2013.*
*1. Heavy vehicle percentages calculated as total number of trucks entering intersection divided by total entering volume at intersection.*
*2. With-project conditions reflect LDW Cleanup with Transport Scenario A, 100% by Trucks.*

## 4.3. Level of Service

Level of service (LOS) analysis was performed at the study area intersections for the PM peak hour. Level of service 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 and B represent conditions with the lowest amounts of delay, and LOS C and D represent intermediate traffic flow with some delay. LOS E indicates that traffic conditions are at or approaching congested conditions and LOS F indicates that traffic volumes are at a high level of congestion with unstable traffic flow. Level of service for intersections is defined in terms of average delay per vehicle in seconds. The thresholds applied to determine levels of service are described in Attachment D.

Levels of service for the study area intersections were analyzed using methodologies presented in the Highway Capacity Manual.[2] All level of service calculations were performed with Trafficware's *Synchro 8.0* analysis software. Table 4 summarizes the PM peak hour levels of service at the five analysis intersections, for existing conditions, 2018 conditions without the LDW project, and 2018 conditions with the LDW project. As shown, projected background traffic growth is expected to add some average delay at the intersections, but would not change the levels of service compared to existing conditions. Under existing conditions and in the future without the LDW project, the intersection of West Marginal Way/S Holden Street is projected to operate at LOS E, and the other four intersections are projected to operate at LOS B or C. The table shows that the potential addition of the LDW truck trips (average of 11 trucks per hour) would add less than 2 seconds of average delay to each intersection, and would not change the overall levels of service. As described previously, at other non-peak times of day background traffic volumes would be lower, and traffic operating conditions with or without the project would be expected to have lower average vehicle delay than what is presented below. Also, the lower number of truck trips generated with Transport Scenarios B or C would have an even lower effect on average delay than the increases shown in the table. Therefore, the impact of project-generated truck trips on roadway operations is considered to be negligible at all times of day with all three transport scenarios.

Table 4. Level of Service Summary – PM Peak Hour

| | Existing (2013) | | 2018 without Project | | 2018 with Project [3] | |
|---|---|---|---|---|---|---|
| Intersection | LOS [1] | Delay [2] | LOS | Delay | LOS | Delay |
| 4th Avenue S / S Spokane Street | B | 10.5 | B | 10.9 | B | 10.9 |
| East Marginal Way S / Diagonal Avenue S | B | 11.9 | B | 13.8 | B | 13.9 |
| 4th Avenue S / S Michigan Street | C | 31.4 | C | 32.6 | C | 32.8 |
| East Marginal Way S / Carleton Avenue S | B | 10.4 | B | 11.1 | B | 11.6 |
| West Marginal Way S / S Holden Street | E | 59.3 | E | 68.7 | E | 70.5 |

*Source: Heffron Transportation, Inc., December 2013.*
*1. Level of service.*
*2. Average seconds of delay per vehicle.*
*3. With-project conditions reflect LDW Cleanup with Transport Scenario A, 100% by Trucks.*

[2] Transportation Research Board, Highway Capacity Manual, 2010.

## 5. Potential Measures to Reduce Truck Trip Impacts

The addition of truck trips generated by LDW cleanup activities may be noticeable to businesses or residents located along the truck haul routes very close to the transload facility or nearshore operations. The additional truck traffic is not expected to be noticeable at the five analysis intersections and would not substantially affect the overall character of traffic or operations along the roadways or at major intersections. However, the following measures could be considered to further reduce potential truck trip impacts, though the measures would need to be considered in context with other factors such as actual facility locations, potential haul routes, and local train routes that will not be determined until immediately before construction:

- Designate truck haul routes on roadways that have minimal non-industrial development and require drivers to use those routes, to minimize potential impacts to residents or non-industrial businesses in the area. (Note, routes similar to those shown on the Attachment B figures could be designated, to make sure the potential impact to the Southpark and Georgetown neighborhoods is minimized.)

- Allow 24-hour transportation of loaded containers in non-residential areas, resulting in fewer truck trips per hour. (Note, this measure would result in a higher number of truck trips during nighttime and is dependent on the operating hours of the receiving facility.)

- If on-site storage is available, stockpile full containers at the nearshore or transload sites to allow trucks to haul containers on days when no dredging operation is underway, spreading truck trips out over a greater number of days. (Note, this would reduce trips per hour but increase the days over which truck trips occur.)

- Restrict trucks from traveling during weekday peak hours (typically 4:00 to 6:00 P.M.). (Note, this measure would result in a higher number of truck trips during off-peak hours.)

- If trucks would need to travel through unsignalized intersections near the nearshore or transload sites to access the arterial roadway system, resulting in operational impact at the intersections, install temporary signals or provide flaggers to direct traffic.

Attachments:
Attachment A – Truck Trip Calculation Worksheet
Attachment B – Potential Truck Haul Routes
Attachment C – Existing and Projected Future Traffic Volumes
Attachment D – Level of Service Description

JAB/tsm

# ATTACHMENT A

# TRUCK TRIP CALCULATION WORKSHEET

**Dredging Assumptions**

91,989 cubic yards dredged per year
1.5 tons per cubic yard
28 tons per load

**Assumed Duration of Construction Activity**

Nearshore Operation (direct to truck)
88 days of operation per year (October 1 through February 15)
11 hours/day nearshore truck operation

Transload Operation (barge to truck)
88 days of operation per year (October 1 through February 15)
11 hours/day barge-to-truck transload operation

