ENVIRONMENTAL CHECKLIST

Seattle-Tacoma International Airport (Sea-Tac Airport)

Air Cargo Road Safety Improvements

A. BACKGROUND

1. **Name of proposed project, if applicable:**

   Air Cargo Road Safety Improvements Project

2. **Name of applicant:**

   Port of Seattle

3. **Address and phone number of applicant and contact person:**

   Port of Seattle
   P.O. Box 68727
   Seattle, WA 98168

   Contact: Steve Rybolt, Senior Environmental Program Manager
   Telephone/Email: (206) 787-5527, Rybolt.S@portseattle.org

4. **Date checklist prepared:** February 27, 2020

5. **Agency requesting checklist:** Port of Seattle – SEPA File Number 2020-01

6. **Proposed timing or schedule (including phasing, if applicable):**

   The Air Cargo Road Safety Improvements Project (Project) is expected to begin construction in early 2021 with project completion expected in mid-2023.

7. **Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.**

   There are no plans for future additions or expansions directly related to the Project at this time. The Port of Seattle (Port) is conducting environmental review for the Sustainable Airport Master Plan (SAMP) Near-Term Projects (NTP), which proposes to cover a portion of Air Cargo Road to accommodate construction of a new terminal concourse (i.e., North Gates and Secondary Airport Rescue and Firefighting station [SAMP NTP environmental review project T01 and S03, respectively]) the Cell Phone Lot function will be relocated with consideration of the use of existing parking garage.

   As proposed in the SAMP NTP environmental review, the existing Air Cargo Road would become a tunnel underneath the North Gates and the Secondary Airport Rescue and Firefighting station. South 170th Street would be reconfigured and partially vacated and provide access to the cemetery, North Airport Expressway (NAE), Second Terminal and Parking (SAMP NTP environmental review project T02), and North Gates. Through consideration of other planned actions in the Project area and construction time frame no cumulative adverse effects are anticipated.

8. **List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.**

   In July 2013, the Port and the City of SeaTac completed an environmental analysis, including

preparation of a SEPA Checklist for the Cell Phone Waiting Lot[1] Relocation (POS SEPA No. 13-05) project at Sea-Tac International Airport (SEA). The relocation of the Cell Phone Lot from the west side of Air Cargo Road, north of South 170th Street to its current location on the south side of South 170th Street included an entrance/exit across from the southbound NAE off-ramp. The project called for construction of a roundabout at the terminus of the ramp from the southbound NAE to South 170th Street to manage traffic along South 170th Street. That roundabout has not been constructed, and traffic at the intersection of the NAE off-ramp and Cell Phone Lot entrance/exit on South 170th Street continues to be managed through a temporary traffic signal. The increased use of the Cell Phone Lot also increases traffic use of both South 170th Street and Air Cargo Road.

The following documents were prepared for this Project:

- Landscape Concept Plan, October 2019 (Appendix A)
- Traffic Analysis Report, November 2018 (Appendix B-1)
- Traffic Analysis Update, December 2019 (Appendix B-2)
- Pavement Assessment Memorandum, August 2019 (Appendix C)

9. Do you know whether applications are pending for governmental approvals or other proposals directly affecting the property covered by your proposal? If yes, explain.

The proposed SAMP NTP discussed in Section A7 above would affect the property covered by the proposed Project; there are no known pending governmental approvals or other proposals directly affecting the property covered by the proposal.

10. List any government approvals or permits that will be needed for your proposal, if known.

Yes, additional government approvals will be required in advance of Project commencement. These approvals include the following:

- City of SeaTac Right-of-Way (ROW) Use Permits – Class B (temporary lane/street closures) and Class C (work within ROW)
- The Port will contract with King County for the operation and maintenance of the new traffic signal. King County approval will be required for the traffic signal design elements.

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

Background

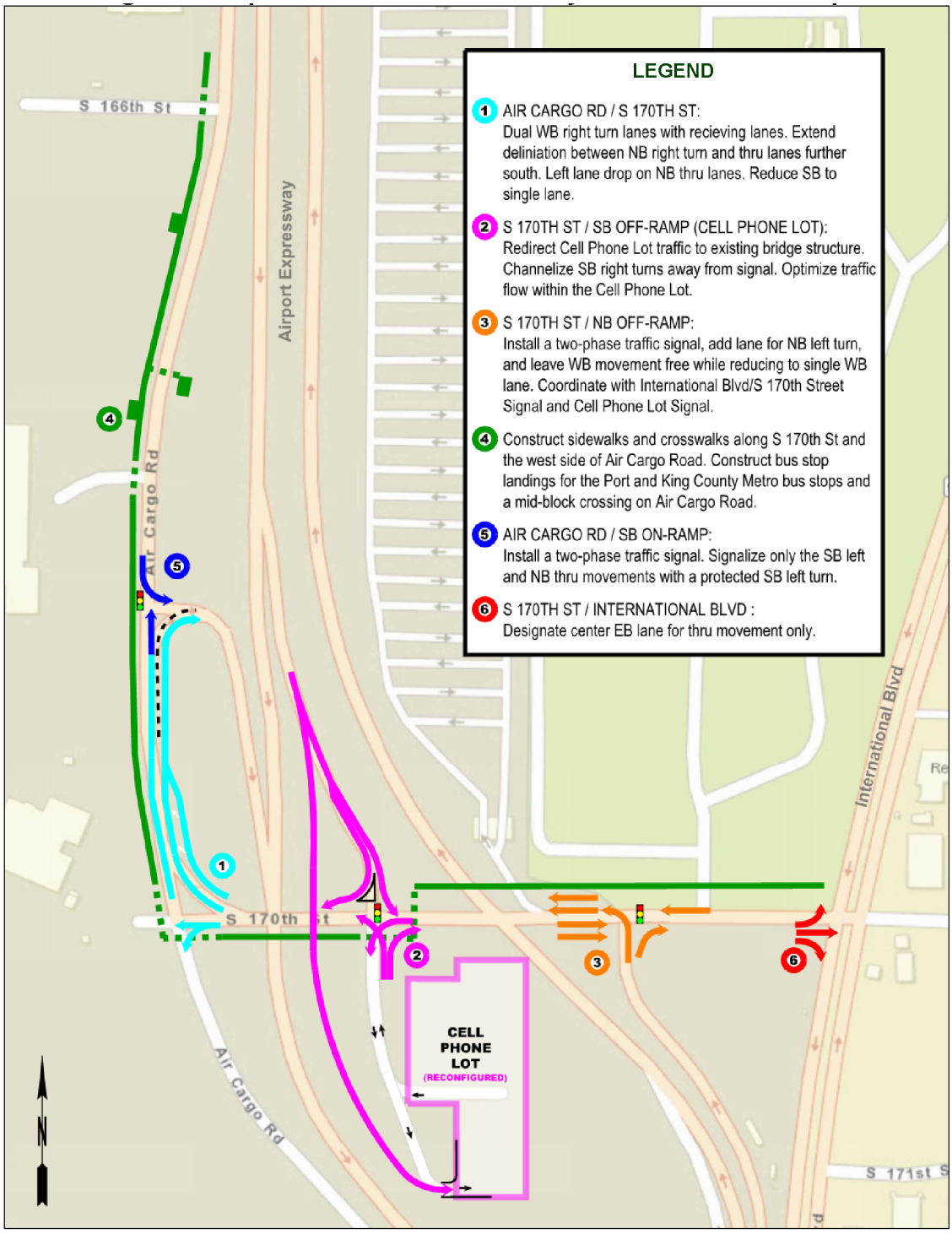
The Port is proposing the Project to improve pedestrian and automobile traffic safety through allowing safe access to the SEA Cell Phone Lot, adjacent land uses, and public transit stops (Figures 1 and 2). The Project will reduce congestion from the airport terminal arrivals and departures traffic by addressing circulation inefficiencies.

The Project is intended to accommodate existing demand at the Cell Phone Lot, which includes addressing safety and congestion issues on Air Cargo Road and South 170th Street as traffic patterns on these roadways are affected by use of the Cell Phone Lot. Air Cargo Road and South 170th Street currently have several identified safety concerns, including unprotected left-turn movements, limited or no pedestrian or bicycle access, and distressed or failing pavement conditions. The surface pavement along South 170th Street near the Cell Phone Lot access and on Air Cargo Road is beyond its design life and showing considerable distress. The majority of

[1] The Cell Phone Waiting Lot is now simply called the "Cell Phone Lot," which is the name used throughout the remainder of this SEPA checklist.

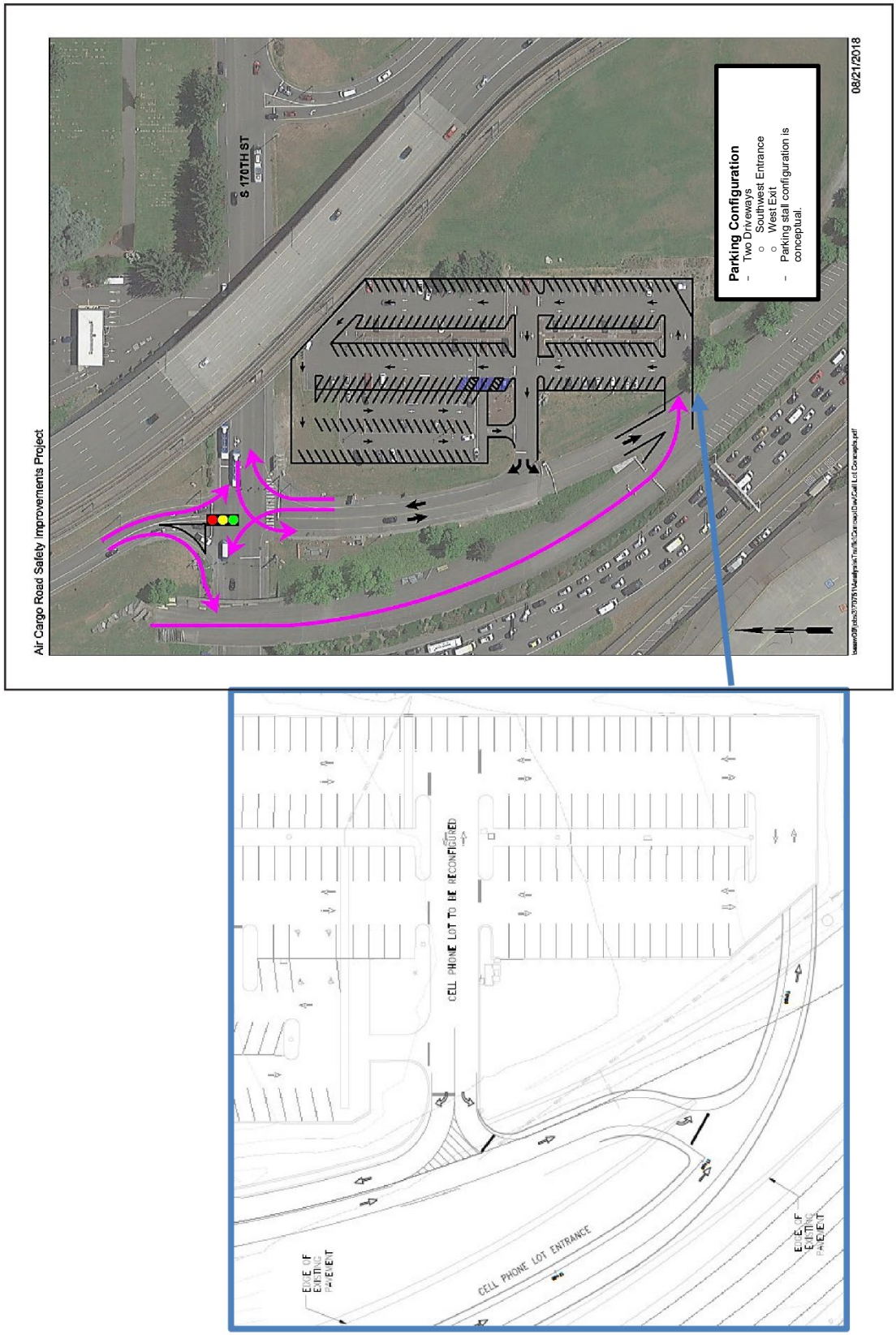
automobile accidents on both South 170th Street and Air Cargo Road are left-turn-related, and most automobile accidents occur during peak traffic periods.

Figure 1. Roadway Modification Plan



Source: HNTB, 2019. Air Cargo Road Safety Improvements Project: Traffic Analysis Update. Prepared for: Port of Seattle. December 18, 2019.

Figure 2. Revised Cellphone Lot Access



Project Elements

Air Cargo Road Improvements

Air Cargo Road is a north-south arterial roadway under the jurisdiction of the Port. The Project limits include the portion of Air Cargo Road from South 166th Street to South 170th Street (Figure 1). Air Cargo Road was originally constructed in 1969 and is the primary access for a number of SEA airfield, cargo, and landside facilities. The Air Cargo Road on-ramp to southbound NAE is one of the primary access routes to the Main Terminal, and currently supports Cell Phone Lot customers, local businesses, ground transportation, and rental car busing. All intersections on the roadway are unsignalized. The existing pavement and lighting infrastructure on Air Cargo Road between South 166th Street and South 170th Street are failing and well beyond their useful life.

Transit service on Air Cargo Road includes King County Metro Route 180 and Port employee parking shuttles. On-street parking is prohibited on Air Cargo Road. Sidewalks and bicycle lanes are not currently provided in the study area.

A series of actions is planned to bring Air Cargo Road up to current standards for operation and safety, as well as new landscaping and lighting as required. The roadway design criteria and roadway standards used for this project follow the design standards adopted by the State of Washington per RCW 35.78.030 and 43.32.020. Traffic signal systems have been designed to King County's standards because traffic signals in the City of SeaTac are operated and maintained by King County. Planned actions include the following:

- Pavement Rehabilitation. Improvements along Air Cargo Road will include overlay, full-depth pavement repair, and shoulder repair.
- Landscaping. ROW buffer improvements will be provided along the extent of planned roadway improvements on both sides of Air Cargo Road per the Port's landscape standards.
- Non-Motorized Transportation. Between South 166th Street and South 170th Street a new sidewalk will be installed on the west side. Additional sidewalk may be installed on the east side as required to support bus stop locations or crosswalks.
- Additional Bus Stops. Two new bus stops serving shuttles for the employee parking facility as well as public transit will be installed just south of South 166th Street. The bus stops will include pedestrian lighting, shelters, indication lights, signage, and other improvements in order to meet Americans with Disabilities Act requirements.

South 170th Street Improvements

South 170th Street is an east-west minor arterial roadway under the jurisdiction of the Port and the City of SeaTac. The project limits include the segment of South 170th Street from Air Cargo Road to International Boulevard (Figure 1). On-street parking is prohibited on South 170th Street. The International Boulevard intersection and the southbound NAE off-ramp /Cell Phone Lot intersection are signalized, but other intersections on South 170th Street are unsignalized.

Transit service on South 170th Street includes King County Metro Route 180, Sound Transit Regional Express Route 574 (inbound to the airport terminal) and Port employee parking shuttles. Sidewalks and bicycle lanes are not currently provided in the study area.

A series of actions is planned to bring South 170th Street up to current standards for operation and safety, as well as new landscaping and lighting as required. These actions include the following:

- Pavement Rehabilitation. The pavement on South 170th Street will be rehabilitated with a new overlay.
- Landscaping. New landscaping is planned along the south side of South 170th Street.

- Non-Motorized Transportation. Sidewalks and crosswalks will be constructed along South 170th Street.

Cell Phone Lot Access Improvements

A series of actions is planned to improve safety, accessibility, and efficiency for Cell Phone Lot traffic:

- Modified Entrance. A new Cell Phone Lot entrance for traffic entering the Cell Phone Lot from the southbound NAE off-ramp is proposed that will use an existing bridge over South 170th Street and will enter the Cell Phone Lot at a new driveway on the southwest corner of the lot (Figure 1 and2). This will eliminate the southbound through movement from NAE at the South 170th Street/Cell Phone Lot intersection, where a westbound left turn lane into the Cell Phone Lot will be added.
- Traffic Signal Replacement. The existing temporary traffic signal will be replaced by a permanent two-phase traffic signal, and the access into the Cell Phone Lot will be widened to provide two exiting lanes.
- Restriping of the Cell Phone Lot. New striping will accommodate the new entrance location and optimize traffic flow for a short-term parking facility with high hourly turnover. Approximately 1,200 square feet of additional space for parking will be included in the reconfigured lot. The Cell Phone Lot currently has 186 stalls. An additional 23 stalls are anticipated to be added for a final parking stall count of 209.
- Landscaping and Biofiltration. Landscaping will be installed with signage at cell phone lot entrances. The existing bioswale on the east side of the cell phone lot will be restored and revegetated. Planned improvements will also dissipate stormwater runoff.

Motorized Transportation Improvements

- Air Cargo Road and South 170th Street. Dual right-turn lanes will be constructed on westbound South 170th Street at Air Cargo Road. The delineation between northbound traffic lanes on Air Cargo Road will extend further south, separating through traffic from traffic entering the southbound NAE on-ramp. Southbound traffic on Air Cargo Road will be reduced to a single lane.
- South 170th Street and Northbound NAE Off-Ramp Intersection. A new two-phase traffic control signal will be added at the South 170th Street/northbound NAE off-ramp to control eastbound and westbound movement from the northbound off-ramp and provide a protected phase for the northbound movements. This signal will work in coordination with the two adjacent signals at International Boulevard and the Cell Phone Lot driveway.
- Air Cargo Road and Southbound NAE On-Ramp Intersection. A new two-phase traffic control signal will be added at the Air Cargo Road/southbound NAE on-ramp to control the southbound left-turn and northbound through movements. The southbound through and northbound right-turn movements will remain unsignalized.
- Eastbound South 170th Street to International Boulevard. The shared left/through lane on the eastbound approach of South 170th Street/International Boulevard will be converted to a dedicated through lane.

Additional Project Features

- Additional improvements are proposed to provide safe and efficient traffic movements in the Project limits as shown in Figures 1 and 2.

Roadway Illumination

- Existing roadway illumination along Air Cargo Road and South 170th Street will be replaced as required to ensure compliance with roadway and pedestrian lighting standards. The project will install 29 light poles, 11 to replace existing light poles and 18 additional light poles. The roadway illumination design follows the Port's Electrical System Standards (2019) and AASHTO's Roadway Lighting Design Guide (2018).

Signage

- Way finding and regulatory signage will be upgraded to support the improvements along the corridor per the Manual on Uniform Traffic Control Devices (2009), and permanent signage will be provided for the Cell Phone Lot.

Roadway Operations/Safety

- Improvements to roadway operations and safety will include driveway modifications to support truck access, intersection or driveway consolidation or relocation, relocation of existing facilities, and installation of guard rail.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

Seattle-Tacoma International Airport

17801 Pacific Highway South

Seattle, WA 98158

The Project site is located on the east side of SEA near the SEA Cell Phone Lot (see Figure 3)

Latitude: 47.450629

Longitude: -122.301295

Section 28, Township 23 North, Range 04 East

Figure 3. Project Location and Vicinity

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other

b. What is the steepest slope on the site (approximate percent slope)?

The Project site area includes roadways and a paved lot and is generally flat. The steepest slope on the site is approximately 2%.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Underlying soil consists of pre-existing glacial till (i.e., Vashon till) and associated outwash sediments or imported sand, gravel, and pre-existing fill that was graded and compacted during original site use.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

There are no surface indications or a history of unstable soil at the site.

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

The total Project area is 11.4 acres. The total area affected by excavation and filling is 0.4 acre (17,300 square feet) and the total volume of excavation and fill is approximately 1,300 cubic yards. Although the source of clean fill is not known at this time, the contractor will provide material from an approved source.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

The potential exists for some erosion to occur during construction; however, erosion and sediment control best management practices will be implemented to minimize that potential per the Project's stormwater pollution prevention plan.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Approximately 64% (7.3 acres) of the site will be covered with impervious surfaces within the Project boundaries after Project completion. Impervious surfaces will be asphalt and concrete pavement; the increase of 4,800 square feet (0.11 acre) in impervious surface area for the Project will be offset by removal of existing impervious surface and replacement with plantings. The cell phone lot biofiltration swale and landscaping areas will be pervious surfaces. The sidewalks proposed along Air Cargo Road and South 170th Street west of the Cell Phone Lot would be impervious.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

During construction, a temporary erosion and sediment control plan will be in place to prevent erosion at the site. This is a requirement of the Port of Seattle's Master Specifications.

2. Air

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

Emissions to the air are expected to occur during construction from temporary activity of construction vehicles, equipment, workers traveling to/from the Project area, and construction-related dust. These short-term impacts will be minimized to the best extent practical (e.g., water trucks to suppress dust and new equipment).

See Appendix D, "Greenhouse Gas Emissions Worksheet Supplemental Information for SEPA Environmental Checklist," for additional information.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no off-site sources of emissions that would affect the Project.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

The contractor performing construction will be required, per Port of Seattle Master Specifications, to maintain and repair all equipment in a manner that meets state regulation and reasonably minimizes emissions.

3. Water

a. Surface Water:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The west branch of Des Moines Creek flows into Puget Sound and is located approximately 0.9 mile south of the Cell Phone Lot, south of Bow Lake Reservoir. Miller Creek is approximately 1 mile to the west, and Gilliam Creek is approximately 1.3 miles north of the Cell Phone Lot. Miller Creek flows directly into Puget Sound, while Gilliam Creek flows east into the Green River.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

No work will occur over, in, or adjacent to the Des Moines Creek, Miller Creek, or Gilliam Creek.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

There will be no fill or dredge material that would be placed in or removed from the surface water or wetlands.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

The Project will not require surface water withdrawals or diversions.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

The Project area does not lie within a 100-year floodplain.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

The Project does not involve any discharges of waste materials to surface waters.

b. Ground Water:

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a

general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known

Groundwater will not be withdrawn, nor will water be discharged to groundwater for this Project.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals . . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

Waste materials will not be discharged into the ground from a septic system or other source.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Runoff from the Project will only be from stormwater. Runoff from the Cell Phone Lot will flow to the existing on-site bioretention swale. Water flowing from the bioretention swale will flow to the SDE4 Pond and Filter vault located south of 188th Street. The SDE4 Pond drains to the East Branch of Des Moines Creek.

Runoff from the Air Cargo Road and South 170th Street will continue to flow into the existing stormwater conveyance system, which connects to the SDE4 Pond that drains to Des Moines Creek and ultimately discharges to Puget Sound.

Storm drain system and discharges are subject to SEA's National Pollutant Discharge Elimination System (NPDES) permit (#WA-0024651).

2) Could waste materials enter ground or surface waters? If so, generally describe.

Project design and construction management will prevent discharge of waste materials to surface waters through existing and upgraded stormwater best management practices as required by the Stormwater Management Manual for Western Washington, 2016 King County Surface Water Design Manual, SEA's individual NPDES permit, and spill prevention, control, and countermeasures plan.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

The Project does not alter or otherwise affect drainage patterns in the vicinity of the Project.

d. Proposed measures to reduce or control surface, ground, runoff water, and drainage pattern impacts, if any:

The majority of the Project stormwater runoff is conveyed to the Port's SDE4 enhanced Level 1 flow control extended detention pond and enhanced treatment facility. In addition to the end of pipe detention and treatment there are several upstream best management practices including the Cell Phone lot bioretention swale. Water quality during construction activities will be maintained by treatment under conditions of the Port's individual NPDES Permit WA0024651, Part 3 Construction Stormwater and an associated stormwater pollution prevention plan. Drainage patterns will remain the same on Air Cargo Road and South 170th Street. The Project has been designed to comply with the Seattle Tacoma International Airport Stormwater Management Manual for the Port Aviation Division.

4. Plants

a. Check the types of vegetation found on the site:

x deciduous tree: alder, maple, aspen, other:

x evergreen tree: fir, cedar, pine, other:

_ shrubs

x grass

_____ pasture

_____ crop or grain

_____ orchards, vineyards or other permanent crops

– wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other

_____ water plants: water lily, eelgrass, milfoil, other

_____ other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Existing vegetation that would be removed includes 1.1 acres of lawn along Air Cargo Road and adjacent to the Cell Phone Lot, and 0.1 acre of shrub-scrub vegetation in the Cell Phone Lot biofiltration swale. The biofiltration swale will be replanted, and disturbed lawn area will be replanted or replaced with a native shrub mix, native grass and herbaceous plant mix, and shore pine (*Pinus contorta*) per Port Landscape Standards[2] (Appendix A: Landscape Concept Plan). Four conifer and four deciduous trees are proposed for removal along the west side of Air Cargo Road. These trees will be replanted with deciduous or conifer trees (including shore pine, sawtooth zelkova [*Zelkova serrata*], and incense cedar [*Calocedrus decurrens*]) at 40-foot spacing on the east and west sides of Air Cargo Road.

c. List threatened, and endangered species known to be on or near the site.

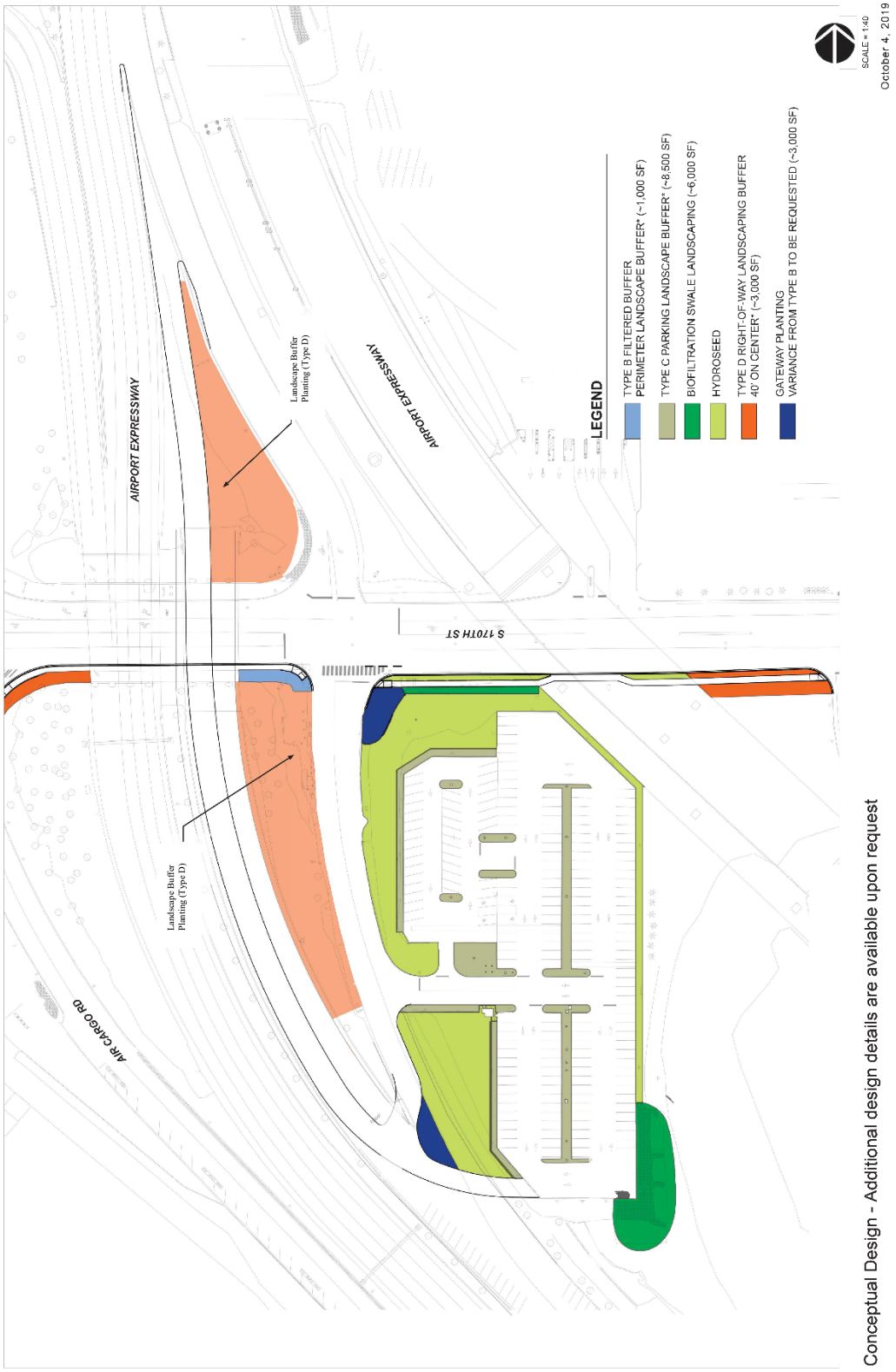
No threatened or endangered plant species are known to be on or near the Project area.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

ROW vegetative buffer improvements will be provided on both sides of Air Cargo Road per the Port's landscape standards. Landscaping will also be completed in and around the Cell Phone Lot as shown in Figure 4. Native deciduous and coniferous trees and shrubs will be planted along with grass and herbaceous mix and hydroseed. Over 2.5 acres of land in the Project area will be replanted (Appendix A: Landscape Concept Plan).

[2] Port of Seattle, 2006. Landscape Design Standards. Seattle-Tacoma International Airport. February 8, 2006.

Figure 4. Landscape Plan in Cell Phone Lot Area



Source: Landscape Plan, Page 1, October 4, 2019

e. List all noxious weeds and invasive species known to be on or near the site.

There are no known noxious weeds or invasive species known in the Project area.

5. Animals

a. List any birds and animals which have been observed on or near the site or are known to be on or near the site. Examples include:

Birds: hawk, heron, eagle, songbirds, other: starlings, crows, gulls, pigeons

Mammals: deer, bear, elk, beaver other: rodents, small mammals

Fish: bass, salmon, trout, herring, shellfish, other:

b. List any threatened and endangered species known to be on or near the site.

No known threatened or endangered animal species are on or near SEA properties.

c. Is the site part of a migration route? If so, explain.

Airport property and lands in the immediate airport vicinity are not part of any known migration routes.

d. Proposed measures to preserve or enhance wildlife, if any:

No preservation or enhancement measures are proposed.

e. List any invasive animal species known to be on or near the site.

Rock pigeons and European starlings are the only invasive animal species known to exist at or near the Project area.

6. Energy and natural resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Electricity will serve the Project area to provide energy needs for the proposed lighting. Existing roadway luminaires will be replaced with LED fixtures throughout the project area.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

The Project is not expected to affect the potential use of solar energy by adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:
With the enhanced energy efficiency of the new and replacement light poles, any additional energy use is expected to be minimal. Energy efficient fixtures will meet current AASHTO Roadway Lighting Design Guide standards for road illumination and parking facilities. The light will be directed within the Project area and use low glare fixtures or shields to block glare visible from the street or adjoining property to minimize impacts.

7. Environmental health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

There are no known environmental health hazards for this Project.

1) Describe any known or possible contamination at the site from present or past uses.

There are no known contaminated soils at the site. Plans will be in place to handle contaminated soil if encountered during program construction and all pertinent local, state, and federal regulations will

be followed.

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity

There are no known hazardous chemicals/conditions that might affect the program. If contaminated chemicals/conditions are encountered that might affect the program, plans will be in place to handle hazardous chemicals/conditions when and if they are encountered. During construction, pertinent local, state, and federal regulations will be followed.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

It is anticipated that lubricants, sealants, glues, and fuels will be used during construction. Lubricants and fuel will be used during operations and maintenance of the Project upon completion. All toxic or hazardous chemicals will be stored in compliance with all applicable regulations.

4) Describe special emergency services that might be required.

No special emergency services are expected as a result of implementing the program. Construction-related accidents or injuries may require response from local fire, police, air units, or ambulances. The Port maintains its own police force and firefighting and rescue units that will be called upon for these types of incidents. The Port also maintains a trained response team available to respond at all times to any spill or loss of contaminated or hazardous materials.

5) Proposed measures to reduce or control environmental health hazards, if any:

There are no known environmental health hazards that have been identified. If encountered, local, state, and federal regulations regarding safety and handling of hazards materials will be followed and enforced.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

In general, the dominant source of noise in the airport vicinity is generated by aircraft operations.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Short-term noise is anticipated from the use of construction equipment during construction activities, which are expected to begin in early 2021 and last approximately 2 years. Construction is anticipated to occur during business hours and adhere to City of SeaTac Municipal Code requirements. The Project area will be open for access to the airport users 24 hours a day in the same manner as the current Cell Phone Lot is used today.

3) Proposed measures to reduce or control noise impacts, if any:

Short-term noise from construction activities will be mitigated by the use of best management practices and adhering to the City of SeaTac's noise ordinance. There are no long-term noise mitigation measures proposed because the Project will not change existing traffic patterns and because of the Project's proximity to SEA.

8. Land and shoreline use

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

The current use of the Project area is a road system serving several SEA facilities and a Cell Phone Lot for SEA users to hold for arrivals. The Project will not affect current land uses on nearby or adjacent properties.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?

The Project area is not used as working farmlands or forestlands.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:

There are no surrounding working farms or forestlands near the Project area.

c. Describe any structures on the site.

Structures existing in the Project area include Air Cargo Road, South 170th Street, streetlights and parking lot lights, public bus stops, and the Cell Phone Lot.

d. Will any structures be demolished? If so, what?

Existing streetlights and parking lot lights will be upgraded or replaced. Existing pavement will be removed in some areas and repaired.

e. What is the current zoning classification of the site?

The current zoning classification of the Project area is designated by the City of SeaTac as Aviation Operations (AVO) and Community Business in Urban Center (CB-C).

f. What is the current comprehensive plan designation of the site?

The current comprehensive plan designation by the City of SeaTac is Airport (AP) for the Project area.

g. If applicable, what is the current shoreline master program designation of the site?

The Project area is not within a shoreline designation.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

The Project area is not classified as a critical area by the City of SeaTac or King County.

i. Approximately how many people would reside or work in the completed project?

No people will reside or work in the Project area.

j. Approximately how many people would the completed project displace?

There will be no displacement impacts expected as a result of this Project.

k. Proposed measures to avoid or reduce displacement impacts, if any:

There are no measures to avoid or reduce displacement impacts.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

No measures are proposed because there will be no changes to existing or projected land use as a result of this program.

m. Proposed measures to ensure the proposal is compatible with nearby agricultural and forest lands of long-term commercial significance, if any:

There are no nearby agricultural or forestlands.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

This Project does not include the construction of any housing.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

This Project does not include the elimination of any housing.

c. Proposed measures to reduce or control housing impacts, if any:

There will be no housing impacts as a result of this program. Therefore, measures to reduce or control housing impacts are not proposed.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The tallest structures proposed for the Project will be light poles. The light poles are approximately 30 feet tall.

b. What views in the immediate vicinity would be altered or obstructed?

Given the location of the Project area and nearby land uses, no views in the immediate vicinity of the Project are expected to be altered or obstructed.

c. Proposed measures to reduce or control aesthetic impacts, if any:

No measures are proposed because no aesthetic impacts are expected from this Project.

11. Light and glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

The project will install 29 light poles, 11 to replace existing light poles and 18 additional light poles. . The American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide will be the design standard used on the Project. Lighting included in the Project will provide illumination during evening hours.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

The light and glare from the light poles will not be a safety hazard or interfere with views.

c. What existing off-site sources of light or glare may affect your proposal?

There are no known existing off-site sources of light or glare that may affect the Project proposal, given the land uses in the vicinity.

d. Proposed measures to reduce or control light and glare impacts, if any:

The light poles will use energy efficient fixtures and meet current AASHTO Roadway Lighting Design Guide standards for road illumination and parking facilities. The light will be directed within the Project area and use low glare fixtures or shields to block glare visible from the street or adjoining property to minimize impacts.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

There are no designated or informal recreational opportunities in the immediate vicinity.

b. Would the proposed project displace any existing recreational uses? If so, describe.

The Project will not displace any existing recreational uses.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

No impacts to recreation, including recreation opportunities, are anticipated.

13. Historic and cultural preservation

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers located on or near the site? If so, specifically describe.

This Project will not affect any buildings, structures, or historic sites.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

There is no change in current use of the area impacted. Review of the Washington State Department of Archaeology and Historic Preservation's database identified no known recorded eligible historical or cultural resource properties in the Project area.[3]

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

The Project area is currently developed. There is no change in current use of the area impacted.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

No known historic properties or cultural resources are within the Project area; therefore, no measures to avoid or minimize impacts are anticipated. The Project does not currently anticipate acquiring any permits related to historic or cultural preservation.

14. Transportation

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

Project activities will occur on Air Cargo Road between South 166th Street and South 170th Street, and along South 170th Street from Air Cargo Road to International Boulevard. South 170th Street and the Cell Phone Lot can be accessed from International Boulevard and NAE for SEA users. During construction, Air Cargo Road and South 170th Street will only have one lane closed at a time to ensure access to the area remains open.

---

[3] WISAARD (Washington Information System for Architectural and Archaeological Records Data), 2019. WISAARD database maintained by the Department of Archaeology and Historic Preservation. Accessed November 6, 2019. Available at: https://dahp.wa.gov/historic-registers/washington-heritage-register.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

There are two bus stops (northbound and southbound) on Air Cargo Road approximately 600 feet north of the intersection with South 170th Street. King County Metro bus route 180 (Burien to Auburn) services these stops.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

The Cell Phone Lot currently has 186 stalls. An additional 23 stalls are anticipated to be added as part of this Project, with a final parking stall count of 209 .

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

The project is primarily a roadway facility project. Road improvements will all occur on public land (See Section A.11). The existing pavement sections within the Project limits will be improved. Additional sidewalk facilities may be installed on the east side of Air Cargo Road as required to support bus stop locations or crosswalks.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The Project will not require the use of water, rail, or air transportation. The Project will occur in the vicinity of SEA.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and non-passenger vehicles). What data or transportation models were used to make these estimates?

There will be no additional vehicular trips generated as a result of this Project because it is intended to alleviate traffic for existing users and conditions. Traffic movements at the intersections of South 170th Street and the Cell Phone Lot, northbound NAE off-ramp, and International Boulevard, are currently operating near or above capacity.[4] Peak periods occur between 12:45 p.m. and 1:45 p.m., 4:15 p.m. and 5:15 p.m., and 8:15 p.m. and 9:15 p.m. The Project is anticipated to relieve congestion in the Cell Phone Lot during these peak times where traffic movements are operating above capacity, when drivers are being turned away and parking alongside the road, in nearby communities, or circulating around the Main Terminal.

Construction would result in a temporary increase in traffic volumes during business hours due to workers and equipment traveling to/from the Project area. This includes the following:

- Approximately 130 truck trips to deliver and haul away about approximately 1,300 cubic yards of fill and excavated material to/from the Project area. This temporary increase in traffic for construction equipment is not anticipated to impact operating conditions in or within the vicinity of the project area.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

The Project will not interfere with, affect, or be affected by the movement of agricultural and forest

[4] HNTB, 2018. Air Cargo Road Safety Improvements Project: Traffic Analysis Report. Prepared for: Port of Seattle. November 14, 2018.

products on roads or streets in the area.

h. Proposed measures to reduce or control transportation impacts, if any:

A traffic control plan will be developed prior to construction to minimize traffic impacts to transportation. During construction, the primary site access routes will be via Air Cargo Road and South 170th Street. The Project would improve the level of service at the Air Cargo Road and South 170th Street intersection from a D (afternoon and evening peak hours) or F (midday peak hour) to an A. The Air Cargo Road and southbound NAE on-ramp would improve from an F to an A, and the South 170th Street and Cell Phone Lot driveway would improve from an F to a C. The South 170th Street and Northbound NAE intersections are anticipated to improve from an F to a B. Level of service grades are assigned according to the amount of delay (with "A" being less than 10 seconds up to "F" being more than 80 seconds for signalized intersections or more than 50 for unsignalized intersections). Grades E and F correspond to high levels of congestion. Queue lengths would also be decreased at these intersections (HNTB 2018, provided in Appendix B-1).

15. Public services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

The Project will not require an increased need for public services because there will be no employees on the site.

b. Proposed measures to reduce or control direct impacts on public services, if any.

There is not expected to be any direct impacts on public services. During construction, one lane will remain open so fire access will be maintained. While construction is occurring near the King County Metro bus stop at Air Cargo Road and South 166th Street, it is likely the stop will be temporarily relocated.

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other: stormwater

A water line connects a fire hydrant in the Cell Phone Lot to 170th Street, and a public Wi-Fi network is provided for Cell Phone Lot users. The Cell Phone Lot also includes electric vehicle charging stations.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

Bonneville Power Administration (Electricity) serves the Project area to provide energy needs for the proposed illumination as well as existing utilities like Wi-Fi, and electric vehicle charging stations.

Stormwater will be managed by the Port (see checklist Section 3.c for additional details on stormwater).

