SOUTH PARK BRIDGE PROJECT

Draft Environmental Impact Statement and Section 4(f) Evaluation

Appendix Volume V

September 2005

U.S. Department of Transportation
Federal Highway Administration

Washington State
Department of Transportation

King County
Department of Transportation

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Appendix U. Water Resources Technical Report

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Technical Report
South Park Bridge Project

Water Resources

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February 2004

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Technical Report
South Park Bridge Project

Water Resources

February 2004

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Chapter 1 Executive Summary

The King County Department of Transportation (DOT) proposes to replace South Park Bridge No. 3179. The existing bridge is located at 14th/16th Avenue South on the Duwamish Waterway, 5 miles south of downtown Seattle (Township 24N, Range 4E, Section 32). The South Park Bridge is in need of replacement or major reconstruction. The deteriorated foundation of the piers supporting the bridge structure threatens to permanently close the bridge with any substantial movement resulting from earthquake forces or the continued degradation and movement of the support piers.

The purpose of the proposed action is to find the most feasible long-term solution to address the deteriorated condition and increasing seismic vulnerability of the South Park Bridge. The proposed action must also maintain the vital transportation linkage for cars, trucks, buses, bicyclists and pedestrians across the Duwamish Waterway.

Five alternatives are considered in this report: No Action, Rehabilitation, Bascule Bridge, Mid-Level Fixed-Span Bridge, and High-Level Fixed-Span Bridge. This report evaluates the impacts and discusses mitigation options for stormwater management, water quality, and bridge hydraulics for each of the proposed alternatives.

Description of Existing Conditions

The stormwater flows on the north side of the Duwamish Waterway are currently collected in a separated stormwater system and conveyed to existing stormwater outfalls located underneath the existing South Park Bridge on the Boeing Plant #2 property. There is currently no stormwater detention provided prior to discharge into the Duwamish Waterway. The stormwater flows on the south side of the Duwamish Watereway is collected in a system of catch basins that connect directly to the City of Seattle combined sewer system and eventually to the Metro combined sewer system. The City of Seattle combined sewer system conveys sanitary and stormwater flows to the King County West Point Treatment Plant for treatment and discharge to Puget Sound.

The primary water resource affected by the removal, rehabilitation, or replacement of the South Park Bridge is the Duwamish Waterway. The Duwamish Waterway is used for industrial, commercial and recreational purposes. The South Park Bridge is within the intertidal zone near the upstream limit of the dredged waterway maintained by the U.S. Army Corps of Engineers. The Duwamish Waterway has been severely impacted by previous dredging and filling activities. Currently, the waterway consists of a straightened river channel with narrow intertidal mud flats extending to steep middle and upper intertidal shorelines.

Flow in the waterway is regulated by the operation of the Howard Hanson Dam in the headwaters of the Green River. Characterized by wet and dry seasons, discharge of the river varies seasonally. The wet season extends from November to July, and the dry season from August to October. The mean monthly flow rate varies from 400 cfs in August to 2,600 cfs in January. According to FEMA, the maximum regulated flow for the 100-year recurrence interval is 12,000 cfs at the project site.

The Duwamish Waterway at the South Park Bridge is within a regulated floodway. Constructed levees and dikes line portions of the waterway along the project site. The Boeing plant on the north side of the waterway acts as a constructed dike. The floodway width is 450 feet within the constructed levee/dike on either side of the waterway. The area to the landward side of the levees/dikes is not within a regulated floodplain. The bridge approach piers on either side of the waterway are protected from the 100-year flood by the levees. The constructed levees on either side of the waterway, along with the regulation of flood flows from Howard Hanson dam, have effectively disconnected the floodplain from the river.

The Duwamish Waterway is on Ecology's 303(d) list of impaired and threatened water bodies for multiple parameters at many sites. The Duwamish Waterway at the project site exceeds the standards for pH (outside the range of 6.5 to 8.5). An unnamed tributary in the project vicinity is listed for fecal coliform bacteria and dissolved oxygen (DO). Near the project site, the Duwamish Waterway has high temperatures and low DO levels during summer low flow periods.

The Duwamish Waterway at the South Park Bridge is within the Lower Duwamish River Superfund Site. Additional information about the project site sediment and groundwater quality, relative to the Lower Duwamish Waterway Superfund Site, is provided in the Hazardous Materials Technical Report.

The project site is not within a sole source aquifer nor wellhead protection area. The area to the south of the Duwamish Waterway is characterized as having a high susceptibility to groundwater contamination according to the King County Department of Natural Resources. The general direction of groundwater flow in the floodplain is towards the waterway, although the direction may vary locally depending upon the nature of subsurface material and proximity to the waterway where tidal action can alter groundwater flows. Although high tides can cause temporary groundwater flow reversal, the net groundwater flow direction is towards the waterway.

Regulatory Requirements

Because the proposed project area in partially within the Lower Duwamish Waterway Superfund Site, any action would need to be reviewed for consistency with the Comprehension Environmental Response, Compensation, and Liability Act (CERCLA), including the goals and policies of Region 10 EPAs management of the Superfund Site.

Stormwater discharged to the Duwamish Waterway would need to meet the requirements of the Washington State Department of Ecology Stormwater Manual for Western Washington (Ecology 2001). In addition, local ordinances apply to stormwater management within the three jurisdictions that encompass the project site, including King County, City of Tukwila, and City of Seattle.

The Duwamish Waterway is exempt from flow control requirements per King County, the City of Seattle, the City of Tukwila, and the Ecology Manual, because it discharges to tidal- and salt-influenced waters. Basic water quality treatment would be required for discharge of stormwater to the Duwamish Waterway.

The Duwamish Waterway is within a federally designated floodway at the bridge crossing. Federally designated floodways are regulated by local jurisdictions, either county or city. The Duwamish Waterway at the project site lies within King County to the south and the City of Tukwila to the north. Floodway conveyance of the bridge opening must meet the requirements for flood hazard areas in the King County Sensitive Areas Ordinance and Chapter 16.52, "Floodplain Management", in the Tukwila Municipal Code.

Impacts and Mitigation

Stormwater Quantity

All of the build alternatives for the South Park Bridge project would require new stormwater facilities. The new conveyance system would consist of curbs, bridge drains, and catch basins to collect and convey the storm runoff. The storm flows would be conveyed to the existing outfall on the north side of the project and to a proposed outfall on the south side of the project. Some stormwater flows may be conveyed to the existing combined sewer system. These flows would likely be equal to or less than the existing volume of flows. No detention would be provided for stormwater discharges to the Duwamish Waterway.

Water Quality - Operational

A stormwater pollutant loading analysis was performed for each of the proposed alternatives in order to determine impacts to water quality. The analysis used the Federal Highway Administration (FHWA) methodology (FHWA 1990) to determine pollutant loads for the three-lane Rehabilitation Alternative. Pollutant loads for the four-lane alternatives (all other alternatives) were scaled up from the Rehabilitation Alternative, in proportion to predicted increases in traffic volume for the four-lane bridge. Annual pollutant loads of oil and grease; copper, lead, and zinc; and total suspended solids (TSS) resulting from both treated and untreated stormwater runoff were estimated.

The four-lane alternatives (High-Level Fixed-Span Bridge, Mid-Level Fixed Span Bridge, and Bascule Bridge) result in a pollutant load to the Duwamish Waterway approximately 1.12 times greater than the Rehabilitation Alternative. The No Action Alternative eliminates pollutant loading from the South Park Bridge, due to the closing and removal of the existing bridge. However, the net impacts to the Duwamish Waterway would be approximately equivalent among all alternatives, since any reduction or increase in traffic volume at the South Park Bridge would be reflected in an approximately equal and opposite effect at other bridges crossing the Duwamish Waterway.

Stormwater draining to the Duwamish Waterway would require water quality treatment prior to discharge. Ecology recommended best management practices (BMPs) for stormwater treatment include sand filter, biofiltration swale, filter strip, basic wetpond, wetvault, stormwater treatment wetland, and combined detention/wetpool facility.

Water Quality - Construction

Construction activity related to any of the five alternatives within the river would likely lead to the suspension or entrainment of sediment, some of it potentially contaminated, into the water. In-river construction activities that could result in water quality degradation include the removal of the existing bridge and fenders, construction of the new bridge foundation and supports, and construction staging.

Suspension of sediments in the water would be minimized through the use of cofferdams, caissons or temporary casings. Cofferdams would be used to isolate the work area from the river flow, thereby reducing the potential for sediment entrainment in river water. The suspension of sediments into the flow of the waterway is an unavoidable adverse impact associated with each of the alternatives. The amount of sediments entrained in the water as a result of construction is likely to be small relative to the background level; however, a portion of these sediments may be contaminated.

The No Action Alternative would likely result in the least disturbance to the waterway, as only the existing structure would be removed. The Bascule Bridge Alternative would have the greatest potential to increase the turbidity of the water, due to the larger footprint of the foundations for the lifting mechanism housings and the necessity to drill more support piers. The Rehabilitation Alternative would be similar, because the replacement footprint is practically the same as for the Bascule Alternative. The sediment disturbance potential of the Mid-Level and High-Level Fixed-Span Bridge Alternatives would be similar to each other and less than the Rehabilitation and Bascule Alternative.

Concrete work in the waterway would also be a potential water quality concern, as the waterway currently exceeds state water quality standards for pH. The amount of time that the water is exposed to the curing concrete would be limited. Spill control measures would be used to minimize the release of petroleum, paint, concrete, and other potentially toxic materials during the construction over and near the river.

To minimize impacts associated with stormwater runoff during construction on-land, temporary erosion and sedimentation control (TESC) measures would be employed.

Waterway - Floodplain

The Duwamish Waterway at the South Park Bridge is within a federally designated and locally regulated floodway. The requirements for a floodway state that proposed projects cannot result in an increase in the water surface elevation of the river for the 100-year peak flow rate. The Army Corps of Engineer's River Analysis System (HEC-RAS, Version 3.0) was used to evaluate floodway conveyance impacts associated with each alternative. A model was developed of the reach of the Duwamish Waterway encompassing the project site and upstream and downstream adjacent cross-sections. The water surface elevation of the 100-year peak flow rate in the Duwamish Waterway was calculated for both pre-project and post-project conditions for each of the alternatives.

The Bascule Bridge alternative would result in a slightly higher water surface elevation (0.01 foot) for the 100-year peak flow rate. The remaining alternatives would result in a slightly lower water surface elevation. Because the Duwamish Waterway is a zero rise

floodway, mitigation would be required for the Bascule Bridge alternative. Mitigation measures that may be appropriate include widening the floodway width at the bridge by moving the levees back or reconfiguring the piers so that they perform better hydraulically.

Waterway – Channel Stability

The bridge hydraulics and channel stability were also evaluated for potential impacts to channel stability. Flow velocities and shear stresses were calculated using the HEC-RAS model under several hydraulic conditions for each proposed alternative.

Due to the relatively low velocities and shear stresses in the waterway under each of the alternatives, it is unlikely that the piers would need to be armored with rip rap. In addition, it is likely that integrated streambank stabilization procedures that consider structural as well as habitat features would suffice for the protection of the levees. However, a more detailed scour and stream stability analysis should be conducted during the design phase to ensure that the bridge geometry does not result in instability in the waterway.

Given that the channel substrate is comprised primarily of finer materials with some cohesion, it is possible that flow conditions would occur that would lead to erosion. Due to the location of the bridge in the intertidal zone and the regulation of flows in the waterway by the Howard Hanson Dam, it is likely that sedimentation would occur as well. The channel bottom likely would shift periodically, depending on the tides and flow rates. It is not anticipated that additional dredging would be required by the Army Corps of Engineers for any of the alternatives.

Groundwater

The project construction and operation would not have any impacts to a sole source aquifer, aquifer flow direction, recharge area or rate, or water supply recharge area. Potential water quality impacts to groundwater would be primarily limited to spills of hazardous material. The identification and/or handling of hazardous materials, including potentially contaminated sediment, is discussed in the Hazardous Materials Technical Report.

Alternative Comparison

Table 1 ranks the alternatives based on the anticipated impacts of each alternative. The table is intended to show the relative impacts of the alternatives and not absolute significance or degree of difference.

Table 1. Bridge Alternative Impacts Comparison

Impact[a]	No Action	Rehabilitation	Bascule	Mid-Level Fixed Span	High-Level Fixed Span
Stormwater Quantity	-	0	0	0	0
Water Quality (in river)	-	0	+	+	+
Construction (Sediment Loading)	+	++	++	+	+
Channel Stability (Bridge Scour)	- -	0	-	-	-
Floodway Conveyance	-	0	0	0	0

[a] Assuming project meets mitigation requirements

- = Slight reduction of impact

- - = Significant reduction of impact

0 = No Change

+ = Slight increase in impact

++ = Significant increase in impact

Chapter 2 Introduction

Chapter 2 is an introduction to the technical analysis contained in this technical report. This chapter describes existing conditions, the history of the project, the purpose and need for the project, and the five project alternatives being considered for environmental review. In addition, this chapter summarizes project coordination conducted to date with agencies, local governments, the community advisory group, and members of the public.

2.1 Description of Existing Conditions

This first section describes existing conditions pertinent to the proposed South Park Bridge Project. The project area is defined. The existing bridge and its current condition are described. The local roadway network in the South Park community is described. Non-vehicular transportation in the community is also summarized.

2.1.1 The Project Area

The South Park community is about four miles south of downtown Seattle (see Figure 1). The community lies south of the Duwamish Waterway, the man-made channel portion of the Duwamish River as it enters Elliott Bay. Though originally incorporated as its own city in 1905, much of the area was annexed by the City of Seattle in 1907.[1] The project area lies south of the industrial Georgetown area of Seattle and the King County International Airport (known as Boeing Field). It encompasses the roadway corridor defined by 16th Avenue S. between East Marginal Way S. and the South Park Bridge and 14th Avenue S. between the bridge and S. Trenton Street. Residents and business owners in the project area generally identify with the City of Seattle.

The project area, however, is governed by three local government jurisdictions. The area north of the Duwamish Waterway (between East Marginal Way S. and the waterway) lies within the city limits of both the City of Seattle (northern portion) and the City of Tukwila (southern portion). The area south of the Duwamish Waterway (between the waterway and S. Trenton Street) lies within unincorporated King County and the City of Seattle. The two-block area between the riverbank and Dallas Avenue S. is in King County, and the city blocks to the south are in the City of Seattle.

Land uses in the project area are mixed residential, retail commercial, and industrial. The Boeing Company's Plant 2 dominates the north side of the Duwamish Waterway. On the south side, retail commercial and light industrial land uses front on 14th Avenue S. and along the south bank upstream of the South Park Bridge. Single-family residences, however, generally characterize the area off of this main transportation artery.

2.1.2 The Existing South Park Bridge

The South Park Bridge was constructed in 1929-1931 (Figure 2). The existing structure consists of a Scherzer rolling-lift double-leaf bascule movable span. Because it is the only operational example of a Scherzer rolling-lift bascule bridge in Washington, the bridge is listed on the National Historic Register.[2]

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[1] City of Seattle, South Park Residential Urban Village Plan, 1998.

[2] King County Landmarks and Heritage Commission. *Findings and Fact Decision – 14th Avenue South Bridge*, decision made December 19, 1996 and filed January 2, 1997.

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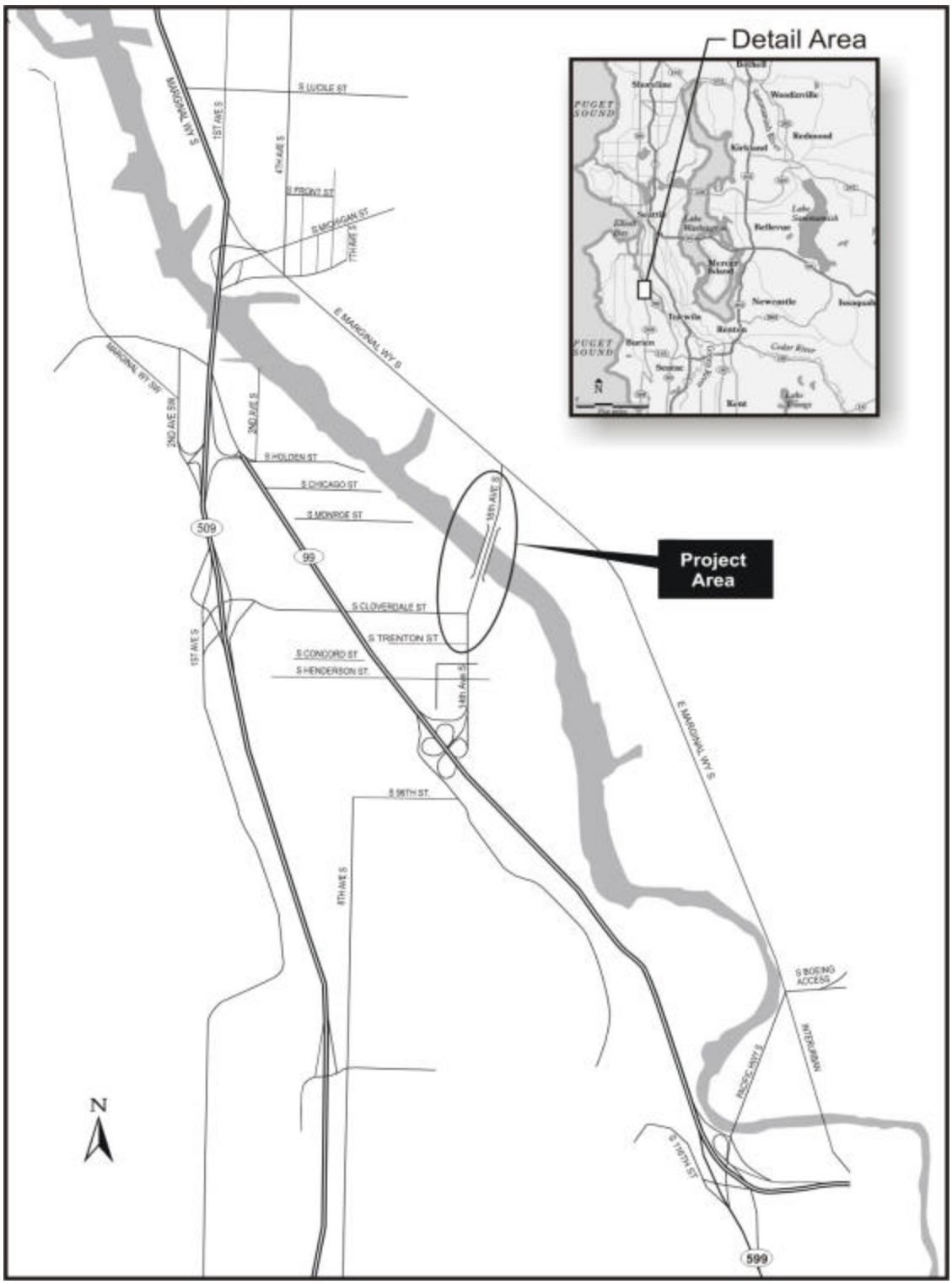

Figure 1.
Project Area and Vicinity

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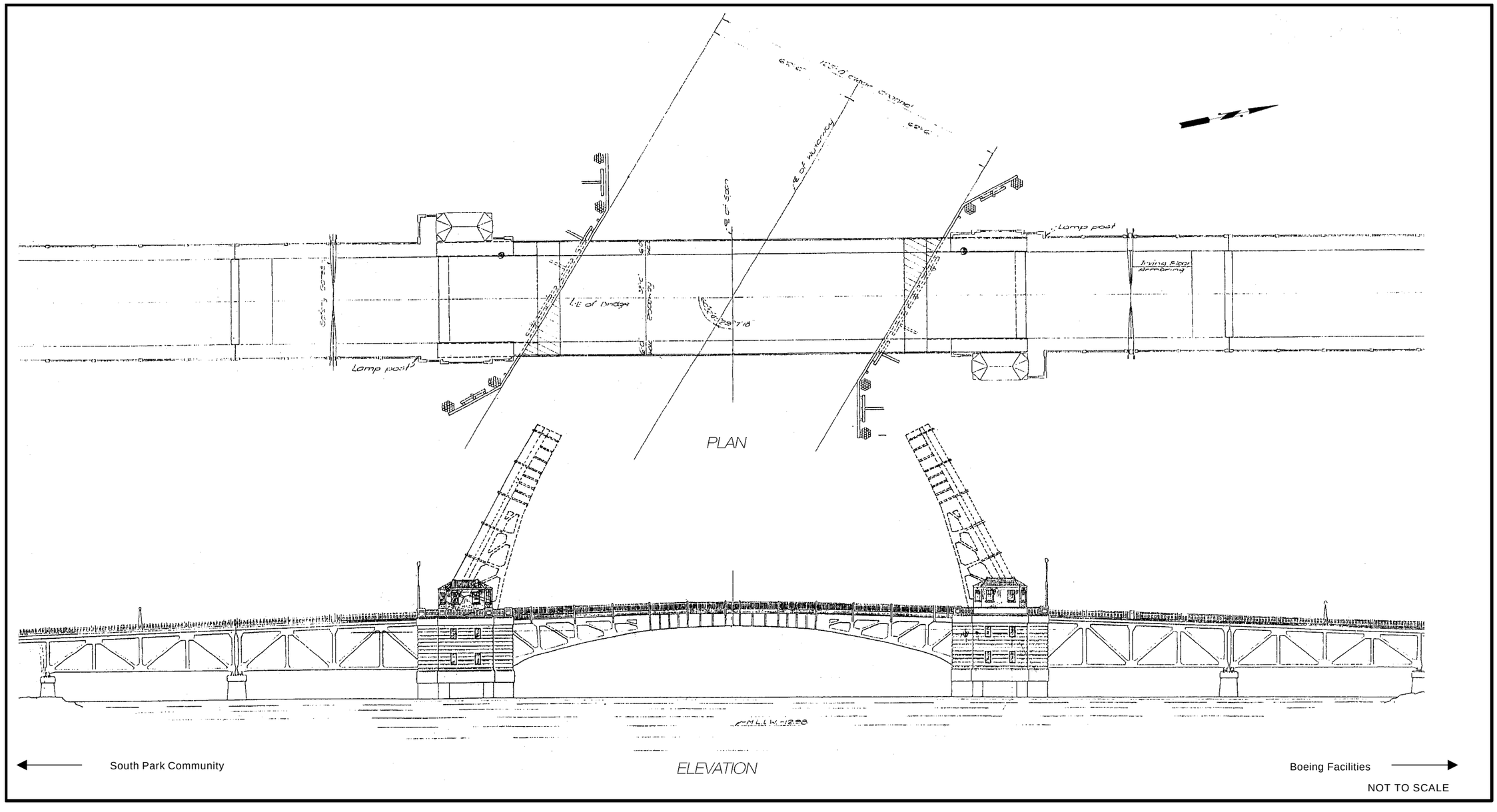

Figure 2.
Existing South Park Bridge

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Each side is flanked by two truss approach spans and twelve concrete slab approach spans. The overall length of the bridge is approximately 1,045 feet abutment-to-abutment and approximately 1,340 feet in entirety to the grade match points. The double-leaf bascule movable span has a center-to-center distance between the front bearing points of approximately 190 feet. The roadway consists of four 9.5-foot lanes. The pavement is 38 feet with 6-foot sidewalks on both sides. Reinforced concrete piers founded on timber piling support the bascule span. Two large in-water piers support the counterweights, track supports, and racks for the rolling lift. The attached towers house the operating machinery, electrical equipment, and operator control room.

The South Park Bridge spans the Duwamish Waterway, which is used for industrial, commercial, and recreational purposes. The bridge is near the upstream limit of heavy industrial uses along the Duwamish Waterway, but it is within the section of the navigation channel maintained by the U.S. Army Corps of Engineers. The existing maximum vertical clearance of the bridge when closed is approximately 34 feet at Mean High Water (MHW). Bridge openings occur approximately three times per day on average to accommodate waterway traffic, although on some days the bridge does not open at all. The existing navigable horizontal clearances is approximately 118 feet at the water level (fender-to-fender), but narrows to 92 feet approximately 114 feet above the water between the open bascule leaves. The depth of the navigation channel is approximately 15 feet at Mean Lower Low-Water (MLLW).

2.1.3 Bridge Condition

In spite of substantial on-going maintenance and repairs, the South Park Bridge has suffered considerable deterioration over the past 70 years. In particular, the bascule piers are cracked and unstable resulting in the misalignment of the movable spans. Consequently, the center lock and glide tracks require on-going modifications and adjustments to allow the bridge to operate properly. Long-term, the stability of the entire bridge is at risk due to the original shallow placement of the supporting piles, which has resulted in movement of the bridge piers over the decades. The condition of the bridge worsened significantly following the Nisqually Earthquake in February 2001, and it remains vulnerable to future seismic events. A 2002 bridge inspection conducted by King County resulted in an existing condition rating of 6.0 out of a possible score of 100 (based on Federal Highway Administration criteria).[3] This was among the lowest ratings given any bridge structure in the State of Washington in 2002.

2.1.4 Roadway Network

The bridge presently accommodates an average daily traffic volume of approximately 20,000 vehicles per day, based on 2001 City of Seattle traffic counts. Many of the vehicle trips originate in residential neighborhoods in the communities of West Seattle, White Center, and SeaTac. For South Park community residents, the bridge is the primary direct means of access to the north, downtown Seattle, and I-5.

[3] King County, *Bridge Inspection Report*, August 1, 2002.

The existing roadway network surrounding the South Park Bridge consists of a variety of roadway types. They range from local two-lane streets to major limited-access highways. Regional traffic movement in the South Park area is concentrated to three nearby north-south corridors including SR-99, SR-509, and East Marginal Way S. Local circulation is provided through a system of local and collector streets. Features such as the Duwamish Waterway and large-scale facilities such as Boeing Field and the Boeing Plant 2 create barriers within the road network and limit opportunities for access to and from the major regional routes.

2.1.5 Freight, Transit, and Pedestrians

Freight movement in peripheral areas of the South Park community is significant due to the high concentration of industrial and manufacturing uses in the general area. Major truck traffic is primarily directed along East Marginal Way S. and SR-99. The South Park Bridge and S. Cloverdale Street are also designated truck routes for oversized vehicles. Trucks use S. Cloverdale Street to access the City of Seattle South Recycling and Disposal Station located at 8105 Fifth Avenue S. as well as SR-509 and SR-99 located on the western edge of the South Park community. With respect to rail movements, the only train crossing in the study area exists immediately south of the intersection of East Marginal Way S. and 16th Avenue S.

Bus routes serving the South Park community are primarily located along major north-south corridors, including East Marginal Way S., 14th and 16th Avenues S., and S. Cloverdale Street. Six major King County Metro bus routes serve the area. Routes 60 and 130 cross the South Park Bridge and four of the six bus routes travel along S. Cloverdale Street.

Pedestrians and bicyclists are commonly seen in the South Park area, especially near the community's center near the intersection of 14th Avenue S. and S. Cloverdale Street. Mid-day pedestrian volumes are higher than the morning or evening commute periods due to shopping, transit use, and lunch-related walking trips.

2.2 History of Project

Since 1931, the moveable bridge has crossed the Duwamish Waterway in the South Park community of the City of Seattle. The following sections contain an overview of the studies preceding the start of the current environmental review effort, a summary of two key documents that framed the initial development of project alternatives, and ongoing reports documenting the changing condition of the bridge.

2.2.1 Overview of Studies

In recent history, over 20 engineering studies have been prepared on the South Park Bridge. Starting in 1987, when the bridge was 56-years-old, King County contracted for the preparation of a general engineering investigation report to assess the condition of the bridge. In 1991 and 1993, additional studies were completed including a geotechnical study, foundation design report, and a life-cycle cost analysis. This information led King County to undertake a series of studies in 1994 addressing liquefaction risks as well as

the condition of the concrete, substructures, approach span joints and loading rating. In addition, a study was conducted to evaluate potential replacement alternatives for the bridge and another study investigated community issues related to the bridge. Since 1994, King County has recognized that the bridge required either rehabilitation or replacement and has continued to investigate the condition and vulnerabilities of the bridge in an effort to evaluate these options.

2.2.2 Summary of Key Engineering Reports

Two key engineering studies were conducted that helped to frame the current pursuit to evaluate potential alternatives to rehabilitate or replace the South Park Bridge. A 1994 Sverdrup study evaluated potential design options and a 1999 Entranco study researched and presented the likely steps required to conduct the necessary environmental review of the project alternatives and to complete necessary permitting. These studies are summarized below.

2.2.2.1 Sverdrup Study

In November 1994, Sverdrup Civil, Inc. completed a report titled *14th/16th Avenue South Park Bridge Rehabilitation/Replacement – Design Report* for the King County Department of Public Works. The objective of that report was to evaluate alternative alignments and bridge types, impacts of the alternatives studied and to present to King County results, findings, conclusions, and recommendations of a preferred replacement bridge for the existing South Park Bridge.

The 1994 design report studied five alternatives: rehabilitation of the existing bridge; two fixed-span bridge replacements (a 100-foot vertical clearance bridge and a 60-foot vertical clearance bridge); a new moveable bridge (double-leaf bascule bridge); and bridge closure (permanent closure and demolition of the existing bridge). Other alternatives that had been evaluated but were not carried forward, according to this report: locating the replacement bridge immediately east (upstream) of the existing alignment; matching the existing alignment; and locating the northbound and southbound lanes on separate structures. These three alternatives were not considered feasible and thus were not studied further.

The 1994 design report concluded that the 60-foot vertical clearance fixed-span bridge design could be used to replace the existing South Park Bridge, with consideration of mitigation of impacts to some users.

2.2.2.2 Entranco Study

In July 1999, Entranco completed the *16th Avenue S. Bridge Replacement Project: Environmental Review Report* for the King County Department of Transportation. The objective of this report was to present to King County a summary of environmental review and permitting activities that would likely be required for replacing the bridge.

The report identified the proposed project as a replacement of the existing bridge, including improvements to the approach road – 14th Avenue S. to the south and 16th Avenue S. to the north of the Duwamish Waterway. The project limits were identified as

East Marginal Way S. on the north and S. Cloverdale Street on the south. The report asserted three build alternatives should be selected for evaluation in the EIS, including alternatives with differing alignments and bridge types. It was further noted that three alternatives would be the least number needed to provide a reasonable range of alternatives under National Environmental Policy Act (NEPA) and Washington State Environmental Policy Act (SEPA) regulations.

Entranco outlined the various tasks that would be required under the WSDOT Environmental Procedures Manual and Federal Highway Administration (FHWA) guidelines. The report identified these tasks to include the following: the development of bridge alternatives, screening, and selection of alternatives for analysis in the EIS; preliminary engineering design, including an update to the1994 rehabilitation/replacement report; survey and mapping work; hydraulic and geotechnical studies, and conceptual-level design documentation. The report concluded that the alternatives proposed, including rehabilitation of the existing bridge, had not been designed in enough detail to make a decision regarding a preferred alternative. Related to the environmental review process, the report recommended the public involvement program include coordination with an Interdisciplinary Team (IDT) of agency representatives and a community advisory committee. The report also listed 17 specific environmental technical reports that would likely be required for the preparation of the EIS.

The findings and recommendations presented in the Entranco report formed the basis from which King County staff developed the current contracted scope of work for environmental review. The scope includes engineering, environmental review, agency coordination, and public involvement tasks.

2.2.3 Continuing Deterioration

Since 1999, King County has continued to move forward to develop alternatives for rehabilitating or replacing the existing South Park Bridge. Bridge conditions have worsened since the engineering studies were conducted in the mid-1990s. In February 2001, the Puget Sound Nisqually Earthquake caused significant and widespread damage to the bridge. Over $740,000 was required to repair the bridge in order to keep it operational.[4] The King County 2001 bridge inspection report recorded a rating of 8.0 out of a total possible score of 100 (based on FHWA criteria).[5] The following year, this rating decreased to 6.0.[6]

2.3 Purpose and Need of Project

As a required element of the EIS, a Purpose and Need Statement was developed for the South Park Bridge Project to clarify the underlying basis for the proposed action. The development of the initial draft Purpose and Need Statement involved review and

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[4] Tim Lane, King County Department of Transportation, Telephone Conversation, September 23, 2002.

[5] King County, *Bridge Inspection Report*, August 21, 2001.

[6] King County, *Bridge Inspection Report*, August 1, 2002.

comment by a number of parties including King County staff and the Project Advisory Committee (PAC) that includes agencies with jurisdiction over the proposed project. The draft Purpose and Need Statement was also revised based on comments received at several public involvement events. In April 2002, King County forwarded the draft Purpose and Need Statement to the Federal Highways Administration (FHWA) for review and approval. The text of the FHWA-approved version of the Propose and Need Statement is presented in the following sub-sections, although minor revisions and footnotes have been included for clarification.

2.3.1 Function and Role of the South Park Bridge

The King County Department of Transportation (KCDOT) is proposing the rehabilitation or replacement of the South Park Bridge located in King County, Washington. Since 1931 the moveable span bridge has carried traffic along the 14th Avenue South and 16th Avenue South corridor across the Duwamish Waterway. On a typical workday, a mix of approximately 20,000 cars, trucks and buses use the bridge to access employment centers in downtown Seattle and the Duwamish industrial area. Many of the vehicle trips originate in residential neighborhoods in the communities of West Seattle, White Center, and SeaTac. For residents of the community of South Park, the bridge is the only immediate means of access to and from destinations east of the community. The moveable structure spans the navigation channel of the Duwamish Waterway. When open, large-size industrial and recreational vessels have access to upriver destinations. The South Park Bridge is also a major route for heavy truck traffic traveling to and from large industrial manufacturers including the Boeing Company.

2.3.2 Purpose of Proposed Project

The purpose of the proposed action is to find the most feasible long-term solution to address the deteriorated condition and increasing seismic vulnerability of the South Park Bridge. The proposed action must also maintain the vital transportation linkage for cars, trucks, buses, bicyclists and pedestrians across the Duwamish Waterway.

2.3.3 Need for the Proposed Project

In spite of substantial ongoing maintenance and repairs, the South Park Bridge has suffered substantial deterioration over the past 70 years. Existing problems with the bridge worsened significantly following the Nisqually Earthquake in February 2001 and the bridge remains vulnerable to future seismic events. A recent 2002 bridge inspection conducted by King County resulted in an existing condition rating of 6.0 out of a possible score of 100 (based on FHWA criteria).[7] This is among the lowest ratings given any bridge structure in the State of Washington.

The bridge could be closed as a consequence of excessive structural deterioration or failure of the moveable span operations (particularly in the event of another seismic

[7] The original text of the FHWA-approved Purpose and Need Statement cited the condition rating of 8.0 from the 2001 King County Bridge Inspection Report. The current cited condition rating of 6.0 is from the King County *Bridge Inspection Report* dated August 1, 2002.

event). Closure of the bridge would have a significant impact on the transportation system and traffic conditions throughout the lower Duwamish industrial area-- including SR-99, SR-509, First Avenue S. and East Marginal Way S. Improvements are required in the near future to protect public safety and to maintain a transportation corridor that is critical to the local and regional economy.

2.3.3.1 Seismic Vulnerability

The February 28, 2001 Nisqually earthquake (magnitude 6.8, located 35 miles from Seattle and deep below the surface) caused significant damage to the South Park Bridge. Since the earthquake, operation of the moveable span has been less reliable, requiring the bridge to be closed for repairs intermittently for several days. The continuing periodic closure of the bridge for repairs has heightened the awareness of the need for rehabilitation or replacement of the existing bridge.

2.3.3.2 Roadway Design Deficiencies

The South Park Bridge does not meet current roadway design standards and has many design deficiencies. For example, the overall bridge width including lane widths, shoulders and sidewalks should be 64 feet according to current design standards. The existing bridge width is currently only 52 feet (measured outside-to-outside).

2.3.3.3 Transportation Issues

An average of 20,000 daily vehicle trips cross the Duwamish Waterway on the South Park Bridge. It is a significant link between the east and west side of the Duwamish, both locally and regionally. The South Park Bridge is also a route for heavy and oversize truck traffic. According to previous studies, closure of the bridge would have a significant noticeable impact on the transportation system and traffic conditions throughout the lower Duwamish industrial area – including the Highway 99 and East Marginal Way S. corridors.

2.3.4 Key Issues

2.3.4.1 Community Impacts

The existing South Park Bridge is a highly valued feature of the South Park community. There is widespread concern in the community that changes to the bridge could have a significant adverse impact on the community and the emerging economic vitality of the South Park business district centered along 14th Avenue South. The *South Park Residential Urban Village Plan of 1998* (the neighborhood plan) identified one of its primary objectives as "finding a solution for the South Park Bridge that is sensitive to the needs of the community."

The South Park community is also ethnically diverse. Approximately 30 percent of the populations' primary language is not English. These factors require greater emphasis on

the consideration of environmental justice[8] in order to ensure that the potential adverse effects from the proposed project do not have a disproportionate impact on lower-income or minority populations.

2.3.4.2 Aquatic Habitat Protection

The Duwamish Waterway is an important route for juvenile and adult salmon migrating between the upper Green River, Elliott Bay and the Pacific Ocean. However, much of the waterway in the vicinity of the South Park Bridge currently provides poor habitat for chinook salmon (listed as threatened under the Endangered Species Act) and other marine organisms. The armored shoreline along the waterway in the project area provides minimal habitat for young chinook salmon during their critical rearing period. Recovery plans now underway for threatened and endangered salmon will address potential means of enhancing habitat favorable to the survival and growth of young salmon from the Duwamish/Green River system. Restoration of the shoreline in the vicinity of the project would address immediate and long-term needs for habitat improvement along the Duwamish Waterway.[9]

2.3.4.3 Duwamish Waterway Navigation

The Duwamish Waterway is used for industrial, commercial and recreational purposes. The South Park Bridge is near the upstream limit of heavy industrial uses along the waterway, but it is within the section of the waterway maintained by the U.S. Army Corps of Engineers as a navigation channel. A number of local businesses, as well as the U.S. Coast Guard, have emphasized to King County that any engineering solutions for the South Park Bridge must maintain navigational access upstream of the existing bridge.

2.4 Description of Alternatives

This section describes the No Action Alternative, the Rehabilitation Alternative, and the three replacement bridge alternatives (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives). The first section explains the transportation engineering criteria and standards used to design the Rehabilitation Alternative and the three replacement bridge alternatives. The second section describes the horizontal and vertical profile of the bridge alternatives, navigation channel clearances, and impacts to the local road network. The last section describes construction activities associated with each of the five alternatives for the South Park Bridge Project.

2.4.1 Design Criteria

Except for the No Action Alternative, construction of any of the project alternatives would incorporate current transportation engineering design criteria for the cross-section, alignment, design speed, maximum grade, and transition segment. The road cross-

[8] Environmental justice concerns the need to avoid disproportionate, significant adverse impact on minority and/or low-income communities.

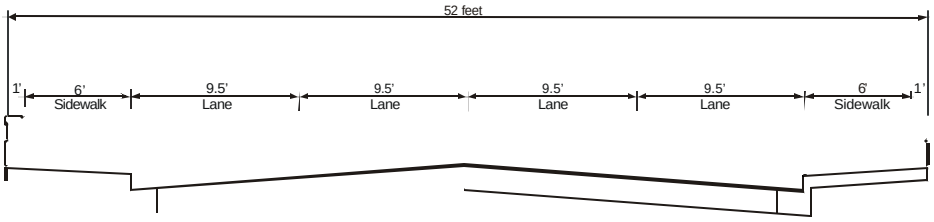
[9] This section highlights the importance of addressing aquatic habitat values in the project area, as well as the implications for species currently listed under the ESA; however, it is not intended as a complete characterization of the factors that need to be considered in this regard.

section design is a key design element that would change for any of the build alternatives (Figure 3). The existing bridge cross-section incorporates four 9.5-foot travel lanes, raised curbs on both sides of the pavement, and a 6-foot sidewalk on either side of the roadway. The outside-to-outside dimension of the existing bridge is 52 feet. These lane widths are non-standard and would be changed for the Rehabilitation Alternative and for the three replacement bridge alternatives. For the Rehabilitation Alternative, the pavement would remain approximately the same width as it is currently, but would be reconfigured for three standard lanes.

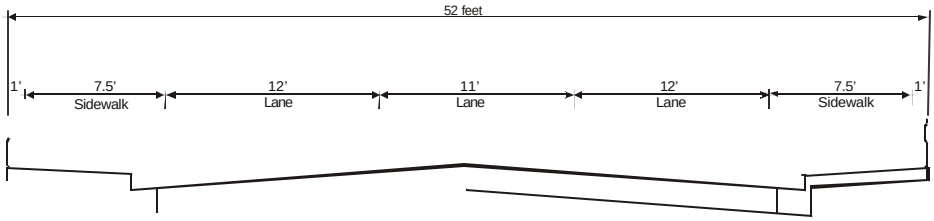
There would be two 12-foot lanes on the outside and one 11-foot lane in the middle of the roadway. Traffic would use one 12-foot lane for northbound travel and the other two lanes for southbound travel. The 6-foot sidewalk on either side of the roadway would be enlarged to approximately 7.5 feet. In contrast, each of the replacement bridge alternatives would be designed with four standard 11-foot lanes, traffic barriers or a painted median down the center, a traffic barrier on each side of the pavement, and a single combined 13-foot pedestrian/bike path on the west (downstream) side of the bridge. The width of the cross-section for the new replacement bridge alternatives including the exterior barriers would total approximately 68 feet (outside-to-outside of the bridge structure).

An initial range of potential bridge alternatives and alignments was considered based on earlier studies,[10] current input from stakeholders, and the project team. During the course of this initial alternatives development process, it was determined that there were no practical alternative alignments for a replacement bridge other than to parallel the existing bridge. It was determined that replacement bridge alternatives should be aligned to the west (downstream) of the existing bridge in order to minimize impacts to existing land uses. Conceptual engineering for the replacement bridge alternatives set the alignment for these bridges at approximately 80 feet to the west of the centerline of the existing bridge (i.e., as close to the existing structure as practicable without compromising constructability). The initial alignment of the new roadway was the same as the existing road alignment on the south side of the waterway. The existing roadway is quite narrow. Matching the centerline of the new bridge alternatives to the existing would require acquisition of both land and buildings on both sides of 14th Avenue S. To minimize these impacts, the alignment of the new transition segment was shifted slightly to the east of the existing road alignment because there are fewer parcels and buildings located on the east side of the road compared to the west. In addition, more of the buildings located on the east side are set back from the existing sidewalk than on the west side. In this way, the proposed alignment for the replacement alternatives has been developed to avoid or minimize potential land use and relocation impacts.

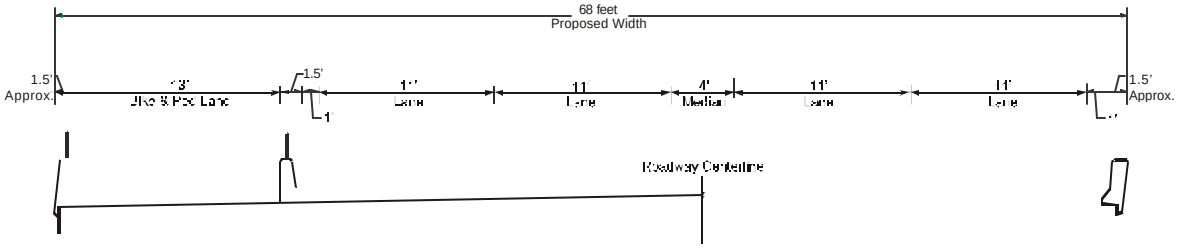
[10] Entranco, Inc., *Environmental Review Report: 16th Avenue S. Bridge Replacement*, July 1999.



Existing Bridge



Rehabilitation Alternative



Bridge Replacement Alternatives

Not to Scale

Figure 3.
Existing and Proposed Bridge Cross-Section Designs

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Other design factors affecting impacts to adjacent properties include the new bridge's design speed and maximum grade. King County road standards call for a 35 mph design speed and a maximum of 8 percent grade. Initially, these standards were incorporated into each of the alternatives. Implementation of an 8 percent maximum grade for the High-Level Fixed-Span Bridge Alternative, however, would have resulted in a very long bridge (project terminus to terminus). For example, the north terminus would have extended across East Marginal Way S. and into Boeing Field. To reduce impacts to land use, the maximum grade for the High-Level Fixed-Span Bridge Alternative would need to slightly exceed 8 percent. In this manner, the north side of the bridge would terminate south of East Marginal Way S. This grade change reduced the overall length of the bridge on both south and north ends of the bridge by several hundred feet for the High-Level Fixed-Span Alternative.

Community impacts would also be affected depending on the design of the transition segment. This is the segment of the roadway that merges the differing widths of the new roadway and the existing narrow roadway. Typically, transition segments begin at the point the grade of the bridge matches the grade of the existing roadway and extends beyond some distance. The actual rate at which the width of the roadway is reduced is defined by transportation engineering design standards. To minimize impacts to land uses along 14th Avenue S., King County proposes to start the transition segment from the abutment for all alternatives. This means that by the time the bridge matches the grade of the existing roadway, the width of the new bridge is nearly the same width as the existing road. As a result, the total length of the roadway is reduced potentially several hundred feet in length. In addition, the width of the transition segment for the Mid-Level Fixed-Span Alternative is further reduced by having the single combined 13-foot pedestrian/bike path split off from the main bridge structure at approximately S. Orr Street and descended to ground level in a zigzag fashion. This design modification further reduced the overall impact of the Mid-Level Fixed-Span Alternative.

Together, the design criteria discussed in this section would allow for the construction of a replacement bridge that provides increased safety for vehicles, bicyclists, and pedestrians.

2.4.2 The Alternatives

A total of five alternatives were selected for evaluation in the environmental review process including: the No Action Alternative, the Rehabilitation Alternative, the Bascule Bridge Alternative, the Mid-Level Fixed-Span Bridge Alternative, and the High-Level Fixed-Span Bridge Alternative. These alternatives were selected from an initial group of nine preliminary project alternatives.[11] The alternatives proposed for evaluation in the environmental review process were selected because they had fewer potential impacts than the other preliminary alternatives. Based on comparison ratings for seven evaluation criteria (regional mobility, local access, navigation, community impacts, aquatic habitat, construction impacts, and estimated project costs), the following preliminary alternatives were dropped from further consideration: a low-level fixed-span bridge, a movable

[11] Parsons Brinckerhoff. *South Park Bridge Project: Summary Technical Memo - Alternatives Development and Screening*, September 6, 2002.

swing bridge, a vertical lift movable bridge, and a tunnel option. The following sections describe each of the proposed project alternatives to be considered in the environmental review process based on conceptual civil and structural engineering.[12] [13]

2.4.2.1 No Action Alternative

The No Action Alternative assumes that the existing bridge structure's poor condition would require it to be closed at some time in the future. Deterioration due to use could allow the bridge to continue to operate for the foreseeable future, but at some time in the future, the bridge would need to be closed. As such, for purposes of environmental review, it is assumed the existing bridge would be closed permanently sometime before 2027.

However, the bridge could be closed for other reasons than simply deteriorated condition. Another earthquake could cause an unexpected emergency closure of the bridge at any time. The on-going movement of the bridge foundations could eventually cause the moveable spans to become misaligned to the extent that repairs would be infeasible. Or, the cost of maintaining the bridge could become more than King County is willing to expend. Under any of these circumstances, the bridge would be closed.

When closed, no vehicular, bicycle, or pedestrian traffic would be allowed to use the bridge. As a navigable waterway, the U.S. Coast Guard regulates bridges that span waterways such as the Duwamish Waterway. If the bridge were no longer operating, the U.S. Coast Guard regulations would require demolition and removal of the bridge. With no structures remaining, there would be no potential navigation obstructions in the Duwamish Waterway.

Under this alternative, there would be no change in the local street network except 14th and 16th Avenue S. would be dead-ended on both the south and north shores of the Duwamish Waterway. Figure 4 shows the existing local street network and Figure 5 shows the local street network following the removal of the existing bridge in the No Action Alternative. As the road does not currently provide direct access to the adjacent Boeing Company properties, the exact location of the road closure on the north side would need to be negotiated with Boeing as well as the owner of the railroad tracks immediately south of East Marginal Way S. In addition, the site of the removed bridge would be restored.

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[12] Parsons Brinckerhoff. *South Park Bridge Project: Conceptual Plans*, June 2003.

[13] Parsons Brinckerhoff. *South Park Bridge Project: Structural Alternatives Study*, November 2003.

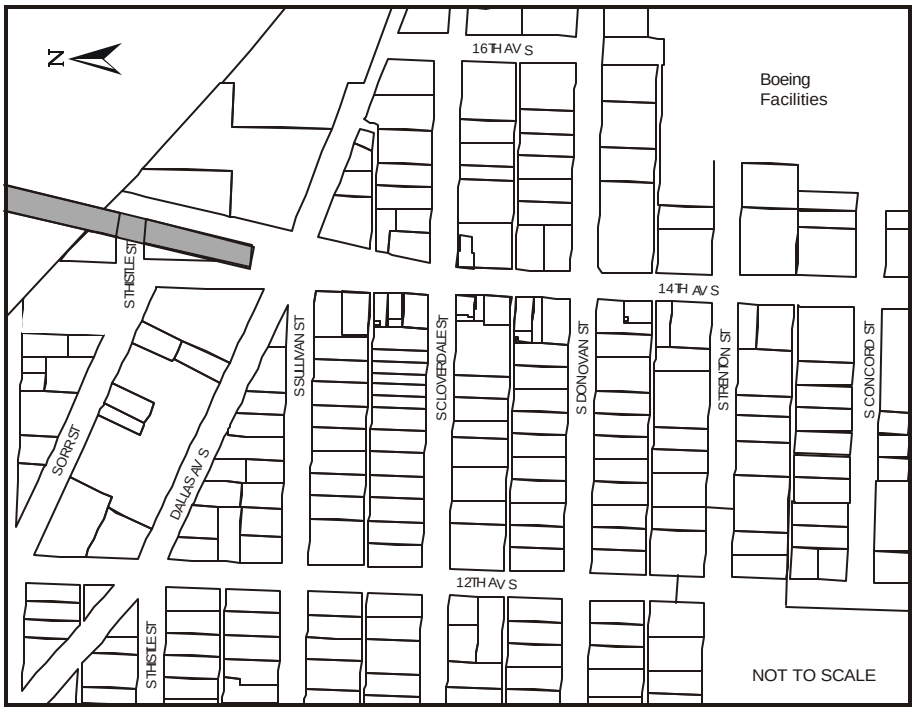

Figure 4.
Existing Conditions Street Network

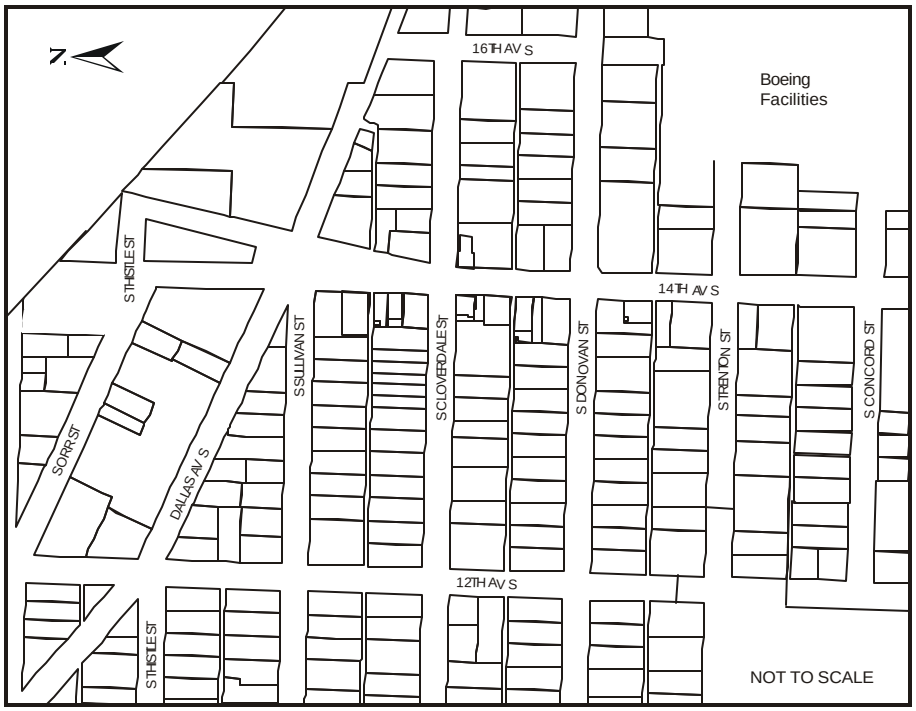

Figure 5.
No Action Alternative Street Network

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2.4.2.2 Rehabilitation Alternative

For the Rehabilitation Alternative, much of the existing bridge structure would need to be replaced. The existing steel trusses of the approach spans and the bascule leaves would be refurbished and reused. The mechanical and electrical operating systems would be refurbished and/or replaced. Studies have confirmed the existing bridge piers are gradually shifting because the foundation pilings were not originally driven to a sufficient depth. Although the initial goal was to rehabilitate the existing piers, the design team's structural analyses determined that the existing bascule piers and truss approach span piers must be replaced in order to ensure the long-term (approximately 75 years) integrity of the bridge. If the bascule piers were reconstructed, the longevity of the Rehabilitation Alternative would be similar to the expected minimum life of a new bridge structure.

For the Rehabilitation Alternative, the new bascule piers are proposed to be approximately the same size, location, and historic character as the existing piers (Figure 6). To construct the new bascule piers, the bascule leaves and steel approach spans would need to be removed. The steel truss elements of the bridge structure would be taken to another site for repair, refurbishment, and/or painting before they are re-installed following the construction of the new piers. The concrete shafts or pilings supporting the foundations of the new piers would extend below the existing pilings to a depth beneath the riverbed where stable soils exist. The removal of the steel truss spans would also allow for replacement of the steel approach piers. The concrete approach spans and bridge abutments would be replaced and the bridge deck would be reconstructed. Like the existing bridge, there would be piers both on land and in the water. The first on-land piers would be only an estimated 20 feet from the top of the south embankment and the closest in-water piers would be approximately 20 feet from the top of the embankment. The piers on the north shoreline would extend through the existing Boeing dock. The conceptual engineering analysis also determined that the mechanical and electrical systems should be replaced. Any required construction activities, including replacement of the bridge railings, bridge tender towers, and lamp posts, would be done in a manner that preserves the historic character of the existing bridge to the greatest extent possible.

To meet current roadway design standards, the new bridge deck would remain approximately the same as the existing, but the pavement would be striped to accommodate three standard traffic lanes. Bicycle and pedestrian traffic would continue to be able to use the bridge via a 7.5-foot pedestrian path on each side of the bridge.

Following construction, the existing 118-foot navigable channel width would be preserved so existing waterway users would be able to continue to use the navigation channel to travel upriver of the South Park Bridge. The extended closure of the bridge during construction, however, would have a significant temporary impact on access to the South Park community.

Following construction, there would be only slight changes in the local street network. Figure 7 shows the local street network in the South Park community following construction activities for the rehabilitation of the existing bridge. The figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. (For comparison, Figure 8 shows the local street network following the

construction of the Bascule Bridge Alternative.) To improve vehicular safety, S. Sullivan Street would intersect Dallas Avenue S., which would become the main cross street intersection with 14th Avenue S. The 16th Avenue S. (immediately east of the bridge) intersection with Dallas Avenue S. as well as 14th Avenue S. may also need to be reconfigured. Access to points north via the South Park Bridge would be maintained.

2.4.2.3 Bascule Bridge Alternative

The Bascule Bridge Alternative would result in the construction of a new movable bridge immediately downriver of the existing bridge (Figure 9). The bridge mechanism could be a Scherzer rolling lift type (no longer a common design for new movable bridges) or another type. The bridge length would be approximately 935 feet from abutment-to-abutment, not including roadway approaches. Road improvements would extend from a point just north of S. Cloverdale Street on the south side of the waterway and north to a point opposite the northeast corner of Boeing Building 2-15. The interior walls of the bridge abutments would be approximately 200 feet from the top of the embankment, or approximately 50 feet closer to the shore than the existing bridge. With fewer piers than the existing bridge, the first on-land piers of this alternative would be approximately 55 feet from the top of the south embankment at the shortest distance and the closest in-water piers would be approximately 65 feet away. On the north shoreline, the closest in-water piers would be approximately 95 feet from the top of the embankment and the closest on-land piers would be approximately 30 feet away. Unlike the existing bridge's grated bascule leaves, the bridge deck of the bascule leaves would be solid surface to improve vehicle traction and to control stormwater runoff.

Similar to the existing bascule bridge, this bridge profile would be approximately 34 feet above the Duwamish Waterway when in the closed position. The mid-section span would be comprised of two movable leaves that could be raised to open the bridge. The navigation channel would be approximately 125 feet in width (slightly greater than the existing 118-foot-wide channel). This two-leaf bascule bridge would not impose limitations to the height of waterway users passing the bridge, because the new bridge would be approximately 125 feet between the tips of the raised spans.

Following construction, there would be some change in the local street network (see Figure 8). S. Sullivan Street would be permanently closed or reconfigured to improve traffic safety and vehicular and truck turning movements from the new bascule bridge to Dallas Avenue S. S. Sullivan Street would no longer have direct access to 14th Avenue S. and the bridge. The intersection of 16th Avenue S. (immediately east of the bridge) and Dallas Avenue S. may also need to be reconfigured. To ensure adequate vertical clearance for vehicles, S. Thistle Street would need to be slightly realigned further to the north and closer to the Duwamish Waterway. This figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. Access to points north via the South Park Bridge would be maintained. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

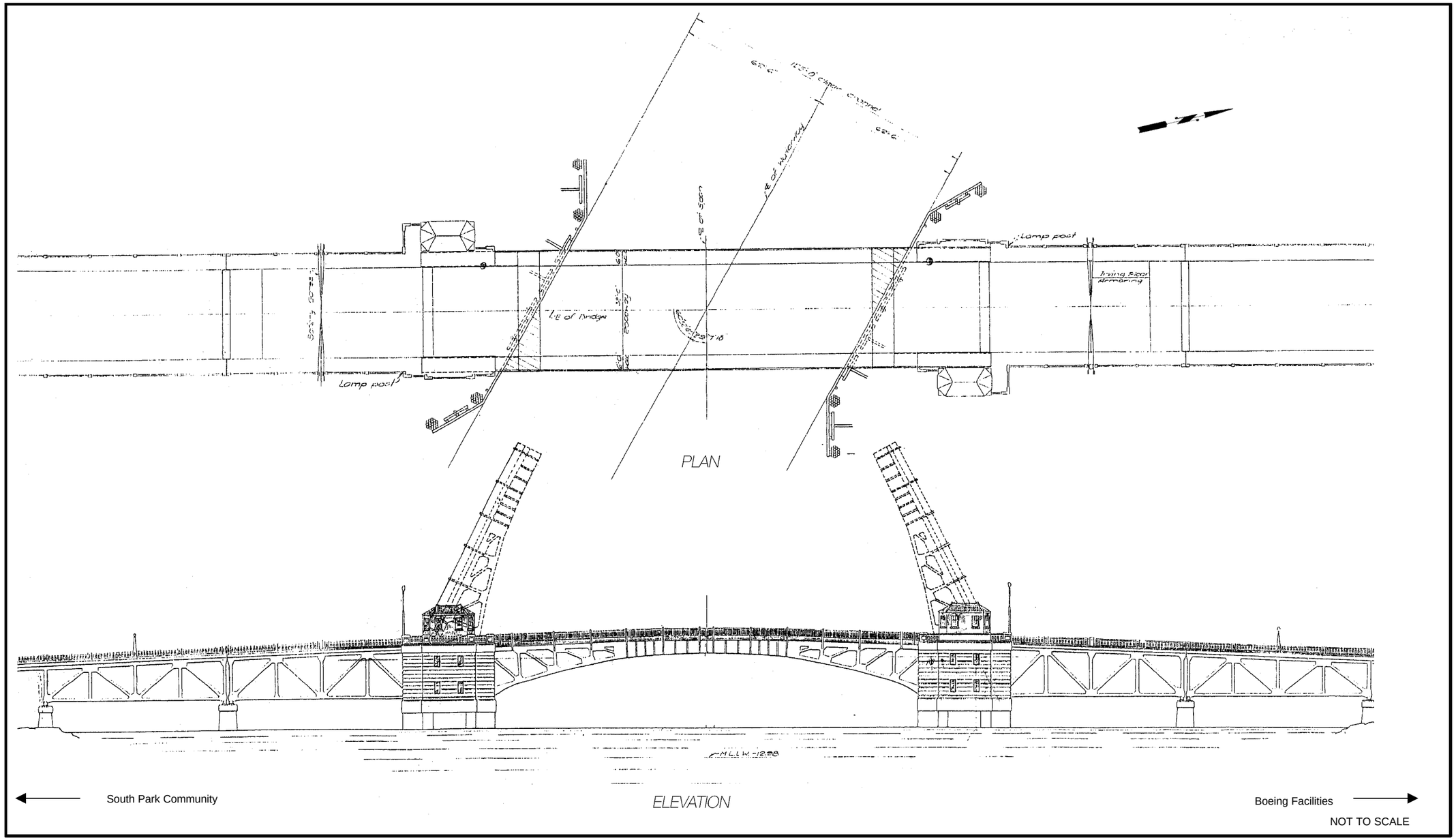

Figure 6.
Rehabilitation Alternative

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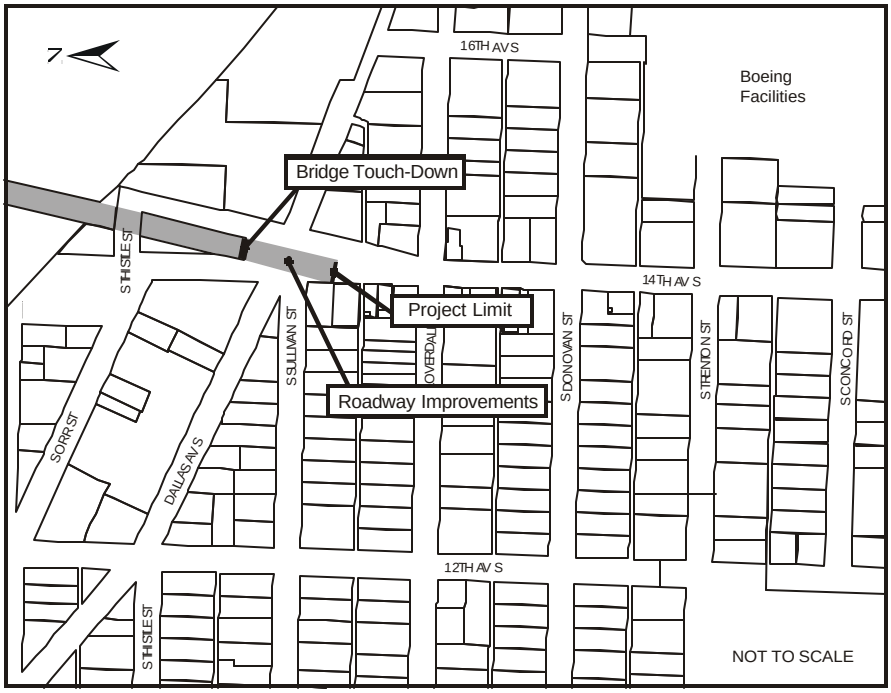

Figure 7.
Rehabilitation Alternative Street Network

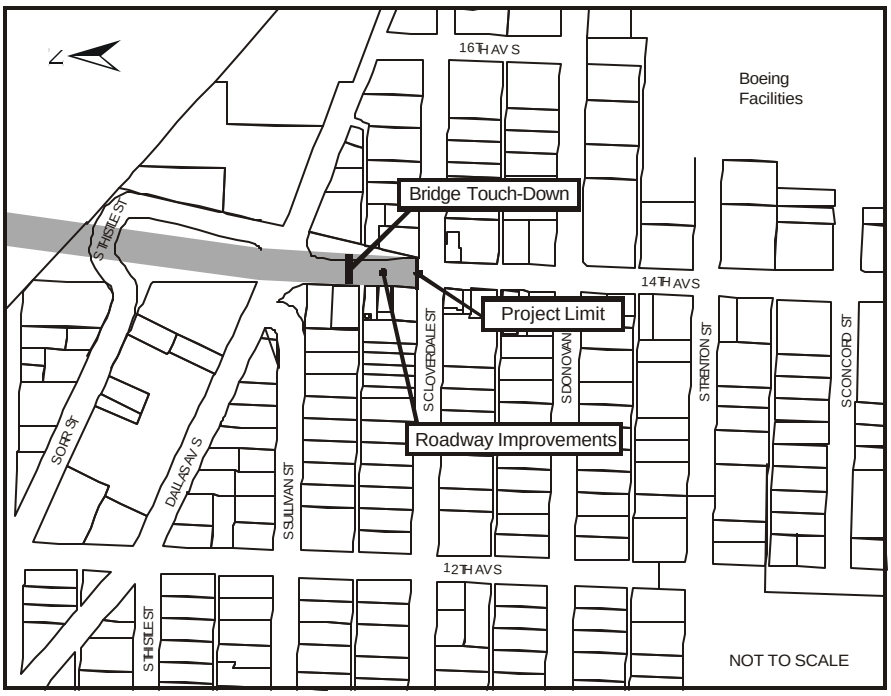

Figure 8.
Bascule Bridge Alternative Street Network

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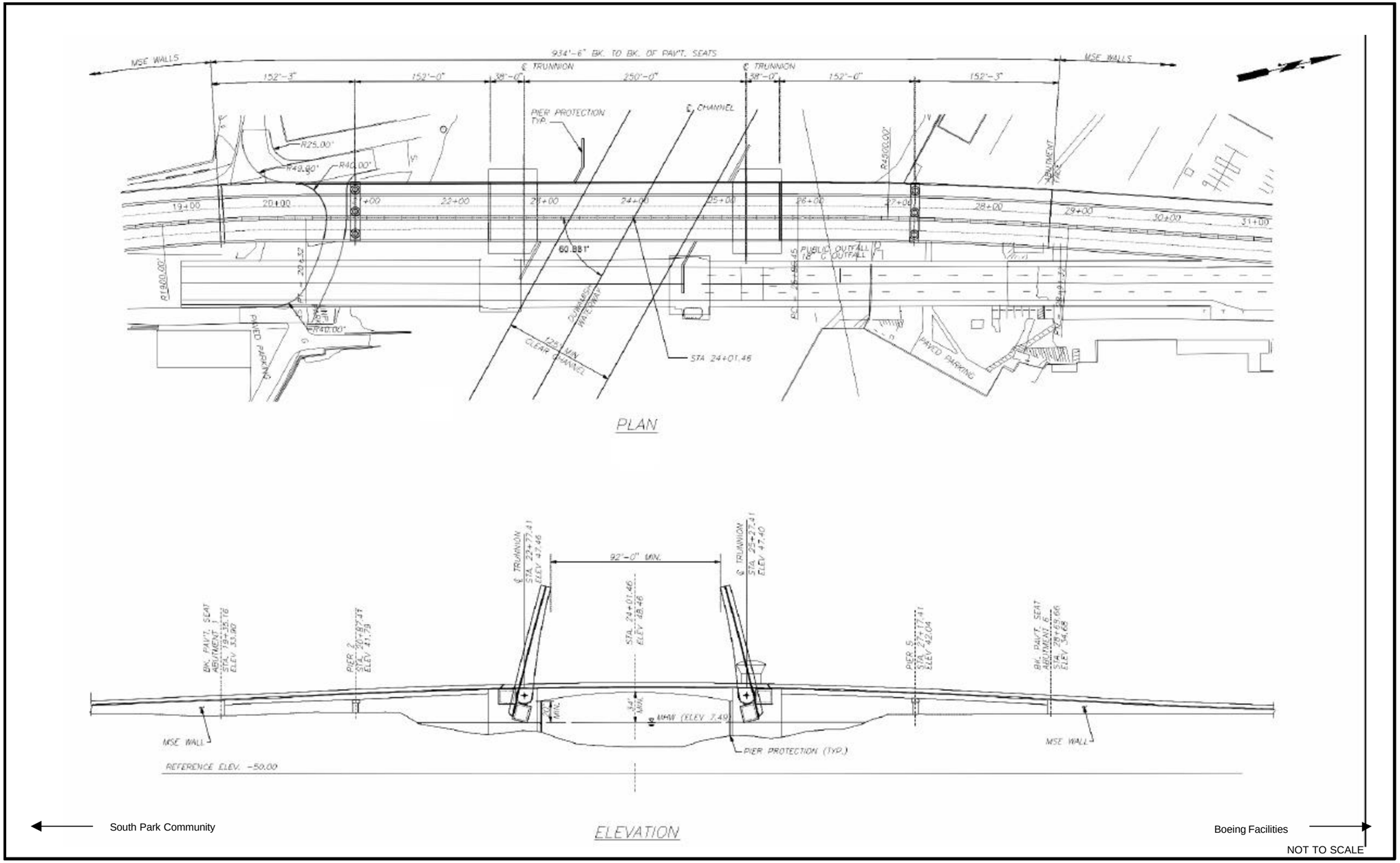

Figure 9.
Bascule Bridge Alternative

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2.4.2.4 Mid-Level Fixed-Span Bridge Alternative

The Mid-Level Fixed-Span Bridge Alternative would result in the construction of a non-movable bridge (see Figure 10). The bridge length would be approximately 1,660 feet abutment-to-abutment, not including roadway approaches. The interior walls of the abutments would be approximately 550 feet from the top of the Duwamish Waterway embankment, or 300 feet further setback than the existing bridge. The closest on-land piers would be approximately 85 feet from the south embankment and the closest in-water piers would be approximately 100 feet away. On the north side, the closest in-water piers would be approximately 130 feet from the top of the embankment and the closest on-land piers would be approximately 65 feet away. Road improvements would extend slightly north of S. Donovan Street and north to a point approximately 320 feet south of East Marginal Way S.