Table A-1. Average Daily and Hourly Truck Trip Estimates - All Cleanup Alternatives

| Scenario | Activity Type [1] | Activity (Percentage of Volume) | Truck Trips Per Day [2] Inbound | Truck Trips Per Day [2] Outbound | Truck Trips Per Day [2] Total | Truck Trips Per Hour [2] Inbound | Truck Trips Per Hour [2] Outbound | Truck Trips Per Hour [2] Total |
|---|---|---|---|---|---|---|---|---|
| A. 100% by Trucks | Nearshore | 22% | 12 | 12 | 24 | 2 | 1 | 3 |
| | Transload | 78% | 44 | 44 | 88 | 4 | 4 | 8 |
| | Direct-to-rail | 0% | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Truck Trips | 100% | 56 | 56 | 112 | 6 | 5 | 11 |
| B. 60% byTrucks | Nearshore | 22% | 12 | 12 | 24 | 2 | 1 | 3 |
| | Transload | 38% | 21 | 21 | 42 | 2 | 2 | 4 |
| | Direct-to-rail | 40% | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Truck Trips | 100% | 33 | 33 | 66 | 4 | 3 | 7 |
| C. 22% by Trucks | Nearshore | 22% | 12 | 12 | 24 | 2 | 1 | 3 |
| | Transload | 0% | 0 | 0 | 0 | 0 | 0 | 0 |
| | Direct-to-rail | 78% | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Truck Trips | 100% | 12 | 12 | 24 | 2 | 1 | 3 |

1. Nearshore - contaminated sediment loaded directly to trucks.
Transload - contaminated sediment loaded from barge to truck at on-site transload facility.
Direct-to-rail - contaminated sediment loaded from barge directly to rail, no truck trips.
2. Average truck trips per day and per hour rounded to whole numbers.

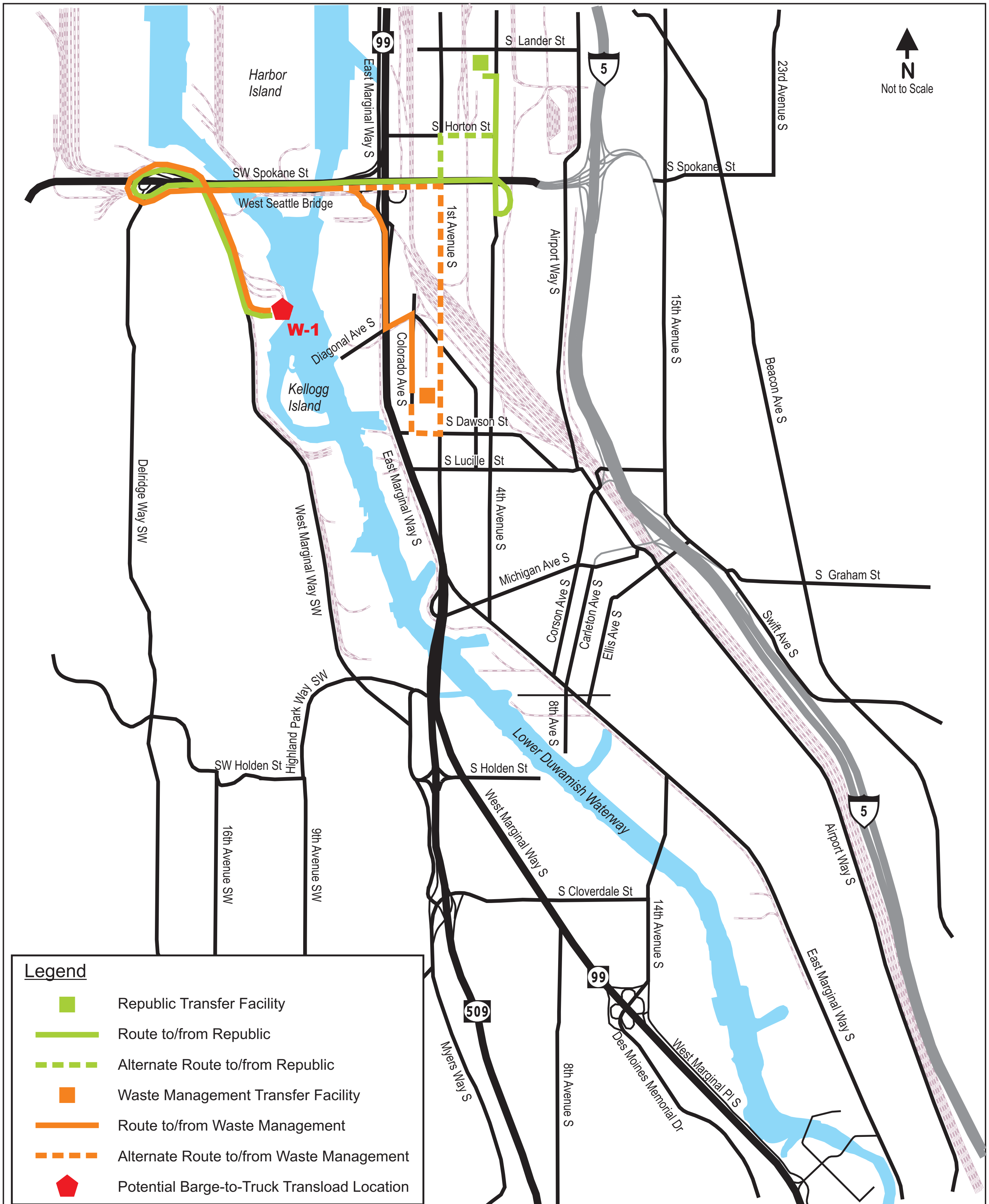
Table A-2. Total Truck Trips Over Duration of Construction - Per Cleanup Alternative

| | Approximate Dredged Volume (cubic yards) | Approximate Number of Dredged Loads | Total Estimated Truck Trips [1] Scenario A 100% by Trucks | Scenario B 60% by Trucks | Scenario C 22% by Trucks |
|---|---|---|---|---|---|
| Alternative 1 - Key Elements | 620,000 | 33,000 | 66,000 | 39,600 | 14,500 |
| Alternative 2 - EPA Proposed | 790,000 | 42,000 | 84,000 | 50,400 | 18,500 |
| Alternative 3 - Most Dredging (5R) | 1,600,000 | 86,000 | 172,000 | 103,200 | 37,800 |