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: _____

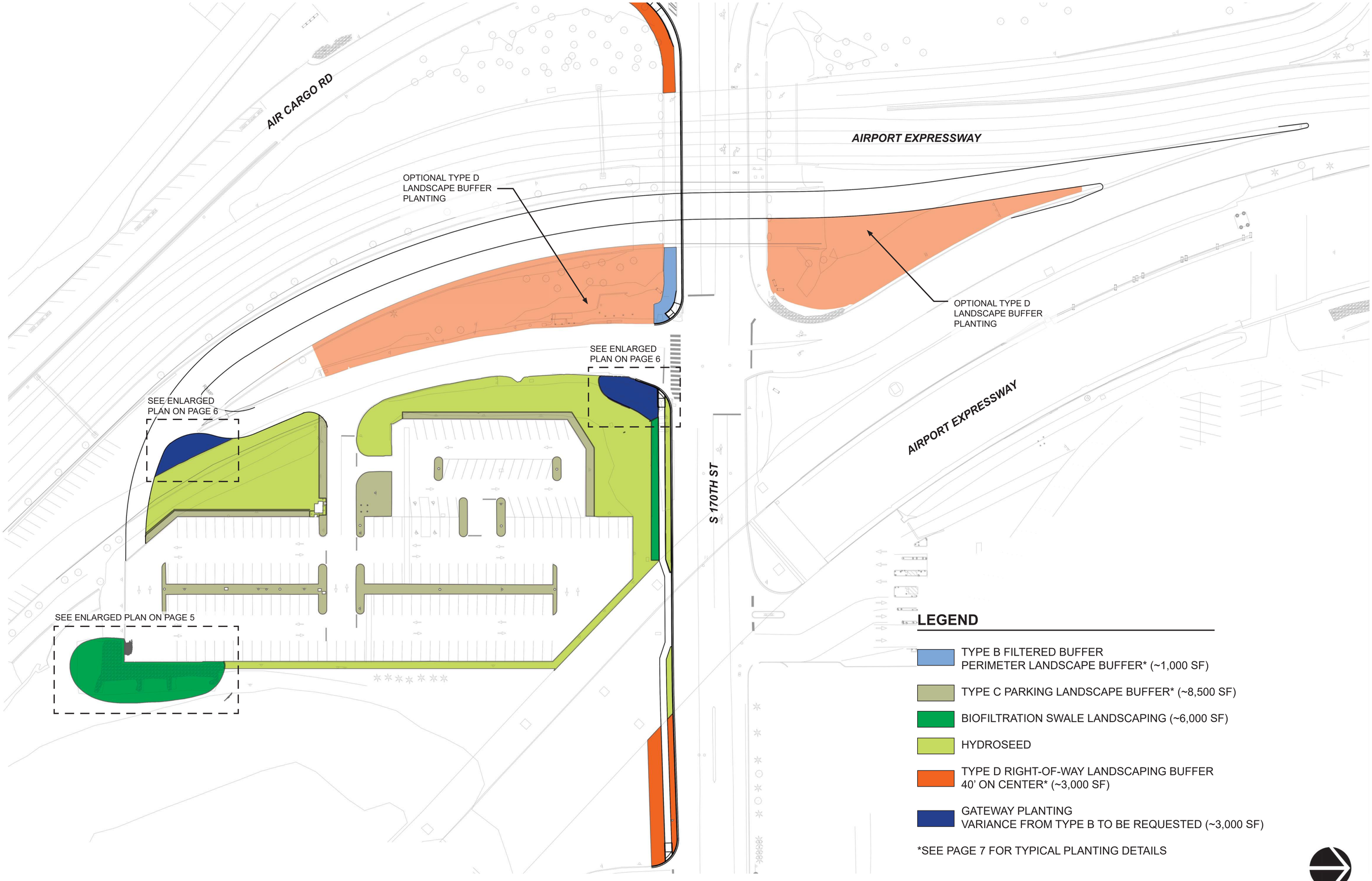
Name of signee: Steven Rybolt

Position /Organization Senior Environmental Programs Manager/Port of Seattle

Date Submitted: February 27, 2020

APPENDIX A

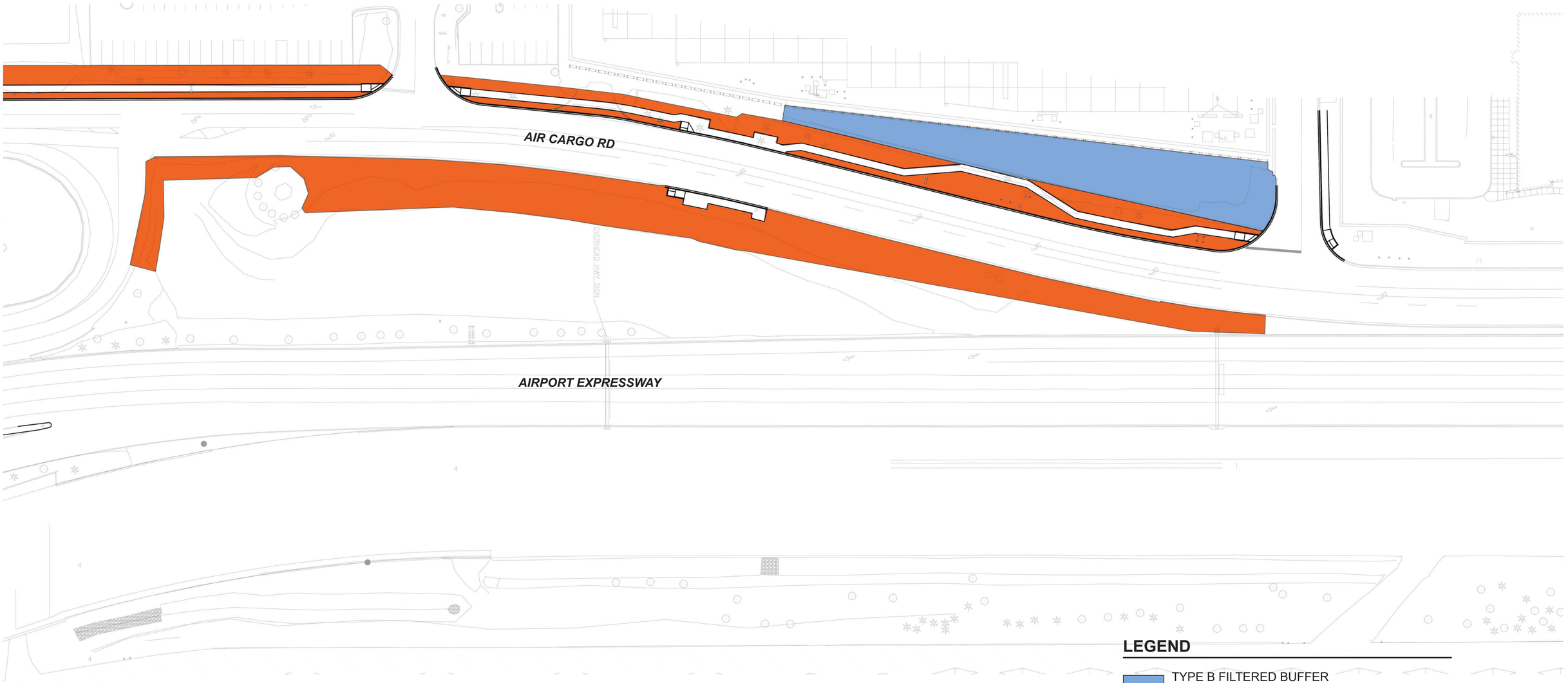
Landscape Concept Plan



LANDSCAPE CONCEPT PLAN
Air Cargo Road: Cell Phone Lot

SCALE = 1:40

October 4, 2019



LEGEND

TYPE B FILTERED BUFFER
PERIMETER LANDSCAPE BUFFER* (~15,000 SF)

TYPE D RIGHT-OF-WAY LANDSCAPING BUFFER
40’ ON CENTER* (~38,000 SF)

*SEE PAGE 7 FOR TYPICAL PLANTING DETAILS

SCALE = 1:40

October 4, 2019

LANDSCAPE CONCEPT PLAN

Air Cargo Road

LEGEND

TYPE D RIGHT-OF-WAY LANDSCAPING BUFFER
40' ON CENTER* (~30,000 SF)

*SEE PAGE 7 FOR TYPICAL PLANTING DETAILS

SCALE = 1:40

October 4, 2019

LANDSCAPE CONCEPT PLAN

Air Cargo Road

LEGEND

TYPE D RIGHT-OF-WAY LANDSCAPING BUFFER
40’ ON CENTER* (~7,500 SF)

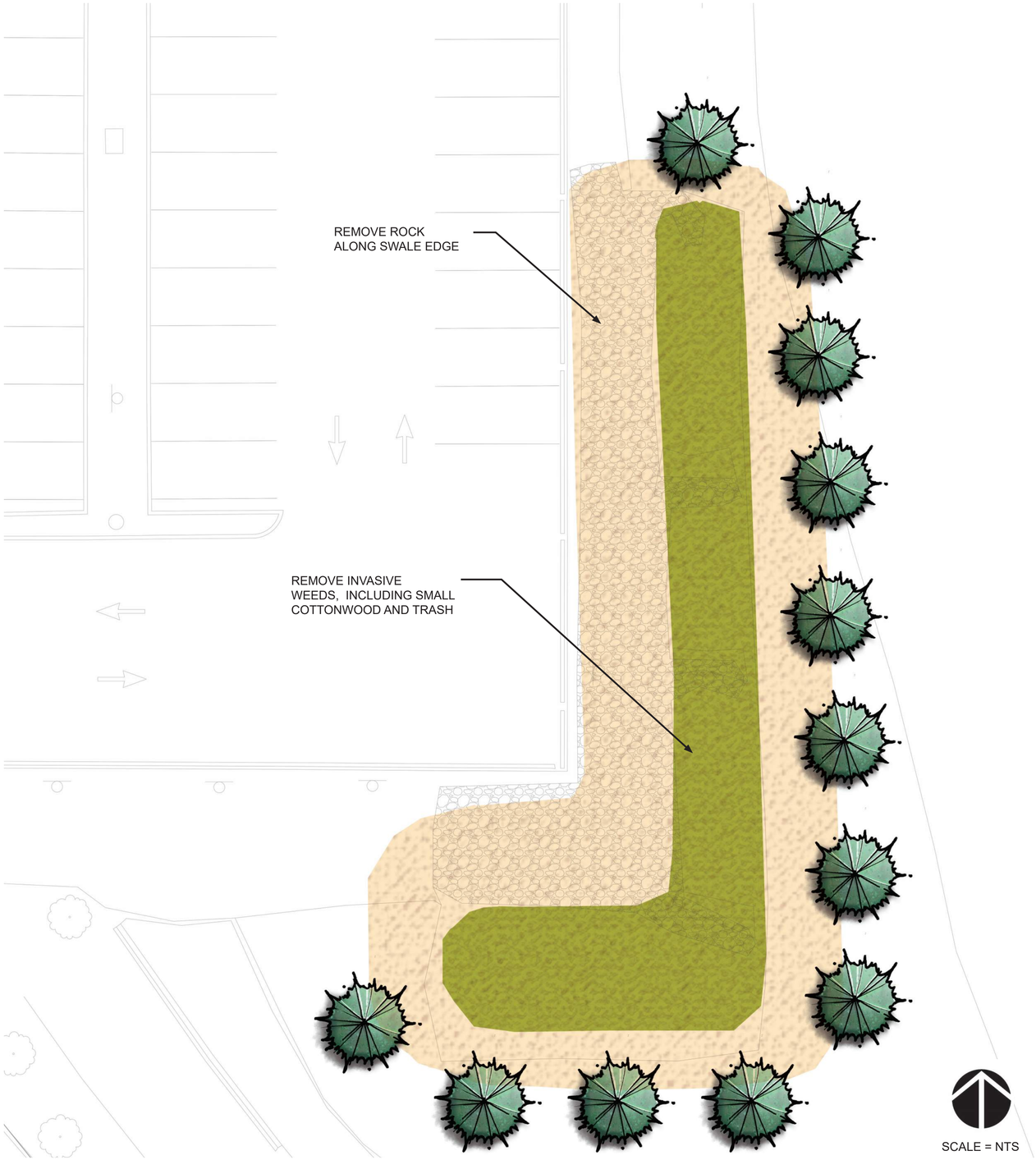
*SEE PAGE 7 FOR TYPICAL PLANTING DETAILS

SCALE = 1:40

October 4, 2019

LANDSCAPE CONCEPT PLAN

Air Cargo Road



BIOFILTRATION SWALE PLANT LIST:

SCIENTIFIC NAME	COMMON NAME	SIZE	SPACING	QTY
Pinus var. contorta	Shore Pine	4'-5' tall	20' O.C.	12
Rosa nutkana	Nootka Rose	1 gal.	4' O.C.	85
Deschampsia caespitosa	Tufted Hairgrass	1 gal.	2' O.C.	150
Potentilla gracilis	Slender Cinquefoil	1 gal.	TBD	85
Penstemon serrulatus	Cascade Penstemom	1 gal.	TBD	85
Ceanothus	Point Reyes	2 gal.	5' O.C.	30
Cistus x purpureus	Orchid Rockrose	2 gal.	TBD	30

LEGEND

SHORE PINE

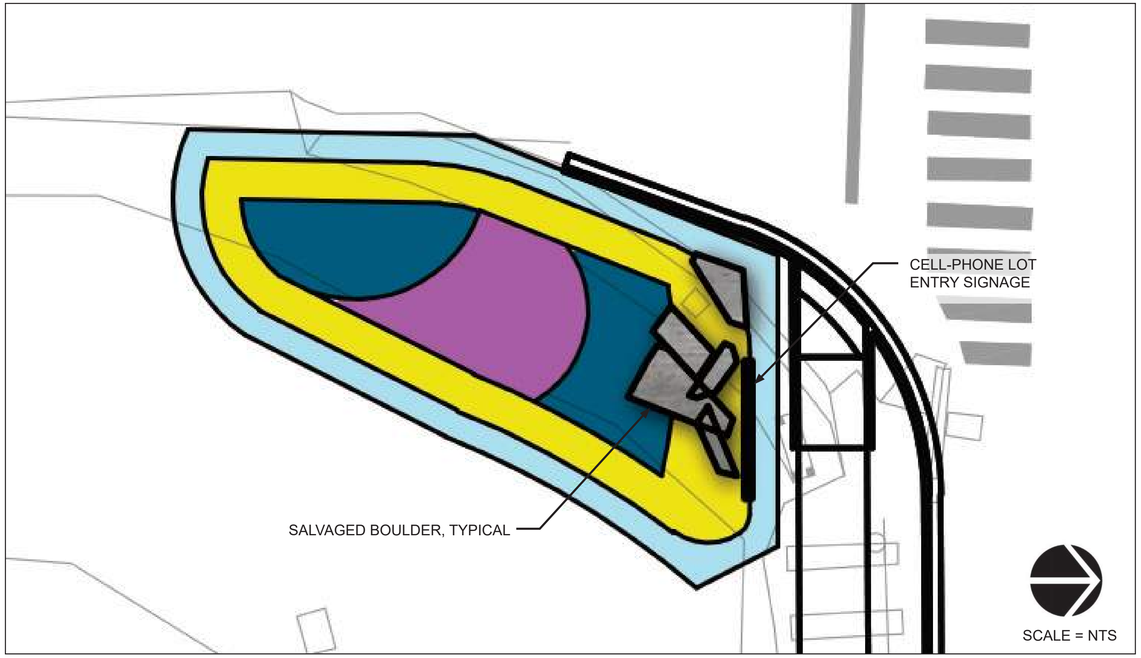
NATIVE SHRUB MIX

BIOFILTRATION SWALE GRASS AND HERBACIOUS PLANT MIX

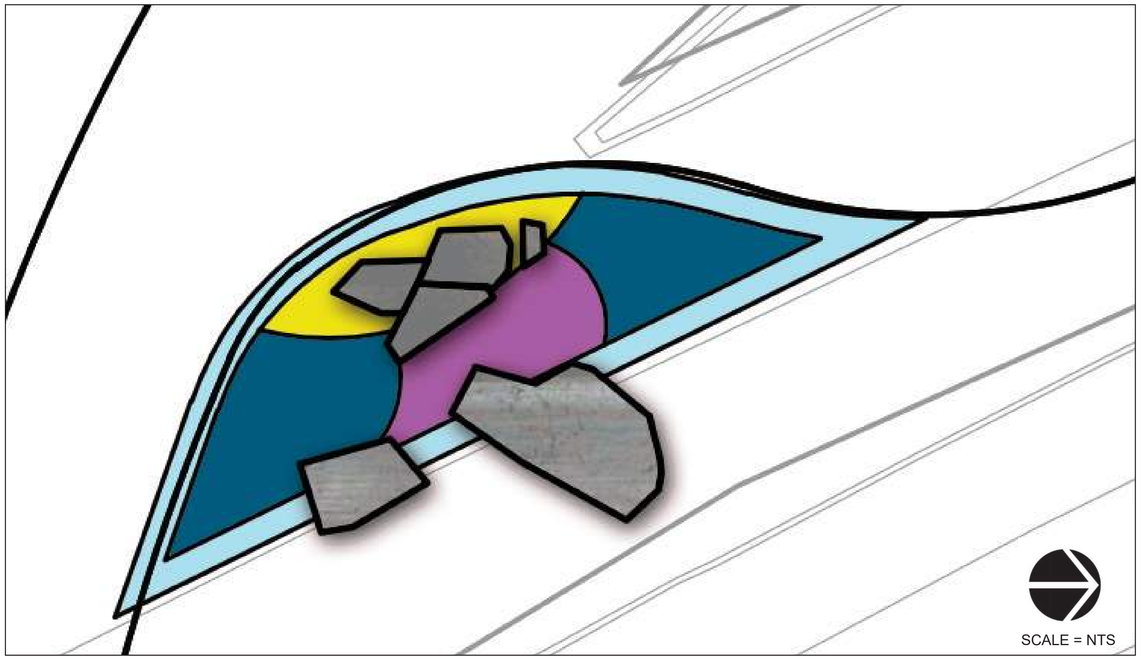
LANDSCAPE CONCEPT PLAN

Air Cargo Road: Biofiltration Swale Enlargement

October 4, 2019



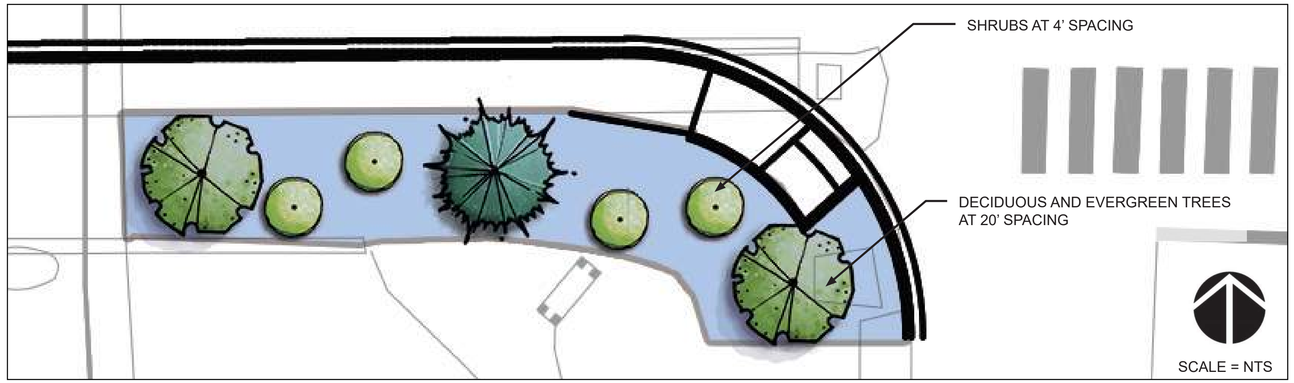
GATEWAY PLANTING #1



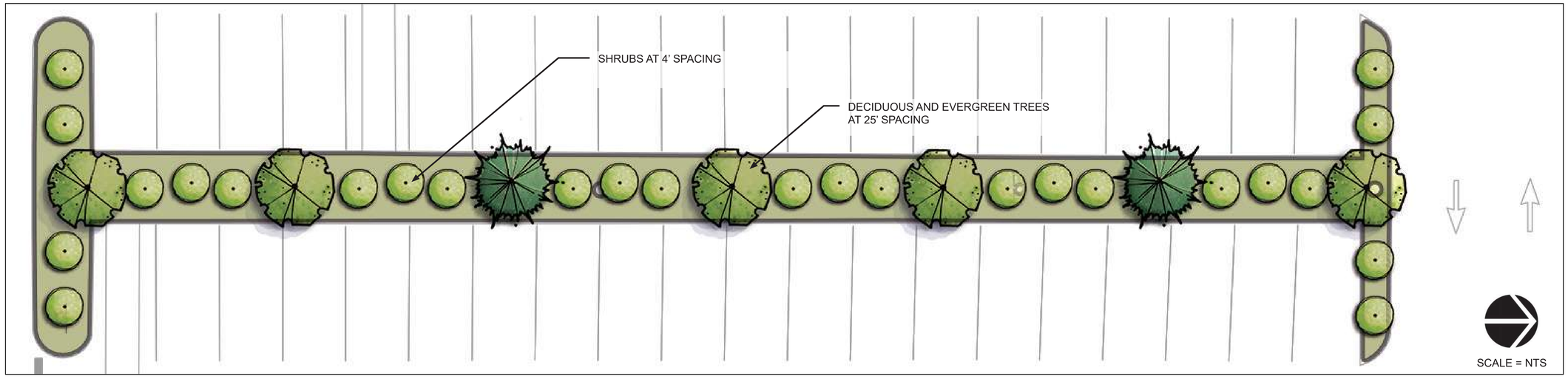
GATEWAY PLANTING #2

LEGEND

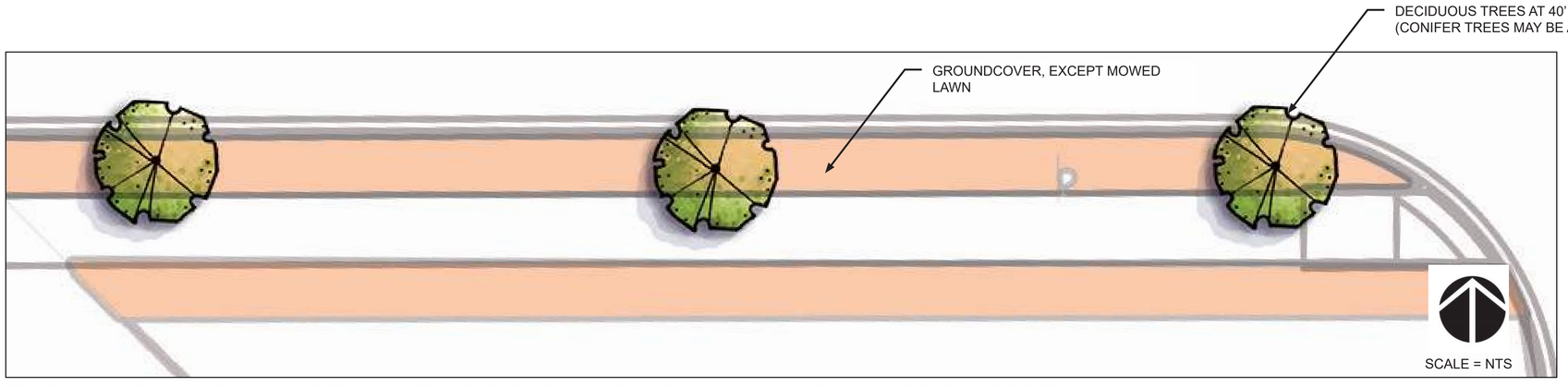
- EVERGREEN GROUNDCOVER
- LOW SMALL GRASS (0.5-1’ HT)
- LOW SPREADING OR MOUNDING EVERGREEN SHRUB
- EVERGREEN SHRUB WITH COLORFUL FLOWERS OR LEAVES



TYPICAL PLANTING DETAIL - TYPE B FILTERED BUFFER



TYPICAL PLANTING DETAIL - TYPE C PARKING LOT LANDSCAPE BUFFER



TYPICAL PLANTING DETAIL - TYvPE D RIGHT-OF-WAY LANDSCAPE BUFFER

LEGEND

- DECIDUOUS TREES
- EVERGREEN TREES
- SHRUB, 4' MAX. HEIGHT AT MATURITY

APPENDIX B-1

Traffic Analysis Report

AIR CARGO ROAD SAFETY IMPROVEMENTS PROJECT

Traffic Analysis Report

Prepared By:
HNTB Corporation
600-108th Avenue NE, Suite 900
Bellevue, WA 98004

November 14, 2018

TABLE OF CONTENTS

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INTRODUCTION

The Air Cargo Road Safety Improvements project will evaluate safety and operational modifications to several roadway facilities under the jurisdiction of the Port of Seattle and/or the City of SeaTac. The primary uses of the roadways in the study area are to access the Sea-Tac airport terminal which is one-half mile south of the study area, and other airport facilities such as the Cell Phone Lot, the consolidated rental car facility, air cargo facilities, and the air traffic control tower. Downstream congestion from both the arrivals and departures curbside operations can result in queues of vehicles regularly extending into the study area of this project.

Potential safety and traffic operations modifications include: traffic signal revisions at the Cell Phone Lot driveway, turn restrictions on S 170th Street, non-motorized facilities on Air Cargo Road and S 170th Street, bus stop amenities, additional turning lanes, and new traffic signals at intersections in the study area. Future Port of Seattle projects will add capacity the airport terminal roadways in order to reduce the queues that extend back from the terminal to S 170th Street and Air Cargo Road.

The purpose of this report is to summarize the existing traffic operations and safety conditions in the study area, and to summarize design year traffic operations analysis of no-build conditions and several build options. The project study area is shown in Figure 1. The study area is one-half mile north of the Sea-Tac Airport terminal and includes the following roadways:

- Air Cargo Road from S 166th Street to S 170th Street
- S 170th Street from Air Cargo Road to International Boulevard

Synchro analysis of existing traffic conditions shows that the following intersections operate at level of service “E” during one or more of the weekday peak hours:

- S 170th Street / Cell Phone Lot intersection during the evening peak hour
- S 170th Street / Northern Airport Expressway Northbound Off-Ramp during the afternoon PM peak hour and evening peak hour
- Air Cargo Road / Northern Airport Expressway Southbound On-Ramp during the midday peak hour

Figure 1 – Project Area

Traffic movements at S 170th Street intersections operating near or above capacity during several of the peak hours include:

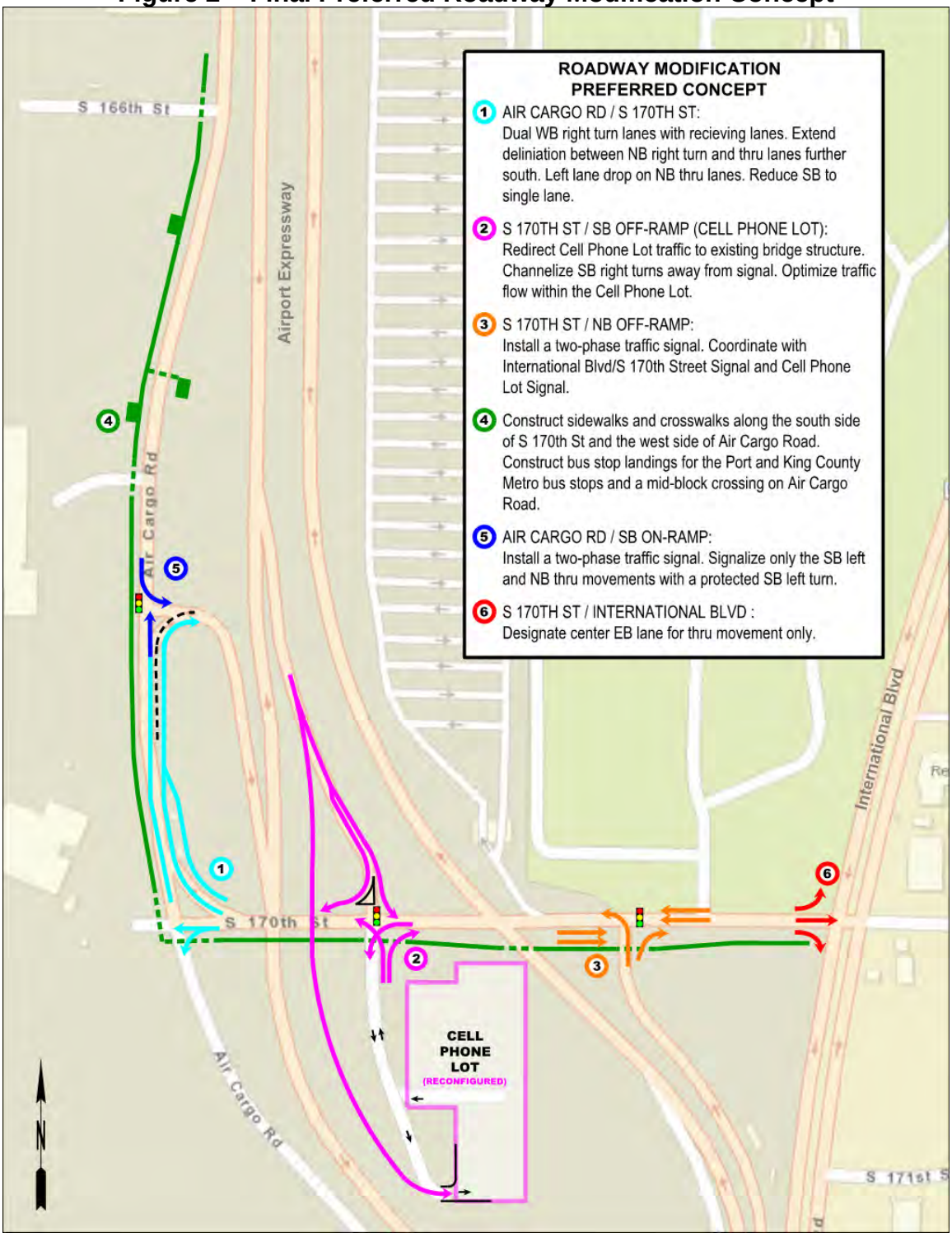
- Northbound and westbound movements at the Cell Phone Lot intersection
- Northbound movements at the Northern Airport Expressway Northbound Off-Ramp
- The eastbound right-turn and northbound left-turn movements at International Boulevard

To address these traffic operation deficiencies and safety issues documented in this report, the recommended roadway modifications include:

- Revised access in and out of the Cell Phone Lot, and associated restriping of the Cell Phone Lot
- Dual westbound right-turn lanes at the S 170th Street / Air Cargo Road intersection
- Installation of a traffic signal at the S 170th Street / Northern Airport Expressway Northbound Off-Ramp intersection
- Rechannelization of the eastbound lanes at the S 170th Street / International Boulevard intersection to provide separate left-turn, through and right-turn lanes
- Sidewalk and bus stop improvements on Air Cargo Road and S 170th Street
- An annual monitoring program of traffic signal warrants to determine when the installation of a traffic signal at the Air Cargo Road / Northern Airport Expressway Southbound On-Ramp intersection would be warranted.

The Preferred Roadway Modification Concept is shown in Figure 2. Analysis and evaluation of the Roadway Modification Concepts is included in the Design Year Traffic Analysis chapter of this report.

Figure 2 – Final Preferred Roadway Modification Concept



EXISTING CONDITIONS TRAFFIC ANALYSIS

The following sections of this report comprise an analysis of existing traffic conditions in the project study area. Roadway descriptions, travel patterns, crash history, peak hour operations analysis and design hour determination are included.

ROADWAY DESCRIPTIONS

Air Cargo Road and S 170th Street are the two roadways included in this project. These roadways provide access to the Northern Airport Expressway, which is the primary access roadway to the airport terminal.

Air Cargo Road is a north-south arterial roadway under the jurisdiction of the Port of Seattle. A single lane is provided in each direction of travel south of S 160th Street, with northbound left-turn lanes to provide access (and periodic freight delivery queuing storage) to properties west of Air Cargo Road. Between S 170th Street and the southbound on-ramp to Northern Airport Expressway two travel lanes are provided in each direction. Transit service on Air Cargo Road includes King County Metro Route 180, Port of Seattle employee parking shuttles, and rental car facility shuttles. On-street parking is prohibited on Air Cargo Road. Sidewalks and bicycle lanes are not provided in the study area. South of S 170th Street, Air Cargo Road is a restricted to airport traffic and public access is not allowed. Intersections on Air Cargo Road include: S 170th Street (accessing the airport fire station), the southbound on-ramp to Northern Airport Expressway, and S 166th Street. All intersections on the roadway are unsignalized. The posted speed limit is 30 mph. The average daily traffic volume in 2018 on Air Cargo Road between S 170th Street and the southbound on-ramp to Northern Airport Expressway is 18,000 vehicles per day (vpd). North of the southbound on-ramp to Northern Airport Expressway, the average daily traffic volume is 13,000 vpd.

S 170th Street is an east-west minor arterial roadway under the jurisdiction of the Port of Seattle and the City of SeaTac. Port of Seattle right-of-way extends west from the west side of the Cell Phone Lot driveway, and City of SeaTac right-of-way extends east from the west side of the Cell Phone Lot driveway. Two lanes are provided in each direction of travel in the study area, and an eastbound left-turn lane is added at the intersection with International Boulevard. Transit service on S 170th Street includes King County Metro Route 180, Sound Transit Regional Express Route 574 (inbound to the airport terminal), Port of Seattle employee parking shuttles, and rental car facility shuttles. On-street parking is prohibited on S 170th Street. Sidewalks and bicycle lanes are not provided in the study area. Intersections on S 170th Street include: Air Cargo Road, the southbound off-ramp from Northern Airport Expressway / Cell Phone Lot, Doug Fox Parking Lot Access, the northbound off-ramp from Northern Airport Expressway, and International Boulevard (State Route 99). The International Boulevard intersection and the southbound off-ramp from Northern Airport Expressway / Cell Phone Lot intersection are signalized, other intersections on S 170th Street are unsignalized. The posted speed limit is 35 mph. The average daily traffic volume in 2018 east of the Air Cargo Road intersection is 18,000 vpd.

S 166th Street is an east-west roadway under the jurisdiction of the Port of Seattle providing access to the airfield, the air traffic control tower and adjacent businesses. A single lane is provided in each direction of travel west of Air Cargo Road. S 166th Street terminates at an airfield gate 500 feet west of Air Cargo Road. No transit routes operate on S 166th Street.

Northern Airport Expressway is a north-south limited access roadway under the jurisdiction of the Port of Seattle. In the project study area, five lanes are provided in the northbound direction, and three lanes are provided in the southbound direction. A fourth southbound inside lane drops off at the off-ramp to S 170th Street, and the on-ramp from Air Cargo Road adds a fourth southbound lane on the outside. Transit service on Northern Airport Expressway includes Sound Transit Regional Express Routes 560 and 574. The posted speed limit in the study area is 40 mph. The average daily traffic volume on southbound Northern Airport Expressway (NAE) at S 160th Street in 2018 is 32,000 vpd.

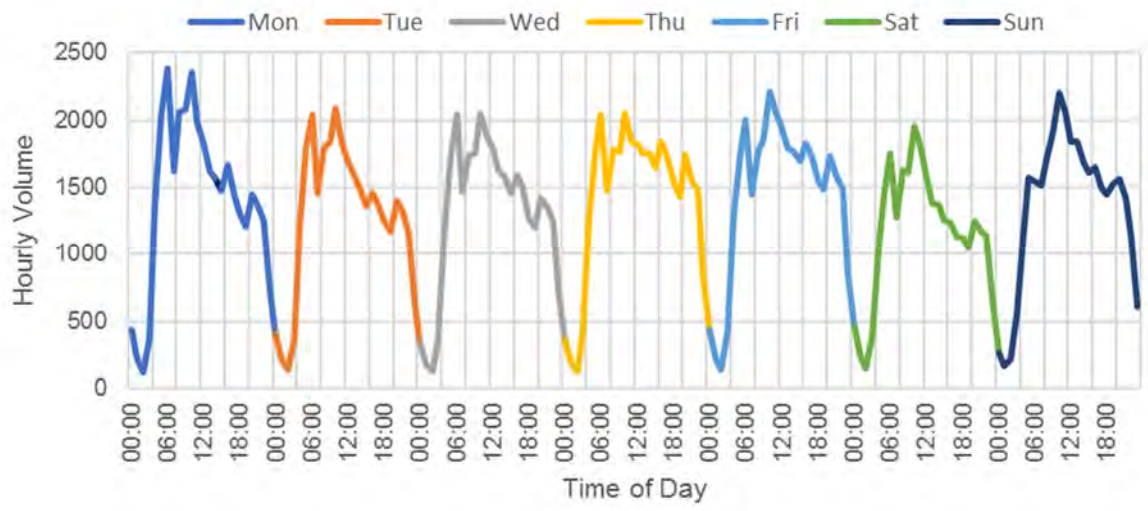
International Boulevard (State Route 99) is a north-south principal arterial roadway under the jurisdiction of the City of SeaTac. Two lanes are provided in each direction of travel in the vicinity of S 170th Street, with a left-turn lane also provided in each direction at the intersection with S 170th Street. A third southbound lane serves as a transit and carpool lane, with right-turns allowed at intersections. Transit service on International Boulevard in the project study area includes King County Metro Route 180 and RapidRide A Line, both of which accommodate transfers to the Sound Transit Link Light Rail station at S 176th Street. On-street parking is prohibited. Sidewalks are provided on both sides of International Boulevard. Bicycle lanes are not provided; however International Boulevard is shown as a bicycle route / shared street in the existing conditions map of the City of SeaTac Safe & Complete Streets Plan. The posted speed limit is 40 mph. The average daily traffic volume reported in WSDOT's 2016 annual traffic report is 27,000 vpd.

EXISTING TRAVEL PATTERNS

The roadways in the project study area provide access to the Sea-Tac airport terminal, air cargo facilities, rental car facilities, and the Cell Phone Lot, as such, peak periods of vehicular traffic volumes correlate to peak periods of airline arrivals and departures. Figure 3 shows the average hourly volumes on southbound Northern Airport Expressway at S 160th Street during the first four months of 2018. Most days of the week show four peak hours: early morning, midday, afternoon, and late evening. The early morning peak is associated with morning flight departures. The midday peak is associated with high volumes of arriving and departing flights. The afternoon and late evening peaks are associated with higher levels of arriving flights.

Times of day with higher levels of arriving flights result in higher levels of roadway congestion in the project study area, both due to the location of the Cell Phone Lot and to roadway capacity constraints further south on Northern Airport Expressway where parking, taxi, transportation network company (TNC), courtesy shuttle, rental car facility bus, and arrivals curbside activities are served in two travel lanes.

**Figure 3 – Southbound Northern Airport Expressway
2018 Hourly Volumes at S 160th Street**



Peak Periods and Peak Hours

Three peak periods are analyzed in this project: weekday midday, afternoon (PM peak), and late evening. The Cell Phone Lot is utilized most in the midday and late evening peak periods. Truck traffic on Air Cargo Road is highest in the midday hours, and traffic in the vicinity of International Boulevard is highest during the weekday PM peak period.

Three-hour peak periods were defined for traffic data collection:

- 11:00 am – 2:00 pm (midday)
- 4:00 pm – 7:00 pm (PM peak)
- 8:00 pm – 11:00 pm (late evening)

Vehicular turning movement counts collected in June 2018 resulted in the following peak hours:

- 12:45 pm – 1:45 pm (midday)
- 4:15 pm – 5:15 pm (PM peak)
- 8:15 pm – 9:15 pm (late evening)

Traffic Data Collection

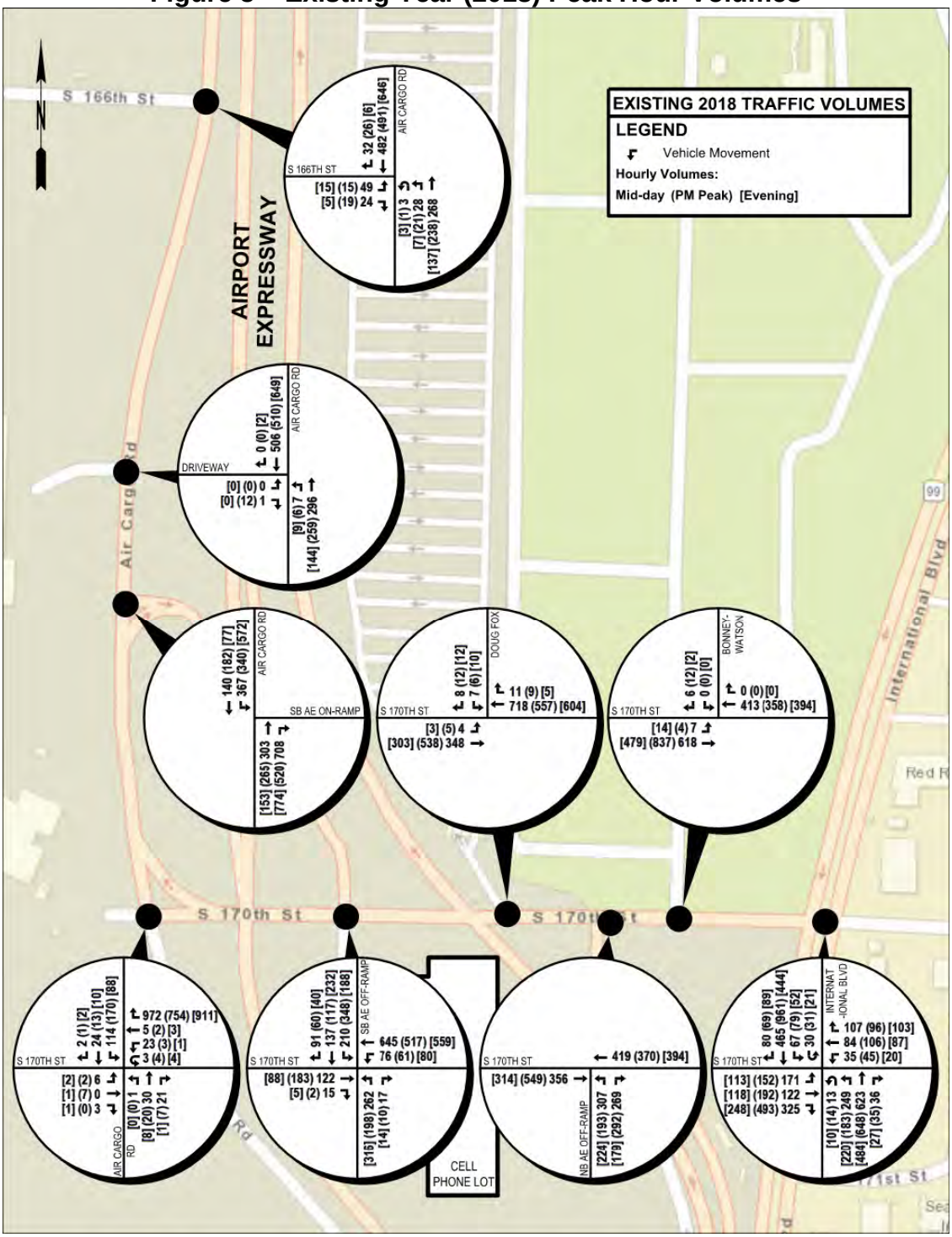
The following traffic data was collected for each of the three 3-hour peak periods in June 2018 to analyze existing conditions on Air Cargo Road and S 170th Street: intersection turning movement counts, queue length data, and vehicle origin-destination data using license plate reading cameras. Volume, speed and, vehicle classification data were collected for a 7-day period in June 2018.

Figure 4 – Traffic Data Collection Locations

2018 Traffic Volumes and Speeds

Intersection turning movement counts are shown in Figure 5 and are also appended to this report in Appendix A.

Figure 5 – Existing Year (2018) Peak Hour Volumes



Average hourly volumes and average speeds on Air Cargo Road south of S 166th Street are shown on Figure 6 and Figure 7, respectively. The highest northbound volume occurs prior to the midday peak period. The highest southbound volume occurs during the late evening peak period. TNCs travel on this segment of Air Cargo Road to access the airport terminal. Average speeds are 30 mph or higher.

Figure 6 – Air Cargo Road south of S 166th Street
2018 Average Weekday Hourly Volumes (vph)

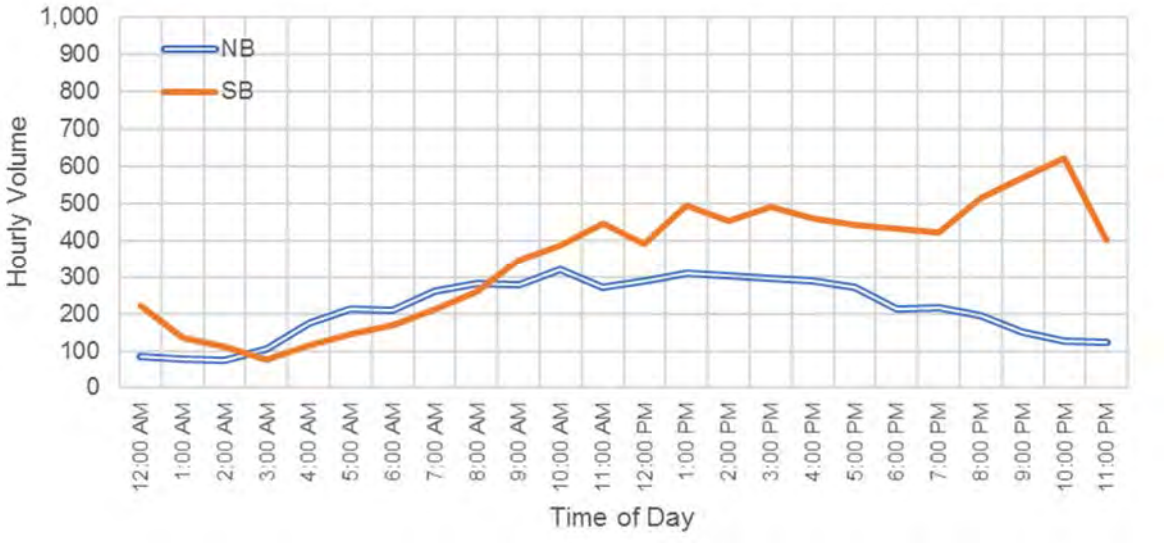
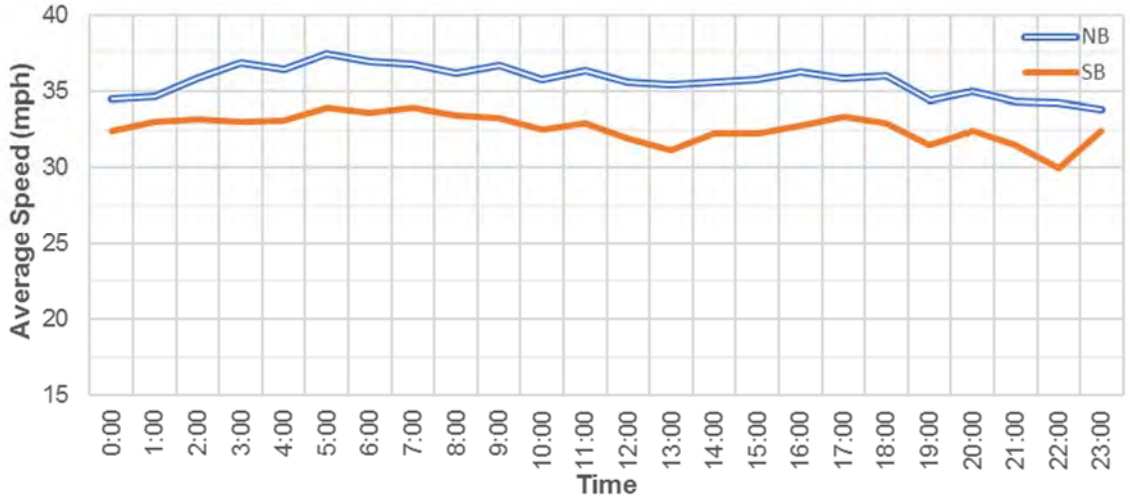


Figure 7 – Air Cargo Road south of S 166th Street
2018 Average Weekday Speeds (mph)



Average hourly volumes and average speeds on Air Cargo Road north of S 170th Street are shown on Figure 8 and Figure 9, respectively. The lowest average speeds occur during the late evening peak period, when northbound speeds average 20 mph. Late evening traffic operations are affected by congestion on Northern Airport Expressway approaching the airport terminal. The highest volumes occur during the midday and late evening peak periods.

Figure 8 – Air Cargo Road north of S 170th Street
2018 Average Weekday Hourly Volumes (vph)

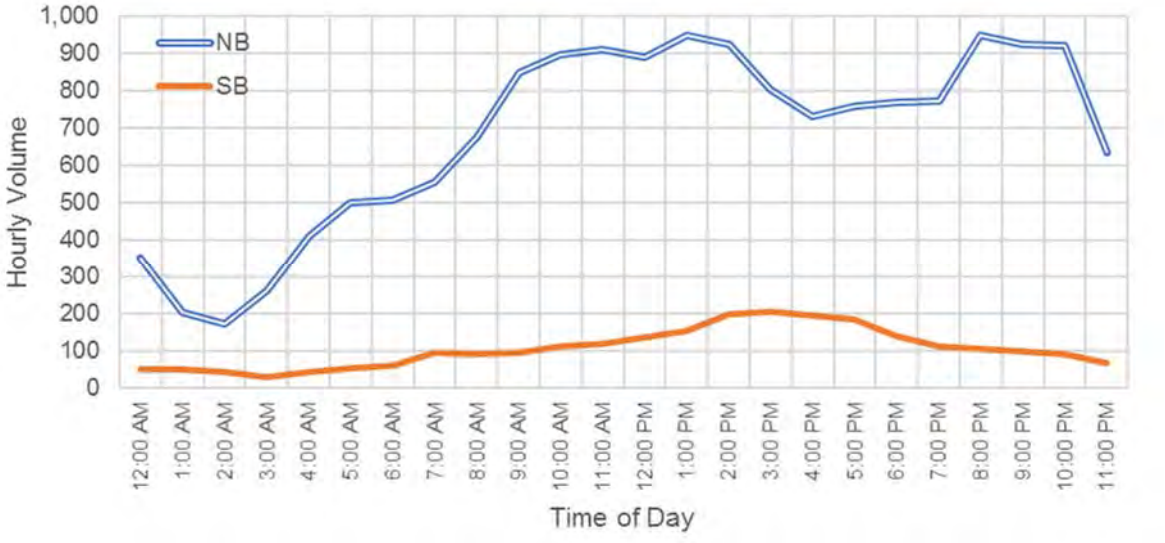
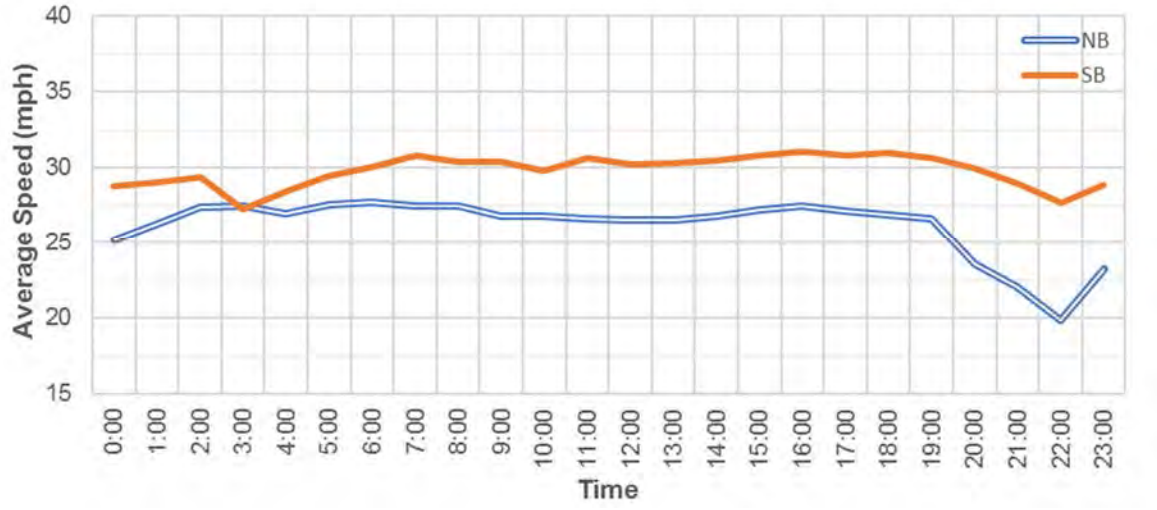


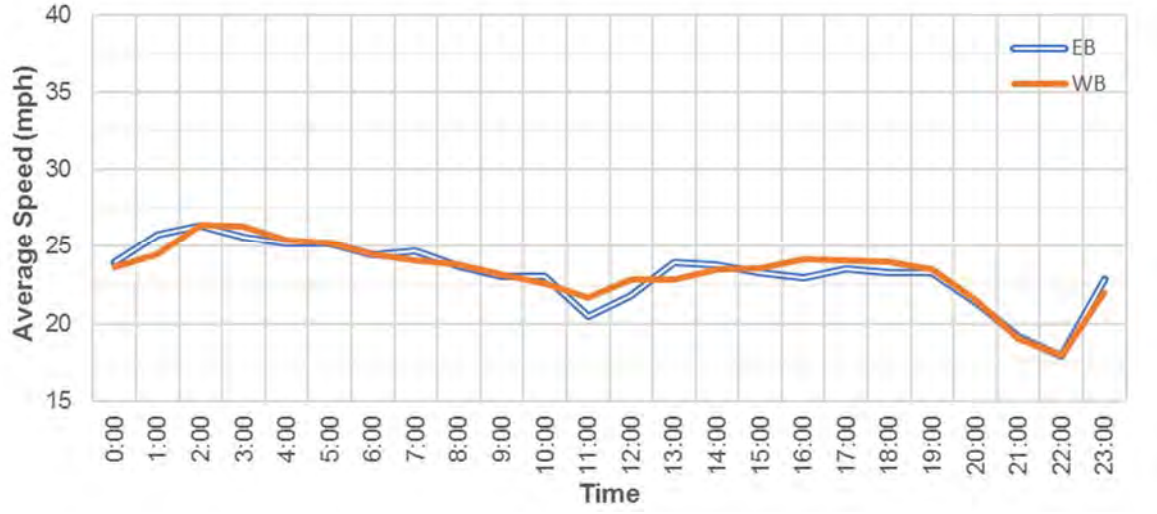
Figure 9 – Air Cargo Road north of S 170th Street
2018 Average Weekday Speeds (mph)



Average hourly volumes and average speeds on S 170th Street, east of Air Cargo Road, are shown on Figure 10 and Figure 11, respectively. The lowest average speeds occur during the late evening peak period, when westbound speeds average less than 20 mph. Late evening traffic operations are affected by congestion on Northern Airport Expressway approaching the airport terminal. The highest volumes occur during the midday and late evening peak periods.