The mid-point of the bridge profile across the Duwamish Waterway would be approximately 65 feet above MHW of the Duwamish Waterway. The horizontal clearance would be approximately 125 feet, or slightly greater than the existing clearance. The vertical clearance, however, would restrict use of some waterway traffic, including some tugs and barges. Most vessels that currently pass the existing bridge would continue to be able to use the navigation channel. As described earlier in the discussion of the design considerations, the width of the new mid-level bridge is reduced when the bike-pedestrian path is separated from the elevated approach roadway near the south side abutment. This design feature reduces land use and relocation impacts.

Following construction, there would be changes in the local street network (see Figure 11). (For comparison, Figure 12 shows the local street network following the construction of the High-Level Fixed-Span Bridge Alternative.) The location of the south abutment and its vertical clearance would require modification of Dallas Avenue S. and S. Sullivan Street. S. Sullivan Street would likely be merged into Dallas Avenue S. just west of the new structure and a new roadway would be constructed under the new bridge. The alignment of this roadway would be slightly to the north to ensure it would have a minimum allowable vertical clearance. Neither street would have direct access to the new South Park Bridge. Figure 11 also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. A retaining wall supporting the elevated approach roadway would be constructed immediately adjacent to properties fronting on the both sides of 14th Avenue S. for the majority of the distance between S. Sullivan Street and S. Cloverdale Street. Traffic would be able to access the bridge at S. Cloverdale Street, which would be raised a maximum of approximately 5 feet at the intersection to meet the descending grade of the bridge. This change in the intersection would allow traffic on S. Cloverdale Street to continue to have direct access to 14th Avenue S. though a retaining wall would also need to be constructed around the four corners of the intersection of S. Cloverdale Street and 14th Avenue S. due to the grade change. S. Orr Street would be closed due to the location of the support structures for the proposed separated pedestrian/bike path, which would allow bicyclists and pedestrians to descend from the bridge level to the street level. In addition, S. Thistle Street would be closed as it would no longer be able to connect to S. Orr Street. Following construction

and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.2.5 High-Level Fixed-Span Bridge Alternative

The High-Level Fixed-Span Bridge Alternative is a non-movable bridge (Figure 13). The bridge length would be approximately 2,332 feet abutment-to-abutment, not including roadway approaches. The interior walls of the abutments would be approximately 900 feet from the top of the Duwamish Waterway embankment, or 650 feet further set back than the existing bridge. The on-land and in-water piers of this alternative are approximately in the same location as proposed for the Mid-Level Fixed-Span Bridge Alternative. Road improvements would extend from S. Trenton Street and continue north to East Marginal Way S. This alternative would require minor modification of the 16th Avenue S. East Marginal Way S. intersection and of the existing railroad track crossing immediately south of this intersection.

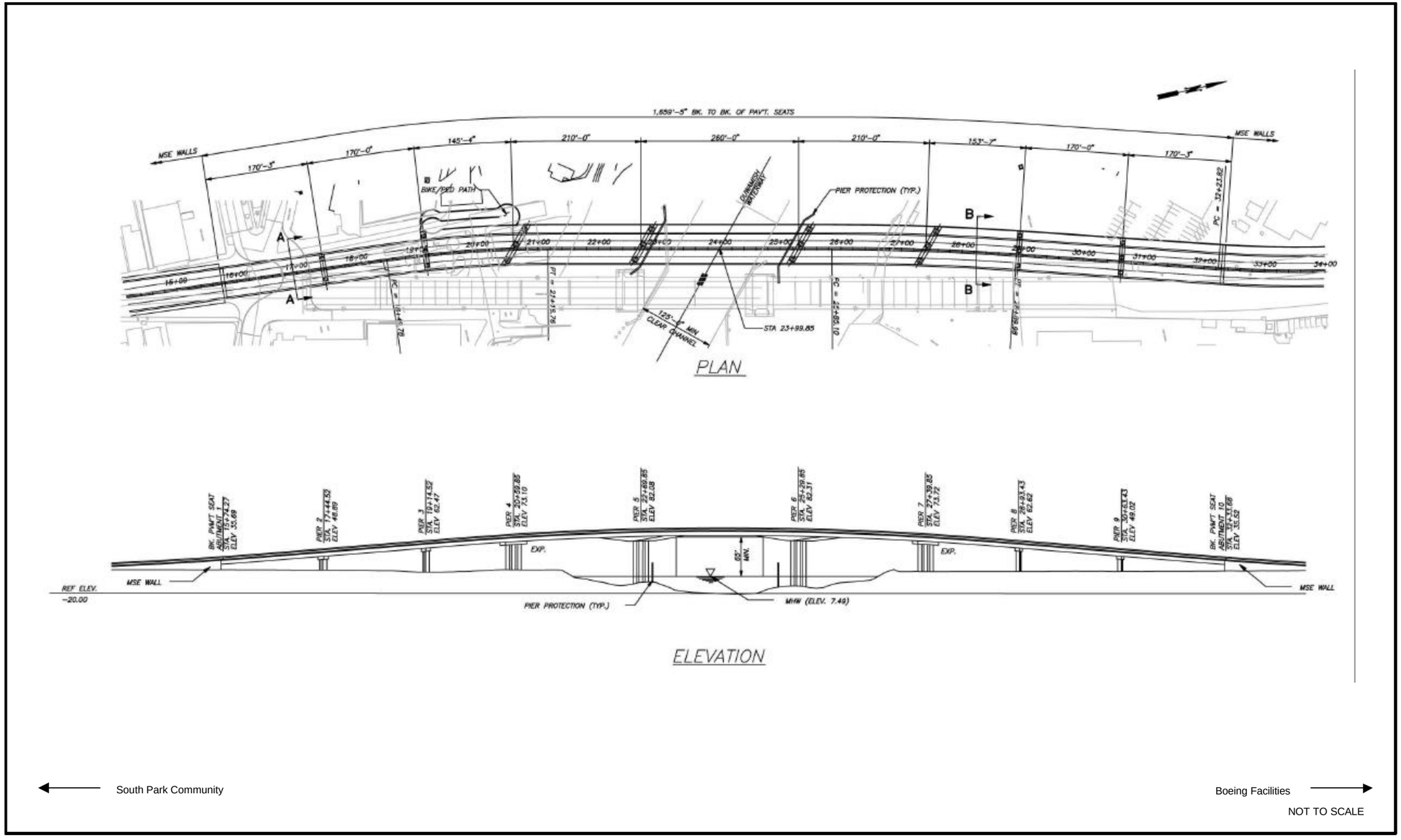

Figure 10.
Mid-Level Fixed-Span Bridge Alternative

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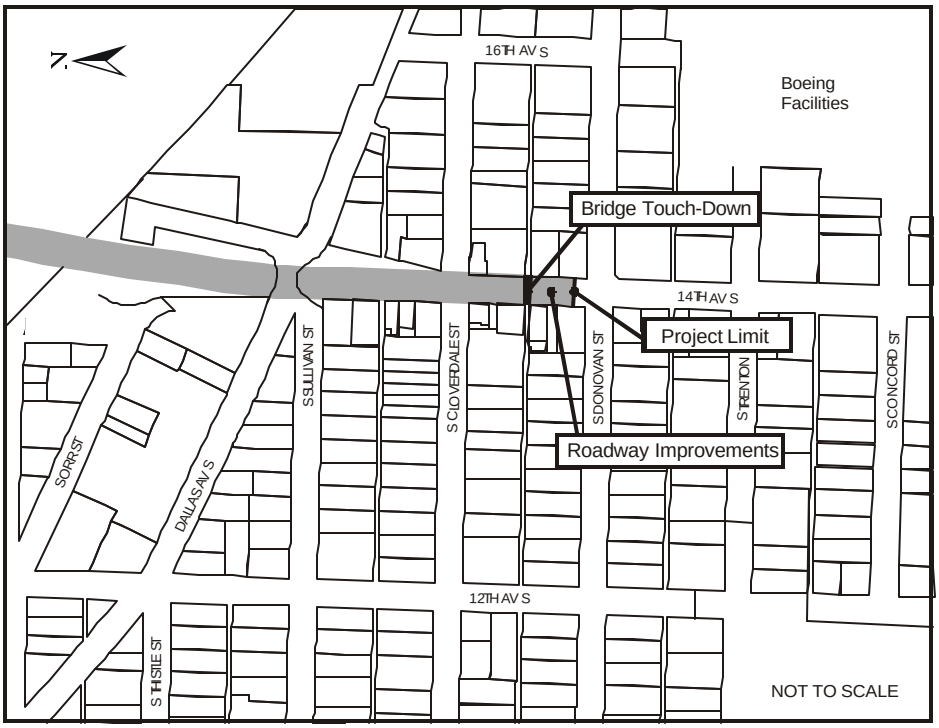

Figure 11.
Mid-Level Fixed-Span Bridge Alternative Street Network

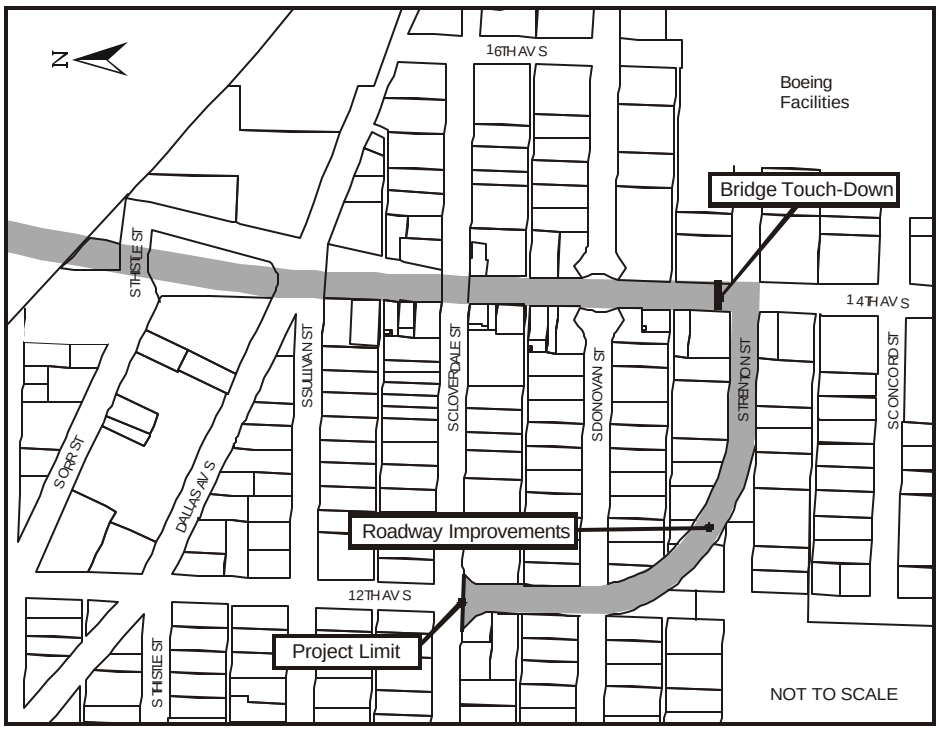

Figure 12.
High-Level Fixed-Span Bridge Alternative Street Network

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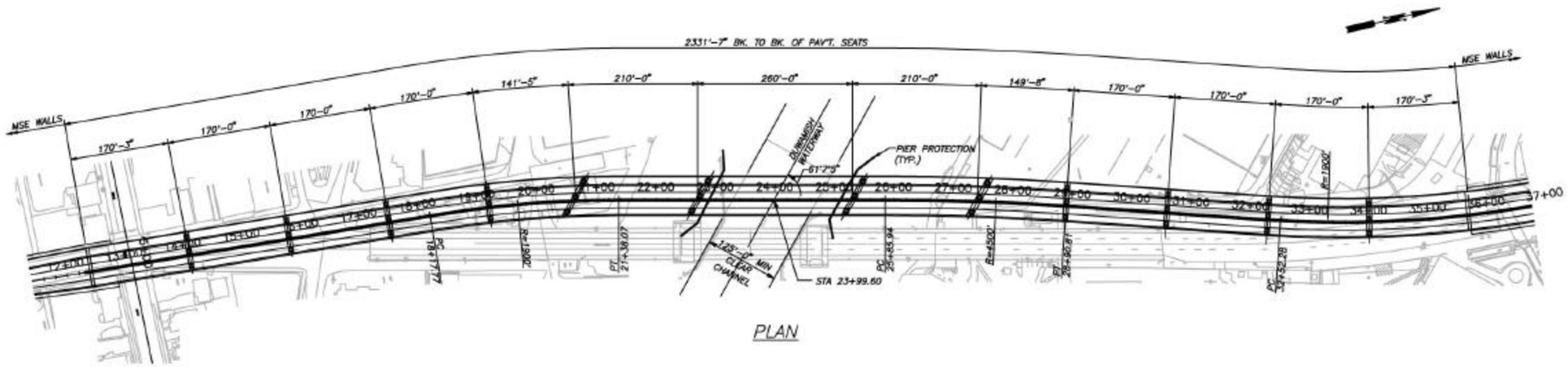
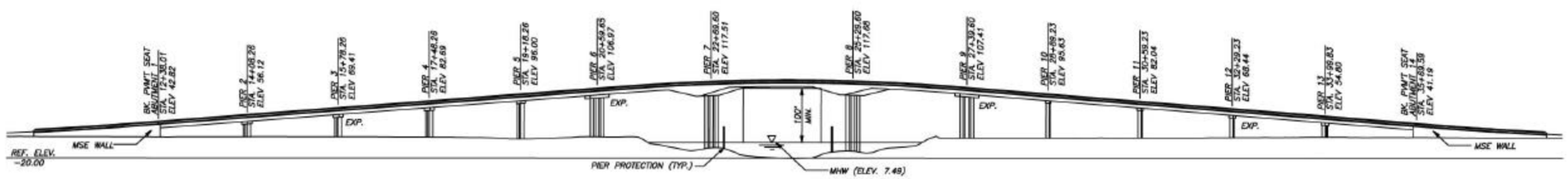


PLAN



ELEVATION

South Park Community

Boeing Facilities

NOT TO SCALE

Figure 13.
High-Level Fixed-Span Bridge Alternative

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The bridge design would allow for approximately 100 feet of vertical clearance above the MHW of the Duwamish Waterway as requested by the U.S. Coast Guard. The horizontal waterway clearance for the navigation channel would be approximately 125 feet, which is slightly greater than the existing 118-foot clearance (fender-to-fender). The bridge's vertical clearance would not be expected to limit the height of boats and barges currently passing the bridge. However, vessels larger than those currently using the navigation channel might not be able to pass the bridge in the future.

Following construction, there would be numerous changes in the local street network as shown in Figure 12. The figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. The bridge south abutment would require Dallas Avenue S., S. Sullivan Street, and S. Cloverdale Street to be converted to underpasses under the new South Park Bridge. A retaining wall supporting the elevated approach roadway would be constructed immediately adjacent to properties fronting on both sides of 14th Avenue S. for the majority of the two-block distance between S. Cloverdale Street and S. Trenton Street. S. Donovan Street would be closed at 14th Avenue S. due to obstruction from the bridge abutment and a vehicle turn-around would be constructed on either side of the abutment on S. Donovan Street. To allow traffic to access the new South Park Bridge, a new principle arterial roadway would need to be constructed between S. Trenton Street and 12th Avenue S. and road improvements would be required on 12th Avenue S. north to S. Cloverdale Street. This new route would allow traffic, trucks, and buses to continue to access the new South Park Bridge from S. Cloverdale Street via 12th Avenue S. and S. Trenton Street. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.3 Construction Durations and Activities

Construction of a rehabilitation or replacement bridge for the existing South Park Bridge is planned to take approximately two to three years, including the demolition and removal of the existing bridge. Construction is anticipated to start within the next several years and opening of the rehabilitation or a replacement bridge is currently anticipated to occur by 2009. The actual time required for construction activities vary for each of the alternatives. Construction activities associated with the No Action Alternative involves only demolition of the existing bridge and restoration of the site. The construction period for this alternative would be the shortest of all alternatives, approximately 8 months. The other alternatives would additionally require rehabilitation or construction of a new replacement bridge. Anticipated construction durations (demolition of existing and construction of new) would be approximately 32 months for the Rehabilitation Alternative, 33 months for the Bascule Bridge Alternative, 20 months for the Mid-Level Fixed-Span Bridge Alternative, and 24 months for the High-Level Fixed-Span Bridge Alternative.[14]

[14] Parsons Brinckerhoff. *South Park Bridge Project: Structural Alternatives Study*, November 2003.

From a construction perspective, the five project alternatives include three different types of construction activities. The No Action Alternative assumes the existing bridge condition would eventually require closure and removal of the bridge structures. Construction activities would focus on demolishing the existing bridge and restoring the project area. The Rehabilitation Alternative would require bridge closure for approximately 30 months for rehabilitation or replacement of various elements of the existing bridge. The Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives would all result in constructing a replacement bridge approximately 80 feet downstream of the existing bridge. For these three alternatives, the new bridge would be constructed while the existing bridge continues to be operational. When the new bridge is connected to the existing road, there would be short-term temporary bridge closures. These closures could be limited to weekends or could extend for approximately one month, depending on the alternative. Once the new bridge is completed, traffic would be rerouted to the new bridge and then the existing bridge structure would be demolished in a similar fashion as described for the No Action Alternative.

Rehabilitation of the existing bridge would require closure of the existing bridge for approximately 30 months, although efforts would be made to minimize the closure period as much as possible. Reconstruction activities would begin as soon as possible after completion of design engineering and acquisition of construction permits. Traffic would be given advance notice to take alternate routes prior to closure of the existing bridge. The construction of a temporary dock and a construction staging area would be required on both banks of the waterway (see Figure 14). Construction of the new bascule piers would likely be the first major construction activity. This would entail removing the existing pier protection fenders, installing temporary supports for the bridge superstructure, removing the bascule leaves as well as the steel truss spans, installing cofferdams around the existing steel truss approach piers and bascule piers, and demolishing the existing piers.

The bascule leaves and steel truss approach spans would be removed from the construction site for refurbishment. Construction of the new piers would involve drilling shafts through the existing timber piles, constructing the pile cap, dewatering the construction area inside the cofferdam, constructing the upper portions of the pier, removing the cofferdam, and finally reconstructing the upper portions of the bascule pier and bridge towers. Workers would reconstruct the concrete approach spans and replace the abutments. Workers would also reconstruct the bridge deck and replace the mechanical and electrical systems used to operate the bridge. Replacement of the piers, bridge tender towers, bridge railings, and lamp posts would be done in a manner that would preserve the historic character of these features of the existing bridge.

Major construction activities and sequencing would be similar for the Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives. The construction duration and the impact area for each of these three alternatives, however, would clearly differ. Following completion of design engineering, acquisition of construction permits, purchase of needed property, and relocation of residents and businesses, construction activities would begin. The first activities would include establishing the construction staging areas and constructing temporary docks with pilings on both sides of the waterway (see Figure 14).

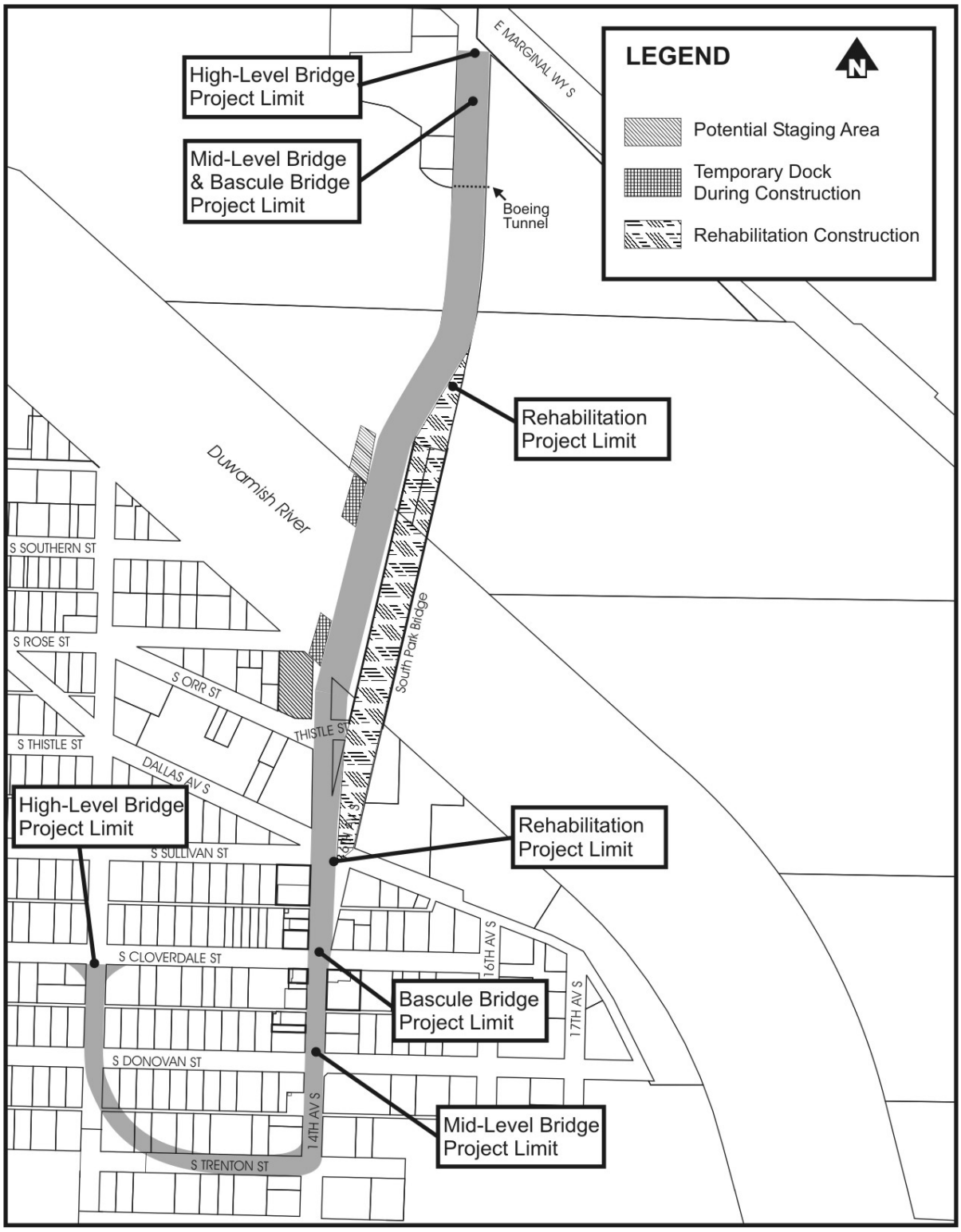

Figure 14
Proposed Construction Staging Areas

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Buildings affected by the construction activities would be demolished and utilities would be either temporarily or permanently relocated. To minimize traffic impacts, construction activities would begin with the construction of the in-water piers. Construction activities would progress landward from the central portion of each bridge alternative. Both in-water and on-land construction would begin with construction of the sub-structures (piers and abutment) and would be followed by placement of the superstructure (beams, deck, rails). On-land construction of the piers, abutment, retaining walls, and transition segments at either end of the bridge would likely require temporary closure of adjacent or nearby roads and rerouting of local traffic. If possible, these temporary closures would be limited to weekend and/or night times to minimize impacts to the community. Construction activities on the north and south portions of the new bridge structures could also occur either separately or concurrently. The last of the construction activities would be the construction of the new curb and gutter of the at-grade roadway, and paving the roadway to match the existing width of 14th Avenue S. Figure 14 shows the project limits, or start and end points, of construction activities for each of the project build alternatives.

For the rehabilitation and new bridge alternatives, new girders and other oversized materials would most likely be delivered to the project site by barge. Large cranes located on the barges or temporary docks would off-load the materials and place them in the nearby construction staging area. Removal of the existing bridge pier foundations and construction of the new bascule and steel truss piers would all require the use of cofferdams to isolate the construction activities. Construction of the new approach-span piers would use drilled shafts, which would likely incorporate the use of temporary casings to isolate the construction activities. This in-water work would be performed by equipment operated from the temporary docks or from barges.

Demolition of the existing bridge would involve disassembly and removal of the existing bascule leaves, superstructure, bridge piers, protection fenders, and abutment. Cranes would use the existing bridge structure and approaches as much as possible to remove the various elements of the bridge. Barges would likely be used to remove oversized materials. At this time, this demolition work is not planned to require construction of temporary docks or the acquisition or temporary use of property on the banks of the Duwamish Waterway for a staging area. Removal of the abutment foundations, however, would likely require temporary short-term closure of adjacent and/or nearby streets. During this time, local traffic would be temporarily rerouted from the immediate area.

Following the completion of the construction activities associated with any of the project alternatives, disturbed areas would be restored. Conceptual site restoration plans would be developed for each alternative based on additional consultation with resource agencies and other stakeholders.

2.4.4 Cost Estimates for the Alternatives

Cost estimates for each of the proposed project alternatives have been prepared by the project engineers (Table 2).[15] The cost estimate for each project alternative, including the No Action alternative, is broken down into the following components: 1) plans, specifications, and estimates (PS&E), 2) right-of-way costs, and 3) construction and construction-related costs. The total cost estimates are provided in 2003 dollars as well as estimated costs escalated for 2008, the anticipated mid-point of the project construction period. These cost estimates were calculated based on the conceptual engineering plans that were prepared for each of the alternatives.[16]

Table 2. Cost Estimates of the Project Alternatives

	PS&E	Right-of-Way	Construction	Total (2003 dollars)	Total (2008 dollars)
No Action	$ 250,000	$ 0	$ 6,750,000	$ 7,000,000	$ 9 M
Rehabilitation	$ 6,843,000	$ 754,000	$56,333,000	$63,930,000	$ 74 M
Bascule	$ 8,253,000	$ 3,655,000	$ 65,426,000	$ 77,334,000	$ 90 M
Mid-Level Fixed-Span	$ 4,235,000	$ 6,377,000	$ 50,911,000	$61,523,000	$ 71 M
High-Level Fixed-Span	$ 5,261,000	$ 15,310,000	$ 49,889,000	$ 70,460,000	$ 82 M

Source: Parsons Brinckerhoff, November 2003.

Clearly, the No Action Alternative is the least expensive as the existing bridge would not be rehabilitated nor would a new replacement bridge be constructed. The cost to remove the existing bridge structure would be approximately $7,000,000 (2003 dollars). The estimated costs to either rehabilitate or replace the existing bridge structure range between approximately $62 million to $77 million in 2003 dollars. The least costly of the build alternatives is the proposed Mid-Level Fixed-Span Alternative, which is estimated to cost approximately $61,523,000 to design and construct. The Rehabilitation Alternative is estimated to cost approximately $63,930,000 and the High-Level Fixed-Span Alternative is estimated to cost approximately $70,460,000. The most costly of the build alternatives is the Bascule Bridge Alternative, which is estimated to cost $77,334,000. The escalated 2008 dollar estimates to design and construction the project alternatives are also shown in the table.

[15] Parsons Brinckerhoff. *South Park Bridge Project: Structural Alternatives Study*, November 2003.

[16] Parsons Brinckerhoff. *South Park Bridge Project: Conceptual Plans*, June 2003.

2.5 Project Coordination

Coordination to date for the South Park Bridge Project has involved members of the public, a special community advisory group, and representatives of government agencies. Formal scoping was initiated through publication of the NEPA Notice of Intent and the SEPA Determination of Significance and Scoping Notice on February 7, 2002 and February 14, 2002, respectively. Separate scoping meetings were conducted in the South Park community for relevant agencies and members of the public. Both meetings were held on February 28, 2002. Written and verbal comments received through the scoping process were reviewed by King County and used in the development of the project alternatives and topics for environmental impact assessment.

A public involvement plan for the proposed South Park Bridge Project was developed during the initial stages of project planning. The Project Advisory Committee (PAC) and the Community Advisory Group (CAG) reviewed this document and provided comments to King County. The first public involvement efforts began prior to the formal scoping period. A public workshop was held in the South Park community on January 17, 2002. At this meeting, the nine preliminary project alternatives were presented. A second public workshop was held on June 19, 2002. At this meeting, the five proposed project alternatives were presented. Members of the public were encouraged to provide comments at both of these meetings. To facilitate participation and input from Hispanic persons living in the community, a bilingual translator attended all meetings. In addition, handouts and newsletters for the project were published in English and Spanish, and public notices were published in "Siete Dias", a local Spanish-speaking newspaper. Future opportunities for public involvement are also planned, including a public hearing and workshop following publication of the Draft Environmental Impact Statement in 2004.

Establishing a CAG was a significant component of the public involvement plan. A total of 17 individuals were chosen to participate in the CAG to represent community stakeholder interests and public concerns. The CAG meets periodically to be briefed on the progress of the project and to provide input to the South Park Bridge project team. Again, a bilingual English-Spanish translator attends the meeting to facilitate communication with Spanish-speaking individuals on the CAG. To date, CAG meetings have been held on April 10, May 21, June 4, June 11, and October 29 of 2002 and on January 7 and November 18, 2003. Additional CAG meetings are planned for the future.

As part of the environmental review process, King County periodically meets with the Project Advisory Committee (PAC) to give a status report of the project, answer questions, and to solicit comments. This committee is comprised of members of various agencies that have potential jurisdiction over the proposed South Park Bridge Project. The committee is the Interdisciplinary Team (IDT) required under NEPA implementation guidelines and provides technical support to King County staff. To date, the PAC has met on January 10, February 20, May 9, May 23, and October 10 of 2002. Coordination with the PAC is planned at critical future steps in the environmental review process.

A non-scientific survey was also conducted of South Park businesses located on 14th Avenue S. during the late spring of 2003.[17] The goal of the survey was to help assess potential impacts to businesses, especially minority-owned and –operated (employees) businesses. The survey respondents were also asked to identify their particular concerns about the proposed rehabilitation or replacement of the existing South Park Bridge. A total of 18 businesses were successfully surveyed. Spanish and Vietnamese translators were provided, as needed, to assist business representatives understand and respond to the questions. In addition, the data was used to assess the potential effects displaced businesses and jobs would have on the South Park community. The analysis of the survey findings are discussed in detail in the Economic, Social, and Relocation technical reports supporting the analysis in the EIS.

As key issues have arisen during development of the project alternatives and in assessing potential environmental impacts, special meetings have also been held with key stakeholders and organizations in the South Park community, as well as with other government agencies and jurisdictions with an interest in the project. For example, on December 3, 2002, King County met with owners of property along 14th Avenue S, and information booths were set up at the Sea-Mar Community Health Center-sponsored annual Fiesta Patrias on September 14, 2002 and at a family night event held at the Concord Elementary School on September 27 and November 22 of 2002. Periodic coordination meetings have also been held with representatives of the City of Seattle and the City of Tukwila, and other government agencies. These coordination activities will continue to occur on an on-going basis as the EIS is prepared and finally adopted.

[17] Parsons Brinckerhoff. *South Park Bridge Project: Survey of 14th Avenue South Businesses*, August 22, 2003.

Chapter 3 Studies and Coordination

This section lists the studies that were previously conducted in the project area related to water resources. This section also summarizes the agencies and experts that were coordinated with in the preparation of this report.

3.1 Previous Studies

Following is a listing and brief description of studies previously conducted on the Duwamish Waterway that contain information useful to the project. No additional water resources studies beyond this technical report have been prepared specifically for the project.

The Water Resource Inventory Area (WRIA) 9 Salmon Recovery Planning Commission is coordinating salmon recovery efforts in the Green/Duwamish watershed. Scientific support for decision making is summarized in *Habitat Limiting Factors and Reconnaissance Assessment Report* (King County, 2000). The report contains sections about water quality, hydrology and sediment transport that provided additional information about the project area. The report was reviewed to ensure this project would be consistent with salmon recovery efforts.

3.1.1 Stormwater Quantity

Seattle Public Utilities completed a drainage plan for the South Park community. The study analyzed and developed solutions to flooding along the 7th Avenue conveyance system. A copy of the final plan was obtained from the city.

The King County combined Sewer Overflow (CSO) Control Programs 2002/2003 Annual Report (King County 2003) was also reviewed to ensure this project's consistencies with current county CSO goals.

3.1.2 Water Quality

King County Department of Natural Resources (KCDNR) conducted a water quality assessment of the Duwamish Waterway and Elliott Bay as part of its combined sewer overflow control program. The results are documented in *King County Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* (1999). The water quality assessment included sampling of physical and chemical constituents at 39 water stations in order to establish baseline conditions in the Duwamish Waterway, including stations near the existing bridge alignment.

In addition, KCDNR has been monitoring water quality sampling stations throughout the Green/Duwamish watershed since 2000. The data from this monitoring effort have been collected, but the results have not been analyzed yet. The raw data was not requested for this report.

3.1.3 Waterway

The Federal Emergency Management Agency (FEMA) conducted an hydraulic analysis of the Duwamish Waterway in 1989. The results of the analysis are published in the *Flood Insurance Study (FIS) for King County, Washington* (1989).

The Army Corps of Engineers developed a two-dimensional hydraulic model of the Duwamish Waterway in 1990 using the DWOPR program. Documentation of this effort can be found in the archives of the Seattle District Office. Since the study used a two-dimensional model that is considerably more sophisticated than was necessary for this environmental analysis, the program and corresponding results were not requested.

3.2 Coordination

Several agencies were contacted to obtain background information and clarify regulatory standards for the project. The agency coordination is summarized in the following sections.

3.2.1 Stormwater Quantity

In order to determine the stormwater quantities and requirements, information has been requested from the City of Seattle, Boeing Plant #2, the City of Tukwila, and King County. The City of Seattle provided the sewer cards for the project area in order to identify the exiting stormwater, sewer, and combined sewer systems. The Boeing Plant #2 provided plant as-built drawings to identify existing manholes that are located in the Boeing property that is part of the project area. The City of Tukwila provided as-built information for the sewer line that services the existing bridge control rooms. King County provided Metro drawings to confirm the location of the Metro sewer and stormwater lines in the project area.

Sahba Mohandessi, Project Manager with Seattle Public Utilities, was consulted regarding the South Park Drainage Study, which is currently being completed by the city.

3.2.2 Stormwater Quality

Ed O'Brien, Program Manager with the Washington State Department of Ecology Water Quality Section, was contacted regarding stormwater management requirements for discharges to the Duwamish Waterway. Information from this communication is included under Section 4.1 Regulatory Standards.

3.3.3 Waterway

Andy Levesque, Senior Engineer with the King County Department of Natural Resources, was contacted regarding floodplain and flooding information along the Duwamish Waterway. Information from this communication is included under Chapter 5 Affected Environment.

Chapter 4 Methodology

This section describes the regulatory standards that the proposed alternatives would need to conform with. The approach and methodology that will be used in the assessment of impacts will be presented as well.

4.1 Regulatory Standards

There are three local government jurisdictions with regulatory authority over the Duwamish Waterway and potential effects from the proposed alternatives: King County, the City of Seattle, and the City of Tukwila. State agencies with jurisdiction over certain aspects of the project include the Washington State Department of Ecology (Ecology) and the Department of Fish and Wildlife (WDFW). Federal agencies with jurisdiction over certain aspects include the U.S. Army Corps of Engineers (COE), Federal Emergency Management Agency (FEMA) and U.S. Coast Guard. The applicable regulatory requirements are described in more detail below.

The Duwamish Waterway at the project location is designated a Class B Freshwater by the State of Washington. Therefore, the regulations for stormwater discharge to a fish-bearing freshwater apply to this project.

4.1.1 Stormwater Quantity

The primary design standard to be used for the design of the stormwater system is the *Stormwater Manual for Western Washington*, referred to as the Ecology Manual (Ecology 2001). In addition to the Ecology Manual, local jurisdictional requirements that apply to stormwater management will also be considered in the design. The three jurisdictions that encompass the project site include King County, City of Tukwila, and City of Seattle.

The design for each of the alternatives will be based on the footprint of the project area. This will include the proposed bridge alignment, the connecting ramps, and any areas adjacent to the bridge area that may be disturbed during construction activities. All flows, including any flows to the Duwamish Waterway, will need to meet the requirements of the Ecology Manual.

The Duwamish Waterway is exempt from flow control requirements in the King County Surface Water Design Manualand the Ecology Manual.

4.1.2 Water Quality

For stormwater collected and conveyed to the City of Seattle combined sewer system, no onsite stormwater treatment would be required, as treatment would occur at the King County West Point Wastewater Treatment Plant.

Stormwater from pollution generating impervious surfaces (PGIS) discharged to the Duwamish Waterway would need to meet the requirements of the Ecology Manual

(Ecology 2001). The Basic Treatment water quality menu in the Ecology Manual applies to stormwater draining to the Duwamish Waterway.

The Ecology Manual also recommends treatment of hydrocarbons (i.e., oil and grease) for roadways but only at "high-use intersections." An intersection qualifies as high-use if the main segment has an average daily traffic volume greater than 25,000 vehicles and each side segment has an average daily traffic greater than 15,000 vehicles. The Transportation Technical Report was referenced for traffic projections for each of the intersections that would be directly impacted by construction activities. None of the intersections under any of the alternatives would qualify as high-use.

A WSDOT instructional letter (WSDOT 2001) requires water quality treatment retrofitting for an area equivalent to 140 percent of the redeveloped PGIS.

In addition, local ordinances apply to water quality within the three jurisdictions that encompass the project site, including King County, City of Tukwila and City of Seattle. The water quality requirements in the *King County Surface Water Design Manual* (1998) are similar to those in the Ecology Manual. The City of Tukwila has adopted the King County Manual with minor revisions for its stormwater code. The City of Seattle requires Basic Treatment for projects discharging to the Duwamish Waterway. All of the jurisdictions require the preparation of a plan for stormwater control during construction.

4.1.3 Waterway

The Duwamish Waterway is within a federally designated floodway at the bridge crossing. Federally designated floodways are regulated by local jurisdictions, either county or city.

The Duwamish Waterway at the project site lies within King County to the south and the City of Tukwila to the north. Floodway conveyance of the bridge opening must meet the requirements for flood hazard areas in the King County Sensitive Areas Ordinance and Chapter 16.52, "Floodplain Management", in the Tukwila Municipal Code.

The county and city requirements state that any modifications to the structure, fill, or encroachment in the waterway shall not result in an increase of the water surface elevation of the 100-year flood event.

4.1.4 Summary of Permits

Table 3 presents a summary of the potentially applicable permits, certificates and approvals related to water resources.

Table 3. Potential Applicable Permits, Certificates or Approvals

Permit, Certificate or Approval	Responsible Agency	Regulated Activity
Corps of Engineers Section 10 Permit	COE	Any obstruction, alteration, or improvement of any navigable water.
Corps of Engineers Section 404 Individual Permit	COE	Any discharging, dredging or placing fill material in waters of the U.S. and adjacent wetlands.
Coast Guard Section 9 Bridge Permit	U.S. Coast Guard	Any work on bridges and causeways in navigable waters.
Water Quality 401 Certification	Ecology	Any activity requiring a federal permit for discharging into waters.
National Pollutant Discharge Elimination System (NPDES) Stormwater Construction Permit	Ecology	Construction activities disturbing more than 5 acres.
Coastal Zone Management (CZM) Certification	Ecology	Any activity requiring a federal permit must certify that the activity will comply with the State's Coastal Zone Management Program.
Hydraulic Project Approval	WDFW	Any project that will cross, obstruct or change the natural flow of any salt or fresh waters of the state.
Critical Areas Ordinance	King County	Any structure or activities that may adversely affect a flood hazard area.
Shoreline Substantial Development Permit	King County and City of Tukwila	Qualified activities within shoreline jurisdiction, including rivers.
Floodplain Development Permit	King County and City of Tukwila	Any structure or activity that may adversely affect the flood regime of a river within the flood zone.

4.2 Methodology

The following sections describe the methodology that will be used to evaluate the impacts of each of the proposed alternatives on water resources. The results of the analyses are presented in Chapter 6, Impacts.

4.2.1 Stormwater Quantity

For this report, the stormwater quantity was based on the total improved and new impervious area. The definition of improved is a function of the total area and cost of the project and the final disposition of the surface in the project area (i.e., grass, pavement, gravel, etc). The improved and new area included the new alignment of the bridge, the staging and work areas, and (in the case of the high-level fixed-span alternative) the Cloverdale reroute to Trenton Avenue S. Figure 14 in Chapter 2 illustrates the locations of the staging area and approximate extent of the project area. All of the project area was considered impervious, with surfaces composed of either pavement or compacted dirt; however, some of the staging and work areas may not ultimately be impervious areas. However, because the future of these areas has not been determined, a conservative approach was taken in determining the stormwater quantities; therefore, these areas were

counted as impervious surfaces in the calculations for determining the total stormwater quantities.

The stormwater volumes were calculated according to the Ecology Manual. The Ecology Manual references the Santa Barbara Urban Hydrograph (SBUH) method as providing acceptable volume estimates for total runoff. The volumes were calculated using WaterWorks software. Waterworks uses the SBUH method with the 25-year, 24-hour storm value input from the WSDOT Highway Runoff Manual. See excerpts and calculation summary sheets in Appendix A for more information.

4.2.2 Water Quality

4.2.2.1 Operational

For this report, it was assumed that the stormwater from the project site would drain to the Duwamish Waterway. The stormwater would receive on-site water quality treatment prior to discharge to the waterway.

Annual pollutant loads to the Duwamish Waterway were estimated for each of the alternatives under operational conditions. Pollutant loadings were assumed to vary with changes in traffic volume. The analysis first used the Federal Highway Administration (FHWA) methodology (FHWA 1990) to estimate loadings from a three-lane Rehabilitation Alternative. Annual pollutant loads of oil and grease; copper, lead, and zinc; and total suspended solids (TSS) resulting from both treated and untreated stormwater runoff were estimated. These pollutants are commonly found in stormwater. Nutrient loading, including nitrogen and phosphorous, was not estimated because the Duwamish Waterway is in the intertidal zone at the bridge, and as such, is not sensitive to nutrient loading.

Calculation of the South Park Bridge pollutant-generating impervious surface (PGIS) areas for the Rehabilitation Alternative was generated from the preliminary CAD drawings. We assumed that the roadway width was 100-percent impervious and all stormwater was collected, including from the bridge deck.

Pollutant load calculations for the Rehabilitation Alternative were performed as outlined in the FHWA methodology for urban highways (e.g., those having average daily traffic amounts greater than 30,000 vehicles per day). Data for the pollutant concentrations of highway runoff were generated from a pool of eight FHWA study sites with 100-percent impervious area. Hydrocarbon concentrations were estimated from a limited sample of three of the eight selected FHWA study sites.

Higher traffic volumes are expected for the four-lane alternatives. Pollutant loads for the four-lane alternatives were scaled up from the three-lane Rehabilitation Alternative, based on increases in traffic volumes. Daily traffic volumes were extrapolated from 3-hour peak period traffic forecasts. The traffic volumes include growth factors from the King County Travel Demand Model, to represent 2007-2009 conditions. The ratio of daily traffic volumes (between the three-lane and four-lane alternatives) was used as a factor by which pollutant loadings would vary between the alternatives.

The Ecology Manual recommends Basic Treatment (primary focus on TSS removal) for projects discharging to the Duwamish Waterway. The effects on pollutant loads of additional treatment for oil and grease were not evaluated, as none of the intersections under any of the alternatives qualify as high-use (refer to Section 4.1.2).

The Ecology Manual lists a numeric removal efficiency goal of 80 percent for TSS. No numeric efficiency goals are provided in the Ecology Manual for metals. For the BMPs listed in the Ecology Manual for the treatment of total metals, a Basic Treatment removal efficiency range of 50 to 75 percent was taken from the *Endangered Species Act (ESA) 7(d) Project List and Stormwater Effects Guidance Instructional Letter* (WSDOT 2001).

4.2.2.2 Construction

A qualitative assessment of potential sediment loads and water quality impacts associated with each alternative was made. Focus of the evaluation was placed on in-water, over-water, and dewatering construction activities. A list of applicable temporary erosion and sedimentation control (TESC) BMPs was developed for mitigation.

4.3 Waterway

4.3.1 Waterway

4.2.3.1 Floodway

The COE's River Analysis System (HEC-RAS, Version 3.0) was used to evaluate floodway conveyance impacts associated with each alternative. A model was developed of the reach of the Duwamish Waterway encompassing the project site and upstream and downstream adjacent cross-sections. The water surface elevation of the 100-year peak flow rate in the Duwamish Waterway was calculated for both pre-project and post-project conditions for each of the alternatives.

A flow rate of 12,000 cfs, taken from the FEMA Flood Insurance Study, was used for the 100-year storm event. The Howard Hanson Dam, located in the headwaters of the Green River, regulates this flow rate.

The cross-sectional data was obtained from topographic information on the base map for the preliminary engineering drawings.

A tidal elevation of 11.78 NAVD 88 was used for the analysis. This tidal elevation was used in the FEMA FIS (8.3 NGVD 29).

4.2.3.2 Channel Stability

The HEC-RAS model developed for the floodway analysis was used for the evaluation of scour resulting from the contraction of the waterway at the bridge structure. Several flow regimes were modeled in order to understand the effects of each bridge geometry on the velocity and bed shear stress in the channel. The flow was held constant at the 100-year rate while the tidal elevations were varied from –8.00 to 11.78 NAVD88. The average velocity and shear stress was calculated over the entire cross-section at the upstream end

of the bridge. These values were then compared to those needed to suspend and move river substrate in order to gain an understanding of the potential for scour. Although total scour was not calculated, the relative potential for scour of each alternative was evaluated. Localized scour due to pier geometry was not evaluated for this report.

A qualitative assessment of the potential long-term channel aggradation or degradation was made based on the hydraulic results, sediment load of the tidal backwater, and upstream watershed and channel bed substrate material.

A qualitative assessment of the stability of the waterway bank and need for armoring was also made. The potential effectiveness of bioengineered bank stabilization was considered, which would have beneficial implications for fish habitat.

The main components of the affected environment include the quantity, rate, and quality of stormwater draining to the Duwamish Waterway; the sediment loading associated with construction activities; the scour associated with the bridge hydraulics; and the conveyance capacity of the floodway.

A visual survey of the South Park Bridge and Duwamish Waterway characteristics was conducted during a low-tide period on July 23, 2002 (-2.4 ft MLLW).

5.1 Duwamish Waterway

The primary water resource affected by the removal, rehabilitation, or replacement of the South Park Bridge is the Duwamish Waterway. The project site crosses the Duwamish Waterway at approximately RM 3.8. The Duwamish Waterway, which is tributary to Elliott Bay, is within Water Resource Inventory Area (WRIA) 9.

The South Park Bridge crosses the navigable portion of the Duwamish Waterway. The Duwamish Waterway is used for industrial, commercial and recreational purposes. The South Park Bridge is near the upstream limit of the dredged waterway maintained by the U.S. Army Corps of Engineers. The bridge is within the intertidal zone of the Duwamish Waterway, with tide elevations typically ranging between 8 and -3 ft MLLW.

The Duwamish Waterway in the vicinity of the South Park Bridge is within both the City of Tukwila (right [north] bank) and King County (left [south] bank) jurisdictions. The south shoreline (left bank) of the Duwamish at this location has a mix of single family residences and small businesses downstream of the bridge and a marina upstream of the bridge. The north shoreline riparian area (right bank) is Boeing Company's Plant 2 and North Duwamish Campus. Plant 2 extends over the shallow portion of the shoreline south of the bridge. The Boeing wharf forms the river bank on the north side of the bridge.

The Duwamish Waterway has been severely impacted by previous dredging and filling activities. Currently, the waterway consists of a straightened river channel with narrow intertidal mud flats extending to steep middle and upper intertidal shorelines. The navigation channel is U-shaped, with a bottom at about –20 ft MLLW. The parallel mud flats are at about –2 to +4 ft MLLW. The shorelines have industrial, business, and residential uses extending to, and in some cases over, the shoreline.

Flow in the waterway is regulated by the operation of the Howard Hanson Dam in the headwaters of the Green River. Characterized by wet and dry seasons, discharge of the river varies seasonally. The wet season extends from November to July, and the dry season from August to October. The mean monthly flow rate varies from 400 cfs in August to 2,600 cfs in January. Stream banks are sloped and diked to contain flows of up to 11,000 cubic feet per second (cfs) (Williams et al. 1975). According to FEMA, the maximum regulated flow for the 100-year recurrence interval is 12,000 cfs at the project site. Historical flooding at the project site is discussed in Section 5.1.

River velocities are dissipated as the Duwamish Waterway widens and currents converge with tidal forces. The waterway bottom is composed primarily of silt and mud in the navigation channel, with compacted silty gravel in the upper section.

5.2 Stormwater Quantity

The South Park Bridge consists of grated bascule leaves and solid deck spans on either side of the basclue leaves. Stormwater falling on the grated bascule leaves falls directly into the Duwamish Waterway. Stormwater from the solid sections on the north and south sides of the bridge is collected and conveyed either to the City of Seattle, King County, or the City of Tukwila storm and/or combined sewer system. It then flows to the King County combined sewer system and eventually to West Point Treatment Plant for treatment. See Figure 15 for general areas of combined sewer, separated sewer and stormwater, and septic systems. The storm flows from each solid side of the bridge will be discussed as either the north or the south flows. There is currently no detention being provided on the project site.

Located in the project area are several outfalls to the Duwamish Waterway which may be associated with the storm drainage system and/or the combined sewer system in the area. The function of these outfalls has been determined to be stormwater convergence. There are five outfalls identified on the project base map. All five are located on the north side of the Duwamish waterway under or near the South Park Bridge. The outfalls' size and type are as follows:

- Outfall No. 25-260, unknown size, stormwater;
- Public outfall, 18", stormwater;
- Outfall 16-271A, 4", stormwater;
- Outfall No. 4-125, 24", stormwater; and
- Outfall No. (unknown), 6", stormwater.

Four of these outfalls are owned by Boeing. One of these outfalls, the Public Outfall, is owned by Seattle Public Utilities.

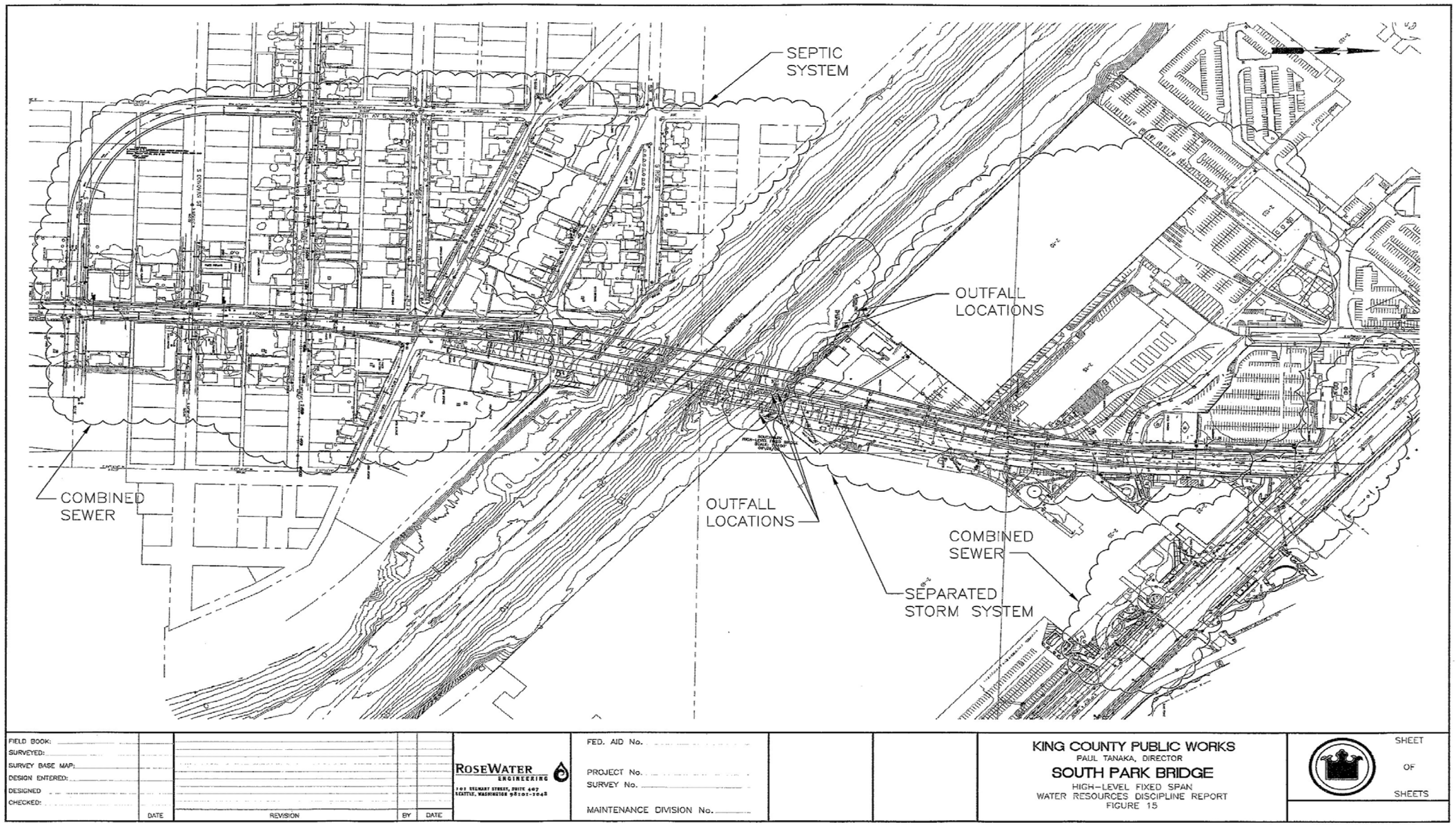

Figure 15.
Combined and Separated Sewer System General Areas

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5.2.1 North Side

The north side of the Duwamish Waterway consists of a partially separated stormwater and sewer system. 16th Avenue S. has a separated stormwater and sewer system; however, at the intersection of 16th Avenue S. and East Marginal Way S., the stormwater and sewer systems return to a combined system that eventually connects to the Metro combined sewer system. The project stormwater on the north side of the Duwamish (i.e., 16th Avenue S.), is collected in the separated stormwater system and conveyed to existing stormwater outfalls located on the Boeing Plant #2 property and underneath the existing South Park Bridge. Some stormwater runoff (i.e., from roof drains is released into the Duwamish through stormwater outfalls located on the Boeing Plant #2 site. Any remaining flow that is not captured in the separated stormwater system or that does not sheet flow into the Duwamish Waterway flows to the City of Seattle combined sewer system at East Marginal Way S. and eventually to the Metro combined sewer system. There is currently no stormwater detention provided prior to discharge into the Duwamish Waterway.

5.2.2 South Side

The stormwater that flows south, (i.e., to 14th Avenue S.) is collected in a system of catch basins. These catch basins connect directly to the combined sewer system and eventually to the Metro combined sewer system. Portions of the King County land south of the bridge are currently on septic systems. The properties on septic systems and on the sewer system will need to be confirmed during later phases of this project. The remaining project area, City of Seattle property south of Dallas Avenue S., is on combined sewer. There is currently no detention provided for any stormwater or sanitary sewer flows.

5.3 Stormwater and Surface Water Quality

Near the project site, the Duwamish Waterway has high temperatures [15 to 23 degrees Celsius (USGS, 1996)] and low dissolved oxygen (DO) levels during summer low flow periods. The Duwamish Waterway in the vicinity of the South Park Bridge is on Ecology's 303(d) list of impaired and threatened water bodies for multiple parameters. The Duwamish Waterway at the project site exceeds the standards for pH (outside the range of 6.5 to 8.5). An unnamed tributary in the project vicinity is listed for fecal coliform bacteria and DO. Refer to Section 3.1.2 for previously conducted studies related to water quality.

EPA requires Washington State to set priorities for cleaning up threatened waters and to establish a Total Maximum Daily Load (TMDL) for each. A TMDL, or water cleanup plan, entails an analysis of pollutant loadings to determine how much pollution a waterbody can receive and still remain healthy for its intended beneficial uses. The TMDLs for the Duwamish Waterway are currently being developed by Ecology. Once developed, the TMDLs are tied to COE Section 404 and 401 water quality permit requirements.

On August 29, 2001, the Washington Pollution Control Hearings Board issued a partial stay of the Construction Stormwater General NPDES Permit. This partial stay applies to

waters listed under Section 303(d) of the Clean Water Act and waters subject to Total Maximum Daily Load determinations. To receive coverage under the construction stormwater general permit, the project proponent must demonstrate that no water quality violation will occur from a stormwater discharge from the project. This is generally demonstrated by submitting the Construction Stormwater Pollution Prevention Plan (SWPPP) for the project, which would identify specific means and methods for preventing or treating discharges of the listed pollutant.

The flow in the waterway carries suspended solids, as evidenced by the need for periodic dredging of the channel by the Army Corps of Engineers. No suspended solids data was obtained for this report.

Past discharges of dissolved and particulate contaminants into the Duwamish Waterway from point and non-point sources have led to an accumulation of contaminants in the river sediment. Sediments exceed standards for numerous chemicals, including a variety of metals, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), phthalate esters, and phenol (Ecology 2000). Additional information about the project site sediment and groundwater quality, relative to the Lower Duwamish Waterway Superfund Site, is provided in the Hazardous Materials Technical Report.

Stormwater from the project site currently does not receive any water quality treatment before discharge to the combined sewer system or Duwamish Waterway. The WSDOT Instructional Letter (WSDOT 2001) requires water quality treatment retrofitting for an area equivalent to 140 percent of the redeveloped PGIS. However, because all areas outside the bridge deck drain to combined sewers, retrofitting cannot be achieved for these areas. They already receive treatment at the West Point Treatment Plant before discharge into receiving waters.

5.4 Waterway

5.4.1 Floodway

The Duwamish Waterway at the South Park Bridge is within a regulated floodway, as designated in the *Flood Insurance Study (FIS) for King County* (FEMA 1989). The floodway was mapped by FEMA (Figure 16) and is regulated by King County and the City of Tukwila. Constructed levees line portions of the waterway along the project site. The Boeing plant on the north side of the waterway acts as a constructed dike. The floodway width is 450 feet within the constructed levee/dike on either side of the waterway. The area to the landward side of the levees/dikes is not within a regulated floodplain. The bridge approach piers on either side of the waterway are protected from the 100-year flood by the levees. The 100-year peak discharge at the bridge is 12,000 cfs, as controlled by the release from the Howard Hanson Dam, located in the headwaters of the Green River. The 100-year water surface elevation at the bridge, as determined by FEMA, is 8.3 feet NGVD. This water surface elevation is dependent upon the tidal elevation assumed by FEMA, as the bridge is within the intertidal zone.