1. Total truck trips rounded to the nearest hundred.

# ATTACHMENT B

# POTENTIAL TRUCK HAUL ROUTES

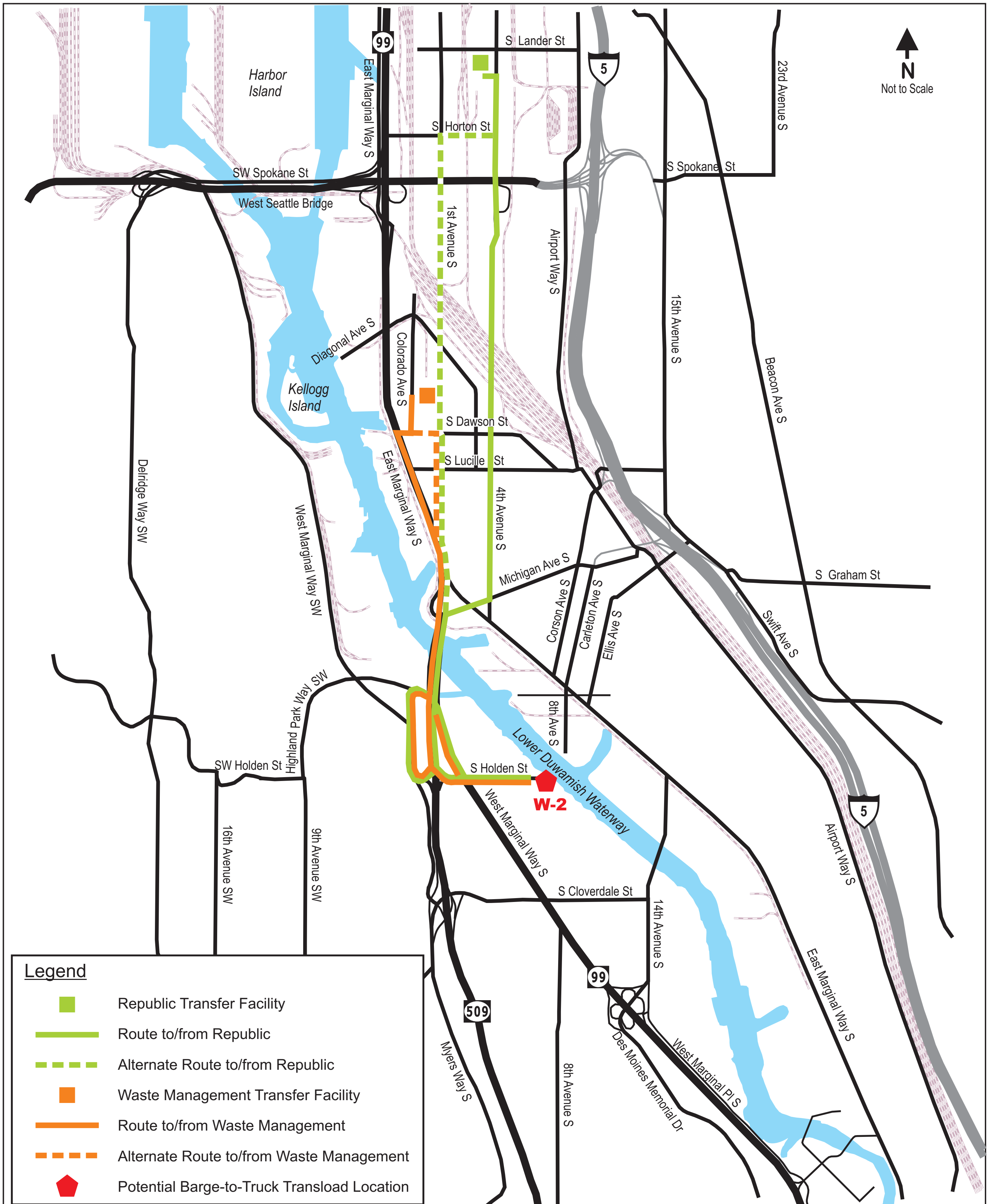



Lower Duwamish Waterway
Cleanup Project

**Figure 1**
**Truck Haul Routes to/from Potential Northern Transload Facility on West Side (W-1)**

heffron transportation, inc.