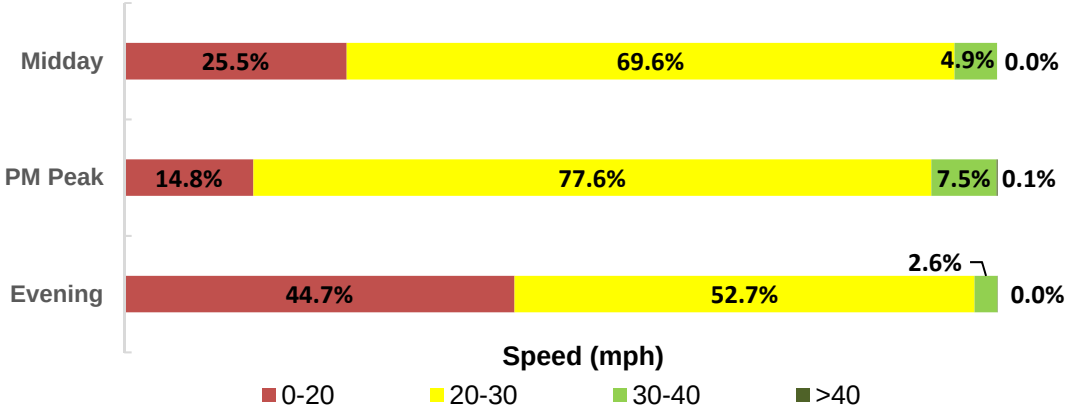
Figure 10 – S 170th Street east of Air Cargo Road
2018 Average Weekday Hourly Volumes (vph)

Figure 11 – S 170th Street east of Air Cargo Road
2018 Average Weekday Speeds (mph)



The distribution of vehicular speeds on westbound S 170th Street during the three weekday peak periods is shown on Figure 12. Travel speeds under 20 mph on this segment of S 170th Street indicate congested traffic operations because the downstream intersection traffic control provides free right-turn movements onto Air Cargo Road and southbound Northern Airport Expressway. Speeds of 20 mph or less were recorded by 45 percent of vehicles in the late evening peak period, 15 percent of vehicles in the PM peak and 25 percent of vehicles in the midday peak period.

Figure 12 – Westbound S 170th Street east of Air Cargo Road
Distribution of Peak Period Speeds



Origin-Destination Patterns

Origin-destination patterns of vehicles on Air Cargo Road and S 170th Street were collected using license plate reading cameras. Cameras were placed at endpoints of the study area, and the data collection software matched the beginning and end points of trips in the project study area. The data was analyzed using a 30-minute time period from when a vehicle first entered the network and the last recorded destination of each matched vehicle. This accounts for vehicles utilizing the Cell Phone Lot. Table 1 shows the beginning points (origins) of interest, and the common end points (destinations). This data is also presented in Figure 13, Figure 14, and Figure 15.

The origin-destination data shows that during the three-hour peak periods:

- 69-percent to 83-percent of vehicles traveling west on S 170th Street from International Boulevard are destined to southbound Northern Airport Expressway, as are 54-percent to 68-percent of vehicles from the Northern Airport Expressway northbound off-ramp.
- 70-percent to 76-percent of vehicles traveling southbound on Air Cargo Road at S 166th Street are destined to southbound Northern Airport Expressway.
- The majority of vehicles turning left from the Northern Airport Expressway southbound off-ramp to eastbound S 170th Street (62-percent to 73-percent) are destined to International Boulevard, and were not recorded recirculating or re-entering the study area.

Table 1 – Weekday Peak Period Origin-Destination Patterns

			Midday Peak Hour	PM Peak Hour	Evening Peak Hour
			% of Trips / Volume	% of Trips / Volume	% of Trips / Volume
WBT S 170th St, west of SR-99	→	NB Air Cargo Rd	23% / 96	25% / 92	16% / 62
		SB Airport Expressway On-Ramp	71% / 297	69% / 254	83% / 328
		Other	6% / 27	6% / 24	1% / 4
NBL Airport Expressway Off-Ramp	→	NB Air Cargo Rd	37% / 113	43% / 83	26% / 58
		SB Airport Expressway On-Ramp	61% / 189	54% / 105	68% / 153
		Other	2% / 5	3% / 5	6% / 13
SBT Air Cargo Rd	→	EB 170th St	9% / 44	14% / 75	8% / 51
		SB Airport Expressway On-Ramp	72% / 367	70% / 365	76% / 495
		Other	19% / 96	16% / 82	16% / 102
SBL Airport Expressway Off-Ramp	→	EB 170th St	62% / 131	71% / 246	73% / 137
		Other	38% / 79	29% / 102	27% / 51

Figure 13 – Weekday Midday Peak Period Origin-Destination Patterns

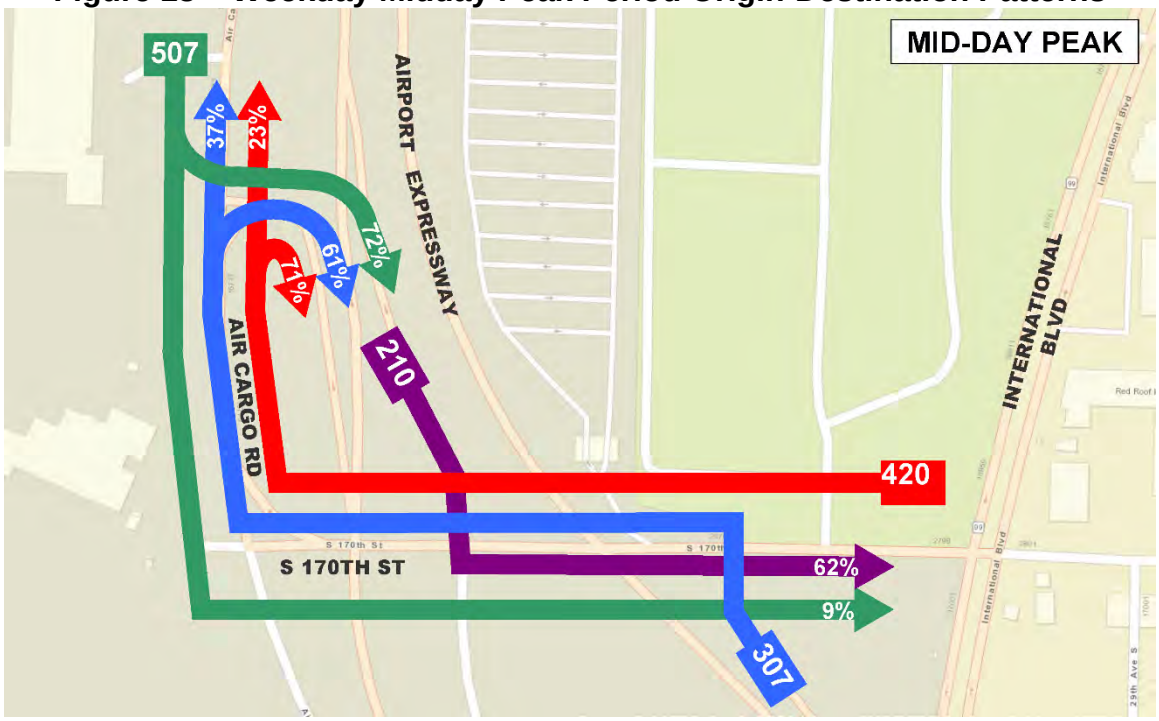


Figure 14 – Weekday PM Peak Period Origin-Destination Patterns

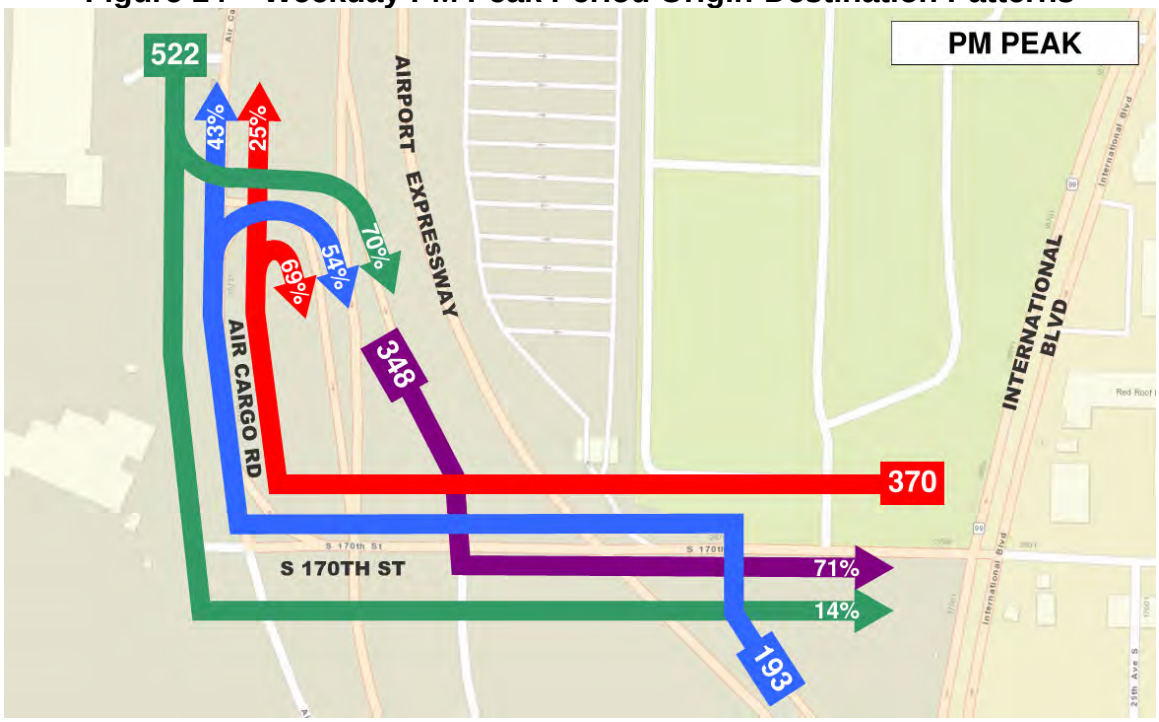
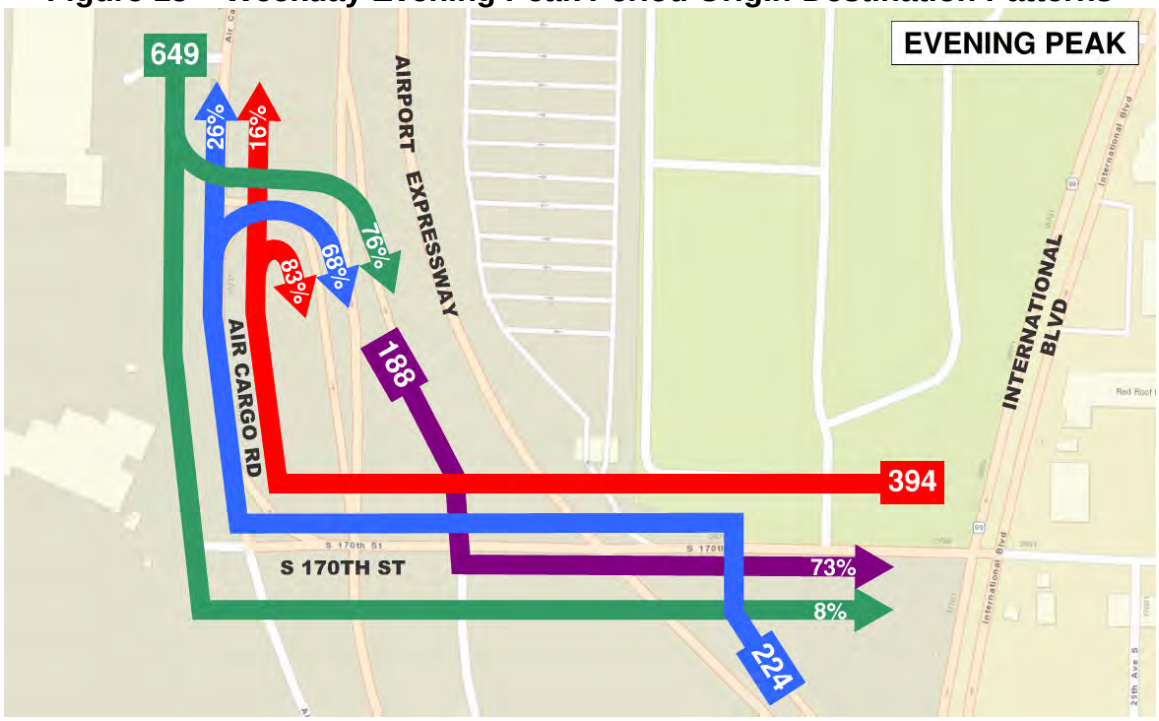


Figure 15 – Weekday Evening Peak Period Origin-Destination Patterns



Vehicle Classification Counts

Axle counts from the 7-day mechanical tube count data are used to determine the classification of vehicles using Air Cargo Road and S 170th Street. Table 2 shows that on an average day in the study area, 1-percent of the vehicles using the roadways are tractor-trailers, 20-percent are buses, courtesy shuttles, or single-unit trucks, and the remaining 79-percent are passenger vehicles.

Table 2 – Average Daily Vehicle Classification Distribution

		Classification			
		Passenger Vehicle	Buses	Single-Unit Trucks	Tractor-Trailer
		FHWA Vehicle Classification Categories			
Location	Direction	1,2,3	4	5,6,7	8 - 13
S 170th St Between Air Cargo Rd & SB Expressway Off-Ramp	EB	1903	8	350	24
	WB	12460	90	3345	128
	Total	14363	99	3695	152
	%	**78%**	**1%**	**20%**	**1%**
Air Cargo Rd Between S 170th St & SB Expressway On-Ramp	NB	12335	88	3527	141
	SB	1794	27	463	39
	Total	14129	115	3991	180
	%	**77%**	**<1%**	**22%**	**1%**
Air Cargo Rd Between SB Expressway On-Ramp & S 166th St	NB	3721	63	944	90
	SB	6750	6	1101	45
	Total	10471	68	2044	135
	%	**82%**	**1%**	**16%**	**1%**

TRAFFIC CRASH HISTORY ANALYSIS

Records of traffic crashes that occurred in the project study area between January 1, 2013 and December 31, 2017 were obtained from the Port of Seattle and WSDOT. Hardcopy records from the Port of Seattle were cross-referenced against the spreadsheet from WSDOT. A single dataset of all crash records was created in spreadsheet format and mapped using GIS software.

Crashes by Location

Crash locations are mapped in Figure 16. The number of crashes that occurred at each of the seven study area intersections is shown, along with the total number of crashes that occurred on Air Cargo Road and S 170th Street in the study area. The intersection with the highest number of crashes was S 170th Street / International Boulevard (167 crashes). The next highest number of crashes was 27 at S 170th Street / Cell Phone Lot. A total of 16 crashes occurred at the Air Cargo Road / Southbound NAE On-Ramp intersection.

The crash rate on S 170th Street between 2013 and 2017 was 2.1 crashes per million vehicle miles traveled (VMT), and the crash rate on Air Cargo Road was 0.6 crashes per million VMT. These crash rates are lower than the King County average of 2.5 crashes per million VMT, as reported in WSDOT's most recent Annual Collision Summary (2015).

Figure 16 – Crash Locations from Years 2013 Through 2017

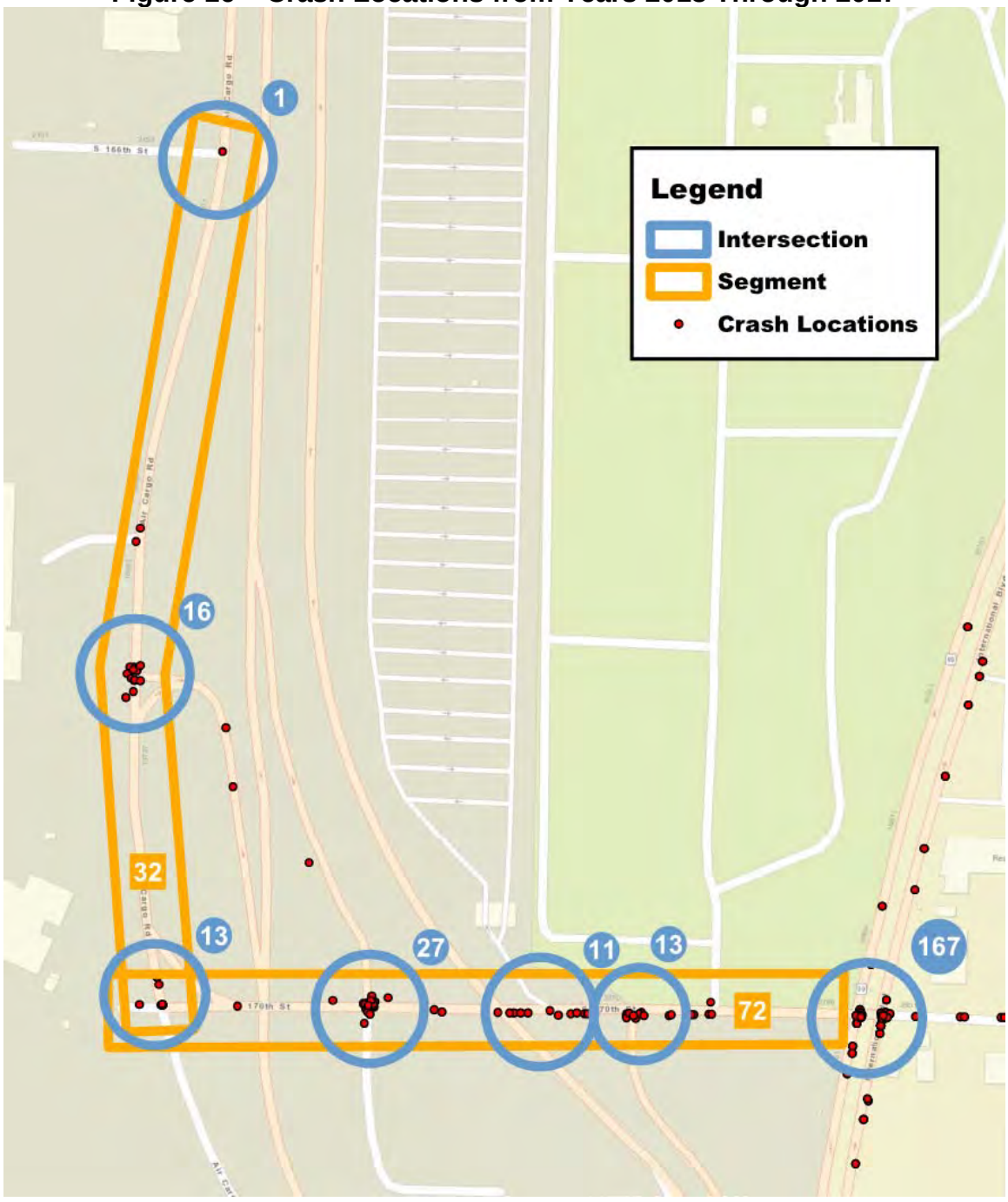
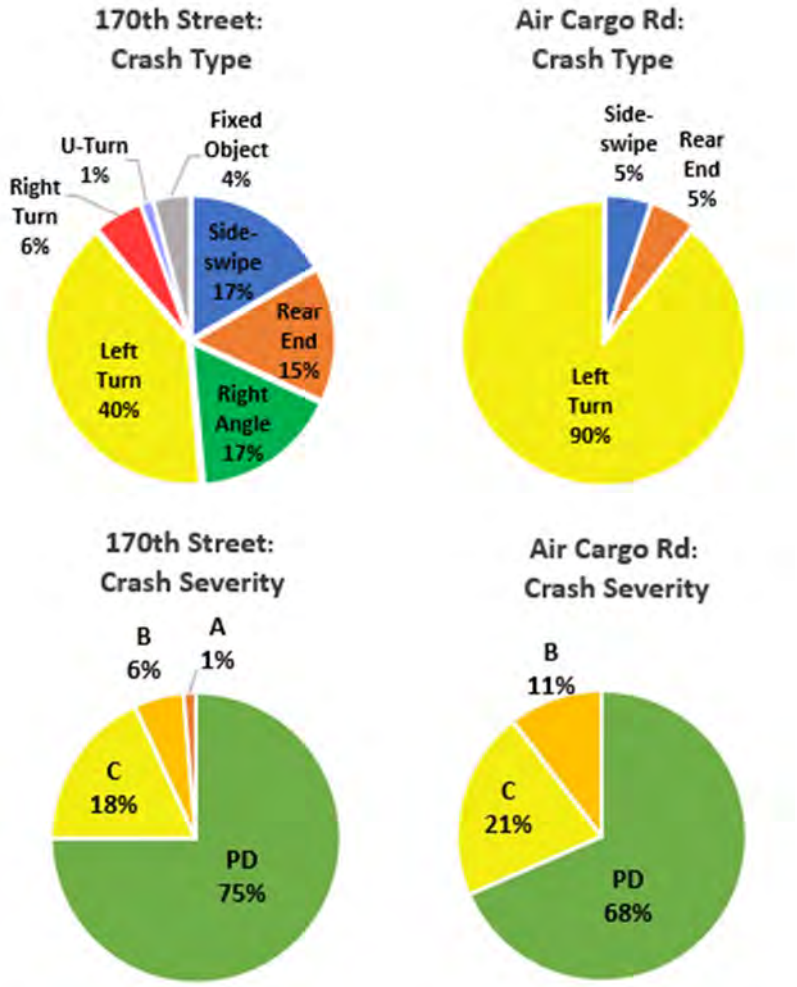


Figure 17 – Crash Types and Severities from Years 2013 Through 2017 on Air Cargo Road and S 170th Street



Crash types and crash severities on Air Cargo Road and S 170th Street are shown on Figure 17. The most common crash type on both of these roadways is left-turn related crashes. Permissive left-turn phasing at signalized intersections and stop-controlled left-turns where the intersecting traffic is not stop-controlled are traffic control types that contribute to left-turn crashes.

Crash severities are categorized as property damage only (PD), possible injury (C), suspected minor injury (B), suspected serious injury (A), and fatality (K). No fatal crashes occurred on Air Cargo Road or S 170th Street between 2013 and 2017. The majority of crashes on Air Cargo Road (89-percent) and S 170th Street (93-percent) were property damage only or possible injury crashes.

Crashes by Year

Crash records at the study area intersections were sorted by year to analyze year-over-year trends. The number of crashes per year was consistent at the S 170th Street intersections at International Boulevard and Air Cargo Road.

The number of crashes at the S 170th Street / Northbound NAE Off-Ramp intersection increased to eight (8) in 2017. There were three or fewer crashes in all other years. The number of crashes at the S 170th Street / Cell Phone Lot intersection increased to nine (9) in 2016. There were five or fewer crashes in all other years. These increases may be related to higher levels of TNC activity around the airport.

The number of crashes at the Air Cargo Road / Southbound NAE On-Ramp intersection peaked in 2015 with five (5) crashes and decreased to three (3) crashes in 2017. This decrease in crashes may be related to channelization changes on northbound Air Cargo Road, encouraging northbound motorists to position in either the through lane or the right-turn lane in advance of the intersection.

Table 3 – Crashes at Study Area Intersections by Year (2013 – 2017)

		Year				
Intersection	Total Crashes	2013	2014	2015	2016	2017
170th St & SR 99	167	38	34	37	28	30
170th St & NB Expressway Off-Ramp	13	0	2	3	0	8
170th St & Doug Fox Lot	11	0	1	4	4	2
170th St & Cell Phone Lot	27	5	4	4	9	5
170th St & Air Cargo Rd	13	2	3	3	2	3
Air Cargo Rd & SB Expressway On-Ramp	16	3	1	5	4	3
Air Cargo Rd & 166th St	1	1	0	0	0	0
Total	248	49	45	56	47	51
%		20%	18%	22%	19%	21%

Crashes by Time of Day

Crash records at the study area intersections were sorted by time of day to investigate the percentage of crashes occurring during peak periods and peak hours. Of the 248 total crashes in the study area between 2013 and 2017, 54-percent (134 crashes) occurred during the three 3-hour peak periods. 22-percent of all crashes occurred during the three peak hours.

Table 4 – Crashes at Study Area Intersections During Peak Hours

		Midday	PM Peak	Evening	All Peak Periods
Intersection	Total Crashes	12:45-13:45	16:15-17:15	20:15-21:15	(9 hours)
170th St & SR 99	167	8	12	10	84
170th St & NB Expressway Off-Ramp	13	2	0	2	8
170th St & Doug Fox Lot	11	2	0	2	8
170th St & Cell Phone Lot	27	1	2	5	15
170th St & Air Cargo Rd	13	2	0	0	6
Air Cargo Rd & SB Expressway On-Ramp	16	3	3	0	13
Air Cargo Rd & 166th St	1	0	0	0	0
Total	248	18	17	19	134
%		7%	7%	8%	54%

EXISTING TRAFFIC OPERATIONS ANALYSIS

Traffic volumes, speeds and queue lengths collected in June 2018 were used to create Synchro models of the three weekday peak hours to analyze existing traffic operations. Synchro 9 by Trafficware is a software package that is commonly used to model traffic operations at intersections. The three Synchro models created for this project were calibrated to replicate field measured queuing.

Delay (seconds per vehicle) is the measure of traffic operations at signalized and unsignalized intersections. Level of service is used to communicate the average amount of delay experienced by users at an intersection. Letter grades are assigned according to the amount of delay as shown in Table 5. LOS E and F correspond to high levels of congestion, waiting through multiple traffic signal cycles and long waits at stop signs due to insufficient gaps in opposing traffic movements.

Delay values at signalized intersections and all-way stop controlled intersections are averaged for all movements, some individual movements may fail (experience LOS F delays) without resulting in LOS F for the entire intersection. Critical movements or failing movements at each intersection will be noted in this report to supplement the intersection level of service determination.

Table 5 – Intersection Level of Service Definition

	Control Delay* (seconds per vehicle)	
Level of Service	**Signalized**	**Unsignalized**
A	≤10	0 to 10
B	>10 to 20	>10 to 15
C	>20 to 35	>15 to 25
D	>35 to 55	>25 to 35
E	>55 to 80	>35 to 50
F	>80	>50

Source: Transportation Research Board. Highway Capacity Manual 2010. Exhibit 18-4 and Exhibit 19-1.

* Control delay is time spent slowing, stopping, moving up in a queue, and accelerating back to desired speed.

Peak Hour Intersection Delay and Level of Service

Intersection delay and level of service values for the weekday midday, PM, and evening peak hours are shown in Table 6.

- During the midday peak hour, the study area intersections operate at LOS D or better except the Air Cargo Road / Southbound NAE On-Ramp intersection, which operates at LOS E.
- During the afternoon PM peak hour, study area intersections operate at LOS D or better except the S 170th Street / Northbound NAE Off-Ramp intersection, which operates at LOS E.
- During the late evening peak hour, study area intersections operate at LOS D or better except the S 170th Street intersections at the Cell Phone Lot and the Northbound NAE Off-Ramp, which both operate at LOS E.

Table 6 – Study Area Intersection Average Delay (sec/veh) and Level of Service

Intersection	Midday Peak Hour Delay (sec/veh) / LOS	PM Peak Hour Delay (sec/veh) / LOS	Evening Peak Hour Delay (sec/veh) / LOS
Air Cargo Rd / S 170th St	30 / D	12 / B	18 / C
Air Cargo Rd / SB NAE On-Ramp	38 / E	27 / D	25 / C
Air Cargo Rd / S 166th St	21 / C	17 / C	18 / C
S 170th St / Cell Phone Lot Dwy	36 / D	28 / C	67 / E
S 170th St / Doug Fox Dwy	17 / C	15 / B	14 / B
S 170th St / NB NAE Off-Ramp	33 / D	46 / E	47 / E
S 170th St / International Blvd	43 / D	52 / D	43 / D

During the midday peak hour, the following intersection movements and/or approaches operate with volume-to-capacity (v/c) ratios near or above 1.0, indicating congested traffic operations:

- Northbound and westbound movements at the S 170th Street / Cell Phone Lot intersection operate with v/c ratios of 1.04 and 0.85, respectively.
- Northbound movements at the S 170th Street / Northbound NAE Off-Ramp intersection operate with a v/c ratio of 0.87.
- The eastbound right-turn and northbound left-turn at the S 170th Street / International Boulevard intersection operate with v/c ratios of 0.83 and 0.84, respectively.

During the afternoon PM peak hour, the following intersection movements and/or approaches operate with v/c ratios near or above 1.0:

- The southbound approach at the S 170th Street / Cell Phone Lot intersection (Southbound NAE Off-Ramp) operates with a v/c ratio of 0.93.
- The northbound approach at the S 170th Street / Northbound NAE Off-Ramp intersection operates with a v/c ratio of 0.92.
- The southbound through movement at the S 170th Street / International Boulevard intersection operates with a v/c ratio of 0.97, and the eastbound right-turn movement operates with a v/c ratio of 0.92.

During the evening peak hour, the following intersection movements and/or approaches operate with v/c ratios near or above 1.0:

- Northbound and westbound approaches at the S 170th Street / Cell Phone Lot intersection operate with v/c ratios of 1.31 and 0.97, respectively.
- The northbound approach at the S 170th Street / Northbound NAE Off-Ramp intersection operates with a v/c ratio of 0.90.
- The eastbound right-turn and northbound left-turn at the S 170th Street / International Boulevard intersection operate with v/c ratios of 0.82 and 0.83, respectively.

Peak Hour Queue Lengths

Queue length data was collected during the three peak periods. The maximum length of the stopped queue each minute was recorded. Average and 95th percentile queue length values were calculated based on data collected in June 2018 and are shown in Table 7.

95th percentile queue lengths of 300-feet for the eastbound through and right-turn movements at the S 170th Street / International Boulevard intersection spill back to the Northbound NAE Off-Ramp intersection.

Queue lengths in excess of 300-feet for the northbound movements at the S 170th Street / Cell Phone Lot intersection spill back into the Cell Phone Lot, affecting internal parking lot circulation.

Table 7 – Peak Hour Average and 95th Percentile Queue Lengths (ft)

Location	Midday Peak Hour Avg (ft) / 95th pct (ft)	PM Peak Hour Avg (ft) / 95th pct (ft)	Evening Peak Hour Avg (ft) / 95th pct (ft)
Air Cargo Rd / SB NAE On-Ramp, SB Left-Turn	60 / 200	40 / 150	50 / 200
S 170th St / Cell Phone Lot Dwy, EB Through/Right Average	30 / 150	50 / 150	30 / 120
S 170th St / Cell Phone Lot Dwy, WB Left/Through Average	100 / 210	80 / 190	110 / 230
S 170th St / Cell Phone Lot Dwy, NB Left-Turn	120 / 250	70 / 130	220 / 450
S 170th St / Cell Phone Lot Dwy, SB Left/Through Average	60 / 140	80 / 170	50 / 130
S 170th St / NB NAE Off-Ramp, NB Left-Turn	140 / 260	120 / 275	90 / 250
S 170th St / International Blvd, EB Left-Turn	70 / 150	90 / 200	80 / 170
S 170th St / International Blvd, EB Through Movement	180 / 300	210 / 300	140 / 240
S 170th St / International Blvd, EB Right-Turn	70 / 200	180 / 300	60 / 140

Vehicles making the westbound free right-turn from S 170th Street to Air Cargo Road and the northbound free right-turn from Air Cargo Road to Southbound NAE On-Ramp move slowly when there is downstream congestion on NAE as shown by the distribution of average speeds in Figure 12, however measurements of fully stopped queues were rare in the data collected in June 2018.

DESIGN HOUR VOLUME DETERMINATION

Hourly traffic volumes on Northern Airport Expressway at 160th Street from 2017 were used to determine the design hour factor. This location on Northern Airport Expressway was selected because it is the furthest removed from congestion related to the terminal drive lanes.

Hourly volumes of northbound and southbound traffic combined were sorted from highest volume to lowest to determine the 30th highest hourly volume. The 30th highest hourly volume on Northern Airport Expressway and volumes within 100 vph typically occurred on Monday mornings (11:00 am) and Thursday evenings (7:00 pm).

The 30th highest hourly volume on Northern Airport Expressway (4,980 vph) was divided by the annual average daily traffic volume from 2017 (67,000 vpd) to define the K_{30} factor (0.074) or the design hour factor for the 30th highest hourly volume in 2017. The K_{30} factor developed from Northern Airport Expressway volumes was applied to Air Cargo Road and S 170th Street due to the proximity of these facilities to the airport terminal building.

The calculated design hour volumes (DHV) for Air Cargo Road and S 170th Street are shown in Table 8. Average daily traffic (ADT) volumes and directional factors used to calculate the directional design hour volume (DDHV) are from the 7-day tube counts collected in June 2018 and appended to this report.

Table 8 – Design Hour Volumes (K_{30})

Location	ADT	DHV	DDHV
S 170th Street, east of Air Cargo Rd	18,300	1,350	1,190
Air Cargo Road, north of S 170th St	18,400	1,360	1,190
Air Cargo Road, south of S 166th St	12,700	940	580

DESIGN YEAR TRAFFIC ANALYSIS

The following sections of this report comprise an analysis of design year (2029) traffic conditions. Design year traffic forecasts, no-build peak hour operations analysis, and operations analysis of roadway modification concepts are included.

The design year was selected to coincide with the year of opening of Sea-Tac Sustainable Airport Master Plan (SAMP) roadway projects that will reconstruct segments of S 170th Street, Air Cargo Road and southbound Northern Airport Expressway.

DESIGN YEAR (2029) TRAFFIC FORECASTS

Peak hour turning movement volume traffic forecasts for a project design year of 2029 were prepared. Several different factors influenced the predicted future traffic patterns including airport growth, background traffic growth, and local/specific trips that were assumed to remain constant.

Local trips were identified using the origin-destination data discussed earlier and were not included in the traffic growth calculations. Specific movements considered "local" included the following:

- Southbound Air Cargo Road to International Boulevard
- International Boulevard to Northbound Air Cargo Road
- Southbound Left-Turns from Northern Airport Expressway to International Boulevard

Other traffic volumes held constant between 2018 and 2029 included driveway trips from Bonney-Watson Cemetery, Doug Fox Parking and cargo traffic from driveways along Air Cargo Road and S 166th Street.

The growth of traffic related to airport activities was determined from data provided by the Port of Seattle in the form of VISSIM model inputs for existing (46 million annual passengers) and year 2029 (54 million annual passengers) conditions. VISSIM model vehicle inputs directly related to each Northern Airport Expressway ramp, the Cell Phone Lot and International Boulevard were identified separately and evaluated for each peak period. The growth rate and traffic volumes associated with each road segment influenced by airport activities are shown in Table 9.

Table 9 – Airport Related Traffic Growth

Input	Direction	Mid-day			PM Peak			Evening		
		Total Growth	2018 Base	2029 Grown	Total Growth	2018 Base	2029 Grown	Total Growth	2018 Base	2029 Grown
International Blvd / S 170th St	NBL		191	247		136	200		185	201
	SBR	29%	61	79	47%	51	76	9%	73	80
	WBT		64	83		79	116		73	80
NB AE Off-Ramp	NB	27%	576	733	48%	485	718	3%	403	416
SB AE Off-Ramp/ Cell Phone Lot	NB	44%	281	405	36%	208	283	47%	335	493
	SB	48%	312	462	42%	279	397	48%	325	483
Air Cargo Rd / S 166th St	SB	40%	469	657	50%	447	670	30%	615	797

Traffic volumes on International Boulevard were increased using an annual growth rate of 3.1% for all movements not originating from or destined to S 170th Street, west of International Boulevard. The 3.1% annual growth rate was derived from 2025 forecasts and 2014 existing volumes shown in the City of SeaTac Transportation Master Plan.

Design year peak hour turning movement volume forecasts for the study area intersections can be found in Figure 18.

A design year traffic forecast was also prepared with the existing Cell Phone Lot no longer in operation. It was assumed that vehicles formerly accessing the Cell Phone Lot from Northern Airport Expressway would continue on the Expressway to the airport terminal, and vehicles formerly accessing the Cell Phone Lot from S 170th Street would continue further west on S 170th Street and Air Cargo Road to reach the airport terminal via Northern Airport Expressway.

Design year peak hour turning movement volume forecasts of the condition with the existing Cell Phone Lot no longer in operation are shown in Figure 19.

Figure 18 – Design Year (2029) Peak Hour Traffic Volumes

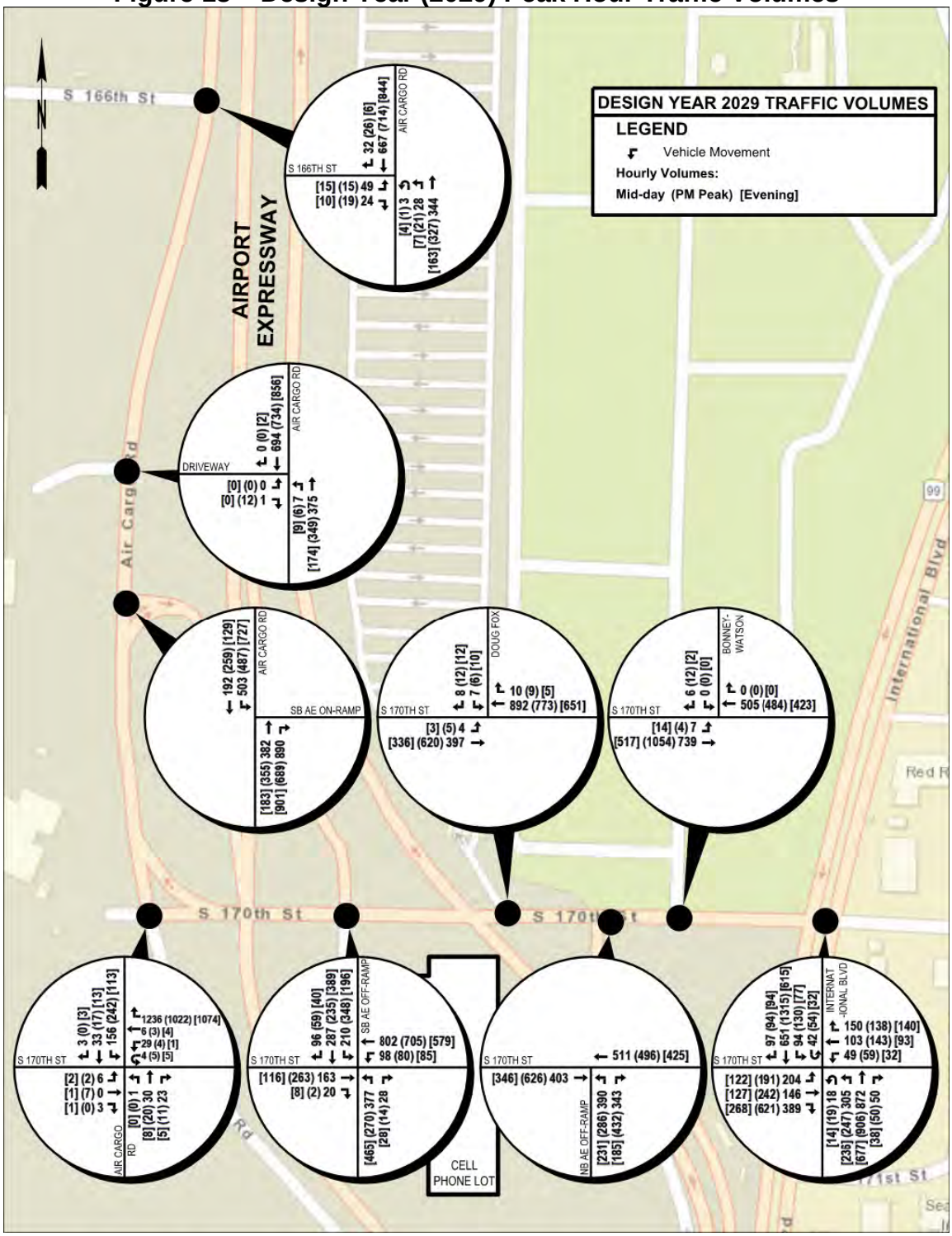
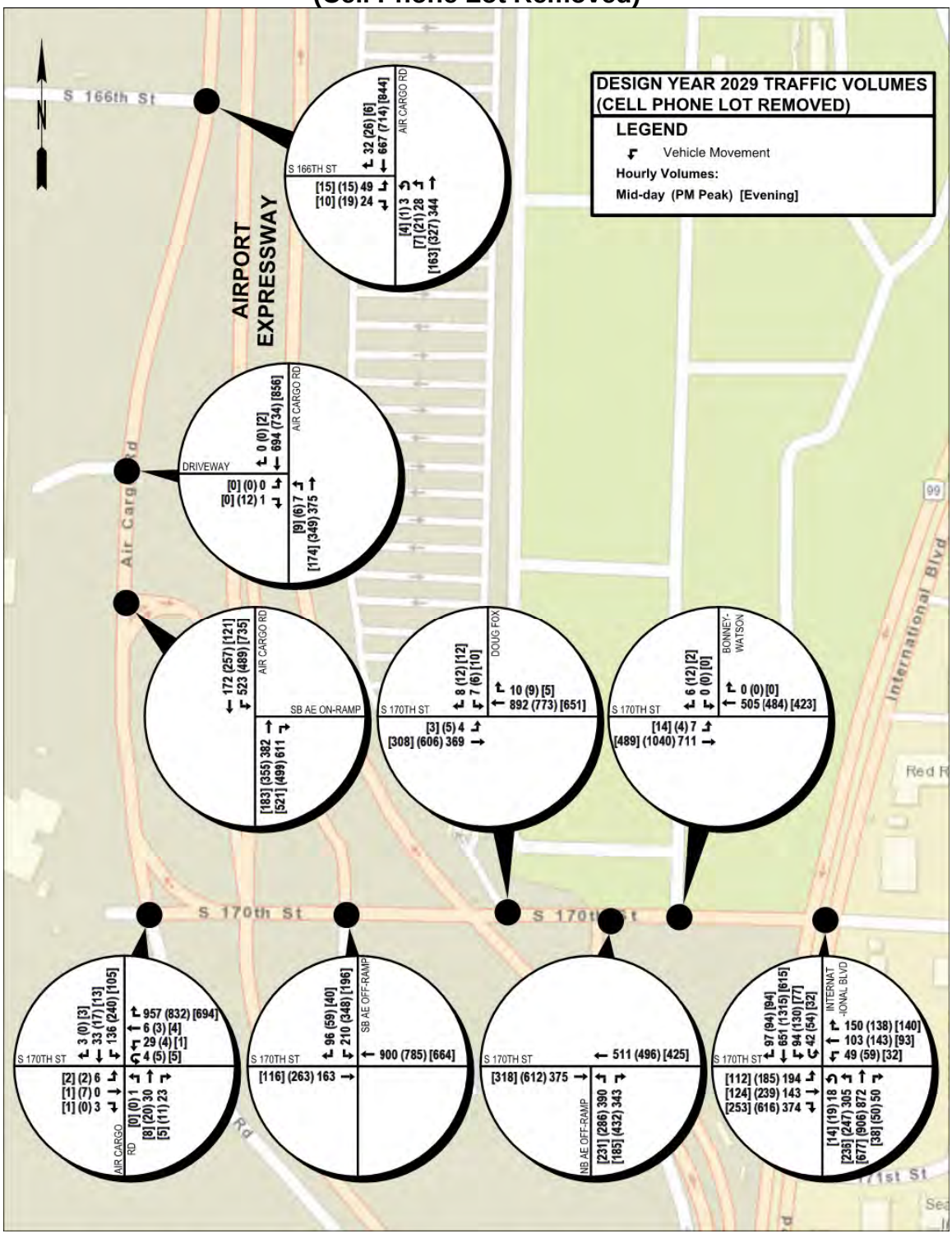


Figure 19 – Design Year (2029) Peak Hour Traffic Volumes (Cell Phone Lot Removed)



DESIGN YEAR NO-BUILD TRAFFIC OPERATIONS ANALYSIS

Design year (2029) "No-Build" traffic conditions were evaluated using Synchro 9 models with the forecasted traffic volumes for the three peak periods. Roadway geometry was left unchanged, while intersection signal timings were optimized.

Two design year no-build conditions were analyzed: with the existing cell phone lot in operation, and without the cell phone lot in operation. Realignment of S 170th Street and the southbound lanes of Northern Airport Expressway as part of the Sustainable Airport Master Plan will require closure of the existing cell phone lot.

Peak Hour Intersection Delay and Level of Service

Intersection delay and level of service values for the weekday midday, PM, and evening peak hours of the design year no-build condition are shown in Table 10.

With the existing Cell Phone Lot open, intersection levels of service are generally LOS D or worse.

- During the midday peak hour, the study area intersections operate at LOS D or worse except the S 170th Street / Doug Fox Lot intersection, which operates at LOS C.
- During the afternoon PM peak hour, the study area intersections operate at LOS D or worse except the S 170th Street / Doug Fox Lot and Air Cargo Road / S 166th Street intersections, which operate at LOS C.
- During the late evening peak hour, the study area intersections operate at LOS D or worse except the S 170th Street / Doug Fox Lot and Air Cargo Road / S 166th Street intersections, which operate at LOS C.

With the existing Cell Phone Lot closed, intersection levels of service are generally LOS D or better.

- During the midday peak hour, the study area intersections operate at LOS D or better except the S 170th Street / Northbound NAE Off-Ramp intersection and Air Cargo Road / Southbound NAE On-Ramp intersection, which operate at LOS F.
- During the afternoon PM peak hour, the study area intersections operate at LOS D or better except the S 170th Street / Northbound NAE Off-Ramp intersection, Air Cargo Road / Southbound NAE On-Ramp intersection, and S 170th Street / International Blvd intersection, which operate at LOS F.
- During the late evening peak hour, the study area intersections operate at LOS D or better except the S 170th Street / Northbound NAE Off-Ramp intersection and Air Cargo Road / Southbound NAE On-Ramp intersection, which operate at LOS F.

Table 10 – Comparison of Existing and Design Year No-Build Intersection Average Delay (sec/veh) and Level of Service

Intersection	2018 Existing Delay (sec/veh) / LOS	No Build Delay (sec/veh) / LOS	No Cell Phone Lot Delay (sec/veh) / LOS
Midday Peak Hour			
Air Cargo Rd / S 170th St	30 / D	79 / F	22 / C
Air Cargo Rd / SB NAE On-Ramp	38 / E	122 / F	140 / F
Air Cargo Rd / S 166th St	21 / C	29 / D	29 / D
S 170th St / Cell Phone Lot Dwy	36 / D	92 / F	24 / C
S 170th St / Doug Fox Dwy	17 / C	21 / C	20 / C
S 170th St / NB NAE Off-Ramp	33 / D	202 / F	164 / F
S 170th St / International Blvd	43 / D	48 / D	48 / D
PM Peak Hour			
Air Cargo Rd / S 170th St	12 / B	29 / D	14 / B
Air Cargo Rd / SB NAE On-Ramp	27 / D	100 / F	101 / F
Air Cargo Rd / S 166th St	17 / C	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	28 / C	84 / F	17 / B
S 170th St / Doug Fox Dwy	15 / B	17 / C	18 / C
S 170th St / NB NAE Off-Ramp	46 / E	540 / F	513 / F
S 170th St / International Blvd	52 / D	124 / F	124 / F
Evening Peak Hour			
Air Cargo Rd / S 170th St	18 / C	35 / D	11 / B
Air Cargo Rd / SB NAE On-Ramp	25 / C	74 / F	78 / F
Air Cargo Rd / S 166th St	18 / C	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	67 / E	138 / F	11 / B
S 170th St / Doug Fox Dwy	14 / B	14 / B	14 / B
S 170th St / NB NAE Off-Ramp	47 / E	69 / F	57 / F
S 170th St / International Blvd	43 / D	45 / D	44 / D

During the peak hours, several intersection movements shown in Table 11 operate with volume-to-capacity (v/c) ratios near or above 1.0, indicating congested traffic operations.