On two occasions in the past, the Duwamish overtopped a Boeing parking lot on the right (north) bank approximately 1,500 feet upstream of the South Park Bridge (personal

communication, King County 2002). Approximate elevation of the parking lot is 10.4 to 11.0 NGVD. The dates and cause of the flooding are unknown.

5.4.2 Channel Stability

The Duwamish Waterway at the South Park Bridge is infrequently dredged (approximately once per decade) by the Army Corps of Engineers in order to maintain the navigability of the channel (ACOE, 2003). The bridge is located in a depositional reach of the Duwamish Waterway that slowly aggrades over time. The streambanks of the waterway are armored with rip-rap in the vicinity of the bridge and do not show signs of instability.

5.5 Groundwater

The project site is not within a sole source aquifer or wellhead protection area. The area to the south of the Duwamish Waterway is characterized as having a high susceptibility to groundwater contamination, according to the King County Department of Natural Resources. Refer to the Hazardous Materials Technical Report for additional information regarding groundwater and contamination issues.

The general direction of groundwater flow in the floodplain is towards the waterway, although the direction may vary locally depending upon the nature of subsurface material and proximity to the waterway where tidal action can alter groundwater flows. Although high tides can cause temporary groundwater flow reversal, the net groundwater flow direction is towards the waterway. Areas affected by tide-related groundwater flow direction reversals are generally within 500 feet of the waterway. In those areas, the density difference between the freshwater groundwater aquifer and the saltwater intrusion tend to force the outflow of the surficial aquifer into the intertidal area.

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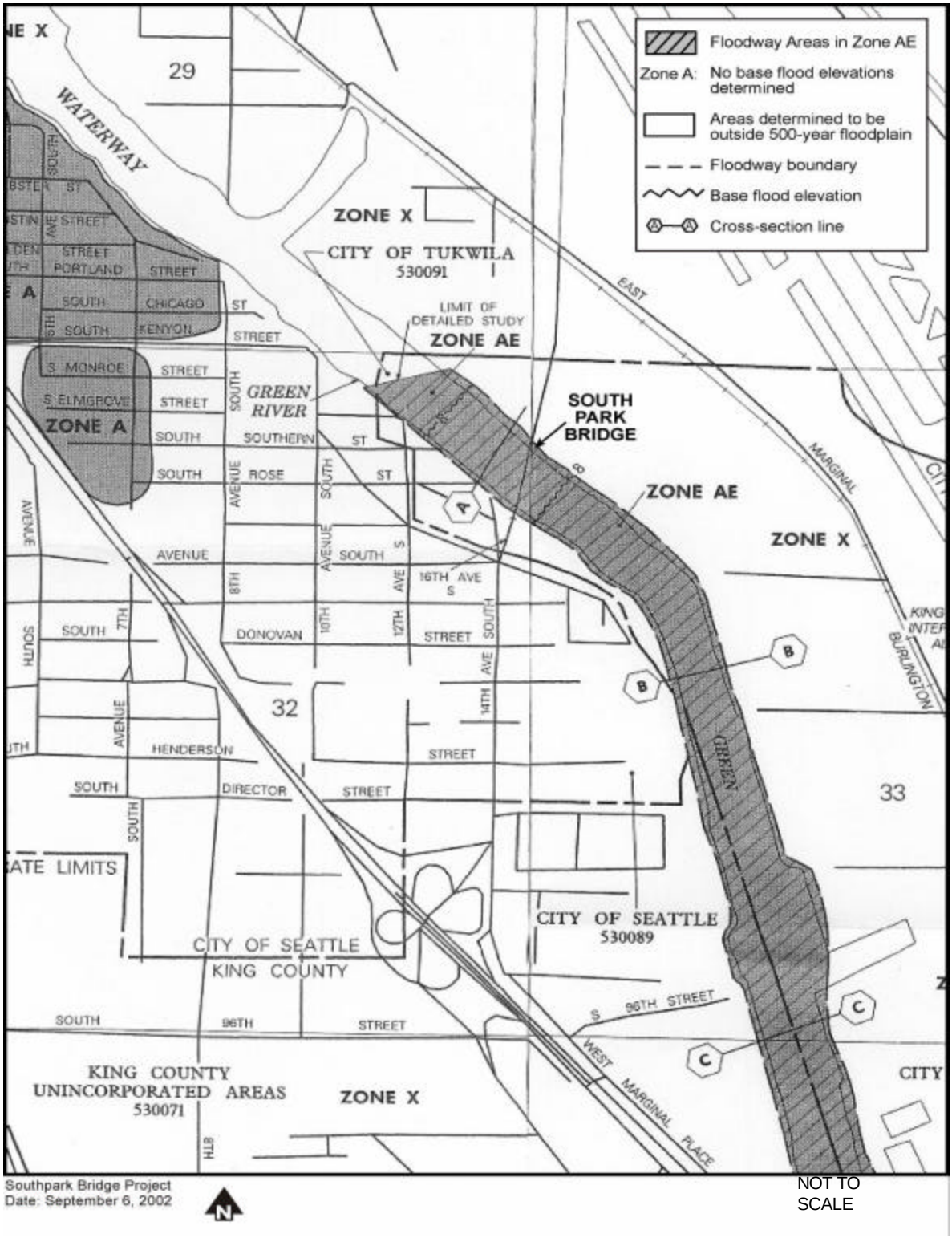

Source: FEMA FIRM Map Number 53033C0645 F & 53033C0640 F

Figure 16.
FEMA Floodplain Map

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The Duwamish Waterway estuary was carved by glacial ice and subsequently filled in by river sediment. The lower boundary of that geologic trough has been reached sporadically by deep borings. Data from these borings indicate that the trough lies roughly 100 feet below the modern ground surface within the project area, and is generally shallower to the south and towards the east and west valley walls. The boundary of these deposits is marked either by bedrock or by very dense sediment that has been glacially overridden. Refer to the Geology and Soils Technical Report for additional information regarding the geology of the project area.

Alluvial deposits within the surficial aquifer of the Duwamish Waterway floodplain are generally fine-grained (fine sand and silty sand) with low to moderate permeabilities (Pentec Environmental 2001). Based on limited studies at industrial sites, groundwater gradients and velocity were low. Although sand and gravel strata with higher permeabilities may occur in localized areas, thick sections of silt and clay are more common. Permeability of fill varies greatly over short distances and is generally greater than overlying or adjacent natural deposits. Permeability of the soil in the unsaturated zone of the aquifer is moderately slow. The depth to groundwater in the project area varies from the ground surface along the shore of the Duwamish Waterway to about 12 feet below ground surface, depending upon location.

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6.1 Direct Impacts

Direct impacts to the affected environment include the quantity, rate, and quality of stormwater draining to the Duwamish Waterway; the sediment loading associated with construction activities; the scour associated with the bridge hydraulics; and the conveyance capacity of the floodway.

6.1.1 Stormwater Quantity

All of the build alternatives for the South Park Bridge project require new stormwater facilities. The facilities may include conveyance systems (catch basins and manholes), detention facilities, and/or water quality facilities. The new conveyance system would consist of curbs, bridge drains, and catch-basins to collect the storm runoff and convey it. Detention will be included, if required by the City of Seattle for storm flows to the combined sewer system. In general, the flow direction will break at the crest of the bridge and flow down either north or south. These storm flows will be conveyed to the existing outfall on the north side of the project and to a proposed outfall on the south side of the project. Some stormwater flows may be conveyed to the existing system. Those flows would likely be equal to, or less than the existing volume of flows.

At this time, the Duwamish Waterway is exempt from flow control per King County, the City of Seattle, and the City of Tukwila. Though the Ecology Manual does not specifically state that the Duwamish is exempt from flow control, it is likely that the exemption will be pursued for this project.

The south side of the bridge may require more new stormwater facilities or upgrades than the north side because of the potential to affect side-street systems. This work may include storm drainage, sanitary sewer, and combined sewer system upgrades. The existing flow patterns will be mimicked as closely as possible to minimize impact to the existing systems. Post-construction stormwater flows to the stormwater system would be equal to or less than the existing flow volumes.

The north side of the bridge has fewer stormwater and sewer systems. There are some separated systems and some combined sewer systems. The ownership of some of these systems will affect the system design for the alternatives. However, as with the south side of the bridge, the existing systems will be matched as closely as possible to minimize impact on the existing systems. Post-construction stormwater flows to the stormwater system would be equal to or less than the existing flow volumes.

Table 4 lists the existing areas, the new and improved areas, and the expected total stormwater runoff from those areas for each of the alternatives. Preliminary impervious surface areas have been calculated based on the assumptions listed in Section 4.2.1, on the sketches provided by Parsons Brinckerhoff of the work zones and staging areas, and on the base maps issued to the consulting team for each of the project alternatives.

Table 4. Total New and Improved Impervious Area

Alternative	Existing Area (ac)	Total New and Improved Area (ac)	Total Stormwater Runoff (ac-ft)
No Action	2.03	0.0	None
Rehabilitation	2.03	2.03	0.54
Bascule Bridge	2.03	3.92	1.03
Mid-Level Fixed-Span Bridge	2.03	4.94	1.30
High-Level Fixed-Span Bridge	2.03	6.66	1.76

6.1.1.1 No Action Alternative

The No Action Alternative will have no immediate impacts. Ultimately this alternative will involve demolition of the bridge. Some existing conveyance system structures including piping and catch basins may be removed and/or abandoned in place. This alternative may also require that sections of pipe be abandoned when the bridge goes out of service and is demolished. During demolition, certain conveyance systems could be impacted, requiring reconstruction and/or temporary bypass. Additionally, the total amount of stormwater runoff would be reduced because the bridge impervious surface would no longer exist. This would have no impact on the function of the existing system except that the stormwater flows would be less.

6.1.1.2 Rehabilitation Alternative

The Rehabilitation Alternative would have no additional impacted areas and would be similar to existing conditions. However, even though the stormwater flows would not likely increase, the City of Seattle, under their redevelopment guidelines, may require that the conveyance system be upgraded to help mitigate the pre-existing flooding problems in the area (i.e., detention facilities and/or the stormwater and sewer system may require separation).

6.1.1.3 Bascule Bridge Alternative

The Bascule Bridge Alternative would have minimal impact on the existing storm drainage system and the combined sewer system because runoff from the Bascule Bridge alternative would discharge directly to the Duwamish Waterway. Flows from the bascule bridge would be routed north from the crest of the bridge to the existing public outfall, and to a proposed stormwater outfall south of the bridge crest. This alternative, similar to the other two build alternatives, would be regulated under Seattle's "new-development" area requirements, but with the least affected land area, because the total new stormwater volume would be less. This alternative would have no measurable effect on the existing CSO capacity.

The Bascule Bridge Alternative would require the least area of excavation for any of the build alternatives. The affected area for new stormwater conveyance would be contained within about a one-block-radius of the bottom of the bridge. Any further excavation required by the project would need to be coordinated with archeological and hazardous material evaluation.

6.1.1.4 Mid-Level Fixed-Span Bridge Alternative

The Mid-Level Fixed-Span Bridge Alternative would have a larger affected land area than the Bascule Bridge Alternative, with some impacts to existing side streets. This may require that improvements be made to the side-street drainage systems, which would result in additional storm drainage needing conveyance. The existing stormwater systems may not be able to handle the additional stormwater flows, which could require that the project install larger pipes in the system or add stormwater detention facilities. However, because stormwater would likely be conveyed to outfalls in the Duwamish, which would actually remove flows from the existing systems, the need to upgrade the existing systems would be unlikely.

This alternative would be compatible with the County CSO reduction plan because no increase n stormwater quantity would be sent to the King County system. Although stormwater retrofit opportunities might be available, they would not be needed for discharges into the Duwamish River.

The extent of stormwater system work for this alternative might extend as far as one block on either side of the bridge and a one-block-radius from the end of bridge alignment. Any further excavation required by the project would need to be coordinated with archaeological and hazardous material evaluations.

6.1.1.5 High-Level Fixed-Span Bridge Alternative

The High-Level Fixed-Span Bridge Alternative would have the largest affected land area of all of the build alternatives and would require side-street conveyance system improvements. The affected side areas requiring system improvements would include the S. Cloverdale/12th reroute to S. Trenton Street (the "connector road"), S. Donovan Street, and S. Cloverdale Street. These streets have existing combined sewer systems that might require rerouting around the new bridge, so that service may continue. Also, the City of Seattle would require that additional stormwater conveyance capacity be provided for these streets as part of "new development". This alternative would generate the most runoff of all the build alternatives and might require detention.

The High-Level Alternative will have the largest impacted area for the stormwater system. The area potentially affected includes areas as far as one block on either side of the bridge structure (four blocks from the Duwamish River) and a one block radius from the end of bridge alignment. Any further excavation required by the project would need to be coordinated with archaeological and hazardous material evaluations.

6.1.2 Water Quality

6.1.2.1 Operational

Potential operational impacts to water quality include pollutant loading form traffic use and spills. For all alternatives, stormwater surrounding the existing and proposed bridge approaches would be routed into existing conveyance systems to the West Point Treatment Plant. For all build alternatives, bridge runoff would discharge into the Duwamish River. This report did not attempt to model spill risks for all five alternatives,

due to the complexity of the numerous risk factors. Instead, a simplified set of assumptions was used to group the alternatives relative to each other. The No Action alternative was assumed to have the least spill risk over time because the bridge would be closed and removed. The Rehabilitation and Bascule Bridge alternatives were grouped together, assuming that they would provide similar vehicle access and capacity with fewer bridge openings (and thus fewer hours with traffic on the bridge). The Fixed Span Bridge alternative were also grouped, based on offering the greatest vehicle access and capacity full time (i.e., the bridge is always "open" to traffic). Therefore, the potential for spill impacts to affect receiving waters of the Duwamish River are more for No Action, low for Rehabilitation and Bascule Bridge alternatives and slightly greater for Fixed-Span Bridge alternative.

For this report, it has been assumed that the stormwater currently draining from the project site to the combined sewer system would continue to drain to the combined sewer system after construction. The stormwater would continue to receive treatment at the West Point Treatment Plant before final release to Puget Sound. Wastewater released from the treatment plant meets federal and state clean water requirements. No additional assessment of water quality impacts associated with discharge of stormwater to the combined system was made.

Water quality impacts to the receiving water from bridge runoff were estimated based on projected traffic volumes for each bridge alternative. Pollutant loading from the bridge would be a function of traffic volume. Certain bridge alternatives will attract slightly higher traffic volumes. Even with differences in traffic volumes among the alternatives, it is important to note that the net impacts to the receiving waters would be approximately equivalent among all alternatives, since any reduction or increase in traffic volume at the South Park Bridge would be reflected in an opposite change at other bridges crossing the Duwamish Waterway. Thus, this analysis only demonstrates the localized water quality impacts from the South Park Bridge for each alternative. As described in the Methodology Section, pollutant loads were estimated for each of the alternatives, with and without treatment. The loading of the following pollutants was estimated: oil and grease, copper, lead, zinc, and total suspended solids (TSS).

The Ecology Manual lists the Duwamish Waterway at the project site as a receiving water for which the Basic Treatment water quality menu applies. Appropriate BMPs under the Basic Treatment menu will be discussed under Mitigation in Section 7.2.1. For the pollutant loading analysis, the removal efficiencies specified in the Basic Treatment menu in the Ecology Manual were applied to each pollutant.

In order to compare pollutant loadings among alternatives, it was necessary to first determine a loading estimate for one of the alternatives, as a "baseline." The rehabilitation alternative was chosen as the baseline. No water quality data were available, thus pollutant loadings were estimated for the rehabilitation alternative using

the FHWA procedure (FHWA 1990), based on a pollution-generating impervious surface (PGIS) area of 1.40 acres. The pollutant loadings for the rehabilitation alternative are given in Table 5.[18]

Table 5. Pollutant Loading Estimate for Rehabilitation Alternative (Three-Lane Bridge)

Pollutant	Annual Mass Loading [lb/year][a]	
	Untreated	Treated[b]
Oil & Grease	259	Unknown[c]
Total Copper	0.69	0.17 – 0.34
Total Lead	9.3	2.31 – 4.63
Total Zinc	5.9	1.48 – 2.97
TSS	1875	375

Notes

[a] Annual mass loadings for all alternatives were computed using the FHWA procedure (FHWA 1990), assuming an existing PGIS of 0.95 acres.

[b] Basic Treatment assumed. Pollutant loadings were reduced assuming treatment efficiencies from Table B-1 in Appendix B.

[c] The Ecology Manual does not assign a treatment goal for oil and grease, and removal efficiencies of BMPs is not well understood. Therefore, oil and grease mass loadings after treatment are designated "unknown."

Table 6 presents the estimated 2007-2009 daily weekday traffic volumes associated with the no-action, three-lane, and four-lane alternatives. Higher traffic volumes are expected for the four-lane alternatives. These volumes are extrapolated from 3-hour peak period traffic forecasts and not actual daily (24-hour) traffic numbers. The traffic volumes include growth factors from the King County Travel Demand Model, to represent 2007-2009 conditions. Based on traffic volumes, Table 6 shows the factor by which pollutant loadings would vary relative to three-lane conditions shown in Table 5.

Table 6. Daily Weekday Traffic Volumes (2007-2009) and Resulting Pollutant Loading Multiplier

Alternative	Traffic Volume	Pollutant Loading Multiplier [a]
No Action (Bridge Removal)	0	0
3 Lanes (Rehabilitation)	18,985	1.00
4 Lanes (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span Bridges)	21,175	1.12

Notes

[a] Relative to three-lane alternative.

[18] Note that the FHWA method is based on area, and does not differentiate between numbers of lanes. Thus, the estimates in Table 6-2 could represent either a three-lane or four-lane bridge. This analysis is not intended to predict exact pollutant loadings, but to demonstrate the approximate magnitude of loadings and compare relative changes in loadings among bridge and stormwater treatment alternatives. Thus, the loadings in Table 6-2 represent a baseline against which to compare the four-lane alternatives.

Table 7 presents a summary of the results of the pollutant loading analysis. The No Action Alternative eliminates the pollutant load from the South Park Bridge, due to the closing and removal of the existing bridge. The four-lane alternatives (High-Level Fixed-Span, Mid-Level Fixed Span, and Bascule bridges) attract a higher traffic volume, and result in a higher pollutant load than the Rehabilitation Alternative. However, as noted above, the net impacts to the Duwamish Waterway would be approximately equivalent among all alternatives, since any reduction or increase in traffic volume at the South Park Bridge would be reflected in an approximately equal and opposite effect at other bridges crossing the Duwamish Waterway.

Table 7. Pollutant Loading Summary

Pollutant	Alternative	Annual Mass Loading [lb/year]	
		Untreated	Treated[a]
Oil & Grease	No Action	0	0
	3 Lanes (Rehabilitation)	259	Unknown[b]
	4 Lanes (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span Bridges)	290	Unknown[b]
Total Copper	No Action	0.00	0.00
	3 Lanes (Rehabilitation)	0.69	0.17 – 0.34[c]
	4 Lanes (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span Bridges)	0.77	0.19 – 0.39[d]
Total Lead	No Action	0.0	0.00
	3 Lanes (Rehabilitation)	9.3	2.31 – 4.63[c]
	4 Lanes (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span Bridges)	10.4	2.59 – 5.18[d]
Total Zinc	No Action	0.0	0.00
	3 Lanes (Rehabilitation)	5.9	1.48 – 2.97[c]
	4 Lanes (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span Bridges)	6.6	1.66 – 3.33[d]
TSS	No Action	0	0
	3 Lanes (Rehabilitation)	1875	375[c]
	4 Lanes (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span Bridges)	2100	420[d]

Notes

[a] Basic Treatment assumed. Pollutant loadings were reduced assuming treatment efficiencies from Table B-1 in Appendix B.

[b] The Ecology Manual does not assign a treatment goal for oil and grease, and removal efficiencies of BMPs is not well documented. Therefore, oil and grease mass loadings after treatment are designated "unknown."

[c] Annual mass loadings computed using the FHWA procedure (FHWA 1990).

[d] Calculated by multiplying the range for 3-lane alternative by the factor of 1.12 from Table 6.

See Appendix B for more detailed information regarding the calculations.

Impacts from pollutant loading during long-term operation of the build alternatives would be further reduced by King County's 4(d) compliant road maintenance program.

6.1.2.2 Construction

Water quality impacts associated with construction activities related to each of the alternatives are discussed in this section. The construction activities can be categorized as on-land and in-water areas. Each area has different impacts and applicable BMPs.

Construction activity within the river for any of the five alternatives would likely lead to the suspension or entrainment of sediment, some of it contaminated, in the water. Because the proposed project is within the Lower Duwamish Superfund Site, any disturbance of sediment would need to be coordinated with Region 10 EPA. For further discussion of contaminated sediments, refer to the Hazardous Materials Technical Report. In-water construction activity includes disturbance of the channel bottom, movement of large objects within the water, and placement or removal of large objects within the water. Suspension of sediments in the water would be minimized through the use of cofferdams, caissons or temporary casings. Minor actions, such as movement of vessels, are not likely to disturb the channel substrate.

Concrete work in the river is also a potential water quality concern, as the waterway currently exceeds state water quality standards for pH. The amount of time that the water is exposed to the curing concrete should be limited.

Potential spills or releases of petroleum, concrete, paint, or other toxic materials could occur during construction of a new structure or removal of the existing bridge. BMPs for spill control would be followed during construction to minimize the potential for these impacts. Spills of concrete and cement would be of particular concern due to the 303(d) listing of the Duwamish Waterway for pH. The contractor would prepare a Spill Prevention Control and Countermeasure (SPCC) Plan for approval prior to construction. See the Hazardous Materials Technical Report for more detailed discussion of the SPCC Plan.

To protect utilities, including sewer lines, all utilities will be located and flagged.

No Action Alternative

The existing bridge would be removed once the structure meets one of the following criteria: emergency closure due to an earthquake, inoperable due to on-going deterioration or closure due to too expensive operations and maintenance. Disassembly of the existing bascule leaves, piers, and foundations would be performed carefully so as to minimize disturbance of river sediments. Cranes would be used to disassemble major elements of the existing bridge. The cranes would use the existing bridge approaches as staging areas. Barges may be used to remove oversize materials from the existing bridge. Duration of bridge removal would be approximately 3 to 6 months. Cofferdams would be used during the removal of the foundations. The existing piers will be cut off at the mud line and left in place when removal is complete. All timber piers in the fender system would be completely removed.

Some sediment would likely enter the river during the removal of the bridge foundations. Cofferdams would be installed to isolate the work area, contain the sediment-laden water, and minimize impacts to the river. Performance of the cofferdams and treatment of dewatering is discussed in more detail in Section 7.2.2.

On-land demolition activities would have a low potential for adding sediment to stormwater runoff entering the river. The on-land and in-water impacts to water quality from removal of the existing bridge structure would be very similar for each of the replacement alternatives.

Rehabilitation Alternative

As discussed in Section 2.4.2.2, the rehabilitation alternative would involve replacing the bascule support columns and the support foundations, and adding new pilings for the foundation. The construction impacts associated with in-water activities would be similar to those for the replacement bridge alternatives, as discussed below.

Replacement Bridge Alternatives

This section addresses construction impacts associated with the three replacement bridge alternatives: bascule, mid-level fixed-span, and high-level fixed-span bridges.

The in-water support structures for the replacement bridge design are different from those currently present. Currently, the support structures consist of two large piers for the lifting mechanism housing and two sets of smaller piers. The Bascule Bridge alternative would have a similar arrangement. The fixed-span alternatives would consist of two sets of three smaller columns. The existing timber piles would be replaced with steel or concrete structures. Only concrete and steel structures would be incorporated into the new bridge.

The new Bascule Bridge Alternative would have large piers housing the lifting mechanism similar to the existing bridge. The housing columns will require cast-in-place foundations. In addition, two piers will be located on either edge of the river. The piers would consist of drilled shafts topped with a concrete cap. Two columns would extend above the concrete cap to support the bridge superstructure. The columns would be aligned perpendicular to the bridge deck.

The new fixed-span bridges would have piers on either edge of the river channel and within the intertidal zone. The piers would consist of three 10-foot-diameter drilled shafts. A concrete cap would be constructed on the top of the drilled shafts. Three columns would extend above the concrete cap to support the bridge superstructure. The columns in the water would be aligned parallel to the flow of the Duwamish Waterway. The distance between centers of the piers of a single set would be approximately 23 feet. The distance between the sets of piers varies.

The fenders for each of the replacement bridge alternatives would be constructed with a similar geometry to the existing fenders. Different materials would be used for the piers and cross-bracing.

Barges would deliver construction material, particularly the large bridge girders. Barges would need to deliver approximately 170-foot-long precast concrete girders and other heavy bridge elements.

Construction of the replacement bridge alternatives within the Duwamish Waterway was assumed to be accomplished from temporary docks on the west side of the new bridge on both sides of the river, extending from the shoreline to the navigable river channel. Approximate dimensions of the docks would be 30 feet by 200 feet. The docks would use temporary 2-foot-diameter steel piles. To minimize river disturbance, the dock piles would be driven and then cut off below the mud line and left in place when construction is complete. From the temporary docks, material would be unloaded from the barges using cranes. The cranes would then facilitate foundation construction and placement of girders and other structural elements.

Drilled shafts are proposed for the foundation for all new bridge alternatives in-water and on-land. This is based on preliminary foundation and soils analysis, minimizing impacts along the Duwamish Waterway, and minimizing potential impacts to the existing weakened bridge foundations and piers. Construction of the drilled shafts would occur from the temporary docks. Steel casings would be used to construct the drilled shafts, thus eliminating the need for cofferdams or other isolation techniques. The drilled shafts are anticipated to be 80 to 140 feet deep. Drilled shaft diameters are anticipated to be 10 feet in diameter in the river and 8 feet on land.

Construction of the new in-river bridge columns, pier caps, and fender system would require temporary cofferdams or other types of form work around the pier/fender location during construction. The cofferdams would isolate the work area from the flow of the river, thereby minimizing mixing of soils into water column. Some of the soils are contaminated and considered hazardous materials.

The cofferdams would need to be dewatered by pumping the water to a treatment system to remove any contaminated sediments. The contaminated sediments would be disposed of appropriately.

Routine maintenance of the bridge structure would occur with each of the alternatives. These activities would include repair and painting as required. Most likely these activities would be essentially the same as existing maintenance activities, except for the emergency repairs required to keep the existing bridge functioning.

The removal of the existing bridge would have the same construction impacts as described under the No Action Alternative section above.

On-land construction activities, such as pavement removal and site grading, would also potentially result in some erosion. However, the potential for sedimentation in the river is small. The levee on either side of the Duwamish Waterway effectively prevents sheet flow from the on-land construction areas from entering the waterway. In addition, BMP's would be implemented to impound the stormwater behind the levees and prevent it from entering the waterway. Stormwater from construction areas would be collected and treated before discharge to the combined sewer system. Traditional temporary erosion

and sedimentation control (TESC) BMPs would be implemented to limit the erosion from disturbed areas. TESC BMP's applicable to this project are discussed in further detail under Chapter 7 Mitigation.

6.1.2.3 Summary

Some sediment would likely enter the river during the construction of the new bridge columns, pier caps, and fender system and the removal of the existing bridge foundations. However, cofferdams would be used to isolate the work area from the river flow, thereby reducing the potential for sediment entrainment in river water. Performance of the cofferdams is discussed in more detail in Section 7.2.2. The suspension of sediments into the flow of the waterway is an unavoidable adverse impact associated with each of the alternatives. The amount of sediments entrained in the water as a result of construction is likely to be small relative to the background level; however, a portion of these sediments may be contaminated. Because the proposed project is within the Lower Duwamish Superfund Site, any disturbance of sediment would need to be coordinated with Region 10 EPA.

The No Action Alternative would likely result in the least disturbance to the waterway, as only the existing structure would be removed. The Rehabilitation and Bascule Bridge Alternatives would have the greatest potential to increase the turbidity of the water, due to the larger footprint of the foundations for the lifting mechanism housings and the necessity to drill more support piers. The sediment disturbance potential of the Mid-Level and High-Level Fixed-Span Bridge Alternatives would be the same.

Each of the replacement bridge alternatives would require drilling piers for foundation support. Steel casings would be used to minimize water quality impacts to the Duwamish Waterway.

6.1.3 Waterway

6.1.3.1 Floodway

The impacts to the floodway due to each of the proposed alternatives were evaluated using the HEC-RAS hydraulic model. The model calculates the water surface elevation given a particular flow rate and downstream tailwater condition. Model input data and detailed output is included in Appendix C.

The results from the HEC-RAS floodway analysis of existing conditions and the proposed alternatives are summarized below. Table 8 shows the predicted water surface elevations for the 100-year peak flow rate for the existing conditions and each alternative.

The Bascule Bridge alternative would result in a slightly higher water surface elevation (0.01 foot) for the 100-year peak flow rate. The remaining alternatives would result in a equal or slightly lower water surface elevations as compared to existing conditions. Since the Duwamish Waterway is a zero rise floodway, mitigation would be required for the Bascule Bridge alternative.

Table 8. Water Surface Elevation for 100-Year Peak Flow Rate Upstream of the Bridge (River Station 1850)

Scenario	Elevation (Feet NAVD88)
Existing Bridge	11.83
No Action	11.80
Rehabilitation	11.83
Bascule Bridge	11.84
Mid-Level Fixed-Span Bridge	11.82
High-Level Fixed-Span Bridge	11.82

6.1.3.2 Channel Stability

The results from the HEC-RAS model were also used to evaluate the effects of each of the alternatives on the channel stability of the Duwamish Waterway. Channel stability refers to the potential for the riverbed to aggrade (i.e., sedimentation) or degrade (i.e., scour) due to the hydraulics of the bridge opening. Channel stability also refers to stability of the streambanks.

Two hydraulic properties calculated by the HEC-RAS model are potential indicators of channel aggradation or degradation: velocity and shear stress. Other factors that contribute to aggradation or degradation are hydrology and substrate composition, which are beyond the scope of this analysis. The total average velocity in the channel at the bridge for existing conditions and for each alternative is summarized in Table 9. Similarly, the total average bed shear stress on the channel bottom at the bridge is summarized in Table 10.

Table 9. Total Average Channel Velocity at Bridge (feet per second) for 100-Year Peak Flow Rate

Tidal Elevation (feet NAVD88)	Existing Bridge	No Action[a]	Rehabilitation	Bascule Bridge	Mid-Level Fixed-Span Bridge	High-Level Fixed-Span Bridge
11.78	2.44	1.29	2.44	2.69	1.38	1.37
10.00	2.69	1.42	2.69	2.94	1.51	1.51
8.00	3.02	1.59	3.02	3.26	1.71	1.71
6.00	3.43	1.80	3.43	3.62	1.94	1.94
4.00	3.95	2.06	3.95	4.04	2.22	2.22
2.00	4.61	2.39	4.61	4.56	2.58	2.58
0.00	5.44	2.81	5.44	5.17	3.05	3.04
-2.00	6.38	3.34	6.38	5.91	3.63	3.63
-4.00	7.40	3.96	7.40	6.71	4.31	4.31
-6.00	8.57	4.62	8.57	7.58	5.03	5.02
-8.00	9.65	5.20	9.65	8.39	5.68	5.67

[a] Data for the No Action Alternative were taken from a cross-section approximately 175 feet upstream from the project area.

Table 10. Total Average Shear Stress at Bridge (pounds per square foot) for 100-Year Peak Flow Rate

Tidal Elevation (feet NAVD88)	Existing Bridge	No Action[a]	Rehabilitation	Bascule Bridge	Mid-Level Fixed-Span Bridge	High-Level Fixed-Span Bridge
11.78	0.05	0.01	0.05	0.06	0.01	0.01
10.00	0.06	0.01	0.06	0.07	0.02	0.02
8.00	0.08	0.02	0.08	0.09	0.02	0.02
6.00	0.10	0.02	0.10	0.11	0.03	0.03
4.00	0.14	0.03	0.14	0.13	0.04	0.04
2.00	0.19	0.04	0.19	0.18	0.06	0.06
0.00	0.27	0.06	0.27	0.23	0.08	0.08
-2.00	0.36	0.09	0.36	0.30	0.12	0.12
-4.00	0.50	0.13	0.50	0.39	0.17	0.16
-6.00	0.68	0.18	0.68	0.51	0.23	0.23
-8.00	0.88	0.23	0.88	0.64	0.30	0.30

[a] Data for the No Action Alternative were taken from a cross-section approximately 175 feet upstream from the project area.

As presented in the two tables, the velocity and shear stress results show that each of the alternatives, except for the rehabilitation bridge, would reduce the potential for scour as compared to existing conditions. The Bascule Bridge Alternative has the highest potential for causing scour, followed by the Fixed-Span Alternatives, the Rehabilitation Alternative and the No Action Alternative. These calculations are only meant to illustrate the effect on the river hydraulics of each of the proposed alternatives, rather than to predict the occurrence of scour. Given the relatively low velocities and shear stresses in the waterway, it is unlikely that the piers would need to be armored with rip rap and it is likely that integrated streambank stabilization procedures that consider structural as well as habitat features would suffice for the protection of the levees. However, a more detailed scour and stream stability analysis should be conducted during the design phase to ensure that the bridge geometry does not result in instability in the waterway.

The general threshold for particle movement is in the range of 0.5 pound per square foot (lb/ft^2) for gravels, and 0.01 lb/ft^2 for sands. Small cobbles might be expected to move and be transported once shear stresses exceed approximately 2 lb/ft^2.

Given that the channel substrate is comprised primarily of finer materials with some cohesion, it is possible that flow conditions would occur that would lead to erosion. Additionally, given the location of the bridge in the intertidal zone and the regulation of flows in the waterway by the Howard Hanson Dam, it is likely that flow conditions would occur that would lead to sedimentation. The channel bottom likely would shift periodically, depending on the tides and flow rates. It is not anticipated that additional dredging would be required by the Army Corps of Engineers for any of the alternatives.

6.1.4 Groundwater

The project construction and operation would not have any impacts to a sole source aquifer. Potential water quality impacts to groundwater would be primarily limited to spills of hazardous material.

Stormwater from the project site would be collected and discharged either to the combined sanitary sewer system or the Duwamish Waterway, thereby avoiding potential impacts to groundwater. Added impervious area over ground surfaces (i.e., not the bridge deck) would reduce the recharge to groundwater. Due to the limited amount of additional impervious area, the impact to groundwater quantity is expected to be small.

6.2 Secondary Impacts

This section evaluates secondary or indirect impacts associated with other activities resulting from the completed project.

Seattle Public Utilities may decide to construct a larger outfall on the south side of the bridge to accommodate tributary off-site drainage that currently discharges to the combined sewer system. The water quantity and quality impacts associated with additional drainage discharge to the Duwamish Waterway would require additional environmental review.

6.3 Cumulative Impacts

This section evaluates cumulative impacts associated with other private or public planned activities in the project vicinity. The following planned projects or on-going activities were considered for cumulative impacts:

- Duwamish Sediment Remediation/Cap (Boeing Company)
- Duwamish Dredging (Army Corps of Engineers)
- Lower Duwamish Waterway Superfund Site remediation (EPA Region 10)

The Boeing Company is expected to implement remediation of contaminated sediments at the project site within the time frame of the South Park Bridge Project. The sediment cap is designed to improve water quality in the Duwamish. Specific plans and timing of the sediment cleanup are not yet available. The selected bridge alternative should precede the sediment cleanup and would be designed to complement it. If sediment clean up precedes bridge construction, it would be necessary to conduct construction in a manner that does not disturb the adjacent remediated sediment, which could result in recontamination.

The periodic dredging of the Duwamish Waterway is a corrective action intended to maintain the navigability of the channel. None of the South Park Bridge alternatives is anticipated to alter the frequency of the dredging operations.

No adverse cumulative impacts are associated with these projects and the South Park Bridge project.

6.4 Impact Summary

Potential impacts to water resources within the project area are similar for the build alternatives. Each alternative would require some amount of construction (including bridge removal) that would generate similar impacts on land and in water. Although potential impacts might vary between alternatives, no single impact or alternative was substantially different from the others.

Stormwater quantity was determined to change slightly between alternatives, with the greatest potential impacts attributable to the greatest area of construction (i.e., high-level fixed span bridge). However, construction of drainage conveyance improvements, including installation of an outfall on the Duwamish River, would mitigate for any impact on the existing stormwater conveyance capacity on either side of the bridge. Furthermore, because all of the project area lies within a developed urban corridor that is essentially all impervious surface, no real increase in on-land impervious area will result from any alternative.

City of Seattle code would likely require mitigation for stormwater quantity for redevelopment alternatives. Most likely for the High-level Fixed-span bridge. Mitigation could consist of using slightly longer-diameter pipes than existing conditions. Because the cost of purchasing slightly larger-diameter pipes relative in significant compared to the construction cost of replacing the existing pipes, this possible mitigation was not considered to be distinguishable from the other alternative.

Stormwater quality was determined to change slightly between alternatives, with the higher impacts attributed to greater traffic volume on the four-lane alternatives (High-Level Fixed-Span Bridge, Mid-Level Fixed Span Bridge, and Bascule Bridge) than the three-lane alternative (Rehabilitation). Stormwater routed to existing conveyance facilities would be treated at the West Treatment Plant before discharge. Stormwater conveyed to the Duwamish outfalls would be treated according to Ecology recommended BMPs before discharge.

Potential impacts from construction related sediment loading were similar between all alternatives, with a slight increase relative to the increase in construction footprint. On-land construction impacts would be avoided by using standard BMPs to control sediment in runoff. In-water mitigation (e.g., coffer dames, caissons, or temporary casings) would help control sediment disturbance during bridge removal and new pier construction. Potential impacts were determined to be relative to the size of new bridge footings and piers, which were greatest for the rehabilitation and bascule alternatives, less for the fixed span alternative, and least for the No-Action alternatives. In-water mitigation would be similar in cost for all construction alternatives.

Woodway conveyance would not be affected by any alternatives except the Bascule Bridge Alternative. The Bascule Bridge Alternative could possibly raise the Duwamish water surface elevation by 0.01 feet fore the 100-year peak flow rate. Mitigation might be avoided by pier reconfiguration. Mitigation might be achieved through levee setback, which would be an additional cost for this alternative.

Bridge induced scour of the waterway was evaluated and determined to be similare between all construction alternatives, with the Bascule Bridge Alternative presenting the greatest potential for impacts, followed by the fixed-span alternatives and Rehabilitation Alternative. However, all construction alternatives were shown to have less scour potential then the existing structure (except the Rehabilitation Alternative, which would have the same potential as existing conditions) and no alternative was considered significant at this level of scour analysis.

No impacts to groundwater were identified.

No basin-wide impacts were identified.

Cost-effectiveness of mitigation measures was not significantly different between alternatives at this level of analysis.

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7.1 Stormwater Quantity

7.1.1 Conveyance

For the replacement bridge alternatives, a new conveyance system would be designed and sized in accordance with applicable standards. No additional mitigation is proposed.

7.1.2 Detention

Stormwater discharge into the Duwamish would be mitigated through flow control structures as required per jurisdictional standards. Detention would be provided for added impervious area discharging to the combined sewer. The detention volume and release rate would be per the City of Seattle design standards.

7.2 Water Quality

7.2.1 Operational

For this report, it was assumed that the stormwater from the project site would be discharged to the Duwamish Waterway. If possible, existing stormwater outfalls on the south and north side of the bridge would be used. However, a new outfall may need to be constructed on either or both sides of the bridge.

Stormwater treatment would be required for runoff from pollutant-generating surfaces discharging to the Duwamish Waterway. The Basic Treatment water quality menu in the Ecology Menu applies to stormwater draining to the Duwamish Waterway.

The following water quality BMPs are listed under the Basic Treatment menu in the Ecology Manual as appropriate for treating stormwater:

- Bio-infiltration Swale
- Infiltration
- Sand Filters
- Biofiltration Swales
- Filter Strips
- Basic Wetpond
- Wetvault
- Stormwater Treatment Wetland
- Combined Detention and Wetpool Facilities

Low impact development techniques for managing and treating stormwater would be the first design option. Because bridge and surrounding area is mostly impervious, implementation of low impact development techniques would require conversion of existing impervious surfaces to pervious surfaces, as well as rehabilitation of soils. Pervious surfacing options (paver blocks, pervious pavement) would also provide some reduction of impervious area; these options would be most feasible for low-traffic areas (shoulders and pedestrian walkways).

Given the lack of available land in the project area, the BMPs that can be located in underground vaults would appear to be the most feasible. BMPs which can be placed in underground vaults include sand filter and wetvault. The vaults would be located underneath the bridge approaches or adjacent to the road within the road right-of-way. The size of the selected facility type(s) would vary depending on the amount of pollution generating impervious surface area receiving treatment. In general, the more pollutant-generating surface area, the larger the facility required. The facilities would be designed to treat only stormwater from the project site.

7.2.2 Construction

Temporary Erosion and Sedimentation Control (TESC) measures would be implemented during construction for all construction activities associated with each of the alternatives. Traditional BMPs listed in the Ecology Manual would be employed, including, but not limited to, the following: silt fence, straw matting and temporary sedimentation pond.

The Contractor would need to prepare a Surface Water Protection Plan (SWPP) that describes water quality protection measures during construction. The SWPP would be submitted for approval to King County and Ecology.

The Hydraulic Project Approval issued by the Washington Department of Fish and Wildlife would likely prohibit in-water construction during the spring in-water closure period from February 15 to July 15. This action would avoid impacts to fisheries, especially the substantial populations of juvenile chinook and other salmon that migrate past the site. Limiting the amount of in-water construction during the spring in-water closure period would minimize water quality impacts during an ecologically sensitive period.

For the in-river construction of piers and foundations and removal of existing structures, cofferdams would be installed to isolate the work area. The cofferdam would be intended to prevent flow from the waterway from entering the work area. As such, they are designed to be waterproof. Unless the bottom of the work area is sealed, groundwater can enter from below. The specific type of cofferdam would be selected by the Contractor and would be documented in the approved SWPP. The cofferdams are intended to effectively impound any sediment-laden water, thereby minimizing impacts to the river. Alternatively, casings would be used for drilling piers to reduce water quality impacts.

Once the cofferdams are installed, the work area would be dewatered using a pump. The water would be pumped to a pond or tank for appropriate treatment and disposal. The

collected water would be tested for adherence to State water quality standards. If permitted, uncontaminated water would be discharged directly to the sanitary sewer system. Alternatively, water meeting the water quality standards would be returned to the Duwamish Waterway. Contaminated water would be shipped off-site for proper disposal in a hazardous waste treatment facility. The specific construction protocols and thresholds for collected stormwater and dewatering would be described in the approved SWPP.

7.3 Waterway

7.3.1 Floodway

Mitigation would be required for floodway impacts associated with the Bascule Bridge alternative. No mitigation was specifically evaluated for this report. Mitigation measures that may be appropriate include widening the floodway width at the bridge by moving the levees back or reconfiguring the piers so that they perform better hydraulically.

7.3.2 Channel Stability

Estimation of total channel aggradation or degradation was beyond the scope for this technical report. In order to determine mitigation measures, a more detailed scour analysis would need to be conducted during the design phase of the rehabilitation and replacement alternatives.

The channel velocities and shear stresses resulting from each of the proposed alternatives are relatively low even under high flow and low tide conditions and would be unlikely to cause significant erosion. In addition, the scour potential would be likely small relative to the riverbed aggradation and degradation resulting from tidal effects and upstream watershed sediment load.

Disturbed portions of the streambank and levee would be stabilized using integrated techniques, such as bioengineering, that consider structural integrity as well as habitat features of the streambank.

Although unlikely, mitigation measures may be required if significant scour is predicted to occur during more detailed analysis. Typical mitigation measures to reduce scour include riprap placement, pier geometry and location modification, and guide bank installation. A guide bank is a dike extending upstream from the approach embankment to direct the flow through the bridge opening. The mitigation measures may have environmental impacts not accounted for in this report.

7.4 Groundwater

Discussion of hazardous material spill control and handling of contaminated groundwater is included in the Hazardous Materials Technical Report. Therefore, no adverse impacts to groundwater quality are anticipated due to the construction or operation of any of the proposed alternatives.

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APPENDIX A

Runoff Calculations

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Location	2-year	10-year	25-year	100-year
Aberdeen and Hoquiam	2.5	3.2	4.0	5.0
Anacortes	1.2	2.0	2.5	3.1
Bellingham	1.8	2.7	3.1	3.8
Bremerton	2.5	3.5	4.5	5.0
Cathlamet	3.5	5.0	5.7	6.8
Centralia and Chehalis	2.2	3.0	3.5	4.3
Clarston and Colfax	1.4	1.8	2.1	2.6
Colville	1.4	1.9	2.2	2.6
Ellensburg	1.5	2.3	2.7	3.5
Elma	3.0	4.2	4.7	6.0
Everett	1.5	2.3	2.6	3.2
Forks	5.5	7.5	8.5	10.0
Gold Bar	3.0	3.5	4.0	5.0
Goldendale	1.5	2.3	2.8	3.5
Hoffstadt Creek	4.5	6.0	7.5	9.0
Hoodsport	4.8	6.6	7.7	9.5
Humptulips	5.0	6.7	8.0	10.0
Kelso and Longview	2.5	3.5	4.0	5.0
Leavenworth	1.5	2.0	2.5	3.0
Long Beach	3.0	4.0	4.5	5.5
Moses Lake	0.7	1.1	1.3	1.7
Mount Vernon	1.7	2.6	3.0	3.7
Naselle	4.5	6.0	7.0	8.5
North Bend	4.0	5.0	6.0	6.5
Olympia	2.8	4.3	5.1	6.1
Omak	1.0	1.6	1.8	2.2
Pasco and Richland	0.8	1.3	1.6	2.0
Port Angeles	2.1	3.1	3.9	4.6
Port Townsend	1.0	1.7	2.0	2.5
Poulsbo	2.0	2.4	3.5	4.0
Queets	5.2	6.5	7.5	9.3
Raymond	3.5	4.9	5.5	6.5
Seattle	2.0	2.8	3.4	4.0
Sequim	1.5	2.0	2.5	2.8
Shelton	4.0	5.5	6.5	8.5
Snoqualmie Pass	5.5	7.0	8.0	10.0
Spokane	1.4	2.0	2.2	2.6
Stevens Pass	5.0	6.5	7.5	9.0
Sumas	2.5	3.3	3.8	4.5
Sumner	2.0	2.8	3.3	3.9
Tacoma	2.0	3.0	3.5	4.0
Toledo	2.3	3.0	3.5	4.2
Vancouver	2.3	3.0	3.5	4.3
Vantage	1.0	1.6	1.9	2.3
Walla Walla	1.2	1.9	2.0	2.4
Wenatchee	1.5	2.2	2.5	3.1
White Pass	4.5	6.0	7.0	8.0
Yakima	1.0	1.5	1.8	2.2

24-Hour Duration Rainfall Volumes

Figure 3-3.1

BASIN SUMMARY

BASIN ID: BB25 NAME: Bascule Bridge 25yr
SBUH METHODOLOGY
TOTAL AREA.....: 3.92 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE2 PERV IMP
PRECIPITATION....: 3.40 inches AREA..: 0.00 Acres 3.92 Acres
TIME INTERVAL....: 10.00 min CN....: 0.00 98.00
TC....: 0.00 min 6.30 min
ABSTRACTION COEFF: 0.20
PEAK RATE: 10.86 cfs VOL: 1.03 Ac-ft TIME: 710 min

BASIN ID: HL25 NAME: High-Level 25yr
SBUH METHODOLOGY
TOTAL AREA.....: 6.66 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE2 PERV IMP
PRECIPITATION....: 3.40 inches AREA..: 0.00 Acres 6.66 Acres
TIME INTERVAL....: 10.00 min CN....: 0.00 98.00
TC....: 0.00 min 6.30 min
ABSTRACTION COEFF: 0.20
PEAK RATE: 18.46 cfs VOL: 1.76 Ac-ft TIME: 710 min

BASIN ID: ML25 NAME: MidLevel Fixed 25yr
SBUH METHODOLOGY
TOTAL AREA.....: 4.94 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE2 PERV IMP
PRECIPITATION....: 3.40 inches AREA..: 0.00 Acres 4.94 Acres
TIME INTERVAL....: 10.00 min CN....: 0.00 98.00
TC....: 0.00 min 6.30 min
ABSTRACTION COEFF: 0.20
PEAK RATE: 13.69 cfs VOL: 1.30 Ac-ft TIME: 710 min

BASIN ID: NA25 NAME: No Action 25yr SAME FOR REHABILITATION
SBUH METHODOLOGY
TOTAL AREA.....: 2.03 Acres BASEFLOWS: 0.00 cfs
RAINFALL TYPE....: TYPE2 PERV IMP
PRECIPITATION....: 3.40 inches AREA..: 0.00 Acres 2.03 Acres
TIME INTERVAL....: 10.00 min CN....: 0.00 98.00
TC....: 0.00 min 6.30 min
ABSTRACTION COEFF: 0.20
PEAK RATE: 5.63 cfs VOL: 0.54 Ac-ft TIME: 710 min

APPENDIX B

Pollutant Loading Calculations

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Table 5. Worksheet B - Highway runoff characteristics.

EXAMPLE TSS LOAD ESTIMATE
HIGH - LEVEL FIXED - SPAN ALTERNATIVE

1 Compute runoff coefficient (Rv) (section 3.1)

a	Percent Impervious (Worksheet A- Item 1c)	IMP	100	%
b	Runoff Coefficient (= 0.007 * IMP + 0.1)	Rv	1.0	ratio

↳ For small, 100% IMP area, set $R_v = 1.0$.

2 Compute runoff flow rates (section 3.1)

a	Flow rate from mean storm = Rv * MIP * AROW	MQR	N/A	CFS
b	Coefficient of variation of runoff flows = CVIP (Worksheet A - Item 2f)	CVQR	N/A	dimensionless

3 Compute runoff volumes (section 3.1)

$(1.0)(0.46\ in)(1.40\ AC)(3630\ \frac{cu.ft.}{AC\text{-}in})$

a	Volume from the mean storm = Rv * MVP * AROW * 3630	MVR	2345	cubic feet
b	Coefficient of variation of runoff volumes = CVVP	CVVR	N/A	dimensionless

4 Compute mass Loads (section 3.2)

Table B-2

	Site Median Conc (~~Worksheet A- Item 4a~~)	TCR	120	mg/l
	Coef of var. of site EMC's (~~Wksht A- 4b~~)	CVCR	0.71	dimensionless
	Number of storms per year (~~Wksht A- 2i~~)	NST	87	number

↳ $(24\ \frac{HR}{D})(365\ \frac{D}{Y}) / MTP = (24\ \frac{HR}{D})(365\ \frac{D}{Y}) / (101\ \frac{HR}{Storm})$

a	mean event concentration (MCR) = TCR * SQRT(1+ CVCR^2)	MCR	147	mg/l
b	mean event mass load = MCR * MVR *(0.00006245) ⇒ CONCENTRATION × VOLUME	M(MASS)	21.6	pounds
c	annual mass load from runoff = M(MASS) * NST	ANMASS	1875	pounds/year

5 Compute flow ratio (MQS/MQR) (section 3.3)

a	ratio of average stream flow (Worksheet A - 7b) to MQR	MQS/MQR	N/A	ratio

Rainfall event statistics for selected cities

ZONE	CITY	STATE	VOLUME (inches) mean MVP	VOLUME (inches) coef of var CVVP	INTENSITY (in/hr) mean MIP	INTENSITY (in/hr) coef of var CVIP	DURATION (hours) mean MDP	DURATION (hours) coef of var CVDP	INTERVAL (hours) mean MTP	INTERVAL (hours) coef of var CVTP
4	Lake Charles	LA	0.66	1.64	0.108	1.40	7.7	1.26	109	0.99
4	New Orleans	LA	0.61	1.46	0.113	1.40	6.9	1.24	89	1.02
4	Shreveport	LA	0.54	1.39	0.080	1.27	7.8	1.09	110	0.99
4	Memphis	TN	0.52	1.36	0.086	1.31	6.9	1.07	89	1.01
5	Houston	TX	0.55	1.73	0.085	1.55	8.2	1.30	104	1.00
6	San Jose (May to Oct.)	CA	0.20	1.59	0.040	1.64	6.7	1.06	842	0.98
6	San Jose (Nov. to Dec.)	CA	0.36	1.38	0.030	1.36	12.4	1.16	127	1.39
6	Phoenix	AZ	0.17	1.38	0.055	1.26	3.2	0.97	286	1.42
6	El Paso	TX	0.15	1.54	0.047	1.12	3.3	1.07	226	1.43
6	Oakland	CA	0.19	1.62	0.033	0.74	4.3	1.03	320	1.60
7	Eugene	OR	0.63	1.88	0.026	0.88	23.1	1.35	118	1.30
7	Portland	OR	0.36	1.51	0.023	0.79	15.5	1.09	83	1.32
7	Seattle	WA	0.46	1.45	0.023	0.86	21.5	1.26	101	1.02
8	Salt Lake City	UT	0.18	1.32	0.025	1.06	7.8	0.85	133	0.97
9	Denver	CO	0.22	1.49	0.032	1.13	9.1	1.15	144	0.92
9	Rapid City	SD	0.20	1.46	0.033	1.09	8.0	1.24	127	0.95

Appendix 3
WSDOT *Highway Runoff Manual*
Best Management Practice Effectiveness Rates

		MEDIAN REMOVAL RATE (%)				
BMP	Information Source	**Total Suspended Solids**	N	P	Lead	Zinc
Biofiltration Swale	FHWA	**70**	25	30	70	70
	WPT	**81**	38	29	67	71
	NTIS	**60**	10	20	70	60
	King Co. SWM	**77**	25	33	66	---
Wet Pond	FHWA	**90**	48	65	---	---
	WPT	**67**	24	48	73	51
	NTIS	**60**	35	45	75	60
Vegetated Filter Strip	FHWA	**70**	30	40	70	70
	WPT	**81**	38	29	67	71
	NTIS	**85**	---	90	---	85
	WSDOT	**83**	---	---	---	---
Extended (nutrient control) wet pond	FHWA	**79**	34	46	66	66
	WPT	**60**	42	58	73	51
Wet vaults/tanks	FHWA	**30**	<10	<10	<10	<10
	NTIS	**15**	5	5	15	5

Averaging all the pollutant removal effectiveness data for wet ponds and bioswales, which constitute ~90% of HRM BMPs constructed by WSDOT, yields a mean 72% (5/7) effectiveness ratio. Assuming that pollutant loadings from new and preexisting impervious surface areas are identical, the area of preexisting impervious surface area for which to provide treatment to yield no-net-increase in pollutant loading becomes (1 minus 5/7) divided by 5/7 = 2/5 = 0.4.

References:

FHWA - *Evaluation and Management of Highway Runoff Water Quality*, FHWA Publication No. FHWA-PD-96-032, June 1996.

NTIS - *Evaluation of Highway Runoff Pollution Control Devices*, U. S. Department of Commerce/National Technical Information Service, Publication Number PB97-138481, December 1996.

King Co. SWM - *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins*, Final Report for Task 5 of Centennial Grant Agreement No. TAX90096, October 1995.

WPT - *Comparative Pollutant Removal Capability of Urban BMPs: A Reanalysis*, Watershed Protection Techniques, Vol. 2, No. 4, June 1997.