12.20.2013




**Lower Duwamish Waterway Cleanup Project**

**Figure 2**
**Truck Haul Routes to/from Potential Southern Transload Facility on West Side (W-2)**

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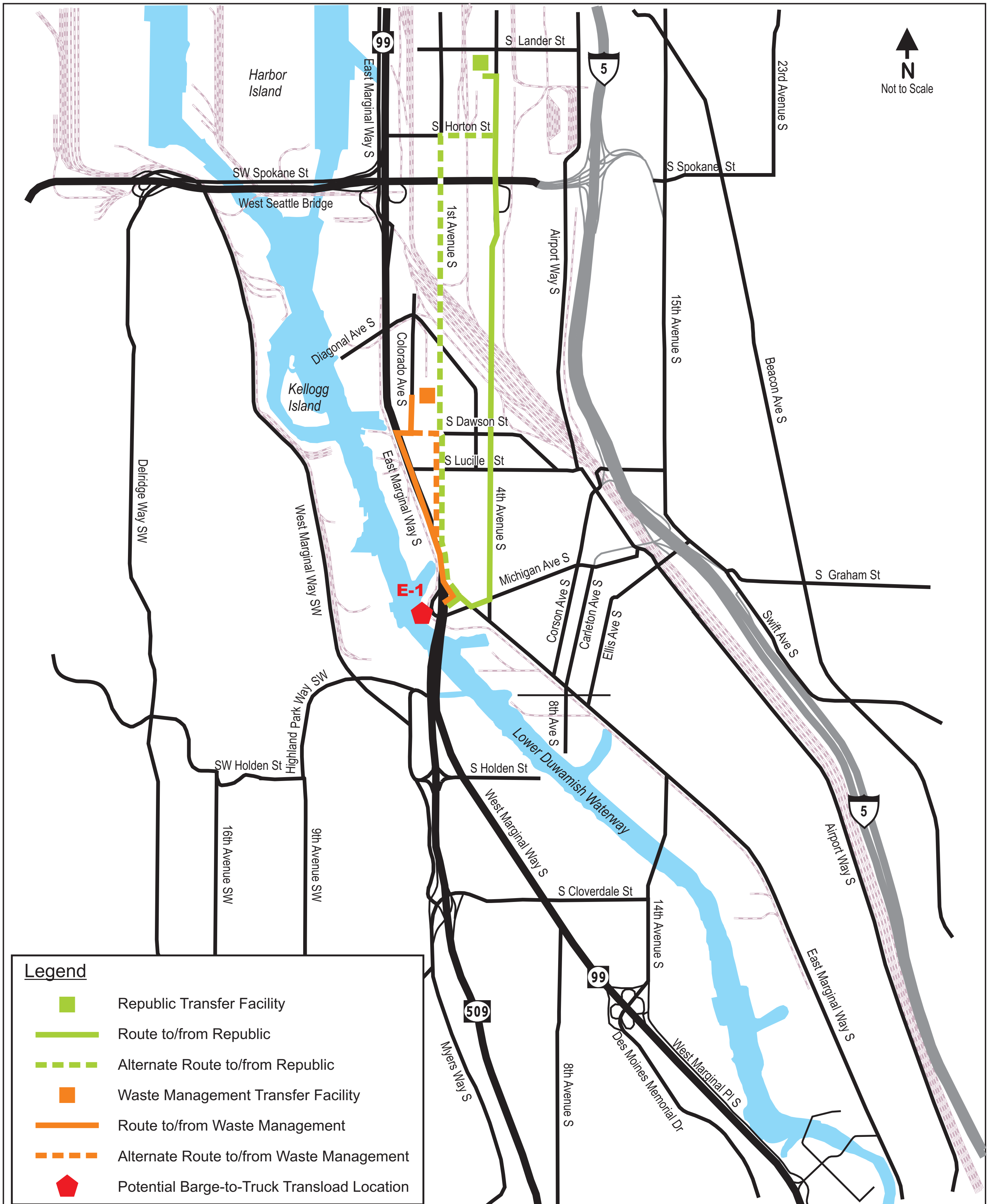
12.20.2013




Lower Duwamish Waterway
Cleanup Project

**Figure 3**
**Truck Haul Routes to/from Potential Northern Transload Facility on East Side (E-1)**

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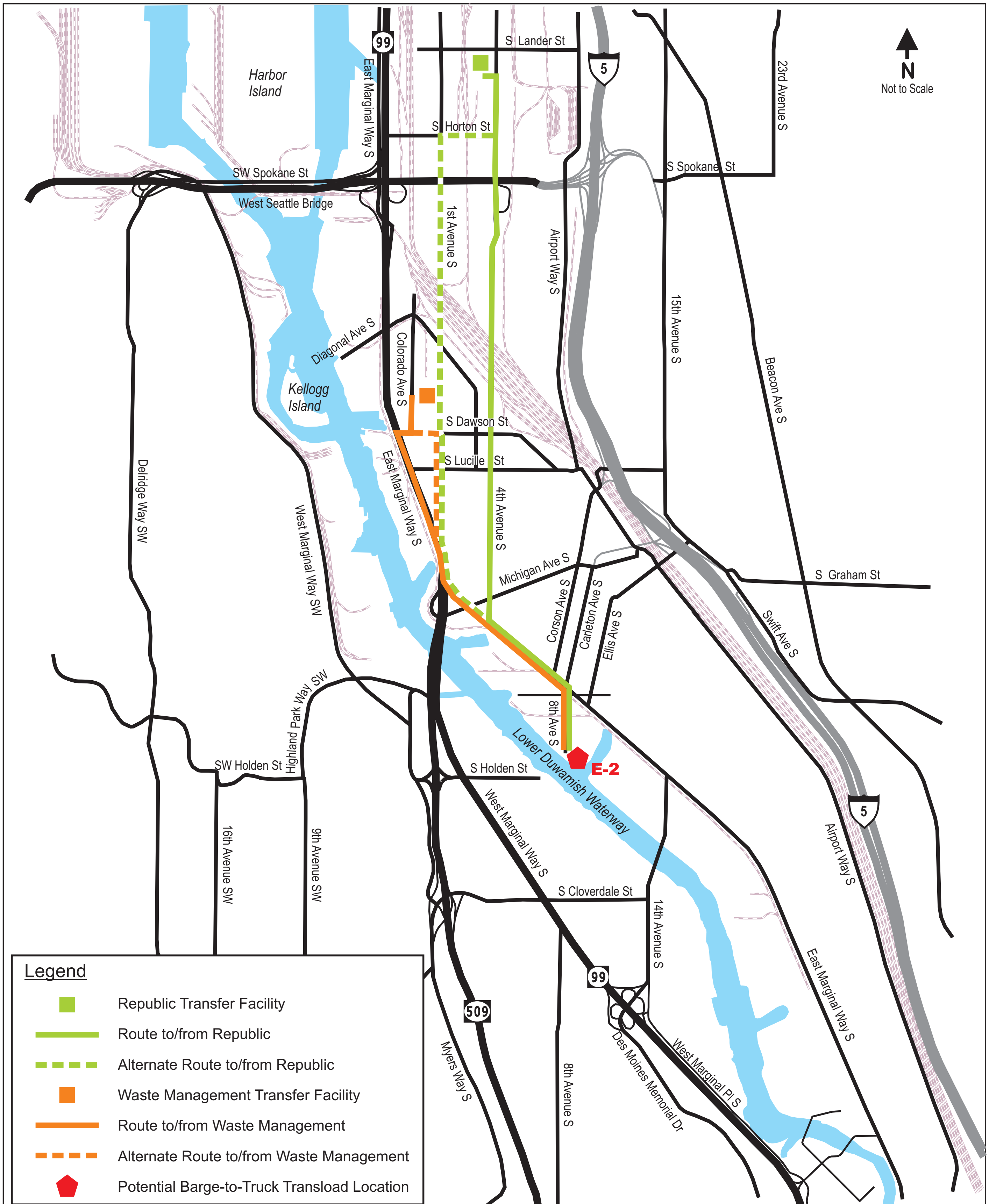
12.20.2013