Table 11 – Design Year No Build Intersection Movement Volume-to-Capacity (v/c) Ratios

		No Build			No Cell Phone Lot		
Intersection	**Movement**	**Mid-day**	**PM**	**Evening**	**Mid-day**	**PM**	**Evening**
S 170th St / International Blvd	Northbound Left Turn	0.80	0.85	0.87	0.80	0.85	0.87
	Eastbound Right Turn	0.86	1.20	0.82	0.86	1.19	0.81
S 170th St / NB NAE Off-Ramp	Northbound Left/Right Turn	1.38	2.13	1.03	1.29	2.07	0.96
S 170th St / Cell Phone Lot	Northbound Left/Right Turn	1.45	0.94	1.85	--	--	--
	Westbound Through	1.03	0.97	1.02	0.75	0.76	0.52
	Southbound Through/Right Turn	1.04	1.65	0.72	0.20	0.12	0.11
Air Cargo Rd / S 170th Street	Westbound Right Turn	1.16	0.96	0.97	0.90	0.78	0.63
Air Cargo Rd / SB NAE On-Ramp	Southbound Left Turn	1.16	1.10	1.06	1.21	1.10	1.07

Peak Hour Queue Lengths

Average and 95th percentile queue length values were collected from the Synchro analysis and are shown in Table 12 in comparison to existing queue data collected in the field.

95th percentile queue lengths for the northbound movements at the S 170th Street / Northbound NAE Off-ramp intersection are shown to extend past the length of the ramp and onto the mainline Airport Expressway in the midday and PM peak hours.

95th percentile queue lengths for the eastbound through and right-turn movements at the S 170th Street / International Boulevard intersection are expected to spill back through the Northbound NAE Off-ramp intersection in the PM peak hour.

Queue lengths in excess of 300-feet for the northbound movements at the S 170th Street / Cell Phone Lot intersection spill back into the Cell Phone Lot, affecting internal parking lot circulation.

Queue lengths on the southbound movements at the Air Cargo Road / Southbound NAE On-Ramp intersection during each of the three peak hours are predicted to be in excess of 400 feet, which would block several driveways north of the intersection.

Table 12 – Comparison of Existing and Design Year No Build Peak Hour Average and 95th Percentile Queue Lengths (ft)

Location	Movement	2018 Existing Avg (ft) / 95th pct (ft)	No Build Avg (ft) / 95th pct (ft)	No Cell Phone Lot Avg (ft) / 95th pct (ft)
Midday Peak Hour				
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	60 / 200	-- / 480*	-- / 540*
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 150	30 / 60	20 / 50
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	100 / 210*	220* / 350*	130 / 310*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	120 / 250	260 / 420*	-- / --
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	60 / 140	130 / 250	40 / 100
S 170th St / NB NAE Off-Ramp	Left-Turn	140 / 260	-- / 870*	-- / 780*
S 170th St / International Blvd	EB Left-Turn	70 / 150	160 / 250	150 / 240
S 170th St / International Blvd	EB Through Movement	180 / 300	210 / 340*	200 / 320*
S 170th St / International Blvd	EB Right-Turn	70 / 200	0 / 210	0 / 210
PM Peak Hour				
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	40 / 150	-- / 420*	-- / 430
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	50 / 150	40 / 60	20 / 60
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	80 / 190*	210* / 350*	120 / 250*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	70 / 130	120 / 270	-- / --
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	80 / 170	160 / 270	40 / 100
S 170th St / NB NAE Off-Ramp	Left-Turn	120 / 275	-- / 1380*	-- / 1350*
S 170th St / International Blvd	EB Left-Turn	90 / 200	160 / 250	150 / 240
S 170th St / International Blvd	EB Through Movement	210 / 300	250 / 420*	250 / 420*
S 170th St / International Blvd	EB Right-Turn	180 / 300	320* / 450*	310* / 440*
Evening Peak Hour				
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	50 / 200	-- / 500*	-- / 510*
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 120	30 / 50	10 / 20
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	110 / 230*	170 / 290*	50 / 120
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	220 / 450*	340* / 400*	-- / --
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	50 / 130	90 / 180	20 / 50
S 170th St / NB NAE Off-Ramp	Left-Turn	90 / 250	-- / 340	-- / 290
S 170th St / International Blvd	EB Left-Turn	80 / 170	110 / 170	100 / 160
S 170th St / International Blvd	EB Through Movement	140 / 240	160 / 250	150 / 240
S 170th St / International Blvd	EB Right-Turn	60 / 140	0 / 150	0 / 140

* Queue extends beyond storage length or blocks adjacent intersection.

(1) NB right-turn queue reported in place of restricted left-turn

DESIGN YEAR BUILD OPERATIONS ANALYSIS

Design year traffic operations for "build" conditions, or future conditions with project improvements were analyzed using Synchro 9 software. Three roadway modification concepts were developed with the existing Cell Phone Lot remaining open, and one roadway modification concept was developed with the Cell Phone Lot no longer in operation.

Analysis of existing and design year no-build conditions identified safety and traffic operations deficiencies that the roadway modification concepts would address.

S 170th Street / Cell Phone Lot: Northbound traffic exiting the Cell Phone Lot is shown to have difficulty turning left onto westbound S 170th Street in both existing and design year (2029) no-build conditions. Northbound left-turning vehicles must yield to southbound vehicles entering the Cell Phone Lot, limiting the number of acceptable gaps during the shared north-south signal phase. This conflict is reflected in the existing crash data, which shows many left-turn-related crashes have occurred at this intersection. Westbound traffic has also been seen to extend past the Doug Fox Parking driveway, blocking traffic from entering or exiting the parking lot.

S 170th Street / Air Cargo Road: Traffic backups on Southbound NAE spill back through the On-Ramp intersection and this intersection. Queues of traffic destined to the airport terminal block the westbound right-turn lane, limiting access to freight, rental car and Port employee parking facilities further north on Air Cargo Road.

S 170th Street / Northbound NAE Off-Ramp: During all three design year peak hours, the northbound left-turn movement is forecast to operate at LOS F, with delays over 200 seconds and queues extending beyond the length of the ramp and onto the expressway mainline. Airport-related traffic growth will increase the number of vehicles on S 170th Street that northbound left-turning traffic yields to. The increased traffic volumes and degradation in operations could also increase the number of left-turn related crashes. Queues extending back onto the Airport Expressway would also increase the risk of collisions on the Northbound expressway.

Air Cargo Road / Southbound NAE On-Ramp: During all three design year peak hours, this intersection is forecast to operate at LOS F in the no-build conditions. Airport-related traffic growth is expected to increase the volume of vehicular conflicts between southbound left-turn and northbound through movements. This increased conflict could also worsen the left-turn related crash patterns shown in the existing data.

S 170th Street / International Boulevard: During all three design year peak hours, this intersection would operate at LOS D or worse. Background traffic growth combined with airport-related growth is expected to increase delay and queuing on all intersection approaches.

Pedestrian / Transit Facilities: Current facilities do not accommodate pedestrians, bicyclists and transit users who travel along S 170th Street and Air Cargo Road. Field observations and stakeholder comments have confirmed there is a need for continuous sidewalks, crosswalks, and improved bus stops with shelters.

Cell Phone Lot Traffic Flow: The current Cell Phone Lot layout contains 187 stalls with a mixture of 90-degree and angled parking, and utilizes two-way drive aisles. The current

configuration is not optimal for a short-term parking facility with a high hourly rate of parking stall turnover.

Strategies to address these safety and traffic operations deficiencies were the basis of the four roadway modification concepts analyzed in this report. Descriptions, visualizations and traffic operations analysis of each roadway modification concept are presented below. Common elements to all concepts are pedestrian and transit facilities. Revisions to the existing Cell Phone Lot are included in all three of the concepts that retain the Cell Phone Lot.

Additional detailed visualizations of the layout and striping concepts proposed for the Cell Phone Lot and the dual right-turn on the S 170th Street /Air Cargo Road westbound approach can also be found in Appendix E.

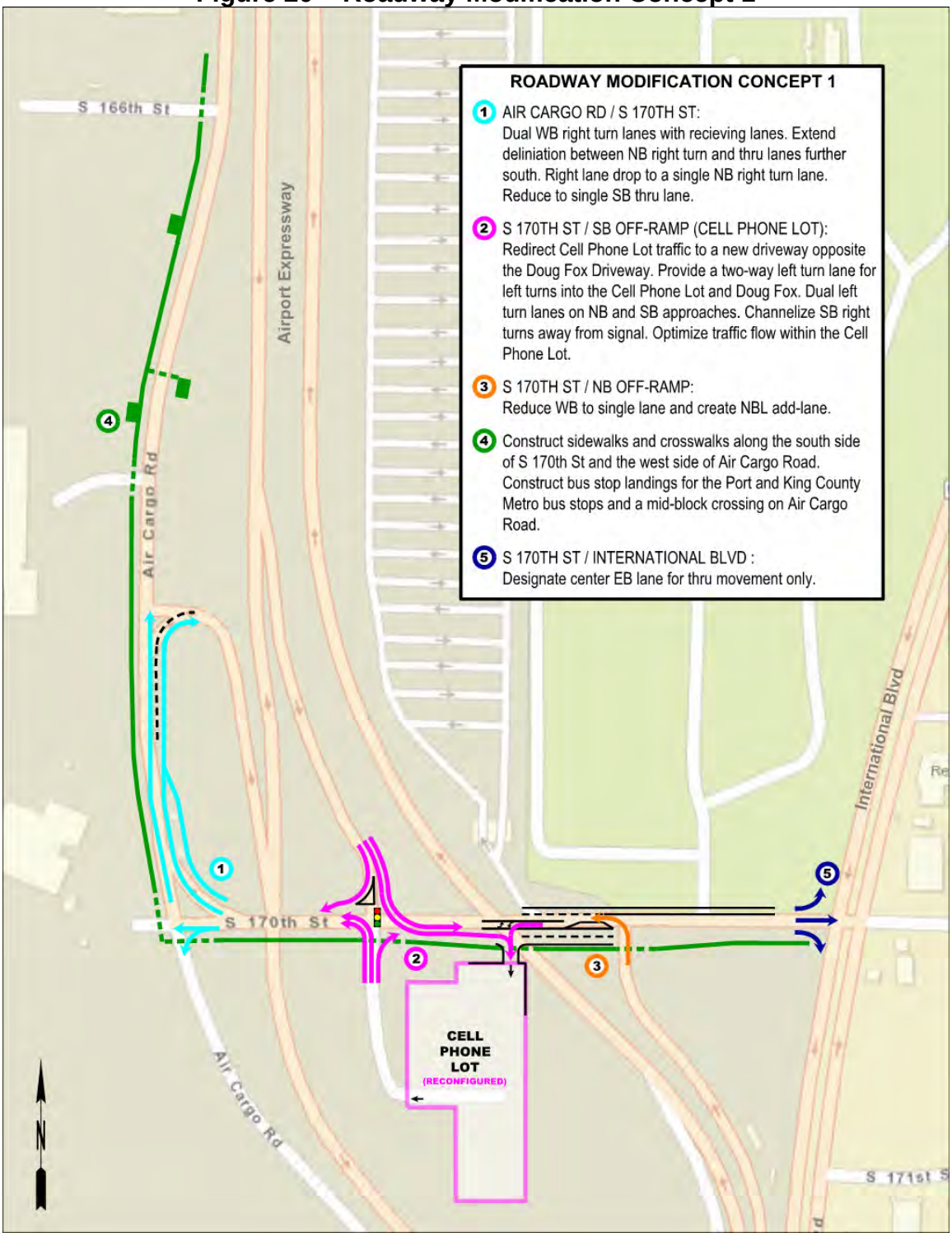
Roadway Modification Concept 1

Roadway Modification Concept 1 includes the following elements, as shown on Figure 20:

- **New Cell Phone Lot Entrance across S 170th Street from Doug Fox Parking:** Traffic entering the Cell Phone Lot would be redirected to a new driveway on S 170th Street across from the Doug Fox Parking Lot access with left-turn lanes on the westbound and eastbound approaches. Dual northbound left-turn lanes would serve vehicles exiting the Cell Phone Lot. Dual southbound left-turn lanes and a channelized southbound right-turn lane with yield control would also be provided at the S 170th Street / Southbound NAE Off-Ramp intersection.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. The outer lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **Northbound NAE Off-Ramp Left-Turn Add-Lane at S 170th Street:** Northbound left-turns from the Northbound NAE Off-Ramp would add a lane onto westbound S 170th Street. This would reduce westbound S 170th Street to a single lane between International Boulevard and the Northbound NAE Off-Ramp.
- **Eastbound Dedicated Through Lane on S 170th Street at International Boulevard:** The shared left/through lane on the eastbound approach of S 170th Street / International Boulevard would be converted to a dedicated through lane.

Additional channelization changes to the westbound approach (east leg) of the S 170th Street / International Boulevard intersection were considered in order to eliminate the split-phase signal control and implement the standard eight-phase signal control. Eight-phase signal control at this intersection resulted in higher overall delay during each of the three peak hours, and higher delays for east/west left-turn movements, so the roadway modification concepts retain the existing split-phase signal control.

Figure 20 – Roadway Modification Concept 1



Intersection Delay and Level of Service

Roadway Modification Concept 1 was evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 13.

All movements entering the Cell Phone Lot at the S 170th Street / Southbound NAE Off-Ramp intersection were shifted to the new driveway across from the Doug Fox Parking Lot access.

Compared to the design year no-build condition, Roadway Modification Concept 1 would improve intersection traffic operations at:

- Air Cargo Road / S 170th Street from LOS D or F to LOS A,
- S 170th Street / Cell Phone Lot Driveway from LOS F to LOS B, and
- S 170th Street / Northbound NAE Off-Ramp from LOS F to LOS E (PM peak hour) or LOS C.

The revised channelization of the eastbound lanes at the S 170th Street / International Blvd intersection reduced delay by 3 seconds in the late evening peak hour, resulted in no change in the midday peak hour, and increased delay by 7 seconds in the PM peak hour.

Peak hour traffic operations at the Air Cargo Road / Southbound NAE On-Ramp, Air Cargo Road / S 166th Street, and S 170th Street / Doug Fox Parking intersections were unaffected by Roadway Modification Concept 1.

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the build concepts are shown in Table 14.

Compared to the design year no-build condition, Roadway Modification Concept 1 would reduce queue lengths at:

- S 170th Street / Cell Phone Lot Driveway westbound queues would reduce to less than 170 feet in the midday and evening peak hours, which would not spill back through the Doug Fox Parking intersection. 95th percentile queues in the PM peak hour would continue to spill back to the Doug Fox Parking driveway.
- S 170th Street / Cell Phone Lot Driveway northbound queues would be 90 feet or less in each of the peak hours, which would not spill back into the Cell Phone Lot.
- S 170th Street / Northbound NAE Off-Ramp northbound queues would be reduced from 1,380 feet in the PM peak hour to 290 feet. Queues in each of the peak hours would not spill back to the NAE mainline.
- S 170th Street / International Blvd eastbound through movement queues would reduce by 70 feet. This would be offset by increases of up to 20 feet in the eastbound left-turn queue lengths.

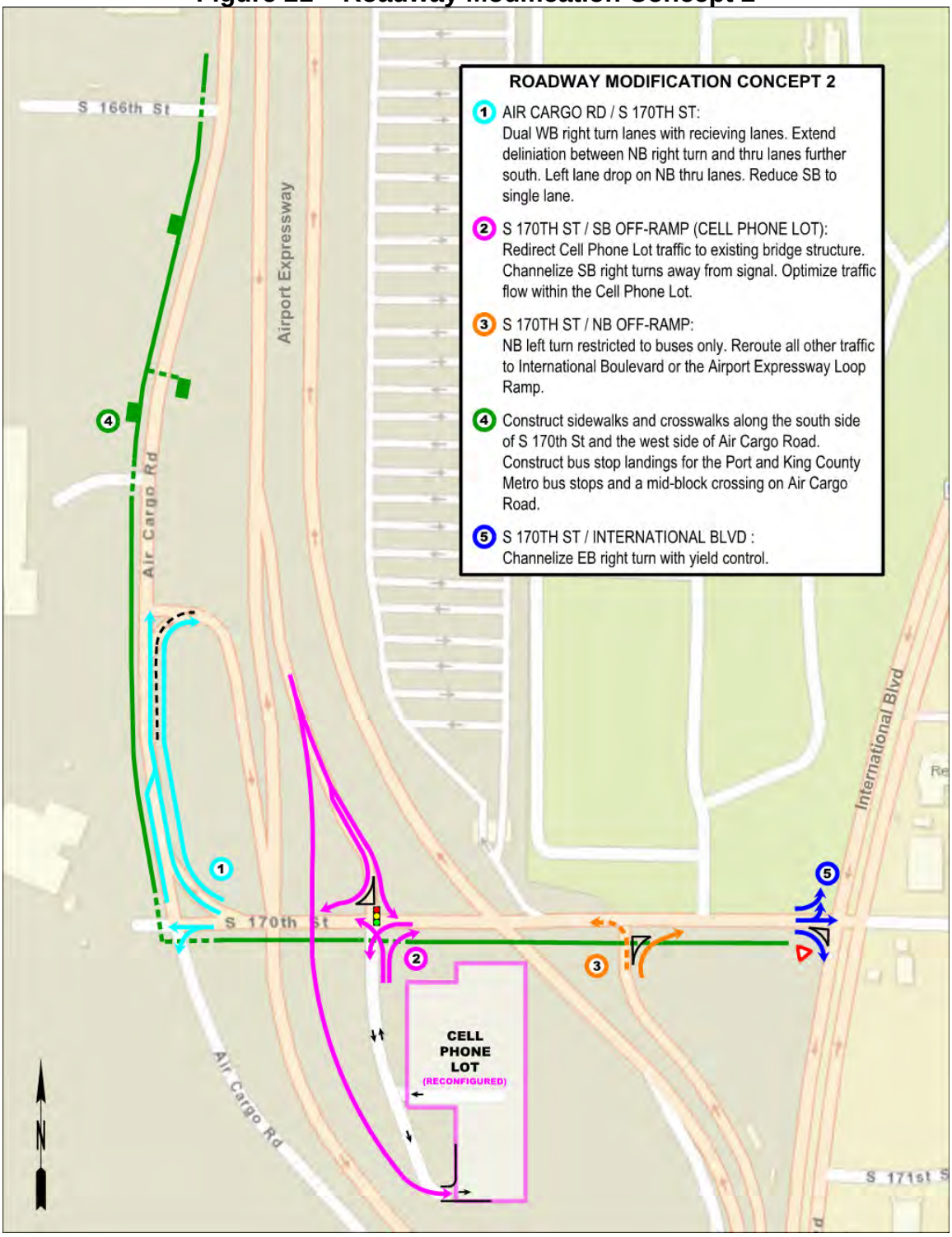
Roadway Modification Concept 2

Roadway Modification Concept 2 includes the following elements, as shown in Figure 21.

- **New Cell Phone Lot Entrance via the old Northbound NAE Bridge over S 170th Street:** Traffic entering the Cell Phone Lot from the Southbound NAE Off-Ramp would utilize the old Northbound NAE bridge over S 170th Street and would enter the Cell Phone Lot at a new driveway on the southwest corner of the Cell Phone Lot. This would eliminate the southbound through movement at S 170th Street / Cell Phone Lot intersection.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. One right-turn lane would provide access to the Southbound NAE On-Ramp, the second right-turn lane would provide access to northbound Air Cargo Road. A third (inside) northbound lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **Northbound NAE Off-Ramp "Bus-Only" Left-Turn at S 170th Street:** The northbound left-turn would be restricted to rental car facility and Port employee parking shuttle buses only. All other traffic would turn right to eastbound S 170th Street. Traffic circulating back to the airport terminal would use the NAE loop ramp, instead of using S 170th Street and Air Cargo Road.
- **Eastbound S 170th Street Channelized Right-Turn Lane at International Blvd:** An island would be constructed to separate the eastbound right-turn movement at the S 170th Street / International Blvd intersection, and this movement would operate with yield control, outside of traffic signal control.

Decision distance on the southbound NAE off-ramp was a concern with the options to exit to the Cell Phone Lot, or to S 170th Street. Decision distance was evaluated based on FHWA standards for conventional roadways. The 2009 MUTCD recommends advanced signage 300 feet ahead of an intersection in urban areas and ahead of a route turn for a high-speed area (*MUTCD, Section 2D*). The proposed ramp would have more than 400 feet spacing between gore noses of the Southbound NAE Off-Ramp, and the ramp to the Cell Phone Lot.

Figure 21 – Roadway Modification Concept 2



Intersection Delay and Level of Service

Roadway Modification Concept 2 was evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 13.

Southbound through movements entering the Cell Phone Lot at the S 170th Street / Southbound NAE Off-Ramp intersection were removed from the intersection. Those vehicles would shift to the bridge over S 170th Street. Northbound left-turns at the S 170th Street / Northbound NAE Off-Ramp intersection were limited to buses only; rerouted traffic would increase the northbound right-turn volume by 10%, all other traffic would remain on NAE and use the loop ramp to recirculate to the airport terminal.

Compared to the design year no-build condition, Roadway Modification Concept 2 would improve intersection traffic operations at:

- Air Cargo Road / S 170th Street from LOS D or F to LOS A,
- Air Cargo Road / Southbound NAE On-Ramp from LOS F to LOS E or LOS F with 25 to 67 seconds less delay due to lower traffic volumes using this ramp to recirculate to the airport terminal,
- S 170th Street / Cell Phone Lot Driveway from LOS F to LOS B, and
- S 170th Street / Northbound NAE Off-Ramp from LOS F to LOS C in the late evening peak hour, LOS B in the midday peak hour, and LOS F in the PM peak hour with several minutes less delay.

The revised channelization of the eastbound lanes at the S 170th Street / International Blvd intersection reduced delay by 1 to 18 seconds, with no change in level of service.

Peak hour traffic operations at the S 170th Street / Doug Fox Parking intersection improved from LOS C to LOS B in the midday and PM peak hours due to lower traffic volumes on S 170th Street with the bus-only left-turn at the Northbound NAE Off-Ramp. Intersection level of service would continue to be LOS B during the late evening peak hour.

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the build concepts are shown in Table 14.

Compared to the design year no-build condition, Roadway Modification Concept 2 would reduce queue lengths at:

- Air Cargo Road / Southbound NAE On-Ramp southbound left-turn queues would reduce from 500 feet to 390 feet in the late evening peak hour. Queue lengths would be 110 to 170 feet shorter in each peak hour.
- S 170th Street / Cell Phone Lot Driveway westbound queues would reduce from 350 feet (midday and PM peak hours) to 160 feet or less, which would not spill back through the Doug Fox Parking intersection.
- S 170th Street / Cell Phone Lot Driveway northbound queues would be 250 feet or less in each of the peak hours, which would not spill back into the Cell Phone Lot.

- S 170th Street / Northbound NAE Off-Ramp northbound queues would be reduced from 1,380 feet in the PM peak hour to 320 feet. Queues in each of the peak hours would not spill back to the NAE mainline.
- S 170th Street / International Blvd eastbound right-turn movement queues would reduce from 450 feet to 60 feet in the PM peak hour.

Roadway Modification Concept 3

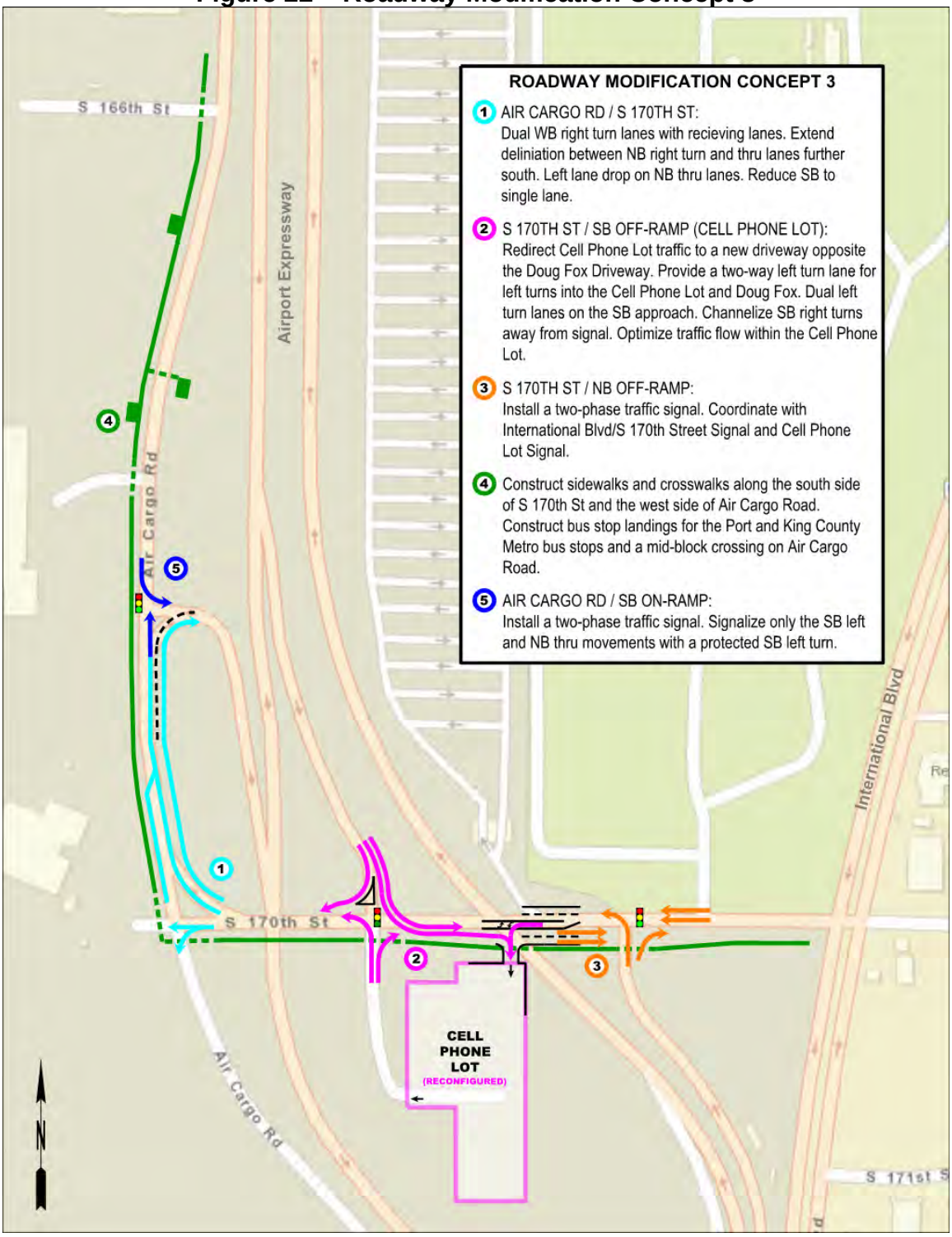
Roadway Modification Concept 3 includes the following elements, as shown in Figure 22.

- **New Cell Phone Lot Entrance across S 170th Street from Doug Fox Parking:** Traffic entering the Cell Phone Lot would be redirected to a new driveway on S 170th Street across from the Doug Fox Parking Lot access with left-turn lanes on the westbound and eastbound approaches. Dual northbound left-turn lanes would serve vehicles exiting the Cell Phone Lot. Dual southbound left-turn lanes and a channelized southbound right-turn lane with yield control would also be provided at the S 170th Street / Southbound NAE Off-Ramp intersection.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. One right-turn lane would provide access to the Southbound NAE On-Ramp, the second right-turn lane would provide access to northbound Air Cargo Road. A third (inside) northbound lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **New Traffic Signal at the S 170th Street / Northbound NAE Off-Ramp Intersection:** Two-phase traffic control signal added at S 170th Street / Northbound NAE Off-Ramp intersection that would operate in coordination with adjacent signals.
- **New Traffic Signal at the Air Cargo Road / Southbound NAE On-Ramp Intersection:** Two-phase traffic control signal added at Air Cargo Road / Southbound NAE On-Ramp to control the southbound left-turn and northbound through movements. The southbound through movement would remain unsignalized.

Following the Federal Highway Administration (FHWA) 2009 Manual on Traffic Control devices (MUTCD) signal justification guidance; under existing and design year traffic conditions, a traffic signal is warranted at the S 170th Street / Northbound NAE Off-Ramp intersection.

A traffic signal would also be warranted at Air Cargo Road / Southbound NAE On-Ramp under design year conditions, but not under existing or year of opening (2020) conditions. Traffic signal warrant analysis is appended to this report in Appendix G.

Figure 22 – Roadway Modification Concept 3



Intersection Delay and Level of Service

Roadway Modification Concept 3 was evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 13.

All traffic movements entering the Cell Phone Lot at the S 170th Street / Southbound NAE Off-Ramp intersection were shifted to the new driveway across from the Doug Fox Parking Lot access.

Compared to the design year no-build condition, Roadway Modification Concept 3 would improve intersection traffic operations at:

- Air Cargo Road / S 170th Street from LOS D or F to LOS A,
- Air Cargo Road / Southbound NAE On-Ramp from LOS F to LOS A,
- S 170th Street / Cell Phone Lot Driveway from LOS F to LOS C or B and
- S 170th Street / Northbound NAE Off-Ramp from LOS F to LOS B or A.

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the build concepts are shown in Table 14.

Compared to the design year no-build condition, Roadway Modification Concept 3 would reduce queue lengths at:

- Air Cargo Road / Southbound NAE On-Ramp southbound left-turn queues would reduce from 500 feet to 220 feet in the late evening peak hour. Queue lengths would be 280 to 430 feet shorter in each peak hour.
- S 170th Street / Cell Phone Lot Driveway westbound queues would reduce to 170 feet or less in the PM and evening peak hours, which would not block the Doug Fox Parking driveway. 95th percentile queues in the midday peak hour would continue to spill back through the Doug Fox Parking driveway.
- S 170th Street / Cell Phone Lot Driveway northbound queues would be 270 feet or less in each of the peak hours, which would not spill back into the Cell Phone Lot.
- S 170th Street / Northbound NAE Off-Ramp northbound queues would be reduced from 1,380 feet in the PM peak hour to 160 feet. Queues in each of the peak hours would not spill back to the NAE mainline.
- S 170th Street / International Blvd eastbound right-turn movement queues could increase in the PM peak hour to 930 feet, which would spill back through the Northbound NAE Off-Ramp intersection.

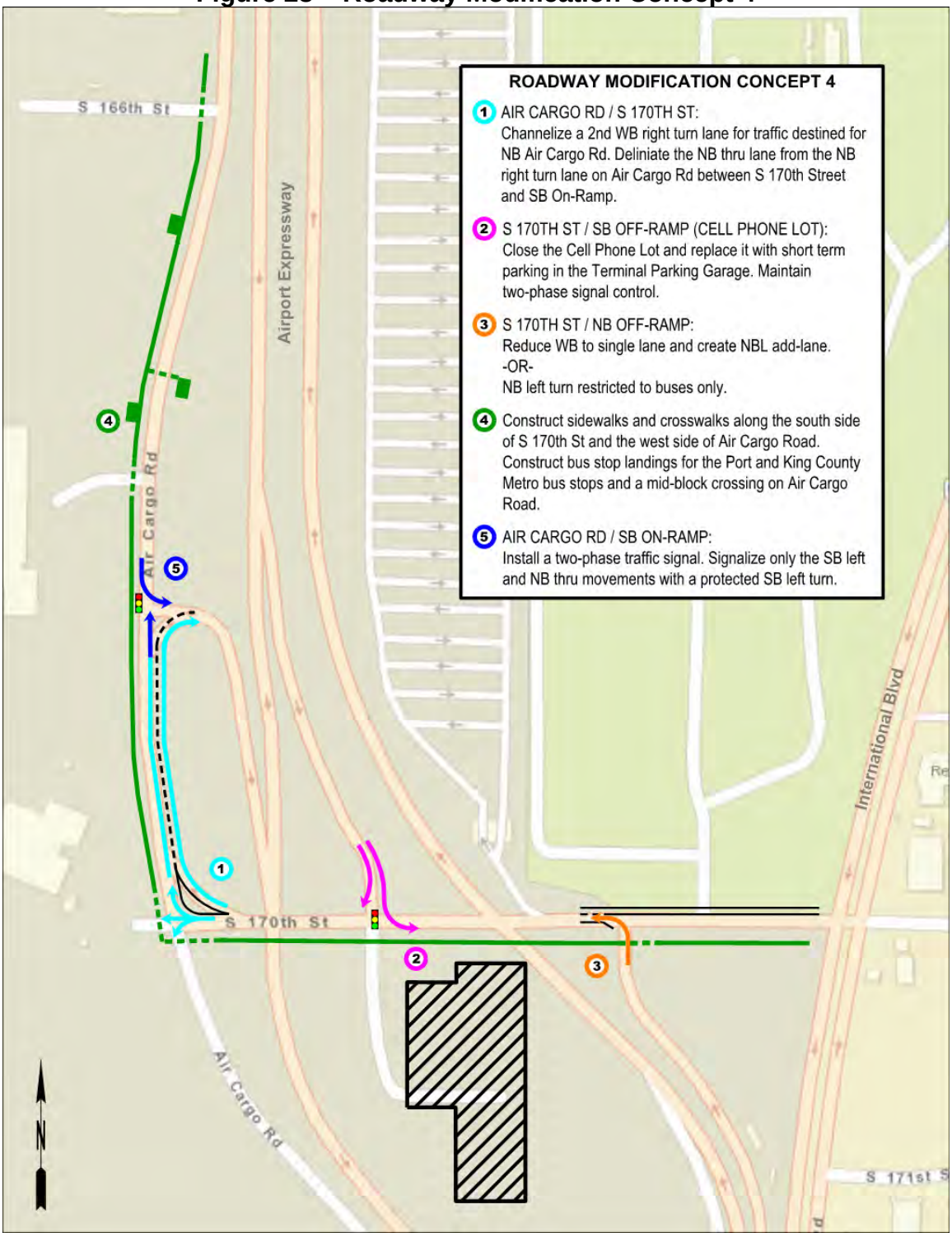
Roadway Modification Concept 4

Roadway Modification Concept 4 includes the following elements, as shown in Figure 23.

- **Cell Phone Lot Removal:** The existing Cell Phone Lot will be closed at some point before the design year in conjunction with SAMP projects. The northbound approach at the S 170th Street / Southbound NAE Off-Ramp intersection would be eliminated.
- **Median Separated Right-Turn Lanes at Air Cargo Road / S 170th Street:** Median separated right-turn lanes would be provided on westbound S 170th Street at Air Cargo Road, one lane would exclusively serve Southbound NAE On-Ramp traffic.
- **Northbound NAE Off-Ramp Left-Turn Add-Lane at S 170th Street:** Northbound left-turns from the Northbound NAE Off-Ramp would add a lane onto westbound S 170th Street. This would reduce westbound S 170th Street to a single lane between International Boulevard and the Northbound NAE Off-Ramp.
- **New Traffic Signal at the Air Cargo Road / Southbound NAE On-Ramp Intersection:** Two-phase traffic control signal added at Air Cargo Road / Southbound NAE On-Ramp to control the southbound left-turn and northbound through movements. The southbound through movement would remain unsignalized.

Removing the Cell Phone Lot would reduce the volume of traffic weaving across Southbound NAE from the Air Cargo Road On-Ramp. Removal of the existing Cell Phone Lot would require further study of traffic and parking impacts.

Figure 23 – Roadway Modification Concept 4



Intersection Delay and Level of Service

Roadway Modification Concept 4 was evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 13.

All traffic entering or exiting the Cell Phone Lot at the S 170th Street / Southbound NAE Off-Ramp intersection was assumed to remain on Southbound NAE, or would use the Southbound NAE On-Ramp via Air Cargo Road and S 170th Street.

Compared to the design year no-build condition, Roadway Modification Concept 4 would improve intersection traffic operations at:

- Air Cargo Road / S 170th Street from LOS D or F to LOS A,
- Air Cargo Road / Southbound NAE On-Ramp from LOS F to LOS A,
- S 170th Street / Southbound NAE Off-Ramp from LOS F to LOS B, and
- S 170th Street / Northbound NAE Off-Ramp from LOS F to LOS C in the late evening and midday peak hours, and LOS F in the PM peak hour with several minutes less delay.

Peak hour traffic operations at the Air Cargo Road / S 166th Street, and S 170th Street / Doug Fox Parking intersections were unaffected by Roadway Modification Concept 4.

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the build concepts are shown in Table 14.

Compared to the design year no-build condition, Roadway Modification Concept 4 would reduce queue lengths at:

- Air Cargo Road / Southbound NAE On-Ramp southbound left-turn queues would reduce from 500 feet to 300 feet in the late evening peak hour. Queue lengths would be 200 to 420 feet shorter in each peak hour.
- S 170th Street / Cell Phone Lot Driveway westbound queues would reduce from 350 feet (midday and PM peak hours) to 180 feet or less, which would not block the Doug Fox Parking driveway.
- S 170th Street / Northbound NAE Off-Ramp northbound queues would be reduced from 1,380 feet in the PM peak hour to 430 feet. Queues in each of the peak hours would not spill back to the NAE mainline.
- S 170th Street / International Blvd eastbound right-turn movement queues would reduce from 450 feet to 350 feet in the PM peak hour.

Table 13 – Roadway Modification Concepts: Design Year Peak Hour Intersection Delay (sec/veh) and Level of Service

Intersection	No Build Delay (sec/veh) / LOS	Concept 1 Delay (sec/veh) / LOS	Concept 2 Delay (sec/veh) / LOS	Concept 3 Delay (sec/veh) / LOS	Concept 4 Delay (sec/veh) / LOS
Midday Peak Hour					
Air Cargo Rd / S 170th St	79 / F	10 / A	9 / A	10 / A	10 / A
Air Cargo Rd / SB NAE On-Ramp	122 / F	122 / F	55 / F	7 / A	6 / A
Air Cargo Rd / S 166th St	29 / D	29 / D	25 / C	29 / D	29 / D
S 170th St / Cell Phone Lot Dwy	92 / F	15 / B	16 / B	19 / B	15 / B
S 170th St / Doug Fox Dwy	21 / C	19 / C	14 / B	18 / C	20 / C
S 170th St / NB NAE Off-Ramp	202 / F	20 / C	15 / B	14 / B	22 / C
S 170th St / International Blvd	48 / D	48 / D	47 / D	48 / D	48 / D
PM Peak Hour					
Air Cargo Rd / S 170th St	29 / D	9 / A	8 / A	9 / A	10 / A
Air Cargo Rd / SB NAE On-Ramp	100 / F	98 / F	46 / E	5 / A	4 / A
Air Cargo Rd / S 166th St	22 / C	22 / C	20 / C	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	84 / F	18 / B	19 / B	21 / C	18 / B
S 170th St / Doug Fox Dwy	17 / C	15 / B	14 / B	15 / B	18 / C
S 170th St / NB NAE Off-Ramp	540 / F	50 / E	59 / F	18 / B	62 / F
S 170th St / International Blvd	124 / F	131 / F	106 / F	127 / F	125 / F
Evening Peak Hour					
Air Cargo Rd / S 170th St	35 / D	9 / A	8 / A	9 / A	8 / A
Air Cargo Rd / SB NAE On-Ramp	74 / F	74 / F	49 / E	9 / A	7 / A
Air Cargo Rd / S 166th St	22 / C	22 / C	21 / C	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	138 / F	16 / B	18 / B	20 / B	17 / B
S 170th St / Doug Fox Dwy	14 / B	15 / B	13 / B	15 / B	15 / B
S 170th St / NB NAE Off-Ramp	69 / F	22 / C	16 / C	10 / A	22 / C
S 170th St / International Blvd	45 / D	42 / D	40 / D	43 / D	42 / D

Table 14 – Roadway Modification Concepts: Design Year Peak Hour Average and 95th Percentile Queue Lengths (ft)

Location	Movement	No Build Avg (ft) / 95th pct (ft)	Concept 1 Avg (ft) / 95th pct (ft)	Concept 2 Avg (ft) / 95th pct (ft)	Concept 3 Avg (ft) / 95th pct (ft)	Concept 4 Avg (ft) / 95th pct (ft)
Midday Peak Hour						
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 480*	-- / 480*	-- / 310*	0 / 50	0 / 0
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 60	40 / 100	40 / 120	60 / 140	10 / 30
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	220* / 350*	80 / 160	60 / 140	130 / 240*	90 / 170
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	260 / 420*	40 / 80	90 / 180	150 / 210	-- / --
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	130 / 250	60 / 110	50 / 100	100 / 120	50 / 110
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 870*	-- / 170	-- / 80(1)	150 / 240	-- / 190
S 170th St / International Blvd	EB Left-Turn	160 / 250	180 / 270	180 / 270	130 / 200	150 / 240
S 170th St / International Blvd	EB Through Movement	210 / 340*	170 / 270	230 / 390*	170 / 270	200 / 320*
S 170th St / International Blvd	EB Right-Turn	0 / 210	0 / 210	0 / 0	90 / 130	0 / 210
PM Peak Hour						
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 420*	-- / 420*	-- / 280*	0 / 30	0 / 0
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	40 / 60	60 / 160	50 / 140	60 / 140	30 / 70
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	210* / 350*	90 / 190*	70 / 160	160 / 160	90 / 180*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	120 / 270	30 / 50	60 / 120	110 / 160	-- / --
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	160 / 270	70 / 130	90 / 180	130 / 160	50 / 100
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 1380*	-- / 290	-- / 320(1)	110 / 160	-- / 430
S 170th St / International Blvd	EB Left-Turn	160 / 250	170 / 260	190 / 290	160 / 230	150 / 230
S 170th St / International Blvd	EB Through Movement	250 / 420*	230 / 350*	250 / 400*	260 / 400*	250 / 390*
S 170th St / International Blvd	EB Right-Turn	320* / 450*	350* / 460*	0 / 60	620* / 930*	240 / 350*
Evening Peak Hour						
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 500*	-- / 500*	-- / 390*	20 / 220	10 / 300*
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 50	20 / 70	30 / 80	50 / 120	10 / 30
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	170 / 290*	60 / 130	60 / 120	80 / 170	60 / 140
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	340* / 400*	50 / 90	110 / 250	180 / 270	-- / --
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	90 / 180	70 / 130	40 / 100	110 / 140	20 / 60
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 340	-- / 100	-- / 40(1)	100 / 140	-- / 110
S 170th St / International Blvd	EB Left-Turn	110 / 170	120 / 190	120 / 180	90 / 160	100 / 160
S 170th St / International Blvd	EB Through Movement	160 / 250	140 / 220	160 / 240	140 / 240	150 / 230
S 170th St / International Blvd	EB Right-Turn	0 / 150	0 / 150	0 / 0	50 / 110	0 / 120

* Queue extends beyond storage length or blocks adjacent intersection.

(1) NB right-turn queue reported in place of restricted left-turn

EVALUATION OF ROADWAY MODIFICATION CONCEPTS

Each roadway modification concept was evaluated by considering traffic operations benefits, safety benefits, and feasibility. Evaluation of the roadway modification concepts is summarized in Table 15.

Access in and out of the existing Cell Phone Lot would be improved by either constructing a new driveway on S 170th Street across from Doug Fox Parking, or by utilizing the old northbound NAE bridge over S 170th Street. Traffic operations and safety benefits would be comparable between these options. Intersection spacing on S 170th Street would be a concern with the new driveway across from Doug Fox Parking, because lane changes would be required for westbound traffic to use the center left-turn lane.

For concepts where the Cell Phone Lot entrance is shifted to a new driveway across from Doug Fox Parking, dual southbound left-turn lanes at the S 170th Street / Southbound NAE Off-Ramp intersection are recommended to minimize queue lengths on the off-ramp. Dual northbound left-turn lanes reduce delay and queue lengths and should be considered in coordination with the westbound right-turn lane channelization at the S 170th Street / Air Cargo Road intersection.

The three dual right-turn lane concepts at Air Cargo Road / S 170th Street all performed well operationally, although challenges arise with each configuration:

- The right-lane drop configuration in Roadway Modification Concept 1 requires all traffic destined to Southbound NAE to merge into a single lane in advance of the on-ramp, simplifying signing and wayfinding for unfamiliar motorists. In terms of freight access to Air Cargo Road, this configuration would be similar to the existing condition.
- The left-lane drop configuration in Roadway Modification Concepts 2 and 3 would provide individual lanes to Air Cargo Road and the Southbound NAE On-Ramp, but signing would need to be provided on S 170th Street to guide motorists to their desired lane.
- The median separated dual right-turn configuration in Roadway Modification Concept 4 would operate similarly to the left-lane drop, but the separated lanes create the potential for missed turns by unfamiliar motorists, and alternate routes to access Southbound NAE are not readily available.

By the design year, delays at the Air Cargo Road / Southbound NAE On-Ramp intersection would result in LOS F. Traffic signal control of the southbound left-turn and northbound through movements would address this issue. A traffic signal would not be warranted under existing or year of opening (2020) conditions, so it is recommended that the installation of this traffic signal be delayed until signal warrants are met.

Following the Federal Highway Administration (FHWA) Manual on Traffic Control devices (MUTCD) signal justification guidance, under existing and design year traffic conditions, a signal would be warranted at S 170th Street / Northbound NAE Off-Ramp. Signal warrants would no longer be met if northbound left-turn traffic is restricted to “Bus-Only”.

Modifying the lane channelization at S 170th Street / International Boulevard to include a dedicated eastbound through lane would distribute queuing evenly between the left-turn and through lane as the volumes of these two movements are comparable. The feasibility of a channelized right turn island on this approach is questionable while maintaining the southbound carpool/transit lane.