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APPENDIX C

HEC-RAS Model Technical Documentation

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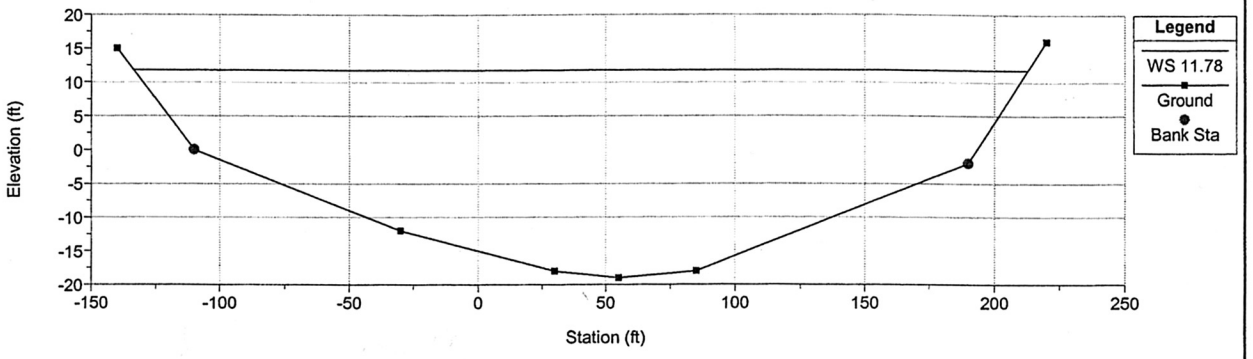
SouthParkBridge Plan: Existing Channel
29+00



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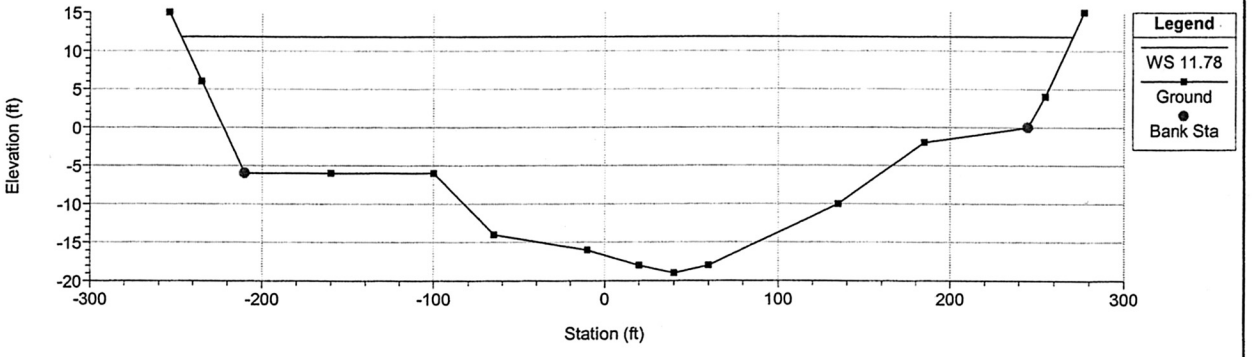
25+50



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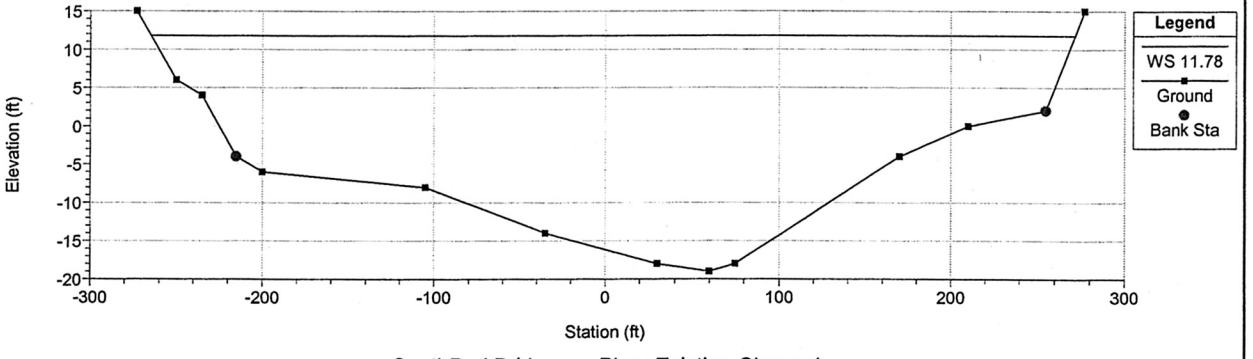

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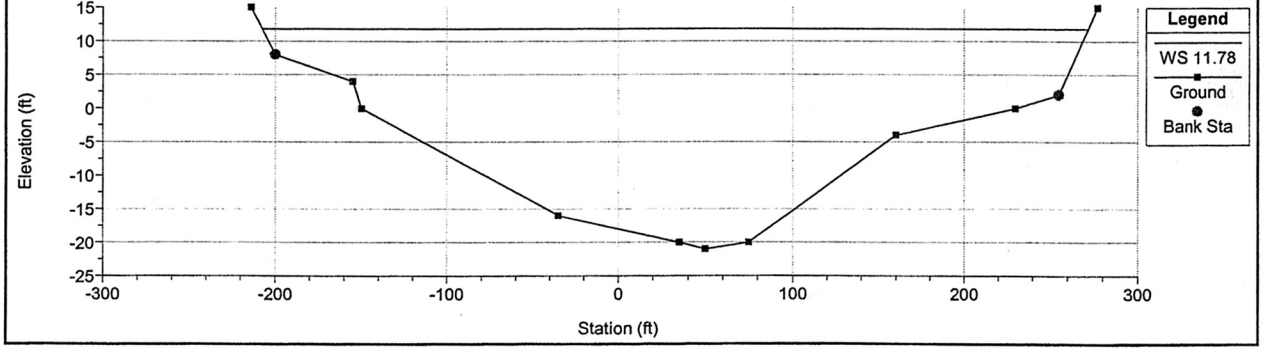

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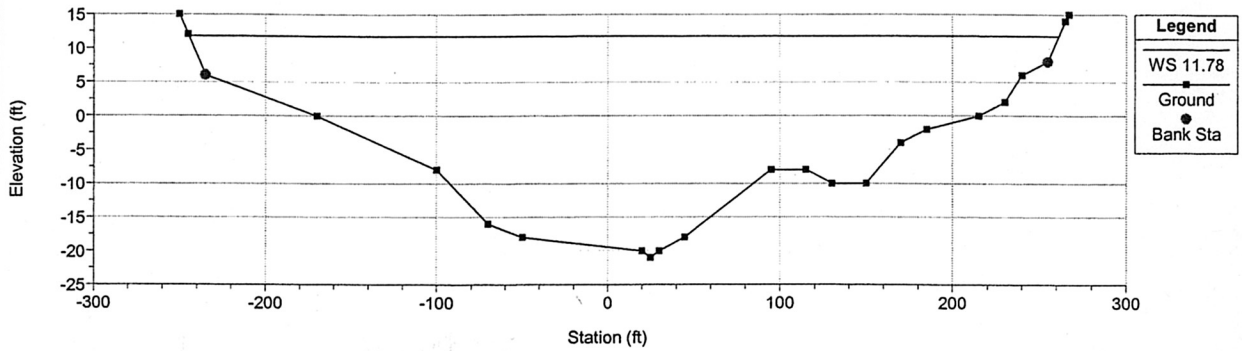

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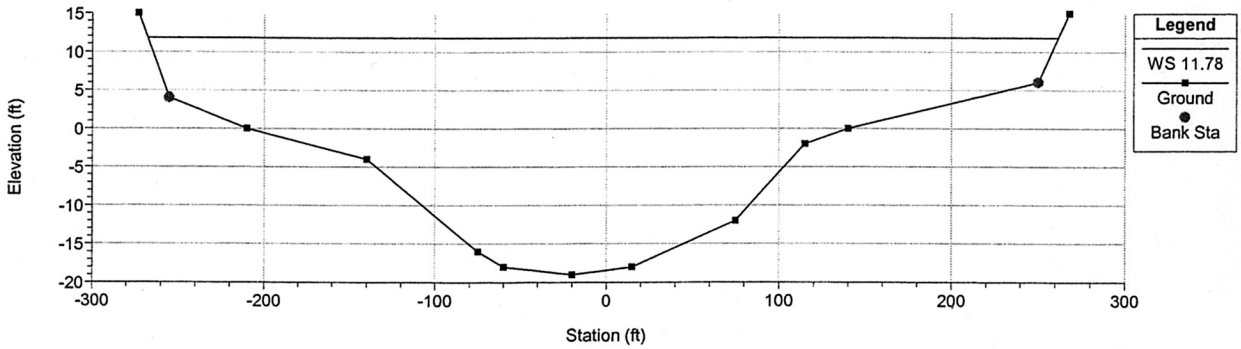

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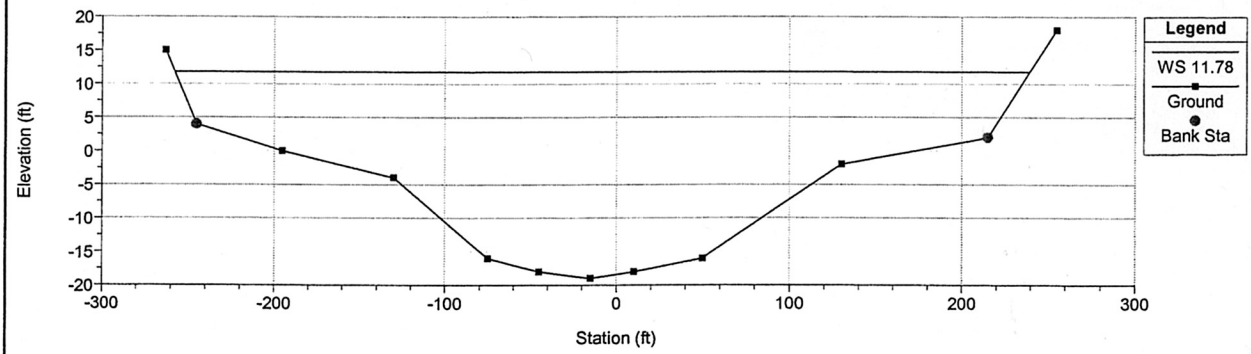

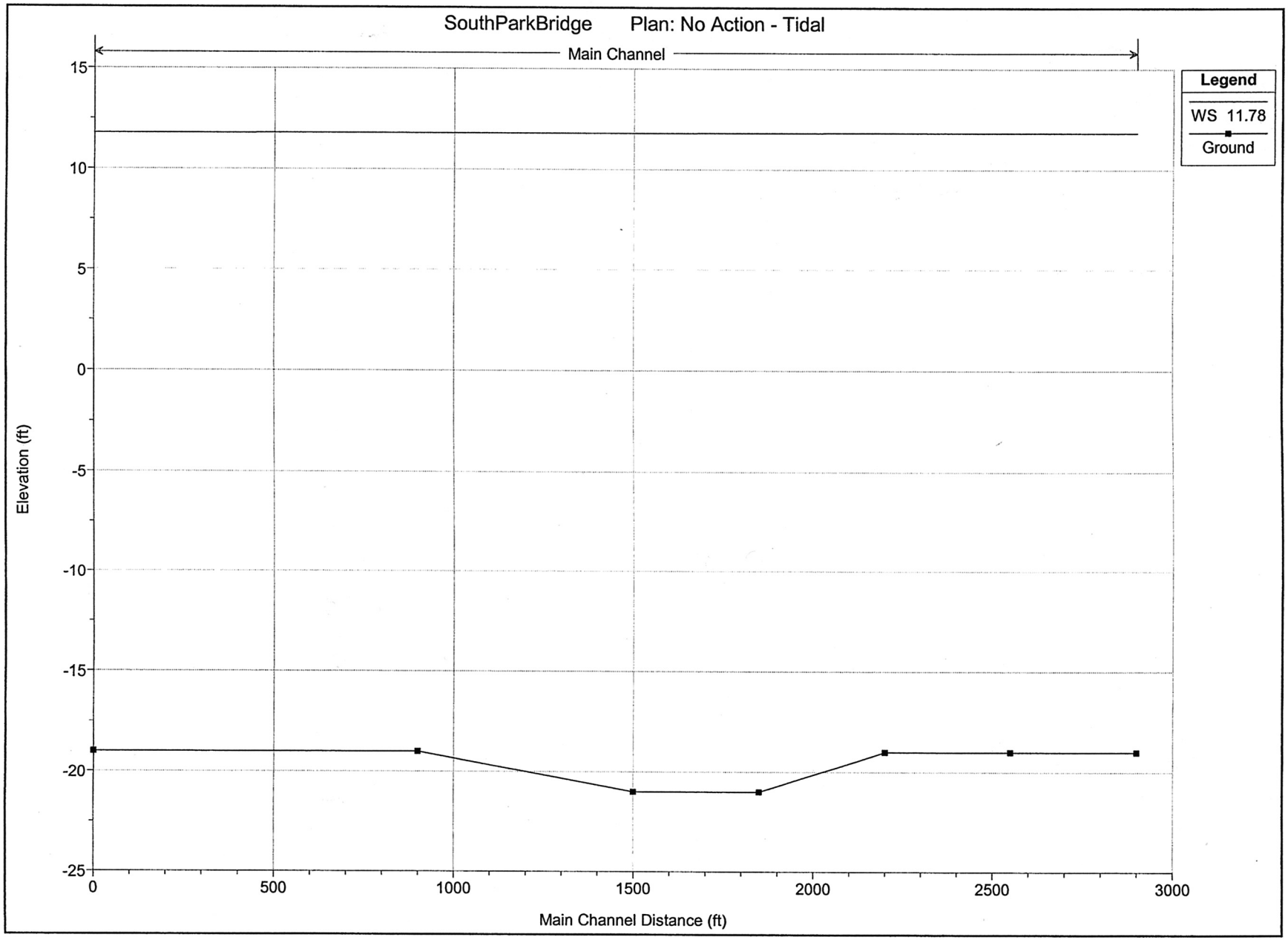
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Main Channel
Legend
WS 11.78
Ground
Elevation (ft)
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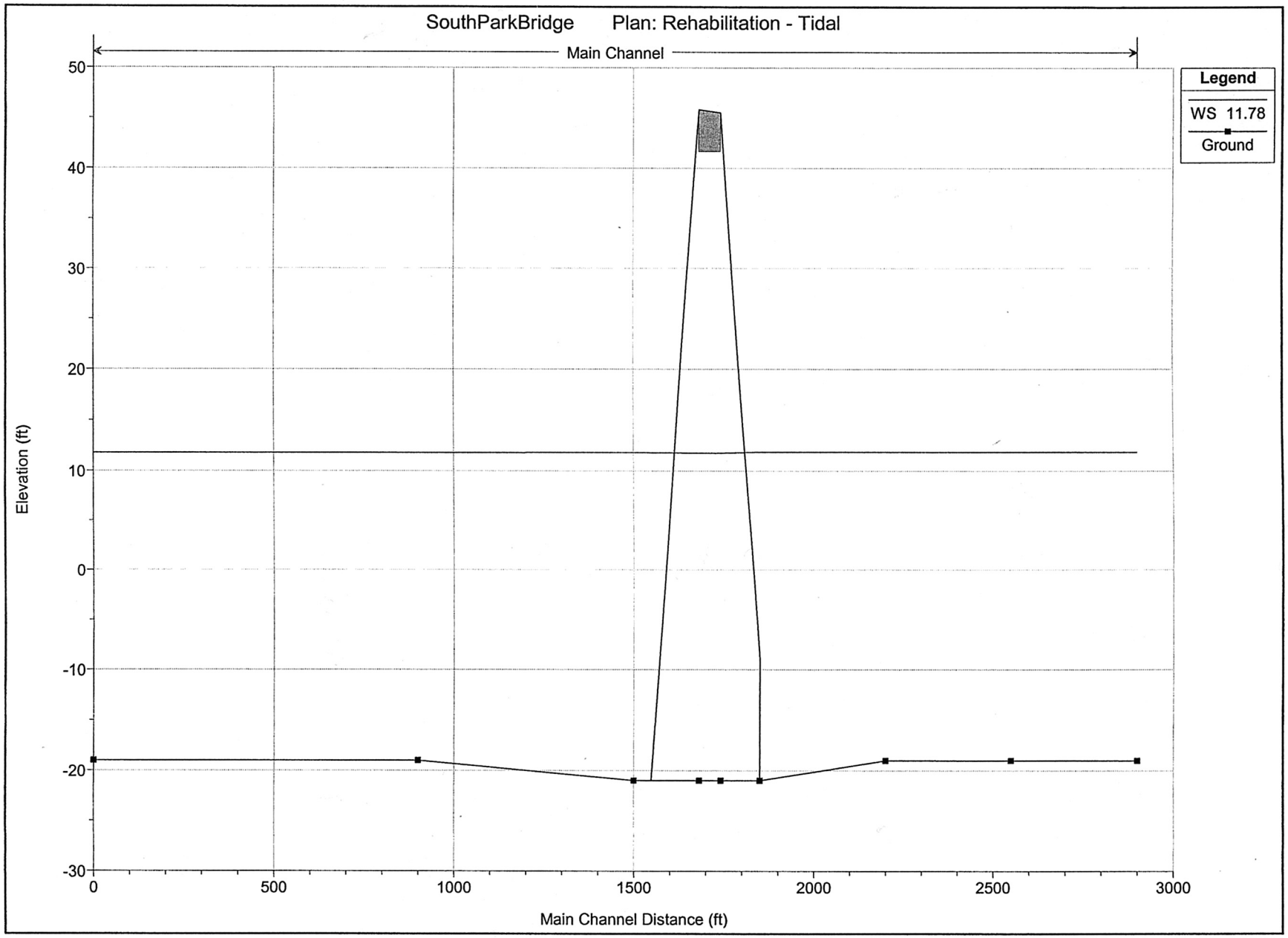
2500
3000
Main Channel Distance (ft)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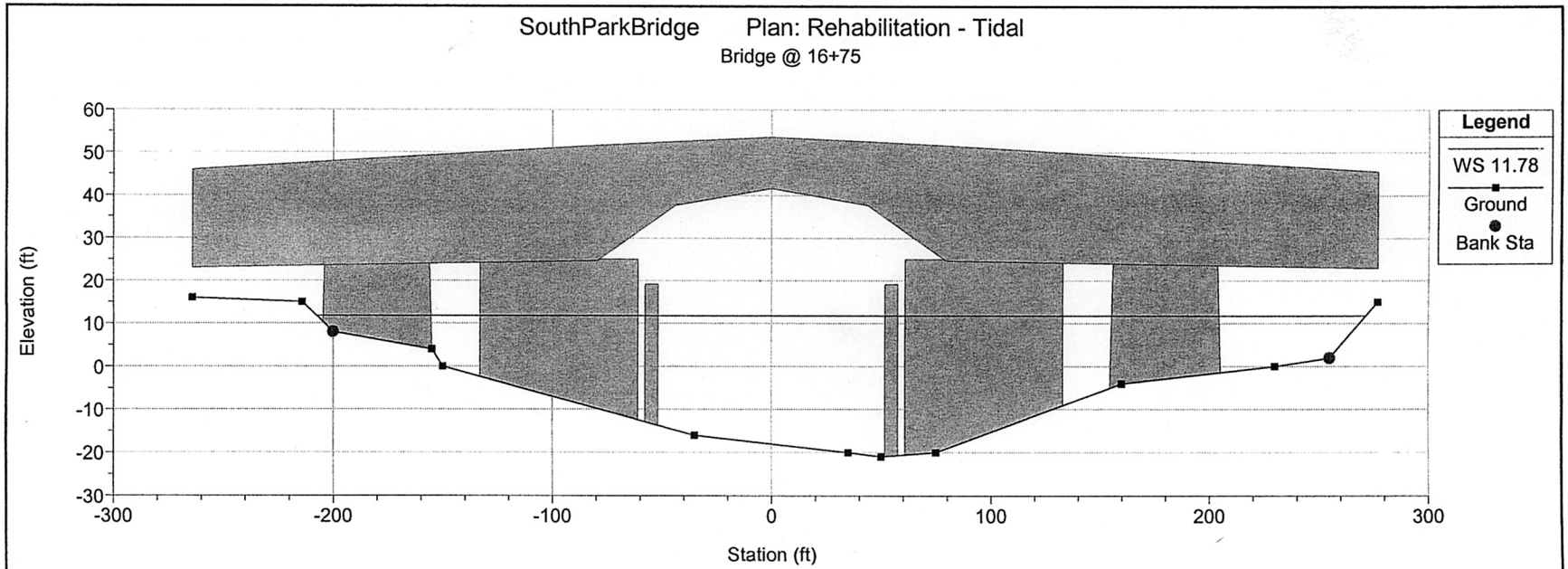
Main Channel Distance (ft)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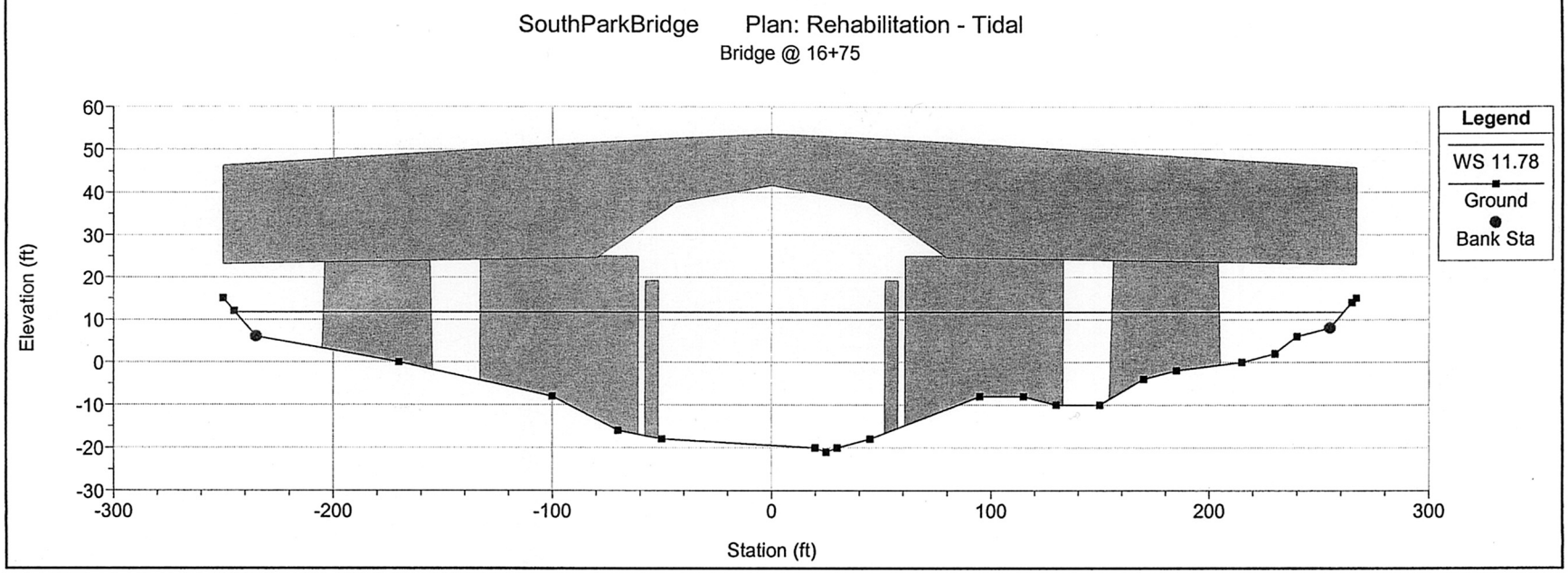
Bridge @ 16+75
Elevation (ft)
Station (ft)
Legend
WS 11.78
Ground
Bank Sta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Bridge @ 16+75
Elevation (ft)
Station (ft)
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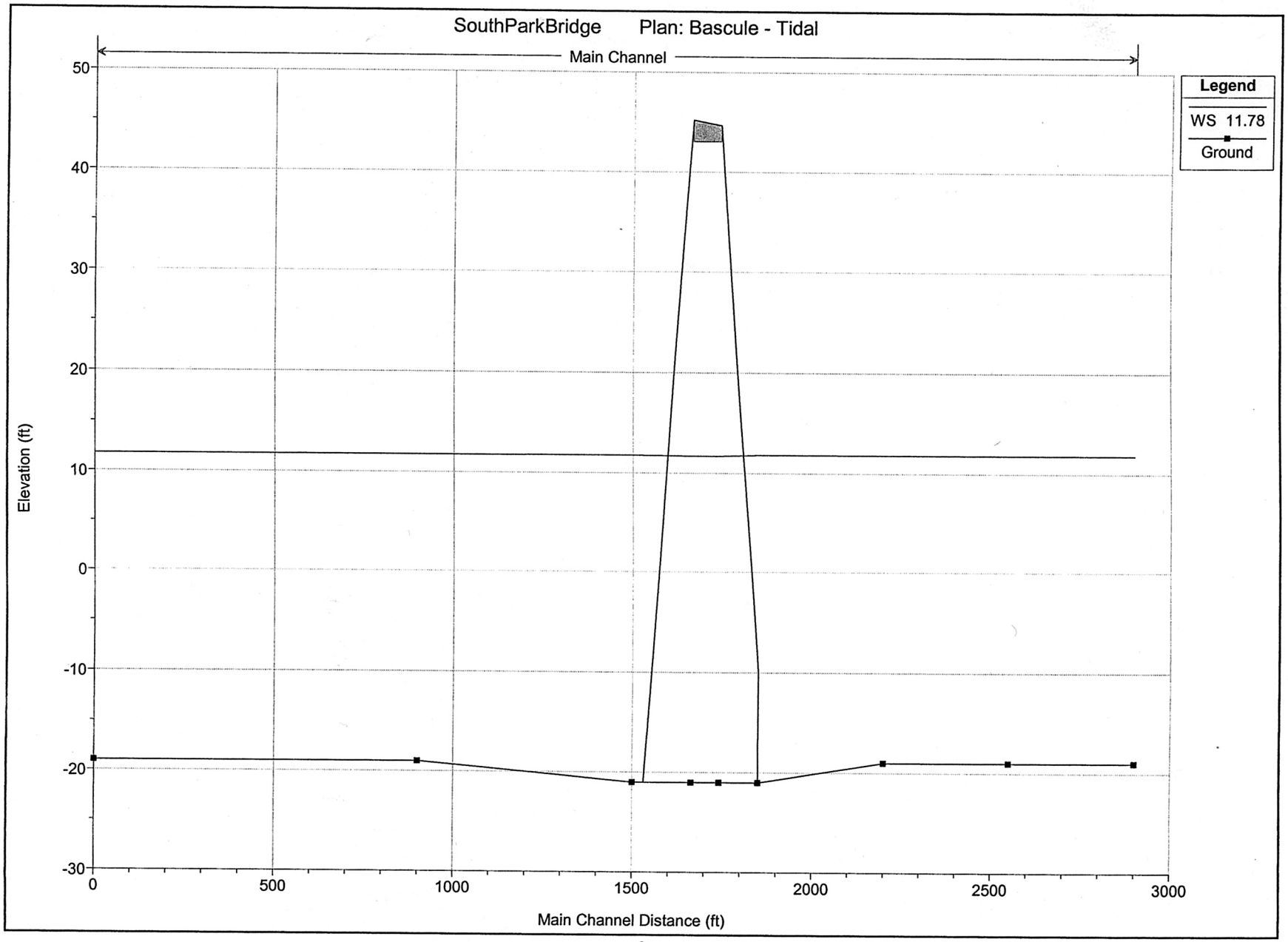
WS 11.78
Ground
Bank Sta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Main Channel
Legend
WS 11.78
Ground
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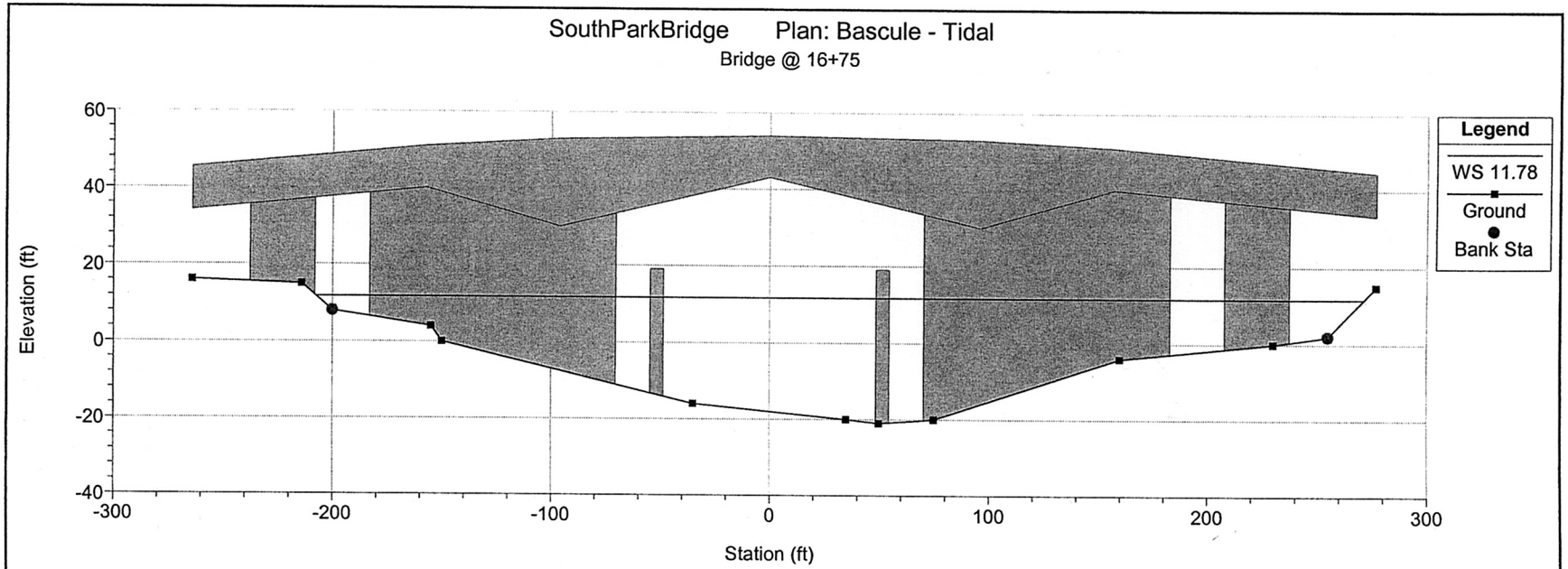
Main Channel Distance (ft)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Bridge @ 16+75
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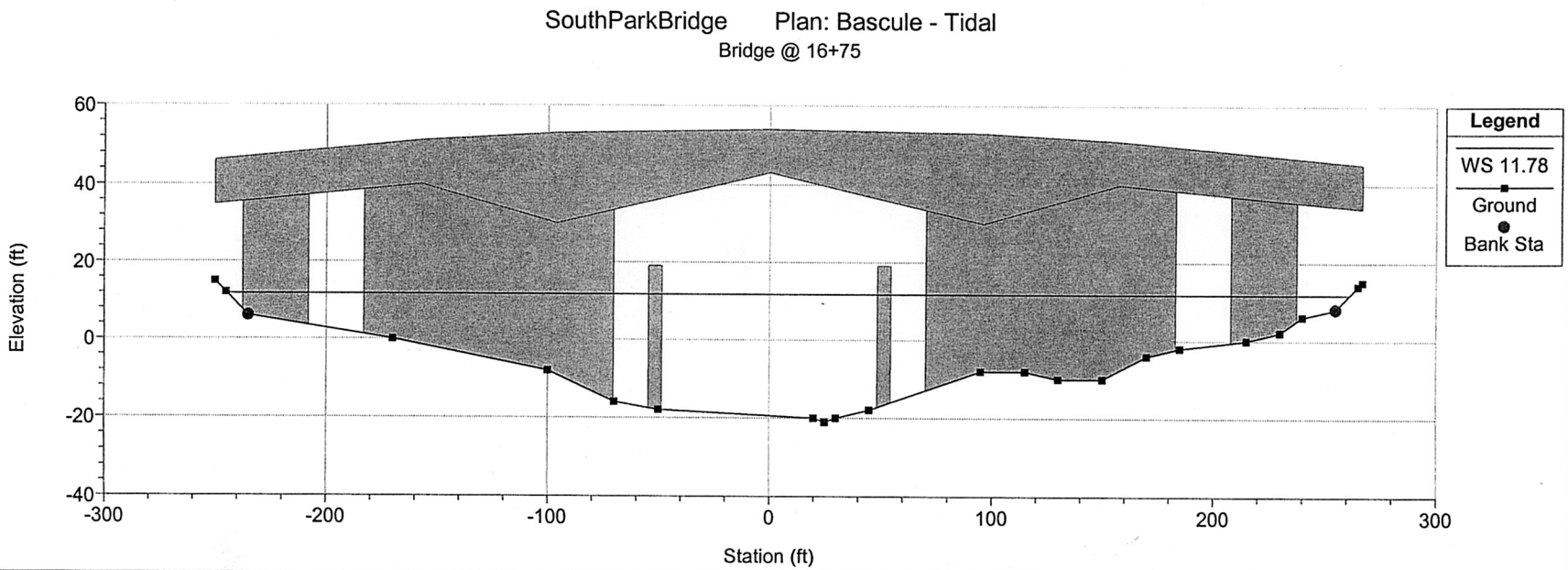
Station (ft)
Legend
WS 11.78
Ground
Bank Sta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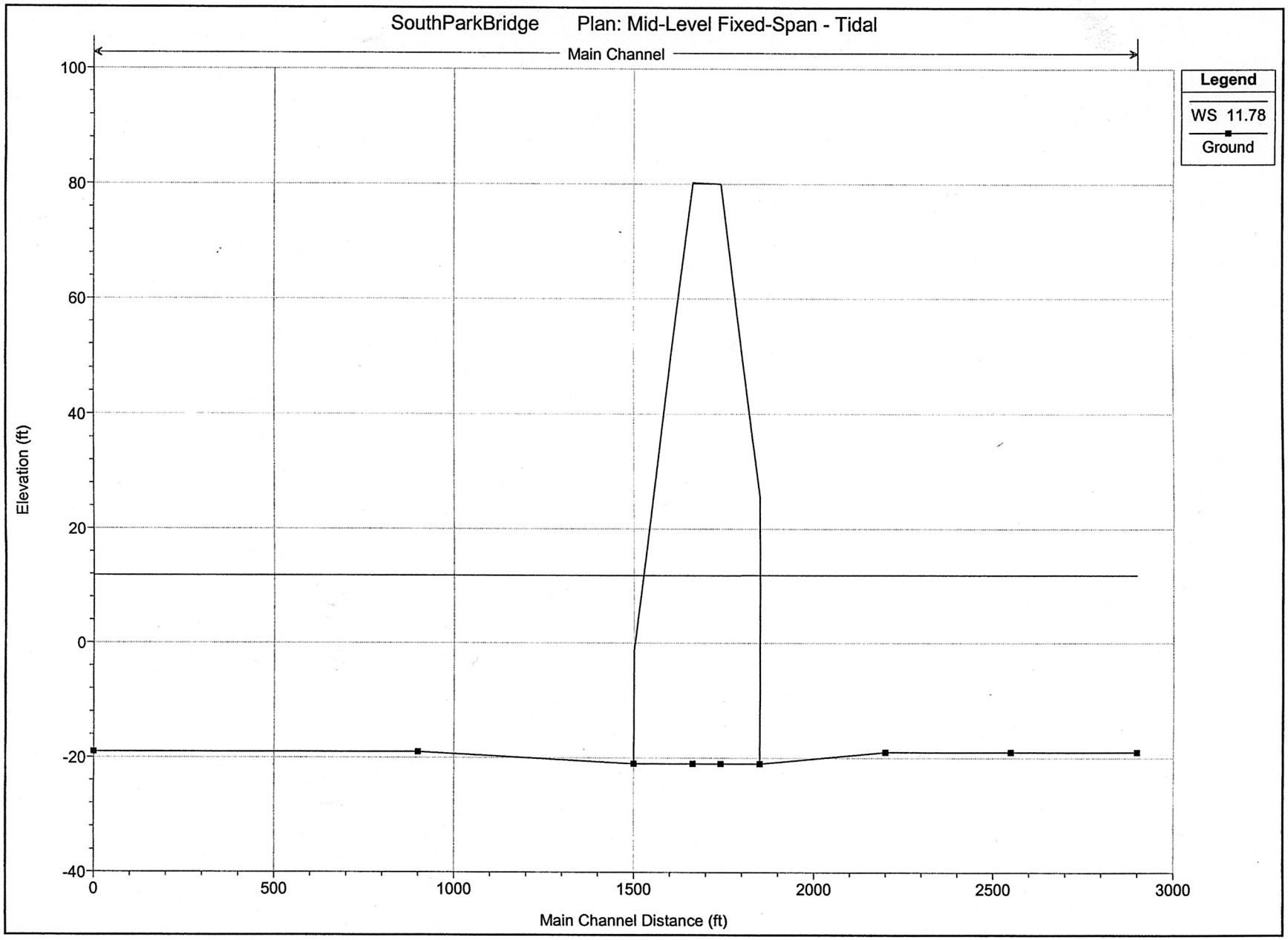
Bridge @ 16+75
Elevation (ft)
Station (ft)
Legend
WS 11.78
Ground
Bank Sta


SouthParkBridge Plan: Mid-Level Fixed-Span - Tidal
Main Channel
Legend
WS 11.78
Ground
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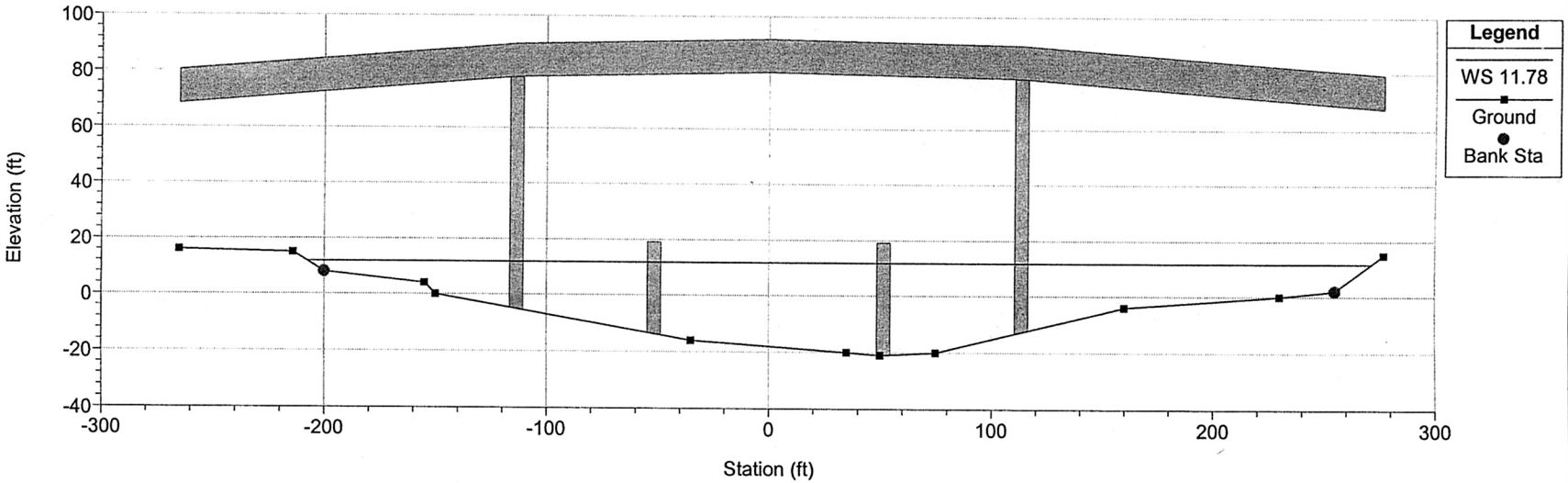
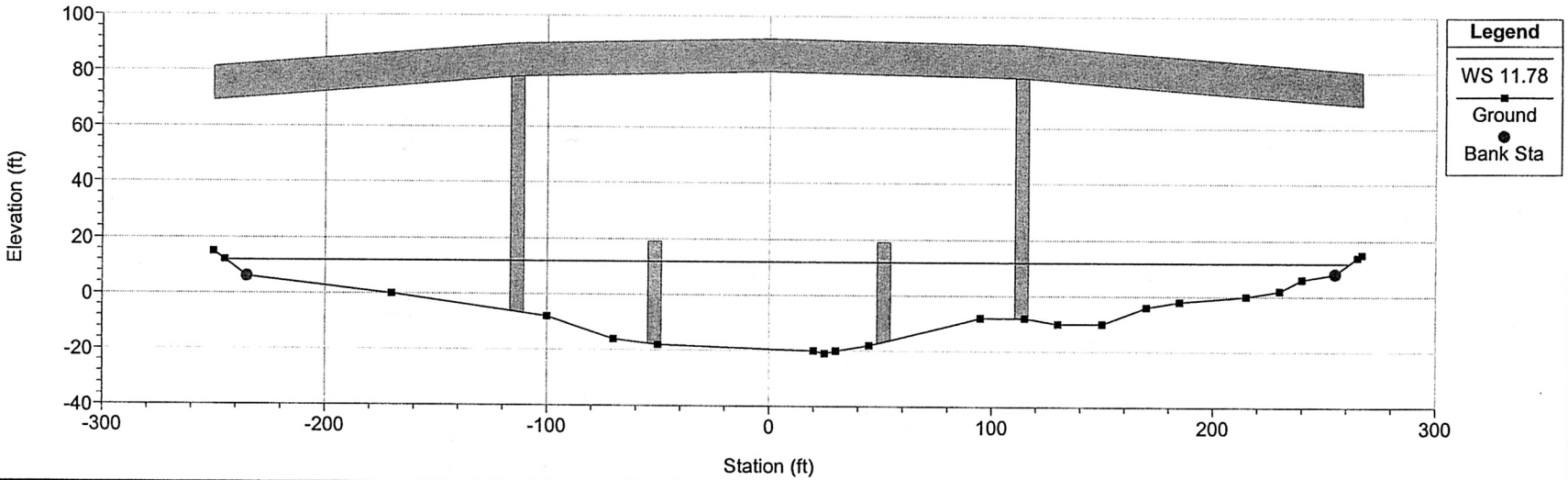
Main Channel Distance (ft)


SouthParkBridge
Plan: Mid-Level Fixed-Span - Tidal
Bridge @ 16+75
Elevation (ft)
Station (ft)
Legend
WS 11.78
Ground
Bank Sta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Plan: Mid-Level Fixed-Span - Tidal
Bridge @ 16+75
Elevation (ft)
Station (ft)
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WS 11.78
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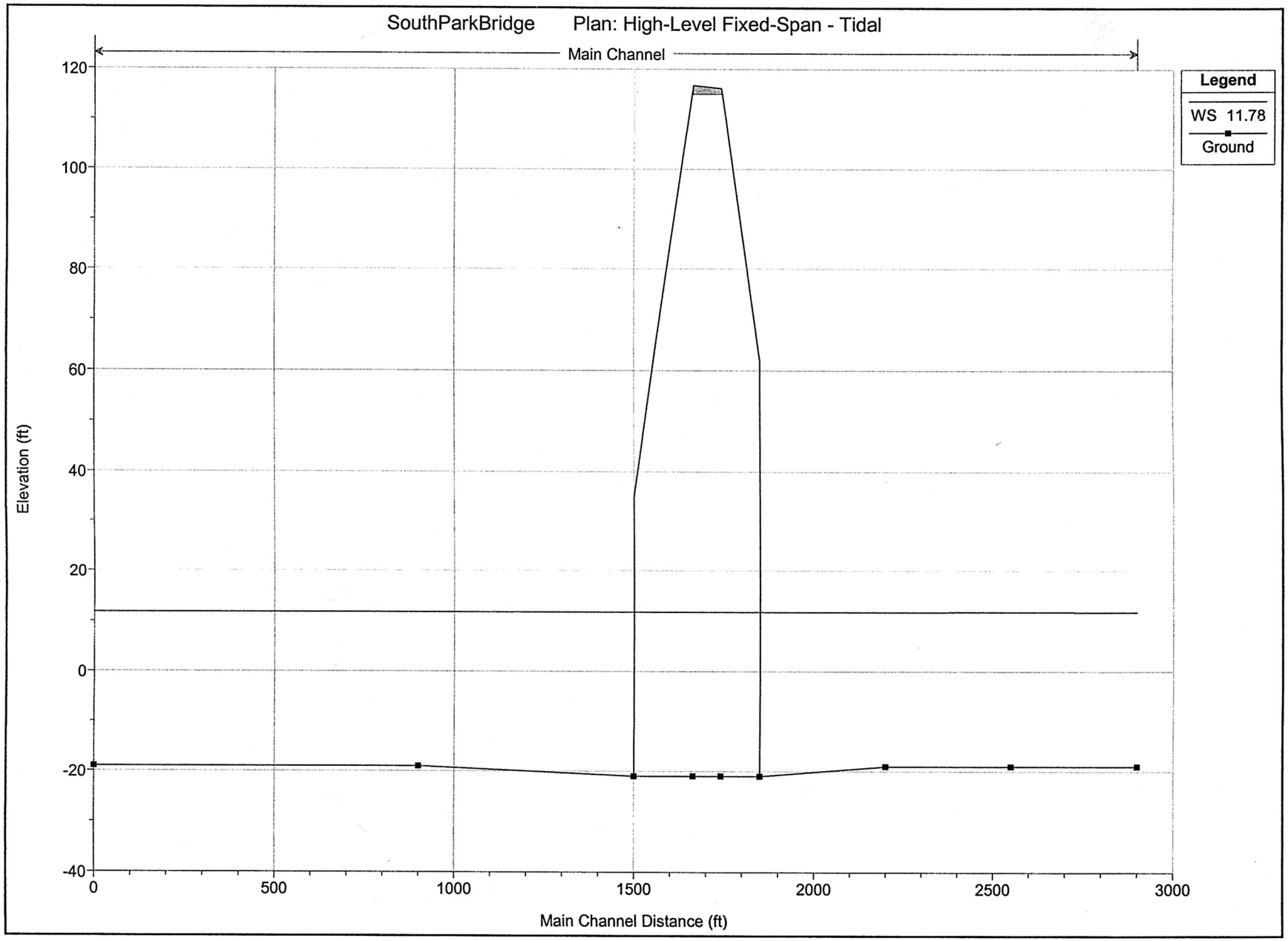
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Main Channel
Legend
WS 11.78
Ground
Elevation (ft)
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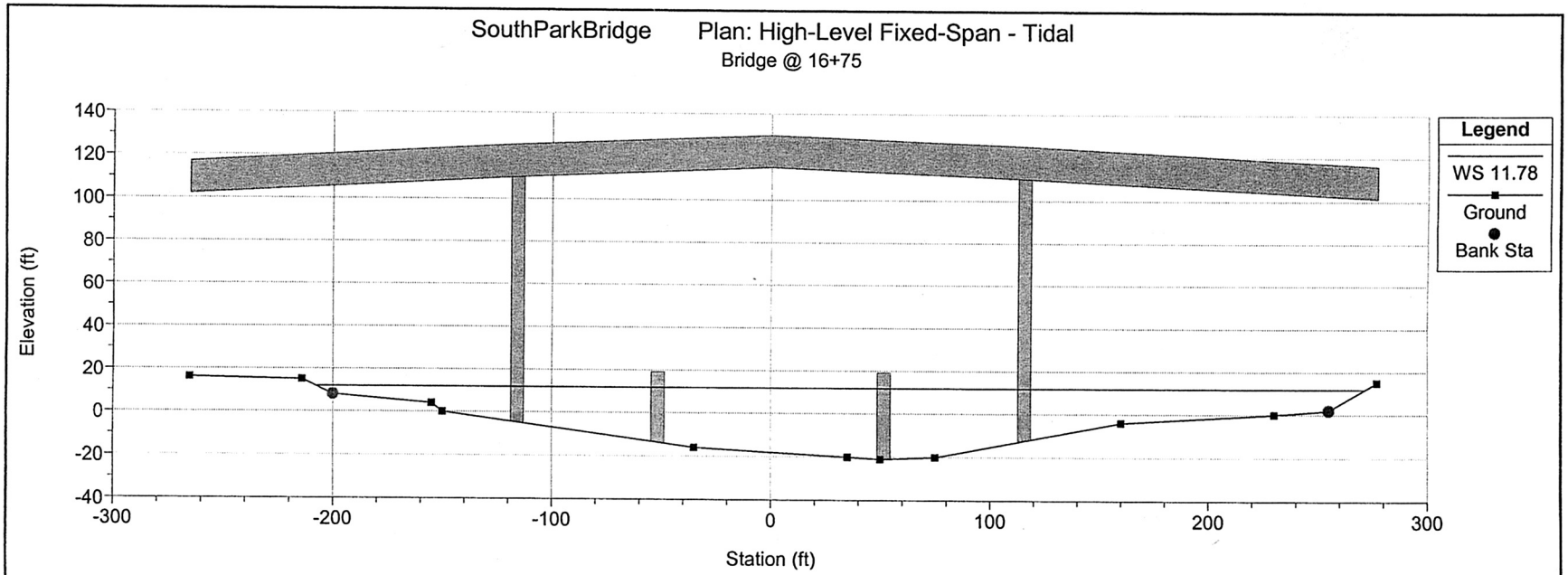
Main Channel Distance (ft)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Plan: High-Level Fixed-Span - Tidal
Bridge @ 16+75
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Station (ft)
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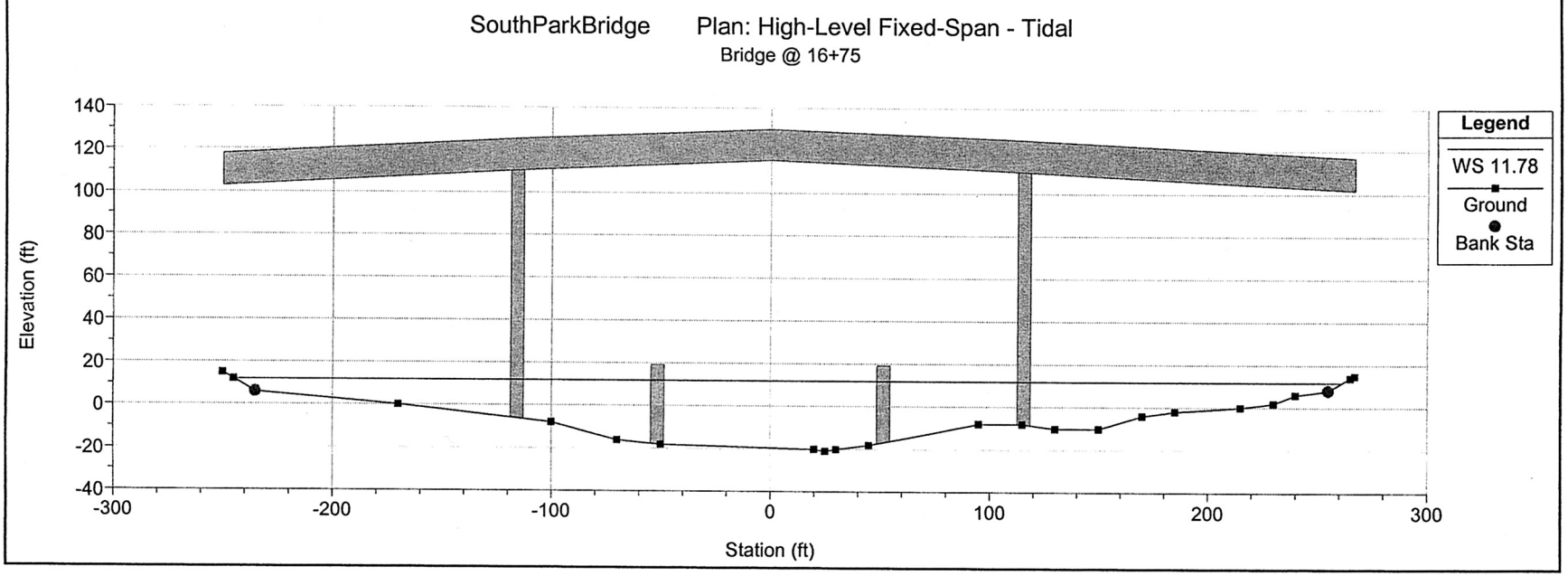
Ground
Bank Sta


SouthParkBridge
Plan: High-Level Fixed-Span - Tidal
Bridge @ 16+75
Elevation (ft)
Station (ft)
Legend
WS 11.78
Ground
Bank Sta

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Appendix V. Fish, Wildlife, and Vegetation Technical Report

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Technical Report
South Park Bridge Project

Fish, Wildlife & Vegetation

Prepared for the
King County
Department of Transportation
201 South Jackson Street
Seattle, Washington 98104

Prepared by
Parametrix, Inc.
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Kirkland, Washington 98033-7350
February 2004

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Technical Report
South Park Bridge Project

Fish, Wildlife & Vegetation

February 2004

Prepared for:
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Chapter 1 Executive Summary

The South Park Bridge located at the junction of 14th Avenue South and 16th Avenue South on the Duwamish River at approximately River Mile 3.8 is in need of replacement or major reconstruction. The poor condition of the existing piers supporting the bridge structure threatens to permanently close the bridge with any substantial movement that may result from a future earthquake or the continued degradation and movement of the support piers.

The purpose of the South Park Bridge Project is to find the most feasible long-term solution to address the deteriorated condition and increasing seismic vulnerability of the South Park Bridge, while maintaining a vital transportation link for cars, trucks, buses, bicyclists, and pedestrians across the Duwamish Waterway.

Project Objective and Description

The no action alternative would eventually result in the removal of the existing bridge at some undefined time in the future. The river habitat at the bridge site would become similar to that immediately upstream and downstream from the bridge crossing when the existing bridge structures were removed. With the Rehabilitation Alternative the bridge would be replaced within its current alignment following removal of the existing bridge. Construction of a replacement bridge would require a temporary support pier adjacent to the replacement bridge to facilitate construction. New concrete and steel piles and support structure would replace the existing treated woodpile and concrete support structures. The rebuilt structure would occupy a larger footprint within the river removing additional benthic habitat. The rows of creosote treated timber piles at middle intertidal elevations would not be replaced with the Rehabilitation Alternative. Mitigation for the lost shallow water habitat would be required by resource agencies.

The designs of the bridge replacement alternatives each occupy a replacement bridge alignment immediately downstream from the existing bridge. Each alternative has in-water support structures that would be fewer in number and would not include the toxic creosote treated timber that is currently present. Numerous creosote treated timber piles and timbers are part of the fender protection of the existing bridge. Only concrete and steel structures are proposed for the rehabilitation and replacement bridge structures. The amount of space occupied by the new structures may also be somewhat less within the water and cover less benthic habitat than the existing structure, depending on the alternative selected. Only two rows of four concrete piers would support the replacement bridge within the river on each side of the river channel for the fixed span alternatives. With the Bascule Bridge Alternative four rows of piers would support the bridge within the river. These rows of concrete piers would be in line with the existing timber piles, but slightly downstream. They would be located at the lower intertidal elevations just outside the dredged river channel. The replacement bridge structure would be about the same height as or higher above the water than the existing bridge. The replacement bridge would be slightly wider over the river habitat than the existing bridge. The aquatic primary

production at this location that is predominately diatoms would likely not be measurable reduced by the new structures.

Description of Existing Conditions

The bridge site is in the middle of a highly urbanized portion of the Seattle metropolitan area and is characterized by industrial, business, and residential development. Fish and wildlife habitat has been extensively altered through human activity with little natural habitat remaining at the bridge location or in its general vicinity. However, the intertidal periphery of the river channel provides substantial amounts of muddy sand habitat supporting juvenile salmon during their migration to the ocean. Other estuarine fishes commonly use this habitat for juvenile rearing. Although this habitat was constructed through previous dredging and filling of the estuarine tideflats, it appears to currently function in the same manner as natural tideflats.

The Duwamish River provides upper estuarine habitat for a variety of fishes. Juvenile salmonids, sculpins, starry flounder, and a few other fishes may be found in this vicinity. Birds using the Duwamish River include several species of gulls, mergansers, and western grebe. Bald Eagles and osprey are not known to nest within the site vicinity, but do forage along the rivers shorelines. Birds common in urban areas such as crow, starling, killdeer, etc. are commonly observed along these shorelines.

Endangered, Threatened and Proposed Species and Designated Habitat Occurrence

The bridge is located on the Duwamish River, which provides habitat supporting substantial populations of young Chinook and other salmon during their migration to the ocean. The sub-yearling Chinook and chum salmon rely on the shallow shoreline habitat during their migration making them potentially sensitive to alterations of the habitat. Yearling coho, steelhead, and possibly Chinook also migrate past the site during the spring, but are less shoreline oriented than the subyearling salmon. Bull trout have been identified in the lower Duwamish on rare occasions, but a sustaining population does not appear to exist within the Green-Duwamish River system. The U.S. Fish and Wildlife Service consider the stock status of bull trout in the basin to be unknown. The individuals observed are likely anadromous subadults and adults migrating into the lower river from other Puget Sound river systems for short periods of foraging. Adult salmon and cutthroat trout return through this area to their spawning areas in the Green River, but do not have specific habitat requirements as they migrate past the project site. No bull trout reproduction is know to occur within the watershed although a small number of bull trout have been observed in the Duwamish River and upstream locations .

Bald eagles and other birds most likely forage at the project location. Nesting bald eagles are not found within the project area; however, wintering bald eagles may be present from October 31 to March 31. There are no trees at the project site large enough to provide bald eagle perch trees. A few large poplar trees occur in the neighborhood near the project site, but away from the river and the bridge site. Ospreys may forage in the project area. The nearest known

osprey-nesting site is over one mile to the southeast of the project site. Other birds and wildlife present at the site includes those species that are adapted to urban development and common throughout the metropolitan area.

Impacts

Each of the proposed alternatives, other than no action, would have similar impacts to fish, wildlife, and vegetation. The No Action Alternative would not result in construction of a replacement bridge and associated impacts. The impacts of replacement bridge construction would vary by amount of substrate disturbed and altered, and by the specific portion of the site disrupted or altered by the alternative. Shading impacts would also vary slightly with different bridge widths and heights among the alternatives.

Each of the proposed alternatives for the South Park Bridge will have short-term impacts resulting from destruction of the existing bridge. The no action alternative would have the impact of continued existence of the existing structure and creosote treated timber for some indefinite period (probably less than 20 years). The rebuild or replacement alternatives would each have similar impacts from and construction of the new structure. For each alternative impacts would be minimized through use of BMPs for these activities. Impact location would either be within the existing bridge alignment through replacement or removal, or on an alignment immediately adjacent to the existing bridge through construction of a new bridge.

Positive impacts would occur through removal of existing creosote treated timbers and piles with each alternative, and new construction using steel and concrete structures with the bridge replacement alternatives. With the fixed bridge alternatives the support structures would occupy less space within the river than the existing bridge.

The replacement bridge would produce a slightly greater shading impact resulting from a wider bridge. Bridge widths vary from 52 ft for the No Action and Rehabilitation Alternatives to 68 ft for the Bascule and Fixed-Span Alternatives. However, no aquatic vegetation and only a small amount of exotic riparian vegetation occur at this location minimizing this impact. Diatom production is not likely to be measurably reduced by the slight additional width of the bridge at heights of 35 ft (No Action), 65 ft (Mid-Level Fixed) and 100 ft (High-Level Fixed).

New shallow water and riparian habitat would be constructed at the site with the rebuild and replacement alternatives providing mitigation for the construction and increased shading impacts. The new shoreline habitat would support juvenile salmonids and juveniles of other fishes that may be present at the project site. Water foul and shorebirds would likely also use the new shoreline habitat.

Some disturbance of contaminated surface sediment will be unavoidable within the immediate vicinity of the project site by in-water demolition and construction activities associated with each alternative. Those sediments are likely to be contaminated based or their location within an area that has been designated a Superfund site by the U.S. Environmental Protection Agency. Final

design and development of construction activities and sequencing for the selected alternative will provide measures to control and monitor contaminated sediment redistribution. Mobilized sediment that cannot be fully contained by appropriate mitigation measures is not expected to be redistributed extensively beyond the immediate project area. More specific measures to address this issue will be developed in conjunction with the appropriate resource agencies following the selection of a preferred alternative.

Analysis of Effects on Listed and Proposed Species and Proposed Critical Habitat

The proposed alternatives are not expected to have long-term adverse affects to listed and proposed species or their critical habitat. Each of the alternatives would improve habitat conditions by removing substantial amounts of existing creosote treated timbers and piles from the project site. Habitat improvement would occur with each alternative through restoration of previously degraded habitat for a small portion of the Duwamish River. Each alternative would result in impacts to habitat at the site during construction of a rehabilitation or replacement bridge and/or demolition of the existing bridge.

Impacts to young salmon would generally be avoided through a combination of timing of in-water construction activities and use of best management practices. Conditions of the Hydraulic Project Approval would likely require in-water construction be avoided during the period of February 15 to July 15 when young salmon are most likely to be in the vicinity of the bridge. Isolation of construction activities from the water would occur during the period closed to in-water construction. Best management practices would be used to minimize the release of petroleum, paint, concrete and other potentially toxic materials during the construction over and near the river. Habitat restoration would improve conditions at the site for young salmonids during their rearing migration through the site vicinity.

Analysis of Effects on Candidate Species, Species of Concern, and Other Sensitive Wildlife

The proposed alternatives are not expected to have adverse affects to candidate species, species of concern and other sensitive wildlife. Impacts to their habitat at the site during construction of a rehabilitation or replacement bridge and/or demolition of the existing bridge would be minimized through actions to minimize sediment disturbance, appropriate containment measures and timing restrictions Each of the alternatives would remove substantial amounts of existing creosote treated timbers and piles from the project site. Each alternative would result in some restoration of previously degraded habitat for a small portion of the Duwamish River.

Mitigation

Removal of the existing bridge following construction of any of the replacement alternatives would provide an opportunity to construct new shallow water habitat within the existing bridge

alignment. New habitat would be designed to improve habitat functions for juvenile salmonids as well as general aquatic production.

King County proposes to construct new shallow water and riparian habitat adjacent to the replacement bridge structure. With the Rehabilitation Alternative the new habitat would be located north (downstream) of the existing bridge alignment. With the replacement alternatives the new habitat would be located within the alignment of the existing bridge. With the Mid-Level and High Level Fixed Span Alternatives the bridge abutments would be set back about 60 ft from the river edge allowing for planting of native riparian vegetation under the bridge. Details of the design would be developed in cooperation with resource agency representatives during final design of the selected bridge alternative. Construction of the new habitat would occur at completion of the replacement bridge and removal of the existing bridge.

Conclusions

The No Action Alternative would remove the existing impacts of the S. Park Bridge and all on-land structures with site restoration at some undefined time in the future. Impacts of the No Action Alternative would be limited to those associated with removal of the existing structures. Disturbance at the bridge site of the Duwamish River and the shoreline area would be restricted to the immediate vicinity of the bridge. Restoration of the disturbed shoreline areas would be provided. There would be no adverse impacts to the fish and wildlife habitat following removal of the existing bridge

The Rehabilitation alternative would involve many of the same bridge removal actions as the No Action Alternative, but would replace the existing support piers with new bascule piers at the same locations. A temporary support pier would be constructed adjacent to the replacement bridge to facilitate construction of the new bridge. Following construction existing habitat conditions would be maintained except that the creosote treated timber and piles would be removed and replaced with non-toxic materials. Construction impacts would be mitigated through actions to minimize sediment disturbance, appropriate containment measures, and timing restrictions. The site would be disrupted for a longer period of time than with the No Action Alternative. Restoration of disturbed shoreline areas would be provided following construction of the new bridge.

The impacts resulting from each of the bridge replacement alternatives (New Bascule, Mid-Level Fixed Span, and High-Level Fixed Span) would be very similar. Each alternative would involve the same bridge removal actions as the No Action Alternative, but would replace the existing bridge with a replacement bridge at a location immediately downstream from the existing bridge prior to its removal. A temporary support pier would be constructed adjacent to the replacement bridge to facilitate construction of the replacement bridge with each alternative. Construction impacts would be mitigated through actions to minimize sediment disturbance, appropriate containment measures, and timing restrictions. Impacts of construction, slight increase in shading, and removal of creosote treated timber would be similar for each alternative.

Shading impacts of the bridge replacement alternatives would be least with the fixed high-level alternative and greatest with the bascule alternative. However, these differences among the alternatives would be small differences in light intensity within the bridge shadow area. With each bridge replacement alternative the amount and characteristics of the new habitat would be essentially the same. Restoration of disturbed shoreline areas would be provided following construction of the new bridge. The Rehabilitation Alternative would place the new habitat north of the existing bridge alignment, while the other alternatives would place the new habitat within the existing bridge alignment.

Chapter 2 Introduction

Chapter 2 is an introduction to the technical analysis contained in this discipline report. This chapter describes existing conditions, the history of the project, the purpose and need for the project, and a description of the five project alternatives being considered for environmental review. In addition, project coordination conducted to date with agencies, local governments, the community advisory group, and members of the public are summarized.

2.1 Description of Existing Conditions

This first section describes existing conditions pertinent to the proposed South Park Bridge Project. The project area is defined. The existing bridge and its current condition are described. The local roadway network in the South Park community is described. Non-vehicular transportation in the community is also summarized.

2.1.1 The Project Area

The South Park community is about four miles south of downtown Seattle (see Figure 1). The community lies south of the Duwamish Waterway, the man-made channel portion of the Duwamish River as it enters Elliott Bay. Though originally incorporated as its own city in 1905, much of the area was annexed by the City of Seattle in 1907.[1] The project area lies south of the industrial Georgetown area of Seattle and the King County International Airport (known as Boeing Field). It encompasses the roadway corridor defined by 16th Avenue S. between East Marginal Way S. and the South Park Bridge and 14th Avenue S. between the bridge and S. Trenton Street. Residents and business owners in the project area generally identify with the City of Seattle.

The project area, however, is governed by three local government jurisdictions. The area north of the Duwamish Waterway (between East Marginal Way S. and the waterway) lies within the city limits of both the City of Seattle (northern portion) and the City of Tukwila (southern portion). The area south of the Duwamish Waterway (between the waterway and S. Trenton Street) lies within unincorporated King County and the City of Seattle. The two-block area between the riverbank and Dallas Avenue S. is in King County, and the city blocks to the south are in the City of Seattle.

Land uses in the project area are mixed residential, retail commercial, and industrial. The Boeing Company's Plant 2 dominates the north side of the Duwamish Waterway. On the south side, retail commercial and light industrial land uses front on 14th Avenue S. and along the south bank upstream of the South Park Bridge. Single-family residences, however, generally characterize the area off of this main transportation artery.

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[1] City of Seattle, *South Park Residential Urban Village Plan*, 1998.

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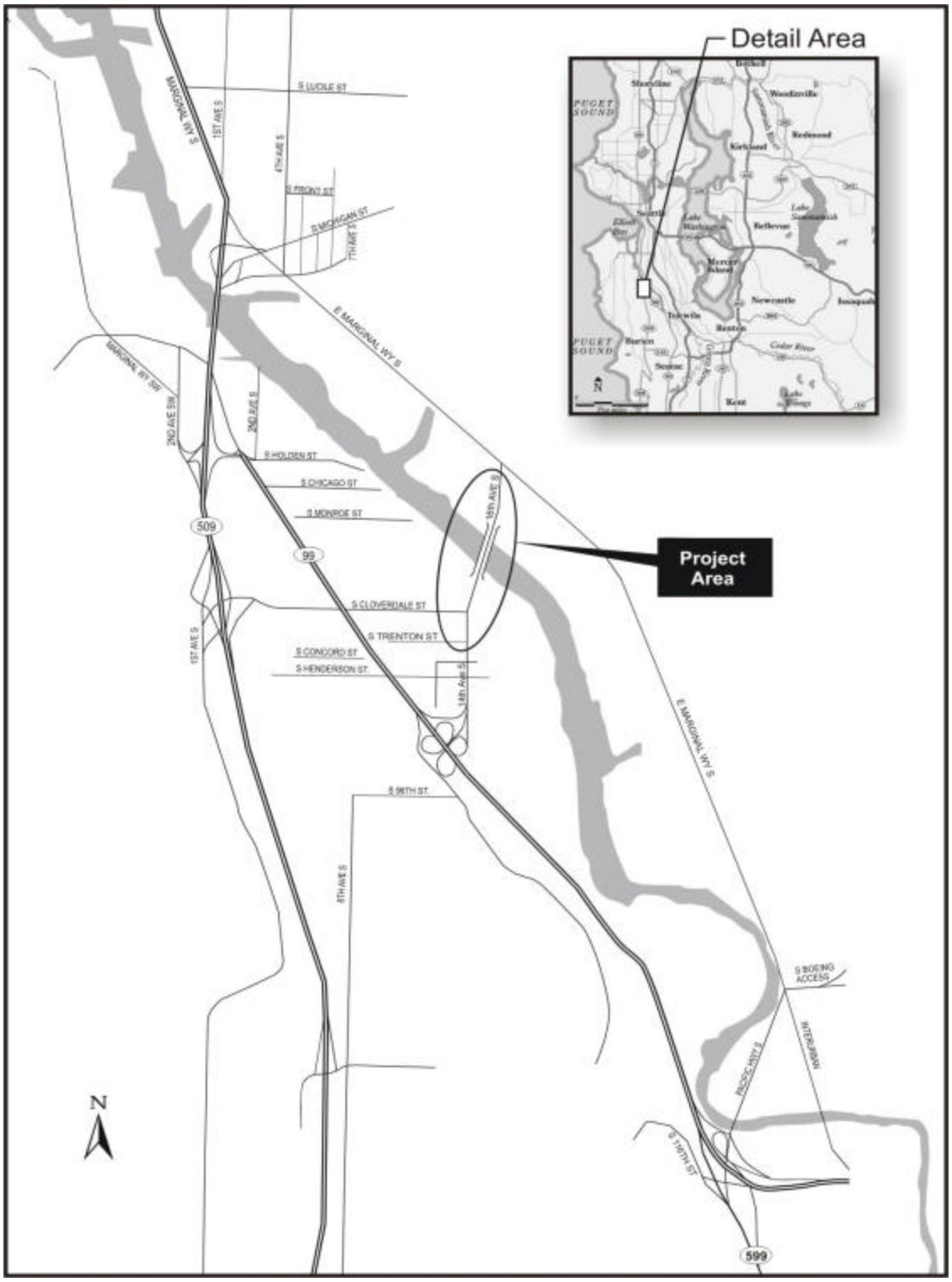

Figure 1
Project Area and Vicinity

2.1.2 The Existing South Park Bridge

The South Park Bridge was constructed in 1929-1931 (see Figure 2). The existing structure consists of a Scherzer rolling-lift double-leaf bascule movable span. Because it is the only operational example of a Scherzer rolling-lift bascule bridge in Washington, the bridge is listed on the National Historic Register.[2] Each side is flanked by two truss approach spans and twelve concrete slab approach spans. The overall length of the bridge is approximately 1,045 feet abutment-to-abutment and approximately 1,340 feet in entirety to the grade match points. The double-leaf bascule movable span has a center-to-center distance between the front bearing points of approximately 190 feet. The roadway consists of four 9.5-foot lanes. The pavement is 38 feet with 6-foot sidewalks on both sides.

Reinforced concrete piers founded on timber piling support the bascule span. Two large in-water piers support the counterweights, track supports, and racks for the rolling lift. The attached towers house the operating machinery, electrical equipment, and operator control room.

The South Park Bridge spans the Duwamish Waterway, which is used for industrial, commercial, and recreational purposes. The bridge is near the upstream limit of heavy industrial uses along the Duwamish Waterway, but it is within the section of the navigation channel maintained by the U.S. Army Corps of Engineers. The existing maximum vertical clearance of the bridge when closed is approximately 34 feet at Mean High Water (MHW). Bridge openings occur approximately three times per day on average to accommodate waterway traffic, although on some days the bridge does not open at all. The existing navigable horizontal clearances is approximately 118 feet at the water level (fender-to-fender), but narrows to 92 feet approximately 114 feet above the water between the open bascule leaves. The depth of the navigation channel is approximately 15 feet at Mean Lower Low-Water (MLLW).

2.1.3 Bridge Condition

In spite of substantial on-going maintenance and repairs, the South Park Bridge has suffered considerable deterioration over the past 70 years. In particular, the bascule piers are cracked and unstable resulting in the misalignment of the movable spans. Consequently, the center lock and glide tracks require on-going modifications and adjustments to allow the bridge to operate properly. Long-term, the stability of the entire bridge is at risk due to the original shallow placement of the supporting piles, which has resulted in movement of the bridge piers over the decades. The condition of the bridge worsened significantly following the Nisqually Earthquake in February 2001, and it remains vulnerable to future seismic events. A 2002 bridge inspection conducted by King County resulted in an existing condition rating of 6.0 out of a possible score

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[2] King County Landmarks and Heritage Commission. *Findings and Fact Decision – 14th Avenue South Bridge*, decision made December 19, 1996 and filed January 2, 1997.

of 100 (based on Federal Highway Administration criteria).[3] This was among the lowest ratings given any bridge structure in the State of Washington in 2002.