**Lower Duwamish Waterway**
**Cleanup Project**

**Figure 4**
**Truck Haul Routes to/from Potential Southern Transload Facility on East Side (E-2)**

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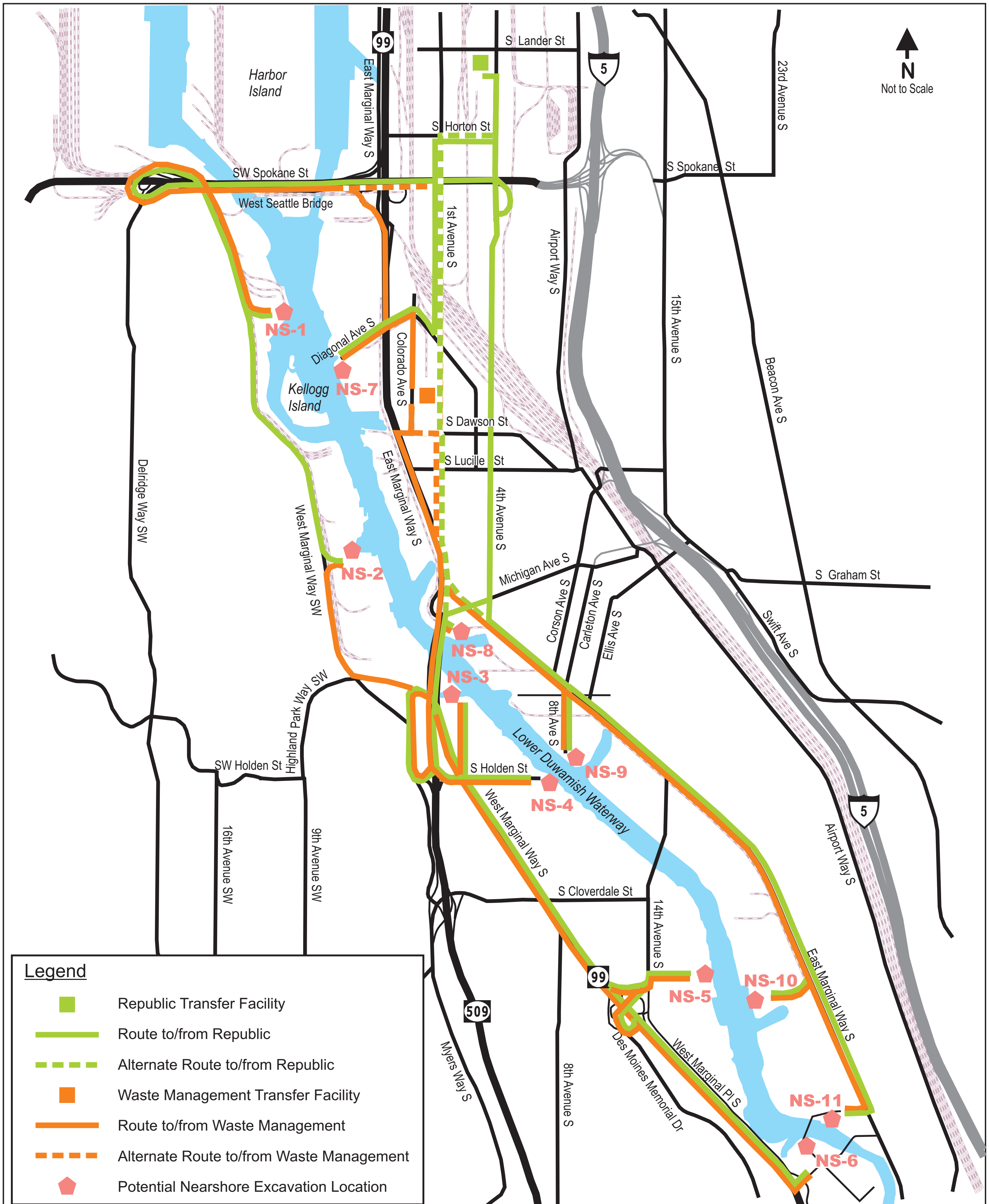
12.20.2013