Table 15 – Roadway Modification Concept Evaluation Matrix

Issues ↓	Concept 1	Concept 2	Concept 3	Concept 4
S 170th St / Cell Phone Lot High delay leaving the Cell Phone Lot, as SB vehicles have priority. Left turn crashes are common.	✓ **New Entrance Opposite Doug Fox** SB thru movement is removed, eliminating conflict with NB left turning vehicles.	✓ **Existing Bridge Connection** SB thru movement is rerouted to bridge, eliminating conflict with NB left turning vehicles.	✓ **New Entrance Opposite Doug Fox** SB thru movement is removed, eliminating conflict with NB left turning vehicles.	✓ **Cell Phone Lot Removed** Eliminates NB approach and reduces traffic demand for S 170th St.
S 170th St / Air Cargo Rd Insufficient capacity for vehicles traveling to SB Airport Expressway On-Ramp from WB S 170th St.	✓ **Dual WB Right Turn Lanes (Right Lane Drop)** Improves WB right turn capacity. Potential merge issues at lane drop.	✓ **Dual WB Right Turn Lanes (Left Lane Drop)** Improves WB right turn capacity. Potential signing and lane utilization issues.	✓ **Dual WB Right Turn Lanes (Left Lane Drop)** Improves WB right turn capacity. Potential signing and lane utilization issues.	✓ **Separated WB Right Turns** Channelized turn for traffic bound for SB NAE On-Ramp. The separated lane could be confusing for unfamiliar drivers.
S 170th St / NB NAE Off-Ramp High delays for traffic turning left from NB Airport Expressway onto WB S 170th St. Left turn crashes common.	⊖ **NBL Add Lane / Single WB Lane** Add lane for NB left turns onto WB S 170th St eliminates conflict between WB traffic and NB left turning cars.	⊖ **Bus-Only Left Turn** NB left turn conflict is minimized. NB right turn delay increases. Queue lengths are reduced significantly.	✓ **Signal** Signal creates a protected NB left turn phase.	⊖ **NBL Add Lane / Single WB Lane** Add lane for NB left turns onto WB S 170th St eliminates conflict between WB traffic and NB left turning cars.
Air Cargo Rd / SB NAE On-Ramp High delay for SB left turns onto SB Airport Expressway On-Ramp. Left turn crashes common.	✗ **No Improvement**	⊖ **Reduced Traffic (Bus-Only Left Turn)** Reduced NB traffic on Air Cargo Rd due to bus-only turn restriction at NB NAE Off-Ramp decreases conflict.	✓ **Signal** Signal creates a protected SB left turn phase while leaving SB thru and NB right turn movements free.	✓ **Signal** Signal creates a protected SB left turn phase while leaving SB thru and NB right turn movements free.
S 170th St / International Blvd High delay on all approaches, especially during the PM peak hour.	⊖ **Exclusive EB Through Lane** Converting the center lane on the EB approach to a thru-only lane evens queuing across all EB lanes.	⊖ **EB Right Turn Channelization** Added right turn island with yield condition improves traffic flow on EB leg.	✗ **No Improvement**	✗ **No Improvement**
Feasibility Issues	Short intersection spacing on S 170th Street. Requires WB lane changes to enter Cell Phone Lot.	Constructability of EB Right-Turn island, while maintaining SB transit/carpool lane.	Short intersection spacing on S 170th Street. Requires WB lane changes to enter Cell Phone Lot.	The separated WB Right-Turn lane could be confusing to unfamiliar drivers.

✓ **Improved**
⊖ **Slight Improvement**
✗ **No Improvement**

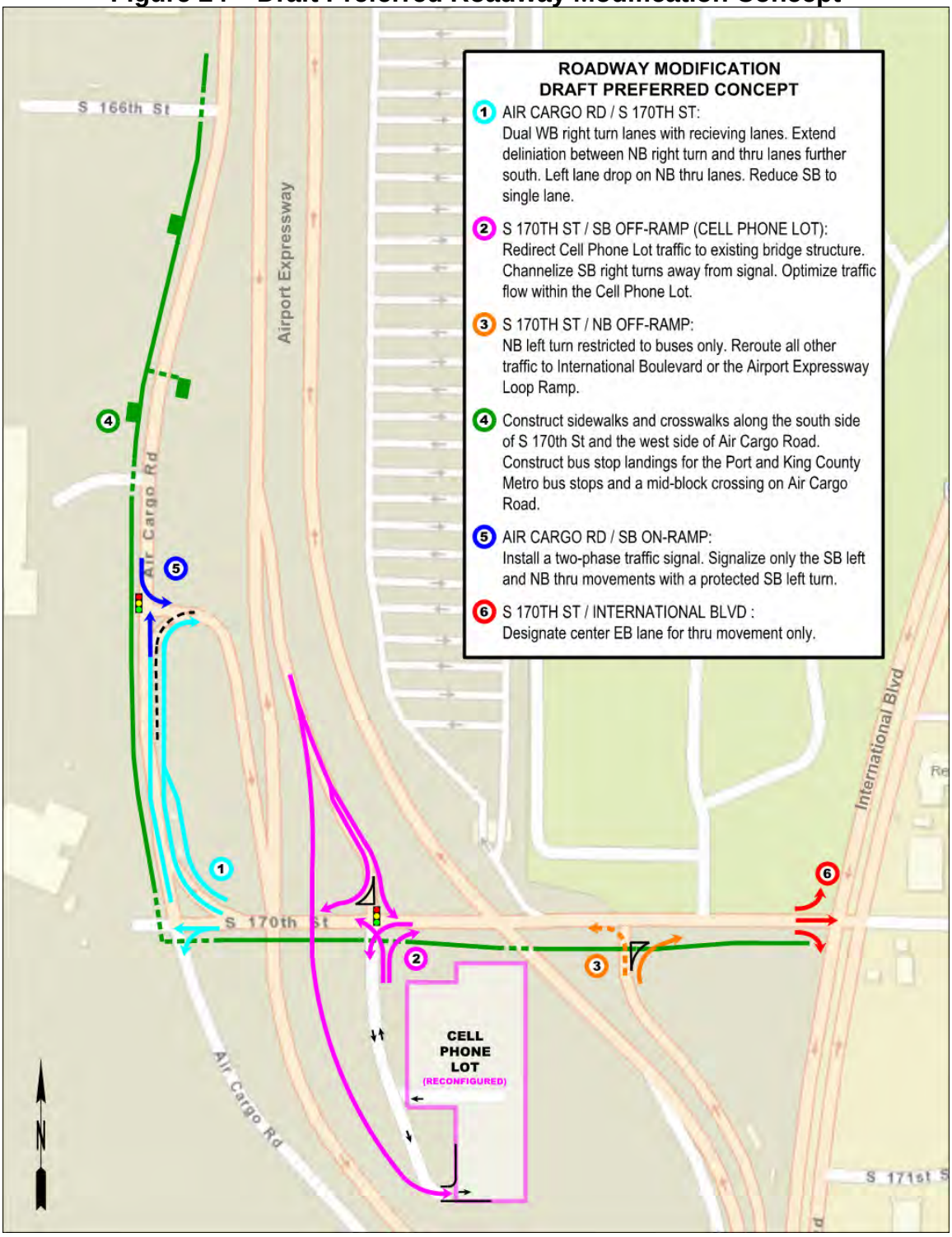
DRAFT PREFERRED ROADWAY MODIFICATION CONCEPT

After considering the benefits and constraints associated with the four roadway modification concepts, a draft preferred concept was created that combined the positive aspects of each while considering feasibility and cost.

The Draft Preferred Roadway Modification Concept included the following elements, as shown in Figure 24.

- **New Cell Phone Lot Entrance via the old Northbound NAE Bridge over S 170th Street:** Traffic entering the Cell Phone Lot from the Southbound NAE Off-Ramp would utilize the old Northbound NAE bridge over S 170th Street and would enter the Cell Phone Lot at a new driveway on the southwest corner of the Cell Phone Lot. This would eliminate the southbound through movement at S 170th Street / Cell Phone Lot intersection.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. The outer lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **New Traffic Signal at the Air Cargo Road / Southbound NAE On-Ramp Intersection:** Two-phase traffic control signal added at Air Cargo Road / Southbound NAE On-Ramp to control the southbound left-turn and northbound through movements. The southbound through movement would remain unsignalized.
- **Northbound NAE Off-Ramp "Bus-Only" Left-Turn at S 170th Street:** The northbound left-turn would be restricted to rental car facility and Port employee parking shuttle buses only. All other traffic would turn right to eastbound S 170th Street. Traffic circulating back to the airport terminal would use the NAE loop ramp, instead of using S 170th Street and Air Cargo Road.
- **Eastbound Dedicated Through Lane on S 170th Street at International Boulevard:** The shared left/through lane on the eastbound approach of S 170th Street / International Boulevard would be converted to a dedicated through lane.
- **Pedestrian and transit improvements:** Sidewalks and crosswalks would be constructed along the south side of S 170th Street and the west side of Air Cargo Road throughout the project area. Bus stop landings and shelters for Port of Seattle and King County Metro bus stops would be constructed in the project area.
- **Improved Cell Phone Lot channelization:** Restriping of the Cell Phone Lot would account for the new entrance location and would optimize traffic flow for a short-term parking facility with high hourly turnover.

Figure 24 – Draft Preferred Roadway Modification Concept



Intersection Delay and Level of Service

The Draft Preferred Roadway Modification Concept was evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 16.

Southbound through movements entering the Cell Phone Lot at the S 170th Street / Southbound NAE Off-Ramp intersection were removed from the intersection. Those vehicles would shift to the bridge over S 170th Street. Northbound left-turns at the S 170th Street / Northbound NAE Off-Ramp intersection were limited to buses only; rerouted traffic would increase the northbound right-turn volume by 10%, all other traffic would remain on NAE and use the loop ramp to recirculate to the airport terminal.

Table 16 – Draft Preferred Concept Design Year Peak Hour Intersection Average Delay (sec/veh) and Level of Service

Intersection	No Build Delay (sec/veh) / LOS	Draft Preferred Concept Delay (sec/veh) / LOS
Midday Peak Hour		
Air Cargo Rd / S 170th St	79 / F	9 / A
Air Cargo Rd / SB NAE On-Ramp	122 / F	5 / A
Air Cargo Rd / S 166th St	29 / D	25 / C
S 170th St / Cell Phone Lot Dwy	92 / F	16 / B
S 170th St / Doug Fox Dwy	21 / C	14 / B
S 170th St / NB NAE Off-Ramp	202 / F	15 / B
S 170th St / International Blvd	48 / D	49 / D
PM Peak Hour		
Air Cargo Rd / S 170th St	29 / D	8 / A
Air Cargo Rd / SB NAE On-Ramp	100 / F	5 / A
Air Cargo Rd / S 166th St	22 / C	20 / C
S 170th St / Cell Phone Lot Dwy	84 / F	25 / C
S 170th St / Doug Fox Dwy	17 / C	14 / B
S 170th St / NB NAE Off-Ramp	540 / F	59 / F
S 170th St / International Blvd	124 / F	125 / F
Evening Peak Hour		
Air Cargo Rd / S 170th St	35 / D	8 / A
Air Cargo Rd / SB NAE On-Ramp	74 / F	7 / A
Air Cargo Rd / S 166th St	22 / C	21 / C
S 170th St / Cell Phone Lot Dwy	138 / F	20 / B
S 170th St / Doug Fox Dwy	14 / B	13 / B
S 170th St / NB NAE Off-Ramp	69 / F	16 / C
S 170th St / International Blvd	45 / D	42 / D

Compared to the design year no-build condition, the Draft Preferred Roadway Modification Concept would improve intersection traffic operations at:

- Air Cargo Road / S 170th Street from LOS D or F to LOS A,
- Air Cargo Road / Southbound NAE On-Ramp from LOS F to LOS A,
- S 170th Street / Southbound NAE Off-Ramp from LOS F to LOS C or B, and
- S 170th Street / Northbound NAE Off-Ramp from LOS F to LOS C in the late evening peak hour, LOS B in the midday peak hour, and LOS F in the PM peak hour with several minutes less delay.

Peak hour traffic operations at the Air Cargo Road / S 166th Street, S 170th Street / Doug Fox Parking, and S 170th Street / International Blvd intersections were unaffected by the Preferred Roadway Modification Concept.

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the Draft Preferred Roadway Modification Concept are shown in Table 17.

Compared to the design year no-build condition, the Draft Preferred Roadway Modification Concept would reduce queue lengths at:

- Air Cargo Road / Southbound NAE On-Ramp southbound left-turn queues would reduce from 500 feet to 260 feet in the late evening peak hour. Queue lengths would be 240 to 400 feet shorter in each peak hour.
- S 170th Street / Cell Phone Lot Driveway westbound queues would reduce from 350 feet (midday and PM peak hours) to 170 feet or less, which would not spill back through the Doug Fox Parking intersection.
- S 170th Street / Northbound NAE Off-Ramp northbound queues would be reduced from 1,380 feet in the PM peak hour to 320 feet. Queues in each of the peak hours would not spill back to the NAE mainline.
- S 170th Street / International Blvd eastbound through movement queues would reduce from 420 feet to 350 feet in the PM peak hour. Through movement queues would be 30 to 70 feet shorter in each peak hour. This is offset by an increase in left-turn queue lengths of 30 to 90 feet in each peak hour.

Table 17 – Draft Preferred Concept Design Year Peak Hour Average and 95th Percentile Queue Lengths (ft)

Location	Movement	No Build Avg (ft) / 95th pct (ft)	Draft Preferred Concept Avg (ft) / 95th pct (ft)
Midday Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 480*	0 / 90
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 60	40 / 120
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	220* / 350*	60 / 140
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	260 / 420*	90 / 180
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	130 / 250	50 / 100
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 870*	-- / 80(1)
S 170th St / International Blvd	EB Left-Turn	160 / 250	220 / 340*
S 170th St / International Blvd	EB Through Movement	210 / 340*	170 / 270
S 170th St / International Blvd	EB Right-Turn	0 / 210	0 / 210
PM Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 420*	0 / 20
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	40 / 60	70 / 140
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	210* / 350*	100 / 170
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	120 / 270	80 / 220
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	160 / 270	90 / 180
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 1380*	-- / 320(1)
S 170th St / International Blvd	EB Left-Turn	160 / 250	220 / 340*
S 170th St / International Blvd	EB Through Movement	250 / 420*	230 / 350*
S 170th St / International Blvd	EB Right-Turn	320* / 450*	250 / 360*
Evening Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 500*	10 / 260
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 50	40 / 80
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	170 / 290*	70 / 120
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	340* / 400*	120 / 300*
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	90 / 180	40 / 100
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 340	-- / 40(1)
S 170th St / International Blvd	EB Left-Turn	110 / 170	130 / 200
S 170th St / International Blvd	EB Through Movement	160 / 250	140 / 220
S 170th St / International Blvd	EB Right-Turn	0 / 150	0 / 150

* Queue extends beyond storage length or blocks adjacent intersection.

(1) NB right-turn queue reported in place of restricted left-turn

FINAL PREFERRED ROADWAY MODIFICATION CONCEPT

After the Draft Preferred Roadway Modification Concept was reviewed by Port of Seattle staff and project stakeholders, a final preferred concept was created that addressed concerns with enforcement of the "bus-only" left turn at S 170th Street / Northbound NAE Off-Ramp. Courtesy vans and shuttle buses would likely qualify as buses, so the benefits associated with reducing the northbound left-turn volume on the off-ramp would not be achieved.

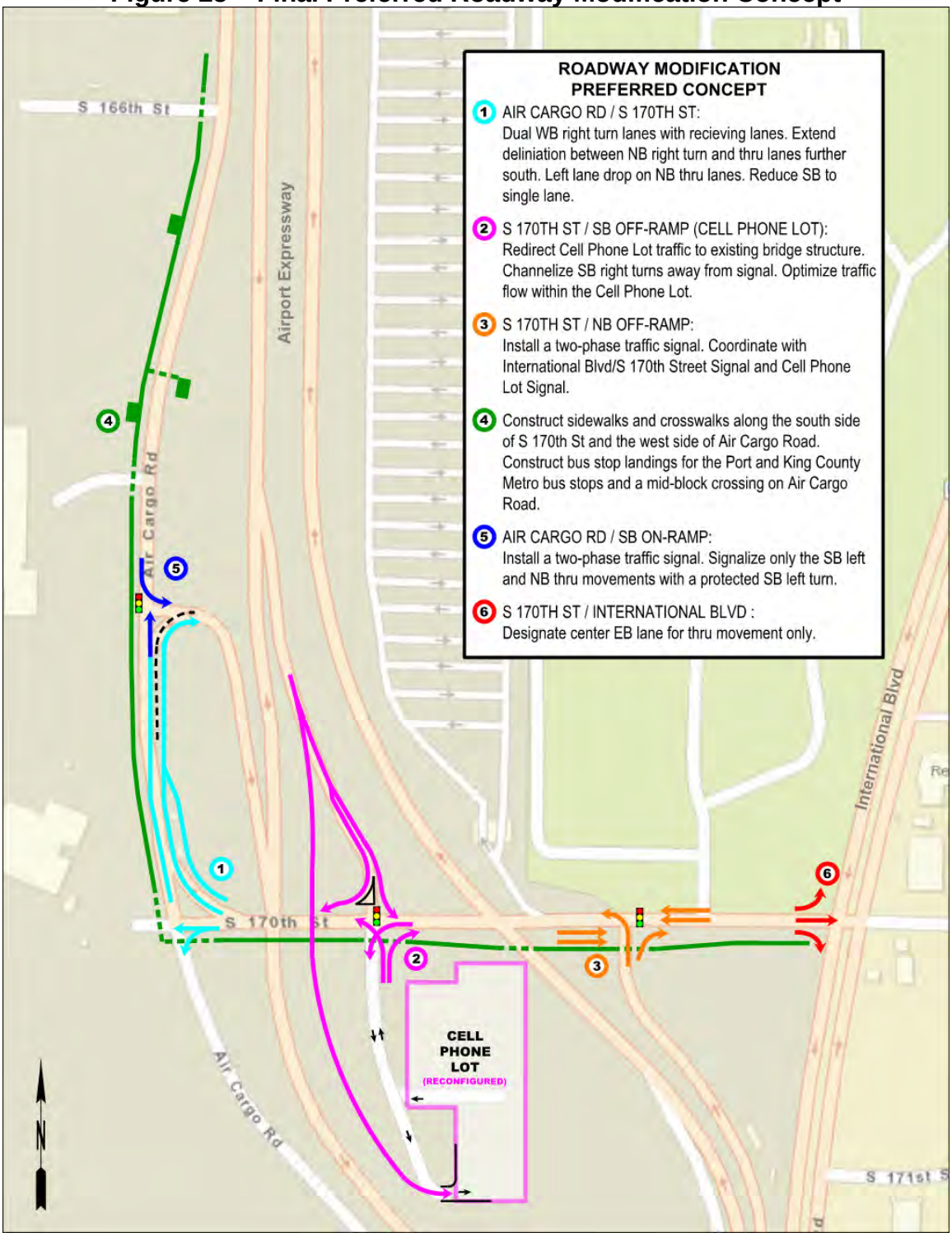
It was determined that installation of a traffic control signal at the S 170th Street / Northbound NAE Off-Ramp intersection would be the best option.

The Final Preferred Roadway Modification Concept includes the following elements, as shown in Figure 25.

- **New Cell Phone Lot Entrance via the old Northbound NAE Bridge over S 170th Street:** Traffic entering the Cell Phone Lot from the Southbound NAE Off-Ramp would utilize the old Northbound NAE bridge over S 170th Street and would enter the Cell Phone Lot at a new driveway on the southwest corner of the Cell Phone Lot. This would eliminate the southbound through movement at S 170th Street / Cell Phone Lot intersection.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. The outer lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **New Traffic Signal at the Air Cargo Road / Southbound NAE On-Ramp Intersection:** Two-phase traffic control signal added at Air Cargo Road / Southbound NAE On-Ramp to control the southbound left-turn and northbound through movements. The southbound through movement would remain unsignalized.
- **New Traffic Signal at the S 170th Street / Northbound NAE Off-Ramp Intersection:** Two-phase traffic control signal added at the S 170th Street / Northbound NAE Off-Ramp to provide a protected phase for the northbound movements. This signal would be in coordination with the two adjacent signals at International Boulevard and the Cell Phone Lot driveway.
- **Eastbound Dedicated Through Lane on S 170th Street at International Boulevard:** The shared left/through lane on the eastbound approach of S 170th Street / International Boulevard would be converted to a dedicated through lane.
- **Pedestrian and transit improvements:** Sidewalks and crosswalks would be constructed along the south side of S 170th Street and the west side of Air Cargo Road throughout the project area. Bus stop landings and shelters for Port of Seattle and King County Metro bus stops would be constructed in the project area.
- **Improved Cell Phone Lot channelization:** Restriping of the Cell Phone Lot would account for the new entrance location and would optimize traffic flow for a short-term parking facility with high hourly turnover.

This concept would address safety and operational concerns and provide acceptable traffic operations in the study area in the design year peak hours.

Figure 25 – Final Preferred Roadway Modification Concept



Intersection Delay and Level of Service

The Final Preferred Roadway Modification Concept was evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 18.

Southbound through movements entering the Cell Phone Lot at the S 170th Street / Southbound NAE Off-Ramp intersection were removed from the intersection. Those vehicles would shift to the bridge over S 170th Street.

Table 18 – Final Preferred Concept Design Year Peak Hour Intersection Average Delay (sec/veh) and Level of Service

	No Build	Final Preferred Concept
Intersection	Delay (sec/veh) / LOS	Delay (sec/veh) / LOS
Midday Peak Hour		
Air Cargo Rd / S 170th St	79 / F	10 / A
Air Cargo Rd / SB NAE On-Ramp	122 / F	8 / A
Air Cargo Rd / S 166th St	29 / D	29 / D
S 170th St / Cell Phone Lot Dwy	92 / F	21 / C
S 170th St / Doug Fox Dwy	21 / C	18 / C
S 170th St / NB NAE Off-Ramp	202 / F	14 / B
S 170th St / International Blvd	48 / D	46 / D
PM Peak Hour		
Air Cargo Rd / S 170th St	29 / D	9 / A
Air Cargo Rd / SB NAE On-Ramp	100 / F	5 / A
Air Cargo Rd / S 166th St	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	84 / F	24 / C
S 170th St / Doug Fox Dwy	17 / C	15 / B
S 170th St / NB NAE Off-Ramp	540 / F	16 / B
S 170th St / International Blvd	124 / F	128 / F
Evening Peak Hour		
Air Cargo Rd / S 170th St	35 / D	9 / A
Air Cargo Rd / SB NAE On-Ramp	74 / F	7 / A
Air Cargo Rd / S 166th St	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	138 / F	22 / C
S 170th St / Doug Fox Dwy	14 / B	15 / B
S 170th St / NB NAE Off-Ramp	69 / F	12 / B
S 170th St / International Blvd	45 / D	42 / D

Compared to the design year no-build condition, the Preferred Roadway Modification Concept would improve intersection traffic operations at:

- Air Cargo Road / S 170th Street from LOS D or F to LOS A,
- Air Cargo Road / Southbound NAE On-Ramp from LOS F to LOS A,
- S 170th Street / Cell Phone Lot driveway from LOS F to LOS C, and
- S 170th Street / Northbound NAE Off-Ramp from LOS F to LOS B.

Peak hour traffic operations at the Air Cargo Road / S 166th Street, S 170th Street / Doug Fox Parking, and S 170th Street / International Blvd intersections were unaffected by the Final Preferred Roadway Modification Concept.

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the Final Preferred Roadway Modification Concept are shown in Table 19.

Compared to the design year no-build condition, the Final Preferred Roadway Modification Concept would reduce queue lengths at:

- Air Cargo Road / Southbound NAE On-Ramp southbound left-turn queues would reduce from 500 feet to 100 feet in the late evening peak hour. Queue lengths would be 380 to 400 feet shorter in each peak hour.
- S 170th Street / Cell Phone Lot Driveway westbound queues would reduce from 350 feet (midday and PM peak hours) to 170 feet (midday) and 230 feet (PM), which would occasionally spill back to the Doug Fox Parking driveway.
- S 170th Street / Northbound NAE Off-Ramp northbound queues would be reduced from 1,380 feet in the PM peak hour to 130 feet. Queues in each of the peak hours would not spill back to the NAE mainline.
- S 170th Street / International Blvd eastbound through movement queues would reduce from 420 feet to 320 feet in the PM peak hour. Through movement queues would be 30 to 120 feet shorter in each peak hour. This is offset by an increase in left-turn queue lengths of 10 feet in each peak hour. Eastbound right-turn queues would continue to spill back through the Northbound NAE Off-Ramp intersection in the PM peak hour.

Table 19 – Final Preferred Concept Design Year Peak Hour Average and 95th Percentile Queue Lengths (ft)

Location	Movement	No Build Avg (ft) / 95th pct (ft)	Final Preferred Concept Avg (ft) / 95th pct (ft)
Midday Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 480*	0 / 40
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 60	50 / 100
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	220* / 350*	170 / 170
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	260 / 420*	150 / 290
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	130 / 250	80 / 140
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 870*	150 / 210
S 170th St / International Blvd	EB Left-Turn	160 / 250	160 / 230
S 170th St / International Blvd	EB Through Movement	210 / 340*	150 / 220
S 170th St / International Blvd	EB Right-Turn	0 / 210	70 / 150
PM Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 420*	0 / 40
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	40 / 60	60 / 120
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	210* / 350*	230* / 230*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	120 / 270	100 / 170
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	160 / 270	150 / 270
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 1380*	100 / 130
S 170th St / International Blvd	EB Left-Turn	160 / 250	170 / 230
S 170th St / International Blvd	EB Through Movement	250 / 420*	240 / 320*
S 170th St / International Blvd	EB Right-Turn	320* / 450*	530* / 900*
Evening Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	-- / 500*	0 / 100
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	30 / 50	50 / 100
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	170 / 290*	200* / 200*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	340* / 400*	180 / 320*
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	90 / 180	70 / 110
S 170th St / NB NAE Off-Ramp	Left-Turn	-- / 340	100 / 140
S 170th St / International Blvd	EB Left-Turn	110 / 170	120 / 160
S 170th St / International Blvd	EB Through Movement	160 / 250	140 / 220
S 170th St / International Blvd	EB Right-Turn	0 / 150	50 / 130

* Queue extends beyond storage length or blocks adjacent intersection.

(1) NB right-turn queue reported in place of restricted left-turn

RECOMMENDATIONS

The final preferred roadway modification concept is recommended to be advanced to final design and construction.

An annual traffic signal warrants monitoring program is recommended for the Air Cargo Road / Southbound NAE On-Ramp intersection before installation of the traffic signal hardware. Engineering design of the traffic signal is recommended to be done concurrently with the pedestrian and transit facilities and other elements of the preferred concept to accommodate all future infrastructure.

It is recommended that the Port of Seattle continue to coordinate with the City of SeaTac and King County regarding the proposed rechannelization of S 170th Street at International Blvd, the installation of traffic signal interconnect equipment, and operation/maintenance of the traffic signals shown in the preferred concept.

The following appendices to the Traffic Analysis Report are over 400 pages long and available upon request:

- Turning Movement Counts (2018)
- Tube Count Data (2018)
- Existing SYNCHRO Analysis Reports
- Design Year No Build SYNCHRO Analysis Reports
- Roadway Modification Concepts
- Design Year Build SYNCHRO Analysis Reports
- Traffic Signal Warrant Analysis

APPENDIX B-2

Traffic Analysis Update

AIR CARGO ROAD SAFETY IMPROVEMENTS PROJECT

Traffic Analysis Update

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December 18, 2019

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INTRODUCTION

The Air Cargo Road Safety Improvements project proposes modifications to several roadway facilities under the jurisdiction of the Port of Seattle and/or the City of SeaTac to improve traffic safety and operations.

The purpose of this report is to summarize the proposed traffic operations in the study area for the design year using the revised channelization and intersection control proposed by the project. The study area is one-half mile north of the Sea-Tac Airport terminal and includes the following roadways:

- Air Cargo Road from S 166th Street to S 170th Street
- S 170th Street from Air Cargo Road to International Boulevard

Design year 2029 traffic volumes developed from 2018 turning movement counts had been used in the previous analysis and were maintained with the updated analysis. Traffic signal timing was unchanged between the previous preferred concept and the updated concept, with the exception of the Northbound NAE off-ramp signal, where the westbound phase became a free movement, and pedestrian phasing was adjusted to match the updated sidewalk facilities.

PREVIOUS ROADWAY MODIFICATION CONCEPT

A previous traffic analysis was performed that evaluated several conceptual roadway alternatives and recommended a preferred alternative that combined the positive aspects of each while considering feasibility and cost.

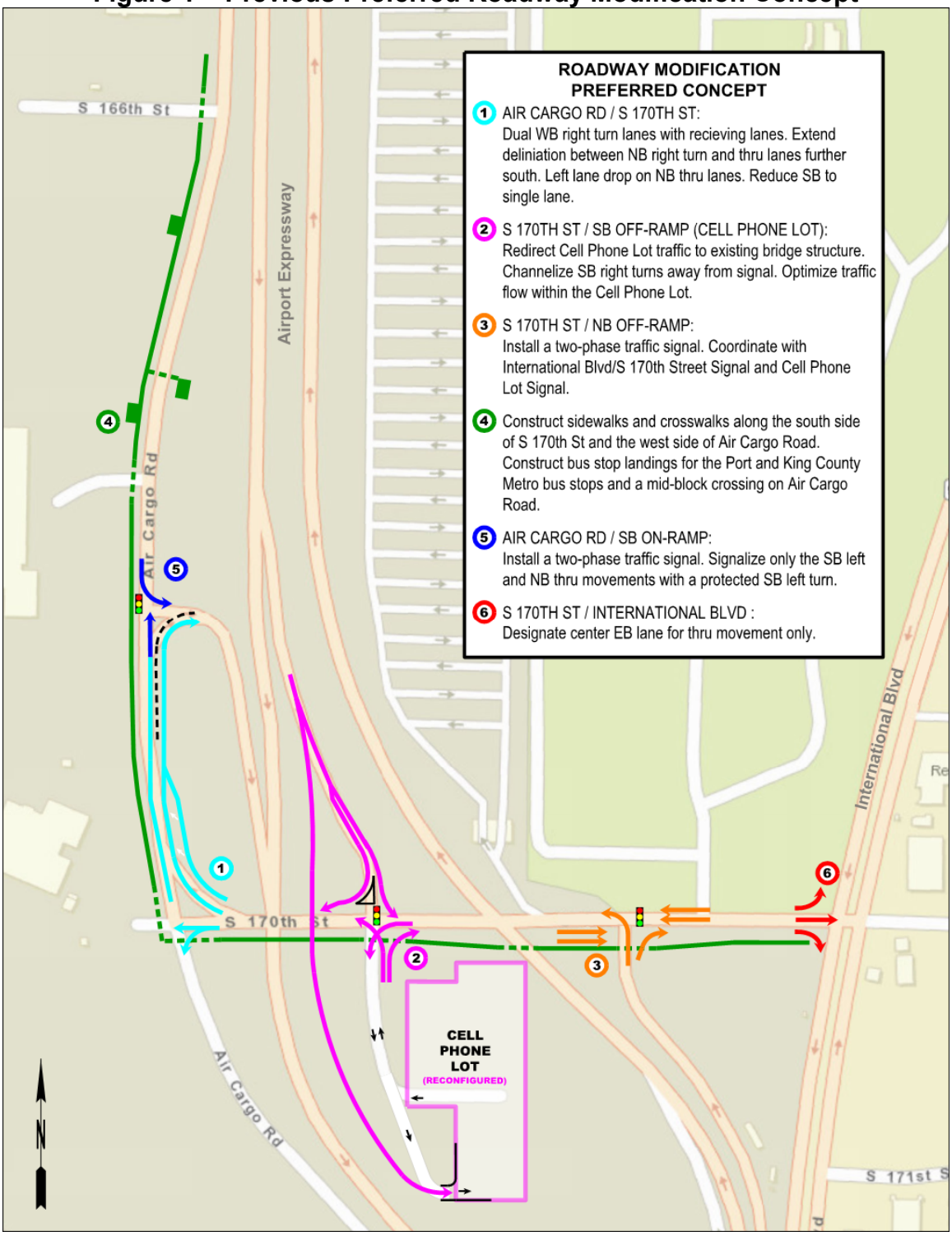
The previous Preferred Roadway Modification Concept included the following elements, as shown in Figure 1.

- **New Cell Phone Lot Entrance via the old Northbound NAE Bridge over S 170th Street:** Traffic entering the Cell Phone Lot from the Southbound NAE Off-Ramp would utilize the old Northbound NAE bridge over S 170th Street and would enter the Cell Phone Lot at a new driveway on the southwest corner of the Cell Phone Lot. This would eliminate the southbound through movement at S 170th Street / Cell Phone Lot intersection.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. The outer lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **New Traffic Signal at the Air Cargo Road / Southbound NAE On-Ramp Intersection:** Two-phase traffic control signal added at Air Cargo Road / Southbound NAE On-Ramp to control the southbound left-turn and northbound through movements. The southbound through movement would remain unsignalized.
- **New Traffic Signal at the S 170th Street / Northbound NAE Off-Ramp Intersection:** Two-phase traffic control signal added at the S 170th Street / Northbound NAE Off-Ramp to provide a protected phase and an add-lane on Westbound S 170th Street for the northbound movements. The westbound movement would remain free while being

reduced to a single lane. This signal would be in coordination with the two adjacent signals at International Boulevard and the Cell Phone Lot driveway.

- **Eastbound Dedicated Through Lane on S 170th Street at International Boulevard:** The shared left/through lane on the eastbound approach of S 170th Street / International Boulevard would be converted to a dedicated through lane.
- **Pedestrian and transit improvements:** Sidewalks and crosswalks would be constructed along S 170th Street and the west side of Air Cargo Road throughout the project area. Bus stop landings and shelters for Port of Seattle and King County Metro bus stops would be constructed in the project area.
- **Improved Cell Phone Lot channelization:** Restriping of the Cell Phone Lot would account for the new entrance location and would optimize traffic flow for a short-term parking facility with high hourly turnover.

Figure 1 – Previous Preferred Roadway Modification Concept



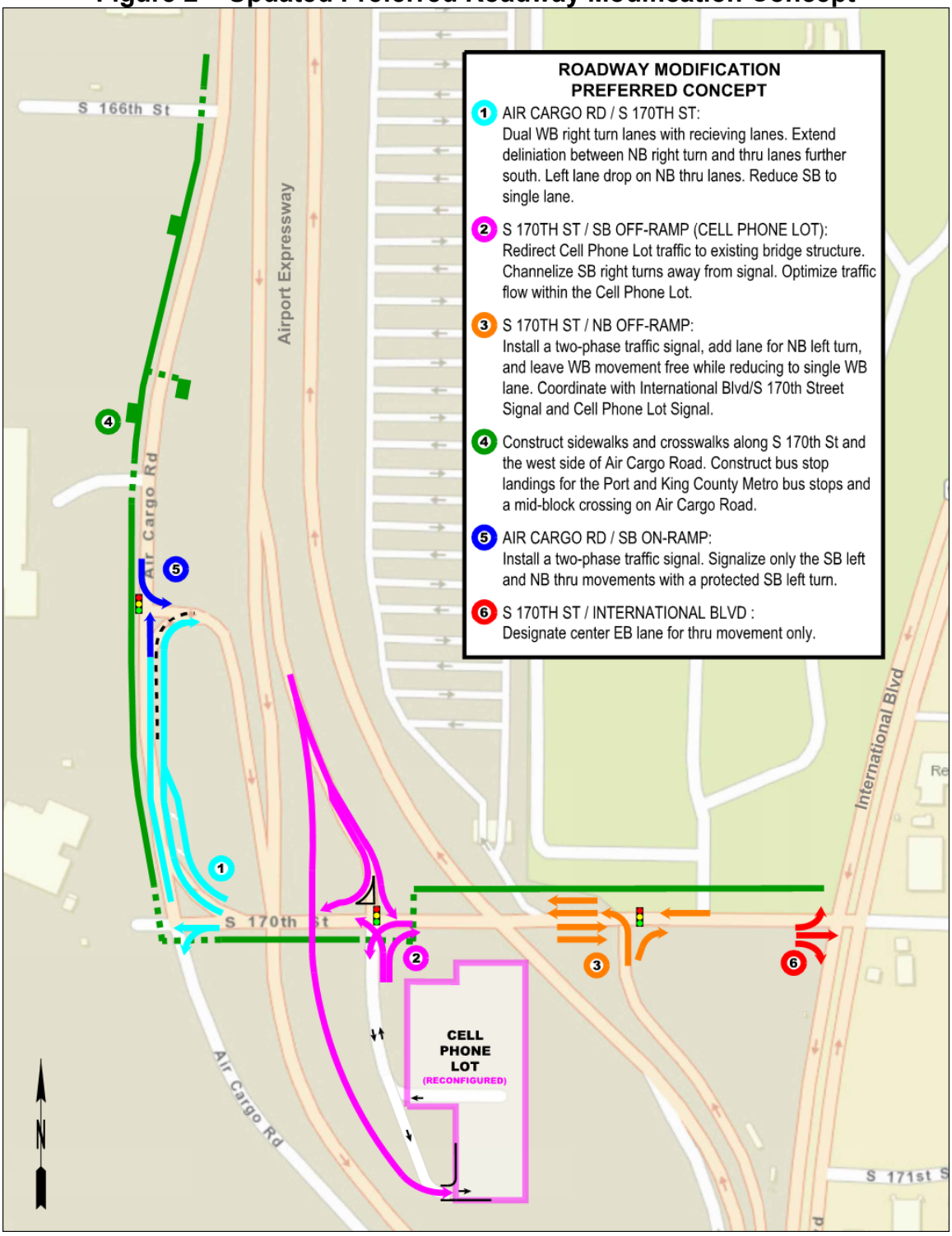
UPDATED PREFERRED ROADWAY MODIFICATION CONCEPT

After the Previous Preferred Roadway Modification Concept was reviewed by Port of Seattle staff and project stakeholders, an updated preferred concept was created to move the sidewalk on S 170th Street from the south side of the road to the north side. The sidewalk would then be forward compatible with potential future Port projects. Moving the sidewalk and reducing the number of westbound travel lanes from two to one provides space for a traffic signal pole on the north side of S 170th Street at the Northbound NAE Off-Ramp intersection.

The Final Preferred Roadway Modification Concept includes the following elements, as shown in Figure 2.

- **New Cell Phone Lot Entrance via the old Northbound NAE Bridge over S 170th Street:** Traffic entering the Cell Phone Lot from the Southbound NAE Off-Ramp would utilize the old Northbound NAE bridge over S 170th Street and would enter the Cell Phone Lot at a new driveway on the southwest corner of the Cell Phone Lot. This would eliminate the southbound through movement at S 170th Street / Cell Phone Lot intersection, where a Westbound left turn lane into the Cell Phone Lot was also added.
- **Westbound S 170th Street at Air Cargo Road Dual Right-Turn Lanes:** Dual right-turn lanes would be constructed on westbound S 170th Street at Air Cargo Road. The outer lane would drop on Air Cargo Road between the S 170th Street and Southbound NAE On-Ramp intersections.
- **New Traffic Signal at the Air Cargo Road / Southbound NAE On-Ramp Intersection:** Two-phase traffic control signal added at Air Cargo Road / Southbound NAE On-Ramp to control the southbound left-turn and northbound through movements. The southbound through movement would remain unsignalized.
- **New Traffic Signal at the S 170th Street / Northbound NAE Off-Ramp Intersection:** Two-phase traffic control signal added at the S 170th Street / Northbound NAE Off-Ramp to provide a protected phase and an add-lane on Westbound S 170th Street for the northbound movements. The westbound movement would remain free while being reduced to a single lane. This signal would be in coordination with the two adjacent signals at International Boulevard and the Cell Phone Lot driveway.
- **Eastbound Dedicated Through Lane on S 170th Street at International Boulevard:** The shared left/through lane on the eastbound approach of S 170th Street / International Boulevard would be converted to a dedicated through lane.
- **Pedestrian and transit improvements:** Sidewalks and crosswalks would be constructed along S 170th Street on the and the west side of Air Cargo Road throughout the project area. Bus stop landings and shelters for Port of Seattle and King County Metro bus stops would be constructed in the project area.
- **Improved Cell Phone Lot channelization:** Restriping of the Cell Phone Lot would account for the new entrance location and would optimize traffic flow for a short-term parking facility with high hourly turnover.

Figure 2 – Updated Preferred Roadway Modification Concept



TRAFFIC OPERATIONS

Intersection Delay and Level of Service

Delay (seconds per vehicle) is the measure of traffic operations at signalized and unsignalized intersections. Level of service is used to communicate the average amount of delay experienced by users at an intersection. Letter grades are assigned according to the amount of delay as shown in Table 1. LOS E and F correspond to high levels of congestion, waiting through multiple traffic signal cycles and long waits at stop signs due to insufficient gaps in opposing traffic movements.

Delay values at signalized intersections and all-way stop controlled intersections are averaged for all movements, some individual movements may fail (experience LOS F delays) without resulting in LOS F for the entire intersection. Critical movements or failing movements at each intersection will be noted in this report to supplement the intersection level of service determination.

Table 1 – Intersection Level of Service Definition

	Control Delay* (seconds per vehicle)	
Level of Service	**Signalized**	**Unsignalized**
A	≤10	0 to 10
B	>10 to 20	>10 to 15
C	>20 to 35	>15 to 25
D	>35 to 55	>25 to 35
E	>55 to 80	>35 to 50
F	>80	>50

Source: Transportation Research Board. Highway Capacity Manual 2010. Exhibit 18-4 and Exhibit 19-1.

* Control delay is time spent slowing, stopping, moving up in a queue, and accelerating back to desired speed.

Both the previous and updated Preferred Roadway Modification Concepts were evaluated using Synchro 9 with design year volumes for the three peak hours. Peak hour intersection delay and level of service for the build concepts are shown in Table 2.

Table 2 – Preferred Concept Design Year Peak Hour Intersection Average Delay (sec/veh) and Level of Service

Intersection	Previous Concept Delay (sec/veh) / LOS	Updated Concept Delay (sec/veh) / LOS
Midday Peak Hour		
Air Cargo Rd / S 170th St	10 / A	10 / A
Air Cargo Rd / SB NAE On-Ramp	8 / A	8 / A
Air Cargo Rd / S 166th St	29 / D	29 / D
S 170th St / Cell Phone Lot Dwy	21 / C	23 / C
S 170th St / Doug Fox Dwy	18 / C	21 / C
S 170th St / NB NAE Off-Ramp	14 / B	12 / B
S 170th St / International Blvd	46 / D	48 / D
PM Peak Hour		
Air Cargo Rd / S 170th St	9 / A	9 / A
Air Cargo Rd / SB NAE On-Ramp	5 / A	6 / A
Air Cargo Rd / S 166th St	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	24 / C	24 / C
S 170th St / Doug Fox Dwy	15 / C	18 / C
S 170th St / NB NAE Off-Ramp	16 / B	11 / B
S 170th St / International Blvd	128 / F	127 / F
Evening Peak Hour		
Air Cargo Rd / S 170th St	9 / A	9 / A
Air Cargo Rd / SB NAE On-Ramp	7 / A	7 / A
Air Cargo Rd / S 166th St	22 / C	22 / C
S 170th St / Cell Phone Lot Dwy	22 / C	21 / C
S 170th St / Doug Fox Dwy	15 / B	15 / B
S 170th St / NB NAE Off-Ramp	12 / B	8 / A
S 170th St / International Blvd	42 / D	42 / D

Compared to the previous concept, the updated Preferred Roadway Modification Concept would maintain the same level of service at all intersections except:

- S 170th Street / Northbound NAE Off-Ramp from LOS B to LOS A in the late evening peak hour

Peak Hour Queue Lengths

Average and 95th percentile queue lengths for each of the three peak hours were calculated by the Synchro software. Peak hour queue lengths for the previous and updated Preferred Roadway Modification Concept are shown in Table 3.

Table 3 – Previous and Updated Preferred Concept Design Year Peak Hour Average and 95th Percentile Queue Lengths (feet)

Location	Movement	Previous Concept Avg (ft) / 95th pct (ft)	Updated Concept Avg (ft) / 95th pct (ft)
Midday Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	0 / 40	0 / 40
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	50 / 100	50 / 100
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	170 / 170	220 / 220
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	150 / 290	150 / 290
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	80 / 140	90 / 220
S 170th St / NB NAE Off-Ramp	Left-Turn	150 / 210	120 / 210
S 170th St / International Blvd	EB Left-Turn	160 / 230	150 / 230
S 170th St / International Blvd	EB Through Movement	150 / 220	140 / 220
S 170th St / International Blvd	EB Right-Turn	70 / 150	100 / 170
PM Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	0 / 40	0 / 0
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	60 / 120	60 / 120
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	230* / 230*	210* / 290*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	100 / 170	100 / 170
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	150 / 270	150 / 270
S 170th St / NB NAE Off-Ramp	Left-Turn	100 / 130	80 / 130
S 170th St / International Blvd	EB Left-Turn	170 / 230	150 / 230
S 170th St / International Blvd	EB Through Movement	240 / 320*	190 / 320*
S 170th St / International Blvd	EB Right-Turn	530* / 900*	480* / 900*
Evening Peak Hour			
Air Cargo Rd / SB NAE On-Ramp	SB Left-Turn	0 / 100	0 / 100
S 170th St / Cell Phone Lot Dwy	EB Through/Right Average	50 / 100	50 / 100
S 170th St / Cell Phone Lot Dwy	WB Left/Through Average	200* / 200*	140 / 240*
S 170th St / Cell Phone Lot Dwy	NB Left-Turn	180 / 320*	180 / 320*
S 170th St / Cell Phone Lot Dwy	SB Left/Through/Right Average	70 / 110	70 / 110
S 170th St / NB NAE Off-Ramp	Left-Turn	100 / 140	70 / 120
S 170th St / International Blvd	EB Left-Turn	120 / 160	100 / 150
S 170th St / International Blvd	EB Through Movement	140 / 220	120 / 180
S 170th St / International Blvd	EB Right-Turn	50 / 130	60 / 130

* Queue extends beyond storage length or blocks adjacent intersection.

Average and 95th percentile queue lengths are comparable between the previous concept and the updated Preferred Roadway Modification Concept.

S 170TH STREET / INTERNATIONAL BOULEVARD INTERSECTION OPERATIONS

Reducing the number of westbound travel lanes on S 170th Street could create the potential for queuing along the corridor to impact traffic operations at the intersection with International Boulevard. The following areas of concern were investigated:

- **Westbound S 170th Street queue lengths:** Because the westbound movement at the S 170th Street / NB NAE off-ramp intersection would operate free-flowing at all times in the updated configuration, the first stop condition on experienced by westbound motorists on S 170th Street is at the Cell Phone Lot Driveway. Queues on this movement are shown to not exceed 290 feet (see Table 3), and are not long enough to reach International Boulevard.
- **Northbound Left Turn from International Boulevard to S 170th Street:** Comparing the previous configuration with the updated concept, vehicle delay and queue lengths are shown to remain unchanged during the PM and evening peak hours but increase slightly in the midday peak.
    - Delay is shown to increase from 62 to 67 seconds.
    - Average queue is shown to remain at 290 feet.
    - 95th Percentile queue is shown to increase from 410 feet to 510 feet.

  Delay and queue length increase for the northbound left-turn movement during the midday peak hour do not result in a change to the overall intersection level of service.
- **Increased pedestrian volumes crossing the West leg of the International Boulevard / S 170th Street intersection:** By shifting the sidewalk to the north side of S 170th Street, pedestrian volumes will likely increase at this location because of adjacent transit stops along International Boulevard. Data collected in 2018 shows a maximum of five pedestrians per hour crossing at this location (during the evening peak), and a maximum of two pedestrians per hour were recorded traveling on S 170th Street between International Boulevard and the NB NAE Off-Ramp intersection. Pedestrian volumes are not expected to increase at a rate that would result in signal timing changes that would affect the Northbound left turn movement.

Traffic analysis shows the proposed single westbound travel lane on S 170th Street between International Boulevard and the NB NAE Off-Ramp does not affect the level of service at the International Boulevard / S 170th Street intersection. Queues on westbound S 170th Street are not expected to spillback to International Boulevard, and impacts to operation of the northbound left-turn movement are modest in the midday peak hour and minimal in the afternoon and evening peak hours.

RECOMMENDATIONS

The updated preferred roadway modification concept is recommended to be advanced to final design and construction.