2.1.4 Roadway Network

The bridge presently accommodates an average daily traffic volume of approximately 20,000 vehicles per day, based on 2001 City of Seattle traffic counts. Many of the vehicle trips originate in residential neighborhoods in the communities of West Seattle, White Center, and SeaTac. For South Park community residents, the bridge is the primary direct means of access to the north, downtown Seattle, and I-5.

The existing roadway network surrounding the South Park Bridge consists of a variety of roadway types. They range from local two-lane streets to major limited-access highways. Regional traffic movement in the South Park area is concentrated to three nearby north-south corridors including SR-99, SR-509, and East Marginal Way S. Local circulation is provided through a system of local and collector streets. Features such as the Duwamish Waterway and large-scale facilities such as Boeing Field and the Boeing Plant 2 create barriers within the road network and limit opportunities for access to and from the major regional routes.

2.1.5 Freight, Transit, and Pedestrians

Freight movement in peripheral areas of the South Park community is significant due to the high concentration of industrial and manufacturing uses in the general area. Major truck traffic is primarily directed along East Marginal Way S. and SR-99. The South Park Bridge and S. Cloverdale Street are also designated truck routes for oversized vehicles. Trucks use S. Cloverdale Street to access the City of Seattle South Recycling and Disposal Station located at 8105 Fifth Avenue S. as well as SR-509 and SR-99 located on the western edge of the South Park community. With respect to rail movements, the only train crossing in the study area exists immediately south of the intersection of East Marginal Way S. and 16th Avenue S.

Bus routes serving the South Park community are primarily located along major north-south corridors, including East Marginal Way S., 14th and 16th Avenues S., and S. Cloverdale Street. Six major King County Metro bus routes serve the area. Routes 60 and 130 cross the South Park Bridge and four of the six bus routes travel along S. Cloverdale Street.

Pedestrians and bicyclists are commonly seen in the South Park area, especially near the community's center near the intersection of 14th Avenue S. and S. Cloverdale Street. Mid-day pedestrian volumes are higher than the morning or evening commute periods due to shopping, transit use, and lunch-related walking trips.

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[3] King County, *Bridge Inspection Report*, August 1, 2002.

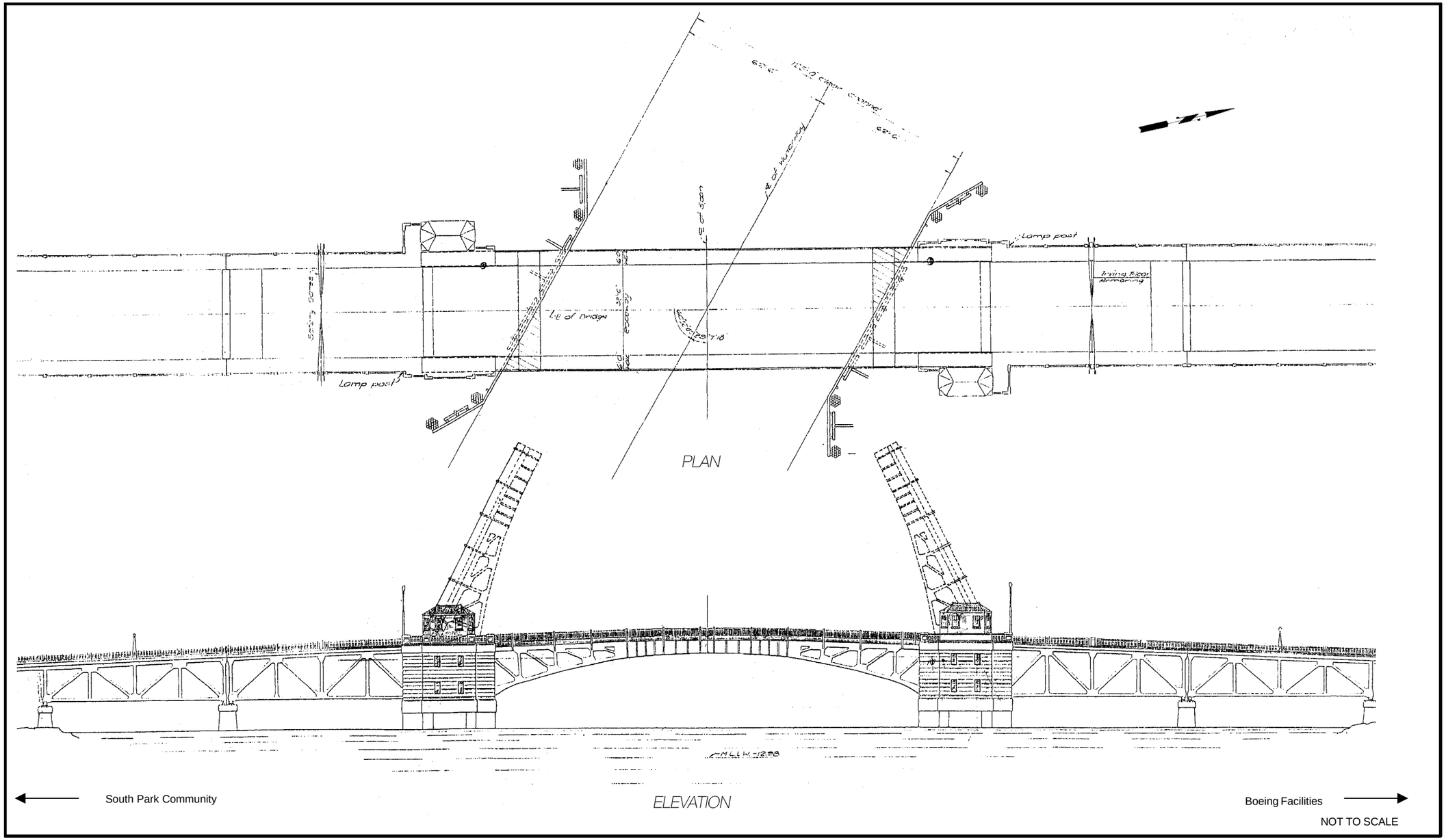

Figure 2
Existing South Park Bridge

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2.2 History of Project

Since 1931, the moveable bridge has crossed the Duwamish Waterway in the South Park community of the City of Seattle. The following sections contain an overview of the studies preceding the start of the current environmental review effort, a summary of two key documents that framed the initial development of project alternatives, and ongoing reports documenting the changing condition of the bridge.

2.2.1 Overview of Studies

In recent history, over 20 engineering studies have been prepared on the South Park Bridge. Starting in 1987, when the bridge was 56 years old, King County contracted for the preparation of a general engineering investigation report to assess the condition of the bridge. In 1991 and 1993, additional studies were completed including a geotechnical study, foundation design report, and a life-cycle cost analysis. This information led King County to undertake a series of studies in 1994 addressing liquefaction risks as well as the condition of the concrete, substructures, approach span joints and loading rating. In addition, a study was conducted to evaluate potential replacement alternatives for the bridge and another study investigated community issues related to the bridge. Since 1994, King County has recognized that the bridge required either rehabilitation or replacement and has continued to investigate the condition and vulnerabilities of the bridge in an effort to evaluate these options.

2.2.2 Summary of Key Engineering Reports

Two key engineering studies were conducted that helped to frame the current pursuit to evaluate potential alternatives to rehabilitate or replace the South Park Bridge. A 1994 Sverdrup study evaluated potential design options and a 1999 Entranco study researched and presented the likely steps required to conduct the necessary environmental review of the project alternatives and to complete necessary permitting. These studies are summarized below.

2.2.2.1 Sverdrup Study

In November 1994, Sverdrup Civil, Inc. completed a report titled *14th/16th Avenue South Park Bridge Rehabilitation/Replacement – Design Report for the King County Department of Public Works.* The objective of that report was to evaluate alternative alignments and bridge types, impacts of the alternatives studied and to present to King County results, findings, conclusions, and recommendations of a preferred replacement bridge for the existing South Park Bridge.

The 1994 design report studied five alternatives: rehabilitation of the existing bridge; two fixed-span bridge replacements (a 100-foot vertical clearance bridge and a 60-foot vertical clearance bridge); a new moveable bridge (double-leaf bascule bridge); and bridge closure (permanent closure and demolition of the existing bridge). Other alternatives that had been evaluated but were not carried forward, according to this report were: locating the replacement bridge

immediately east (upstream) of the existing alignment; matching the existing alignment; and locating the northbound and southbound lanes on separate structures. These three alternatives were not considered feasible and thus were not studied further.

The 1994 design report concluded that the 60-foot vertical clearance fixed-span bridge design could be used to replace the existing South Park Bridge, with consideration of mitigation of impacts to some users.

2.2.2.2 Entranco Study

In July 1999, Entranco completed the *16th Avenue S. Bridge Replacement Project: Environmental Review Report* for the King County Department of Transportation. The objective of this report was to present to King County a summary of environmental review and permitting activities that would likely be required for replacing the bridge.

The report identified the proposed project as a replacement of the existing bridge, including improvements to the approach road – 14th Avenue S. to the south and 16th Avenue S. to the north of the Duwamish Waterway. The project limits were identified as East Marginal Way S. on the north and S. Cloverdale Street on the south. The report asserted three build alternatives should be selected for evaluation in the EIS, including alternatives with differing alignments and bridge types. It was further noted that three alternatives would be the least number needed to provide a reasonable range of alternatives under National Environmental Policy Act (NEPA) and Washington State Environmental Policy Act (SEPA) regulations.

Entranco outlined the various tasks that would be required under the WSDOT *Environmental Procedures Manual* and Federal Highway Administration (FHWA) guidelines. The report identified these tasks to include the following: the development of bridge alternatives, screening, and selection of alternatives for analysis in the EIS; preliminary engineering design, including an update to the1994 rehabilitation/replacement report; survey and mapping work; hydraulic and geotechnical studies, and conceptual-level design documentation. The report concluded that the alternatives proposed, including rehabilitation of the existing bridge, had not been designed in enough detail to make a decision regarding a preferred alternative. Related to the environmental review process, the report recommended the public involvement program include coordination with an Interdisciplinary Team (IDT) of agency representatives and a community advisory committee. The report also listed 17 specific environmental discipline reports that would likely be required for the preparation of the EIS.

The findings and recommendations presented in the Entranco report formed the basis from which King County staff developed the current contracted scope of work for environmental review. The scope includes engineering, environmental review, agency coordination, and public involvement tasks.

2.2.3 Continuing Deterioration

Since 1999, King County has continued to move forward to develop alternatives for rehabilitating or replacing the existing South Park Bridge. Bridge conditions have worsened since the engineering studies were conducted in the mid-1990s. In February 2001, the Puget Sound Nisqually Earthquake caused significant and widespread damage to the bridge. Over $740,000 was required to repair the bridge in order to keep it operational.[4] The King County 2001 bridge inspection report recorded a rating of 8.0 out of a total possible score of 100 (based on FHWA criteria).[5] The following year, this rating decreased to 6.0.[6]

2.3 Purpose and Need of Project

As a required element of the EIS, a Purpose and Need Statement was developed for the South Park Bridge Project to clarify the underlying basis for the proposed action. The development of the initial draft Purpose and Need Statement involved review and comment by a number of parties including King County staff and the Project Advisory Committee (PAC) that includes agencies with jurisdiction over the proposed project. The draft Purpose and Need Statement was also revised based on comments received at several public involvement events. In April 2002, King County forwarded the draft Purpose and Need Statement to the Federal Highways Administration (FHWA) for review and approval. The text of the FHWA-approved version of the Propose and Need Statement is presented in the following sub-sections, although minor revisions and footnotes have been included for clarification.

2.3.1 Function and Role of the South Park Bridge

The King County Department of Transportation (KCDOT) is proposing the rehabilitation or replacement of the South Park Bridge located in King County, Washington. Since 1931 the moveable span bridge has carried traffic along the 14th Avenue South and 16th Avenue South corridor across the Duwamish Waterway. On a typical workday, a mix of approximately 20,000 cars, trucks, and buses use the bridge to access employment centers in downtown Seattle and the Duwamish industrial area. Many of the vehicle trips originate in residential neighborhoods in the communities of West Seattle, White Center, and SeaTac. For residents of the community of South Park, the bridge is the only immediate means of access to and from destinations east of the community. The moveable structure spans the navigation channel of the Duwamish Waterway. When open, large-size industrial and recreational vessels have access to upriver destinations. The South Park Bridge is also a major route for heavy truck traffic traveling to and from large industrial manufacturers including the Boeing Company.

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[4] Tim Lane, King County Department of Transportation, Telephone Conversation, September 23, 2002.

[5] King County, *Bridge Inspection Report*, August 21, 2001.

[6] King County, *Bridge Inspection Report*, August 1, 2002.

2.3.2 Purpose of Proposed Project

The purpose of the proposed action is to find the most feasible long-term solution to address the deteriorated condition and increasing seismic vulnerability of the South Park Bridge. The proposed action must also maintain the vital transportation linkage for cars, trucks, buses, bicyclists and pedestrians across the Duwamish Waterway.

2.3.3 Need for the Proposed Project

In spite of substantial ongoing maintenance and repairs, the South Park Bridge has suffered significant deterioration over the past 70 years. Existing problems with the bridge worsened significantly following the Nisqually Earthquake in February 2001 and the bridge remains vulnerable to future seismic events. A recent 2002 bridge inspection conducted by King County resulted in an existing condition rating of 6.0 out of a possible score of 100 (based on FHWA criteria).[7] This is among the lowest ratings given any bridge structure in the State of Washington.

The bridge could be closed as a consequence of excessive structural deterioration or failure of the moveable span operations (particularly in the event of another seismic event). Closure of the bridge would have a significant impact on the transportation system and traffic conditions throughout the lower Duwamish industrial area-- including SR-99, SR-509, First Avenue S. and East Marginal Way S. Improvements are required in the near future to protect public safety and to maintain a transportation corridor that is critical to the local and regional economy.

2.3.3.1 Seismic Vulnerability

The February 28, 2001 Nisqually earthquake (magnitude 6.8, located 35 miles from Seattle and deep below the surface) caused significant damage to the South Park Bridge. Since the earthquake, operation of the moveable span has been less reliable, requiring the bridge to be closed for repairs intermittently for several days. The continuing periodic closure of the bridge for repairs has heightened the awareness of the need for rehabilitation or replacement of the existing bridge.

2.3.3.2 Roadway Design Deficiencies

The South Park Bridge does not meet current roadway design standards and has many design deficiencies. For example, the overall bridge width including lane widths, shoulders, and sidewalks should be 64 feet according to current design standards. The existing bridge width is currently 52 feet (measured outside-to-outside).

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[7] The original text of the FHWA-approved Purpose and Need Statement cited the condition rating of 8.0 from the 2001 King County Bridge Inspection Report. The current cited condition rating of 6.0 is from the King County *Bridge Inspection Report* dated August 1, 2002.

2.3.3.3 Transportation Issues

An average of 20,000 daily vehicle trips cross the Duwamish Waterway on the South Park Bridge. It is a significant link between the east and west side of the Duwamish, both locally and regionally. The South Park Bridge is also a route for heavy and oversize truck traffic. According to previous studies, closure of the bridge would have a significant noticeable impact on the transportation system and traffic conditions throughout the lower Duwamish industrial area – including the Highway 99 and East Marginal Way S. corridors.

2.3.4 Key Issues

2.3.4.1 Community Impacts

The existing South Park Bridge is a highly valued feature of the South Park community. There is widespread concern in the community that changes to the bridge could have a significant adverse impact on the community and the emerging economic vitality of the South Park business district centered along 14th Avenue South. The *South Park Residential Urban Village Plan of 1998* (the neighborhood plan) identified one of its primary objectives as "finding a solution for the South Park Bridge that is sensitive to the needs of the community."

The South Park community is also ethnically diverse. Approximately 30 percent of the populations' primary language is not English. These factors require greater emphasis on the consideration of environmental justice[8] in order to ensure that the potential adverse effects from the proposed project do not have a disproportionate impact on lower-income or minority populations.

2.3.4.2 Aquatic Habitat Protection

The Duwamish Waterway is an important route for juvenile and adult salmon migrating between the upper Green River, Elliott Bay, and the Pacific Ocean. However, much of the waterway in the vicinity of the South Park Bridge currently provides poor habitat for Chinook salmon (listed as threatened under the Endangered Species Act) and other marine organisms. The armored shoreline along the waterway in the project area provides minimal habitat for young Chinook salmon during their critical rearing period. Recovery plans now underway for threatened and endangered salmon will address potential means of enhancing habitat favorable to the survival and growth of young salmon from the Duwamish/Green River system. Restoration of the shoreline in the vicinity of the project would address immediate and long-term needs for habitat improvement along the Duwamish Waterway.[9]

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[8] Environmental justice concerns the need to avoid disproportionate, significant adverse impact on minority and/or low-income communities.

[9] This section highlights the importance of addressing aquatic habitat values in the project area, as well as the implications for species currently listed under the ESA; however, it is not intended as a complete characterization of the factors that need to be considered in this regard.

2.3.4.3 Duwamish Waterway Navigation

The Duwamish Waterway is used for industrial, commercial, and recreational purposes. The South Park Bridge is near the upstream limit of heavy industrial uses along the waterway, but it is within the section of the waterway maintained by the U.S. Army Corps of Engineers as a navigation channel. A number of local businesses, as well as the U.S. Coast Guard, have emphasized to King County that any engineering solutions for the South Park Bridge must maintain navigational access upstream of the existing bridge.

2.4 Description of Alternatives

This section describes the No Action Alternative, the Rehabilitation Alternative, and the three replacement bridge alternatives (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge Alternatives). The first section explains the transportation engineering criteria and standards used to design the Rehabilitation Alternative and the three replacement bridge alternatives. The second section describes the horizontal and vertical profile of the bridge alternatives, navigation channel clearances, and impacts to the local road network. The last section describes construction activities associated with each of the five alternatives for the South Park Bridge Project.

2.4.1 Design Criteria

Except for the No Action Alternative, construction of any of the project alternatives would incorporate current transportation engineering design criteria for the cross-section, alignment, design speed, maximum grade, and transition segment. The road cross-section design is a key design element that would change for any of the build alternatives (see Figure 3). The existing bridge cross-section incorporates four 9.5-foot travel lanes, raised curbs on both sides of the pavement, and a 6-foot sidewalk on either side of the roadway. The outside-to-outside dimension of the existing bridge is 52 feet. These lane widths are non-standard and would be changed for the Rehabilitation Alternative and for the three replacement bridge alternatives. For the Rehabilitation Alternative, the pavement would remain approximately the same width as it is currently, but would be reconfigured for three standard lanes. There would be two 12-foot lanes on the outside and one 11-foot lane in the middle of the roadway. Traffic would use one 12-foot lane for northbound travel and the other two lanes for southbound travel. The 6-foot sidewalk on either side of the roadway would be enlarged to approximately 7.5 feet. In contrast, each of the replacement bridge alternatives would be designed with four standard 11-foot lanes, traffic barriers or a painted median down the center, a traffic barrier on each side of the pavement, and a single combined 13-foot pedestrian/bike path on the west (downstream) side of the bridge. The width of the cross-section for the new replacement bridge alternatives including the exterior barriers would total approximately 68 feet (outside-to-outside of the bridge structure).

An initial range of potential bridge alternatives and alignments was considered based on earlier studies,[10] current input from stakeholders, and the project team. During the course of this initial alternatives development process, it was determined that there were no practical alternative alignments for a replacement bridge other than to parallel the existing bridge. It was determined that replacement bridge alternatives should be aligned to the west (downstream) of the existing bridge in order to minimize impacts to existing land uses. Conceptual engineering for the replacement bridge alternatives set the alignment for these bridges at approximately 80 feet to the west of the centerline of the existing bridge (i.e., as close to the existing structure as practicable without compromising constructability). The initial alignment of the new roadway was the same as the existing road alignment on the south side of the waterway. The existing roadway is quite narrow. Matching the centerline of the replacement bridge alternatives to the existing would require acquisition of both land and buildings on both sides of 14th Avenue S. To minimize these impacts, the alignment of the new transition segment was shifted slightly to the east of the existing road alignment because there are fewer parcels and buildings located on the east side of the road compared to the west. In addition, more of the buildings located on the east side are set back from the existing sidewalk than on the west side. In this way, the proposed alignment for the replacement alternatives has been developed to avoid or minimize potential land use and relocation impacts.

Other design factors affecting impacts to adjacent properties include the new bridge's design speed and maximum grade. King County road standards call for a 35 mph design speed and a maximum of 8 percent grade. Initially, these standards were incorporated into each of the alternatives. Implementation of an 8 percent maximum grade for the High-Level Fixed-Span Bridge Alternative, however, would have resulted in a very long bridge (project terminus to terminus). For example, the north terminus would have extended across East Marginal Way S. and into Boeing Field. To reduce impacts to land use, the maximum grade for the High-Level Fixed-Span Bridge Alternative would need to slightly exceed 8 percent. In this manner, the north side of the bridge would terminate south of East Marginal Way S. This grade change reduced the overall length of the bridge on both south and north ends of the bridge by several hundred feet for the High-Level Fixed-Span Alternative.

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[10] Entranco, Inc., *Environmental Review Report: 16th Avenue S. Bridge Replacement*, July 1999.

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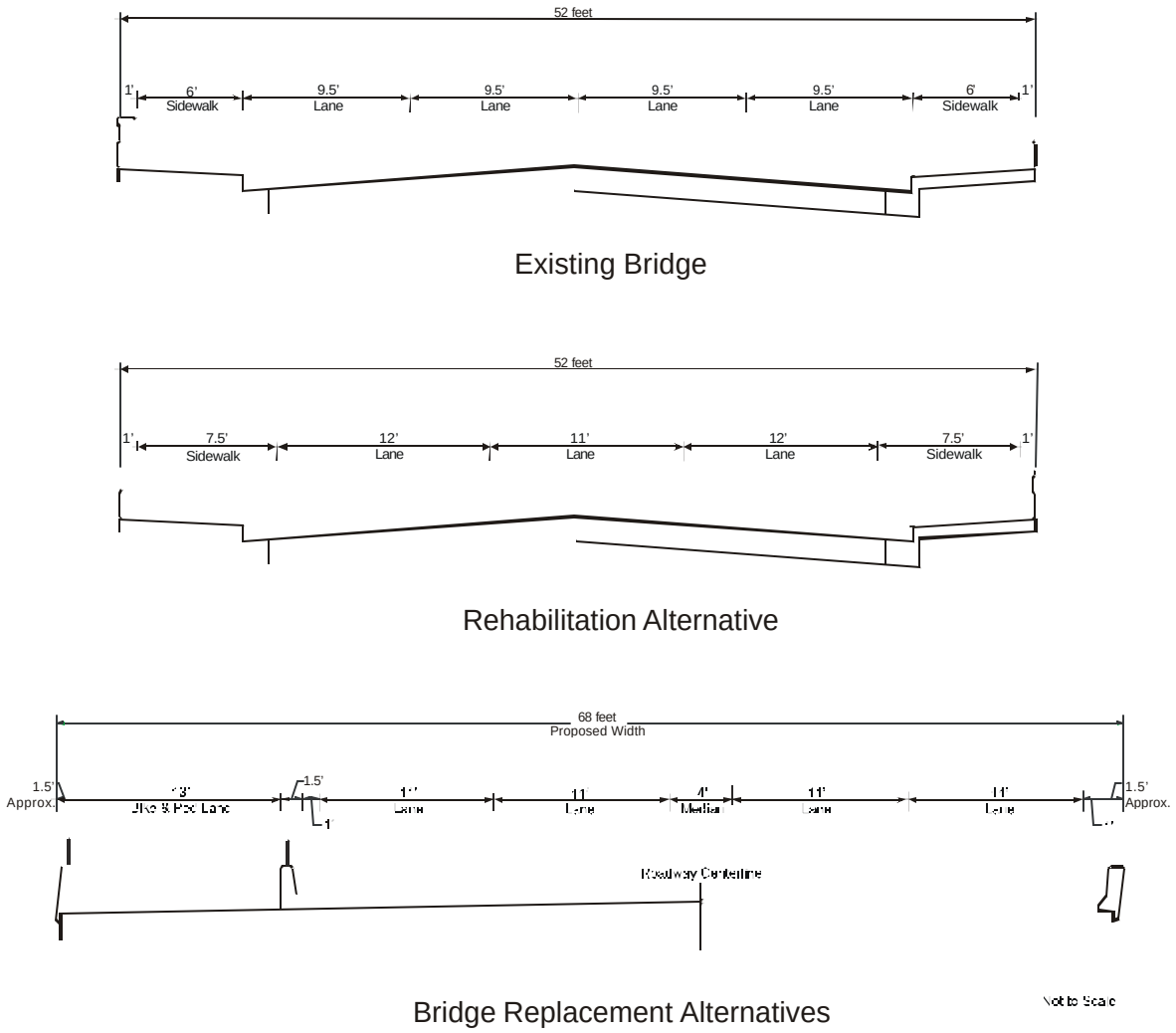

Figure 3
Existing and Proposed Bridge Cross-Section Designs

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Community impacts would also be affected depending on the design of the transition segment. This is the segment of the roadway that merges the differing widths of the new roadway and the existing narrow roadway. Typically, transition segments begin at the point the grade of the bridge matches the grade of the existing roadway and extends beyond some distance. The actual rate at which the width of the roadway is reduced is defined by transportation engineering design standards. To minimize impacts to land uses along 14th Avenue S., King County proposes to start the transition segment from the abutment for all alternatives. This means that by the time the bridge matches the grade of the existing roadway, the width of the replacement bridge is nearly the same width as the existing road. As a result, the total length of the roadway is reduced potentially several hundred feet in length. In addition, the width of the transition segment for the Mid-Level Fixed-Span Alternative is further reduced by having the single combined 13-foot pedestrian/bike path split off from the main bridge structure at approximately S. Orr Street and descended to ground level in a zigzag fashion. This design modification further reduced the overall impact of the Mid-Level Fixed-Span Alternative.

Together, the design criteria discussed in this section would allow for the construction of a replacement bridge that provides increased safety for vehicles, bicyclists, and pedestrians.

2.4.2 The Alternatives

A total of five alternatives were selected for evaluation in the environmental review process including: the No Action Alternative, the Rehabilitation Alternative, the Bascule Bridge Alternative, the Mid-Level Fixed-Span Bridge Alternative, and the High-Level Fixed-Span Bridge Alternative. These alternatives were selected from an initial group of nine preliminary project alternatives.[11] The alternatives proposed for evaluation in the environmental review process were selected because they had fewer potential impacts than the other preliminary alternatives. Based on comparison ratings for seven evaluation criteria (regional mobility, local access, navigation, community impacts, aquatic habitat, construction impacts, and estimated project costs), the following preliminary alternatives were dropped from further consideration: a low-level fixed-span bridge, a movable swing bridge, a vertical lift movable bridge, and a tunnel option. The following sections describe each of the proposed project alternatives to be considered in the environmental review process based on conceptual civil and structural engineering.[12] [13]

2.4.2.1 No Action Alternative

The No Action Alternative assumes that the existing bridge structure's poor condition would require it to be closed at some time in the future. Deterioration due to use could allow the

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[11] Parsons Brinckerhoff, Inc. *Summary Technical Memo: Alternatives Development and Screening*, September 6, 2002.

[12] Parson Brinckerhoff, Inc. *South Park Bridge Conceptual Plans*, June 2003.

[13] Parsons Brinckerhoff, Inc. *South Park Bridge Structural Alternatives Study*, November 2003.

bridge to continue to operate for the foreseeable future, but at some time in the future, the bridge would need to be closed. As such, for purposes of environmental review, it is assumed the existing bridge would be closed permanently sometime before 2027.

However, the bridge could be closed for other reasons than simply deteriorated condition. Another earthquake could cause an unexpected emergency closure of the bridge at any time. The on-going movement of the bridge foundations could eventually cause the moveable spans to become misaligned to the extent that repairs would be infeasible. Or, the cost of maintaining the bridge could become more than King County is willing to expend. Under any of these circumstances, the bridge would be closed.

When closed, no vehicular, bicycle, or pedestrian traffic would be allowed to use the bridge. As a navigable waterway, the U.S. Coast Guard regulates bridges that span waterways such as the Duwamish Waterway. If the bridge were no longer operating, the U.S. Coast Guard regulations would require demolition and removal of the bridge. With no structures remaining, there would be no potential navigation obstructions in the Duwamish Waterway.

Under this alternative, there would be no change in the local street network except 14th and 16th Avenue S. would be dead-ended on both the south and north shores of the Duwamish Waterway. Boeing Company properties, the exact location of the road closure on the north side would need to be negotiated with Boeing as well as the owner of the railroad tracks immediately south of East Marginal Way S. In addition, the site of the removed bridge would be restored.

Figure 4 shows the existing local street network and Figure 5 shows the local street network following the removal of the existing bridge in the No Action Alternative. As the road does not currently provide direct access to the adjacent Boeing Company properties, the exact location of the road closure on the north side would need to be negotiated with Boeing as well as the owner of the railroad tracks immediately south of East Marginal Way S. In addition, the site of the removed bridge would be restored.

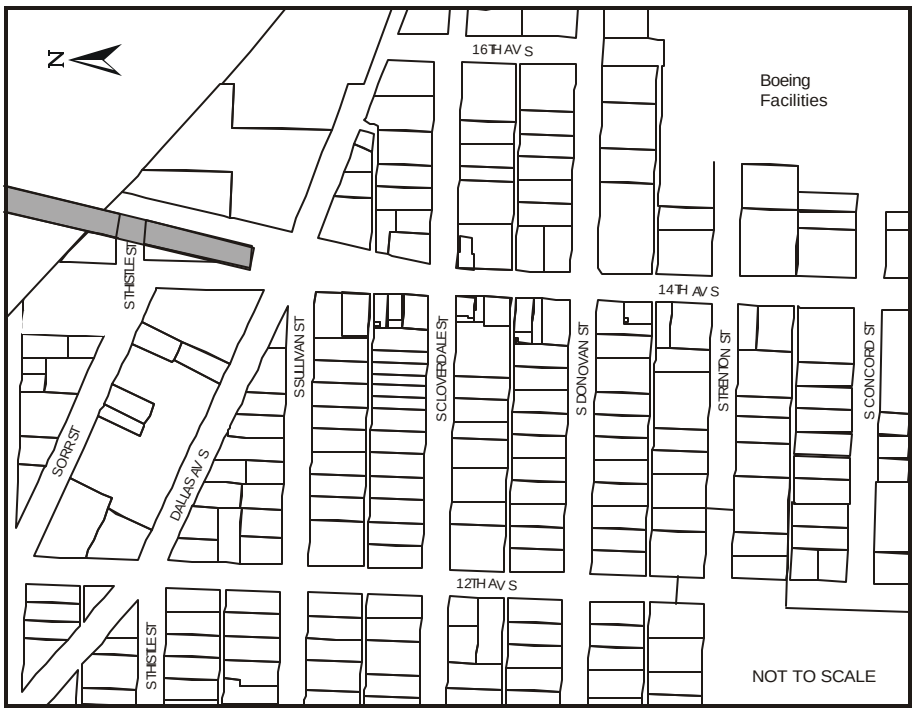

Figure 4
Existing Conditions Street Network

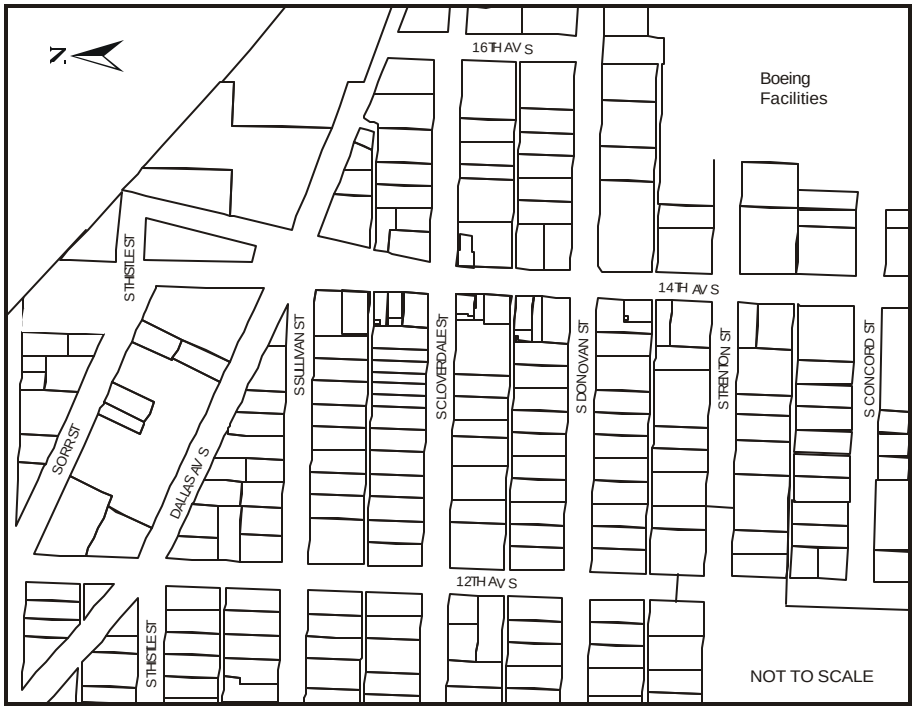

Figure 5
No Action Alternative Street Network

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2.4.2.2 Rehabilitation Alternative

For the Rehabilitation Alternative, much of the existing bridge structure would need to be replaced. The existing steel trusses of the approach spans and the bascule leaves would be refurbished and reused. The mechanical and electrical operating systems would be refurbished and/or replaced (see Figure 6). Studies have confirmed the existing bridge piers are gradually shifting because the foundation pilings were not originally driven to a sufficient depth. Although the initial goal was to rehabilitate the existing piers, the design team's structural analyses determined that the existing bascule piers and truss approach span piers must be replaced in order to ensure the long-term (approximately 75 years) integrity of the bridge. If the bascule piers were reconstructed, the longevity of the Rehabilitation Alternative would be similar to the expected minimum life of a replacement bridge structure.

For the Rehabilitation Alternative, the new bascule piers are proposed to be approximately the same size, location, and historic character as the existing piers. To construct the new bascule piers, the bascule leaves and steel approach spans would need to be removed. The steel truss elements of the bridge structure would be taken to another site for repair, refurbishment, and/or painting before they are re-installed following the construction of the new piers. The concrete shafts or pilings supporting the foundations of the new piers would extend below the existing pilings to a depth beneath the riverbed where stable soils exist. The removal of the steel truss spans would also allow for replacement of the steel approach piers. The concrete approach spans and bridge abutments would be replaced and the bridge deck would be reconstructed. Like the existing bridge, there would be piers both on land and in the water. The first on-land piers would be only an estimated 20 feet from the top of the south embankment and the closest in-water piers would be approximately 20 feet from the top of the embankment. The piers on the north shoreline would extend through the existing Boeing dock. The conceptual engineering analysis also determined that the mechanical and electrical systems should be replaced. Any required construction activities, including replacement of the bridge railings, bridge tender towers, and lampposts, would be done in a manner that preserves the historic character of the existing bridge to the greatest extent possible.

To meet current roadway design standards, the replacement bridge deck would remain approximately the same as the existing, but the pavement would be striped to accommodate three standard traffic lanes. Bicycle and pedestrian traffic would continue to be able to use the bridge via a 7.5-foot pedestrian path on each side of the bridge.

Following construction, the existing 118-foot navigable channel width would be preserved so existing waterway users would be able to continue to use the navigation channel to travel upriver of the South Park Bridge. The extended closure of the bridge during construction, however, would have a significant temporary impact on access to the South Park community. Following construction, there would be only slight changes in the local street network. Figure 7 shows the local street network in the South Park community following construction activities for the rehabilitation of the existing bridge.

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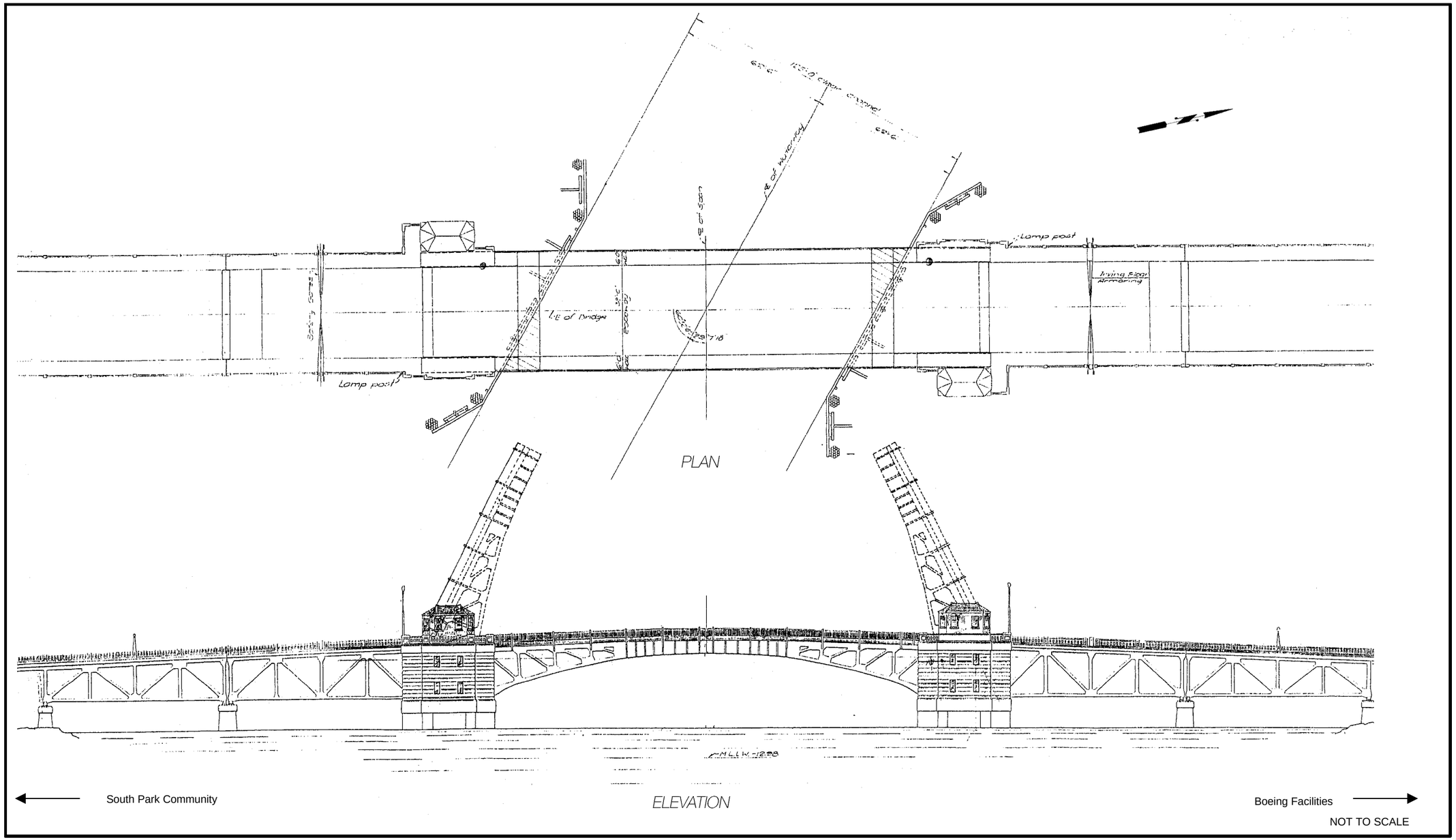

Figure 6
Rehabilitation Alternative

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Figure 7 also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. For comparison, Figure 8 shows the local street network following the construction of the Bascule Bridge Alternative. To improve vehicular safety, S. Sullivan Street would intersect Dallas Avenue S., which would become the main cross street intersection with 14th Avenue S. The 16th Avenue S. (immediately east of the bridge) intersection with Dallas Avenue S. as well as 14th Avenue S. may also need to be reconfigured. Access to points north via the South Park Bridge would be maintained.

2.4.2.3 Bascule Bridge Alternative

The Bascule Bridge Alternative would result in the construction of a new movable bridge immediately downriver of the existing bridge (see Figure 9). The bridge mechanism could be a Scherzer rolling lift type (no longer a common design for new movable bridges) or another type. The bridge length would be approximately 935 feet from abutment-to-abutment, not including roadway approaches. Road improvements would extend from a point just north of S. Cloverdale Street on the south side of the waterway and north to a point opposite the northeast corner of Boeing Building 2-15. The interior walls of the bridge abutments would be approximately 200 feet from the top of the embankment, or approximately 50 feet closer to the shore than the existing bridge. With fewer piers than the existing bridge, the first on-land piers of this alternative would be approximately 55 feet from the top of the south embankment at the shortest distance and the closest in-water piers would be approximately 65 feet away. On the north shoreline, the closest in-water piers would be approximately 95 feet from the top of the embankment and the closest on-land piers would be approximately 30 feet away. Unlike the existing bridge's grated bascule leaves, the bridge deck of the bascule leaves would be solid surface to improve vehicle traction and control of stormwater runoff.

Similar to the existing bascule bridge, this bridge profile would be approximately 34 feet above the Duwamish Waterway when in the closed position. The mid-section span would be comprised of two movable leaves that could be raised to open the bridge. The navigation channel would be approximately 125 feet in width (slightly greater than the existing 118-foot-wide channel). This two-leaf bascule bridge would not impose limitations to the height of waterway users passing the bridge, because the replacement bridge would be approximately 125 feet between the tips of the raised spans.

Following construction, there would be some change in the local street network (see Figure 8). S. Sullivan Street would be permanently closed or reconfigured to improve traffic safety and vehicular and truck turning movements from the new bascule bridge to Dallas Avenue S. S. Sullivan Street would no longer have direct access to 14th Avenue S. and the bridge. The intersection of 16th Avenue S. (immediately east of the bridge) and Dallas Avenue S. may also need to be reconfigured. To ensure adequate vertical clearance for vehicles, S. Thistle Street would need to be slightly realigned further to the north and closer to the Duwamish Waterway. This figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements.

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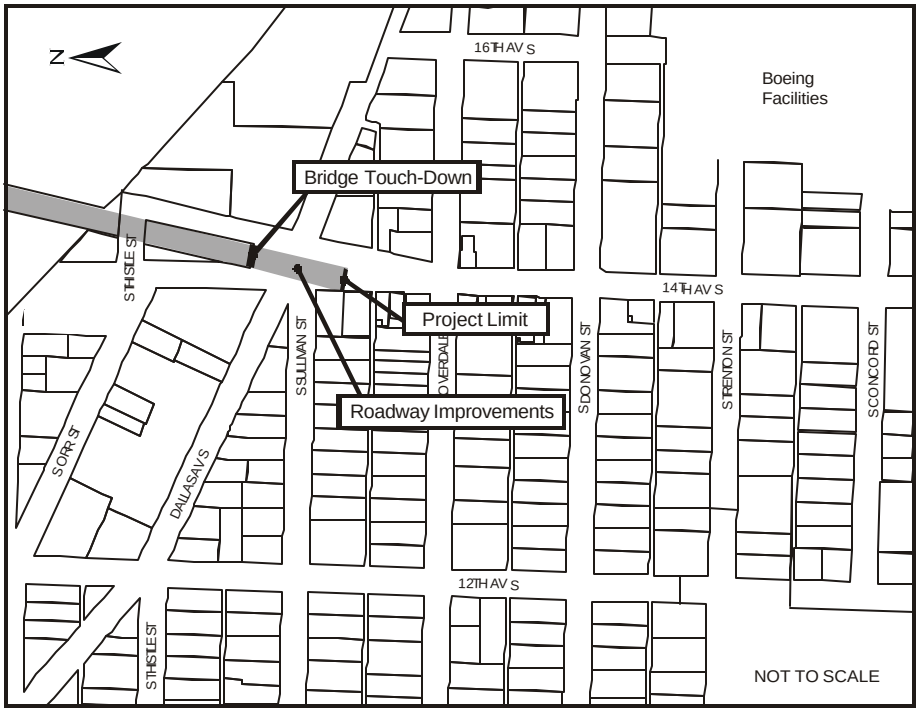

Figure 7
Rehabilitation Alternative Street Network

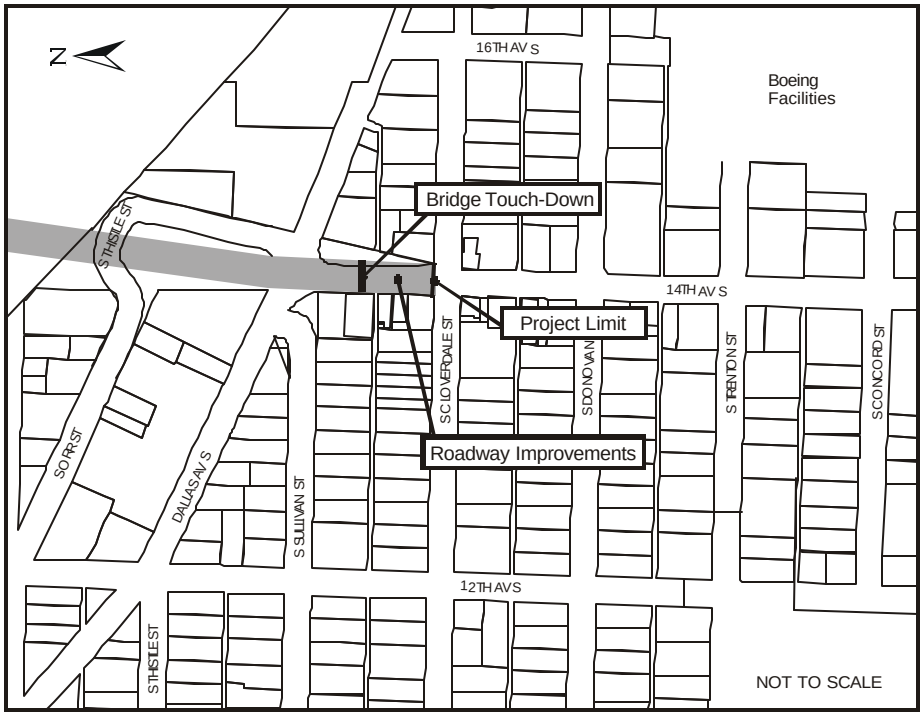

Figure 8
Bascule Bridge Alternative Street Network

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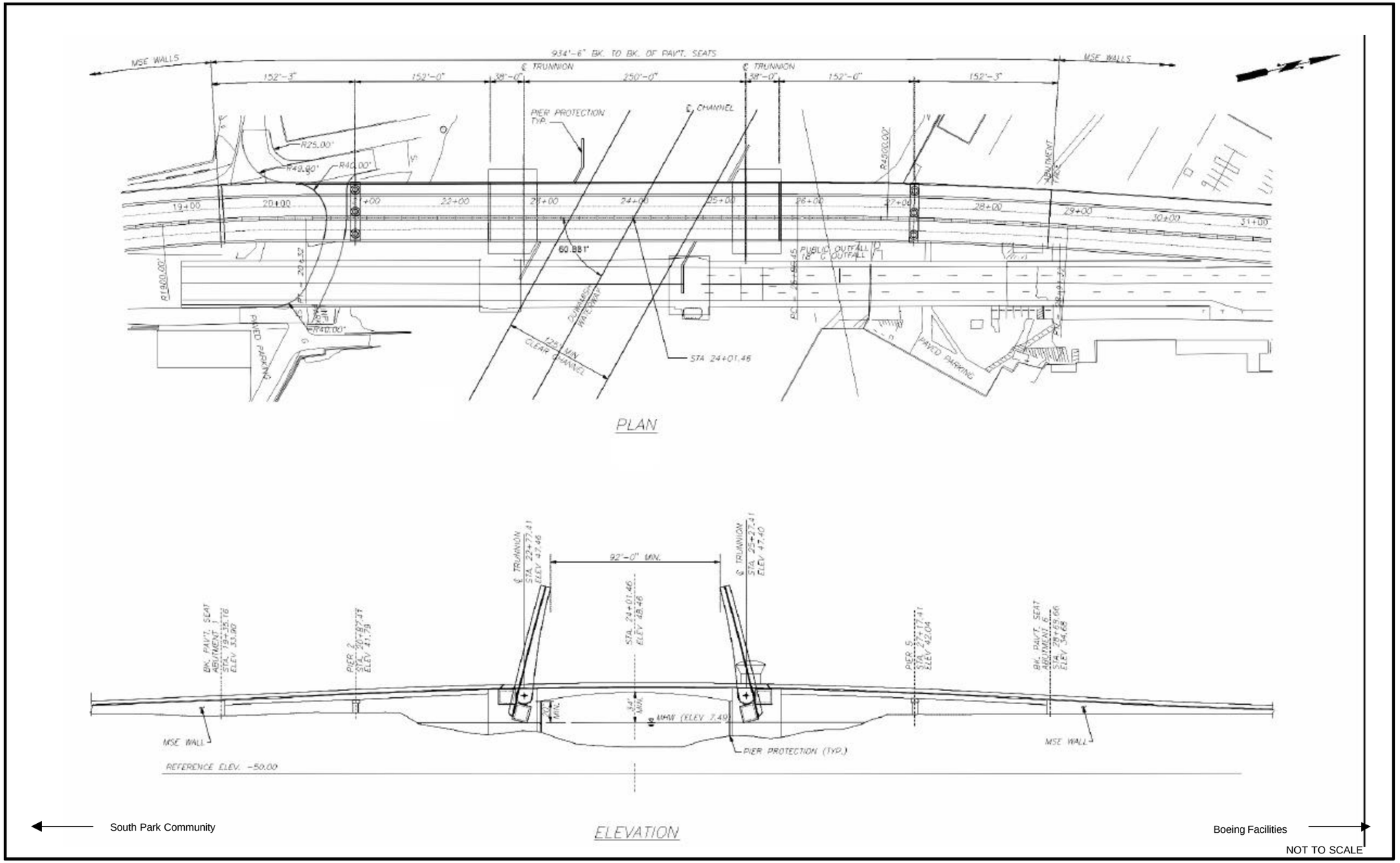

Figure 9
Bascule Bridge Alternative

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Access to points north via the South Park Bridge would be maintained. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.2.4 Mid-Level Fixed-Span Bridge Alternative

The Mid-Level Fixed-Span Bridge Alternative would result in the construction of a non-movable bridge (see Figure 10). The bridge length would be approximately 1,660 feet abutment-to-abutment, not including roadway approaches. The interior walls of the abutments would be approximately 550 feet from the top of the Duwamish Waterway embankment, or 300 feet further setback than the existing bridge. The closest on-land piers would be approximately 85 feet from the south embankment and the closest in-water piers would be approximately 100 feet away. On the north side, the closest in-water piers would be approximately 130 feet from the top of the embankment and the closest on-land piers would be approximately 65 feet away. Road improvements would extend slightly north of S. Donovan Street and north to a point approximately 320 feet south of East Marginal Way S.

The mid-point of the bridge profile across the Duwamish Waterway would be approximately 65 feet above MHW of the Duwamish Waterway. The horizontal clearance would be approximately 125 feet, or slightly greater than the existing clearance. The vertical clearance, however, would restrict use of some waterway traffic, including some tugs and barges. Most vessels that currently pass the existing bridge would continue to be able to use the navigation channel. As described earlier in the discussion of the design considerations, the width of the new Mid-Level Fixed Span Bridge is reduced when the bike-pedestrian path is separated from the elevated approach roadway near the south side abutment. This design feature reduces land use and relocation impacts.

Following construction, there would be changes in the local street network (see Figure 11). For comparison, Figure 12 shows the local street network following the construction of the High-Level Fixed-Span Bridge Alternative. The location of the south abutment and its vertical clearance would require modification of Dallas Avenue S. and S. Sullivan Street. S. Sullivan Street would likely be merged into Dallas Avenue S. just west of the new structure and a new roadway would be constructed under the new bridge. The alignment of this roadway would be slightly to the north to ensure it would have a minimum allowable vertical clearance. Neither street would have direct access to the new South Park Bridge. Figure 11 also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. A retaining wall supporting the elevated approach roadway would be constructed immediately adjacent to properties fronting on the both sides of 14th Avenue S. for the majority of the distance between S. Sullivan Street and S. Cloverdale Street. Traffic would be able to access the bridge at S. Cloverdale Street, which would be raised a maximum of approximately 5 feet at the intersection to meet the descending grade of the bridge. This change in the intersection would allow traffic on S. Cloverdale Street to continue to have direct access to 14th Avenue S., though a retaining wall would also need to be constructed around the four corners of the intersection of

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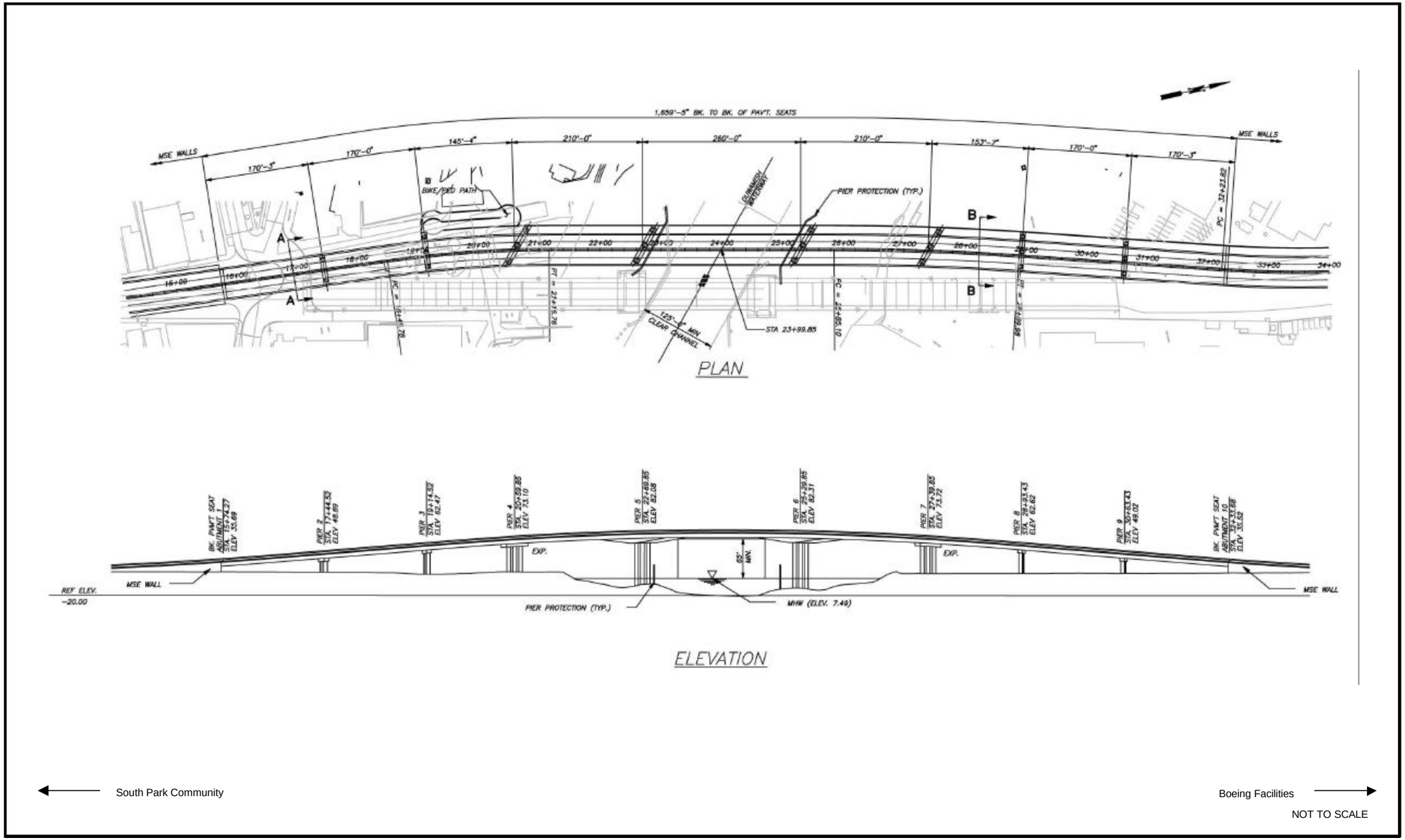

Figure 10
Mid-Level Fixed-Span Bridge Alternative

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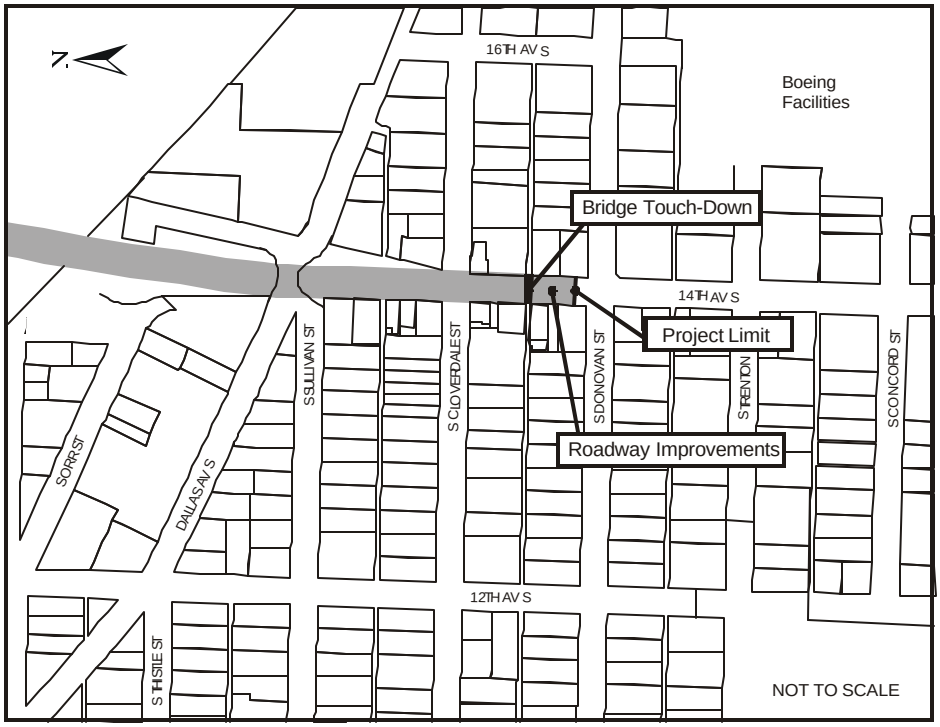

Figure 11
Mid-Level Fixed-Span Bridge Alternative Street Network

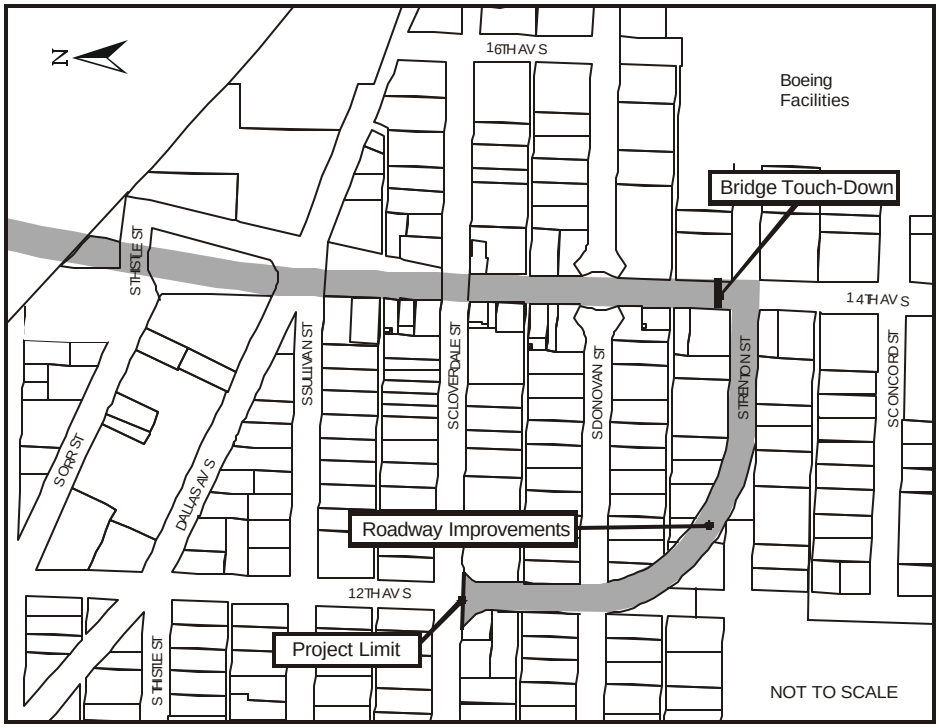

Figure 12
High-Level Fixed-Span Bridge Alternative Street Network

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S. Cloverdale Street and 14th Avenue S. due to the grade change. S. Orr Street would be closed due to the location of the support structures for the proposed separated pedestrian/bike path that would allow bicyclists and pedestrians to descend from the bridge level to the street level. In addition, S. Thistle Street would be closed as it would no longer be able to connect to S. Orr Street. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.2.5 High-Level Fixed-Span Bridge Alternative

The High-Level Fixed-Span Bridge Alternative is a non-movable bridge (see Figure 13). The bridge length would be approximately 2,332 feet abutment-to-abutment, not including roadway approaches. The interior walls of the abutments would be approximately 900 feet from the top of the Duwamish Waterway embankment, or 650 feet further set back than the existing bridge. The on-land and in-water piers of this alternative are approximately in the same location as proposed for the Mid-Level Fixed-Span Bridge Alternative. Road improvements would extend from S. Trenton Street and continue north to East Marginal Way S. This alternative would require minor modification of the 16th Avenue S./East Marginal Way S. intersection and of the existing railroad track crossing immediately south of this intersection.

The bridge design would allow for approximately 100 feet of vertical clearance above the MHW of the Duwamish Waterway as requested by the U.S. Coast Guard. The horizontal waterway clearance for the navigation channel would be approximately 125 feet, which is slightly greater than the existing 118-foot clearance (fender-to-fender). The bridge's vertical clearance would not be expected to limit the height of boats and barges currently passing the bridge. However, vessels larger than those currently using the navigation channel might not be able to pass the bridge in the future.