**Lower Duwamish Waterway Cleanup Project**

**Figure 5**
**Truck Haul Routes to/from Potential Nearshore Locations**

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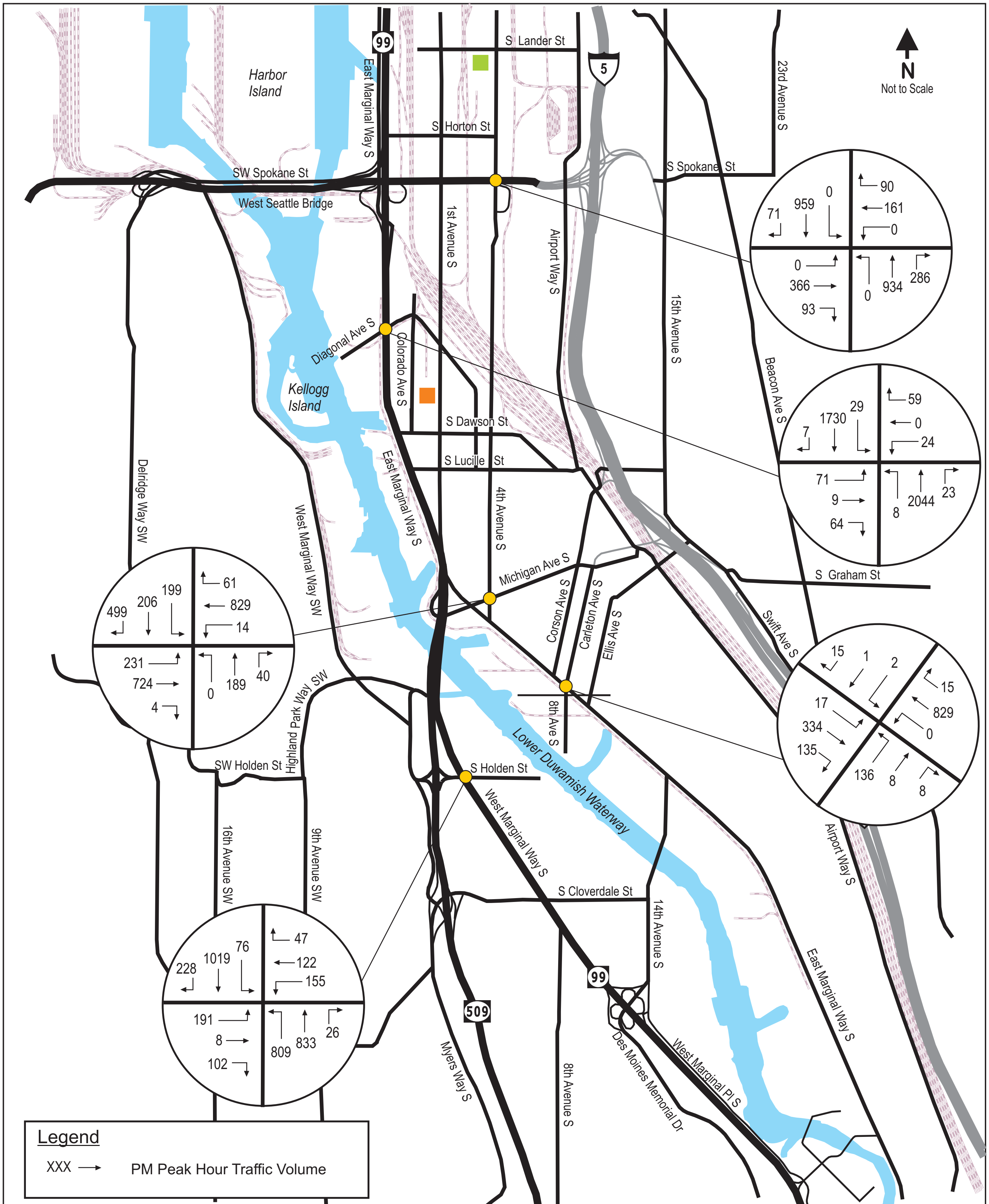
12.20.2013