APPENDIX A –DESIGN YEAR BUILD SYNCHRO ANALYSIS REPORTS

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Sign Control		Stop				Stop			Stop			Stop
Traffic Volume (vph)	6	0	3	4	29	6	1236	1	30	23	156	33
Future Volume (vph)	6	0	3	4	29	6	1236	1	30	23	156	33
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	6	0	3	0	31	6	1301	1	32	24	164	35

Direction, Lane #	EB 1	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total (vph)	9	37	651	651	33	24	202
Volume Left (vph)	6	31	0	0	1	0	164
Volume Right (vph)	3	0	651	651	0	24	3
Hadj (s)	0.31	0.44	-0.33	-0.33	0.62	0.01	0.48
Departure Headway (s)	4.8	4.9	3.2	3.2	4.9	3.2	4.5
Degree Utilization, x	0.01	0.05	0.58	0.58	0.04	0.02	0.25
Capacity (veh/h)	696	687	1118	1118	719	1121	779
Control Delay (s)	7.9	8.2	10.5	10.5	8.1	6.3	9.1
Approach Delay (s)	7.9	10.4			7.3		9.1
Approach LOS	A	B			A		A

Intersection Summary				
Delay	10.1			
Level of Service	B			
Intersection Capacity Utilization	68.3%	ICU Level of Service	C	
Analysis Period (min)	15			

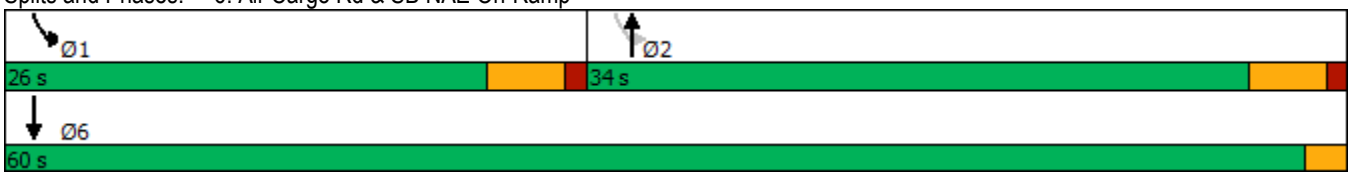
Movement	SBR
Lane Configurations	
Sign Control	
Traffic Volume (vph)	3
Future Volume (vph)	3
Peak Hour Factor	0.95
Hourly flow rate (vph)	3

Direction, Lane #	

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	0	0	382	890	503	192
Future Volume (vph)	0	0	382	890	503	192
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650
Grade (%)	0%		3%			-3%
Storage Length (ft)	0	0		0	100	
Storage Lanes	0	0		1	1	
Taper Length (ft)	50				50	
Satd. Flow (prot)	0	0	1401	1191	1421	1495
Flt Permitted					0.484	
Satd. Flow (perm)	0	0	1401	1191	724	1495
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)				507		
Link Speed (mph)	30		25			30
Link Distance (ft)	314		318			224
Travel Time (s)	7.1		8.7			5.1
Lane Group Flow (vph)	0	0	402	937	529	202
Turn Type			NA	Free	D.P+P	NA
Protected Phases			2		1	6
Permitted Phases				Free	2	
Total Split (s)			34.0		26.0	60.0
Total Lost Time (s)			4.5		4.5	2.0
Act Effct Green (s)			15.7	36.9	26.9	36.9
Actuated g/C Ratio			0.43	1.00	0.73	1.00
v/c Ratio			0.67	0.79	0.72	0.14
Control Delay			15.4	5.9	8.5	0.2
Queue Delay			0.0	0.0	0.0	0.0
Total Delay			15.4	5.9	8.5	0.2
LOS			B	A	A	A
Approach Delay			8.8			6.2
Approach LOS			A			A

Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 36.9			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 0.79			
Intersection Signal Delay: 7.9		Intersection LOS: A	
Intersection Capacity Utilization 62.3%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 6: Air Cargo Rd & SB NAE On-Ramp



Movement	EBL	EBR	NBU	NBL	NBT	SBT	SBR
Lane Configurations							
Traffic Volume (veh/h)	49	24	3	28	344	667	32
Future Volume (Veh/h)	49	24	3	28	344	667	32
Sign Control	Stop				Free	Free	
Grade	0%				1%	-1%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	52	25	0	29	362	702	34
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type					None	None	
Median storage veh)							
Upstream signal (ft)					960		
pX, platoon unblocked			0.00				
vC, conflicting volume	1139	719	0	736			
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1139	719	0	736			
tC, single (s)	6.7	6.5	0.0	4.3			
tC, 2 stage (s)							
tF (s)	3.8	3.6	0.0	2.4			
p0 queue free %	72	93	0	96			
cM capacity (veh/h)	187	381	0	781			

Direction, Lane #	EB 1	NB 1	NB 2	SB 1
Volume Total	77	29	362	736
Volume Left	52	29	0	0
Volume Right	25	0	0	34
cSH	224	781	1700	1700
Volume to Capacity	0.34	0.04	0.21	0.43
Queue Length 95th (ft)	36	3	0	0
Control Delay (s)	29.3	9.8	0.0	0.0
Lane LOS	D	A		
Approach Delay (s)	29.3	0.7		0.0
Approach LOS	D			

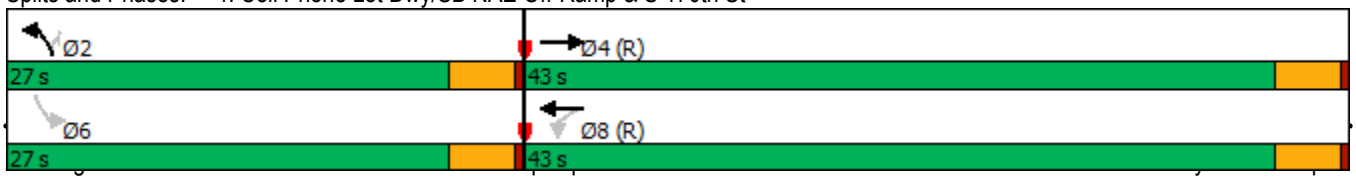
Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		

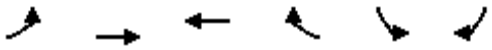
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	163	20	98	802	0	377	0	28	210	0	96
Future Volume (vph)	0	163	20	98	802	0	377	0	28	210	0	96
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
Lane Width (ft)	12	12	12	13	13	13	12	12	12	14	12	12
Grade (%)		3%			-3%			0%			-4%	
Storage Length (ft)	0		0	100		0	0		100	300		50
Storage Lanes	0		0	1		0	1		1	1		0
Taper Length (ft)	50			50			50			50		
Satd. Flow (prot)	0	1121	0	1370	2740	0	1568	0	1402	1656	0	1389
Flt Permitted				0.609			0.950	*0.420		*0.480		
Satd. Flow (perm)	0	1121	0	876	2740	0	1568	0	1372	835	0	1389
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		13							28			101
Link Speed (mph)		20			20			20			20	
Link Distance (ft)		381			238			336			1004	
Travel Time (s)		13.0			8.1			11.5			34.2	
Lane Group Flow (vph)	0	193	0	103	844	0	397	0	29	221	0	101
Turn Type		NA		Perm	NA		Prot		Perm	Perm		Free
Protected Phases		4			8		2					
Permitted Phases				8					2	6		Free
Total Split (s)		43.0		43.0	43.0		27.0		27.0	27.0		
Total Lost Time (s)		7.0		4.0	7.0		4.0		4.0	7.0		
Act Effct Green (s)		37.0		40.0	37.0		22.0		22.0	19.0		70.0
Actuated g/C Ratio		0.53		0.57	0.53		0.31		0.31	0.27		1.00
v/c Ratio		0.32		0.21	0.58		0.81		0.06	0.97		0.07
Control Delay		11.0		4.8	9.0		36.3		7.4	83.1		0.1
Queue Delay		0.0		0.0	0.0		0.0		0.0	0.0		0.0
Total Delay		11.0		4.8	9.0		36.3		7.4	83.1		0.1
LOS		B		A	A		D		A	F		A
Approach Delay		11.0			8.6			34.4			57.1	
Approach LOS		B			A			C			E	

Intersection Summary			
Area Type:	Other		
Cycle Length: 70			
Actuated Cycle Length: 70			
Offset: 18 (26%), Referenced to phase 4:EBT and 8:WBTL, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.97			
Intersection Signal Delay: 22.9		Intersection LOS: C	
Intersection Capacity Utilization 60.3%		ICU Level of Service B	
Analysis Period (min) 15			

* User Entered Value

Splits and Phases: 4: Cell Phone Lot Dwy/SB NAE Off-Ramp & S 170th St





Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	4	397	892	10	7	8
Future Volume (Veh/h)	4	397	892	10	7	8
Sign Control		Free	Free		Stop	
Grade		2%	-2%		0%	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	4	405	910	10	7	8
Pedestrians		1	1		1	
Lane Width (ft)		13.0	12.0		12.0	
Walking Speed (ft/s)		3.5	3.5		3.5	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		238	248			
pX, platoon unblocked						
vC, conflicting volume	921				1128	462
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	921				1128	462
tC, single (s)	4.2				7.5	7.6
tC, 2 stage (s)						
tF (s)	2.3				3.8	3.6
p0 queue free %	99				95	98
cM capacity (veh/h)	712				155	469

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	139	270	607	313	7	8
Volume Left	4	0	0	0	7	0
Volume Right	0	0	0	10	0	8
cSH	712	1700	1700	1700	155	469
Volume to Capacity	0.01	0.16	0.36	0.18	0.05	0.02
Queue Length 95th (ft)	0	0	0	0	4	1
Control Delay (s)	0.4	0.0	0.0	0.0	29.3	12.8
Lane LOS	A				D	B
Approach Delay (s)	0.1		0.0		20.5	
Approach LOS					C	

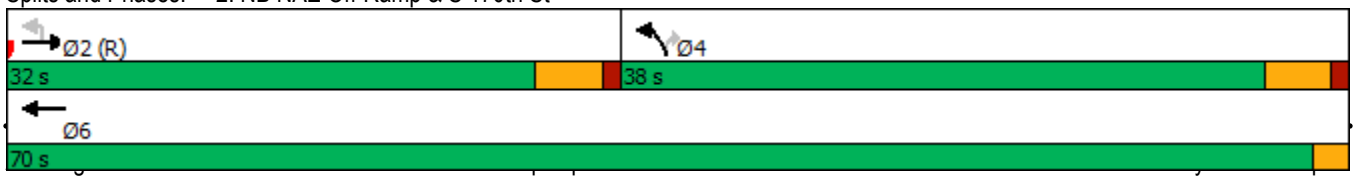
Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBU	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations							
Traffic Volume (vph)	1	403	0	0	511	390	343
Future Volume (vph)	1	403	0	0	511	390	343
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650	1650
Lane Width (ft)	12	12	12	11	11	14	14
Grade (%)		2%			-2%	-4%	
Storage Length (ft)	0		0	0		0	240
Storage Lanes	0		0	0		1	1
Taper Length (ft)	50			50		50	
Satd. Flow (prot)	0	2928	0	0	1320	1483	1327
Flt Permitted		0.954				0.950	
Satd. Flow (perm)	0	2793	0	0	1320	1481	1310
Right Turn on Red			Yes				Yes
Satd. Flow (RTOR)							268
Link Speed (mph)		20			20	20	
Link Distance (ft)		120			141	650	
Travel Time (s)		4.1			4.8	22.2	
Lane Group Flow (vph)	0	425	0	0	538	411	361
Turn Type	Perm	NA			NA	Prot	Perm
Protected Phases		2			6!	4!	
Permitted Phases	2						4
Total Split (s)	32.0	32.0			70.0	38.0	38.0
Total Lost Time (s)		4.5			2.0	4.5	4.5
Act Effct Green (s)		27.5			70.0	33.5	33.5
Actuated g/C Ratio		0.39			1.00	0.48	0.48
v/c Ratio		0.39			0.41	0.58	0.47
Control Delay		22.3			4.1	17.3	5.7
Queue Delay		0.0			0.0	0.0	0.0
Total Delay		22.3			4.1	17.3	5.7
LOS		C			A	B	A
Approach Delay		22.3			4.1	11.8	
Approach LOS		C			A	B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 70			
Actuated Cycle Length: 70			
Offset: 44 (63%), Referenced to phase 2:EBTU, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.58			
Intersection Signal Delay: 12.0		Intersection LOS: B	
Intersection Capacity Utilization 62.9%		ICU Level of Service B	
Analysis Period (min) 15			

! Phase conflict between lane groups.

Splits and Phases: 2: NB NAE Off-Ramp & S 170th St



Lanes, Volumes, Timings
1: SR 99 Intl Blvd & S 170th St

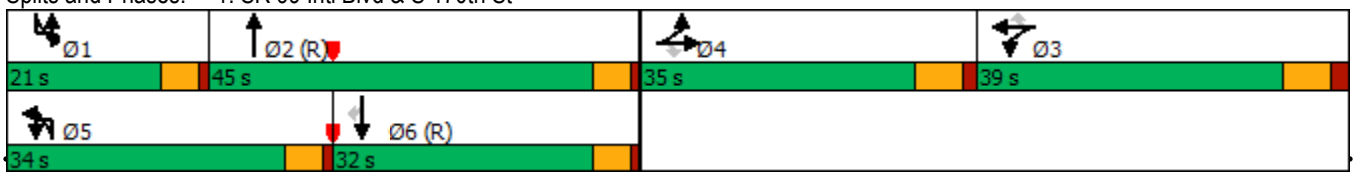
12/18/2019

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	204	146	389	49	103	150	18	305	872	50	42	94
Future Volume (vph)	204	146	389	49	103	150	18	305	872	50	42	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	12	12	12	12	12	12	12	12
Grade (%)		-4%			-4%				-2%			
Storage Length (ft)	0		0	0		350		425		0		325
Storage Lanes	1		1	0		1		1		0		1
Taper Length (ft)	50			50				50				50
Satd. Flow (prot)	1633	1323	773	0	1734	1498	0	1673	3302	0	0	1736
Flt Permitted	0.950				0.984			0.950				0.950
Satd. Flow (perm)	1631	1323	757	0	1730	1478	0	1666	3302	0	0	1703
Right Turn on Red			Yes			Yes				Yes		
Satd. Flow (RTOR)			409			158			4			
Link Speed (mph)		20			25				40			
Link Distance (ft)		281			1404				1885			
Travel Time (s)		9.6			38.3				32.1			
Lane Group Flow (vph)	215	154	409	0	160	158	0	340	971	0	0	143
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	Prot	NA		Prot	Prot
Protected Phases	4	4		3	3		5	5	2		1	1
Permitted Phases			4			3						
Total Split (s)	35.0	35.0	35.0	39.0	39.0	39.0	34.0	34.0	45.0		21.0	21.0
Total Lost Time (s)	6.5	6.5	6.5		7.0	7.0		5.0	5.0			5.0
Act Effct Green (s)	25.7	25.7	25.7		19.3	19.3		34.4	56.5			15.0
Actuated g/C Ratio	0.18	0.18	0.18		0.14	0.14		0.25	0.40			0.11
v/c Ratio	0.72	0.63	0.87		0.67	0.46		0.83	0.73			0.77
Control Delay	58.5	55.9	30.2		69.8	11.3		67.4	41.1			86.3
Queue Delay	0.0	0.0	1.9		0.0	0.0		0.0	0.0			0.0
Total Delay	58.5	55.9	32.1		69.8	11.3		67.4	41.1			86.3
LOS	E	E	C		E	B		E	D			F
Approach Delay		44.1			40.7				47.9			
Approach LOS		D			D				D			

Intersection Summary

Area Type: Other
Cycle Length: 140
Actuated Cycle Length: 140
Offset: 80 (57%), Referenced to phase 2:NBT and 6:SBT, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 47.9 Intersection LOS: D
Intersection Capacity Utilization 89.3% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 1: SR 99 Intl Blvd & S 170th St



Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	651	97
Future Volume (vph)	651	97
Ideal Flow (vphpl)	1900	1900
Lane Width (ft)	12	12
Grade (%)	-2%	
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Satd. Flow (prot)	3472	1553
Flt Permitted		
Satd. Flow (perm)	3472	1508
Right Turn on Red		Yes
Satd. Flow (RTOR)		160
Link Speed (mph)	40	
Link Distance (ft)	1814	
Travel Time (s)	30.9	
Lane Group Flow (vph)	685	102
Turn Type	NA	Perm
Protected Phases	6	
Permitted Phases		6
Total Split (s)	32.0	32.0
Total Lost Time (s)	5.0	5.0
Act Effct Green (s)	37.1	37.1
Actuated g/C Ratio	0.26	0.26
v/c Ratio	0.75	0.20
Control Delay	54.3	1.6
Queue Delay	0.0	0.0
Total Delay	54.3	1.6
LOS	D	A
Approach Delay	53.5	
Approach LOS	D	

Intersection Summary

Arterial Level of Service: EB S 170th St

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cell Phone Lot Dwy	IV	20	19.1	11.0	30.1	0.07	8.6	E
NB NAE Off-Ramp	IV	20	20.2	22.3	42.5	0.09	7.8	E
SR 99 Intl Blvd	IV	20	17.6	55.9	73.5	0.08	3.9	F
Total	IV		56.9	89.2	146.1	0.24	6.0	F

Arterial Level of Service: WB S 170th St

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
SR 99 Intl Blvd	IV	25	40.7	69.8	110.5	0.27	8.7	E
NB NAE Off-Ramp	IV	20	17.6	4.1	21.7	0.08	13.3	C
SB NAE Off-Ramp	IV	20	20.2	9.0	29.2	0.09	11.3	D
Total	IV		78.5	82.9	161.4	0.44	9.8	D

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Sign Control		Stop				Stop			Stop			Stop
Traffic Volume (vph)	2	7	0	5	4	3	1022	0	20	11	242	17
Future Volume (vph)	2	7	0	5	4	3	1022	0	20	11	242	17
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	2	7	0	0	4	3	1076	0	21	12	255	18

Direction, Lane #	EB 1	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total (vph)	9	7	538	538	21	12	273
Volume Left (vph)	2	4	0	0	0	0	255
Volume Right (vph)	0	0	538	538	0	12	0
Hadj (s)	0.42	0.39	-0.33	-0.33	0.61	0.01	0.51
Departure Headway (s)	5.0	5.0	3.2	3.2	4.8	3.2	4.5
Degree Utilization, x	0.01	0.01	0.48	0.48	0.03	0.01	0.34
Capacity (veh/h)	664	667	1116	1116	724	1121	794
Control Delay (s)	8.1	8.1	9.1	9.1	8.0	6.2	9.8
Approach Delay (s)	8.1	9.1			7.3		9.8
Approach LOS	A	A			A		A

Intersection Summary				
Delay	9.2			
Level of Service	A			
Intersection Capacity Utilization	59.7%	ICU Level of Service	B	
Analysis Period (min)	15			

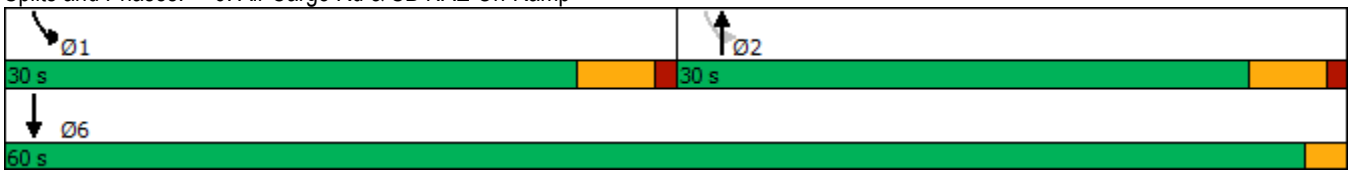
Movement	SBR
Lane Configurations	
Sign Control	
Traffic Volume (vph)	0
Future Volume (vph)	0
Peak Hour Factor	0.95
Hourly flow rate (vph)	0

Direction, Lane #

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	0	0	355	689	487	259
Future Volume (vph)	0	0	355	689	487	259
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650
Grade (%)	0%		3%			-3%
Storage Length (ft)	0	0		0	100	
Storage Lanes	0	0		1	1	
Taper Length (ft)	50				50	
Satd. Flow (prot)	0	0	1401	1191	1421	1495
Flt Permitted					0.514	
Satd. Flow (perm)	0	0	1401	1191	769	1495
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)				515		
Link Speed (mph)	30		25			30
Link Distance (ft)	314		318			224
Travel Time (s)	7.1		8.7			5.1
Lane Group Flow (vph)	0	0	374	725	513	273
Turn Type			NA	Free	D.P+P	NA
Protected Phases			2		1	6
Permitted Phases				Free	2	
Total Split (s)			30.0		30.0	60.0
Total Lost Time (s)			4.5		4.5	2.0
Act Effct Green (s)			14.5	35.3	25.4	35.3
Actuated g/C Ratio			0.41	1.00	0.72	1.00
v/c Ratio			0.65	0.61	0.68	0.18
Control Delay			15.0	2.3	6.9	0.3
Queue Delay			0.0	0.0	0.0	0.0
Total Delay			15.0	2.3	6.9	0.3
LOS			B	A	A	A
Approach Delay			6.6			4.6
Approach LOS			A			A

Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 35.3			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 0.68			
Intersection Signal Delay: 5.8		Intersection LOS: A	
Intersection Capacity Utilization 59.7%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 6: Air Cargo Rd & SB NAE On-Ramp



Movement	EBL	EBR	NBU	NBL	NBT	SBT	SBR
Lane Configurations							
Traffic Volume (veh/h)	15	19	1	21	327	714	26
Future Volume (Veh/h)	15	19	1	21	327	714	26
Sign Control	Stop				Free	Free	
Grade	0%				1%	-1%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	16	20	0	22	344	752	27
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type					None	None	
Median storage veh)							
Upstream signal (ft)					960		
pX, platoon unblocked			0.00				
vC, conflicting volume	1154	766	0	779			
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1154	766	0	779			
tC, single (s)	6.7	6.5	0.0	4.3			
tC, 2 stage (s)							
tF (s)	3.8	3.6	0.0	2.4			
p0 queue free %	91	94	0	97			
cM capacity (veh/h)	184	357	0	752			

Direction, Lane #	EB 1	NB 1	NB 2	SB 1
Volume Total	36	22	344	779
Volume Left	16	22	0	0
Volume Right	20	0	0	27
cSH	252	752	1700	1700
Volume to Capacity	0.14	0.03	0.20	0.46
Queue Length 95th (ft)	12	2	0	0
Control Delay (s)	21.7	9.9	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	21.7	0.6		0.0
Approach LOS	C			

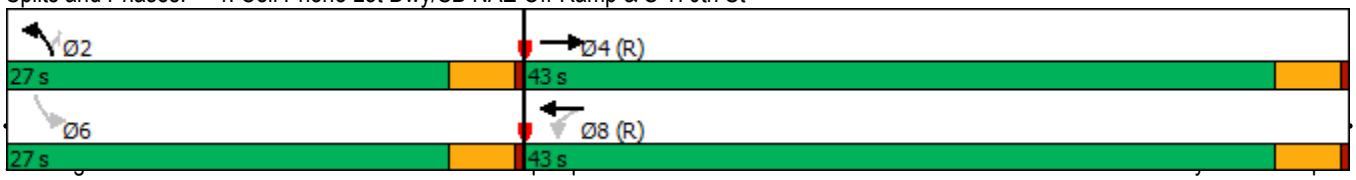
Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	15		

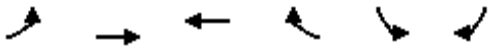
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	263	2	80	705	0	270	0	14	348	0	59
Future Volume (vph)	0	263	2	80	705	0	270	0	14	348	0	59
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
Lane Width (ft)	12	12	12	13	13	13	12	12	12	14	12	12
Grade (%)		3%			-3%			0%			-4%	
Storage Length (ft)	0		0	100		0	0		100	300		50
Storage Lanes	0		0	1		0	1		1	1		0
Taper Length (ft)	50			50			50			50		
Satd. Flow (prot)	0	1424	0	1370	2307	0	1568	0	1402	1656	0	1389
Flt Permitted				0.588			0.950	*0.420		0.950		
Satd. Flow (perm)	0	1424	0	846	2307	0	1568	0	1372	1653	0	1389
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1							16			78
Link Speed (mph)		20			20			20			20	
Link Distance (ft)		381			238			336			1004	
Travel Time (s)		13.0			8.1			11.5			34.2	
Lane Group Flow (vph)	0	279	0	84	742	0	284	0	15	366	0	62
Turn Type		NA		Perm	NA		Prot		Perm	Perm		Free
Protected Phases		4			8		2					
Permitted Phases				8					2	6		Free
Total Split (s)		43.0		43.0	43.0		27.0		27.0	27.0		
Total Lost Time (s)		7.0		4.0	7.0		4.0		4.0	7.0		
Act Effct Green (s)		39.1		42.1	39.1		19.9		19.9	16.9		70.0
Actuated g/C Ratio		0.56		0.60	0.56		0.28		0.28	0.24		1.00
v/c Ratio		0.35		0.17	0.58		0.64		0.04	0.92		0.04
Control Delay		10.9		10.5	16.1		28.3		8.4	54.9		0.1
Queue Delay		0.0		0.0	0.0		0.0		0.0	0.0		0.0
Total Delay		10.9		10.5	16.1		28.3		8.4	54.9		0.1
LOS		B		B	B		C		A	D		A
Approach Delay		10.9			15.6			27.3			46.9	
Approach LOS		B			B			C			D	

Intersection Summary			
Area Type:	Other		
Cycle Length: 70			
Actuated Cycle Length: 70			
Offset: 40 (57%), Referenced to phase 4:EBT and 8:WBTL, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.92			
Intersection Signal Delay: 24.1		Intersection LOS: C	
Intersection Capacity Utilization 59.8%		ICU Level of Service B	
Analysis Period (min) 15			

* User Entered Value

Splits and Phases: 4: Cell Phone Lot Dwy/SB NAE Off-Ramp & S 170th St





Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	620	773	9	6	12
Future Volume (Veh/h)	5	620	773	9	6	12
Sign Control		Free	Free		Stop	
Grade		2%	-2%		0%	
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	5	633	789	9	6	12
Pedestrians		1	1		1	
Lane Width (ft)		13.0	12.0		12.0	
Walking Speed (ft/s)		3.5	3.5		3.5	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		238	248			
pX, platoon unblocked						
vC, conflicting volume	799				1122	401
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	799				1122	401
tC, single (s)	4.2				7.5	7.6
tC, 2 stage (s)						
tF (s)	2.3				3.8	3.6
p0 queue free %	99				96	98
cM capacity (veh/h)	793				156	518

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	216	422	526	272	6	12
Volume Left	5	0	0	0	6	0
Volume Right	0	0	0	9	0	12
cSH	793	1700	1700	1700	156	518
Volume to Capacity	0.01	0.25	0.31	0.16	0.04	0.02
Queue Length 95th (ft)	0	0	0	0	3	2
Control Delay (s)	0.3	0.0	0.0	0.0	29.0	12.1
Lane LOS	A				D	B
Approach Delay (s)	0.1		0.0		17.7	
Approach LOS					C	

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	35.3%	ICU Level of Service	A
Analysis Period (min)	15		

Lanes, Volumes, Timings
2: NB NAE Off-Ramp & S 170th St

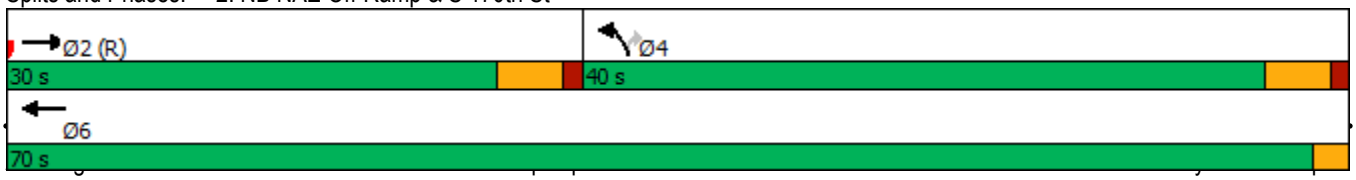
12/18/2019

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	626	0	0	496	286	432
Future Volume (vph)	626	0	0	496	286	432
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650
Lane Width (ft)	12	12	11	11	14	14
Grade (%)	2%			-2%	-4%	
Storage Length (ft)		0	0		0	240
Storage Lanes		0	0		1	1
Taper Length (ft)			50		50	
Satd. Flow (prot)	2928	0	0	1320	1483	1327
Flt Permitted					0.950	
Satd. Flow (perm)	2928	0	0	1320	1481	1310
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)						99
Link Speed (mph)	20			20	20	
Link Distance (ft)	120			141	650	
Travel Time (s)	4.1			4.8	22.2	
Lane Group Flow (vph)	659	0	0	522	301	455
Turn Type	NA			NA	Prot	Perm
Protected Phases	2			6!	4!	
Permitted Phases						4
Total Split (s)	30.0			70.0	40.0	40.0
Total Lost Time (s)	4.5			2.0	4.5	4.5
Act Effct Green (s)	25.5			70.0	35.5	35.5
Actuated g/C Ratio	0.36			1.00	0.51	0.51
v/c Ratio	0.62			0.40	0.40	0.64
Control Delay	15.4			2.7	12.7	14.6
Queue Delay	0.0			0.0	0.0	0.1
Total Delay	15.4			2.7	12.7	14.7
LOS	B			A	B	B
Approach Delay	15.4			2.7	13.9	
Approach LOS	B			A	B	

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 70
Offset: 42 (60%), Referenced to phase 2:EBT, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.64
Intersection Signal Delay: 11.4 Intersection LOS: B
Intersection Capacity Utilization 58.3% ICU Level of Service B
Analysis Period (min) 15
! Phase conflict between lane groups.

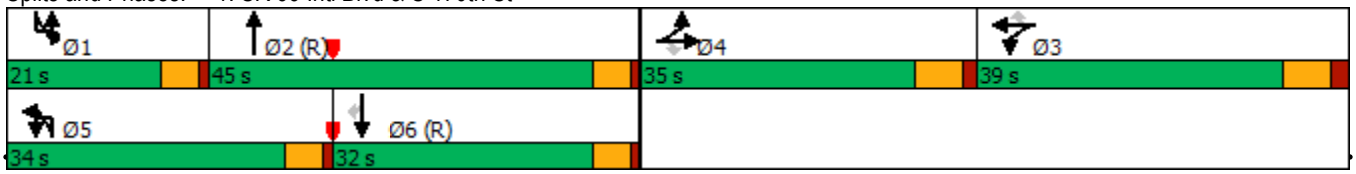
Splits and Phases: 2: NB NAE Off-Ramp & S 170th St



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	191	242	621	59	143	138	19	247	906	50	54	130
Future Volume (vph)	191	242	621	59	143	138	19	247	906	50	54	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	12	12	12	12	12	12	12	12
Grade (%)		-4%			-4%				-2%			
Storage Length (ft)	0		0	0		350		425		0		325
Storage Lanes	1		1	0		1		1		0		1
Taper Length (ft)	50			50				50				50
Satd. Flow (prot)	1584	1667	756	0	1737	1498	0	1673	3302	0	0	1736
Flt Permitted	0.950				0.986			0.950				0.950
Satd. Flow (perm)	1582	1667	740	0	1734	1478	0	1670	3302	0	0	1705
Right Turn on Red			Yes			Yes				Yes		
Satd. Flow (RTOR)			510			145			4			
Link Speed (mph)		20			25				40			
Link Distance (ft)		281			1404				1885			
Travel Time (s)		9.6			38.3				32.1			
Lane Group Flow (vph)	201	255	654	0	213	145	0	280	1007	0	0	194
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	Prot	NA		Prot	Prot
Protected Phases	4	4		3	3		5	5	2		1	1
Permitted Phases			4			3						
Total Split (s)	35.0	35.0	35.0	39.0	39.0	39.0	34.0	34.0	45.0		21.0	21.0
Total Lost Time (s)	6.5	6.5	6.5		7.0	7.0		5.0	5.0			5.0
Act Effct Green (s)	28.5	28.5	28.5		22.5	22.5		27.4	45.1			20.4
Actuated g/C Ratio	0.20	0.20	0.20		0.16	0.16		0.20	0.32			0.15
v/c Ratio	0.62	0.75	1.18		0.77	0.41		0.86	0.95			0.77
Control Delay	52.3	57.9	111.0		73.2	10.3		77.7	63.5			77.1
Queue Delay	0.0	0.1	0.4		0.0	0.0		0.0	0.0			0.0
Total Delay	52.3	58.1	111.4		73.2	10.3		77.7	63.5			77.1
LOS	D	E	F		E	B		E	E			E
Approach Delay		88.4			47.7				66.6			
Approach LOS		F			D				E			

Intersection Summary			
Area Type:	Other		
Cycle Length: 140			
Actuated Cycle Length: 140			
Offset: 82 (59%), Referenced to phase 2:NBT and 6:SBT, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.47			
Intersection Signal Delay: 127.4		Intersection LOS: F	
Intersection Capacity Utilization 121.1%		ICU Level of Service H	
Analysis Period (min) 15			

Splits and Phases: 1: SR 99 Intl Blvd & S 170th St



Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1315	94
Future Volume (vph)	1315	94
Ideal Flow (vphpl)	1900	1900
Lane Width (ft)	12	12
Grade (%)	-2%	
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Satd. Flow (prot)	3472	1553
Flt Permitted		
Satd. Flow (perm)	3472	1508
Right Turn on Red		Yes
Satd. Flow (RTOR)		160
Link Speed (mph)	40	
Link Distance (ft)	1814	
Travel Time (s)	30.9	
Lane Group Flow (vph)	1384	99
Turn Type	NA	Perm
Protected Phases	6	
Permitted Phases		6
Total Split (s)	32.0	32.0
Total Lost Time (s)	5.0	5.0
Act Effct Green (s)	38.1	38.1
Actuated g/C Ratio	0.27	0.27
v/c Ratio	1.47	0.19
Control Delay	251.8	1.2
Queue Delay	0.0	0.0
Total Delay	251.8	1.2
LOS	F	A
Approach Delay	216.8	
Approach LOS	F	

Intersection Summary

Arterial Level of Service: EB S 170th St

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cell Phone Lot Dwy	IV	20	19.1	10.9	30.0	0.07	8.7	E
NB NAE Off-Ramp	IV	20	20.2	15.4	35.6	0.09	9.3	D
SR 99 Intl Blvd	IV	20	17.6	57.9	75.5	0.08	3.8	F
Total	IV		56.9	84.2	141.1	0.24	6.2	F

Arterial Level of Service: WB S 170th St

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
SR 99 Intl Blvd	IV	25	40.7	73.2	113.9	0.27	8.4	E
NB NAE Off-Ramp	IV	20	17.6	2.7	20.3	0.08	14.2	C
SB NAE Off-Ramp	IV	20	20.2	16.1	36.3	0.09	9.1	D
Total	IV		78.5	92.0	170.5	0.44	9.2	D

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Sign Control		Stop				Stop			Stop			Stop
Traffic Volume (vph)	2	1	1	5	1	4	1074	0	8	5	113	13
Future Volume (vph)	2	1	1	5	1	4	1074	0	8	5	113	13
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	2	1	1	0	1	4	1131	0	8	5	119	14

Direction, Lane #	EB 1	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total (vph)	4	5	566	566	8	5	136
Volume Left (vph)	2	1	0	0	0	0	119
Volume Right (vph)	1	0	566	566	0	5	3
Hadj (s)	0.32	0.31	-0.33	-0.33	0.61	0.01	0.48
Departure Headway (s)	4.6	4.6	3.2	3.2	4.7	3.2	4.4
Degree Utilization, x	0.01	0.01	0.50	0.50	0.01	0.00	0.17
Capacity (veh/h)	759	761	1116	1116	754	1121	803
Control Delay (s)	7.6	7.6	9.4	9.4	7.7	6.2	8.3
Approach Delay (s)	7.6	9.4			7.1		8.3
Approach LOS	A	A			A		A

Intersection Summary				
Delay	9.2			
Level of Service	A			
Intersection Capacity Utilization	61.8%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	SBR
Lane Configurations	
Sign Control	
Traffic Volume (vph)	3
Future Volume (vph)	3
Peak Hour Factor	0.95
Hourly flow rate (vph)	3

Direction, Lane #	

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	0	0	183	901	727	129
Future Volume (vph)	0	0	183	901	727	129
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650
Grade (%)	0%		3%			-3%
Storage Length (ft)	0	0		0	100	
Storage Lanes	0	0		1	1	
Taper Length (ft)	50				50	
Satd. Flow (prot)	0	0	1401	1191	1421	1495
Flt Permitted					0.636	
Satd. Flow (perm)	0	0	1401	1191	951	1495
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)				348		
Link Speed (mph)	30		25			30
Link Distance (ft)	314		318			224
Travel Time (s)	7.1		8.7			5.1
Lane Group Flow (vph)	0	0	193	948	765	136
Turn Type			NA	Free	D.P+P	NA
Protected Phases			2		1	6
Permitted Phases				Free	2	
Total Split (s)			24.0		36.0	60.0
Total Lost Time (s)			4.5		4.5	2.0
Act Effct Green (s)			11.4	36.5	29.8	36.5
Actuated g/C Ratio			0.31	1.00	0.82	1.00
v/c Ratio			0.44	0.80	0.73	0.09
Control Delay			17.0	6.4	7.4	0.1
Queue Delay			0.0	0.0	0.0	0.0
Total Delay			17.0	6.4	7.4	0.1
LOS			B	A	A	A
Approach Delay			8.2			6.3
Approach LOS			A			A

Intersection Summary			
Area Type:	Other		
Cycle Length: 60			
Actuated Cycle Length: 36.5			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 0.80			
Intersection Signal Delay: 7.4		Intersection LOS: A	
Intersection Capacity Utilization 64.6%		ICU Level of Service C	
Analysis Period (min) 15			

Splits and Phases: 6: Air Cargo Rd & SB NAE On-Ramp

Movement	EBL	EBR	NBU	NBL	NBT	SBT	SBR
Lane Configurations							
Traffic Volume (veh/h)	15	10	4	7	163	844	6
Future Volume (Veh/h)	15	10	4	7	163	844	6
Sign Control	Stop				Free	Free	
Grade	0%				1%	-1%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	16	11	0	7	172	888	6
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type					None	None	
Median storage veh)							
Upstream signal (ft)					960		
pX, platoon unblocked			0.00				
vC, conflicting volume	1077	891	0	894			
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1077	891	0	894			
tC, single (s)	6.7	6.5	0.0	4.3			
tC, 2 stage (s)							
tF (s)	3.8	3.6	0.0	2.4			
p0 queue free %	92	96	0	99			
cM capacity (veh/h)	210	300	0	678			

Direction, Lane #	EB 1	NB 1	NB 2	SB 1
Volume Total	27	7	172	894
Volume Left	16	7	0	0
Volume Right	11	0	0	6
cSH	239	678	1700	1700
Volume to Capacity	0.11	0.01	0.10	0.53
Queue Length 95th (ft)	9	1	0	0
Control Delay (s)	22.0	10.4	0.0	0.0
Lane LOS	C	B		
Approach Delay (s)	22.0	0.4		0.0
Approach LOS	C			

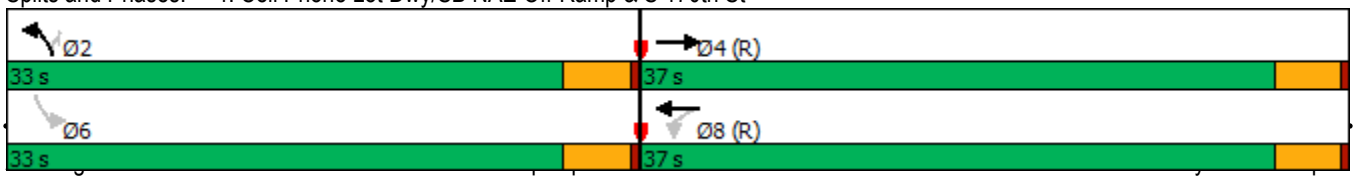
Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	61.6%	ICU Level of Service	B
Analysis Period (min)	15		

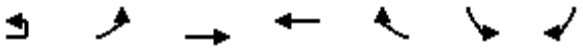
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	116	8	85	579	0	465	0	28	196	0	40
Future Volume (vph)	0	116	8	85	579	0	465	0	28	196	0	40
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
Lane Width (ft)	12	12	12	13	13	13	12	12	12	14	12	12
Grade (%)		3%			-3%			0%			-4%	
Storage Length (ft)	0		0	100		0	0		100	300		50
Storage Lanes	0		0	1		0	1		1	1		0
Taper Length (ft)	50			50			50			50		
Satd. Flow (prot)	0	989	0	1370	2509	0	1568	0	1402	1656	0	1389
Flt Permitted				0.640			0.950	*0.420		0.950		
Satd. Flow (perm)	0	989	0	920	2509	0	1568	0	1373	1653	0	1389
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		6							26			78
Link Speed (mph)		20			20			20			20	
Link Distance (ft)		381			238			336			1004	
Travel Time (s)		13.0			8.1			11.5			34.2	
Lane Group Flow (vph)	0	130	0	89	609	0	489	0	29	206	0	42
Turn Type		NA		Perm	NA		Prot		Perm	Perm		Free
Protected Phases		4			8		2					
Permitted Phases				8					2	6		Free
Total Split (s)		37.0		37.0	37.0		33.0		33.0	33.0		
Total Lost Time (s)		7.0		4.0	7.0		4.0		4.0	7.0		
Act Effct Green (s)		33.4		36.4	33.4		25.6		25.6	22.6		70.0
Actuated g/C Ratio		0.48		0.52	0.48		0.37		0.37	0.32		1.00
v/c Ratio		0.27		0.19	0.51		0.85		0.06	0.39		0.03
Control Delay		13.9		10.5	14.3		35.7		6.1	19.7		0.1
Queue Delay		0.0		0.0	0.0		0.0		0.0	0.0		0.0
Total Delay		13.9		10.5	14.3		35.7		6.1	19.7		0.1
LOS		B		B	B		D		A	B		A
Approach Delay		13.9			13.8			34.0			16.4	
Approach LOS		B			B			C			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 70			
Actuated Cycle Length: 70			
Offset: 31 (44%), Referenced to phase 4:EBT and 8:WBTL, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 20.8		Intersection LOS: C	
Intersection Capacity Utilization 65.1%		ICU Level of Service C	
Analysis Period (min) 15			

* User Entered Value

Splits and Phases: 4: Cell Phone Lot Dwy/SB NAE Off-Ramp & S 170th St





Movement	EBU	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations							
Traffic Volume (veh/h)	1	3	336	651	5	10	12
Future Volume (Veh/h)	1	3	336	651	5	10	12
Sign Control			Free	Free		Stop	
Grade			2%	-2%		0%	
Peak Hour Factor	0.95	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	0	3	343	664	5	10	12
Pedestrians			1	1		1	
Lane Width (ft)			13.0	12.0		12.0	
Walking Speed (ft/s)			3.5	3.5		3.5	
Percent Blockage			0	0		0	
Right turn flare (veh)							
Median type			None	None			
Median storage veh)							
Upstream signal (ft)			238	248			
pX, platoon unblocked	0.00						
vC, conflicting volume	0	670				846	336
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	0	670				846	336
tC, single (s)	0.0	4.2				7.5	7.6
tC, 2 stage (s)							
tF (s)	0.0	2.3				3.8	3.6
p0 queue free %	0	100				96	98
cM capacity (veh/h)	0	889				246	576

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	117	229	443	226	10	12
Volume Left	3	0	0	0	10	0
Volume Right	0	0	0	5	0	12
cSH	889	1700	1700	1700	246	576
Volume to Capacity	0.00	0.13	0.26	0.13	0.04	0.02
Queue Length 95th (ft)	0	0	0	0	3	2
Control Delay (s)	0.3	0.0	0.0	0.0	20.3	11.4
Lane LOS	A				C	B
Approach Delay (s)	0.1		0.0		15.4	
Approach LOS					C	

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	31.2%	ICU Level of Service	A
Analysis Period (min)	15		

Lanes, Volumes, Timings
2: NB NAE Off-Ramp & S 170th St

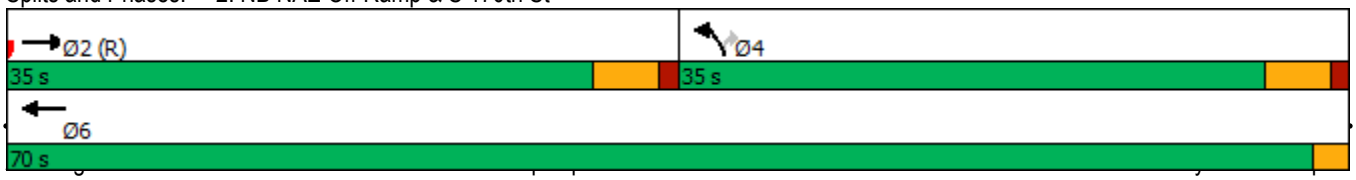
12/18/2019

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	346	0	0	425	231	185
Future Volume (vph)	346	0	0	425	231	185
Ideal Flow (vphpl)	1650	1650	1650	1650	1650	1650
Lane Width (ft)	12	12	11	11	14	14
Grade (%)	2%			-2%	-4%	
Storage Length (ft)		0	0		0	240
Storage Lanes		0	0		1	1
Taper Length (ft)			50		50	
Satd. Flow (prot)	2928	0	0	1320	1483	1327
Flt Permitted					0.950	
Satd. Flow (perm)	2928	0	0	1320	1481	1310
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)						195
Link Speed (mph)	20			20	20	
Link Distance (ft)	120			141	650	
Travel Time (s)	4.1			4.8	22.2	
Lane Group Flow (vph)	364	0	0	447	243	195
Turn Type	NA			NA	Prot	Perm
Protected Phases	2			6!	4!	
Permitted Phases						4
Total Split (s)	35.0			70.0	35.0	35.0
Total Lost Time (s)	4.5			2.0	4.5	4.5
Act Effct Green (s)	30.5			70.0	30.5	30.5
Actuated g/C Ratio	0.44			1.00	0.44	0.44
v/c Ratio	0.29			0.34	0.38	0.29
Control Delay	13.6			2.5	15.5	3.3
Queue Delay	0.0			0.0	0.0	0.0
Total Delay	13.6			2.5	15.5	3.3
LOS	B			A	B	A
Approach Delay	13.6			2.5	10.1	
Approach LOS	B			A	B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 70			
Actuated Cycle Length: 70			
Offset: 34 (49%), Referenced to phase 2:EBT, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.38			
Intersection Signal Delay: 8.4		Intersection LOS: A	
Intersection Capacity Utilization 47.6%		ICU Level of Service A	
Analysis Period (min) 15			

! Phase conflict between lane groups.