Following construction, there would be numerous changes in the local street network as shown in Figure 12. The figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. The bridge south abutment would require Dallas Avenue S., S. Sullivan Street, and S. Cloverdale Street to be converted to underpasses under the new South Park Bridge. A retaining wall supporting the elevated approach roadway would be constructed immediately adjacent to properties fronting on both sides of 14th Avenue S. for the majority of the two-block distance between S. Cloverdale Street and S. Trenton Street. S. Donovan Street would be closed at 14th Avenue S. due to obstruction from the bridge abutment and a vehicle turn-around would be constructed on either side of the abutment on S. Donovan Street. To allow traffic to access the new South Park Bridge, a new principle arterial roadway would need to be constructed between S. Trenton Street and 12th Avenue S. and road improvements would be required on 12th Avenue S. north to S. Cloverdale Street. This new route would allow traffic, trucks, and buses to continue to access the new South Park Bridge from S. Cloverdale Street via 12th Avenue S. and S. Trenton Street. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

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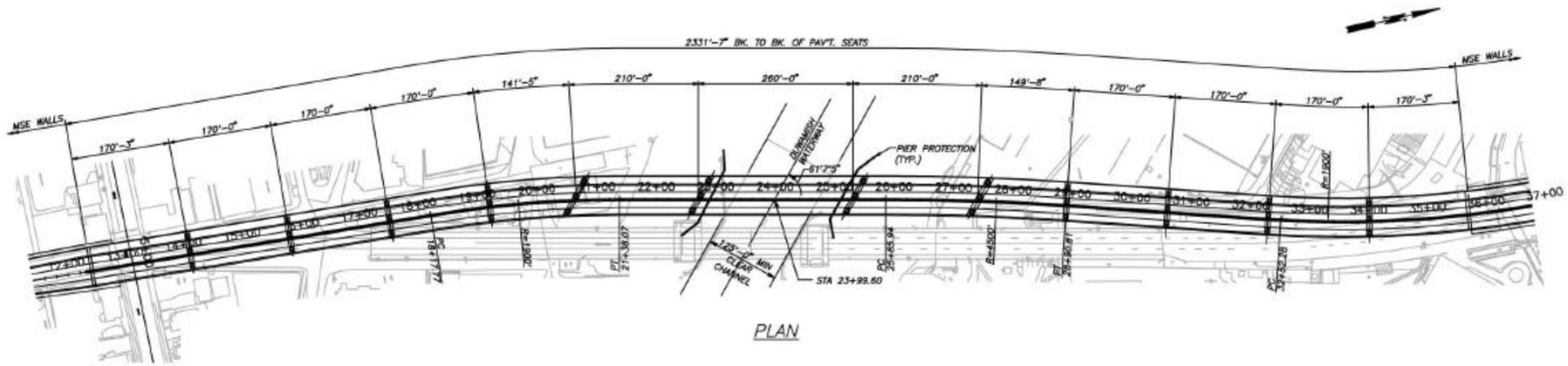

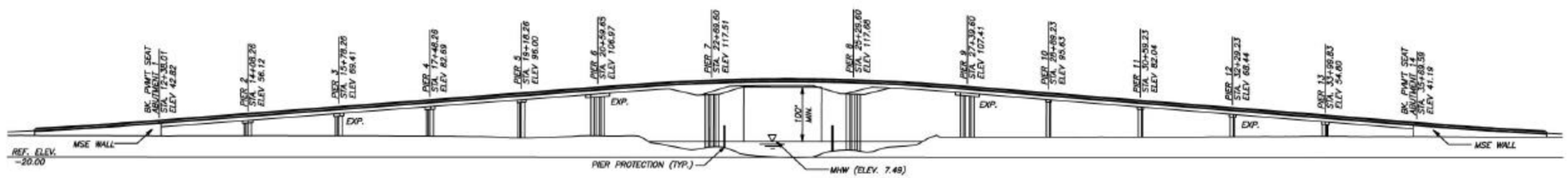

South Park Community

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Figure 13
High-Level Fixed-Span Bridge Alternative

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2.4.3 Construction Durations and Activities

Construction of a rehabilitation or replacement bridge for the existing South Park Bridge is planned to take approximately two to three years, including the demolition and removal of the existing bridge. Construction is anticipated to start within the next several years and opening of the rehabilitation or a replacement bridge is currently anticipated to occur by 2009. The actual time required for construction activities vary for each of the alternatives. Construction activities associated with the No Action Alternative involves only demolition of the existing bridge and restoration of the site. The construction period for this alternative would be the shortest of all alternatives, approximately 8 months. The other alternatives would additionally require rehabilitation or construction of a new replacement bridge. Anticipated construction durations (demolition of existing and construction of new) would be approximately 32 months for the Rehabilitation Alternative, 33 months for the Bascule Bridge Alternative, 20 months for the Mid-Level Fixed-Span Bridge Alternative, and 24 months for the High-Level Fixed-Span Bridge Alternative.[14]

From a construction perspective, the five project alternatives include three different types of construction activities. The No Action Alternative assumes the existing bridge condition would eventually require closure and removal of the bridge structures. Construction activities would focus on demolishing the existing bridge and restoring the project area. The Rehabilitation Alternative would require bridge closure for approximately 30 months for rehabilitation or replacement of various elements of the existing bridge. The Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives would all result in constructing a replacement bridge approximately 80 feet downstream of the existing bridge. For these three alternatives, the replacement bridge would be constructed while the existing bridge continues to be operational. When the replacement bridge is connected to the existing road, there would be short-term temporary bridge closures. These closures could be limited to weekends or could extend for approximately one month, depending on the alternative. Once the replacement bridge is completed, traffic would be rerouted to the replacement bridge and then the existing bridge structure would be demolished in a similar fashion as described for the No Action Alternative.

Rehabilitation of the existing bridge would require closure of the existing bridge for approximately 30 months, although efforts would be made to minimize the closure period as much as possible. Reconstruction activities would begin as soon as possible after completion of design engineering and acquisition of construction permits. Traffic would be given advance notice to take alternate routes prior to closure of the existing bridge. The construction of a temporary dock and a construction staging area would be required on both banks of the waterway (see Figure 14). Construction of the new bascule piers would likely be the first major construction activity. This would entail removing the existing pier protection fenders, installing temporary supports for the bridge superstructure, removing the bascule leaves as well as the steel truss spans, installing cofferdams around the existing steel truss approach piers and bascule piers, and demolishing the existing piers.

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[14] Parsons Brinckerhoff, Inc. *South Park Bridge Structural Alternatives Study*, November 2003.

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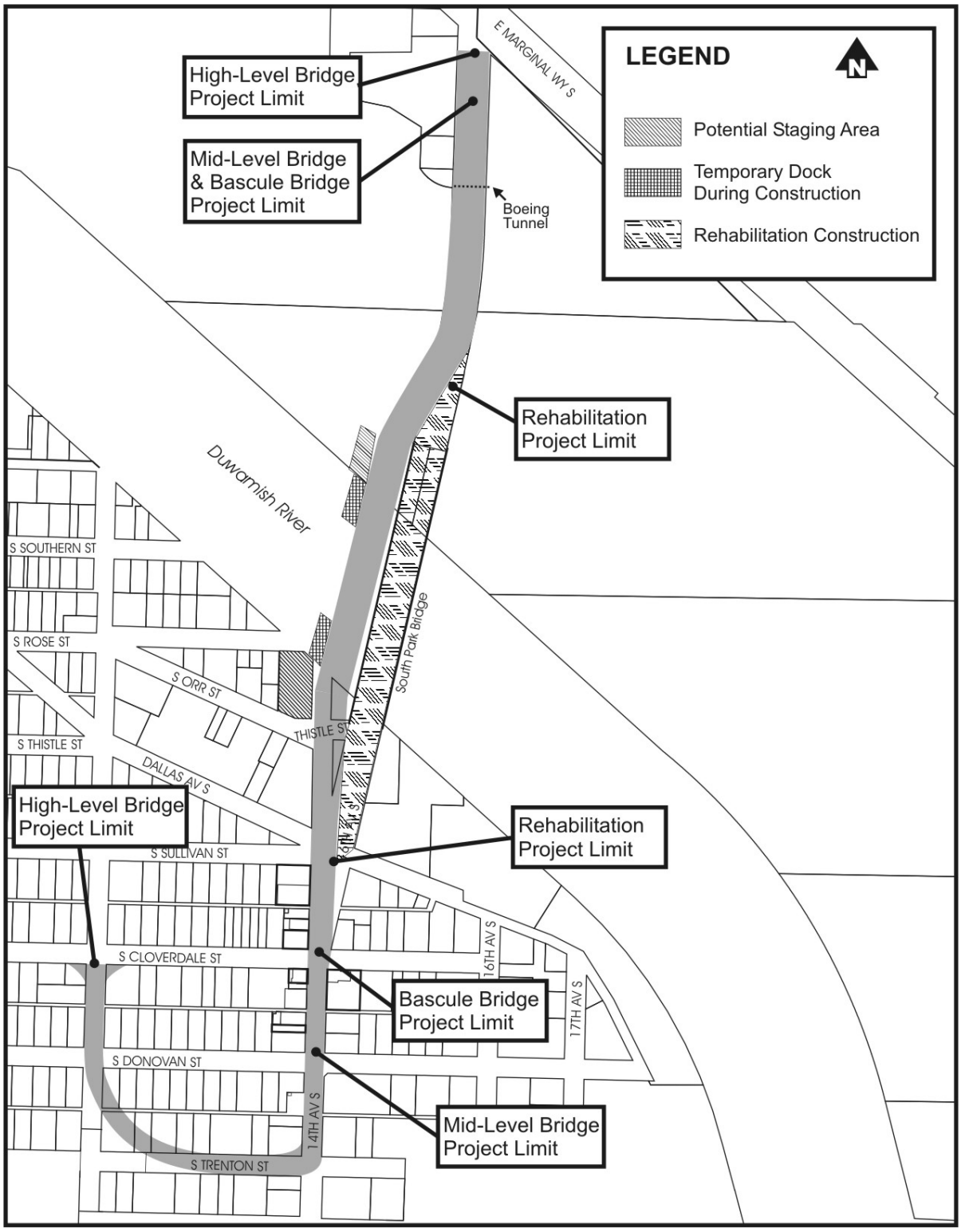

Figure 14
Proposed Construction Staging Areas

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The bascule leaves and steel truss approach spans would be removed from the construction site for refurbishment. Construction of the new piers would involve drilling shafts through the existing timber piles, constructing the pile cap, dewatering the construction area inside the cofferdam, constructing the upper portions of the pier, removing the cofferdam, and finally reconstructing the upper portions of the bascule pier and bridge towers. Workers would reconstruct the concrete approach spans and replace the abutments. Workers would also reconstruct the bridge deck and replace the mechanical and electrical systems used to operate the bridge. Replacement of the piers, bridge tender towers, bridge railings, and lamp posts would be done in a manner that would preserve the historic character of these features of the existing bridge.

Major construction activities and sequencing would be similar for the Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives. The construction duration and the impact area for each of these three alternatives, however, would clearly differ. Following completion of design engineering, acquisition of construction permits, purchase of needed property, and relocation of residents and businesses, construction activities would begin. The first activities would include establishing the construction staging areas and constructing temporary docks with pilings on both sides of the waterway (see Figure 14).

Buildings affected by the construction activities would be demolished and utilities would be either temporarily or permanently relocated. To minimize traffic impacts, construction activities would begin with the construction of the in-water piers. Construction activities would progress landward from the central portion of each bridge alternative. Both in-water and on-land construction would begin with construction of the sub-structures (piers and abutment) and would be followed by placement of the superstructure (beams, deck, rails). On-land construction of the piers, abutment, retaining walls, and transition segments at either end of the bridge would likely require temporary closure of adjacent or nearby roads and rerouting of local traffic. If possible, these temporary closures would be limited to weekend and/or night times to minimize impacts to the community. Construction activities on the north and south portions of the replacement bridge structures could also occur either separately or concurrently. The last of the construction activities would be the construction of the new curb and gutter of the at-grade roadway, and paving the roadway to match the existing width of 14th Avenue S. Figure 14 shows the project limits, or start and end points, of construction activities for each of the project build alternatives.

For both the rehabilitation and replacement bridge alternatives, new girders and other oversized materials would most likely be delivered to the project site by barge. Large cranes located on the barges or temporary docks would off-load the materials and place them in the nearby construction staging area. Removal of the existing bridge pier foundations and construction of the new bascule and steel truss piers would all require the use of cofferdams to isolate the construction activities. Construction of the new approach-span piers would use drilled shafts, which would likely incorporate the use of temporary casings to isolate the construction activities.

This in-water work would be performed by equipment operated from the temporary docks or from barges.

Demolition of the existing bridge would involve disassembly and removal of the existing bascule leaves, superstructure, bridge piers, protection fenders, and abutment. Cranes would use the existing bridge structure and approaches as much as possible to remove the various elements of the bridge. Barges would likely be used to remove oversized materials. At this time, this demolition work is not planned to require construction of temporary docks or the acquisition or temporary use of property on the banks of the Duwamish Waterway for a staging area. Removal of the abutment foundations, however, would likely require temporary short-term closure of adjacent and/or nearby streets. During this time, local traffic would be temporarily rerouted.

Following the completion of the construction activities associated with any of the project alternatives, disturbed areas would be restored. Conceptual site restoration plans would be developed for each alternative based on additional consultation with resource agencies and other stakeholders.

2.4.4 Cost Estimates for the Alternatives

Cost estimates for each of the proposed project alternatives have been prepared by the project engineers (see Table 1). The cost estimate for each project alternative, including the No Action alternative, is broken down into the following components: 1) plans, specifications, and estimates (PS&E), 2) right-of-way costs, and 3) construction and construction-related costs. The total cost estimates are provided in 2003 dollars as well as estimated costs escalated for 2008, the anticipated mid-point of the project construction period. These cost estimates were calculated based on the conceptual engineering plans that were prepared for each of the alternatives (Parsons Brinckerhoff, June 2003). Clearly, the No Action Alternative is the least expensive as the existing bridge would not be rehabilitated nor would a new replacement bridge be constructed. The cost to remove the existing bridge structure would be approximately $7,000,000 (2003 dollars). The estimated costs to either rehabilitate or replace the existing bridge structure range between approximately $62 million to $77 million in 2003 dollars. The least costly of the build alternatives is the proposed Mid-Level Fixed-Span Alternative, which is estimated to cost approximately $61,523,000 to design and construct. The Rehabilitation Alternative is estimated to cost approximately $63,930,000 and the High-Level Fixed-Span Alternative is estimated to cost approximately $70,460,000. The most costly of the build alternatives is the Bascule Bridge Alternative, which is estimated to cost $77,334,000. The escalated 2008 dollar estimates to design and construction the project alternatives are also shown in the table.

Table 1. Cost Estimates of the Project Alternatives

	PS&E	Right-of-Way	Construction	Total 2003 dollars)	Total (2008 dollars)
No Action	$ 250,000	$ 0	$ 6,750,000	$ 7,000,000	$ 9 M
Rehabilitation	$ 6,843,000	$ 754,000	$56,333,000	$63,930,000	$ 74 M
Bascule	$ 8,253,000	$ 3,655,000	$ 65,426,000	$ 77,334,000	$ 90 M
Mid-Level Fixed-Span	$ 4,235,000	$ 6,377,000	$ 50,911,000	$61,523,000	$ 71 M
High-Level Fixed-Span	$ 5,261,000	$ 15,310,000	$ 49,889,000	$ 70,460,000	$ 82 M

Source: Parsons Brinckerhoff, November 2003.

2.5 Project Coordination

Coordination to date for the South Park Bridge Project has involved members of the public, a special community advisory group, and representatives of government agencies. Formal scoping was initiated through publication of the NEPA Notice of Intent and the SEPA Determination of Significance and Scoping Notice on February 7, 2002 and February 14, 2002, respectively. Separate scoping meetings were conducted in the South Park community for relevant agencies and members of the public. Both meetings were held on February 28, 2002. Written and verbal comments received through the scoping process were reviewed by King County and used in the development of the project alternatives and topics for environmental impact assessment.

A public involvement plan for the proposed South Park Bridge Project was developed during the initial stages of project planning. The Project Advisory Committee (PAC) and the Community Advisory Group (CAG) reviewed this document and provided comments to King County. The first public involvement efforts began prior to the formal scoping period. A public workshop was held in the South Park community on January 17, 2002. At this meeting, the nine preliminary project alternatives were presented. A second public workshop was held on June 19, 2002. At this meeting, the five proposed project alternatives were presented. Members of the public were encouraged to provide comments at both of these meetings. To facilitate participation and input from Hispanic persons living in the community, a bilingual translator attended all meetings. In addition, handouts and newsletters for the project were published in English and Spanish, and public notices were published in "Siete Dias," a local Spanish-speaking newspaper. Future opportunities for public involvement are also planned, including a public hearing and workshop following publication of the Draft Environmental Impact Statement in 2004.

Establishing a CAG was a significant component of the public involvement plan. A total of 17 individuals were chosen to participate in the CAG to represent community stakeholder interests and public concerns. The CAG meets periodically to be briefed on the progress of the project and to provide input to the South Park Bridge project team. Again, a bilingual English-Spanish

translator attends the meeting to facilitate communication with Spanish-speaking individuals on the CAG. To date, CAG meetings have been held on April 10, May 21, June 4, June 11, and October 29 of 2002 and on January 7 and November 18, 2003. Additional CAG meetings are planned for the future.

As part of the environmental review process, King County periodically meets with the Project Advisory Committee (PAC) to give a status report of the project, answer questions, and to solicit comments. This committee is comprised of members of various agencies that have potential jurisdiction over the proposed South Park Bridge Project. The committee is the Interdisciplinary Team (IDT) required under NEPA implementation guidelines and provides technical support to King County staff. To date, the PAC has met on January 10, February 20, May 9, May 23, and October 10 of 2002. Coordination with the PAC is planned at critical future steps in the environmental review process.

A non-scientific survey was also conducted of South Park businesses located on 14th Avenue S. during the late spring of 2003.[15] The goal of the survey was to help assess potential impacts to businesses, especially minority-owned and –operated (employees) businesses. The survey respondents were also asked to identify their particular concerns about the proposed rehabilitation or replacement of the existing South Park Bridge. A total of 18 businesses were successfully surveyed. Spanish and Vietnamese translators were provided, as needed, to assist business representatives understand and respond to the questions. In addition, the data was used to assess the potential effects displaced businesses and jobs would have on the South Park community. The analysis of the survey findings are discussed in detail in the Economic, Social, and Relocation technical reports supporting the analysis in the EIS.

As key issues have arisen during development of the project alternatives and in assessing potential environmental impacts, special meetings have also been held with key stakeholders and organizations in the South Park community, as well as with other government agencies and jurisdictions with an interest in the project. For example, on December 3, 2002, King County met with owners of property along 14th Avenue S, and information booths were set up at the Sea-Mar Community Health Center-sponsored annual Fiesta Patrias on September 14, 2002 and at a family night event held at the Concord Elementary School on September 27 and November 22 of 2002. Periodic coordination meetings have also been held with representatives of the City of Seattle and the City of Tukwila, and other government agencies. These coordination activities will continue to occur on an on-going basis as the EIS is prepared and finally adopted.

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[15] Parsons Brinckerhoff, Inc. *South Park Bridge Project Survey of 14th Avenue South Businesses*, August 22, 2003.

King County Department of Transportation recently assembled information on rare, sensitive, threatened, and endangered plant species and plant communities that may occur in the project vicinity from the Department of Natural Resources (DNR) Plant Natural Heritage Database. The database did not include any threatened or endangered plants occurring within the vicinity of the project site. Parametrix, Inc. received a list of federally threatened and endangered species from the USFWS for the South Park Bridge location dated August 6, 2002 and a review of the Natural Heritage Information System data March 14, 2003. The NOAA Fisheries web page was reviewed to obtain the current listings of fish species under their jurisdiction on January 27, 2003. No new listings for this area have occurred since that date. A large number of species are identified by the WDFW Priority Habitats and Species list as being present in Region 4 (Puget Sound). However, most of these species, with the exception of salmonids, are not found in habitat of the nature of that present at the South Park Bridge site.

Analysis of the environmental issues for fish, wildlife, and vegetation is based on information available in existing published literature and unpublished reports. Substantial information is available on the species of fish present in the lower Duwamish River and the project vicinity. The available reports provide information on the life stages present, times of year when fish are present, prey resources used by the fish, and characteristics of habitat used by the fish.

King County has provided descriptions of project alternatives and an opportunity to comment on the alternatives to representatives of the USFWS, NMFS, Muckleshoot Tribe, and Washington Department of Fish and Wildlife.

Superfund investigations and remedial action for the Duwamish Waterway are in progress. The South Park Bridge is within the area proposed for sediment clean up at an undefined time in the near future. Recently chemical contamination of sediment at and near the project site was reported by Windward (2002). Surface sediment in the intertidal portions of the river tend to be contaminated with a variety of organic chemicals.

WRIA 9 habitat restoration and evaluation actions have been conducted, and are proposed for the Duwamish Waterway area at various locations. None of these sites is in the immediate vicinity of the South Park Bridge location.

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Chapter 4 Methodology

Information on fish and wildlife resources of the project site and the lower Duwamish River have been gathered from existing sources available in published and gray literature. Additional information has been sought from resource agency representatives (personal communication Glenn St. Amant, Kurt Buchanan). Parametrix biologists (Don Weitkamp-fish biologist, Elaine Mayer-wildlife biologist) visited the site on two low tide occasions to visually observe and photograph the site to determine existing habitat characteristics within several hundred yards of the site. The fisheries and wildlife biologists walked the shorelines north and south of the site where the habitat is accessible within 100 yards of the bridge, and examined the inaccessible shorelines from the bridge. Previously the fisheries biologist had examined the project vicinity on numerous occasions from the water during low tide conditions. Physical habitat features (substrate type, slope) and visible biota were noted within the riparian and intertidal portions of the existing habitat at the bridge site. The Boeing buildings extending over the shoreline and attached fence limited access on the northeast side of the river channel. Information for adjoining portions of the Duwamish River was obtained from existing literature and past experience of the biologists. These information sources were used to assemble the information presented in this document. This assessment focuses on the bridge site and the immediate vicinity within ¼ mile of the site. In the Duwamish River impacts are assessed for approximately ½ mile downstream.

Analysis of impacts to the existing habitat conditions and biota using the existing habitat was determined by evaluating physical changes predicted with each alternative. Existing habitat conditions were examined during a –1 ft MLLW tide condition. Nearly all intertidal habitat, which is located outside the dredged channel, was visible during this site inspection. Changes in location, area, and characteristics of in-water structures were considered for their potential affects to the habitat characteristics. Changes in the habitat characteristics were used to identify likely affects to the fish and wildlife populations using the habitat of the project site

No site-specific investigations of fish or wildlife were conducted for this environmental analysis. A second visual survey of the habitat characteristics at the site was conducted during a low tide period on July 23, 2002 (-2.4 ft MLLW).

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The project site is located on the Duwamish River at River Mile 3.8. This site is located within the dredged portion of the Duwamish River commonly referred to as the Duwamish Waterway. All project alternatives span the Duwamish Waterway. The fish, wildlife, and vegetation environment potentially affected by the replacement of the South Park Bridge includes the Duwamish River shorelines, bottom and water column. Construction and removal activities for each alternative together with the new structures have the potential to alter existing conditions within this portion of the local environment. During construction impacts to water quality could potentially occur in the absence of preventative measures. In-water work could potentially cause estuarine fishes to avoid the immediate vicinity of the bridge construction site. It is unlikely either juvenile or adult salmon would be directly injured by the construction activities. Timing restrictions for in-water work, restrictions on the use of construction lighting to extend working days, and the use of appropriate BMPs would avoid or minimize impacts to juvenile and adult salmon as well as estuarine fishes

5.1 Green-Duwamish River Project Site

The Duwamish River is the lower 11 mile long estuarine portion of the Green-Duwamish River System from Tukwila to Puget Sound. The dredged navigation channel commonly referred to as the Duwamish Waterway extends from Elliott Bay to river mile (RM) 6. It is tidally influenced, including saltwater intrusion upstream from the project site. At the South Park Bridge location surface salinities may be reduced to 5 percent or less by the freshwater discharge of the river (Dawson and Tilley 1972). Bottom salinities tend to be substantially higher, but vary depending on tide stage and river discharge. The Green-Duwamish River consists primarily of the Green River which extends from the Duwamish River reach upstream to head waters in the west slope of the Cascade Mountains about 30 miles north of Mount Rainier. Howard Hanson Dam impounds the mainstem river at RM 64.5, and a low head City of Tacoma diversion dam at RM 61. Two major tributaries, Newaukum and Soos Creeks enter the Green River downstream at about RM 40.5 and RM 33.5 respectively. Both these streams provide substantial habitat supporting anadromous salmonids.

5.1.1 Existing Physical Habitat

Habitat conditions at the bridge site and along most of the lower Duwamish River are highly influenced by the previous dredging and filling. Currently there is a straightened river channel with narrow intertidal tideflats extending to steep middle and upper intertidal shorelines. Both river shorelines are heavily armored upstream and downstream from the bridge site. Shoreline modifications associated with past development have limited native vegetation to small pockets scattered along the shoreline. These physical and habitat conditions extend approximately one mile upstream and downstream from the bridge site. The navigation channel is U shaped with a bottom at about -20 ft mean lower low water (MLLW). The parallel tideflats are at about -2 to +4 ft MLLW. The shorelines have industrial, business, and residential uses extending to, and in

some cases over the shoreline. The channel profile characteristics, straight shorelines, absence of off channel habitat, and steep hardened upper intertidal areas provide little refugia for young salmonids and limited habitat for estuarine fishes. The narrow tide flats paralleling the river channel at lower intertidal elevations provide foraging habitat and reduced current velocities for juvenile salmonids migrating through the project site. Little estuarine vegetation is present along the lower Duwamish River, which historically had extensive salt marsh habitat (Blomberg et al. 1988). The portion of the project site within the Duwamish River and the adjacent shorelines provide habitat for anadromous salmonids, estuarine fishes, and birds that prey on these species.

River velocities are dissipated as the Duwamish River widens and currents converge with tidal forces upstream from the project site. The river bottom is composed primarily of silt and mud in the navigation channel with compacted silty gravel in the upper section. Discharge of the river varies seasonally characterized by wet and dry seasons. The wet season extends from November to July, and the dry season from August to October. River banks are sloped and diked to contain flows of up to 11,000 ft^3/s (Williams et al. 1975). In the vicinity of the bridge site the area behind the dikes has subsequently been filled to the level of the dikes or higher.

The existing South Park Bridge has support structures in the Duwamish River that occupy 8,200 ft^2 of substrate surface area. These structures include two large bascule piers at either side of the navigation channel and two pairs of smaller piers between the bascule piers and the shoreline in the intertidal portion of the river channel. Bridge approach structures extend into the riparian area at each shoreline.

Near the project site, water quality is a potential limiting condition with high temperatures and low dissolved oxygen levels occurring downstream from RM 5.2 during summer low flow periods. The Duwamish River is on the Washington Department of Ecology's 303(d) list of impaired water bodies for multiple sites and parameters. Although water in the Duwamish River is only listed for exceeding pH, fecal coliform bacteria, and dissolved oxygen standards, sediments exceeded standards for numerous chemicals including a variety of metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phthalate esters, and phenol (Ecology 2000). Past discharges of dissolved and particulate contaminants into the Duwamish River from point and non-point sources have led to an accumulation of contaminants in the river sediment. The lower Duwamish River is a superfund site with sediment clean-up actions proposed for the South Park Bridge vicinity. The timing of this action is uncertain, and may either precede or follow construction of the selected South Park Bridge alternative.

5.1.2 Existing Biological Conditions

The portion of the Duwamish River and the adjacent shorelines in the vicinity of the project provides habitat for anadromous salmonids, estuarine fishes, and birds that prey on these fishes. The river at this location provides migration and estuarine rearing habitat for anadromous salmonids, but does not provide spawning or early freshwater rearing habitat (Weitkamp and Ruggerone 2000). The substantial middle intertidal flats along the dredged river channel provide

foraging habitat for young Chinook and other salmonids. Three Pacific salmon species inhabit the Duwamish-Green River basin in significant numbers: Chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), and chum (*O. keta*) salmon. Pink (*O. gorbuscha*) (odd year returns only in Washington) and sockeye (*O. nerka*) salmon may occasionally be seen in the Green-Duwamish River basin, but the Green River is primarily a chum, coho, and Chinook salmon stream (Williams et al. 1975). Although sockeye salmon are occasionally seen in streams that are not tributary to lakes, sockeye almost always require a rearing lake below, or near their spawning area (Foerster 1968). Anadromous game fish using these waters include steelhead (*O. mykiss*), sea-run cutthroat trout (*O. clarki clarki*), Dolly Varden (*Salvelinus malma*), and bull trout (*Salvelinus confluentus)*. Spawning and early rearing of all salmonids takes place in the Green River portion of the system. Anadromous forms of the salmonids migrate through the Duwamish River portion during their migrations to and from the ocean. The Duwamish River also provides a migratory corridor for adult chinook. These adults do not have specific habitat requirements within this migratory corridor other than water temperature, dissolved oxygen, and absence of passage barriers.

Studies of juvenile salmonids in the Duwamish River (Bostick 1955, Salo 1969, Williams et al. 1975, Weitkamp and Campbell 1980, Weitkamp and Shadt 1982, Meyer et al. 1980, Warner and Fritz 1995) have demonstrated the species present, their timing within the project vicinity, and various characteristics of the fish. These investigations together with those from other estuarine areas show subyearling Chinook and chum salmon use shallow water shoreline habitats of various characteristics during their rearing migration to the ocean. Juvenile pink salmon are likely to be found in the same areas during their spring migration period. The young salmon appear to prefer relatively protected shorelines with gradual slopes and depths of less than about six feet. However, they are also found along hard steep to vertical substrates that are either natural or man-made. The young salmon tend to remain close to the shoreline but apparently cross deep water at night (Tyler 1962, Stober et al. 1971, Bax et al. 1978). Wetherall (1971) found substantial numbers of Chinook in the lower Duwamish and Elliott Bay were sufficiently far from shorelines to be collected by a 10 ft deep surface trawl towed by two boats. Most likely this sampling was conducted in water of 35-100 ft deep based on maps provided in the document and safe operation depths for a two-boat trawl.

Yearling chinook, steelhead, and coho also use shoreline areas but appear to be less shoreline oriented than the subyearling migrants. The substantially larger yearlings are commonly found in the near-surface water well away from the shoreline. Subadult and adult cutthroat and bull trout (Dolly Varden) are likely to forage within the project vicinity during their late spring to summer migrations into Puget Sound.

Juvenile salmon migrating past the South Park Bridge site include numerous Chinook produced from the Soos Creek Hatchery located about 39 miles upstream from the site. Wetherall found that most juvenile Chinook from the hatchery reach the lower Duwamish River at Tukwila about 2-7 days following release from the hatchery. However, a small number take from one to three weeks to reach the lower river. Large numbers of hatchery Chinook reached Elliott Bay within

six days following release at the hatchery. The juvenile migration period potentially extends from late February through mid-June with wild fish commonly occurring over a broader range during this time than hatchery fish.

The tideflats and steep armored shorelines provide foraging habitat for approximately one mile upstream and downstream from the site. The tideflats produce insect (chironomids) and epibenthic zooplankton prey supporting juvenile salmonids during their spring migration through the Duwamish estuary. The project site and adjacent areas do not provide refugia for juvenile salmon. The channel is a migratory corridor for adult salmon and does not have any migration barriers to anadromous salmonids or other fish species. The tideflats resulting from previous dredging and filling of the estuary function in a manner similar to natural tideflats.

The site does not provide spawning or other habitat supporting forage fish. This location is in the upper portion of the Duwamish estuary outside the relatively high salinity range commonly used by Puget Sound forage fish (Pacific herring, Pacific sand lance, surf smelt).

Aquatic vegetation is limited to diatoms that grow on much of the intertidal substrate during the spring and summer. These diatoms provide a forage base for epibenthic zooplankton, which provide prey for young Chinook and chum salmon as they migrate through this area. No eelgrass or macro algae are present in the low salinities of the upper estuary. No marsh vegetation is present within the project site or adjacent shorelines.

Riparian vegetation in the vicinity of the project is sparse or absent. Riparian vegetation consists primarily of small amounts of Himalayan blackberries, grasses, and other non-native vegetation in narrow bands along portions of the areas shorelines. This vegetation grows up to the existing bridge, including directly in its shadow. Trees are generally absent in the riparian zone downstream from RM 5.2, excluding Kellogg Island and a few small pockets of deciduous trees. The Boeing facilities on the northeast side of the river channel extend to or over the channel edge, with blackberries and perennials at the edge of the parking area adjacent to the bridge. The southwest side has a ramp and marina upstream that exclude riparian vegetation. Downstream a narrow strip of grasses, perennials and some blackberries occurs between developed areas and the river channel. A few deciduous trees occur downstream in the residential area on the southwest side of the river channel.

Wildlife resources are also sparse within the project area. Priority Habitats and Species data from the Washington Department of Fish and Wildlife do not indicate any species of concern or state monitored species with the project area. While nesting bald eagles are not found within the project area, wintering bald eagles may be present during the wintering period. The wintering period extends from October 31 to March 31. Wintering bald eagles may forage in the vicinity of the bridge during this period. Resident bald eagles may forage in the vicinity of the site at any time during the year as they do along most of the regions urban shorelines. However, there are no trees affected by the project that are large enough likely to be used as perching trees. The only shoreline vegetation within the vicinity of the bridge is scattered deciduous trees about ¼ mile downstream of the bridge within the residential area. Ospreys may also be found

foraging along the river shorelines within the project area; however, the closest breeding territory is over one mile to the southeast of the project site.

The Muckleshoot Tribe conducts fishing activities in the lower Duwamish River, including in the immediate vicinity of the South Park Bridge. Set net fishing commonly extends nets from shoreline structures into or near the navigation channel, perpendicular to the shoreline.

5.2 Site Fish & Wildlife Resources

Fish resources of the project site include chinook, chum, coho, and pink salmon, steelhead, bull and cutthroat trout and various other freshwater and estuarine species. Wildlife resources include bald eagles, peregrine falcons, gulls, and a variety of birds that commonly use urban waterway areas. Fish species found in the Duwamish River estuary (Matsuda et al. 1968) and likely to be found at the upper end of the estuary in the vicinity of the South Park Bridge include those listed in Table 2. There are no site specific features that are unique in supporting any of the species identified in Table 2.

Table 2. Fish Species Likely to Occur at the South Park Bridge Site

Common Name	Scientific Name	Occurrence
Pacific lamprey	*Entosphenus tridenatus*	Occasional
Pacific herring	*Clupea harengus pallasi*	Rare
chum salmon	*Oncorhynchus keta*	Common
Chinook salmon	*Oncorhynchus tshawytscha*	Common
coho salmon	*Oncorhynchus kisutch*	Common
pink salmon	*Oncorhynchus gorbuscha*	common every other year
sockeye salmon	*Oncorhynchus nerka*	Occasional
rainbow / steelhead	*Oncorhynchus mykiss*	Common
cutthroat trout	*Oncorhynchus clarki clarki*	Occasional
bull trout (Dolly Varden)	*Oncorhynchus confluentus (malma)*	Rare
mountain whitefish	*Prosopium williamsoni*	Occasional
northern pikeminnow	*Ptylocheilus oregonensis*	occasional
longnose dace	*Rhinichthys cataroctae*	common
specled dace	*Rhynichthys osculus*	Occasional
large-scale sucker	*Catostomus macrocheilus*	Common
threespine stickleback	*Gasterosteus aculeatus*	Common
shiner perch	*Cymatogaster aggregatea*	Occasional
prickley sculpin	*Cottus asper*	Occasional
buffalo sculpin	*Enophrys bison*	Occasional
Pacific staghorn sculpin	*Leptocottus armatus*	Common
starry flounder	*Platichthys stellatus*	Occasional

The highly developed urban nature of the site and the surrounding area limit wildlife to those species adapted to urban habitats.

5.2.1 ESA Species Listing Information

King County DOT has assembled information on rare, sensitive, threatened, and endangered plant species and plant communities that may occur in the project vicinity from the Department of Natural Resources (DNR) Plant Natural Heritage Database. The database did not include any threatened or endangered plants occurring within the vicinity of the project site. The USFWS (Appendix) provided a list of federally threatened and endangered species for the South Park Bridge location on August 6, 2002. No new listings for this area have occurred since that date.

The USFWS indicated that the coastal Puget Sound distinct population segment (DPS) of bull trout (*Salvelinus confluentus*) and wintering bald eagles (*Haliaeetus leucocephalus*) may occur in the project vicinity (Appendix). The USFWS recently declined to list the coastal cutthroat trout. Information on federally threatened and endangered species under the jurisdiction of the National Marine Fisheries Service (NMFS) was obtained from their web site at http://www.nwr.noaa.gov/1salmon/salmesa/index.htm. One threatened species, the Puget Sound population of Chinook salmon (*Oncorhynchus tshawytscha*), was identified from the NMFS web site and does occur in the project vicinity.

Consequently, this report describes existing conditions, habitat requirements and project alternative direct impacts and indirect impacts to species and their habitat and forage base for Chinook salmon, bull trout, and bald eagles.

5.2.2 Chinook Salmon

Chinook salmon are present at the project site as both juvenile downstream migrants and as adults returning to their natal streams to spawn. Chinook salmon is a species listed as threatened under the Endangered Species Act (ESA). The Duwamish-Green stock is a part of the Puget Sound Chinook evolutionarily significant unit (ESU). The contribution of hatchery fish to the natural spawning population is substantial, but is currently uncertain.

5.2.2.1 ESA Status

The ESA status review of Chinook salmon populations from Washington, Oregon, Idaho, and California conducted by NMFS defined 15 evolutionarily significant units (ESUs) (each considered a species under the ESA). Naturally spawned spring, summer/fall, and fall Chinook salmon runs from the Puget Sound ESU were considered likely to become endangered in the foreseeable future (Myers et al. 1998). The abundance of Chinook salmon in the Puget Sound ESU has declined substantially from historic levels, and there is concern over the effects of hatchery supplementation on genetic fitness of stocks, as well as severely degraded spawning and rearing habitats throughout the area (Myers et al. 1998). In addition, harvest exploitation

rates in excess of 90% were estimated to occur on some Puget Sound Chinook salmon stocks. In May 1999 NMFS issued a ruling listing the Puget Sound ESU as threatened (NMFS 1999a). Primary factors contributing to declines in Chinook salmon in the Puget Sound ESU include: habitat blockages, hatchery introgression, urbanization, logging, hydropower development, harvests, and flood control and flood effects (NMFS 1998).

The Green River fall Chinook salmon stock appears to be healthy based on escapement levels (Weitkamp and Ruggerone 2000). Escapement levels, based upon redd counts, averaged 7,600 from 1987 to 1991 with a range of 4,792 to 10,263 fish (WDF et al. 1993). There is some indication that the decline in Green River natural spawners is not as great as for other rivers (King County 2000). The actual level of decline may be obscured by a relatively high straying rate of hatchery fish.

Presently, Chinook salmon in the Green River are nearly all summer/fall run fish. Chinook begin entering the Duwamish River in mid-June, peak in August and continue entering the river through early November (Weitkamp and Ruggerone 2000). Although spring Chinook salmon is occasionally found in the Green River, there is no evidence available indicating that these fish constitute a self-sustained run (Weitkamp and Ruggerone 2000).

The Duwamish-Green River fall Chinook salmon stock is part of the Puget Sound ESU (NMFS 1999a). Duwamish-Green River summer/fall Chinook salmon are classified as a distinct stock based on geographic distribution. The stock's origin is mixed, with hatchery production at Soos Creek and natural spawning throughout the river. No genetic data exists for natural spawners. Hatchery Chinook salmon have been documented in the natural spawning populations in the Green River and Newaukum Creek. Coded-wire-tag data indicated that the percentage of hatchery fish on the mainstem spawning grounds ranges from 25% to 83% and for Newaukum Creek from 17% to 79% (King County 2000, Weitkamp and Ruggerone 2000). Genetic data (allele frequencies) are available for Chinook sampled in Newaukum Creek (one year of data), a tributary to the Green River, and for Chinook collected in the Green River Hatchery on Soos Creek (Weitkamp and Ruggerone 2000). Genetic analysis indicated the hatchery and naturally spawning stocks were sufficiently similar that they could not be distinguished using genetic stock identification techniques, probably due to the use of Green River wild fish to establish the hatchery stock.

Chinook salmon spawning in the mainstem Green River occurs from the vicinity of the City of Kent (RM 24), which is roughly 20 miles upstream from the project site, to the City of Tacoma diversion downstream (RM 61) (WDF et al. 1993). The Chinook salmon populating the Green River system are principally fall Chinook salmon, as distinguished from the spring Chinook salmon race (Williams et el. 1975). Spring Chinook salmon have utilized the system to some degree, although their numbers are thought to be limited and their spawning grounds located in the upper Green River Gorge (Williams et el. 1975). The current status of this population is undefined. The Duwamish River summer/fall Chinook salmon stock is similar to other Puget Sound stocks in the timing of its spawning activities, which occur in mid-September through October (WDF et al. 1993).

5.2.2.2 Pertinent Life History

Adult Chinook salmon begin entering the Duwamish River in mid-June, peak in August and continue entering the river through early November. Although spring Chinook salmon are occasionally found in the Green River, it does not appear that these fish constitute a self-sustained run (Weitkamp and Ruggerone 2000). Spawning begins in mid-September, peaks in October, and continues into November, similar to other Chinook salmon stocks in south Puget Sound. Late summer water temperatures most likely restrict upstream migration of adults until mid-September. Temperatures of 22-25°C commonly occur in the Duwamish River during late summer. Adult salmon apparently do not migrate into water of 21°C or higher (Fish and Hanavan, 1948, Major and Mighell 1967). Historically, adult Chinook have been recorded in the Green River as early as late May (Williams et al. 1975). These probably constitute the small population of spring Chinook salmon that have used the upper reaches of the river system.

Chinook salmon spawning naturally in the Green River is most abundant in the mainstem of the river from the City of Tacoma water diversion (RM 61) downstream to Soos Creek (RM 33.6). Some natural spawning does occur in the main stem Green River downstream from Soos Creek. Substantial natural spawning also occurs in Soos Creek and Newaukum Creek (Williams et al. 1975, WDF et al. 1993, Weitkamp and Ruggerone 2000).

Chinook fry emerge from gravel during late winter and spring. Following emergence the "ocean type" juvenile fall Chinook rear in fresh water from a few days to about 3 months migrating to the estuary and offshore during their first year of life (Myers et al. 1998, Weitkamp and Ruggerone 2000). The timing of the juvenile migration in the Green River potentially produces substantial numbers of young Chinook in the project area from March through June. Yearling spring Chinook smolts are also likely to migrate past the project site during this period, corresponding with the normally high spring run-off flows. Peak abundance of juvenile Chinook in the Duwamish River estuary occurs during late May and early June as a result of hatchery releases, although Chinook may be present through July (Bostick 1955, Salo 1969, Weitkamp and Campbell 1980, Meyer et al. 1980). The peak abundance of wild spawned juveniles is likely earlier.

Juvenile Chinook salmon rear in the entire accessible length of the Green River and in those tributaries used by spawning adults. Much early rearing also takes place in the basin's estuarine waters with the lower Duwamish River and Elliott Bay providing critical rearing and migration habitat. The estuarine area of the lower Duwamish River and Elliott Bay provides a rearing area where young Chinook grow rapidly to reach a size suitable for offshore migration. Residence time in the estuary is relatively brief. Weitkamp and Shadt (1982) concluded from a mark-recapture study that residence time of chum in the Duwamish estuary was approximately one week. Warner and Fritz (1995) noted that most Chinook smolts left the river system within two weeks of peak abundance in the estuary. Food for the juveniles appears to be relatively abundant in the Green-Duwamish River. Warner and Fritz (1995) reported that coded wire tagged Chinook released from the hatchery and recaptured in the estuary after approximately

25 days (range: 8-61 days) had gained approximately 1 gram or 70% gain in weight (range: 3.7 gram or 540% gain).

Juveniles rapidly reach a size of 70 mm or greater appropriate for offshore migration. Salo (1969) reported that mean length of Chinook salmon captured in the estuary increased from 76 mm on June 1 to over 90 mm by early July. Weitkamp and Schadt (1982) found young Chinook in the lower Duwamish ranged from 55 to 90 mm. Most of the juvenile Chinook were in the 70-85 mm size range.

Young Chinook fry tend to rear and migrate in shallow water along the banks and avoid the high velocity water (thalweg) near the center of the channel (Healey 1991). Juveniles are seldom found in estuarine waters at depths greater than about 6 ft (2 m), although they do migrate in the surface water away from shore at times. Migration commonly occurs during the night, although some fish may migrate during the day (Healey 1991).

5.2.2.3 Critical Habitat

The designation of critical habitat for listed species is required under Section 4(a)(3)(A) of the ESA. The ESA defines critical habitat in Section 3(5)(A) as "the specific areas within the geographic area occupied by the species, on which are found those physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection." Recently, NMFS (2000a) designated critical habitat to include all marine, estuarine, and river reaches accessible to listed Chinook salmon in Puget Sound. The Green-Duwamish River is one of many river basins that contain critical habitat for Puget Sound Chinook salmon (NMFS 2000a). However, most recently the NMFS asked the U.S. District Court for the District of Columbia to allow the withdrawal of critical habitat designations for 19 Pacific salmon and steelhead ESUs listed under the ESA. Resolution of this matter is pending.

5.2.3 Coho Salmon

A status review of coho salmon was recently completed by NMFS in response to petitions seeking to list several Pacific Northwest populations as threatened or endangered (Weitkamp et al. 1995). Coho (*Oncorhynchus kisutch*) are currently designated as a candidate species for listing in Puget Sound.

Based on genetic, life history, biogeographic, geologic, and environmental information, six Ecological Significant Units (ESUs) were defined for coho salmon in Washington, Oregon, and California. Despite recent stable trends in population abundance near historic levels, the status of the Puget Sound/Strait of Georgia ESU was determined to warrant further consideration for listing due to concerns over current genetic, environmental, and habitat conditions. Risk factors identified as potentially deleterious to Puget Sound coho salmon stocks included high harvest rates, extensive habitat degradation, unfavorable ocean conditions, and declines in adult size (Weitkamp et al. 1995). The genetic fitness of Puget Sound coho stocks has been altered by

widespread and intensive artificial propagation that includes interbasin transfers of broodstock, and by natural spawning between wild and hatchery origin fish. Hatchery supplementation in South Puget Sound, including the Green-Duwamish River, has been extensive (Weitkamp et al. 1995).

Coho fry in the Green-Duwamish River basin are dependent on availability of quality river habitat for growth, and typically use side channels, wetlands, and off-channel sloughs for over-wintering and rearing (Grette and Salo 1986). Young-of-the-year coho occur almost exclusively in the upper Green River basin. Juveniles migrate out during spring freshets, usually in May, after rearing in freshwater for about 18 months. Coho smolts use the shorelines of estuarine areas, but tend to be less shoreline oriented than subyearling Chinook and chum. Smolts mature in the marine environment for another 18 months before returning to spawn as three-year-old fish (Weitkamp et al. 1995).

Adult coho enter the Duwamish River from mid-August through December, with peak migration activity in November.

5.2.4 Bull Trout

Bull trout have been identified in the Green River but there does not appear to be a reproducing population within this basin. The observed individuals are most likely anadromous bull trout from other basins that have entered the Duwamish-Green basin from Puget Sound. Individual bull trout may at times pass the project site, but most likely there is no sustained presence of bull trout at this location. Currently, elevated water temperatures would tend to restrict bull trout use of the project area during the summer low-flow period. Some of the past observations of a few Dolly Varden in the Duwamish River may have been bull trout, and would be classified as char along with bull trout by the State of Washington.

5.2.4.1 ESA and Stock Status

USFWS (1998a) identifying five distinct population segments (DPSs) of bull trout in the coterminous U.S. The Coastal-Puget Sound bull trout DPS includes 34 sub-populations (USFWS 1998b, 1999a). USFWS listed bull trout in the Coastal-Puget Sound DPS as threatened under ESA on November 1, 1999 (USFWS 1999a).

Four life history forms are generally recognized for bull trout, which include resident (non-migratory), adfluvial (lake dwelling), fluvial (migratory stream and river dwelling), and anadromous fish (saltwater migratory). The Coastal-Puget Sound population segment of bull trout, which includes the Skykomish River/Snohomish River sub-population, is unique because it is thought to contain the only anadromous forms of bull trout within the coterminous U.S. (USFWS 1998a). The status of the migratory (fluvial, adfluvial, and anadromous) forms are of greatest concern throughout most of their range. The majority of the remaining populations in some areas may be largely composed of resident bull trout (Leary et al. 1991; Williams and Mullan 1992).

Bull trout have a wide but very patchy distribution across their range, even in pristine environments (Rieman and McIntyre 1993). Bull trout have been extirpated from many of the large rivers within their historic range and exist primarily in isolated headwater populations. The decline of bull trout has been attributed to habitat degradation, blockage of migratory corridors by dams, poor water quality, the introduction of non-native species, and the effects of past fisheries management practices (USFWS 1998a).

Historically, bull trout were probably well distributed throughout the central Puget Sound region (Goetz 1994). Currently both bull trout and Dolly Varden are collectively classified as "native char" since their morphological characteristics make them virtually indistinguishable in the field. The WDFW has combined information on their status and distribution into a common inventory (WDFW 1998). The Green River is known to support native char (bull trout or Dolly Varden), however, information regarding the presence, abundance, distribution, and life history of bull trout in the basin is extremely limited (WDFW 1998). Numerous collections of salmonids in the Duwamish River during the last 40 years have collected only a small number of native char, Taylor and Associates (Bill Taylor, personal communication 5/12/03) collected eight bull trout at the Duwamish River turning basin (RM) in August-September 2000, and a single bull trout in September 2002. This information indicates the number of native char that presently use this river is small. During the 1930s, Pautzke and Meigs (1940) described the Green River as containing a "few" Dolly Varden. Matsuda et al. (1968) collected three Dolly Varden from the estuary in 1964. A single native char was reported in Soos Creek in 1956 (King County DNR 2000). A single native char was also observed at the mouth of the Duwamish River in the spring of 1984 (Warner 1998, personal communication). Native char have been captured in the Green River as far upstream as RM 40.0 (Watson and Toth 1994). Fish distribution and habitat surveys by the United States Forest Service (USFS) (1996) and extensive presence/absence surveys by Plum Creek Timber (Watson and Toth 1994) have found no native char above Howard Hansen Reservoir. Mongillo (1993) classified the bull trout population in the Green River as a remnant population with unknown status. It is not known whether the Green River habitat can currently support native char, or if there was any historical use of the upper watershed (WDFW 1998). The stock status and life history forms of the Green-Duwamish River sub-population are unknown (WDFW 1998; USFWS 1998b) with USFWS estimating total abundance for the sub-population at less than 5,000 individuals or 500 adults.

Anadromous bull trout are known to migrate extensively, and enter rivers other than their natal system to feed or spawn (Armstrong 1984). These migrant fish are not likely to reach upstream tributaries in the non-natal streams they enter prior to returning to their natal stream. The native char that have been recently observed in the lower Green River may be anadromous forms, which have migrated into this drainage from other rivers (WDFW 1998). Self-sustaining populations of native char occur in the upper Cedar River drainage (including Cedar and Rex Rivers and Chester Morse Lake), the White River drainage, and the Skykomish River (upper Snohomish River drainage) (WDFW 1998). Incidental and anecdotal observations indicate bull

trout in Issaquah Creek, lower and middle Cedar River, and lower Green River. These observations likely include a mixture of fluvial and anadromous bull trout.

5.2.4.2 Pertinent Life History

The anadromous life-history form of bull trout is not well understood (USFWS 1999a). For many years, it was thought that anadromous char in Washington were Dolly Varden and that freshwater char were bull trout. There is conclusive evidence that anadromous bull trout populate Puget Sound (Kraemer 1994), and anecdotal evidence suggests these native char were once much more abundant (USFWS 1999a). In Washington State, bull trout and Dolly Varden coexist and are managed as a single species, native char. Separate inventories are not maintained by WDFW due to the considerable biological similarities in life history and habitat requirements that exist between the two species. Although historic reports of char may have specified either bull trout or Dolly Varden, methodologies for reliably distinguishing between the two have only recently been developed and have not yet been widely applied (WDFW 1998).

Bull trout are considered to be optionally anadromous, (i.e., the survival of individuals is not dependent upon whether they can migrate to sea), in contrast to obligate anadromous species like pink (*Oncorhynchus gorbuscha*) and chum salmon (Pauley 1991). Nonetheless, the anadromous life history form is important to the long-term persistence of bull trout and their metapopulation structure. Anadromous char are generally larger and more fecund than their freshwater counter parts, and migratory forms play an important role in facilitating gene flow among sub-populations.

Bull trout are believed to be restricted in their spawning distribution by water temperature. Bull trout spawn in late summer and early fall (Bjornn 1991). Locally, anadromous forms typically return to fresh water in late summer and fall to spawn in upper tributaries and headwater areas. In the Green River system, spawning information is lacking. Puget Sound stocks typically initiate spawning in late October or early November as water temperature falls below 7-8º C. Spawning habitat generally consists of very clean gravel, often in areas of groundwater upwelling or cold spring inflow (Goetz 1994). Neither of these conditions exists in the action area. Egg incubation temperatures needed for survival have been shown to range from 2º to 4º C (Willamette National Forest 1989). Bull trout eggs require approximately 100 to 145 days to hatch, followed by an additional 65 to 90 days of yolk sac absorption during alevin incubation. Thus, in-gravel incubation spans 6 months or more. Hatching occurs in winter or late spring and fry emergence occurs from early April through May (Rieman and McIntyre 1993).

Generally, for their first 1 to 2 years, bull trout juveniles rear near their natal tributary and exhibit a preference for cool water temperatures (Bjornn 1991), although they appear less restricted by temperature than spawners. Newly emerged bull trout fry are often found in shallow, backwater areas of streams that contain woody debris refugia. Later and in habitats lacking woody debris, fry are bottom dwellers, and may occupy interstitial spaces in the streambed (Brown 1992). Since no known spawning occurs in the lower Duwamish River sub-basin, these habitat requirements are not pertinent to the proposed project.

Resident forms of bull trout spend their entire lives in small streams, while migratory forms live in tributary streams for several years before migrating to larger rivers (fluvial form) or lakes (adfluvial form). Migratory individuals typically move downstream in the summer and often congregate in large, low-velocity pools to feed (Bjornn 1991). Anadromous bull trout usually remain in freshwater 2 or 3 years before migrating to salt water in spring (Wydoski and Whitney 1979).

Bull trout life histories are plastic (i.e., variable and changeable between generations), and juveniles may develop a life history strategy that differs from their parents. The shift between resident and migratory life forms may depend on environmental conditions. For example, resident forms may increase within a population when survival of migratory forms is low (Rieman and McIntyre 1993). Char are generally longer-lived than salmon, and bull trout up to 12 years old have been identified in Washington (Brown 1992).

5.2.4.3 Critical Habitat

The designation of critical habitat for listed species is required under Section 4(a)(3)(A) of the ESA and is generally determined at the time of the listing. The critical habitat designation was deemed "not determinable" by USFWS (1998a) due to the meager understanding of the biological needs of the species. A critical habitat designation was expected within 2 years of the proposed rule (USFWS 1998a), but has not yet been issued.

Use of the Green-Duwamish River by bull trout is largely uncertain. There are no known documented occurrences of bull trout at the project site, but several adult bull trout have been observed in the Duwamish River (Bill Taylor, personal communication to Don Weitkamp, 2003). Currently, elevated water temperatures, low stream flows, and a degraded stream corridor would tend to obstruct or deter bull trout movement into the project area during the summer low flow period. The action area, however, includes the Duwamish River, which apparently may serve as a migratory corridor for bull trout elsewhere in the basin where they occasionally have been found. Suitable habitat for bull trout in the action area is limited to foraging movements within the Duwamish/Green River basin, and over-wintering habitat.

5.2.5 Sea-Run Cutthroat Trout

Cutthroat trout (*Oncorhynchus clarki*) in Puget Sound are not currently listed by the U.S. Fish and Wildlife Service. They were proposed for listing, but listing was determined to not be warranted. They are included in this analysis because of public concern and their potential for future listing. Juvenile cutthroat migrate to Puget Sound in the spring, during their second or third year of life at a size of about 120-170 mm (Behnke 1979, Hickman and Raleigh 1982). Although sea-run cutthroat tend to remain in bays and estuaries, they apparently enter shallow water only when feeding on salmon and other small fishes. Both juvenile and adult cutthroat are predacious on fish, including other salmonids and larger invertebrates such as shrimp (Giger 1972).

Sea-run cutthroat trout do not over winter in marine waters and remain close to the coast before returning to spawn (Johnson et al. 1994). Spawning migrations may begin after as few as eight months in the marine environment (Grette and Salo 1986). Spawning migrations of adults probably occur from late summer through mid winter. In the Green River basin of Puget Sound, adults begin spawning migrations from July to January, with peak in October and November (Grette and Salo 1986). In Minter Creek, peak returns occur in December and January, and continue through March (Johnson et al. 1994). Spawning occurs between December and May in small, low-gradient tributary streams (Trotter 1989). Some sea-run cutthroat trout remain in fresh water after spawning, but most return to Puget Sound.

5.2.6 Bald Eagles

Bald eagles do forage within the Duwamish River area, including the project site. It is likely that the eagles do fly over the site but no existing features of the site or its immediate surrounding area provide specific features likely to be attractive to bald eagles.

5.2.6.1 ESA Status and Distribution

Bald eagles were first protected by the Bald Eagle Protection Act of 1940 and later listed as endangered under the Endangered Species Act of 1973. In 1978, the eagle was reclassified as threatened in five states, including Washington. Once numbering between 250,000 and 500,000 in the continental U.S., human development and the use of the pesticide DDT reduced the population to a low of about 400 pairs by the early 1960s. With the banning of DDT in 1972, and a number of subsequent recovery efforts, the continental U.S. population of bald eagles has since made a dramatic recovery, and by 1998, breeding pairs numbered approximately 6,000. Because of this recovery, USFWS has proposed that the bald eagle be delisted (USFWS 1999b).

Recovery has been dramatic in Washington State, where there are now over 600 nesting pairs, with approximately 300 pairs in Puget Sound alone. Bald eagle nesting territories are now found along much of the shorelines of Puget Sound and Lake Washington. Washington State also supports the largest wintering population of bald eagles in the continental U.S. Eagles nesting in Washington commonly winter in British Columbia and Southeast Alaska where winter runs of salmon occur. A few thousand birds can be found throughout the state where waterfowl and fish congregate, including along the shorelines of Puget Sound.

5.2.6.2 Pertinent Life History

Nesting, foraging, and perching habitat for bald eagles is typically associated with water features such as rivers, lakes, and coast shorelines where eagles prey upon fish, waterfowl, and seabirds (Stalmaster 1980, 1983, 1987). During the breeding season, eagles establish and maintain territorial boundaries, and breeding birds will rarely be found in high numbers. Breeding eagles show strong fidelity to a particular nesting territory, and will prevent other eagles from entering it

(Grubb 1980). Territories frequently contain two or more nests, but will be used exclusively by one breeding pair, thereby reducing competition for local food resources.

Suitable nesting habitat for bald eagles is typically in mature forests that contain large, dominant trees for nesting, and is in close proximity to aquatic foraging habitat (Anthony and Isaacs 1989). Douglas fir (*Pseudotsuga menziesii*) appears to be the most common tree species used for nesting in forests of western Oregon and Washington. Lack of suitable nesting habitat has been shown to be limiting factor for population growth in some raptors (Newton 1979). Unoccupied nests may indicate suitable physical habitat attributes are available but human activity precludes their successful use (Anthony and Isaacs 1989).

Priority Habitats and Species (PHS) data from WDFW did not indicate any nesting bald eagle within 1 mile of the project area. The nearest nesting territory is over 4 miles from the project site, well beyond the 0.25- to 0.4-mile distance within which researchers have found nesting eagles to react to potentially disturbing activities (Fraser et al. 1985; Anthony and Isaacs 1989; Grubb and King 1991; Parson 1994). The winter period for bald eagles is from October 31 through March 31.

Bald eagles may spend nights together in communal roosts, more commonly in winter and extreme weather. Many roosts are traditional sites that are used repeatedly and are typically located in areas where the eagles have protection from the weather, and away from human activity (Hansen et al. 1980). PHS data do not indicate any roost sites near the project.

5.2.6.3 Critical Habitat

Critical habitat has not been designated for bald eagles.

5.3 Essential Fish Habitat

The Magnuson-Stevens Act requires the evaluation of proposed projects with a federal nexus include impacts to habitat of commercially managed fish populations. Essential fish habitat (EFH) has been defined for the purposes of the Magnuson-Stevens Act as "*those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity*" (NMFS 1999b). NMFS has further added the following interpretations to clarify this definition:

- "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate.
- "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.
- "Spawning, breeding, feeding, or growth to maturity" covers the full life cycle of a species.

At the project site essential fish habitat is present for salmon. NMFS has recently defined Essential Fish Habitat for Pacific Coast salmonids, including Chinook salmon, within Amendment 14 to the Pacific Coast Salmon Plan (NMFS 2000c). The important elements of Essential Fish Habitat for chinook, coho, chum and pink salmon are: 1) estuarine rearing; 2) early ocean rearing; and 3) juvenile and adult migration. Important features of estuarine and marine habitats are: 1) adequate water quality; 2) adequate temperature; 3) adequate prey species and forage food; and 4) adequate depth, cover, marine vegetation, and algae in estuarine and nearshore habitats. While limited information exists on the characteristics of habitat that salmon use when they are in marine waters, it is clear that those habitats used during early-ocean entry are the most important. The geographic extent of Essential Fish Habitat for salmon in marine waters includes all waters from mean high water to 60 km (35 miles) offshore north of Point Conception, California (NMFS 2000c).

Estuarine habitat used by juvenile salmon is expected to include beaches, bays, and inland passages during spring, and summer, over all bottom types, with preferred forage of copepods, euphausids, and amphipods. Dissolved oxygen in the water is lethal at < 2.0 mg/L, and is optimum at saturation. Water temperature may range from 0 to 26° C, but 12-14° C is considered optimum (NMFS 2000c).

The location of the project site well upstream in the Duwamish River estuary provides no essential fish habitat for groundfish or coastal pelagic species. The South Park Bridge site is likely the periphery of habitat occupied by English sole and starry flounder, which are marine groundfish that also occur in the higher salinity areas of estuaries.

Among numerous types of non-fishing activities that may affect Essential Fish Habitat, those applicable to this project area include those that would:

- alter sediment delivery to and quantity in streams, intertidal areas, and estuaries,
- alter water flow, quantity, timing, temperature, or chemistry,
- alter the amount or types of nutrients or prey,
- alter estuarine habitat (includes water quality, eelgrass beds, tide flats, channels, or marshes), and
- discharge pollutants, nutrients, or contaminants.

6.1 Direct Impacts

Direct impacts to the fish and wildlife resulting from the project would include impacts resulting from both construction of new structures and removal of existing structures within the aquatic habitat of the Duwamish River. The determination of potential effects of alternatives is based upon life history analysis, habitat requirements, literature review, agency consultation, Priority Habitats and Species (PHS) data from WDFW, and field reconnaissance studies conducted by Parametrix biologists.

6.1.1 Construction Impacts

Each of the alternatives would result in essentially the same impacts resulting from removal of the existing bridge. Each alternative would involve the same removal of in-water piles, protection fenders, and concrete pier foundations supporting the existing bridge. For the Replacement Alternative construction impacts would occur at the location of the existing bridge following removal of the existing bridge. The existing untreated piles would either be pulled or cut off at the mud line.

Construction impacts for the replacement bridge alternatives (New Bascule, Mid-Level Fixed Span, and High-Level Fixed Span) would be similar for each alternative. Construction impacts would occur immediately downstream from the existing bridge site prior to removal of the existing bridge. The rehabilitation and replacement alternatives would each involve similar types of in-water work activities. A temporary pier would be constructed adjacent to the replacement bridge to provide a working platform during construction. New concrete shafts or piles would be placed to support the foundations of the replacement bridge. Fish may avoid or not use the site in the immediate vicinity of work during the in-water construction activities.

With each alternative, young salmonids are likely to avoid the immediate vicinity of the construction activity during periods that involve disruption of the bottom, movement of large objects within the water, and placement or removal of large objects within the water. Minor actions such as movement of vessels is not likely to disturb the activity of the young fish, except directly adjacent to the activity. The Hydraulic Project Approval issued by the Washington Department of Fish and Wildlife would likely prohibit in-water construction during the spring in-water closure period of February 15 to July 15 when young salmon are most likely to be present at the project site. This prohibition would avoid impacts from in-water construction to young salmonids.

Each alternative would involve removal of existing in-water structures. The existing piles would be removed following demolition of the above water structures of the existing bridge. Only timing of the removal activity would vary with the alternatives. With no action, the removal would occur at some unidentified time in the future after the bride is no longer functional. With

the High and Low-Level Fixed and Bascule alternatives, the removal would occur immediately following completion of the new structure. With the Rehabilitation Alternative removal would occur at the beginning of the project.