# ATTACHMENT C

# EXISTING AND PROJECTED FUTURE TRAFFIC VOLUMES

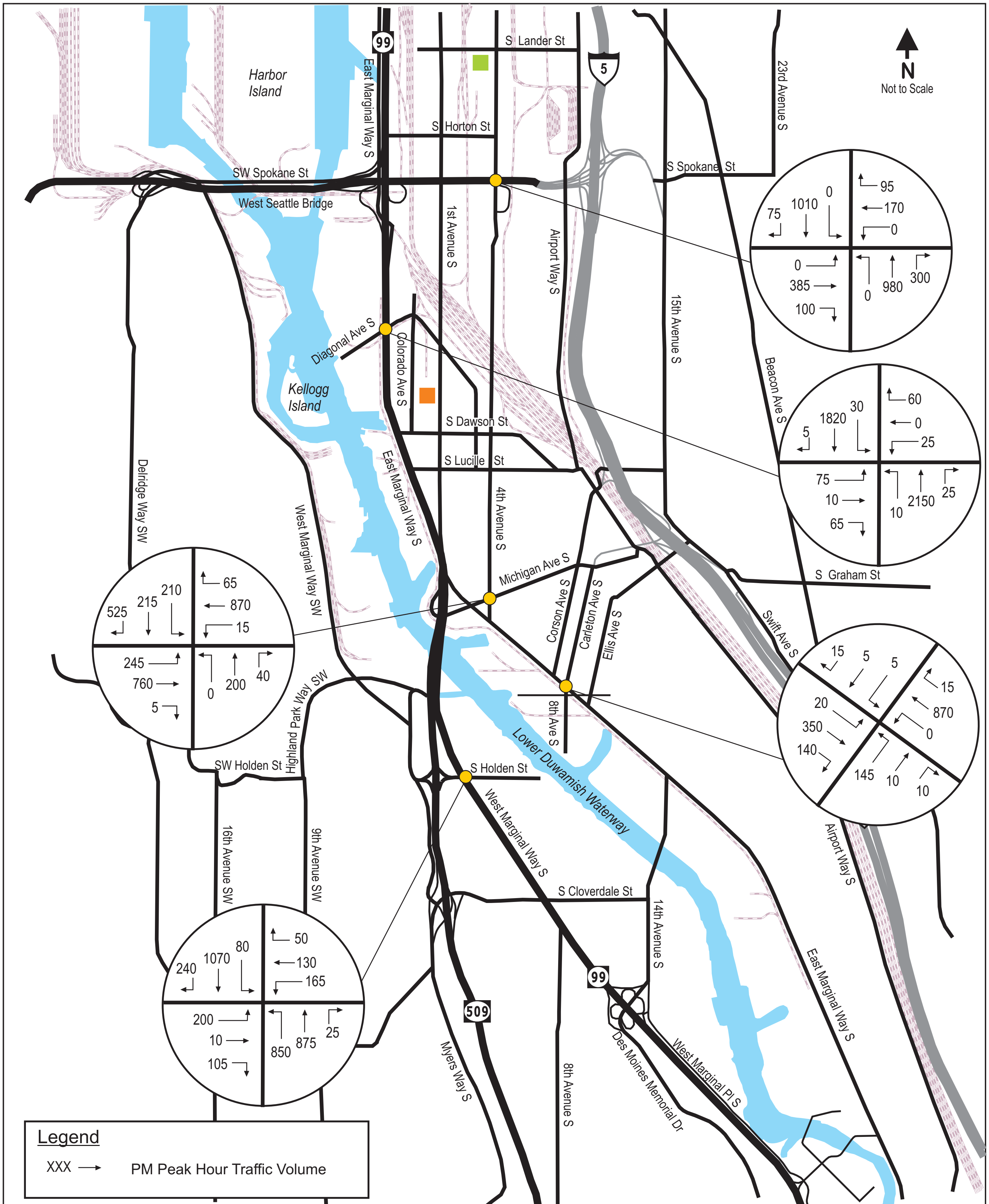



**Lower Duwamish Waterway**
**Cleanup Project**

**Figure 6**
**Existing (2013) Traffic Volumes**
**PM Peak Hour**

heffron transportation, inc.

12.20.2013




Lower Duwamish Waterway
**Cleanup Project**

**Figure 7**
**Future (2018) Traffic Volumes**
**Without Project - PM Peak Hour**

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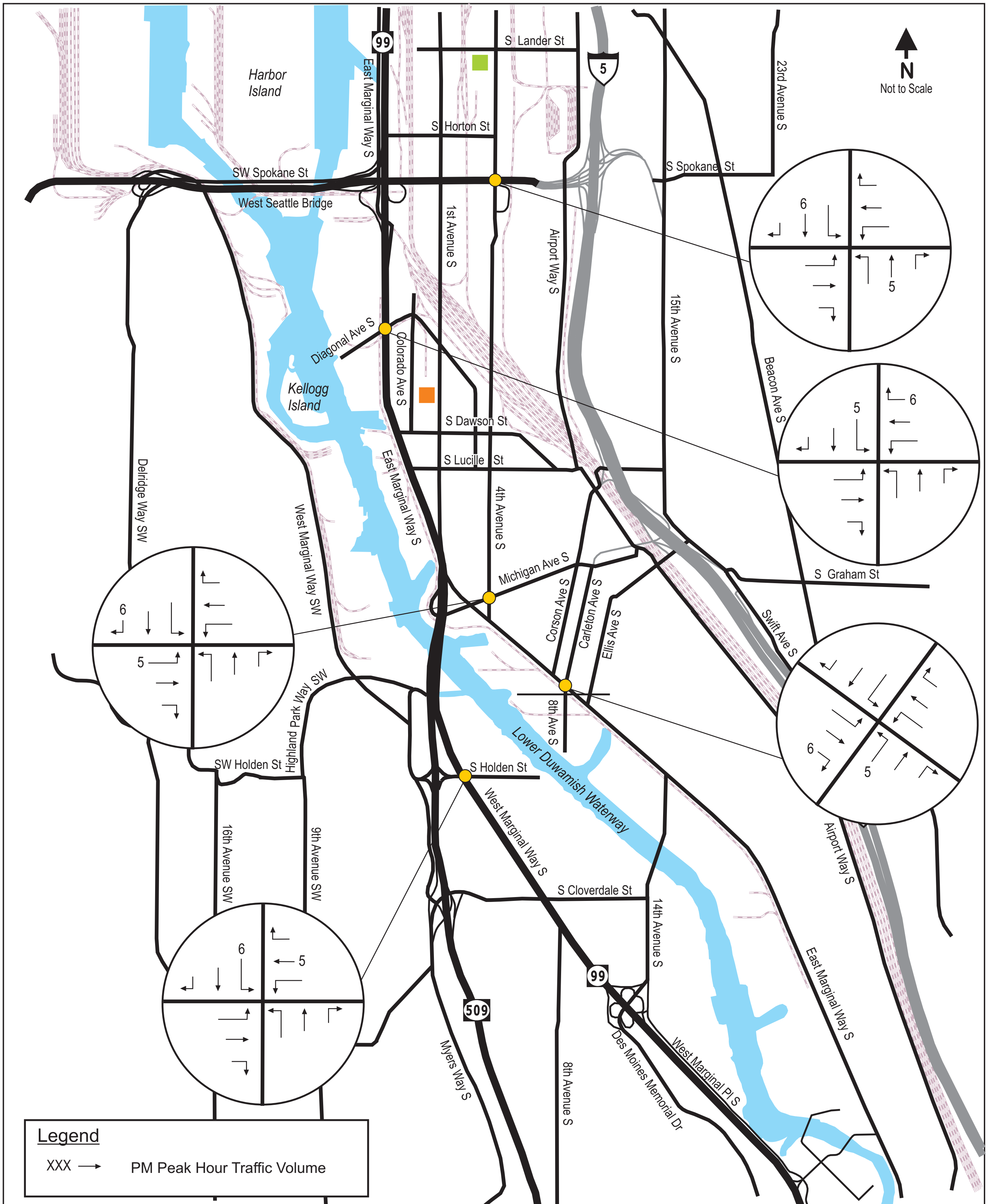