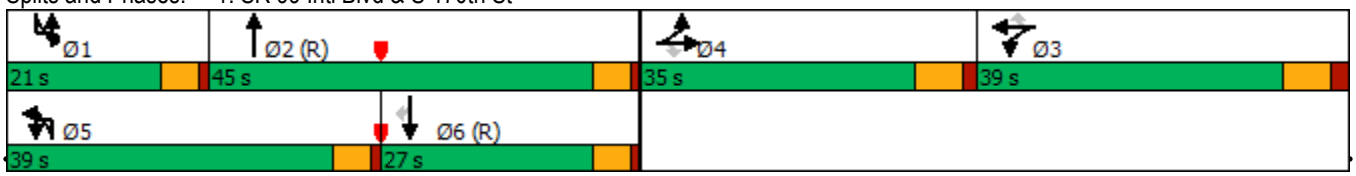
Splits and Phases: 2: NB NAE Off-Ramp & S 170th St



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	122	127	268	32	93	140	14	236	677	38	32	77
Future Volume (vph)	122	127	268	32	93	140	14	236	677	38	32	77
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	12	12	12	12	12	12	12	12
Grade (%)		-4%			-4%				-2%			
Storage Length (ft)	0		0	0		350		425		0		325
Storage Lanes	1		1	0		1		1		0		1
Taper Length (ft)	50			50				50				50
Satd. Flow (prot)	1470	1339	739	0	1739	1498	0	1673	3302	0	0	1736
Flt Permitted	0.950				0.987			0.950				0.950
Satd. Flow (perm)	1468	1409	724	0	1736	1478	0	1666	3302	0	0	1692
Right Turn on Red			Yes			Yes				Yes		
Satd. Flow (RTOR)			282			147			4			
Link Speed (mph)		20			25				40			
Link Distance (ft)		281			1404				1885			
Travel Time (s)		9.6			38.3				32.1			
Lane Group Flow (vph)	128	134	282	0	132	147	0	263	753	0	0	115
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	Prot	NA		Prot	Prot
Protected Phases	4	4		3	3		5	5	2		1	1
Permitted Phases			4			3						
Total Split (s)	35.0	35.0	35.0	39.0	39.0	39.0	39.0	39.0	45.0		21.0	21.0
Total Lost Time (s)	6.5	6.5	6.5		7.0	7.0		5.0	5.0			5.0
Act Effct Green (s)	21.7	21.7	21.7		17.6	17.6		26.8	64.2			13.0
Actuated g/C Ratio	0.16	0.16	0.16		0.13	0.13		0.19	0.46			0.09
v/c Ratio	0.56	0.65	0.81		0.61	0.47		0.82	0.50			0.72
Control Delay	57.8	63.2	30.5		67.9	12.1		74.1	31.3			85.2
Queue Delay	0.0	0.0	1.0		0.0	0.0		0.0	0.0			0.0
Total Delay	57.8	63.2	31.4		67.9	12.1		74.1	31.3			85.2
LOS	E	E	C		E	B		E	C			F
Approach Delay		45.4			38.5				42.4			
Approach LOS		D			D				D			

Intersection Summary			
Area Type:	Other		
Cycle Length: 140			
Actuated Cycle Length: 140			
Offset: 80 (57%), Referenced to phase 2:NBT and 6:SBT, Start of Green			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.82			
Intersection Signal Delay: 42.4		Intersection LOS: D	
Intersection Capacity Utilization 77.4%		ICU Level of Service D	
Analysis Period (min) 15			

Splits and Phases: 1: SR 99 Intl Blvd & S 170th St



Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	615	94
Future Volume (vph)	615	94
Ideal Flow (vphpl)	1900	1900
Lane Width (ft)	12	12
Grade (%)	-2%	
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Satd. Flow (prot)	3472	1553
Flt Permitted		
Satd. Flow (perm)	3472	1508
Right Turn on Red		Yes
Satd. Flow (RTOR)		160
Link Speed (mph)	40	
Link Distance (ft)	1814	
Travel Time (s)	30.9	
Lane Group Flow (vph)	647	99
Turn Type	NA	Perm
Protected Phases	6	
Permitted Phases		6
Total Split (s)	27.0	27.0
Total Lost Time (s)	5.0	5.0
Act Effct Green (s)	50.4	50.4
Actuated g/C Ratio	0.36	0.36
v/c Ratio	0.52	0.15
Control Delay	40.3	0.9
Queue Delay	0.0	0.0
Total Delay	40.3	0.9
LOS	D	A
Approach Delay	41.8	
Approach LOS	D	

Intersection Summary

Arterial Level of Service: EB S 170th St

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cell Phone Lot Dwy	IV	20	19.1	13.9	33.0	0.07	7.9	E
NB NAE Off-Ramp	IV	20	20.2	13.6	33.8	0.09	9.8	D
SR 99 Intl Blvd	IV	20	17.6	63.2	80.8	0.08	3.6	F
Total	IV		56.9	90.7	147.6	0.24	6.0	F

Arterial Level of Service: WB S 170th St

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
SR 99 Intl Blvd	IV	25	40.7	67.9	108.6	0.27	8.8	E
NB NAE Off-Ramp	IV	20	17.6	2.5	20.1	0.08	14.3	C
SB NAE Off-Ramp	IV	20	20.2	14.3	34.5	0.09	9.6	D
Total	IV		78.5	84.7	163.2	0.44	9.7	D

APPENDIX C

Pavement Assessment Memorandum

HWA GeoSciences Inc.
Geotechnical & Pavement Engineering • Hydrogeology • Geoenvironmental • Inspection & Testing

August 14, 2019
HWA Project No. 2018-020-21

Port of Seattle
P.O. Box 1209
Seattle, Washington 98111-1209

Attention: Heather Bornhorst

Subject: **Port of Seattle**
Air Cargo Road Safety Improvements
SeaTac, Washington

Mrs. Bornhorst:

In accordance with Service Directive 1 of Contract P-00319130, HWA GeoSciences Inc. (HWA) completed a pavement investigation in support of the Air Cargo Road Safety Improvements project at the Port of Seattle in SeaTac, Washington. The purpose of our investigation was to assess pavement layer thicknesses along three alignments as well as pavement response to loading, in order to provide recommendations for pavement rehabilitation and/or reconstruction. The following sections discuss the results of our investigations for each alignment. A brief summary of recommendations is presented at the end of the report. Figure 1 shows the project vicinity and Figures 2A through 2C show the locations of pavement coring and FWD testing.

CELL PHONE PARKING LOT ACCESS ROAD

This alignment extends south from S 170th Street to the Cell Phone Parking Lot. The alignment is about 300 feet long and consists of one northbound (NB) lane and one southbound (SB) lane. The roadway is surfaced with Hot Mix Asphalt (HMA). The surface exhibits significant longitudinal and alligator cracking. Pictures 1 through 3 show the surface condition in June 2019. Pavement distresses are more severe near the entrance to the parking lot (south end of alignment) as shown in Picture 1.

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Picture 1. Cell Phone Parking Lot Access Road (looking south at entrance to parking lot).

Picture 2. Cell Phone Parking Lot Access Road (looking south at entrance to parking lot).

Picture 3. Cell Phone Parking Lot Access Road (looking north towards S 170th Street).

PAVEMENT CORES

Pavement layer thickness and shallow subgrade support conditions along the Cell Phone Parking Lot Access Road were investigated by conducting two, 6-inch diameter pavement cores, designated Core-7 and Core-8, on May 2, 2019. Shallow subsurface explorations were performed beneath each pavement core using hand augers and hand digging tools. The approximate locations of the pavement cores are indicated on Figure 2A. Photographic logs of the cores are presented in Appendix A, Figures A-7 and A-8.

The coring and subsurface explorations were performed by two geologists from HWA. All core holes were backfilled with compacted gravel and patched with Aquaphalt. Table 1 provides the pavement layer thicknesses encountered in the pavement cores.

Table 1. Pavement Core Results – Cell Phone Parking Lot Access Road

Designation	Location	HMA Thickness, (in.)	ATB Thickness, (in.)
Core-7	NB Lane – See Figure 2A	4	6
Core-8	SB Lane – See Figure 2A	5	3

Pictures 4 and 5 show the pavement surface condition at the locations of Core-7 and Core-8, respectively.

Picture 4. Pavement surface condition at Core-7.

Core-7 was performed in the NB lane on the intersection of medium severity longitudinal and transverse cracks. The crack extended through the 4-inch thick HMA layer. Cracking did not extend into the Asphalt Treated Base (ATB), which was in good condition (see Figure A-7). Below the ATB, the exploration encountered medium dense, silty sand subgrade soils to 2 feet (maximum depth of exploration).

Picture 5. Pavement surface condition at Core-8.

Core-8 was performed in the SB lane on the intersection of medium to high severity longitudinal and transverse cracks. Cracking extended through both the HMA and ATB (8 inches total thickness) and both layers were in poor condition (see Figure A-8). Below the ATB, the exploration encountered medium dense to dense, silty sand subgrade soils to 2 feet (maximum depth of exploration).

FWD TESTING

Falling Weight Deflectometer (FWD) testing was conducted on May 2, 2019 along both travel lanes at intervals of about 25 feet. The test stationing was measured in the field using a digital measuring instrument attached to the FWD. GPS coordinates were taken at each test location. Station 0+00 was arbitrarily set by HWA at the south end of the alignment, as shown in Figure 2A.

The FWD testing was undertaken using a Dynatest Model 8081 Heavy Falling Weight Deflectometer. This FWD allows the pavement to be tested under a wide range of loading conditions (6,500 to 54,000 pounds) to simulate a variety of traffic loads.

For this project, pulse loads of approximately 6,000, 9,000 and 12,000 pounds were applied to the pavement surface at each test location. The corresponding pavement surface deflections were measured with velocity transducers located directly under the loaded area, and at 12, 24, 36, 48, 60 and 72 inches from the center of the loaded area.

Figure 3A presents the maximum deflections (immediately under the applied load), normalized to a load of 9,000 pounds, for each test location. Figure 3B presents the backcalculated subgrade resilient moduli values for each test location. Figure 3C presents the existing AASHTO Structural Number (SN) for each test location.

Table 2 summarizes the FWD deflection data.

Table 2. FWD Test Results – Maximum Deflection Normalized to 9,000-pound Load

Test Lane	Number of Tests Included	Average Maximum Deflection, mils	Standard Deviation	Highest Deflection in Segment, mils	Lowest Deflection in Segment, mils
NB	9	7.2	3.0	13.8	4.1
SB	8	7.0	2.8	12.1	3.4

Table 3 summarizes the backcalculated resilient moduli values. The computer program Elmod, by Dynatest, was used for the backcalculation.

Table 3. FWD Test Results – Backcalculated Parameters

Test Lane	Number of Tests Included	Average Subgrade Resilient Modulus, ksi	Standard Deviation	Highest Value, ksi	Lowest Value, ksi
NB	9	18.0	7.8	29.6	8.0
SB	8	13.6	7.3	30.3	6.0

Table 4 summarizes the backcalculated AASHTO Structural Number (SN) values of the existing pavement using YONAPAVE (Hoffman, 2002).

Table 4. FWD Test Results – Existing AASHTO SN

Test Lane	Number of Tests Included	Average SN	Standard Deviation	Highest Value, ksi	Lowest Value, ksi
NB	9	3.3	0.8	4.5	2.2
SB	8	3.8	1.0	4.8	2.4

Both lanes exhibited similar deflection results, with an average of about 7 mils for a 9,000-pound load. As indicated in Figure 3B, the moduli values are fairly uniform for both lanes, with the exception of two test points in the SB lane at Station 1+28 and 1+50, where lower values were determined from backcalculation.

CONCLUSIONS & RECOMMENDATIONS

The existing pavement surface is beyond its design life, shows considerable distress, and requires rehabilitation. In general, the pavement distresses observed appear to be related to the old age of the HMA and traffic loading. Currently, it appears that most traffic consists of passenger vehicles with very little heavy truck traffic. Subgrade support appears adequate and no indications of subgrade failure were observed.

For pavement rehabilitation, we understand that a design life of 10 years is required. As no traffic data was available for this alignment and given the fact that little to no heavy vehicular

traffic exists, we recommend that the pavement be rehabilitated by grinding 3 inches and constructing a new 3-inch thick overlay. We recommend that the overlay be constructed using HMA Class ½-inch HMA with PG 58H-22 binder. Following asphalt grinding, the surface should be thoroughly cleaned and any cracks larger than ¼-inch sealed. Sufficient tack coat should be applied uniformly and allowed to break and set before placing the new HMA overlay in order to create a strong bond between layers. The surface of the pavement should be thoroughly cleaned prior to tack coat application. Improper tack coat application can result in loss of bond between HMA layers and lead to premature pavement distress/failure. If only a 5-year design life is desired, we recommend the grind and overlay be reduced to 2 inches.

Reflective cracking from the pavement below the new overlay will eventually work its way to the surface over time. The time for reflective cracking to manifest at the surface can be delayed by increasing the thickness of the new overlay; by using a fiberglass pavement grid within the new overlay; or by using Kevlar fiber-reinforced HMA for the new overlay.

S 170TH STREET

This alignment runs east-west from Air Cargo Road east to International Boulevard. The alignment is about 1,200 feet long and generally consists of two travel lanes in each direction. The roadway is surfaced with HMA and most of the roadway is in good condition, exhibiting only minor surface distresses, typically low severity longitudinal cracking with some short sections of medium severity longitudinal cracking. Some low to medium severity alligator cracking was observed in the eastbound lanes near the intersection with International Boulevard (east end of alignment). Only one significant area of high severity distress was observed, located in the westbound (WB) outside lane (OL) below the abandoned overpass just east of the Airport Expressway overpass. This area is shown in Picture 6 and appears to consist of subgrade failure resulting in high severity alligator cracking that has been temporarily patched.

Picture 6. Location of subgrade failure/patching in WB OL (looking west towards intersection with Air Cargo Road).

PAVEMENT CORES

Pavement layer thickness and shallow subgrade support conditions along S 170th Street were investigated in a single core (Core-5) performed in the WB OL, as shown in Figures 2A and 2B. This core was located about 100 feet west of the subgrade failure distress shown in Picture 6, on a medium to high severity longitudinal crack, as shown in Pictures 7 and 8. This crack was only about 10 feet in length and located in the outside wheel path.

Picture 7. Location of Core-5 (looking east towards area of subgrade failure/pavement patch).

Picture 8. Pavement surface condition at location of Core-5 (looking south).

In addition to Core-5, we were requested to perform a core in the driveway/access road to the Port of Seattle Fire Department. The location of this core, Core-6, is shown on Figures 2A and 2B. Surface conditions at Core-6 are shown in Picture 9.

Picture 9. Pavement surface condition at location of Core-6 (looking east towards intersection with Air Cargo Road).

Core-5 and Core-6 were each 6 inches in diameter and performed on May 1, 2019. Shallow subsurface explorations were performed beneath each pavement core using hand augers and hand digging tools. The approximate locations of the pavement cores are indicated on Figures 2A and 2B. Photographic logs of the cores are presented in Appendix A, Figures A-5 and A-6.

The coring and subsurface explorations were performed by two geologists from HWA. All core holes were backfilled with compacted gravel and patched with Aquaphalt. Table 5 provides the pavement layer thicknesses encountered in the pavement cores.

Table 5. Pavement Core Results – S 170th Street

Designation	Location	HMA Thickness, (in.)	Crushed Base Course Thickness, (in.)
Core-5	WB OL – See Figure 2A	5	13
Core-6	Fire Station Driveway – See Figure 2A	7	4

In Core-5, cracking extended through the entire 5-inch thick HMA layer and the core broke into several pieces as shown in Figure A-5. Below the HMA was 13 inches of medium dense Crushed Surfacing Top Course (CSTC) over medium dense, silty sand soils to 2 feet (maximum depth explored). It is unclear if this pavement section is representative of the remaining pavement along S 170th Street, as only one core was performed.

No cracking was observed in Core-6, which encountered 7 inches of HMA over 4 inches of Crushed Surfacing Base Course (CSBC) above dense, silty sand to 2 feet (maximum depth explored).

FWD TESTING

Falling Weight Deflectometer (FWD) testing was conducted on May 2, 2019 along all four travel lanes at intervals of about 50 to 100 feet. The test stationing was measured in the field using a digital measuring instrument attached to the FWD. GPS coordinates were taken at each test location. Station 0+00 was arbitrarily set by HWA at the east end of the alignment, as shown in Figure 2A.

The FWD testing was undertaken using a Dynatest Model 8081 Heavy Falling Weight Deflectometer. This FWD allows the pavement to be tested under a wide range of loading conditions (6,500 to 54,000 pounds) to simulate a variety of traffic loads.

For this project, pulse loads of approximately 6,000, 9,000 and 12,000 pounds were applied to the pavement surface at each test location. The corresponding pavement surface deflections were measured with velocity transducers located directly under the loaded area, and at 12, 24, 36, 48, 60 and 72 inches from the center of the loaded area.

Figure 4A presents the maximum deflections (immediately under the applied load), normalized to a load of 9,000 pounds, for each test location. Figure 4B presents the backcalculated subgrade resilient moduli values for each test location. Figure 4C presents the existing AASHTO Structural Number (SN) for each test location.

Table 6 summarizes the FWD deflection data.

Table 6. FWD Test Results – Maximum Deflection Normalized to 9,000-pound Load

Test Lane	Number of Tests Included	Average Maximum Deflection, mils	Standard Deviation	Highest Deflection in Segment, mils	Lowest Deflection in Segment, mils
WB OL	7	10.2	8.8	28.6	4.5
WB IL	12	7.9	2.9	13.5	4.8
EB IL	13	8.1	5.6	22.9	3.6
EB OL	13	8.8	4.7	22.5	5.2

Table 7 summarizes the backcalculated resilient moduli values. The computer program Elmod, by Dynatest, was used for the backcalculation.

Table 7. FWD Test Results – Backcalculated Parameters

Test Lane	Number of Tests Included	Average Subgrade Resilient Modulus, ksi	Standard Deviation	Highest Value, ksi	Lowest Value, ksi
WB OL	7	12.2	4.2	16.7	5.1
WB IL	12	16.0	7.1	28.1	4.7
EB IL	13	18.6	6.5	29.0	8.6
EB OL	13	15.2	5.1	27.7	8.8

Table 8 summarizes the backcalculated AASHTO Structural Number (SN) values of the existing pavement using YONAPAVE (Hoffman, 2002).

Table 8. FWD Test Results – Existing AASHTO SN

Test Lane	Number of Tests Included	Average SN	Standard Deviation	Highest Value, ksi	Lowest Value, ksi
WB OL	7	3.6	1.4	5.0	1.3
WB IL	12	3.5	0.8	5.1	2.3
EB IL	13	3.5	1.1	5.3	1.7
EB OL	13	3.4	1.0	5.1	1.6

As shown on Figure 4A, the highest deflection recorded was in the WB OL at Station 6+04. This test was performed on the high severity distress that is shown in Picture 6 above. Incidentally, the lowest recorded subgrade resilient modulus value (5 ksi) of this alignment was at this location (see Figure 4B). Several high deflection values (about 23 mils) were recorded at the very east end of the alignment in both eastbound lanes, likely associated with some low severity alligator cracking in this area.

EXISTING INFORMATION

We reviewed the following documents provided to us regarding this segment of the project:

- *Air Cargo Road Pavement Condition Assessment, SeaTac International Airport, SeaTac, Washington,* prepared by GeoEngineers for Port of Seattle, dated January 31, 2014.
- STIA-6934 170th Pavement Section – PDF provided by the Port of Seattle. Drawing is titled "Terminal Area Drives Typical Roadway Sections", dated September 18, 1969.
- STIA-6934 170th Plan – PDF provided by the Port of Seattle. Drawing is titled "Terminal Area Drives Site Plan No.13", dated September 18, 1969.

The typical roadway section is shown as two, 12-feet wide lanes comprised of 0.15 feet of Asphalt Concrete Class B over 0.20 feet of Asphalt Concrete Class B over 0.50 feet of Asphalt Treated Granular Base (ATB) or Class E over subgrade. The section also shows a 5.75-feet wide shoulder on the outside of each lane, comprised of 0.17 feet of Asphalt Concrete Class B over 0.25 feet ATB over subgrade. The plan sheet does not indicate where this section exists. Our single pavement core performed on S 170th Street, in the westbound outside lane, did not match

either section. The assessment report prepared by GeoEngineers provided the following evaluations:

- Zone 3 – "Zone 3 contains Section 16 which includes the intersection of Air Cargo Road and South 170th Street. The most severe pavement distress was observed in this zone. We noted minor to moderate longitudinal and transverse cracking and moderate to severe fatigue cracking in the pavement within the intersection. Damage was especially prevalent in the southbound lanes of Air Cargo Road near the north limit of the intersection." This Zone was assigned a Present Serviceability Index (PSI) of 1.5 and the report indicates it is currently at the end of useful pavement life.

- Zone 5 – "Zone 5 contains Section 21 and includes approximately 850 feet of AC paved roadway on South 170th Street. This pavement appeared in relatively good condition with very minor cracking distresses near construction joints." This Zone was assigned a PSI of 4.0 and the report indicates it has an estimated remaining life of 30 to 12 million ESALs.

CONCLUSIONS & RECOMMENDATIONS

In general, the pavement condition along this alignment is relatively good with only minimal surface distress. The one exception is the patched area shown in Picture 6. This area appears to be related to subgrade failure and full-depth reconstruction will be required. For reconstruction, we recommend removing 10 inches of material be removed, the exposed subgrade thoroughly compacted, and 10 inches of Class ½-inch HMA be replaced. The remaining portions of the alignment can be rehabilitated with a grind and overlay; however, the pavement should be re-evaluated prior to construction to identify any other areas of distress not identified in this investigation. It should be noted that only one pavement core was performed on S 170th Street, and pavement layer thicknesses could be considerably different elsewhere. We recommend additional coring be performed, ideally one core per travel lane minimum, if more accurate/detailed information on existing pavement layer thicknesses is desired..

Current design traffic parameters were provided by HNTB, consisting of ADT volumes in both the EB and WB directions. The traffic data provided was separated into FHWA Vehicle Classifications 1-3; 4; 5-7; and 8-13. We assigned the following Equivalent Single Axle Loads per Classification as follows:

- Class 1 – 3: 0.0008 ESAL/vehicle

- Class 4: 2 ESAL/vehicle

- Class 5 – 7: 0.5 ESAL/vehicle

- Class 8 – 13: 1.3 ESAL/vehicle

The WB ADT provided was 16,023 vehicles. The EB ADT provided was 2,285. The WB traffic was used for design. We used an annual traffic volume growth of 0.77%, per HNTB. Based on the information provided and the above assumptions, the following design ESALs were calculated, assuming 50% of the traffic in the design lane (since two lanes in each direction):

- 5-Year Design Life: 1,868,212
- 10-Year Design Life: 3,809,466
- 15-Year Design Life: 5,826,619

The pavement recommendations presented in this report are based on these traffic calculations. If additional traffic count information is obtained that varies appreciably from these values, the recommendations given in this report should be reviewed and revised as necessary.

All pavement designs were based on the design method given in the AASHTO Guide for Design of Pavement Structures (AASHTO, 1993) using the following parameters:

- Reliability = 90%
- Initial Serviceability = 4.5
- Terminal Serviceability = 2.5
- Overall Standard Deviation = 0.5
- Subgrade Resilient Modulus = 12,000 psi (based on FWD testing)

Rehabilitation designs were determined by comparing the required AASHTO Structural Number (SN) to the existing average SN determined from FWD testing. An existing SN of 3.2 was selected based on the results shown in Table 8, Figure 4C, and the fact that the area of pavement failure will be reconstructed. Table 9 provides our rehabilitation recommendations, assuming an AASHTO structural coefficient of 0.44 for new HMA and 0.30 for existing in-place HMA given its age and relatively good condition.

Table 9. S 170th Street Pavement Rehabilitation

Design Life, years	Assumed Existing AASHTO SN	Required AASHTO SN	Grind Depth, inches	Overlay Depth, inches
5	3.2	3.30	2	2
10	3.2	3.70	2	2.5
15	3.2	3.95	3	4

The results in Table 9 are based on FWD test results and provided traffic data. Given the predominately good condition of the existing roadway, with the exception of minor isolated areas described above, we anticipate that the existing roadway would be adequate for a 5-year period, after reconstruction of areas exhibiting severe distresses. Additional coring is recommended to better evaluate pavement layer thicknesses if longer design life periods are desired.

We recommend that overlays be constructed using HMA Class ½-inch HMA with PG 58H-22 binder. Following asphalt grinding, the surface should be thoroughly cleaned and any cracks larger than ¼-inch sealed. Sufficient tack coat should be applied uniformly and allowed to break and set before placing the new HMA overlay in order to create a strong bond between layers. The surface of the pavement should be thoroughly cleaned prior to tack coat application. Improper tack coat application can result in loss of bond between HMA layers and lead to premature pavement distress/failure.

AIR CARGO ROAD

This alignment runs north-south from S 170th Street to S 166th Street, as shown on Figures 2B and 2C. The alignment is about 1,600 feet long and typically has two lanes in the NB direction (inside lane is generally for left turns) and one lane in the southbound direction with a left turn lane at the south end of the alignment. The roadway is surfaced with Hot Mix Asphalt (HMA). The surface exhibits significant longitudinal, transverse, and alligator cracking. It appears that patching and crack-sealing has been performed in the near past. In addition, we understand that the southern approximately 400 feet of the alignment was rehabilitated with a 3-inch thick grind and overlay about 2-3 years ago. As of June 2019, no reflective cracking had propagated to the surface and the overlaid section had no visible distresses. Pictures 10 through 15 show the surface condition in June 2019.

Picture 10. Air Cargo Road (looking north).

Picture 11. Air Cargo Road (looking north).

Picture 12. Air Cargo Road (looking south).

Picture 13. Air Cargo Road (looking south).

Picture 14. Air Cargo Road (looking south).

Picture 15. Air Cargo Road (looking south at new overlay section).

PAVEMENT CORES

Pavement layer thickness and shallow subgrade support conditions along Air Cargo Road were investigated by conducting four, 6-inch diameter pavement cores, designated Core-1 through Core-4, on May 1 & 2, 2019. Shallow subsurface explorations were performed beneath each pavement core using hand augers and hand digging tools. The approximate locations of the pavement cores are indicated on Figures 2B and 2C. Photographic logs of the cores are presented in Appendix A, Figures A-1 through A-4.

The coring and subsurface explorations were performed by two geologists from HWA. All core holes were backfilled with compacted gravel and patched with Aquaphalt. Table 10 provides the pavement layer thicknesses encountered in the pavement cores.

Table 10. Pavement Core Results – Air Cargo Road

Designation	Location	HMA Thickness, (in.)	ATB Thickness, (in.)
Core-1	SB Lane – See Figure 2C	7	4
Core-2	NB IL – See Figure 2C	6.5	5.5
Core-3	SB OL – See Figure 2B	8	4
Core-4	NB OL – See Figure 2C	7.5	3.75

Pictures 16 through 19 show the pavement surface condition at the locations of Core-1 though Core-4, respectively.

Picture 16. Pavement surface condition at Core-1 (looking west).

Core-1 was located in the SB lane at the location shown in Figure 2C. The core was performed on a medium severity transverse crack that had been sealed. Cracking extended through the upper three lifts of HMA, a depth of 4.75 inches. The lower 2.25 inches of HMA and 4 inches of ATB were not cracked. Medium dense sand with silt subgrade soils extended to 2 feet (maximum depth explored).

Picture 17. Pavement surface condition at Core-2 (at intersection of sealed longitudinal and transverse cracks in white painted area – looking west).

Core-2 was performed in the NB IL at the location shown in Figure 2C. The core was performed at the intersection of the pavement joint (longitudinal crack) and a medium to high severity transverse crack. Cracking extended through the entire 6.5-inch thick HMA layer. An ATB layer 5.5 inches thick was encountered below the HMA. A 6-inch thick layer of medium dense clean sand was encountered below the HMA. Dense, silty sand extended to a depth of 2 feet (maximum depth explored).

Picture 18. Pavement surface condition at Core-3 (looking east).

Core-3 was performed in the SB OL at the location shown in Figure 2B. The core was performed on an area of medium severity alligator cracking. Cracking extended through 3.5 inches of the 8-inch thick HMA layer. A 4-inch thick layer of ATB in good condition was encountered below the HMA. Medium dense to dense, silty sand soils were encountered to a depth of 2 feet (maximum depth explored).

Picture 19. Pavement surface condition at Core-4 (looking west).

Core-4 was performed in the NB OL at the location shown in Figure 2C. The core was performed at the intersection of a sealed medium severity longitudinal joint and low severity transverse crack. Cracking extended through 4.75 inches of the 7.5-inch thick HMA layer. A 3.75-inch thick layer of ATB was encountered below the HMA. Medium dense to very dense, silty sand soils were encountered to 2 feet (maximum depth explored).

FWD TESTING

Falling Weight Deflectometer (FWD) testing was conducted on May 2, 2019 along the NB and SB outside lanes at intervals of about 100 feet. The test stationing was measured in the field using a digital measuring instrument attached to the FWD. GPS coordinates were taken at each test location. Station 0+00 was arbitrarily set by HWA at the south end of the alignment, as shown in Figure 2B.

The FWD testing was undertaken using a Dynatest Model 8081 Heavy Falling Weight Deflectometer. This FWD allows the pavement to be tested under a wide range of loading conditions (6,500 to 54,000 pounds) to simulate a variety of traffic loads.

For this project, pulse loads of approximately 6,000, 9,000 and 12,000 pounds were applied to the pavement surface at each test location. The corresponding pavement surface deflections were measured with velocity transducers located directly under the loaded area, and at 12, 24, 36, 48, 60 and 72 inches from the center of the loaded area.

Figure 5A presents the maximum deflections (immediately under the applied load), normalized to a load of 9,000 pounds, for each test location. Figure 5B presents the backcalculated subgrade resilient moduli values for each test location. Figure 5C presents the existing AASHTO Structural Number (SN) for each test location.

Table 11 summarizes the FWD deflection data.

Table 11. FWD Test Results – Maximum Deflection Normalized to 9,000-pound Load

Test Lane	Number of Tests Included	Average Maximum Deflection, mils	Standard Deviation	Highest Deflection in Segment, mils	Lowest Deflection in Segment, mils
NB	16	4.1	2.1	11.7	2.7
SB	16	5.2	2.9	15.2	3.3

Table 12 summarizes the backcalculated resilient moduli values. The computer program Elmod, by Dynatest, was used for the backcalculation.

Table 12. FWD Test Results – Backcalculated Parameters

Test Lane	Number of Tests Included	Average Subgrade Resilient Modulus, ksi	Standard Deviation	Highest Value, ksi	Lowest Value, ksi
NB	16	18.1	5.6	29.8	12.2
SB	16	16.4	6.4	29.0	7.1

Table 13 summarizes the backcalculated AASHTO Structural Number (SN) values of the existing pavement using YONAPAVE (Hoffman, 2002).

Table 13. FWD Test Results – Existing AASHTO SN

Test Lane	Number of Tests Included	Average SN	Standard Deviation	Highest Value, ksi	Lowest Value, ksi
NB	16	4.5	0.9	5.6	1.7
SB	16	4.3	0.9	5.8	2.1

As indicated in Figure 5A, two of the highest deflections recorded (NB Sta 1+55 and SB Sta 0+98) are located in the area that received a recent grind and overlay (no distress evident). This suggests that the HMA below the new overlay is likely highly distressed and moving under load. The remainder of the deflections are quite low and exhibit strong pavement support.

EXISTING INFORMATION

We reviewed the following documents provided to us regarding this segment of the project:

- *Air Cargo Road Pavement Condition Assessment, SeaTac International Airport, SeaTac, Washington,* prepared by GeoEngineers for Port of Seattle, dated January 31, 2014.
- STIA-6922 ACR Pavement Section – PDF provided by the Port of Seattle. Drawing is titled "Airport Service Road and Utilities South 160th Street to South 170th Street Typical Roadway Sections", dated September 16, 1969.
- STIA-6922 ACR Plan – PDF provided by the Port of Seattle. Drawing is titled "Airport Service Road and Utilities South 160th Street to South 170th Street Plan & Profile Sta 102+00 to Sta 128+00", dated September 16, 1969.

The Roadway Section A is shown as two, 24-feet wide lanes comprised of 0.25 feet of Asphalt Concrete Class B over 0.35 feet of Asphalt Concrete Class E over 0.40 feet of Asphalt Treated Base over subgrade. The plan sheet shows Section A extending through the limits of this current project. The four pavement cores performed by HWA for this project (Core-1 through Core-4) closely matched the Roadway Section A pavement design. The assessment report prepared by GeoEngineers provided the following evaluations:

- Zone 2 – "Zone 2 contains Sections 10 through 15 and includes most of the length of Air Cargo Road between South 160th Street and South 170th Street. The condition of the

pavement in this zone appeared to be in marginally better condition overall than the pavement in Zone 1. We observed some patched spalling associated with construction joints throughout Zone 2. Spalling and damage of the construction joints was noticeably more significant where construction joints were located in the wheel paths. In section 11 we observed heaving and cracking of the pavement surface that appeared to be from tree roots spreading laterally across the roadway alignment. We estimated that approximately 25 to 75 percent of the observed distress cracks and construction joints in Zone 2 contained sealant." This Zone was assigned a Present Serviceability Index (PSI) of 3.0 and the report indicates it has an estimated remaining life of 46 to 14 million ESALs.

CONCLUSIONS & RECOMMENDATIONS

The existing pavement surface is beyond its design life, shows considerable distress, and requires rehabilitation. In general, the pavement distresses observed appear to be related to the old age of the HMA and traffic loading. A significant portion of the traffic consists of heavy vehicles. Subgrade support appears adequate and no significant areas of subgrade failure were observed. Given the relatively low deflection values and adequate subgrade support, this section can be rehabilitated by a grind/overlay to prolong its useful life; however reflective cracking will eventually work its way to the surface over time, from the pavement below the new overlay. The time for reflective cracking to manifest at the surface can be delayed by increasing the thickness of the new overlay; by using a fiberglass pavement grid within the new overlay; or by using Kevlar fiber-reinforced HMA for the new overlay.

We recommend that overlays be constructed using HMA Class ½-inch HMA with PG 58H-22 binder. Following asphalt grinding, the surface should be thoroughly cleaned and any cracks larger than ¼-inch sealed. Sufficient tack coat should be applied uniformly and allowed to break and set before placing the new HMA overlay in order to create a strong bond between layers. The surface of the pavement should be thoroughly cleaned prior to tack coat application. Improper tack coat application can result in loss of bond between HMA layers and lead to premature pavement distress/failure.

We understand that Air Cargo Road is to be considered in two separate sections:

- South Section – S170th Street to SB Expressway On-Ramp
- North Section – SB Expressway On-Ramp to S 166th Street

South Section – S 170th Street to SB Expressway On-Ramp

Current design traffic parameters were provided by HNTB, consisting of ADT volumes in both the NB and SB directions. The traffic data provided was separated into FHWA Vehicle

Classifications 1-3; 4; 5-7; and 8-13. We assigned the following Equivalent Single Axle Loads per Classification as follows:

- Class 1 – 3: 0.0008 ESAL/vehicle
- Class 4: 2 ESAL/vehicle
- Class 5 – 7: 0.5 ESAL/vehicle
- Class 8 – 13: 1.3 ESAL/vehicle

The NB ADT provided was 16,091 vehicles. The SB ADT provided was 2,323. The NB traffic was used for design. We used an annual traffic volume growth of 0.77%, per HNTB. Based on the information provided and the above assumptions, the following design ESALs were calculated:

- 5-Year Design Life: 3,926,389
- 10-Year Design Life: 8,006,290
- 15-Year Design Life: 12,245,705

The pavement recommendations presented in this report are based on these traffic calculations. If additional traffic count information is obtained that varies appreciably from these values, the recommendations given in this report should be reviewed and revised as necessary.

All pavement designs were based on the design method given in the 1993 AASHTO Design Guide (AASHTO, 1993) using the following parameters:

- Reliability = 90%
- Initial Serviceability = 4.5
- Terminal Serviceability = 2.5
- Overall Standard Deviation = 0.5
- Subgrade Resilient Modulus = 12,000 psi (based on FWD testing)

Rehabilitation designs were determined by comparing the required AASHTO Structural Number (SN) to the existing average SN determined from FWD testing. An existing SN of 3.5 was selected based on the results shown in Table 13 and Figure 5C. Table 14 provides our

rehabilitation recommendations, assuming an AASHTO structural coefficient of 0.44 for new HMA and 0.25 for existing in-place HMA given its age and relatively poor condition.

Table 14. South Section – S 170th Street to SB Expressway On-Ramp

Design Life, years	Average Existing AASHTO SN	Required AASHTO SN	Grind Depth, inches	Overlay Depth, inches
5	3.5	3.70	2	2
10	3.5	4.00	3	3
15	3.5	4.20	4	4

North Section – SB Expressway On-Ramp to S 166th Street

Current design traffic parameters were provided by HNTB, consisting of ADT volumes in both the NB and SB directions. The traffic data provided was separated into FHWA Vehicle Classifications 1-3; 4; 5-7; and 8-13. We assigned the following Equivalent Single Axle Loads per Classification as follows:

- Class 1 – 3: 0.0008 ESAL/vehicle
- Class 4: 2 ESAL/vehicle
- Class 5 – 7: 0.5 ESAL/vehicle
- Class 8 – 13: 1.3 ESAL/vehicle

The NB ADT provided was 4,818 vehicles. The SB ADT provided was 7,902. Although the SB had a higher ADT, the percentage of heavy trucks in the NB lane resulted in slightly higher ESALs. The NB traffic was used for design. We used an annual traffic volume growth of 0.77%, per HNTB. Based on the information provided and the above assumptions, the following design ESALs were calculated:

- 5-Year Design Life: 1,313,962
- 10-Year Design Life: 2,679,298
- 15-Year Design Life: 4,098,014

The pavement recommendations presented in this report are based on these traffic calculations. If additional traffic count information is obtained that varies appreciably from these values, the recommendations given in this report should be reviewed and revised as necessary.

All pavement designs were based on the design method given in the 1993 AASHTO Design Guide (AASHTO, 1993) using the following parameters:

- Reliability = 90%
- Initial Serviceability = 4.5
- Terminal Serviceability = 2.5
- Overall Standard Deviation = 0.5
- Subgrade Resilient Modulus = 12,000 psi (based on FWD testing)

Rehabilitation designs were determined by comparing the required AASHTO Structural Number (SN) to the existing average SN determined from FWD testing. An existing SN of 3.5 was selected based on the results shown in Table 13 and Figure 5C. Table 15 provides our rehabilitation recommendations, assuming an AASHTO structural coefficient of 0.44 for new HMA and 0.25 for existing in-place HMA given its age and relatively poor condition.

Table 15. North Section – SB Expressway On-Ramp to S 166th Street

Design Life, years	Average Existing AASHTO SN	Required AASHTO SN	Grind Depth, inches	Overlay Depth, inches
5	3.5	3.15	2*	2*
10	3.5	3.50	2*	2*
15	3.5	3.75	3**	3**

*Although the existing AASHTO SN is greater than or equal to that required for the 5-year and 10-year design life values, we recommend a 2-inch grind and 2-inch overlay to remove surface cracking and restore a smooth surface.

**Although the design SN is greater than the required SN, we recommend a 3-inch thick grind and 3-inch thick overlay in order to minimize/delay occurrence of reflective cracking.

PROJECT SUMMARY

The following tables summarize the rehabilitation recommendations presented in this report:

Cell Phone Parking Lot Access Road

Design Life, years	Grind Depth, inches	Overlay Depth, inches
5	2	2
10	3	3

S 170th Street

Design Life, years	Assumed Existing AASHTO SN	Required AASHTO SN	Grind Depth, inches	Overlay Depth, inches
5	3.2	3.30	2	2
10	3.2	3.70	2	2.5
15	3.2	3.95	3	4

Air Cargo Road – South Section – S 170th Street to SB Expressway On-Ramp

Design Life, years	Average Existing AASHTO SN	Required AASHTO SN	Grind Depth, inches	Overlay Depth, inches
5	3.5	3.70	2	2
10	3.5	4.00	3	3
15	3.5	4.20	4	4

Air Cargo Road – North Section – SB Expressway On-Ramp to S 166th Street

Design Life, years	Average Existing AASHTO SN	Required AASHTO SN	Grind Depth, inches	Overlay Depth, inches
5	3.5	3.15	2	2
10	3.5	3.50	2	2
15	3.5	3.75	3	3

CONDITIONS AND LIMITATIONS

Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical and pavement engineering at the time the report was prepared. No warranty, express or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or ground water at this site.

We appreciate this opportunity to provide geotechnical and pavement engineering services on this project. If you have any questions or if we may be of further assistance, please contact the undersigned at (425) 774-0106.

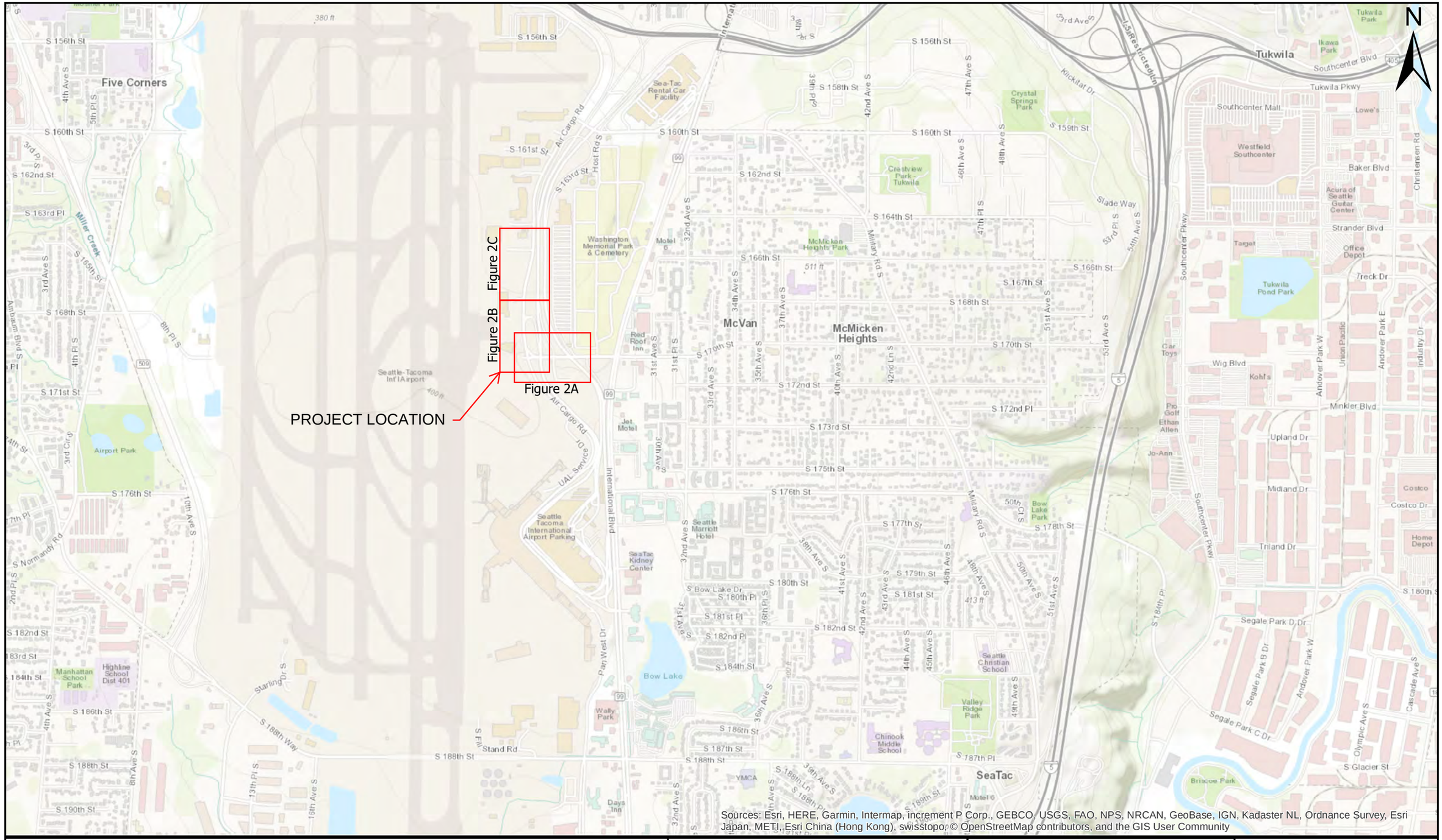
Sincerely,

HWA GEOSCIENCES INC.