Each replacement bridge alternative and the Rehabilitation Alternative would use the same construction techniques and the same types of materials. These alternatives vary in that replacement bridge alternatives would occur within a corridor immediately northwest of the existing bridge, whereas the Rehabilitation Alternative would replace the existing bridge support piers within the basic footprint of the existing bridge. The Rehabilitation Alternative would not involve in-water work outside the footprint of the existing bridge and fender system. A smaller footprint would be disturbed over the course of construction with the Rehabilitation Alternative than with the Bascule Bridge, Mid-Level Fixed Span, and High-Level Fixed Span Alternatives. The Bascule Bridge, Mid-Level Fixed Span, High-Level Fixed Span Alternatives would not include the second set of support piles that are located between the shoreline and the main support piers that are part of the existing bridge. The Bascule Bridge, Mid-Level Fixed Span, High-Level Fixed Span Alternatives would not include support piers in shallow water near the shoreline. The Rehabilitation Alternative support structures would occupy 8,200 ft^2 of river substrate, while the New Bascule Bridge Alternative would occupy 11,000 ft^2 of substrate. The fixed alternatives would each occupy only 471 ft^2 of river substrate following construction. Each of the replacement bridge alternatives would place the shoreline support structures further from the shoreline than with the existing and Rehabilitation Alternative.

Construction or removal of structures has the potential to remove diatom production and the related production of epibenthic zooplankton. Epibenthic zooplankton are a potential prey resource for juvenile salmon and other young fishes. Diatom production is likely to resume within weeks following replacement of a substrate in shallow water. Avoiding removal of existing structures and construction of new structures during the spring in-water closure period would avoid any impacts of this nature. New structures and substrate at sites of removed structures would likely provide normal diatom and epibenthic zooplankton production by the following spring when young salmon are abundant in the lower Duwamish.

A variety of BMPs would be used to protect the aquatic environment from contaminants during construction. Work areas would be isolated from the aquatic environment during the February 15 to July 15 period when in-water construction is generally prohibited. This action would avoid impacts to the substantial populations of juvenile Chinook and other salmon that migrate past the site. Installation and removal of caissons and piles will disrupt surface substrate resulting in displacement of small amounts of contaminated sediment to adjacent areas of contaminated sediment. Short-term localized turbidity would occur during these activities

Potentially spills or releases of petroleum, concrete, paint or other toxic materials could occur during construction or a new structure or removal of the existing bridge. Best management practices for construction activities would be followed to minimize the potential for these impacts. Quantities of these materials used over water and available to be spilled would generally be small (gallons to several hundred gallons). Spills of this nature could negatively

impact fish and wildlife present at the time of the spill. Specific spill prevention measures would be identified and implemented prior to construction, and spill containment equipment and materials would be required to be on-site during construction.

Development of construction access, staging areas, and temporary docks would result in temporary modification of the riparian area. Most of the area to be modified is currently developed for human activities (roads, parking, and buildings). Small strips of vegetation along the armored shorelines would be disrupted, although no native vegetation or large trees have been identified in the riparian area to potentially be disrupted. Construction activities would generate noise typical of those currently produced by the industrial and commercial activities that currently occur within the area surrounding the project site. Construction activities such as pile driving may produce short duration noise at higher levels than currently occur at the site. Wildlife potentially using the site is apparently limited to those species that tolerate the existing substantial noise levels. Construction actions are not anticipated to produce noise that would displace foraging bald eagles and ospreys that use the Duwamish Waterway in this industrial area.

Fishing at the bridge site will be complicated by construction activities. Existing sites for placement of nets will be removed and new sites made available by the reconstructed bridge. Barge delivery of materials may make locations adjacent to the construction pier temporarily unavailable to fishing.

6.1.2 Operation Impacts

Operation of the bridge would produce similar types of impacts with each alternative. These impacts are presence of man-made structures within the shallow water habitat of the Duwamish River at the bridge site, noise from traffic on the bridge and its approaches, and shading of the river and riparian areas by the bridge structure. Existing impacts to water quality from stormwater runoff and bridge maintenance would be reduced with bridge replacement and eliminated with bridge removal. The existing impact of substantial quantities of creosote treated timber (fender system) in contact with the water and substrate would be eliminated in the near future with any of the alternatives except No Action.

The No action would provide continuation of existing impacts for some indefinite period. Assuming the bridge would be operated as long as the structure could feasibly be maintained, these impacts could continue for a substantial number of years. Each of the construction alternatives would produce impacts similar to existing bridge with the exception of the creosote treated timber that is part of the existing structure. No creosote treated timber would be in contact with the aquatic habitat with the each of the replacement bridge alternatives.

Existing operational impacts would continue for some undefined period with the No Action Alternative. Maintenance activities would by greater with the No Action alternative due to the structural deficiencies of the existing bridge. Routine maintenance would include general upkeep, structural repairs, and painting as required. Short-term, minor impacts to air and water

can result form the release of particulate matter from repair and painting, but would be avoided or minimized through BMPs.

The replacement bridge designs provide in-water support structure of the same general nature as those currently present, with the exception of creosote treated timber piles. The existing creosote treated piles would be replaced with steel or concrete structures. This would involve the numerous creosote treated piles and timbers that currently provide the fender system protecting the bridge support structure. Only concrete, steel, and materials other than creosote treated wood are incorporated in the replacement bridge designs.

The new High Level and Mid Level alternatives would have a row of three 6 ft diameter piles on either edge of the river channel where the bottom is approximately –10 to –15 ft MLLW. No other structures would be placed within the aquatic environment. The amount of space occupied by the new piers would be about the same as that occupied by the existing treated timber pile structures. The existing bridge has large concrete structures resting on numerous treated wood piles that support each end of the bascule bridge. It also has two concrete piers resting on wood piles on either side within the intertidal zone at a depth of about -2 ft MLLW. These treated wood piles would be removed with replacement of the bridge.

With the High Level and Mid Level alternatives the new structure would be higher above the water than the existing bridge. Each of the alternatives would be slightly wider than the existing bridge. Thus, shading would cover a slightly wider area but be slightly less intense due to the higher elevation of the bridge. The bascule bridge alternative would replace the existing deck grate with a solid surface. The solid deck would decrease the small amount of light passing through the grate deck of the existing bridge over the river channel. The Bascule Bridge Alternative would also be slightly wider but at about the same elevation as the existing bridge, resulting in shading over a slightly wider area at a greater intensity than the existing bridge. The absence of an aquatic plant community (eelgrass or aquatic macrophytes) in this vicinity of the Duwamish River restricts the shading impact to that of potentially reduced diatom production within the bridge shadow. Diatoms provide a forage base for epibenthic zooplankton that are prey for juvenile salmonids and other fishes. The Rehabilitation Alternative would retain the existing impact to photosynthetic activity. Riparian vegetation currently grows in a narrow shoreline band directly in the shadow of the existing solid portion of the bridge approaches and is expected to continue to grow in available riparian habitat with any of the alternatives.

The High Level and Mid Level alternatives would have shoreline support piers set back to about 55 ft from the river shoreline. This is substantively further from the shoreline than the existing bridge support piers (~20 ft). The additional shoreline space would provide opportunity for more and larger riparian vegetation under the bridge. In-water piers would be about 60 ft from the shoreline rather than the existing 20 ft.

6.2 Secondary and Cumulative Impacts

No other state action is expected to occur in the vicinity of the project site in the foreseeable future that would measurably add to any unmitigated effects of the project. The Boeing Company is expected to implement clean-up of contaminated sediments at the project site within the time frame of the South Park Bridge Project. Specific plans and timing of the sediment clean up is not yet available. The selected bridge alternative will be designed to complement the sediment clean up and should precede sediment clean. If sediment clean up precedes bridge construction it would be necessary to conduct construction in a manner that does not recontaminate the adjacent remediated sediment or removes recontamination.

The Wastewater Treatment Division of King County has been dealing with Combined Sewer Overflow (CSO) issues in the Duwamish River and other locations within the Seattle area since the 1960s. There are no CSOs in the immediate vicinity of the South Park Bridge site. King County CSOs 040 and 043 are located slightly more than ¼ mile downstream from the bridge site. The Norfolk CSO is located more than one mile upstream from the site. The Norfolk site had contaminated sediment removed from the Duwamish River in 1999 (King County 2002a). The King County source control program is currently reducing discharge of contaminants to the Duwamish River from CSOs (King County 2002b).

No interrelated and inter-dependent effects on fish or wildlife are expected from the project. The project is not linked, directly or indirectly, to any other projects in the area.

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Compensatory mitigation would be required for unavoidable impacts to and loss of aquatic and riparian habitat or for lost habitat functions resulting from construction of new structures associated with the alternatives for rehabilitation or replacement of the South Park Bridge. Mitigation would likely be required for both the existence of the new structures and the temporal losses associated with construction activities such as a temporary pier to support construction equipment. Mitigation would likely involve construction and restoration of intertidal and riparian habitat at the site. Both of these habitat types have been substantially modified at and near the site by dredging and filling, shoreline armoring, and vegetation removal to provide flood control and industrial/commercial development along the lower Duwamish River.

Both the existing bridge and any replacement alternatives have support structures that occupy a portion of the Duwamish River shallow water substrate. This substrate provides foraging habitat for young salmonids and other estuarine fishes. No net loss of substrate is anticipated with any alternative, except the new Bascule Alternative. New shallow water substrate would be constructed at the site in part to provide mitigation for the continued presence of these structures with each of the bridge replacement alternatives. It is anticipated that the amount of new habitat constructed would exceed the amount altered during construction. This mitigation would replace a small amount of the intertidal habitat previously lost through development of the Duwamish River estuary.

Mitigation for the minor impacts to the riparian zone would involve construction using natural soils where hardened substrates currently exist, along with planting of native vegetation. Based on existing vegetation growing within the shadow of the bridge, it is likely that native understory species of riparian vegetation can be grown adjacent to and under the replacement bridge with any of the replacement alternatives. The addition of native vegetation would provide a more diverse community structure resulting in the project site providing more appropriate habitat functions.

The No Action alternative would result in removal of existing structures at some undefined time in the future that would produce restoration of aquatic habitat at the bridge site similar to that of the surrounding intertidal area. Restoration of the natural riverine habitat would provide mitigation for the temporal impacts of the removal activities. Mitigation would involve restoration of river and riparian substrates to natural sediment types facilitating restoration of natural biota within the footprint of the existing support structures. The shadow of the existing bridge would cease to exist, however little aquatic and riparian vegetation occurs in this area outside the influence of the bridge shadow indicating removal of the shadow would not likely produce a noticeable change in aquatic production.

Rehabilitation of the existing bridge would maintain the existing footprint occupied by the bridge at the existing location. Mitigation for the loss of temporal disruption of the aquatic habitat could be accomplished through construction of new shallow water habitat immediately downstream

from the bridge on the left bank of the Duwamish River and/or improvement of riparian habitat. New aquatic habitat would provide additional support for primary and secondary production resulting in greater prey availability for young salmon and other fishes. Construction of new shallow water habitat would support foraging and refuge functions for juvenile salmonids and young of other fish species that might use this site. This would replace a small portion of the historic habitat type that has been greatly diminished in the Duwamish River estuary by dredging and filling. Mitigation could involve riparian planting around the periphery of new habitat restore natural conditions. Removal of the existing creosote treated timbers and piles of the fender system protecting the existing bridge would provide mitigation in part for the new concrete structures.

Each of the replacement bridge alternatives would result in a new structure immediately downstream from the existing bridge. The size of the in-water structure would vary with the alternative, being largest for the Bascule Bridge Alternative, the same as existing for the Rehabilitation Alternative, and considerably less for the fixed level alternatives. Mitigation for each of the replacement alternatives would be of the same type as for the Rehabilitation Alternative.

The specific features of the new aquatic and riparian habitats that are to be constructed for mitigation would be developed in greater detail following selection of a preferred alternative. The mitigation strategy would also be refined in accordance with the more detailed analysis of impacts to species listed under the Endangered Species Act through the preparation of and agency review of a Biological Assessment. Other agencies and jurisdictions may also provide guidance or requirements for mitigation through their review and permitting processes.

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APPENDIX A

ESA Letters from Federal Services

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

February 24, 2003

John Heinley
Washington State Department of Transportation
Highways and Local Programs Service Center
310 Maple Park Ave SE
Olympia, Washington 98504-7300

Re: Endangered Species Act Section 7 Informal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the King County South Park Bridge Replacement Pre-Construction Soil Borings.
(NOAA Fisheries No. 2003/00124) (WRIA 9)

Dear Mr. Heinley:

This correspondence is in response to your request for consultation under the Endangered Species Act (ESA). Additionally, this letter serves to meet the requirements for consultation under the Magnuson Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Endangered Species Act

The National Marine Fisheries Service (NOAA Fisheries) has reviewed the above referenced Biological Assessment (BA) dated February 2003. According to the BA, the King County is proposing to conduct 14 soil-borings for the replacement of the South Park Bridge over the Duwamish River. Two of the soil-borings will occur within the ordinary high water mark of the Duwamish River. King County has determined that there is a "may affect, not likely to adversely affect" to Puget Sound (PS) chinook. The Duwamish River drains into Puget Sound and is located in Water Resource Inventory Area (WRIA) 9. PS chinook (*Oncorhynchus tshawytscha*) is listed as threatened under the ESA.

During consultation, King County identified the following avoidance and minimization measures will be taken to avoid and minimize the potential effects of the project.

1) King County will follow all the requirements of the Hydraulic Project Approval (HPA).

2) The proposed project activities will be implemented during the low tides when potential delivery of disturbed soils will be minimized. A Temporary Erosion and Sedimentation Control (TESC) plan is proposed and includes Best Management Practices (BMPs). All disturbed areas will be mulched and re-seeded with native grasses/shrubs/trees immediately after construction.

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3) A Spill Prevention Control and Countermeasures (SPCC) plan will be used to avoid the delivery of chemical contaminants from equipment to surface water bodies.

Since the proposed action incorporates avoidance and minimization measures into this project (# 1 through # 3 listed directly above), NOAA Fisheries can expect the effects of the action to be discountable or insignificant. Therefore, NOAA Fisheries concurs with your effect determination of "may affect, but not likely to adversely affect" for PS chinook salmon

The regulations (50 CFR 402.08) implementing Section 7 of the ESA, allow a Federal Agency to designate a non-federal representative to conduct informal consultations or prepare biological assessments by giving written notice to the Director of such designation. The Service has received the letter written May 10, 1999 from Federal Highways Administration, Gene Fong, Division Administrator, so designating Washington Department of Transportation as their non-federal representative. The ultimate responsibility for compliance with Section 7 remains with the Federal agency.

This concludes informal consultation on these actions in accordance with 50 CFR 402.14(b)(1). The Federal Highway Administration must reinitiate this ESA consultation: (1) if new information reveals effects of the action that may affect listed species in a way not previously considered; (2) if the action is modified in a manner that causes an effect to the listed species that was not previously considered; or (3) if a new species is listed or critical habitat designated that may be affected by the identified actions.

Essential Fish Habitat

Federal agencies are required, under §305(b)(2) of the MSA and its implementing regulations (50 C.F.R. 600 Subpart K), to consult with NOAA Fisheries regarding actions that are authorized, funded, or undertaken by that agency that may adversely affect Essential Fish Habitat (EFH). The MSA (§3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." If an action would adversely affect EFH, NOAA Fisheries is required to provide the Federal action agency with EFH conservation recommendations (MSA §305(b)(4)(A)). This consultation is based, in part, on information provided by the Federal action agency and descriptions of EFH for Pacific salmon contained in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (August 1999) developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce (September 27, 2000).

The proposed action and action area are described in the BA submitted by King County. The project area includes habitat which has been designated as EFH for various life stages of: chinook and coho (*O. kisutch*).

Because the habitat requirements (*i.e.*, EFH) for the MSA-managed species in the project area are similar to that of the ESA-listed species, and because the conservation measures that the FHWA/King County included as part of the proposed action to address ESA concerns are also

adequate to avoid, minimize, or otherwise offset potential adverse effects to designated EFH, conservation recommendations pursuant to MSA (§305(b)(4)(A)) are not necessary. Since NOAA Fisheries is not providing conservation recommendations at this time, no 30-day response from the FHWA is required (MSA §305(b)(4)(B)).

This concludes consultation under the MSA. If the proposed action is modified in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries' EFH conservation recommendations, the FHWA will need to reinitiate consultation in accordance with the implementing regulations for EFH at 50 C.F.R. 600.920(l).

Thank you for your effort to protect threatened Puget Sound chinook. If you have any questions, please contact Barbara Wood of the Washington Habitat Branch Office at (360) 534-9307 or barb.wood@noaa.gov,

Sincerely,

D. Robert Lohn
Regional Administrator

cc: John Heinley, WSDOT
Terry Paananen, WSDOT
Don Weitkamp, Parametrix, Inc.

ATTACHMENT A

August 5, 2002

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CRITICAL HABITAT, CANDIDATE SPECIES, AND SPECIES OF CONCERN THAT MAY OCCUR IN THE VICINITY OF THE PROPOSED CITY OF TUKWILA 16TH AVENUE BRIDGE RECONSTRUCTION PROJECT IN KING COUNTY, WASHINGTON

(T24N R4E S32)

FWS REF: 1-3-02-SP-1822

LISTED

Wintering bald eagles (*Haliaeetus leucocephalus*) may occur in the vicinity of the project. Wintering activities occur from October 31 through March 31.

Bull trout (*Salvelinus confluentus*) occur in the vicinity of the project.

Major concerns that should be addressed in your biological assessment of the project impacts to listed species include:

1. Level of use of the project area by listed species;
2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project; and
3. Impacts from project construction (i.e., habitat loss, increased noise levels, increased human activity) that may result in disturbance to listed species and/or their avoidance of the project area.

PROPOSED

None

CANDIDATE

None

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2. Consultation with the U.S. Fish and Wildlife Service (FWS) when a Federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and

3. Conference with the FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species that is/are likely to be affected by a construction project. The process is initiated by a Federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with the Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Endangered Species Division, 510 Desmond Drive SE, Suite 102, Lacey, WA 98503-1273.

---

* "Construction project" means any major Federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes Federal action such as permits, grants, licenses, or other forms of Federal authorization or approval which may result in construction.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Western Washington Fish and Wildlife Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 534-9331

AUG 6 2002

Dear Species List Requester:

We (U.S. Fish and Wildlife Service) are providing the information you requested to assist your determination of possible impacts of a proposed project to species of Federal concern. Attachment A includes the listed threatened and endangered species, species proposed for listing, candidate species, and/or species of concern that may be within the area of your proposed project.

Any Federal agency, currently or in the future, that provides funding, permitting, licensing, or other authorization for this project must assure that its responsibilities under section 7(a)(2) of the Endangered Species Act of 1973, as amended (Act), are met. Attachment B outlines the responsibilities of Federal agencies for consulting or conferencing with us.

If both listed and proposed species occur in the vicinity of a project that meets the requirements of a major Federal action (i.e., "major construction activity"), impacts to both listed and proposed species must be considered in a biological assessment (BA) (section 7(c); see Attachment B). Although the Federal agency is not required, under section 7(c), to address impacts to proposed species if listed species are not known to occur in the project area, it may be in the Federal agency's best interest to address impacts to proposed species. The listing process may be completed within a year, and information gathered on a proposed species could be used to address consultation needs should the species be listed. However, if the proposed action is likely to jeopardize the continued existence of a proposed species, or result in the destruction or adverse modification of proposed critical habitat, a formal conference with us is required by the Act (section 7(a)(4)). The results of the BA will determine if conferencing is required.

The Federal agency is responsible for making a determination of the effects of the project on listed species and/or critical habitat. For a Federal agency determination that a listed species or critical habitat is likely to be affected (adversely or beneficially) by the project, you should request section 7 consultation through this office. For a "not likely to adversely affect" determination, you should request our concurrence through the informal consultation process.

Candidate species and species of concern are those species whose conservation status is of concern to us, but for which additional information is needed. Candidate species are included as an advance notice to Federal agencies of species that may be proposed and listed in the future. Conservation measures for candidate species and species of concern are voluntary but recommended. Protection provided to these species now may preclude possible listing in the future.

Appendix Volume V

Appendix W. Geology and Soils Technical Report

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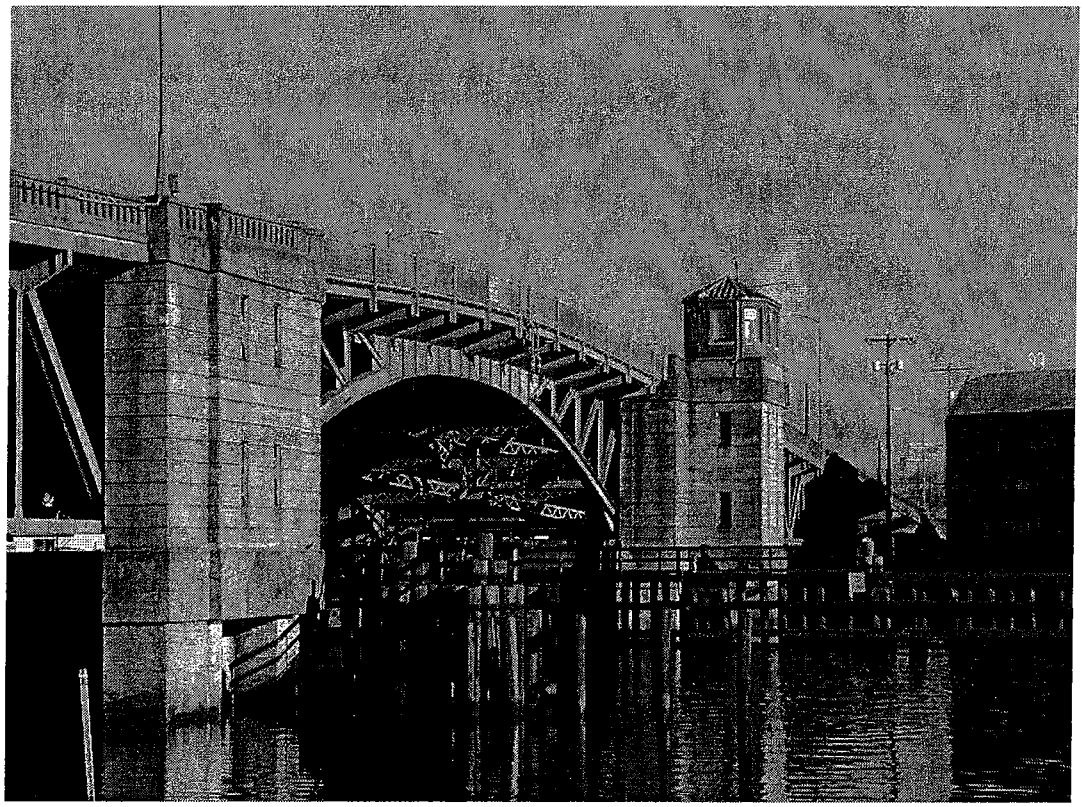
South Park Bridge Project

Geology and Soils Technical Report



Prepared for the
King County
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February 2004

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Technical Report
South Park Bridge Project

Geology and Soils

February 2004

Prepared for:
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Chapter 1 Executive Summary

The project objective is to find the most feasible long-term solution to address the deteriorated condition and increasing seismic vulnerability of the South Park Bridge while maintaining a vital transportation linkage for cars, trucks, buses, bicyclists, and pedestrians across the Duwamish Waterway.

Based on an alternative development and screening study performed by Parsons Brinckerhoff, Inc. (PB), five project alternatives were selected for environmental review. The five proposed project alternatives include a No Action Alternative, a Rehabilitation Alternative, and three replacement bridge alternatives (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives).

The No Action Alternative assumes that the existing bridge would be closed, demolished, and removed at some time in the future. For the Rehabilitation Alternative, the existing bridge would remain in place. Its structural components would be reinforced or replaced and the equipment used to operate the bridge would be refurbished or replaced. The three replacement bridge alternatives would result in construction of a new bridge. The new bridge for all three replacement alternatives would follow the same horizontal alignment to be located approximately 80 feet, center-to-center, west (downstream) of the existing bridge.

This geology and soils technical report describes the geologic conditions present along the corridor of the South Park Bridge project, and discusses the geotechnical design and construction issues and related impacts and mitigation. Existing data used to assess these issues are presented in Shannon & Wilson's "Geotechnical Report for Conceptual Engineering, South Park Bridge Project, King County, Washington," dated May 2003.

The project area is located in the Duwamish Waterway valley, a broad, glacially carved trough bounded by upland areas to the east and west. The Duwamish Waterway valley is filled with a complex sequence of glacial and nonglacial sediments that overlie bedrock.

The project corridor is generally underlain by relative soft or loose Holocene fill, marsh, alluvium, and estuarine deposits that extend to considerable depths in most places. More competent, glacial soils and bedrock underlie these less competent soils. The depth to these more competent soils and rock varies considerably along and in the vicinity of the project corridor. The subsurface conditions at the south end of the project area differ significantly from those along the rest of the corridor, in that competent, glacial soils and bedrock exist at a relatively shallow depth.

Groundwater levels along most of the project corridor are within 10 to 12 feet of the ground surface. The groundwater is tidally influenced and fluctuates as much as 11 feet near the waterway. The magnitude of fluctuations decreases away from the waterway.

The project area is located in a moderately active tectonic province that has been subjected to numerous earthquakes of low to moderate strength and occasionally to strong shocks during the brief 165-year record history in the Pacific Northwest. The project area is located within the Seattle Fault Zone, which consists of four or more east-west-trending faults that coalesce at a depth to a master, south-dipping fault. Earthquake-induced geologic hazards that may affect any given site include liquefaction and related effects, landsliding, soft-soil ground motion amplification, and fault surface rupture.

Soils- and geology-related impacts and mitigation measures were developed based on the project area geology and the five proposed project alternatives. Considering the close proximity of the proposed horizontal alignments for the Rehabilitation Alternative and three replacement bridge alternatives, impacts and mitigation measures for these alternatives are anticipated to be similar.

A summary matrix of these impacts and mitigation measures is presented on Table 1.

TABLE 1 – Summary Matrix – Geology and Soils

Alternative	Impacts	Mitigation Measures
No Action	*Operation:*	
	Existing timber pile foundation may experience additional settlement for No Build Alternative.	No mitigation proposed.
	Settlement of backfill in areas currently occupied by existing bridge.	Settlement impacts could be mitigated by using lightweight fill. Undesirable settlement due to secondary compression of peat and organic soil layers could be mitigated by removing and replacing the unsuitable soil and/or by performing ground improvement. Affected utilities may be relocated.
	Construction (related to bridge removal):	
	Erosion could cause increased sediment transport onto other areas of the project area and into surface water streams and storm drains.	Construction would be performed according to WSDOT BMPs. Standard erosion control measures would be implemented including both vegetative controls and structural controls. In sensitive areas, construction could be limited to the dry weather season. Stormwater treatment would be performed in accordance with King County requirements.
	Settlement of backfill in areas currently occupied by existing bridge.	Settlement impacts could be mitigated by using lightweight fill. Undesirable settlement due to secondary compression of peat and organic soil layers could be mitigated by removing and replacing the unsuitable soil and/or by performing ground improvement. Affected utilities may be relocated.
	Secondary:	
	No impacts anticipated.	No mitigation proposed.
	Cumulative:	
	No impacts anticipated	No mitigation proposed.

TABLE 1 – Summary Matrix – Geology and Soils (continued)

Alternative	Impacts	Mitigation Measures
Rehabilitation/ Replacement	*Operation:*	
	Differing subsurface conditions than those disclosed by available field explorations could result in incorrectly designed structures.	The project would be designed based on design criteria and procedures approved by KCDOT. Additional explorations would be performed along proposed alignment of preferred alternative to obtain sufficient subsurface information.
	Recent fill and Holocene deposits are susceptible to liquefaction and associated effects.	Potential liquefaction could be mitigated using ground improvement such as earthquake drains, compaction grouting, jet grouting, or deep soil mixing.
	No impacts anticipated for bridge substructures.	No mitigation proposed.
	Settlement of fill embankments for approaches could impact underlying and adjacent utilities or structures as well as walls or structures constructed on the fill embankment.	Settlement impacts could be mitigated by using MSE walls or lightweight fill. Affected utilities may be relocated. Undesirable settlement due to secondary compression of peat and organic soil layers could be mitigated by removing and replacing the unsuitable soil and/or by performing ground improvement.
	Settlement of backfill in areas currently occupied by existing bridge.	Settlement impacts could be mitigated by using lightweight fill. Undesirable settlement due to secondary compression of peat and organic soil layers could be mitigated by removing and replacing the unsuitable soil and/or by performing ground improvement. Affected utilities may be relocated.
	Permanent drainage facilities may result in increased water flow to existing drainage facilities.	Permanent drainage facilities should be designed for anticipated capacities.

Continued on next page

TABLE 1 – Summary Matrix – Geology and Soils (continued)

Alternative	Impacts	Mitigation Measures
Rehabilitation/ Replacement (cont.)	*Construction*	
	Erosion could cause increased sediment transport onto other areas of the project area and into surface water streams and storm drains.	Construction would be performed according to WSDOT BMPs. Standard erosion control measures would be implemented including both vegetative controls and structural controls. In sensitive areas, construction could be limited to the dry weather season. Stormwater treatment would be performed in accordance with King County requirements.
	Settlement of fill embankments for approaches could impact underlying and adjacent utilities or structures as well as walls or structures constructed on the fill embankment.	Settlement impacts could be mitigated by using MSE walls or lightweight fill. Undesirable settlement due to secondary compression of peat and organic soil layers could be mitigated by removing and replacing the unsuitable soil and/or by performing ground improvement. Affected utilities may be relocated.
	Settlement of backfill in areas currently occupied by existing bridge.	Settlement impacts could be mitigated by using lightweight fill. Undesirable settlement due to secondary compression of peat and organic soil layers could be mitigated by removing and replacing the unsuitable soil and/or by performing ground improvement. Affected utilities may be relocated.
	Using open-hole excavation method to install drilled shafts could result in caving or sloughing of drilled hole. Such caving or sloughing could impact adjacent structures and buried utilities.	Potential caving of soils in excavated hole would be mitigated by casing the upper, unstable soils.
	Driven piles could cause noise and vibrations that would impact adjacent facilities.	Appropriate driving equipment can be selected to drive piles, which can reduce the noise and vibration levels to the specified limits. Predrilling prior to pile driving can also reduce vibration level.

Continued on next page

TABLE 1 – Summary Matrix – Geology and Soils (continued)

Alternative	Impacts	Mitigation Measures
Rehabilitation/ Replacement (cont.)	Construction inside the waterway for temporary trestle and cofferdam construction could temporarily degrade the waters of the Duwamish Waterway.	Proper construction methods can be used to substantially reduce sediments from entering the surrounding waters.
	Poor drainage practices during construction could result in surface water drainage onto adjacent slopes. This could result in landslides, erosion, or other adverse impacts to adjacent properties.	Drainage water from construction areas should be tightlined and directed to suitable drainage features.
	Poor subgrade of existing roadways would lead to settlement, potholes, cracks, and other roadway distress as a result of construction traffic. Existing pavement sections that are not thick enough may cause similar types of distress.	All unsuitable subgrade soils of existing roadways should be removed and replaced with structural fill. Subgrade should be well compacted. Existing roadways with pavement sections for construction traffic should be replaced with new pavement sections with adequate thickness.
	Secondary:	
	Sediment from erosion or landsliding could be discharged into existing drainage features.	Mitigation measures proposed for the direct and construction impacts would apply to mitigation for the secondary impacts.
	Construction traffic and operations could affect existing adjacent roadways.	Standard erosion control measures would be implemented including structural controls.
	Cumulative:	
	Erosion and sediment transport would be increased if adjacent projects are performed concurrently. Landsliding and slope instability impacts may be increased if construction is occurring above proposed slope cuts. Additional surface loading in the vicinity of the proposed fills could contribute to excessive settlements of utilities or structures.	Coordination should be performed with adjacent projects. The effects of cumulative impacts should be evaluated and design and construction procedures altered where necessary.

Note: Please refer to the text of the report for a detailed description of the impacts and mitigation.

Chapter 2 Introduction

Chapter 2 is an introduction to the technical analysis contained in this technical report. This chapter describes existing conditions, the history of the project, the purpose and need for the project, and the five project alternatives being considered for environmental review. In addition, this chapter summarizes project coordination conducted to date with agencies, local governments, the community advisory group, and members of the public.

2.1 Description of Existing Conditions

This first section describes existing conditions pertinent to the proposed South Park Bridge Project. The project area is defined. The existing bridge and its current condition are described. The local roadway network in the South Park community is described. Non-vehicular transportation in the community is also summarized.

2.1.1 The Project Area

The South Park community is about four miles south of downtown Seattle (see Figure 1). The community lies south of the Duwamish Waterway, the man-made channel portion of the Duwamish River as it enters Elliott Bay. Though originally incorporated as its own city in 1905, much of the area was annexed by the City of Seattle in 1907.[1] The project area lies south of the industrial Georgetown area of Seattle and the King County International Airport (known as Boeing Field). It encompasses the roadway corridor defined by 16th Avenue S. between East Marginal Way S. and the South Park Bridge and 14th Avenue S. between the bridge and S. Trenton Street. Residents and business owners in the project area generally identify with the City of Seattle.

The project area, however, is governed by three local government jurisdictions. The area north of the Duwamish Waterway (between East Marginal Way S. and the waterway) lies within the city limits of both the City of Seattle (northern portion) and the City of Tukwila (southern portion). The area south of the Duwamish Waterway (between the waterway and S. Trenton Street) lies within unincorporated King County and the City of Seattle. The two-block area between the riverbank and Dallas Avenue S. is in King County, and the city blocks to the south are in the City of Seattle.

Land uses in the project area are mixed residential, retail commercial, and industrial. The Boeing Company's Plant 2 dominates the north side of the Duwamish Waterway. On the south side, retail commercial and light industrial land uses front on 14th Avenue S. and along the south bank upstream of the South Park Bridge. Single-family residences, however, generally characterize the area off of this main transportation artery.

[1] City of Seattle, *South Park Residential Urban Village Plan*, 1998.

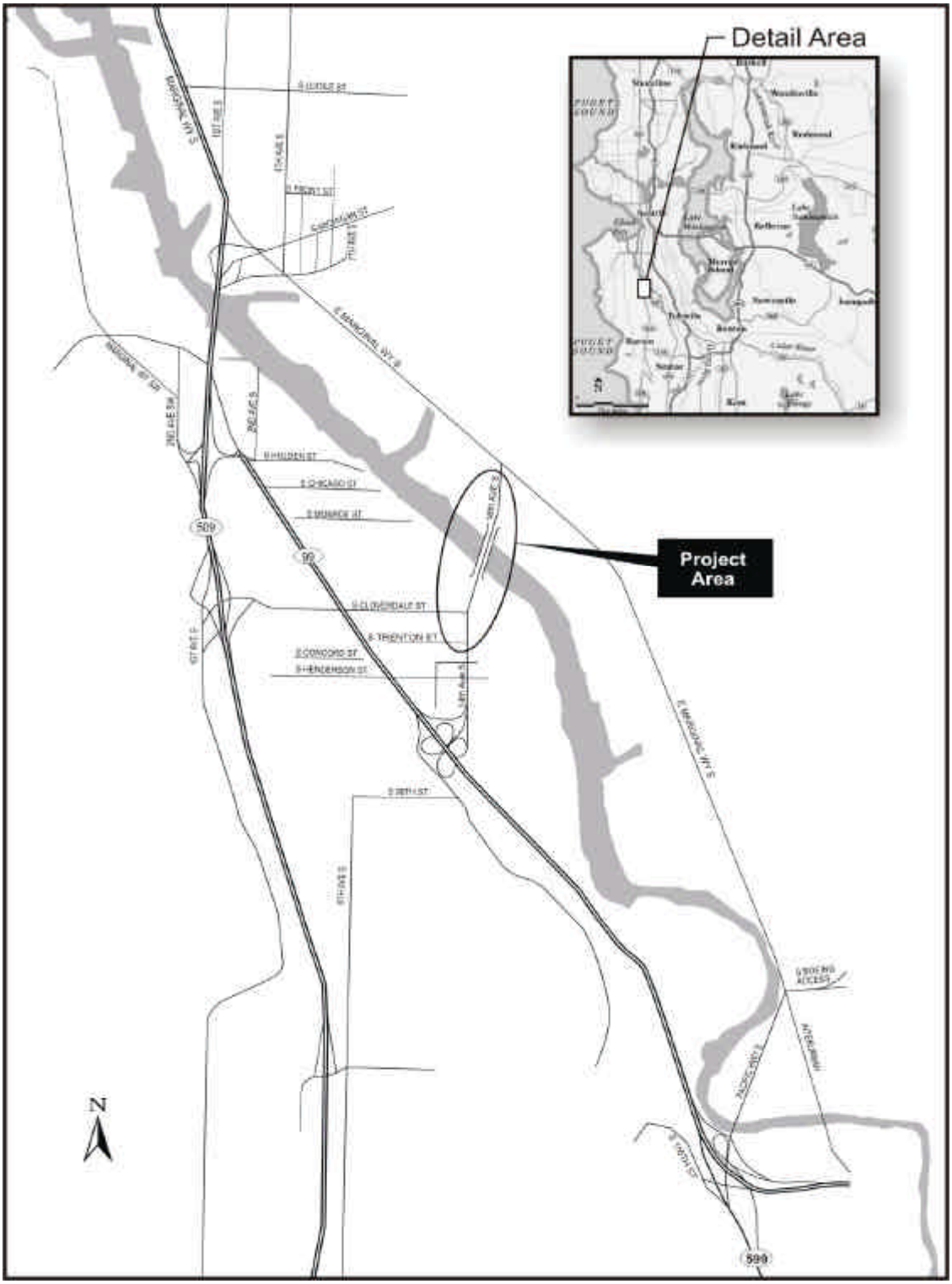

Figure 1

Project Area and Vicinity

2.1.2 The Existing South Park Bridge

The South Park Bridge was constructed in 1929-1931 (see Figure 2). The existing structure consists of a Scherzer rolling-lift double-leaf bascule movable span. Because it is the only operational example of a Scherzer rolling-lift bascule bridge in Washington, the bridge is listed on the National Historic Register.[1]

Each side is flanked by two truss approach spans and twelve concrete slab approach spans. The overall length of the bridge is approximately 1,045 feet abutment-to-abutment and approximately 1,340 feet in entirety to the grade match points. The double-leaf bascule movable span has a center-to-center distance between the front bearing points of approximately 190 feet. The roadway consists of four 9.5-foot lanes. The pavement is 38 feet with 6-foot sidewalks on both sides. Reinforced concrete piers founded on timber piling support the bascule span. Two large in-water piers support the counterweights, track supports, and racks for the rolling lift. The attached towers house the operating machinery, electrical equipment, and operator control room.

The South Park Bridge spans the Duwamish Waterway, which is used for industrial, commercial, and recreational purposes. The bridge is near the upstream limit of heavy industrial uses along the Duwamish Waterway, but it is within the section of the navigation channel maintained by the U.S. Army Corps of Engineers. The existing maximum vertical clearance of the bridge when closed is approximately 34 feet at Mean High Water (MHW). Bridge openings occur approximately three times per day on average to accommodate waterway traffic, although on some days the bridge does not open at all. The existing navigable horizontal clearances is approximately 118 feet at the water level (fender-to-fender), but narrows to 92 feet approximately 114 feet above the water between the open bascule leaves. The depth of the navigation channel is approximately 15 feet at Mean Lower Low-Water (MLLW).

2.1.3 Bridge Condition

In spite of substantial on-going maintenance and repairs, the South Park Bridge has suffered considerable deterioration over the past 70 years. In particular, the bascule piers are cracked and unstable resulting in the misalignment of the movable spans. Consequently, the center lock and glide tracks require on-going modifications and adjustments to allow the bridge to operate properly. Long-term, the stability of the entire bridge is at risk due to the original shallow placement of the supporting piles, which has resulted in movement of the bridge piers over the decades. The condition of the bridge worsened significantly following the Nisqually Earthquake in February 2001, and it remains vulnerable to future seismic events. A 2002 bridge inspection conducted by King County resulted in an existing condition rating of 6.0 out of a possible score of 100 (based on Federal Highway Administration criteria).[2] This was among the lowest ratings given to any bridge structure in the State of Washington in 2002.

---

[1] King County Landmarks and Heritage Commission. *Findings and Fact Decision – 14th Avenue South Bridge*, decision made December 19, 1996 and filed January 2, 1997.

[2] King County, *Bridge Inspection Report*, August 1, 2002.

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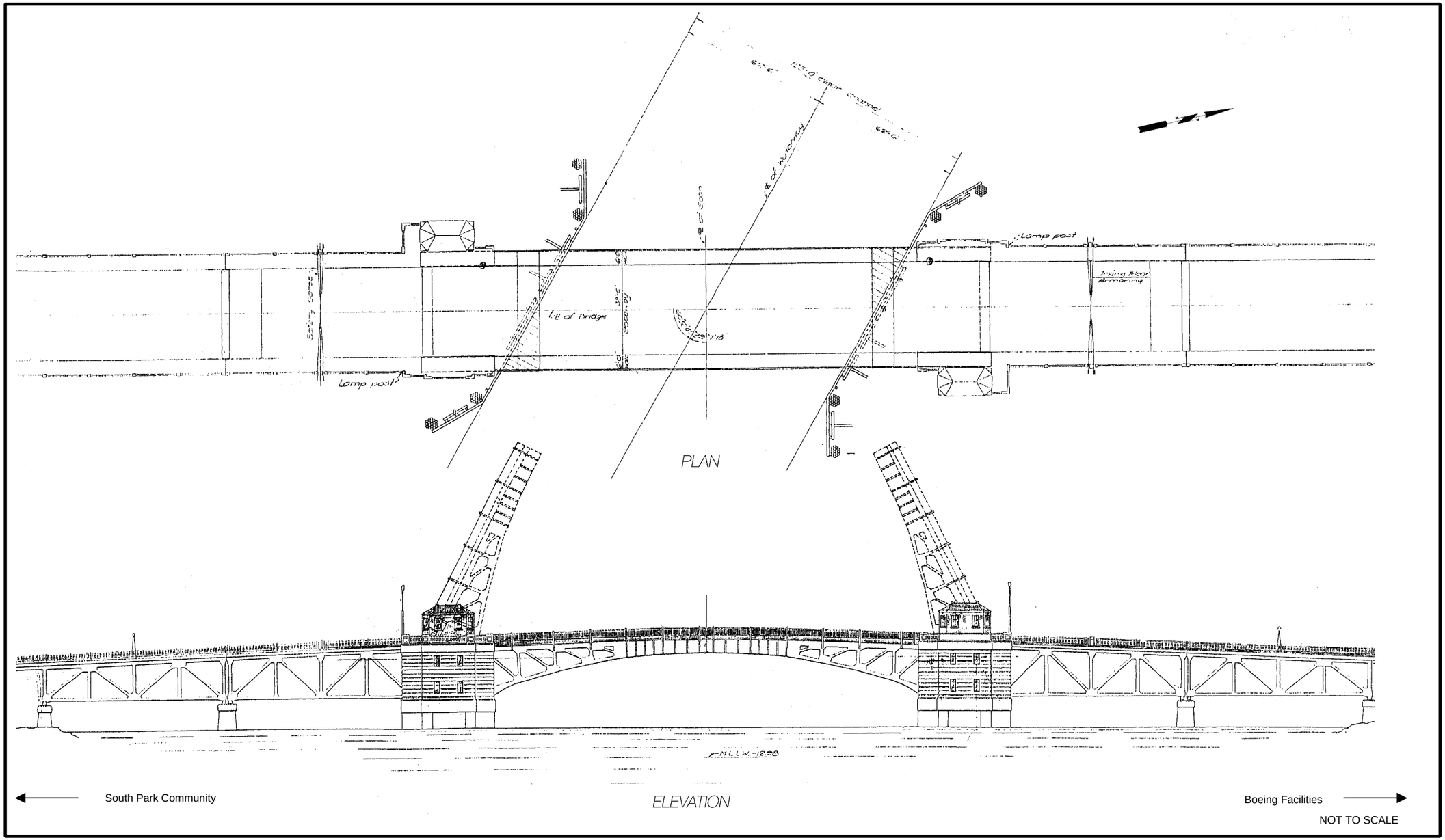

Figure 2

Existing South Park Bridge

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2.1.4 Roadway Network

The bridge presently accommodates an average daily traffic volume of approximately 20,000 vehicles per day, based on 2001 City of Seattle traffic counts. Many of the vehicle trips originate in residential neighborhoods in the communities of West Seattle, White Center, and SeaTac. For South Park community residents, the bridge is the primary direct means of access to the north, downtown Seattle, and I-5.

The existing roadway network surrounding the South Park Bridge consists of a variety of roadway types. They range from local two-lane streets to major limited-access highways. Regional traffic movement in the South Park area is concentrated to three nearby north-south corridors including State Route (SR)-99, SR-509, and East Marginal Way S. Local circulation is provided through a system of local and collector streets. Features such as the Duwamish Waterway and large-scale facilities such as Boeing Field and the Boeing Plant 2 create barriers within the road network and limit opportunities for access to and from the major regional routes.

2.1.5 Freight, Transit, and Pedestrians

Freight movement in peripheral areas of the South Park community is significant due to the high concentration of industrial and manufacturing uses in the general area. Major truck traffic is primarily directed along East Marginal Way S. and SR-99. The South Park Bridge and S. Cloverdale Street are also designated truck routes for oversized vehicles. Trucks use S. Cloverdale Street to access the City of Seattle South Recycling and Disposal Station located at 8105 Fifth Avenue S. as well as SR-509 and SR-99 located on the western edge of the South Park community. With respect to rail movements, the only train crossing in the study area exists immediately south of the intersection of East Marginal Way S. and 16th Avenue S.

Bus routes serving the South Park community are primarily located along major north-south corridors, including East Marginal Way S., 14th and 16th Avenues S., and S. Cloverdale Street. Six major King County Metro bus routes serve the area. Routes 60 and 130 cross the South Park Bridge and four of the six bus routes travel along S. Cloverdale Street.

Pedestrians and bicyclists are commonly seen in the South Park area, especially near the community's center near the intersection of 14th Avenue S. and S. Cloverdale Street. Mid-day pedestrian volumes are higher than the morning or evening commute periods due to shopping, transit use, and lunch-related walking trips.

2.2 History of Project

Since 1931, the moveable bridge has crossed the Duwamish Waterway in the South Park community of the City of Seattle. The following sections contain an overview of the studies preceding the start of the current environmental review effort, a summary of two key documents that framed the initial development of project alternatives, and ongoing reports documenting the changing condition of the bridge.

2.2.1 Overview of Studies

In recent history, over 20 engineering studies have been prepared on the South Park Bridge. Starting in 1987, when the bridge was 56-years-old, King County contracted for the preparation of a general engineering investigation report to assess the condition of the bridge. In 1991 and 1993, additional studies were completed including a geotechnical study, foundation design report, and a life-cycle cost analysis. This information led King County to undertake a series of studies in 1994 addressing liquefaction risks as well as the condition of the concrete, substructures, approach span joints and loading rating. In addition, a study was conducted to evaluate potential replacement alternatives for the bridge and another study investigated community issues related to the bridge. Since 1994, King County has recognized that the bridge required either rehabilitation or replacement and has continued to investigate the condition and vulnerabilities of the bridge in an effort to evaluate these options.

2.2.2 Summary of Key Engineering Reports

Two key engineering studies were conducted that helped to frame the current pursuit to evaluate potential alternatives to rehabilitate or replace the South Park Bridge. A 1994 Sverdrup study evaluated potential design options and a 1999 Entranco study researched and presented the likely steps required to conduct the necessary environmental review of the project alternatives and to complete necessary permitting. These studies are summarized below.

2.2.2.1 Sverdrup Study

In November 1994, Sverdrup Civil, Inc. completed a report titled *14th/16th Avenue South Park Bridge Rehabilitation/Replacement – Design Report* for the King County Department of Public Works. The objective of that report was to evaluate alternative alignments and bridge types, impacts of the alternatives studied and to present to King County results, findings, conclusions, and recommendations of a preferred replacement bridge for the existing South Park Bridge.

The 1994 design report studied five alternatives: rehabilitation of the existing bridge; two fixed-span bridge replacements (a 100-foot vertical clearance bridge and a 60-foot vertical clearance bridge); a new moveable bridge (double-leaf bascule bridge); and bridge closure (permanent closure and demolition of the existing bridge). Other alternatives that had been evaluated but were not carried forward, according to this report were: locating the replacement bridge immediately east (upstream) of the existing alignment; matching the existing alignment; and locating the northbound and southbound lanes on separate structures. These three alternatives were not considered feasible and thus were not studied further.

The 1994 design report concluded that the 60-foot vertical clearance fixed-span bridge design could be used to replace the existing South Park Bridge, with consideration of mitigation of impacts to some users.

2.2.2.2 Entranco Study

In July 1999, Entranco completed the *16th Avenue S. Bridge Replacement Project: Environmental Review Report* for the King County Department of Transportation. The objective of this report was to present to King County a summary of environmental review and permitting activities that would likely be required for replacing the bridge.

The report identified the proposed project as a replacement of the existing bridge, including improvements to the approach road – 14th Avenue S. to the south and 16th Avenue S. to the north of the Duwamish Waterway. The project limits were identified as East Marginal Way S. on the north and S. Cloverdale Street on the south. The report asserted three build alternatives should be selected for evaluation in the environmental impact statement (EIS), including alternatives with differing alignments and bridge types. It was further noted that three alternatives would be the least number needed to provide a reasonable range of alternatives under National Environmental Policy Act (NEPA) and Washington State Environmental Policy Act (SEPA) regulations.

Entranco outlined the various tasks that would be required under the Washington State Department of Transportation (WSDOT) Environmental Procedures Manual and Federal Highway Administration (FHWA) guidelines. The report identified these tasks to include the following: the development of bridge alternatives, screening, and selection of alternatives for analysis in the EIS; preliminary engineering design, including an update to the 1994 rehabilitation/replacement report; survey and mapping work; hydraulic and geotechnical studies, and conceptual-level design documentation. The report concluded that the alternatives proposed, including rehabilitation of the existing bridge, had not been designed in enough detail to make a decision regarding a preferred alternative. Related to the environmental review process, the report recommended the public involvement program include coordination with an Interdisciplinary Team (IDT) of agency representatives and a community advisory committee. The report also listed 17 specific environmental technical reports that would likely be required for the preparation of the EIS.

The findings and recommendations presented in the Entranco report formed the basis from which King County staff developed the current contracted scope of work for environmental review. The scope includes engineering, environmental review, agency coordination, and public involvement tasks.

2.2.3 Continuing Deterioration

Since 1999, King County has continued to move forward to develop alternatives for rehabilitating or replacing the existing South Park Bridge. Bridge conditions have worsened since the engineering studies were conducted in the mid-1990s. In February 2001, the Puget Sound Nisqually Earthquake caused significant and widespread damage to the bridge. Over $740,000 was required to repair the bridge in order to keep it operational.[4] The King County 2001 bridge inspection report recorded a rating of 8.0 out

[4] Tim Lane, King County Department of Transportation, Telephone Conversation, September 23, 2002.

of a total possible score of 100 (based on FHWA criteria).[5] The following year, this rating decreased to 6.0.[6]

2.3 Purpose and Need of Project

As a required element of the EIS, a Purpose and Need Statement was developed for the South Park Bridge Project to clarify the underlying basis for the proposed action. The development of the initial draft Purpose and Need Statement involved review and comment by a number of parties including King County staff and the Project Advisory Committee (PAC) that includes agencies with jurisdiction over the proposed project. The draft Purpose and Need Statement was also revised based on comments received at several public involvement events. In April 2002, King County forwarded the draft Purpose and Need Statement to the FHWA for review and approval. The text of the FHWA-approved version of the Propose and Need Statement is presented in the following sub-sections, although minor revisions and footnotes have been included for clarification.

2.3.1 Function and Role of the South Park Bridge

The King County Department of Transportation (KCDOT) is proposing the rehabilitation or replacement of the South Park Bridge located in King County, Washington. Since 1931 the moveable span bridge has carried traffic along the 14th Avenue South and 16th Avenue South corridor across the Duwamish Waterway. On a typical workday, a mix of approximately 20,000 cars, trucks and buses use the bridge to access employment centers in downtown Seattle and the Duwamish industrial area. Many of the vehicle trips originate in residential neighborhoods in the communities of West Seattle, White Center, and SeaTac. For residents of the community of South Park, the bridge is the only immediate means of access to and from destinations east of the community. The moveable structure spans the navigation channel of the Duwamish Waterway. When open, large-size industrial and recreational vessels have access to upriver destinations. The South Park Bridge is also a major route for heavy truck traffic traveling to and from large industrial manufacturers including the Boeing Company.

2.3.2 Purpose of Proposed Project

The purpose of the proposed action is to find the most feasible long-term solution to address the deteriorated condition and increasing seismic vulnerability of the South Park Bridge. The proposed action must also maintain the vital transportation linkage for cars, trucks, buses, bicyclists and pedestrians across the Duwamish Waterway.

2.3.3 Need for the Proposed Project

In spite of substantial ongoing maintenance and repairs, the South Park Bridge has suffered substantial deterioration over the past 70 years. Existing problems with the

[5] King County, *Bridge Inspection Report*, August 21, 2001.

[6] King County, *Bridge Inspection Report*, August 1, 2002.

bridge worsened significantly following the Nisqually Earthquake in February 2001 and the bridge remains vulnerable to future seismic events. A recent 2002 bridge inspection conducted by King County resulted in an existing condition rating of 6.0 out of a possible score of 100 (based on FHWA criteria).[7] This is among the lowest ratings given any bridge structure in the State of Washington.

The bridge could be closed as a consequence of excessive structural deterioration or failure of the moveable span operations (particularly in the event of another seismic event). Closure of the bridge would have a significant impact on the transportation system and traffic conditions throughout the lower Duwamish industrial area--including SR-99, SR-509, First Avenue S. and East Marginal Way S. Improvements are required in the near future to protect public safety and to maintain a transportation corridor that is critical to the local and regional economy.

2.3.3.1 Seismic Vulnerability

The February 28, 2001, Nisqually earthquake (magnitude 6.8, located 35 miles from Seattle and deep below the surface) caused significant damage to the South Park Bridge. Since the earthquake, operation of the moveable span has been less reliable, requiring the bridge to be closed for repairs intermittently for several days. The continuing periodic closure of the bridge for repairs has heightened the awareness of the need for rehabilitation or replacement of the existing bridge.

2.3.3.2 Roadway Design Deficiencies

The South Park Bridge does not meet current roadway design standards and has many design deficiencies. For example, the overall bridge width including lane widths, shoulders and sidewalks should be 64 feet according to current design standards. The existing bridge width is currently only 52 feet (measured outside-to-outside).

2.3.3.3 Transportation Issues

An average of 20,000 daily vehicle trips cross the Duwamish Waterway on the South Park Bridge. It is a significant link between the east and west side of the Duwamish, both locally and regionally. The South Park Bridge is also a route for heavy and oversize truck traffic. According to previous studies, closure of the bridge would have a significant noticeable impact on the transportation system and traffic conditions throughout the lower Duwamish industrial area – including the SR-99 and East Marginal Way S. corridors.

[7] The original text of the FHWA-approved Purpose and Need Statement cited the condition rating of 8.0 from the 2001 King County Bridge Inspection Report. The current cited condition rating of 6.0 is from the King County *Bridge Inspection Report* dated August 1, 2002.

2.3.4 Key Issues

2.3.4.1 Community Impacts

The existing South Park Bridge is a highly valued feature of the South Park community. There is widespread concern in the community that changes to the bridge could have a significant adverse impact on the community and the emerging economic vitality of the South Park business district centered along 14th Avenue South. The *South Park Residential Urban Village Plan of 1998* (the neighborhood plan) identified one of its primary objectives as "finding a solution for the South Park Bridge that is sensitive to the needs of the community."

The South Park community is also ethnically diverse. Approximately 30 percent of the populations' primary language is not English. These factors require greater emphasis on the consideration of environmental justice[8] in order to ensure that the potential adverse effects from the proposed project do not have a disproportionate impact on lower-income or minority populations.

2.3.4.2 Aquatic Habitat Protection

The Duwamish Waterway is an important route for juvenile and adult salmon migrating between the upper Green River, Elliott Bay and the Pacific Ocean. However, much of the waterway in the vicinity of the South Park Bridge currently provides poor habitat for chinook salmon (listed as threatened under the Endangered Species Act) and other marine organisms. The armored shoreline along the waterway in the project area provides minimal habitat for young chinook salmon during their critical rearing period. Recovery plans now underway for threatened and endangered salmon will address potential means of enhancing habitat favorable to the survival and growth of young salmon from the Duwamish/Green River system. Restoration of the shoreline in the vicinity of the project would address immediate and long-term needs for habitat improvement along the Duwamish Waterway.[9]

2.3.4.3 Duwamish Waterway Navigation

The Duwamish Waterway is used for industrial, commercial and recreational purposes. The South Park Bridge is near the upstream limit of heavy industrial uses along the waterway, but it is within the section of the waterway maintained by the U.S. Army Corps of Engineers as a navigation channel. A number of local businesses, as well as the U.S. Coast Guard, have emphasized to King County that any engineering solutions for the South Park Bridge must maintain navigational access upstream of the existing bridge.

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[8] Environmental justice concerns the need to avoid disproportionate, significant adverse impact on minority and/or low-income communities.

[9] This section highlights the importance of addressing aquatic habitat values in the project area, as well as the implications for species currently listed under the ESA; however, it is not intended as a complete characterization of the factors that need to be considered in this regard.

2.4 Description of Alternatives

This section describes the No Action Alternative, the Rehabilitation Alternative, and the three replacement bridge alternatives (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives). The first section explains the transportation engineering criteria and standards used to design the Rehabilitation Alternative and the three replacement bridge alternatives. The second section describes the horizontal and vertical profile of the bridge alternatives, navigation channel clearances, and impacts to the local road network. The last section describes construction activities associated with each of the five alternatives for the South Park Bridge Project.

2.4.1 Design Criteria

Except for the No Action Alternative, construction of any of the project alternatives would incorporate current transportation engineering design criteria for the cross-section, alignment, design speed, maximum grade, and transition segment. The road cross-section design is a key design element that would change for any of the build alternatives (see Figure 3). The existing bridge cross-section incorporates four 9.5-foot travel lanes, raised curbs on both sides of the pavement, and a 6-foot sidewalk on either side of the roadway. The outside-to-outside dimension of the existing bridge is 52 feet. These lane widths are non-standard and would be changed for the Rehabilitation Alternative and for the three replacement bridge alternatives. For the Rehabilitation Alternative, the pavement would remain approximately the same width as it is currently, but would be reconfigured for three standard lanes. There would be two 12-foot lanes on the outside and one 11-foot lane in the middle of the roadway. Traffic would use one 12-foot lane for northbound travel and the other two lanes for southbound travel. The 6-foot sidewalk on either side of the roadway would be enlarged to approximately 7.5 feet. In contrast, each of the replacement bridge alternatives would be designed with four standard 11-foot lanes, traffic barriers or a painted median down the center, a traffic barrier on each side of the pavement, and a single combined 13-foot pedestrian/bike path on the west (downstream) side of the bridge. The width of the cross-section for the new replacement bridge alternatives including the exterior barriers would total approximately 68 feet (outside-to-outside of the bridge structure).

An initial range of potential bridge alternatives and alignments was considered based on earlier studies,[10] current input from stakeholders, and the project team. During the course of this initial alternatives development process, it was determined that there were no practical alternative alignments for a replacement bridge other than to parallel the existing bridge. It was determined that replacement bridge alternatives should be aligned to the west (downstream) of the existing bridge in order to minimize impacts to existing land uses. Conceptual engineering for the replacement bridge alternatives set the alignment for these bridges at approximately 80 feet to the west of the centerline of the existing bridge (i.e., as close to the existing structure as practicable without compromising constructability). The initial alignment of the new roadway was the same as the existing road alignment on the south side of the waterway. The existing roadway

[10] Entranco, Inc., *Environmental Review Report: 16th Avenue S. Bridge Replacement*, July 1999.

is quite narrow. Matching the centerline of the new bridge alternatives to the existing would require acquisition of both land and buildings on both sides of 14th Avenue S. To minimize these impacts, the alignment of the new transition segment was shifted slightly to the east of the existing road alignment because there are fewer parcels and buildings located on the east side of the road compared to the west. In addition, more of the

buildings located on the east side are set back from the existing sidewalk than on the west side. In this way, the proposed alignment for the replacement alternatives has been developed to avoid or minimize potential land use and relocation impacts.

Other design factors affecting impacts to adjacent properties include the new bridge's design speed and maximum grade. King County road standards call for a 35 mph design speed and a maximum of 8 percent grade. Initially, these standards were incorporated into each of the alternatives. Implementation of an 8 percent maximum grade for the High-Level Fixed-Span Bridge Alternative, however, would have resulted in a very long bridge (project terminus to terminus). For example, the north terminus would have extended across East Marginal Way S. and into Boeing Field. To reduce impacts to land use, the maximum grade for the High-Level Fixed-Span Bridge Alternative would need to slightly exceed 8 percent. In this manner, the north side of the bridge would terminate south of East Marginal Way S. This grade change reduced the overall length of the bridge on both south and north ends of the bridge by several hundred feet for the High-Level Fixed-Span Alternative.

Community impacts would also be affected depending on the design of the transition segment. This is the segment of the roadway that merges the differing widths of the new roadway and the existing narrow roadway. Typically, transition segments begin at the point the grade of the bridge matches the grade of the existing roadway and extends beyond some distance. The actual rate at which the width of the roadway is reduced is defined by transportation engineering design standards. To minimize impacts to land uses along 14th Avenue S., King County proposes to start the transition segment from the abutment for all alternatives. This means that by the time the bridge matches the grade of the existing roadway, the width of the new bridge is nearly the same width as the existing road. As a result, the total length of the roadway is reduced potentially several hundred feet in length. In addition, the width of the transition segment for the Mid-Level Fixed-Span Alternative is further reduced by having the single combined 13-foot pedestrian/bike path split off from the main bridge structure at approximately S. Orr Street and descended to ground level in a zigzag fashion. This design modification further reduced the overall impact of the Mid-Level Fixed-Span Alternative.

Together, the design criteria discussed in this section would allow for the construction of a replacement bridge that provides increased safety for vehicles, bicyclists, and pedestrians.

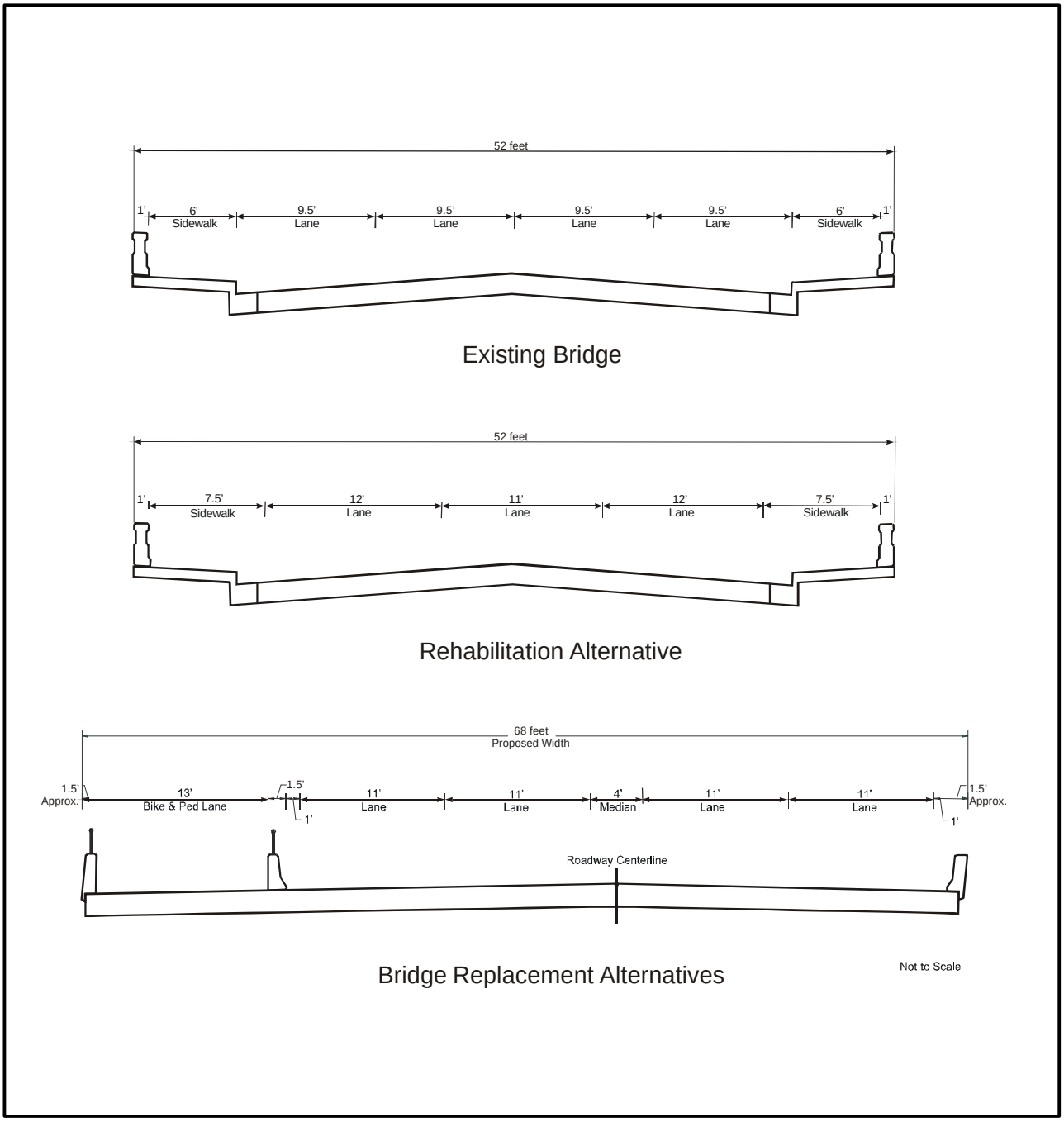
2.4.2 The Alternatives

A total of five alternatives were selected for evaluation in the environmental review process including: the No Action Alternative, the Rehabilitation Alternative, the Bascule Bridge Alternative, the Mid-Level Fixed-Span Bridge Alternative, and the High-Level Fixed-Span Bridge Alternative. These alternatives were selected from an initial group of nine preliminary project alternatives.[11] The alternatives proposed for evaluation in the

[11] Parsons Brinckerhoff. *South Park Bridge Project: Summary Technical Memo - Alternatives Development and Screening*, September 6, 2002.