**Lower Duwamish Waterway**
**Cleanup Project**

**Figure 8**
**Average Truck Trips per Hour Generated by Project**

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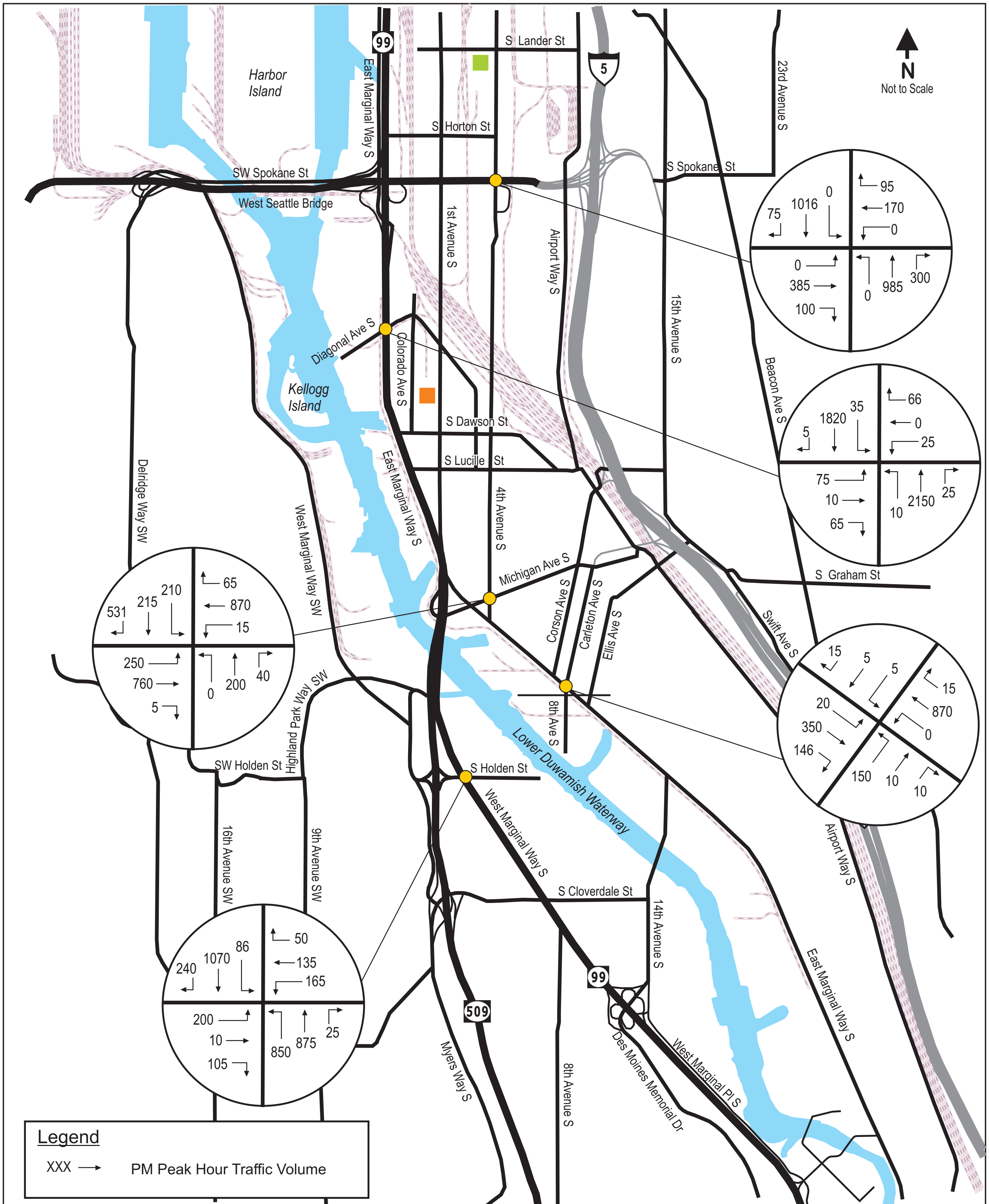


**Lower Duwamish Waterway Cleanup Project**

**Figure 9**
**Future (2018) Traffic Volumes With Project - PM Peak Hour**

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12.20.2013

# ATTACHMENT D

# LEVEL OF SERVICE DESCRIPTION

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 D-1 shows the level of service criteria for signalized intersections from the *Highway Capacity Manual*.

Table D-1. Level of Service Criteria for Signalized Intersections

| Level of Service | Average Delay Per Vehicle | General Description |
|---|---|---|
| A | Less than 10.0 Seconds | Free flow |
| B | 10.1 to 20.0 seconds | Intermediate flow |
| C | 20.1 to 35.0 seconds | Intermediate flow |
| D | 35.1 to 55.0 seconds | Intermediate flow |
| E | 55.1 to 80.0 seconds | Approaching forced flow |
| F | Greater than 80.0 seconds | Forced flow |

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