Bryan K. Hawkins, P.E.
Senior Geotechnical Engineer

ATTACHMENTS:

Figure 1	Vicinity Map
Figures 2A – 2C	Site and Exploration Plans
Figures 3A – 3B	FWD Test Results for Cell Phone Parking Lot Access Road
Figures 4A – 4C	FWD Test Results for S 170th Street
Figures 5A – 5C	FWD Test Results for Air Cargo Road
Appendix A	Pavement Core Logs



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

HWA GeoSciences Inc.
Federal and State Certified DBE/MWBE

0 1,500 3,000 6,000 Feet

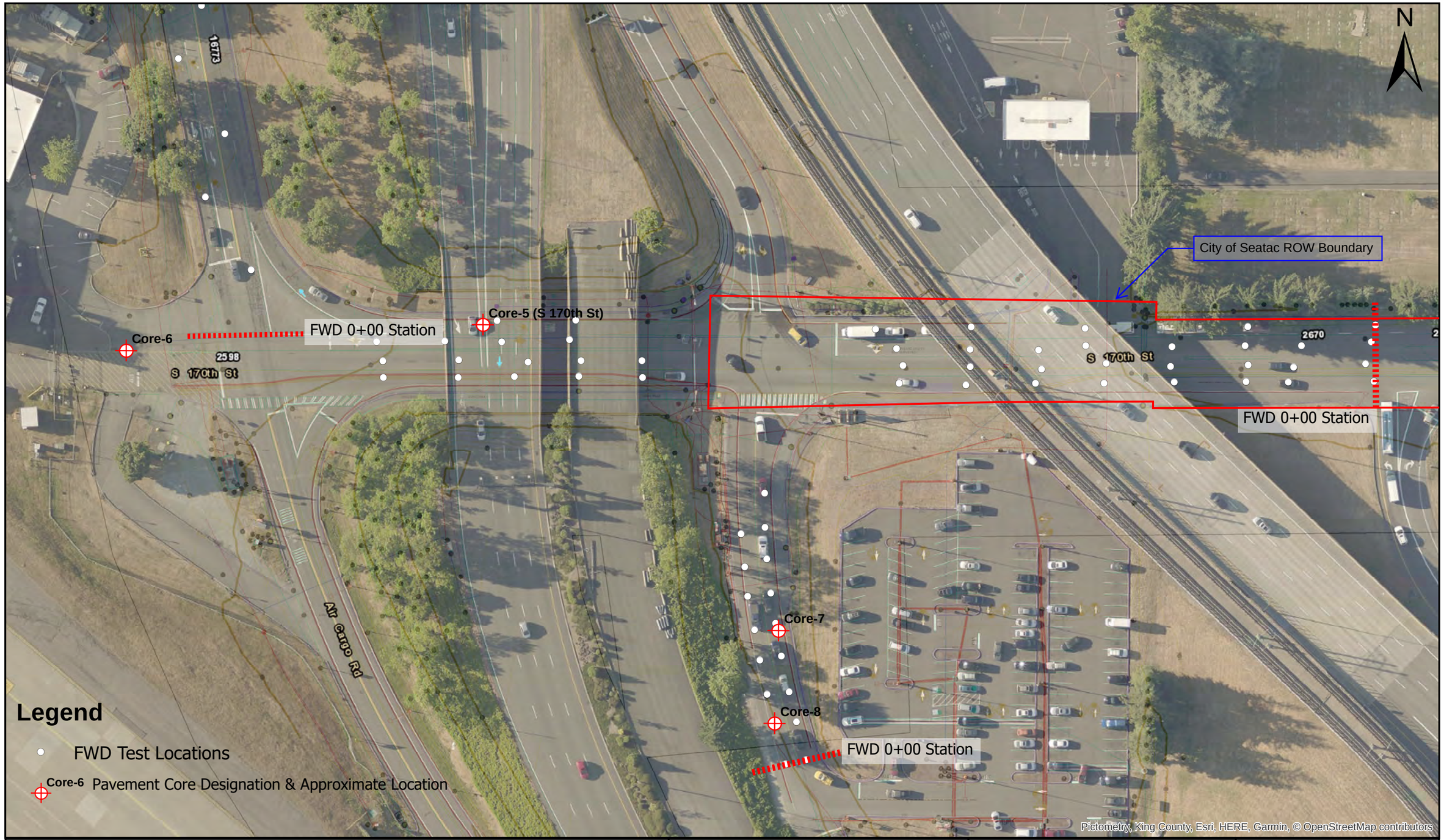
Port of Seattle
Air Cargo Road Safety Improvements
Seatac, Washington

VICINITY MAP

FIGURE # 1

PROJECT # 2018-020-21

Document Path: F:\GIS Projects\Project by Year\2018 Projects\2018-020-21\Site Plan.mxd



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0 75 150 300 Feet

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, Washington

SITE & EXPLORATION PLAN

FIGURE # 2A

PROJECT # 2018-020-21

Document Path: F:\GIS Projects\Project by Year\2018 Projects\2018-020-21\Site Plan.mxd

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0 75 150 300 Feet

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, Washington

SITE & EXPLORATION PLAN

FIGURE # **2B**

PROJECT # 2018-020-21

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HWA GeoSciences Inc.
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0 75 150 300 Feet

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, Washington

SITE & EXPLORATION PLAN

FIGURE # **2C**

PROJECT # 2018-020-21

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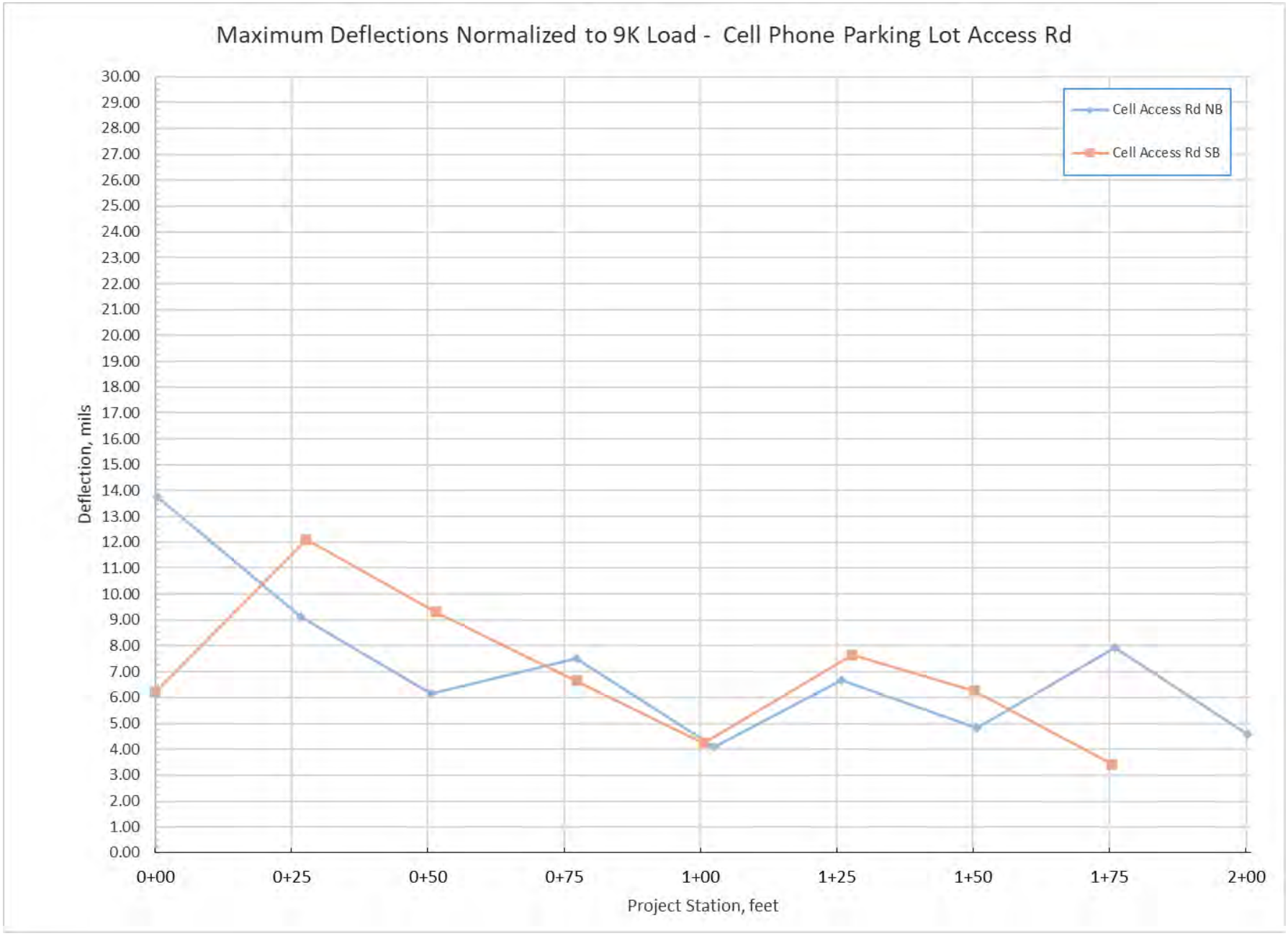


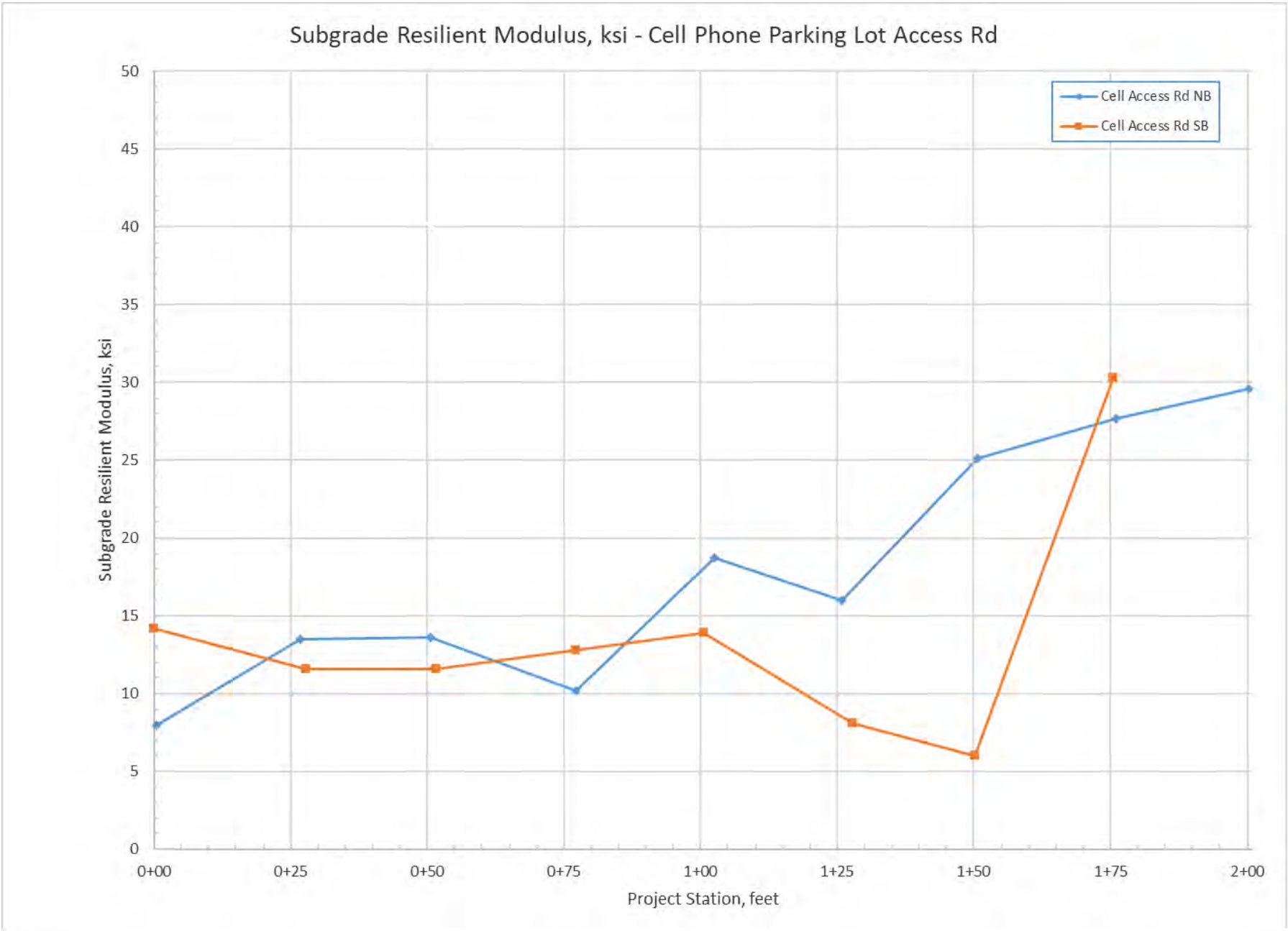
HWA GeoSciences Inc.

MAXIMUM DEFLECTIONS NORMALIZED TO 9K LOAD

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
3A

PROJECT NO.
2018-020



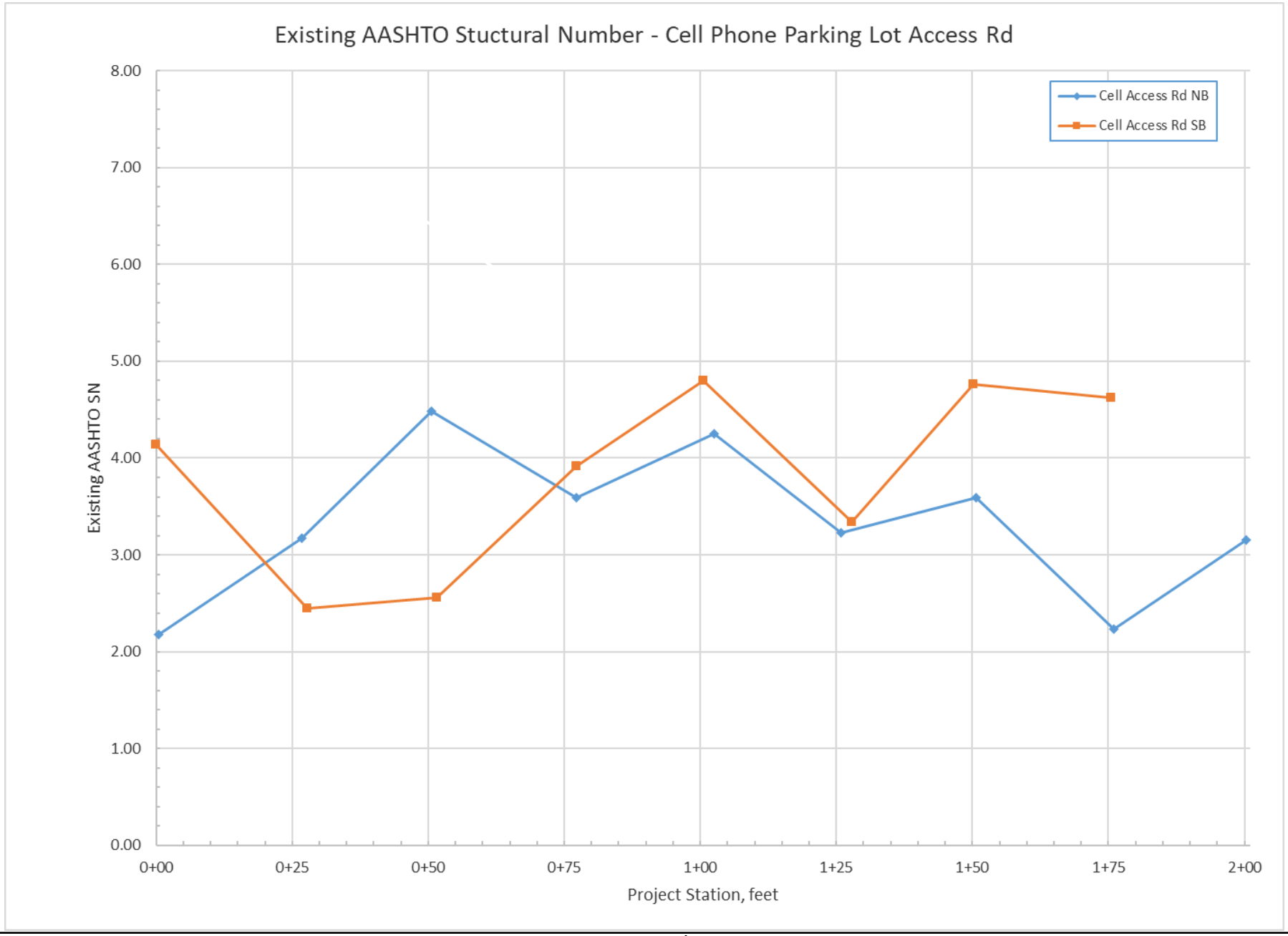
HWA GeoSciences Inc.

SUBGRADE RESILIENT MODULUS

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
3B

PROJECT NO.
2018-020



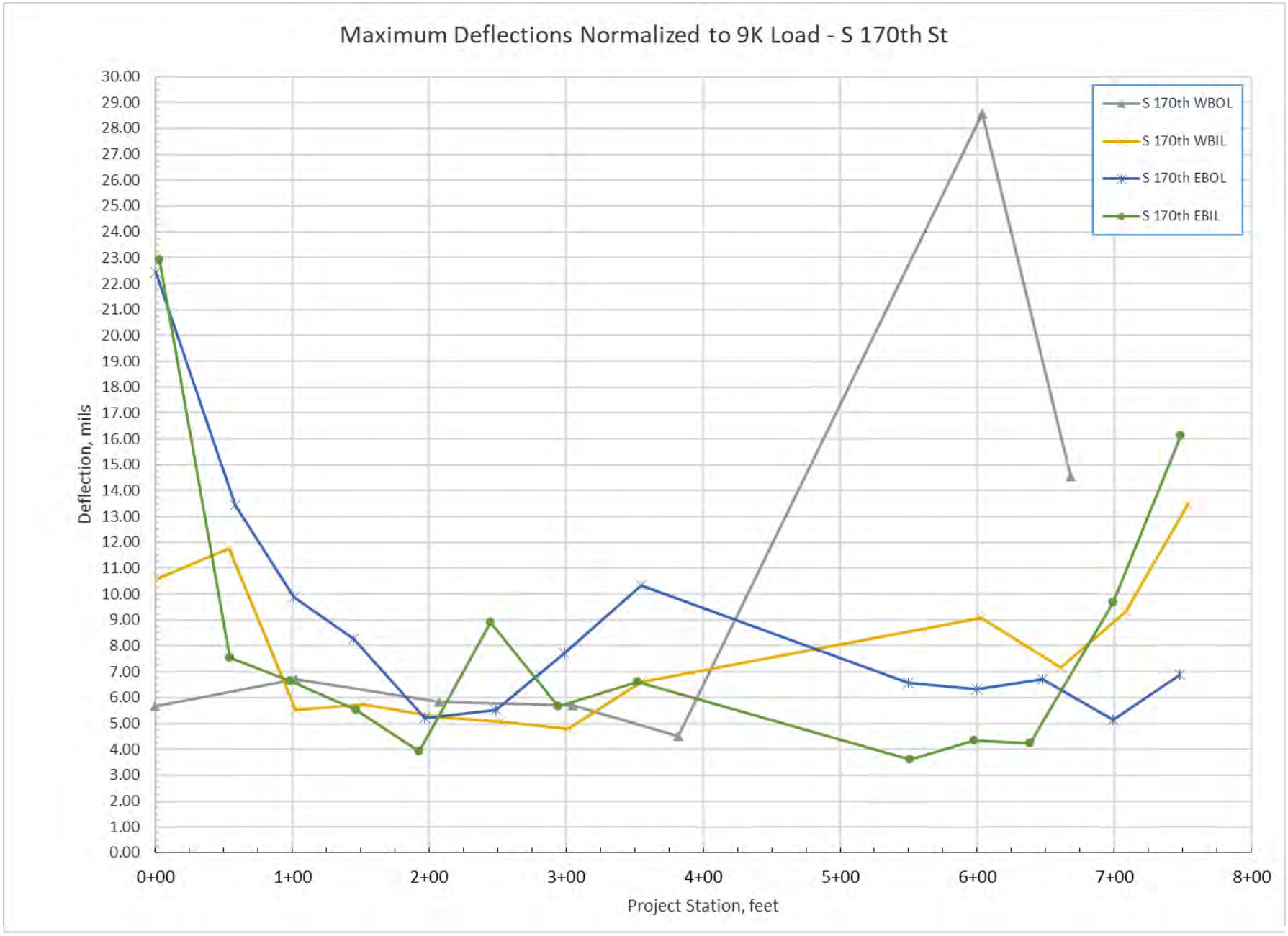
HWA GeoSciences Inc.

EXISTING AASHTO STRUCTURAL NUMBER

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
3C

PROJECT NO.
2018-020



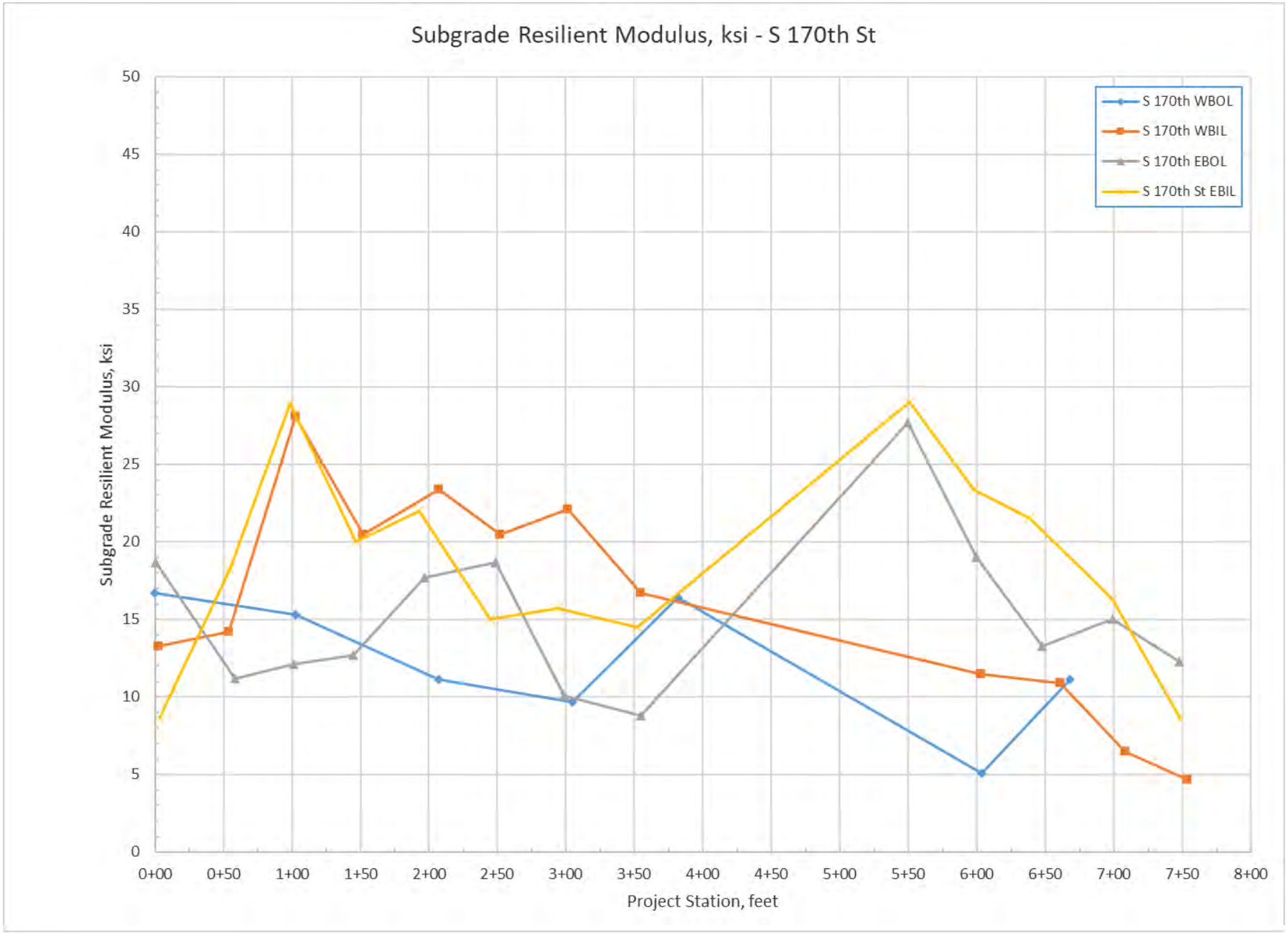
HWA GeoSciences Inc.

MAXIMUM DEFLECTIONS NORMALIZED TO 9K LOAD

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
4A

PROJECT NO.
2018-020



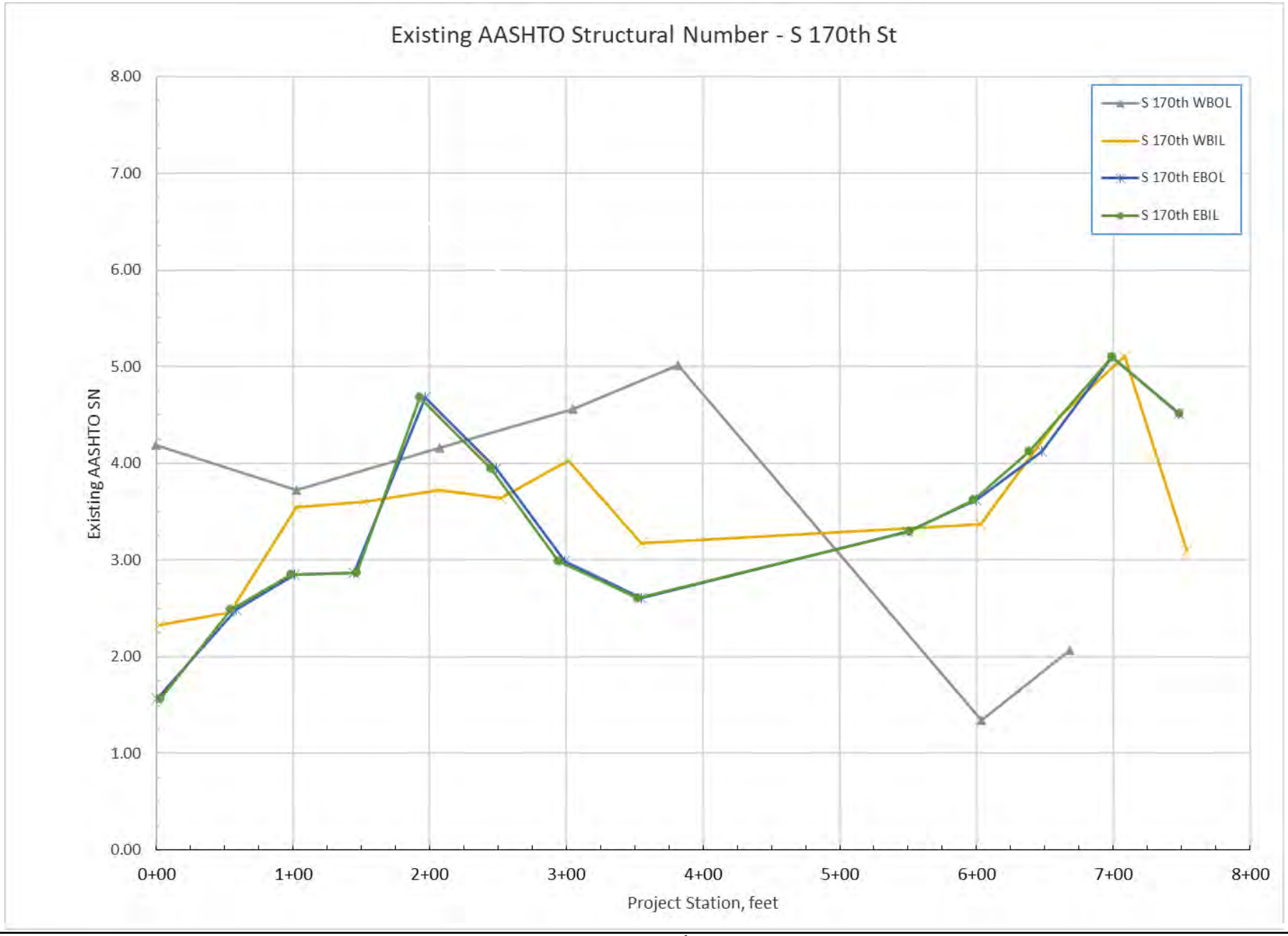
HWA GeoSciences Inc.

SUBGRADE RESILIENT MODULUS

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
4B

PROJECT NO.
2018-020



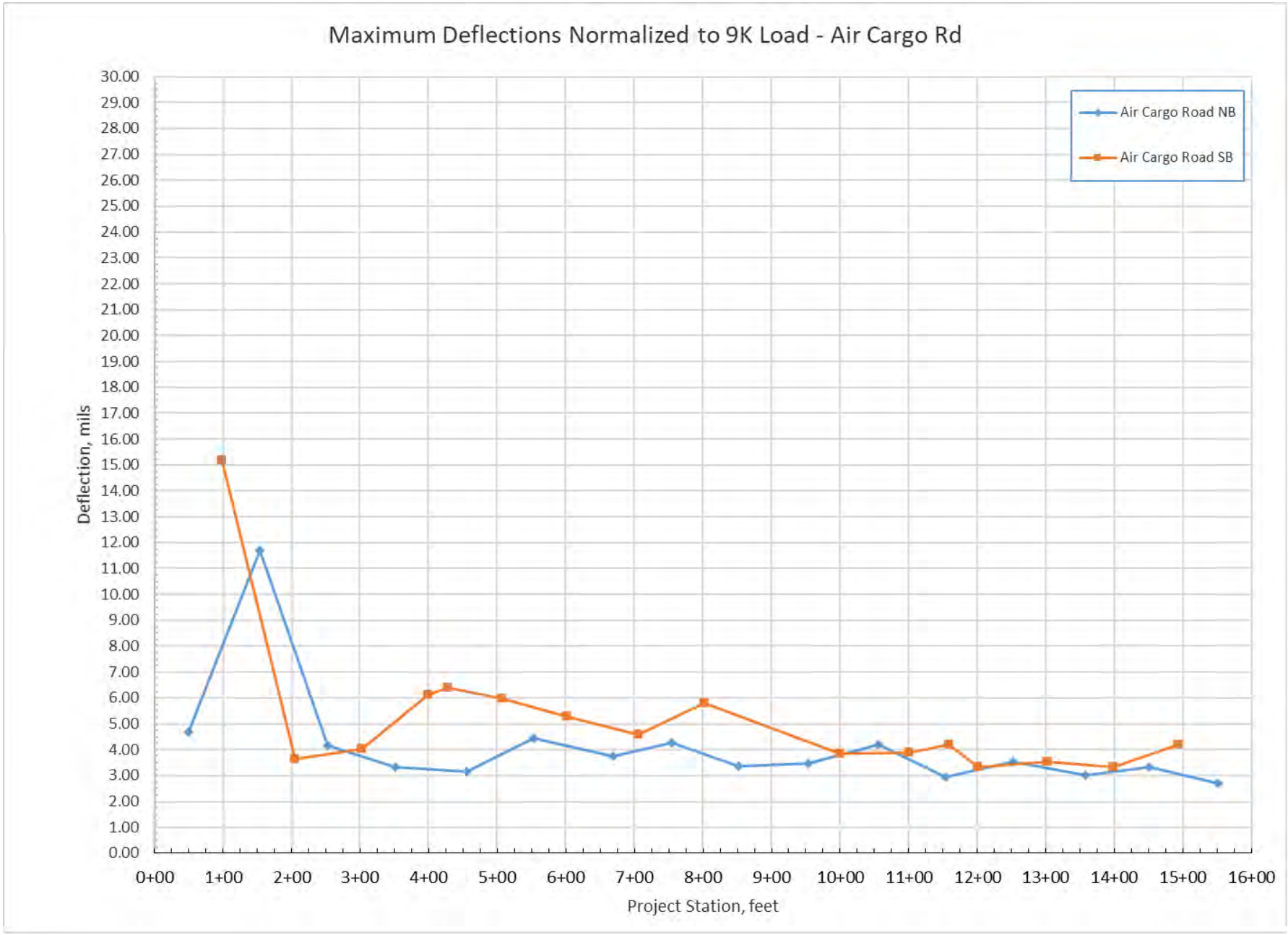
HWA GeoSciences Inc.

EXISTING AASHTO STRUCTURAL NUMBER

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
4C

PROJECT NO.
2018-020



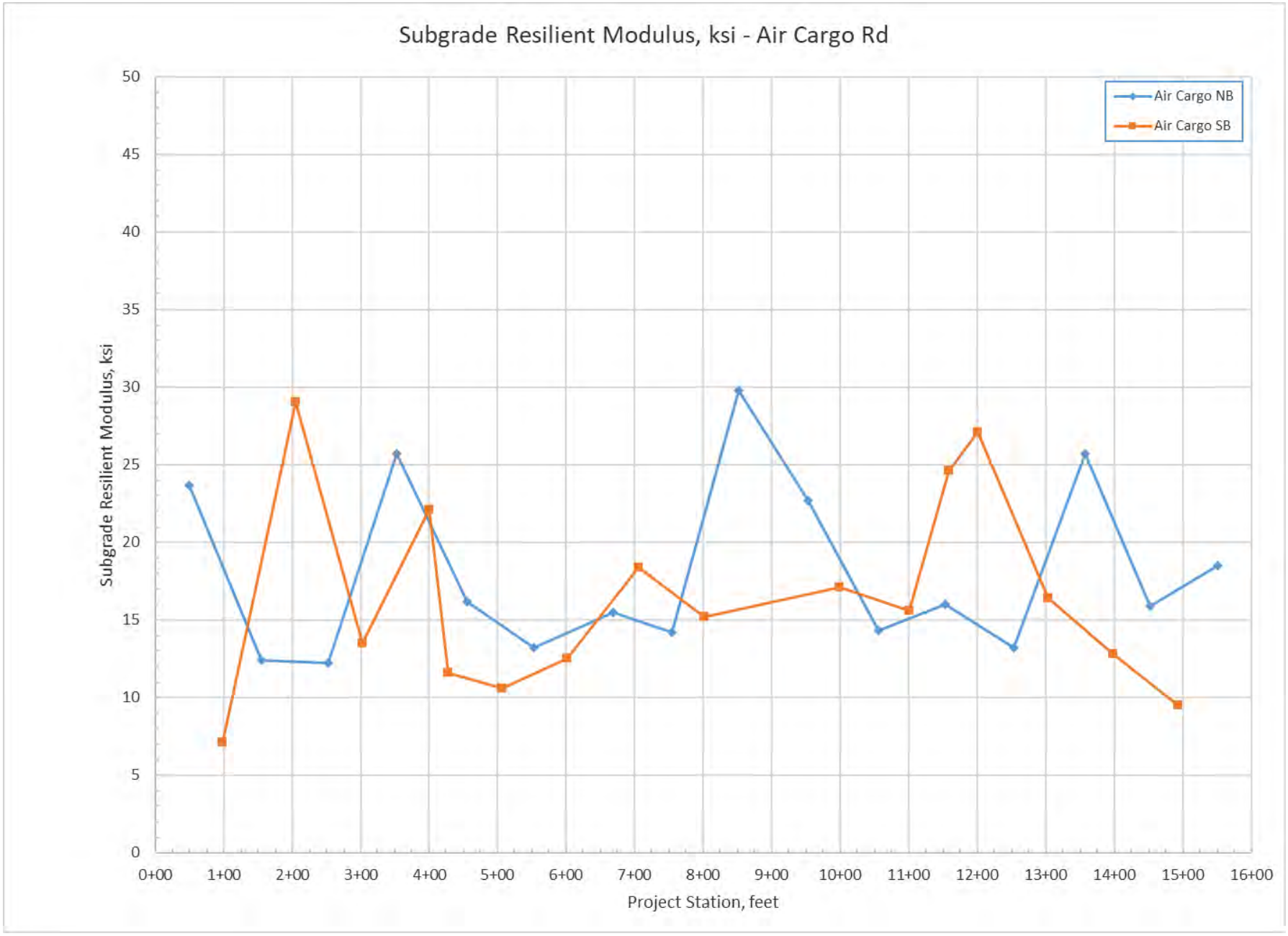
HWA GeoSciences Inc.

MAXIMUM DEFLECTIONS NORMALIZED TO 9K LOAD

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
5A

PROJECT NO.
2018-020



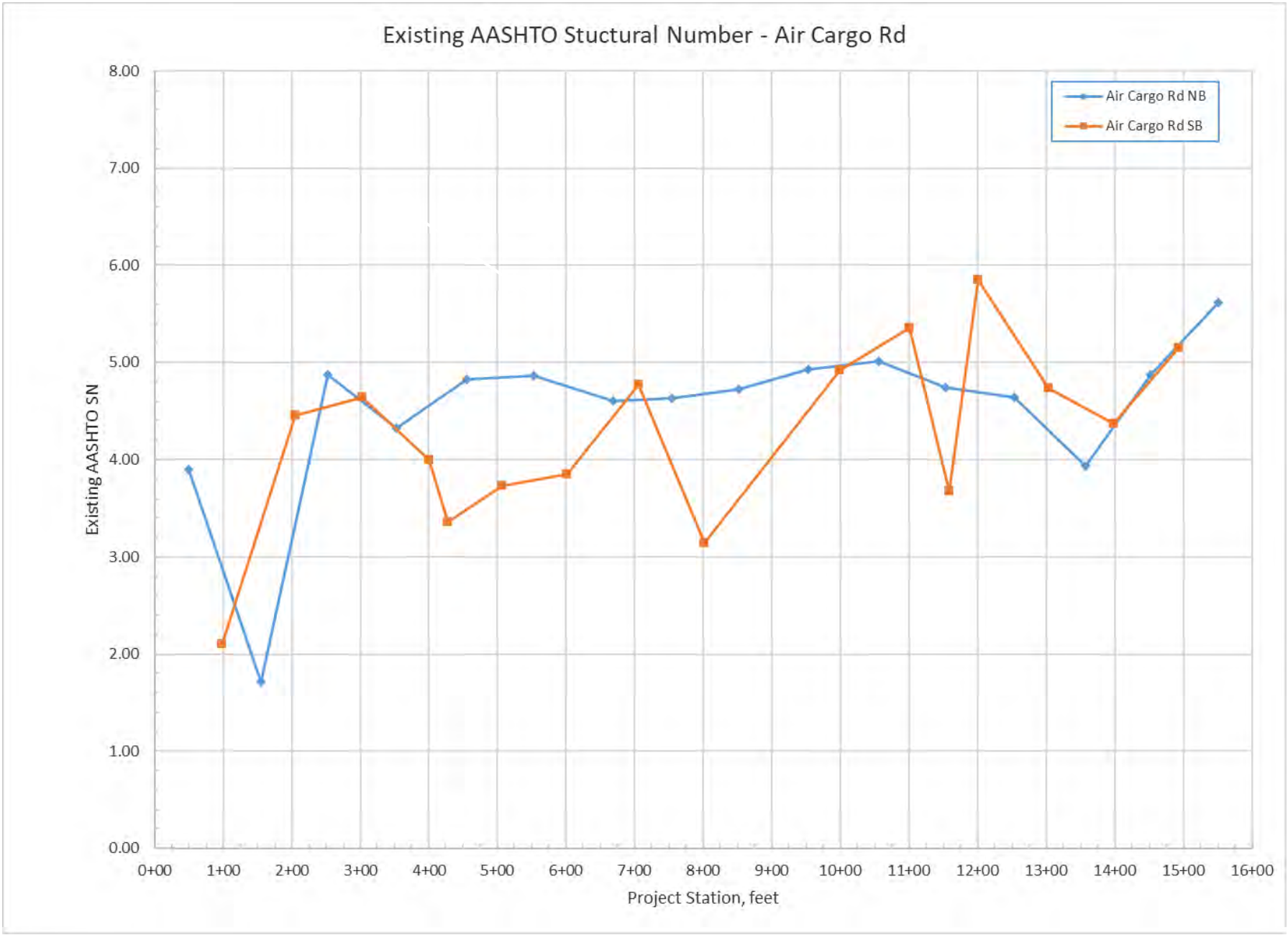
HWA GeoSciences Inc.

SUBGRADE RESILIENT MODULUS

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
5B

PROJECT NO.
2018-020



HWA GeoSciences Inc.

EXISTING AASHTO STRUCTURAL NUMBER

PORT OF SEATTLE
AIR CARGO ROAD SAFETY IMPROVEMENTS
SEATAC, WASHINGTON

FIGURE NO.
5C

PROJECT NO.
2018-020

APPENDIX A

PAVEMENT CORE LOGS

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Air Cargo Road, Southbound Lane, 9' from curb.

LOCATION: See Figure 2C
DATE COMPLETED: 5/2/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			7.0-inches Hot Mix Asphalt 4 lifts: 1.25 x 1.5 x 2.0 x 2.25 Cored on medium severity transverse cracking in longitudinal/transverse cracking area. Cracking extends through upper three lifts. **(HMA)**				
			4.0-inches Asphalt Treated Base 1 lift: 4.0 Crumbled at edges during drilling. Fair condition. **(ATB)**				
		SP SM	Medium dense, gray, fine to medium SAND, with silt and gravel, moist. **(FILL)** Becomes dense.				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-1

PROJECT NO.: 2018-020 FIGURE: A-1

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Air Cargo Road, Northbound Inside Lane, 7' from centerline.

LOCATION: See Figure 2C
DATE COMPLETED: 5/1/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			6.5-inches Hot Mix Asphalt 3 lifts: 1.5 x 1.5 x 3.0 Cored on joint of medium to high severity transverse cracking and old pavement. Transverse crack extends through all lifts. All lifts are unbonded. **(HMA)**				
			5.5-inches Asphalt Treated Base 2 lifts: 2.75 x 2.75 Crumbles easily. **(ATB)**				
		SP	Medium dense, olive brown, fine to coarse SAND, with gravel, moist. **(FILL)**				
		SM	Dense, olive gray, silty, fine to medium SAND, with gravel, moist.				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-2

PROJECT NO.: 2018-020 FIGURE: A-2

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Air Cargo Road, Southbound Outside Lane, 5' from curb.

LOCATION: See Figure 2B
DATE COMPLETED: 5/1/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			8.0-inches Hot Mix Asphalt 4 lifts: 1.5 x 2.0 x 2.5 x 2.0 Cored on medium severity alligator cracking. Upper two lifts are unbonded. Cracking extends through upper two lifts. Lower lifts in good condition. **(HMA)**				
			4.0-inches Asphalt Treated Base 2 lifts: 2.0 x 2.0 Lifts are unbonded. **(ATB)**				
		SP SM	Medium dense, olive gray, fine to medium SAND, with silt and gravel, moist. **(FILL)** Becomes dense. Becomes gray.				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-3

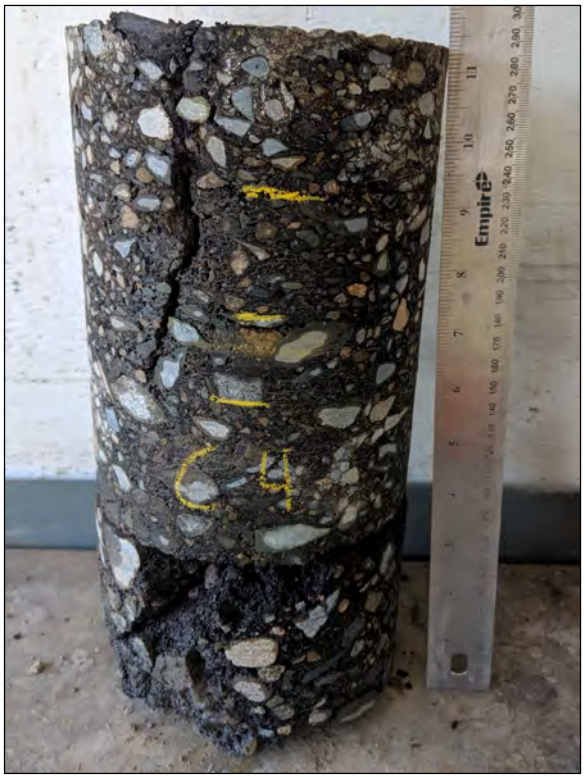
PROJECT NO.: 2018-020 FIGURE: A-3

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Air Cargo Road, Northbound Outside Lane, 4'3" from fogline.

LOCATION: See Figure 2C
DATE COMPLETED: 5/1/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			7.5-inches Hot Mix Asphalt 4 lifts: 1.75 x 1.75 x 1.25 x 2.75 Cored at intersection of medium severity longitudinal and transverse cracking. All lifts bonded. Cracking extends through upper three lifts. Bottom lift is Class 1-inch. **(HMA)**				
			3.75-inches Asphalt Treated Base 1 lift: 3.75 **(ATB)**				
		SM	Medium dense to dense, gray, silty, fine to medium SAND, with gravel, moist. **(FILL)** Becomes very dense.				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-4

PROJECT NO.: 2018-020 FIGURE: A-4

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: S. 170th St., Westbound Outside Lane, 2' from fogline.

LOCATION: See Figure 2A
DATE COMPLETED: 5/1/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			5.0-inches Hot Mix Asphalt 3 lifts: 1.5 x 2.0 x 1.5 Cored on high severity longitudinal cracking. Cracked through upper two lifts. Second lift is unbonded from third. Poor condition. **(HMA)**				
			13.0-inches Crushed Surfacing Top Course Medium dense, olive gray, crushed fine GRAVEL, with sand, moist. **(CSTC)**				
		SP SM	Medium dense, olive brown, fine to medium SAND, with silt and gravel, moist. **(FILL)**				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-5

PROJECT NO.: 2018-020 FIGURE: A-5

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Fire Station Access Road, 11' East of curb.

LOCATION: See Figure 2A
DATE COMPLETED: 5/2/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			7.0-inches Hot Mix Asphalt 3 lifts: 2.0 x 1.0 x 4.0 Cored on joint between newer utility patch and old pavement. All lifts bonded. Lower lift may be Asphalt Treated Base with crushed aggregate; binder is weak. **(HMA)**				
			4-inches Crushed Surfacing Base Course Medium dense to dense, olive gray, crushed fine to coarse GRAVEL, with sand, moist. **(CSBC)**				
		SP SM	Dense, gray, fine to medium SAND, with silt and gravel, moist. **(FILL)**				
3							

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-6

PROJECT NO.: 2018-020 FIGURE: A-6

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Cell Phone Lot Access Road, Northbound, 6' from fogline.

LOCATION: See Figure 2A
DATE COMPLETED: 5/2/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			4-inches Hot Mix Asphalt 2 lifts: 2.0 x 2.0 Cored on intersection of medium severity longitudinal and transverse cracks. Cracked through. Both lifts are bonded. **(HMA)**				
			6.0-inches Asphalt Treated Base 2 lifts: 3.0 x 3.0 Good condition, no cracking. **(ATB)**				
		SM	Medium dense, brown, silty, fine to medium SAND, with gravel, moist. **(FILL)**				
			Becomes dense				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-7

PROJECT NO.: 2018-020 FIGURE: A-7

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 6-inch Diameter Core Barrel
STREET: Cell Phone Lot Access Road, Southbound, 1.5' from fogline.

LOCATION: See Figure 2A
DATE COMPLETED: 5/2/19
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			5-inches Hot Mix Asphalt 3 lifts: 1.75 x 1.5 x 1.75 Cored at intersection of medium to high severity longitudinal and transverse cracking. Cracked through upper lift. Upper lift is unbonded, poor condition. **(HMA)**				
		SM	3.0-inches Asphalt Treated Base 1 lift: 3.0 Cracked through, poor condition. **(ATB)**				
			Medium dense, gray, silty, fine to medium SAND, with gravel, moist. **(FILL)**				
3			Corehole was terminated at 2.0 feet below ground surface. No ground water seepage was observed during the exploration.				

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Port of Seattle
Air Cargo Road Safety Improvements
Seatac, WA

PAVEMENT CORE
Core-8

PROJECT NO.: 2018-020 FIGURE: A-8

APPENDIX D

Greenhouse Gas Emissions Worksheet
Supplemental Information for SEPA Environmental Checklist

GHG Emission Sources (CO2, CH4, N2O, HFCs, PFCs, SF6)[1]	**What sources are likely from the proposal?** ***List specific type of activities, and duration of emissions***	**What is the quantitative or qualitative assessment of those emissions?**	**What available mitigation will avoid or reduce those emissions?**
On-Road Mobile Sources	Privately owned vehicles using the Cell Phone Lot and Project roads	Improvements proposed for this Project anticipate alleviating and reducing the number of cars idling at intersections and improve circulation around the Cell Phone Lot.	No net increase in emissions is expected to result from the Project; therefore, no mitigation is proposed.
Non-Road Mobile Sources	Not Applicable	Not Applicable	
Stationary Combustion	Not Applicable	Not Applicable	
Industrial Processes	Not Applicable	Not Applicable	
Fugitive Emissions	Not Applicable	Not Applicable	
Agricultural Emissions	Not Applicable	Not Applicable	
Land Disturbance	Not Applicable	Not Applicable	
Purchased Electricity and Steam	Not Applicable	Not Applicable	
Construction	Construction vehicles (See Section 14.f)	Temporary/short-term use associated with construction-related emissions is not expected to be significant. Approximately 130 truck trips are anticipated for hauling material to/from the Project area. This additional vehicular traffic will be short-term.	Contractor performing construction/demolition would be required to maintain and repair all equipment in a manner that reasonably minimizes emissions.
Extraction of Purchased Materials	Not Applicable	Not Applicable	
Processing of Purchased Materials	Not Applicable	Not Applicable	

GHG Emission Sources (CO2, CH4, N2O, HFCs, PFCs, SF6)[1]	**What sources are likely from the proposal?** ***List specific type of activities, and duration of emissions***	**What is the quantitative or qualitative assessment of those emissions?**	**What available mitigation will avoid or reduce those emissions?**
Transportation of Purchased Materials	Concrete, asphalt, and the structure are the primary components of the Project. The Port will work with the contractor to source these components locally to the extent practical.	Temporary/short-term use associated with construction-related emissions is not expected to be significant.	Contractor transporting equipment would be required to maintain and repair all vehicles in a manner that reasonably minimizes emissions.
Employee Commute	Not Applicable	Not Applicable	
Other Mobile Emissions	Not Applicable	Not Applicable	
Water Use and Wastewater Disposal	Not Applicable	Not Applicable	
Waste Management	Not Applicable	Not Applicable	
Product Use	Not Applicable	Not Applicable	

**Calculated via City of Seattle Department of Planning and Development SEPA GHG Emissions Worksheet.*

CH4	Methane	Landfills, production and distribution of natural gas & petroleum, fermentation from the digestive system of livestock, rice cultivation, fossil fuel combustion, etc.
N2O	Nitrous Oxide	Fossil fuel combustion, fertilizers, nylon production, manure, etc.
HFC's	Hydrofluorocarbons	Refrigeration gases, aluminum smelting, semiconductor manufacturing, etc.
PFC's	Perfluorocarbons	Aluminum production, semiconductor industry, etc.
SF6	Sulfur Hexafluoride	Electrical transmissions and distribution systems, circuit breakers, magnesium production, etc.