Figure 3

Existing and Proposed Bridge Cross-Section Designs



environmental review process was selected because they had fewer potential impacts than the other preliminary alternatives. Based on comparison ratings for seven evaluation criteria (regional mobility, local access, navigation, community impacts, aquatic habitat, construction impacts, and estimated project costs), the following preliminary alternatives were dropped from further consideration: a low-level fixed-span bridge, a movable swing bridge, a vertical lift movable bridge, and a tunnel option. The following sections describe each of the proposed project alternatives to be considered in the environmental review process based on conceptual civil and structural engineering.[12] [13]

2.4.2.1 No Action Alternative

The No Action Alternative assumes that the existing bridge structure's poor condition would require it to be closed at some time in the future. Deterioration due to use could allow the bridge to continue to operate for the foreseeable future, but at some time in the future, the bridge would need to be closed. As such, for purposes of environmental review, it is assumed the existing bridge would be closed permanently sometime before 2027.

However, the bridge could be closed for other reasons than simply deteriorated condition. Another earthquake could cause an unexpected emergency closure of the bridge at any time. The on-going movement of the bridge foundations could eventually cause the moveable spans to become misaligned to the extent that repairs would be infeasible. Or, the cost of maintaining the bridge could become more than King County is willing to expend. Under any of these circumstances, the bridge would be closed.

When closed, no vehicular, bicycle, or pedestrian traffic would be allowed to use the bridge. As a navigable waterway, the U.S. Coast Guard regulates bridges that span waterways such as the Duwamish Waterway. If the bridge were no longer operating, the U.S. Coast Guard regulations would require demolition and removal of the bridge. With no structures remaining, there would be no potential navigation obstructions in the Duwamish Waterway.

Under this alternative, there would be no change in the local street network except 14th and 16th Avenue S. would be dead-ended on both the south and north shores of the Duwamish Waterway. Figure 4 shows the existing local street network and Figure 5 shows the local street network following the removal of the existing bridge in the No Action Alternative. As the road does not currently provide direct access to the adjacent Boeing Company properties, the exact location of the road closure on the north side would need to be negotiated with Boeing as well as the owner of the railroad tracks immediately south of East Marginal Way S. In addition, the site of the removed bridge would be restored.

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[12] Parsons Brinckerhoff. *South Park Bridge Project: Conceptual Plans*, June 2003.

[13] Parsons Brinckerhoff. *South Park Bridge Project: Structural Alternatives Study*, November 2003.

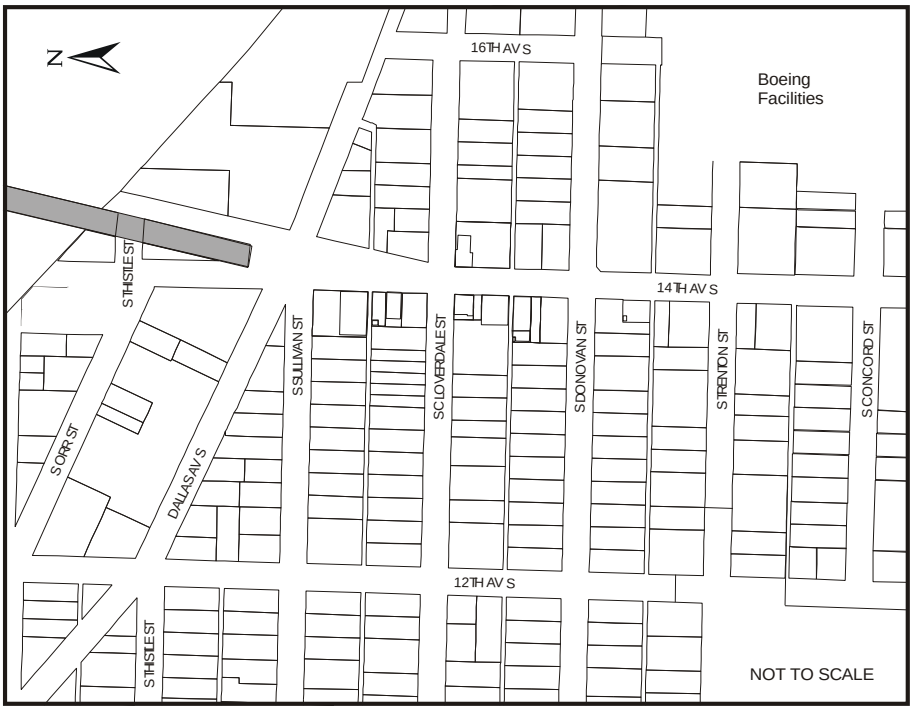

Figure 4
Existing Conditions Street Network

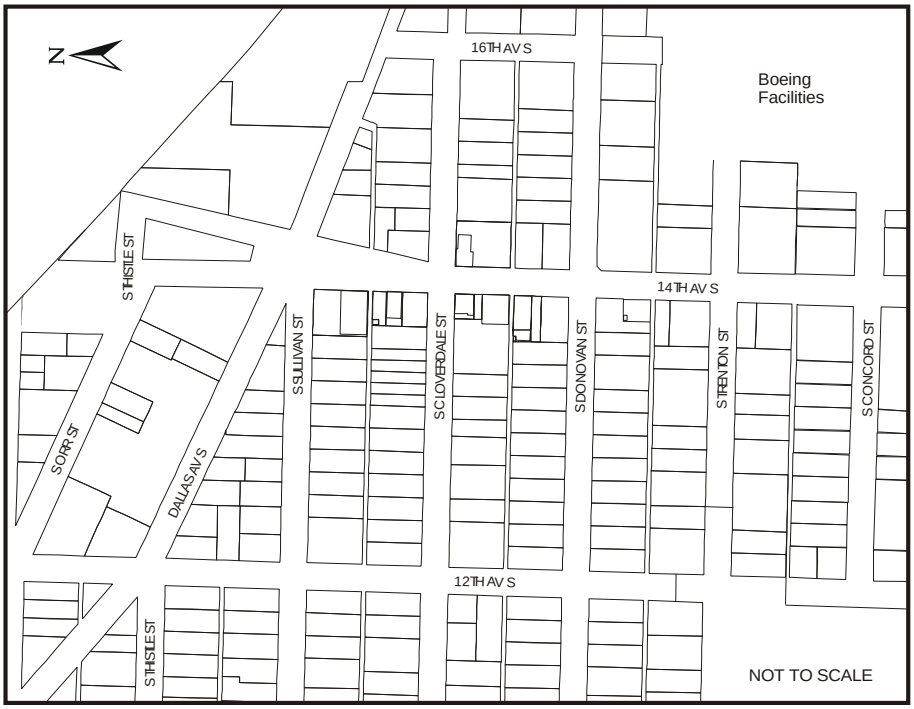

Figure 5
No Action Alternative Street Network

2.4.2.2 Rehabilitation Alternative

For the Rehabilitation Alternative, much of the existing bridge structure would need to be replaced. The existing steel trusses of the approach spans and the bascule leaves would be refurbished and reused. The mechanical and electrical operating systems would be refurbished and/or replaced. Studies have confirmed the existing bridge piers are gradually shifting because the foundation pilings were not originally driven to a sufficient depth. Although the initial goal was to rehabilitate the existing piers, the design team's structural analyses determined that the existing bascule piers and truss approach span piers must be replaced in order to ensure the long-term (approximately 75 years) integrity of the bridge. If the bascule piers were reconstructed, the longevity of the Rehabilitation Alternative would be similar to the expected minimum life of a new bridge structure.

For the Rehabilitation Alternative, the new bascule piers are proposed to be approximately the same size, location, and historic character as the existing piers (see Figure 6). To construct the new bascule piers, the bascule leaves and steel approach spans would need to be removed. The steel truss elements of the bridge structure would be taken to another site for repair, refurbishment, and/or painting before they are re-installed following the construction of the new piers. The concrete shafts or pilings supporting the foundations of the new piers would extend below the existing pilings to a depth beneath the riverbed where stable soils exist. The removal of the steel truss spans would also allow for replacement of the steel approach piers. The concrete approach spans and bridge abutments would be replaced and the bridge deck would be reconstructed. Like the existing bridge, there would be piers both on land and in the water. The first on-land piers would be only an estimated 20 feet from the top of the south embankment and the closest in-water piers would be approximately 20 feet from the top of the embankment. The piers on the north shoreline would extend through the existing Boeing dock. The conceptual engineering analysis also determined that the mechanical and electrical systems should be replaced. Any required construction activities, including replacement of the bridge railings, bridge tender towers, and lamp posts, would be done in a manner that preserves the historic character of the existing bridge to the greatest extent possible.

To meet current roadway design standards, the new bridge deck would remain approximately the same as the existing, but the pavement would be striped to accommodate three standard traffic lanes. Bicycle and pedestrian traffic would continue to be able to use the bridge via a 7.5-foot pedestrian path on each side of the bridge.

Following construction, the existing 118-foot navigable channel width would be preserved so existing waterway users would be able to continue to use the navigation channel to travel upriver of the South Park Bridge. The extended closure of the bridge during construction, however, would have a significant temporary impact on access to the South Park community.

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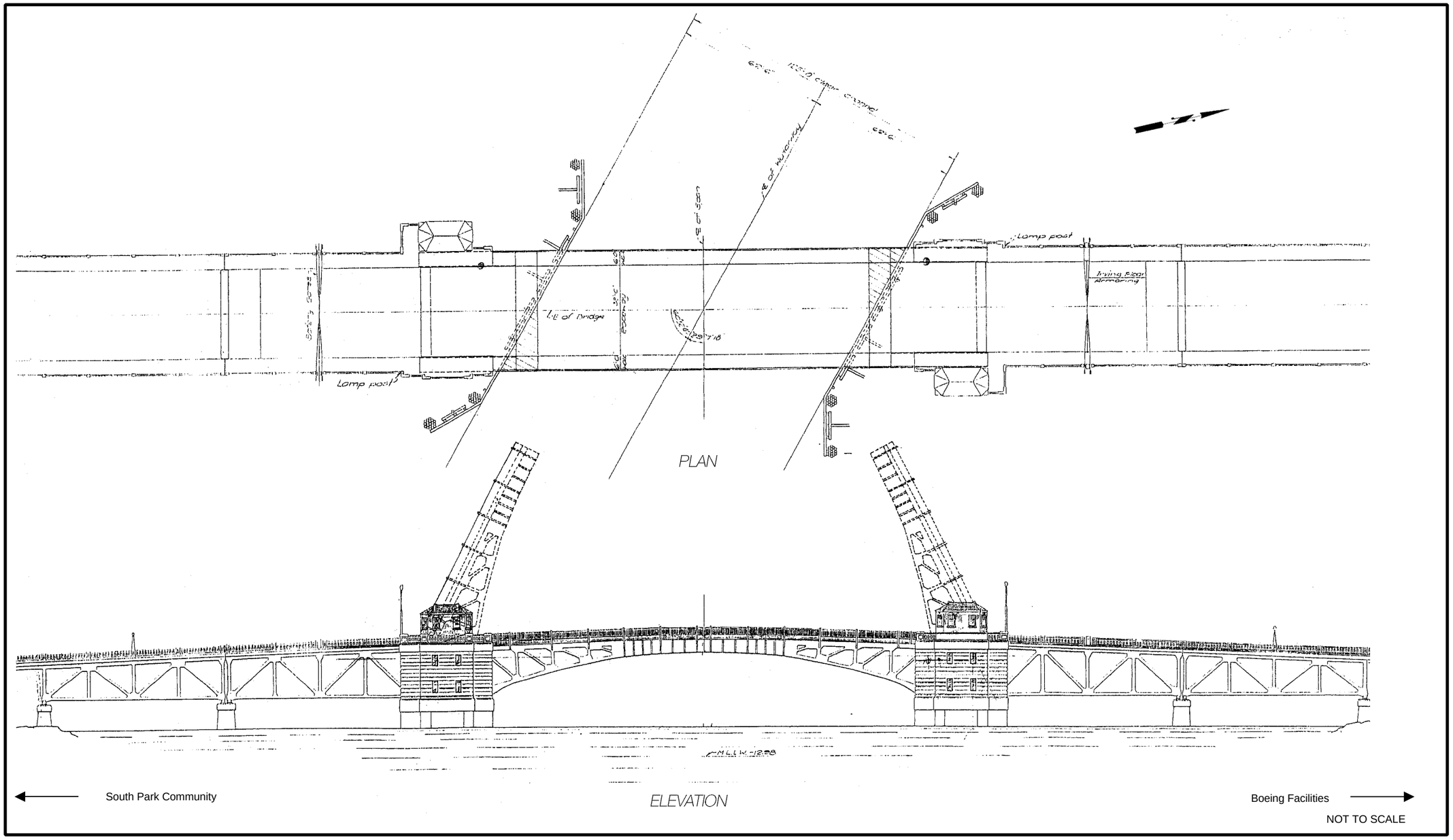

Figure 6

Rehabilitation Alternative

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Following construction, there would be only slight changes in the local street network. Figure 7 shows the local street network in the South Park community following construction activities for the rehabilitation of the existing bridge. The figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. (For comparison, Figure 8 shows the local street network following the construction of the Bascule Bridge Alternative.) To improve vehicular safety, S. Sullivan Street would intersect Dallas Avenue S., which would become the main cross street intersection with 14th Avenue S. The 16th Avenue S. (immediately east of the bridge) intersection with Dallas Avenue S. as well as 14th Avenue S. may also need to be reconfigured. Access to points north via the South Park Bridge would be maintained.

2.4.2.3 Bascule Bridge Alternative

The Bascule Bridge Alternative would result in the construction of a new movable bridge immediately downriver of the existing bridge (see Figure 9). The bridge mechanism could be a Scherzer rolling lift type (no longer a common design for new movable bridges) or another type. The bridge length would be approximately 935 feet from abutment-to-abutment, not including roadway approaches. Road improvements would extend from a point just north of S. Cloverdale Street on the south side of the waterway and north to a point opposite the northeast corner of Boeing Building 2-15. The interior walls of the bridge abutments would be approximately 200 feet from the top of the embankment, or approximately 50 feet closer to the shore than the existing bridge. With fewer piers than the existing bridge, the first on-land piers of this alternative would be approximately 55 feet from the top of the south embankment at the shortest distance and the closest in-water piers would be approximately 65 feet away. On the north shoreline, the closest in-water piers would be approximately 95 feet from the top of the embankment and the closest on-land piers would be approximately 30 feet away. Unlike the existing bridge's grated bascule leaves, the bridge deck of the bascule leaves would be solid surface to improve vehicle traction and to control stormwater runoff.

Similar to the existing bascule bridge, this bridge profile would be approximately 34 feet above the Duwamish Waterway when in the closed position. The mid-section span would be comprised of two movable leaves that could be raised to open the bridge. The navigation channel would be approximately 125 feet in width (slightly greater than the existing 118-foot-wide channel). This two-leaf bascule bridge would not impose limitations to the height of waterway users passing the bridge, because the new bridge would be approximately 125 feet between the tips of the raised spans.

Following construction, there would be some change in the local street network (see Figure 8). S. Sullivan Street would be permanently closed or reconfigured to improve traffic safety and vehicular and truck turning movements from the new bascule bridge to Dallas Avenue S. S. Sullivan Street would no longer have direct access to 14th Avenue S. and the bridge. The intersection of 16th Avenue S. (immediately east of the bridge) and Dallas Avenue S. may also need to be reconfigured. To ensure adequate vertical clearance for vehicles, S. Thistle Street would need to be slightly realigned further to the north and closer to the Duwamish Waterway. This figure also shows the portion of the

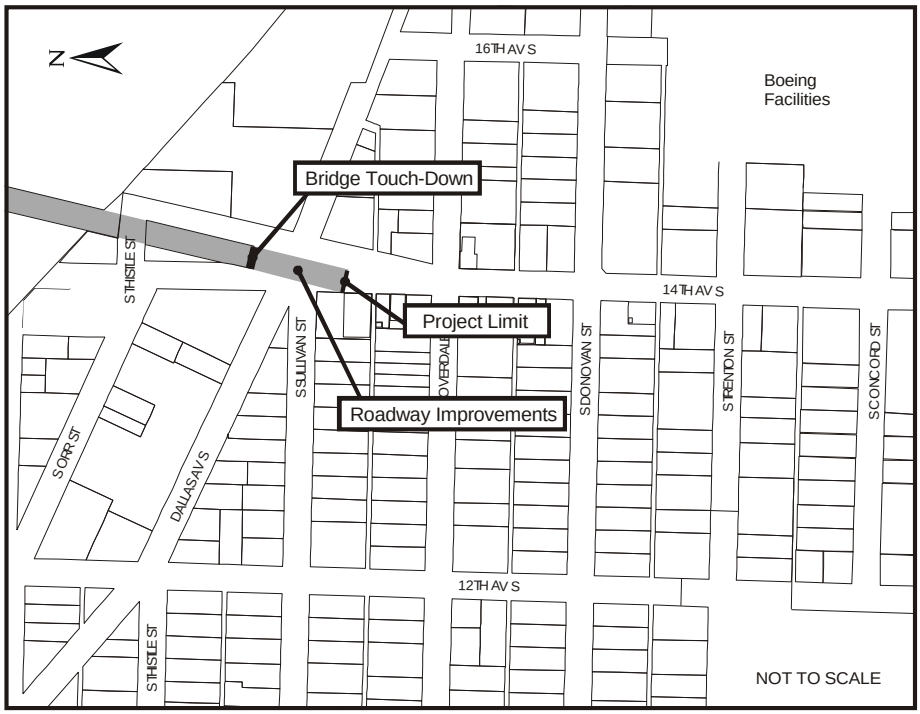
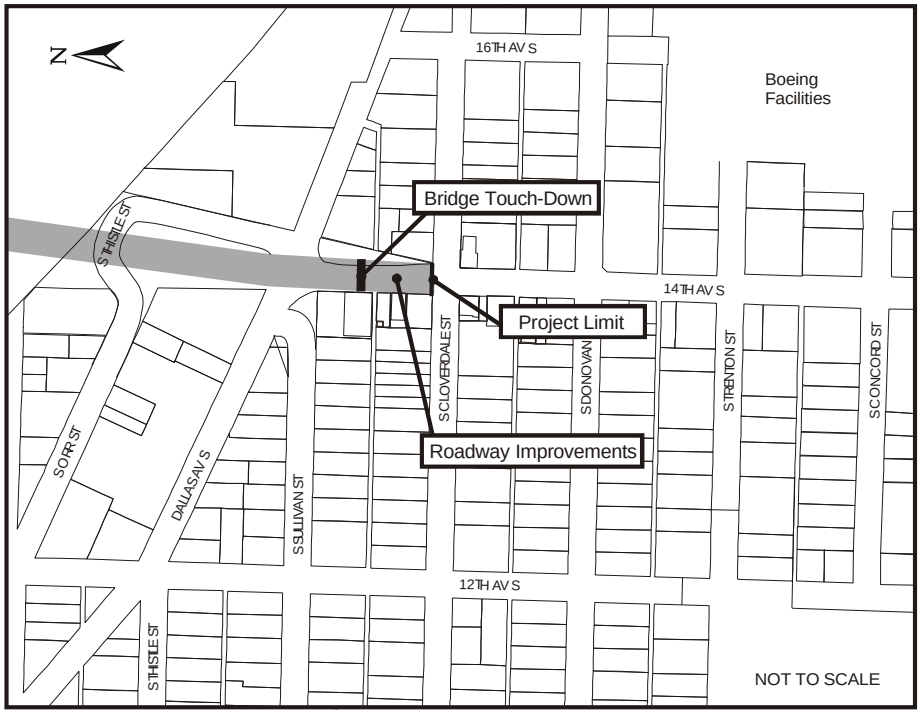
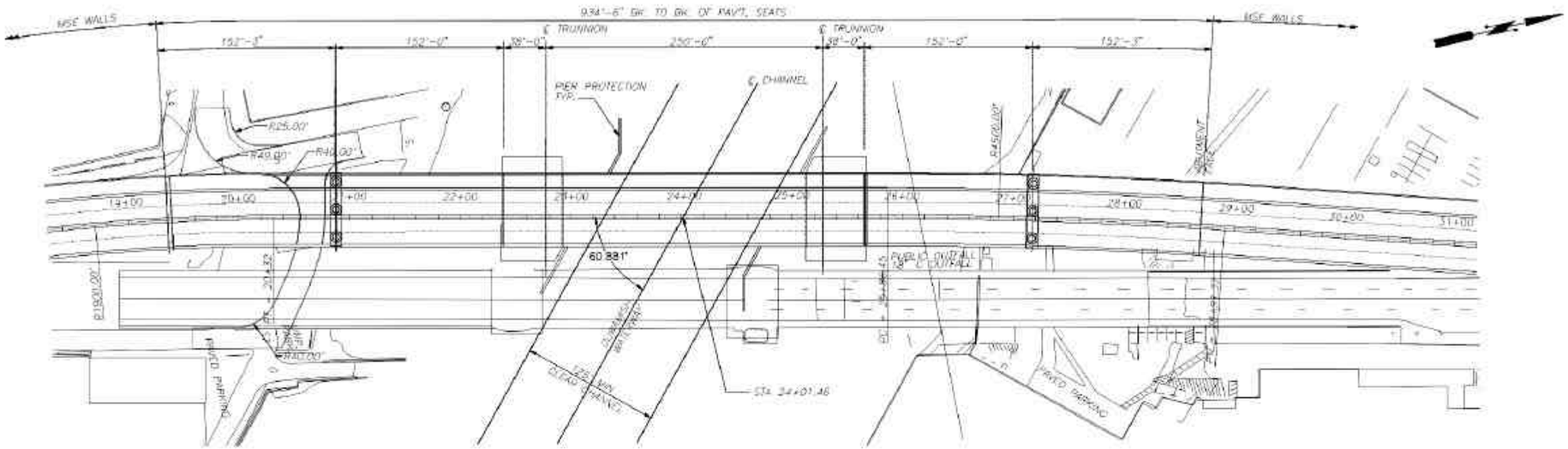
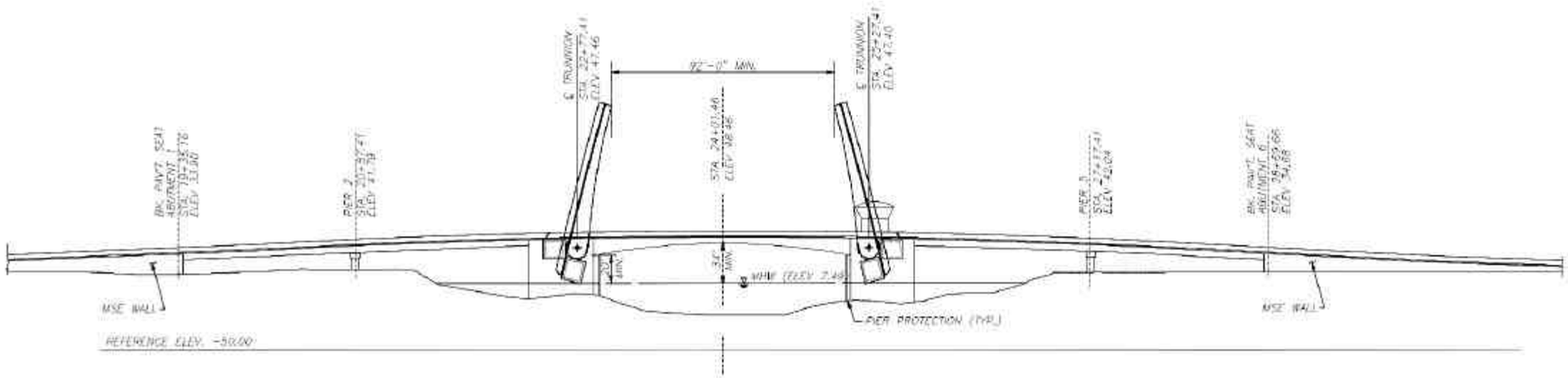


Figure 7
Rehabilitation Alternative Street Network





PLAN



South Park Community

ELEVATION

Boeing Facilities

NOT TO SCALE

Figure 9

Bascule Bridge Alternative

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project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. Access to points north via the South Park Bridge would be maintained. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.2.4 Mid-Level Fixed-Span Bridge Alternative

The Mid-Level Fixed-Span Bridge Alternative would result in the construction of a non-movable bridge (see Figure 10). The bridge length would be approximately 1,660 feet abutment-to-abutment, not including roadway approaches. The interior walls of the abutments would be approximately 550 feet from the top of the Duwamish Waterway embankment, or 300 feet further setback than the existing bridge. The closest on-land piers would be approximately 85 feet from the south embankment and the closest in-water piers would be approximately 100 feet away. On the north side, the closest in-water piers would be approximately 130 feet from the top of the embankment and the closest on-land piers would be approximately 65 feet away. Road improvements would extend slightly north of S. Donovan Street and north to a point approximately 320 feet south of East Marginal Way S.

The mid-point of the bridge profile across the Duwamish Waterway would be approximately 65 feet above MHW of the Duwamish Waterway. The horizontal clearance would be approximately 125 feet, or slightly greater than the existing clearance. The vertical clearance, however, would restrict use of some waterway traffic, including some tugs and barges. Most vessels that currently pass the existing bridge would continue to be able to use the navigation channel. As described earlier in the discussion of the design considerations, the width of the new mid-level bridge is reduced when the bike-pedestrian path is separated from the elevated approach roadway near the south side abutment. This design feature reduces land use and relocation impacts.

Following construction, there would be changes in the local street network (see Figure 11). (For comparison, Figure 12 shows the local street network following the construction of the High-Level Fixed-Span Bridge Alternative.) The location of the south abutment and its vertical clearance would require modification of Dallas Avenue S. and S. Sullivan Street. S. Sullivan Street would likely be merged into Dallas Avenue S. just west of the new structure and a new roadway would be constructed under the new bridge. The alignment of this roadway would be slightly to the north to ensure it would have a minimum allowable vertical clearance. Neither street would have direct access to the new South Park Bridge. Figure 11 also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. A retaining wall supporting the elevated approach roadway would be constructed immediately adjacent to properties fronting on the both sides of 14th Avenue S. for the majority of the distance between S. Sullivan Street and S. Cloverdale Street. Traffic would be able to access the bridge at S. Cloverdale Street, which would be raised a maximum of approximately 5 feet at the intersection to meet the descending grade of the bridge. This change in the intersection would allow traffic on S. Cloverdale Street to continue to have direct access to

14th Avenue S. though a retaining wall would also need to be constructed around the four corners of the intersection of S. Cloverdale Street and 14th Avenue S. due to the grade change. S. Orr Street would be closed due to the location of the support structures for the proposed separated pedestrian/bike path, which would allow bicyclists and pedestrians to descend from the bridge level to the street level. In addition, S. Thistle Street would be closed as it would no longer be able to connect to S. Orr Street. Following construction and transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.2.5 High-Level Fixed-Span Bridge Alternative

The High-Level Fixed-Span Bridge Alternative is a non-movable bridge (see Figure 13). The bridge length would be approximately 2,332 feet abutment-to-abutment, not including roadway approaches. The interior walls of the abutments would be approximately 900 feet from the top of the Duwamish Waterway embankment, or 650 feet further set back than the existing bridge. The on-land and in-water piers of this alternative are approximately in the same location as proposed for the Mid-Level Fixed-Span Bridge Alternative. Road improvements would extend from S. Trenton Street and continue north to East Marginal Way S. This alternative would require minor modification of the 16th Avenue S. East Marginal Way S. intersection and of the existing railroad track crossing immediately south of this intersection.

The bridge design would allow for approximately 100 feet of vertical clearance above the MHW of the Duwamish Waterway as requested by the U.S. Coast Guard. The horizontal waterway clearance for the navigation channel would be approximately 125 feet, which is slightly greater than the existing 118-foot clearance (fender-to-fender). The bridge's vertical clearance would not be expected to limit the height of boats and barges currently passing the bridge. However, vessels larger than those currently using the navigation channel might not be able to pass the bridge in the future.

Following construction, there would be numerous changes in the local street network as shown in Figure 12. The figure also shows the portion of the project alternative that would be elevated for the bridge structure, the bridge touch-down point, and the portion that would have surface roadway improvements. The bridge south abutment would require Dallas Avenue S., S. Sullivan Street, and S. Cloverdale Street to be converted to underpasses under the new South Park Bridge. A retaining wall supporting the elevated approach roadway would be constructed immediately adjacent to properties fronting on both sides of 14th Avenue S. for the majority of the two-block distance between S. Cloverdale Street and S. Trenton Street. S. Donovan Street would be closed at 14th Avenue S. due to obstruction from the bridge abutment and a vehicle turn-around would be constructed on either side of the abutment on S. Donovan Street. To allow traffic to access the new South Park Bridge, a new principle arterial roadway would need to be constructed between S. Trenton Street and 12th Avenue S. and road improvements would be required on 12th Avenue S. north to S. Cloverdale Street. This new route would allow traffic, trucks, and buses to continue to access the new South Park Bridge from S. Cloverdale Street via 12th Avenue S. and S. Trenton Street. Following construction and

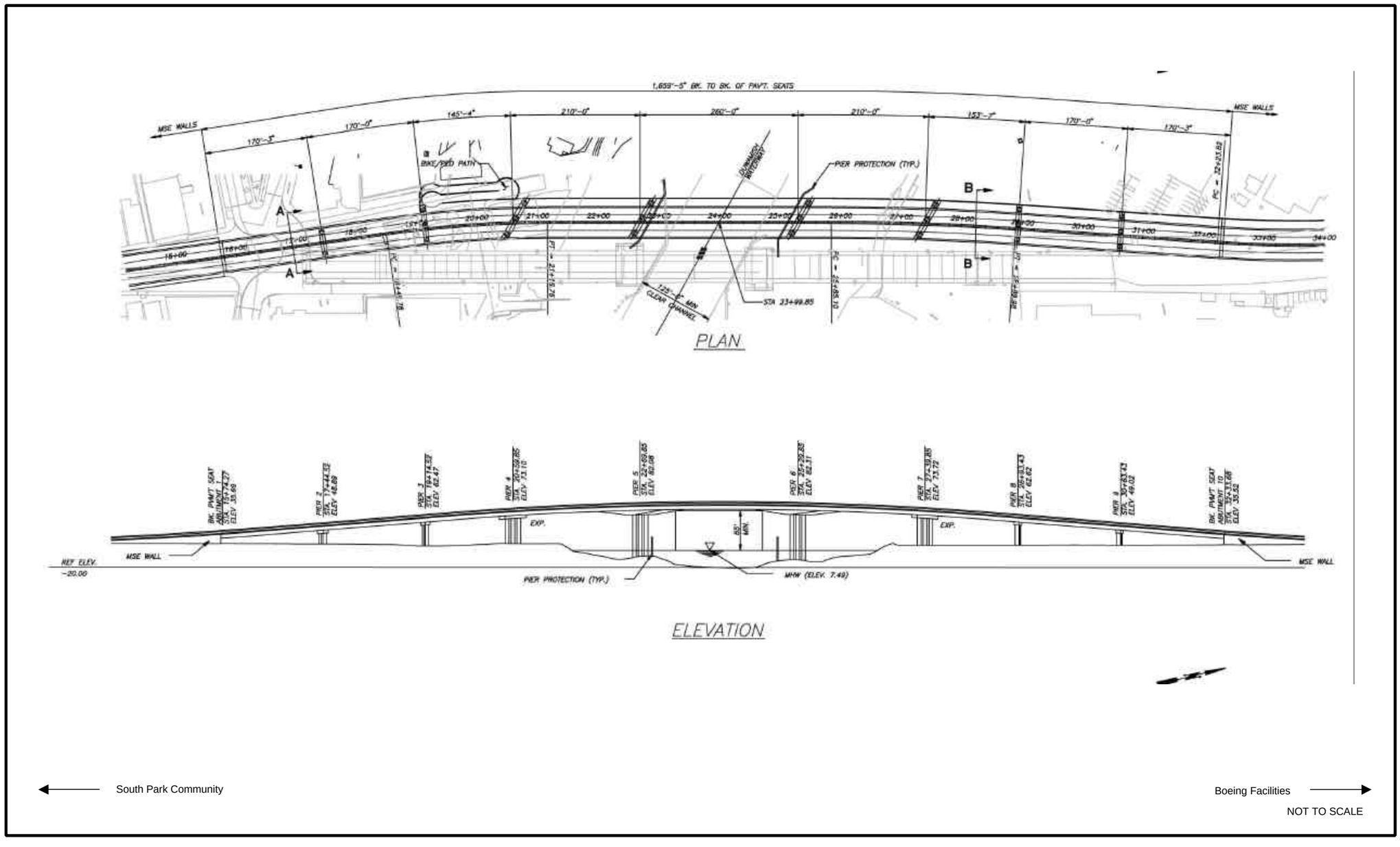

Figure 10

Mid-Level Fixed-Span Bridge Alternative

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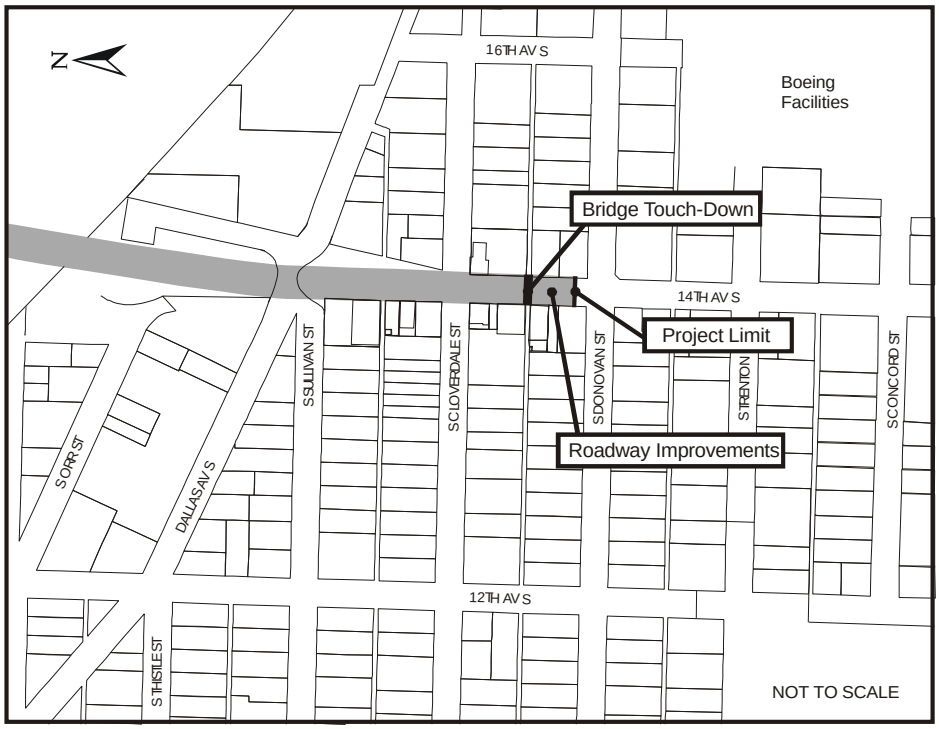

Figure 11

Mid-Level Fixed-Span Bridge Alternative Street Network

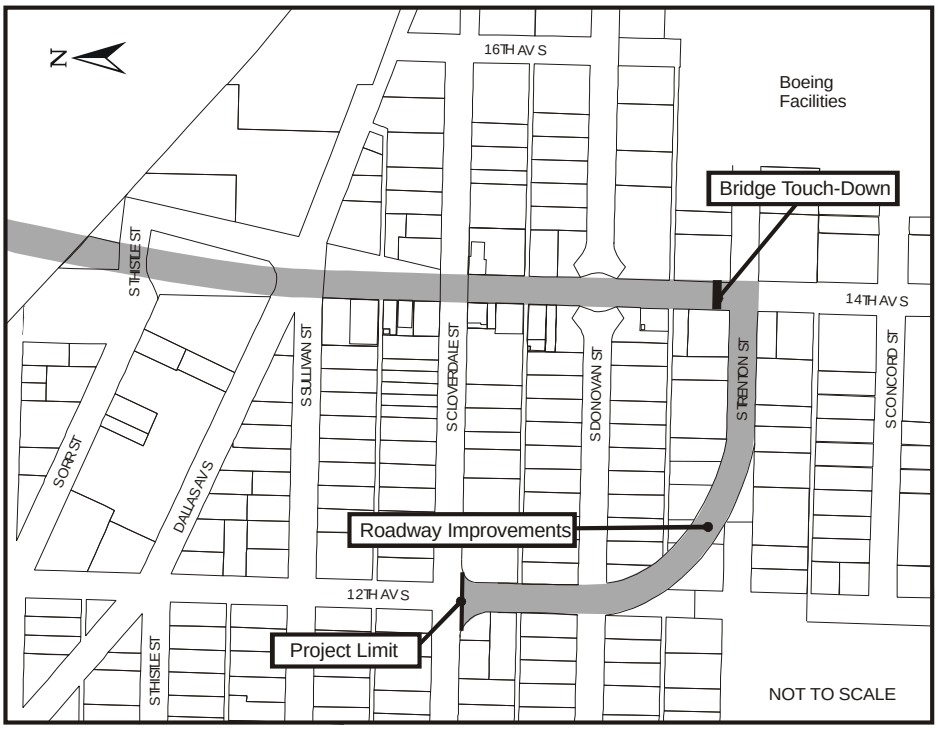

Figure 12

High-Level Fixed-Span Bridge Alternative Street Network

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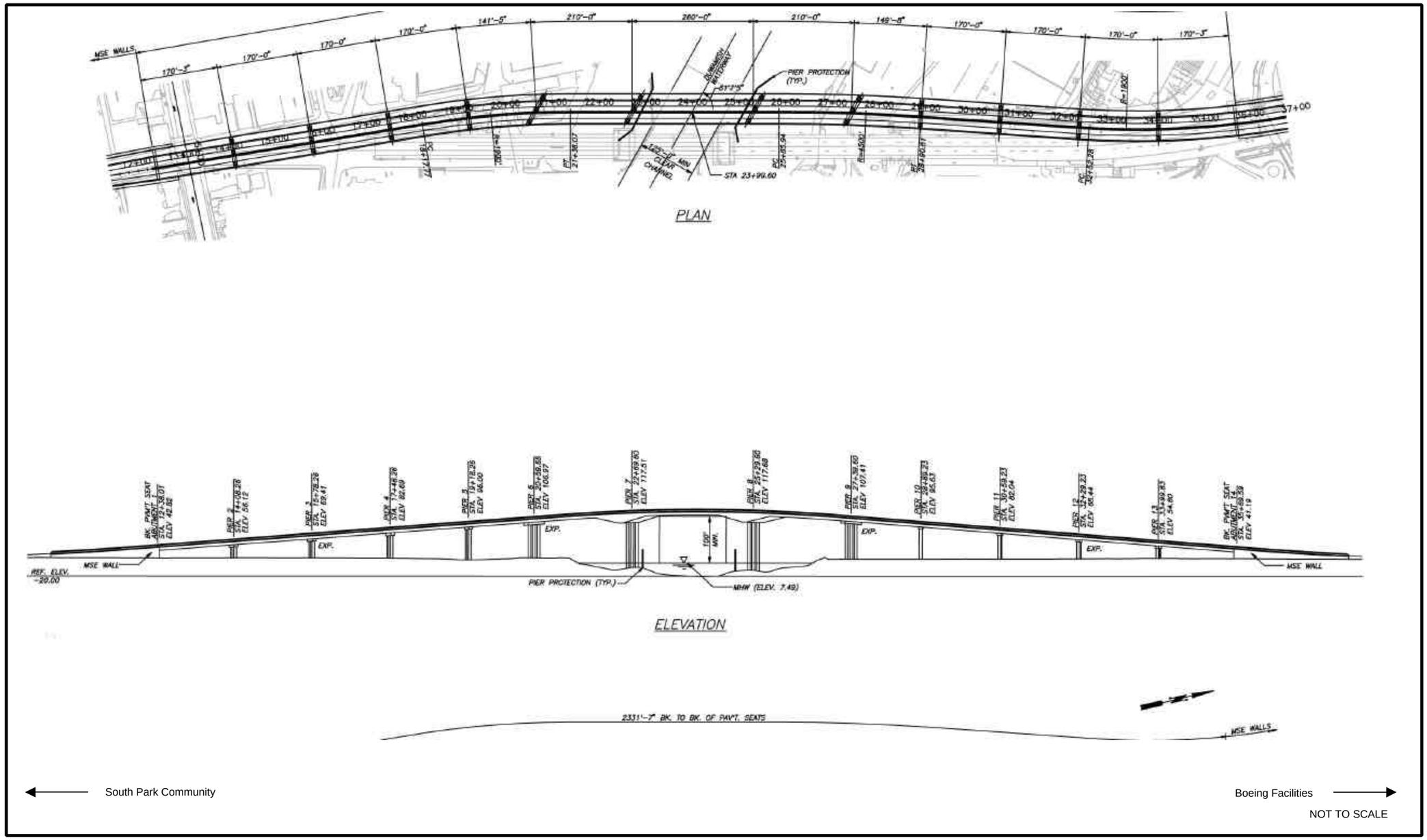

Figure 13

High-Level Fixed-Span Bridge Alternative

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transfer of the traffic to the new bridge, the existing bridge would be demolished and removed as described for the No Action Alternative.

2.4.3 Construction Durations and Activities

Construction of a rehabilitation or replacement bridge for the existing South Park Bridge is planned to take approximately two to three years, including the demolition and removal of the existing bridge. Construction is anticipated to start within the next several years and opening of the rehabilitation or a replacement bridge is currently anticipated to occur by 2009. The actual time required for construction activities vary for each of the alternatives. Construction activities associated with the No Action Alternative involves only demolition of the existing bridge and restoration of the site. The construction period for this alternative would be the shortest of all alternatives, approximately 8 months. The other alternatives would additionally require rehabilitation or construction of a new replacement bridge. Anticipated construction durations (demolition of existing and construction of new) would be approximately 32 months for the Rehabilitation Alternative, 33 months for the Bascule Bridge Alternative, 20 months for the Mid-Level Fixed-Span Bridge Alternative, and 24 months for the High-Level Fixed-Span Bridge Alternative.[14]

From a construction perspective, the five project alternatives include three different types of construction activities. The No Action Alternative assumes the existing bridge condition would eventually require closure and removal of the bridge structures. Construction activities would focus on demolishing the existing bridge and restoring the project area. The Rehabilitation Alternative would require bridge closure for approximately 30 months for rehabilitation or replacement of various elements of the existing bridge. The Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives would all result in constructing a replacement bridge approximately 80 feet downstream of the existing bridge. For these three alternatives, the new bridge would be constructed while the existing bridge continues to be operational. When the new bridge is connected to the existing road, there would be short-term temporary bridge closures. These closures could be limited to weekends or could extend for approximately one month, depending on the alternative. Once the new bridge is completed, traffic would be rerouted to the new bridge and then the existing bridge structure would be demolished in a similar fashion as described for the No Action Alternative.

Rehabilitation of the existing bridge would require closure of the existing bridge for approximately 30 months, although efforts would be made to minimize the closure period as much as possible. Reconstruction activities would begin as soon as possible after completion of design engineering and acquisition of construction permits. Traffic would be given advance notice to take alternate routes prior to closure of the existing bridge. The construction of a temporary dock and a construction staging area would be required on both banks of the waterway (see Figure 14). Construction of the new bascule piers would likely be the first major construction activity. This would entail removing the

[14] Parsons Brinckerhoff. *South Park Bridge Project: Structural Alternatives Study*, November 2003.

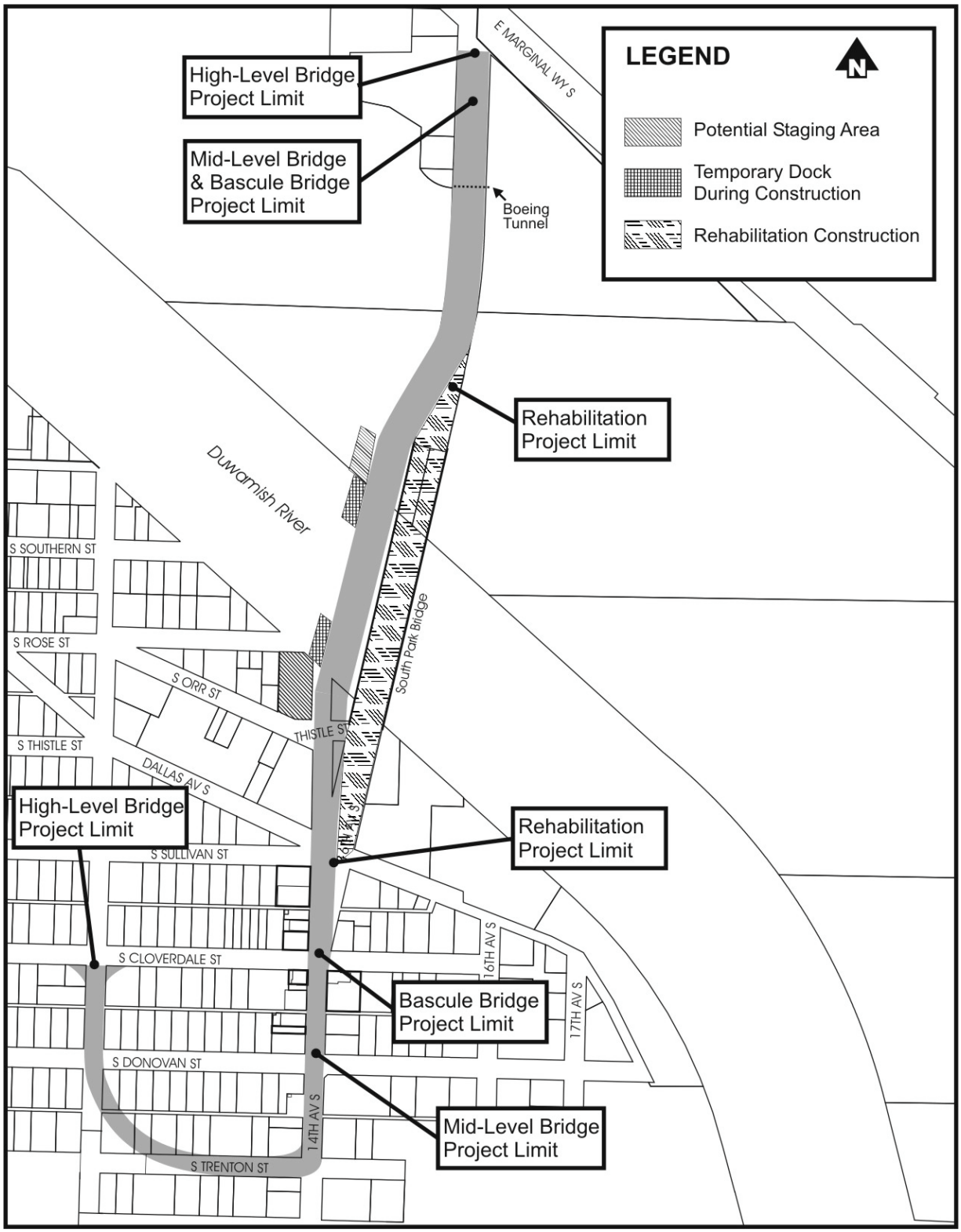


Figure 14

Proposed Construction Staging Areas

existing pier protection fenders, installing temporary supports for the bridge superstructure, removing the bascule leaves as well as the steel truss spans, installing cofferdams around the existing steel truss approach piers and bascule piers, and demolishing the existing piers.

The bascule leaves and steel truss approach spans would be removed from the construction site for refurbishment. Construction of the new piers would involve drilling shafts through the existing timber piles, constructing the pile cap, dewatering the construction area inside the cofferdam, constructing the upper portions of the pier, removing the cofferdam, and finally reconstructing the upper portions of the bascule pier and bridge towers. Workers would reconstruct the concrete approach spans and replace the abutments. Workers would also reconstruct the bridge deck and replace the mechanical and electrical systems used to operate the bridge. Replacement of the piers, bridge tender towers, bridge railings, and lamp posts would be done in a manner that would preserve the historic character of these features of the existing bridge.

Major construction activities and sequencing would be similar for the Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives. The construction duration and the impact area for each of these three alternatives, however, would clearly differ. Following completion of design engineering, acquisition of construction permits, purchase of needed property, and relocation of residents and businesses, construction activities would begin. The first activities would include establishing the construction staging areas and constructing temporary docks with pilings on both sides of the waterway (see Figure 14).

Buildings affected by the construction activities would be demolished and utilities would be either temporarily or permanently relocated. To minimize traffic impacts, construction activities would begin with the construction of the in-water piers. Construction activities would progress landward from the central portion of each bridge alternative. Both in-water and on-land construction would begin with construction of the sub-structures (piers and abutment) and would be followed by placement of the superstructure (beams, deck, rails). On-land construction of the piers, abutment, retaining walls, and transition segments at either end of the bridge would likely require temporary closure of adjacent or nearby roads and rerouting of local traffic. If possible, these temporary closures would be limited to weekend and/or night times to minimize impacts to the community. Construction activities on the north and south portions of the new bridge structures could also occur either separately or concurrently. The last of the construction activities would be the construction of the new curb and gutter of the at-grade roadway, and paving the roadway to match the existing width of 14th Avenue S. Figure 14 shows the project limits, or start and end points, of construction activities for each of the project build alternatives.

For the rehabilitation and new bridge alternatives, new girders and other oversized materials would most likely be delivered to the project site by barge. Large cranes located on the barges or temporary docks would off-load the materials and place them in the nearby construction staging area. Removal of the existing bridge pier foundations and

construction of the new bascule and steel truss piers would all require the use of cofferdams to isolate the construction activities. Construction of the new approach-span piers would use drilled shafts, which would likely incorporate the use of temporary casings to isolate the construction activities. This in-water work would be performed by equipment operated from the temporary docks or from barges.

Demolition of the existing bridge would involve disassembly and removal of the existing bascule leaves, superstructure, bridge piers, protection fenders, and abutment. Cranes would use the existing bridge structure and approaches as much as possible to remove the various elements of the bridge. Barges would likely be used to remove oversized materials. At this time, this demolition work is not planned to require construction of temporary docks or the acquisition or temporary use of property on the banks of the Duwamish Waterway for a staging area. Removal of the abutment foundations, however, would likely require temporary short-term closure of adjacent and/or nearby streets. During this time, local traffic would be temporarily rerouted from the immediate area.

Following the completion of the construction activities associated with any of the project alternatives, disturbed areas would be restored. Conceptual site restoration plans would be developed for each alternative based on additional consultation with resource agencies and other stakeholders.

2.4.4 Cost Estimates for the Alternatives

Cost estimates for each of the proposed project alternatives have been prepared by the project engineers (see Table 2).[15] The cost estimate for each project alternative, including the No Action alternative, is broken down into the following components: (1) plans, specifications, and estimates (PS&E), (2) right-of-way costs, and (3) construction and construction-related costs. The total cost estimates are provided in 2003 dollars as well as estimated costs escalated for 2008, the anticipated mid-point of the project construction period. These cost estimates were calculated based on the conceptual engineering plans that were prepared for each of the alternatives.[16]

Clearly, the No Action Alternative is the least expensive as the existing bridge would not be rehabilitated nor would a new replacement bridge be constructed. The cost to remove the existing bridge structure would be approximately $7,000,000 (2003 dollars). The estimated costs to either rehabilitate or replace the existing bridge structure range between approximately $62 million to $77 million in 2003 dollars. The least costly of the build alternatives is the proposed Mid-Level Fixed-Span Alternative, which is estimated to cost approximately $61,523,000 to design and construct. The Rehabilitation Alternative is estimated to cost approximately $63,930,000 and the High-Level Fixed-Span Alternative is estimated to cost approximately $70,460,000. The most costly of the build alternatives is the Bascule Bridge Alternative, which is estimated to cost $77,334,000. The escalated

[15] Parsons Brinckerhoff. *South Park Bridge Project: Structural Alternatives Study*, November 2003.

[16] Parsons Brinckerhoff. *South Park Bridge Project: Conceptual Plans*, June 2003.

2008 dollar estimates to design and construction the project alternatives are also shown in the table.

Table 2. Cost Estimates of the Project Alternatives

	PS&E	Right-of-Way	Construction	Total (2003 dollars)	Total (2008 dollars)
No Action	$ 250,000	$ 0	$ 6,750,000	$ 7,000,000	$ 9 M
Rehabilitation	$ 6,843,000	$ 754,000	$56,333,000	$63,930,000	$ 74 M
Bascule	$ 8,253,000	$ 3,655,000	$ 65,426,000	$ 77,334,000	$ 90 M
Mid-Level Fixed-Span	$ 4,235,000	$ 6,377,000	$ 50,911,000	$61,523,000	$ 71 M
High-Level Fixed-Span	$ 5,261,000	$ 15,310,000	$ 49,889,000	$ 70,460,000	$ 82 M

Source: Parsons Brinckerhoff, November 2003.

2.5 Project Coordination

Coordination to date for the South Park Bridge Project has involved members of the public, a special community advisory group, and representatives of government agencies. Formal scoping was initiated through publication of the NEPA Notice of Intent and the SEPA Determination of Significance and Scoping Notice on February 7, 2002, and February 14, 2002, respectively. Separate scoping meetings were conducted in the South Park community for relevant agencies and members of the public. Both meetings were held on February 28, 2002. Written and verbal comments received through the scoping process were reviewed by King County and used in the development of the project alternatives and topics for environmental impact assessment.

A public involvement plan for the proposed South Park Bridge Project was developed during the initial stages of project planning. The Project Advisory Committee (PAC) and the Community Advisory Group (CAG) reviewed this document and provided comments to King County. The first public involvement efforts began prior to the formal scoping period. A public workshop was held in the South Park community on January 17, 2002. At this meeting, the nine preliminary project alternatives were presented. A second public workshop was held on June 19, 2002. At this meeting, the five proposed project alternatives were presented. Members of the public were encouraged to provide comments at both of these meetings. To facilitate participation and input from Hispanic persons living in the community, a bilingual translator attended all meetings. In addition, handouts and newsletters for the project were published in English and Spanish, and public notices were published in “Siete Dias”, a local Spanish-speaking newspaper. Future opportunities for public involvement are also planned, including a public hearing and workshop following publication of the Draft Environmental Impact Statement in

2004.

Establishing a CAG was a significant component of the public involvement plan. A total of 17 individuals were chosen to participate in the CAG to represent community stakeholder interests and public concerns. The CAG meets periodically to be briefed on the progress of the project and to provide input to the South Park Bridge project team. Again, a bilingual English-Spanish translator attends the meeting to facilitate communication with Spanish-speaking individuals on the CAG. To date, CAG meetings have been held on April 10, May 21, June 4, June 11, and October 29, 2002, and on January 7 and November 18, 2003. Additional CAG meetings are planned for the future.

As part of the environmental review process, King County periodically meets with the Project Advisory Committee (PAC) to give a status report of the project, answer questions, and to solicit comments. This committee is comprised of members of various agencies that have potential jurisdiction over the proposed South Park Bridge Project. The committee is the Interdisciplinary Team (IDT) required under NEPA implementation guidelines and provides technical support to King County staff. To date, the PAC has met on January 10, February 20, May 9, May 23, and October 10, 2002. Coordination with the PAC is planned at critical future steps in the environmental review process.

A non-scientific survey was also conducted of South Park businesses located on 14th Avenue S. during the late spring of 2003.[17] The goal of the survey was to help assess potential impacts to businesses, especially minority-owned and –operated (employees) businesses. The survey respondents were also asked to identify their particular concerns about the proposed rehabilitation or replacement of the existing South Park Bridge. A total of 18 businesses were successfully surveyed. Spanish and Vietnamese translators were provided, as needed, to assist business representatives understand and respond to the questions. In addition, the data was used to assess the potential effects displaced businesses and jobs would have on the South Park community. The analysis of the survey findings are discussed in detail in the Economic, Social, and Relocation technical reports supporting the analysis in the EIS.

As key issues have arisen during development of the project alternatives and in assessing potential environmental impacts, special meetings have also been held with key stakeholders and organizations in the South Park community, as well as with other government agencies and jurisdictions with an interest in the project. For example, on December 3, 2002, King County met with owners of property along 14th Avenue S, and information booths were set up at the Sea-Mar Community Health Center-sponsored annual Fiesta Patrias on September 14, 2002, and at a family night event held at the Concord Elementary School on September 27 and November 22, 2002. Periodic coordination meetings have also been held with representatives of the City of Seattle and the City of Tukwila, and other government agencies. These coordination activities will continue to occur on an on-going basis as the EIS is prepared and finally adopted.

[17] Parsons Brinckerhoff. *South Park Bridge Project: Survey of 14th Avenue South Businesses*, August 22, 2003.

Geologic data was obtained for the project area by collecting and reviewing existing data, including previous field explorations and geotechnical studies, reviewing available geologic maps, and performing a geologic reconnaissance. The geologic evaluation of the project area was performed based on these data sources.

3.1 Existing Subsurface Data

Project files and archives from several sources were reviewed to obtain existing geotechnical subsurface information in the project area. These efforts were concentrated on sources where large amounts of information were already stored and easily accessed. Data, primarily consisting of boring logs, were collected from the following sources:

- Seattle's Department of Planning and Development (DPD)
- Materials Lab of Seattle Public Utilities
- Seattle-Area Geologic Mapping Project
- The Boeing Company.
- Shannon & Wilson, Inc.

Only data that contained sufficient information to locate the borings and to evaluate the subsurface geology were selected. The approximate locations of the existing borings are shown on Figure 15. The locations of these borings were estimated from available plans and should be considered approximate. The logs of borings shown on Figure 15 are included in Appendix A of Shannon & Wilson's "Geotechnical Report for Conceptual Engineering, South Park Bridge Project, King County, Washington," dated May 2003.

3.2 Geologic Literature Review

Prior to the field geologic reconnaissance, available published geologic literature was reviewed for the Proposed Action area. These data included the following:

- Map Showing Depth to Bedrock in the Seattle 30'x 60' Quadrangle, Washington (Young et al., 1985)

- Geologic Map of Surficial Deposits in Seattle 30' x 60' Quadrangle, Washington (Yount et al., 1993)

- Bedrock Geologic Map of the Seattle 30' x 60' Quadrangle, Washington (Yount and Grower, 1991)

- City of Seattle Critical Areas Map Folios

- City of Tukwila Sensitive Areas Maps (Tukwila Department of Community Development, 1990)

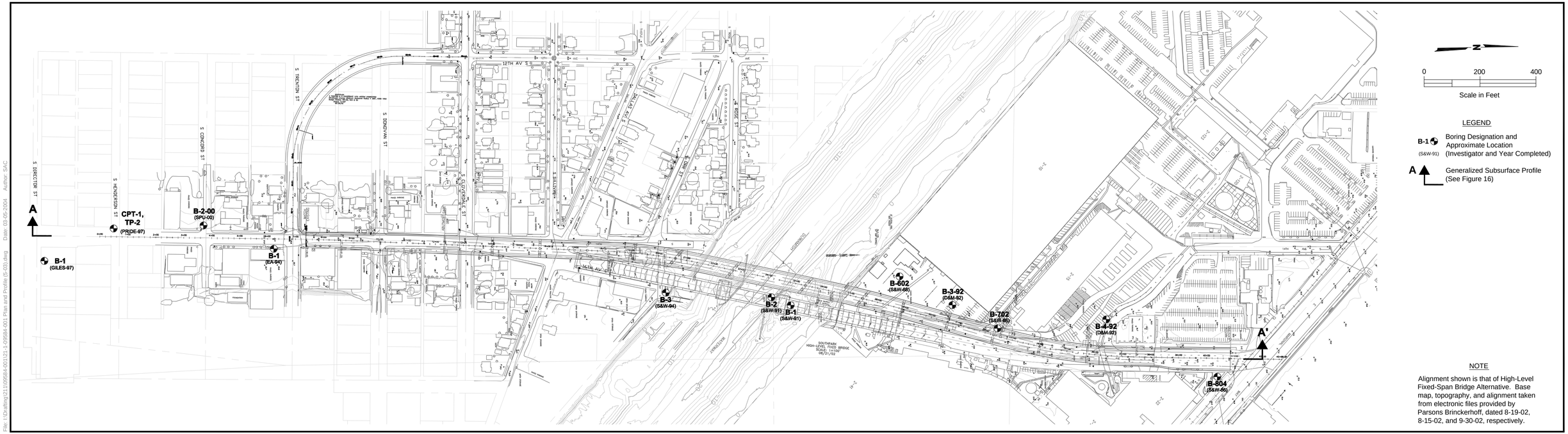
- King County Sensitive Areas Map Folio (King County, 1990)
- King County Soil Survey (1952 and 1973)
- Preliminary Geologic Map of Seattle and Vicinity (Waldron et al., 1962)

3.3 Geologic Reconnaissance

A visit was made to the project area to perform the geologic field reconnaissance. The reconnaissance was performed by walking around the project area and noting geologic features such as soil and rock exposures, cut and fill slopes, evidence of slope instability, erosional areas, vegetational clues to geologic conditions, and evidence of ground and structural distress attributable to the Nisqually earthquake or poor subsurface conditions.

3.4 New Subsurface Explorations

No new subsurface explorations were performed for this study.



File: H:\Drafting\2111\09584-001\21-1-09584-001 Plan and Profile (S-03).dwg Date: 03-05-2004 Author: SAC

Figure 15

Site and Exploration Plan

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Chapter 4 Methodology

The objective of the Geology and Soils Technical Report is to identify geologic and soil conditions for the project area, characterize the engineering properties and potential hazards associated with these conditions, assess the impacts of the proposed project alternatives with respect to geology and soils, and identify measures to mitigate adverse impacts.

Subsurface conditions in the project area were developed by compiling and reviewing existing available exploration data, published and unpublished geologic maps and documents, and a field reconnaissance. No new subsurface explorations were conducted for the preparation of this report.

Published geologic maps and reports were reviewed to understand general topographic and geologic conditions along the project corridor and adjacent areas and to gain an understanding of historical changes that have occurred during residential and industrial development of the area.

To understand in better detail the subsurface conditions in the project area, we reviewed information about the existing bridge that were obtained from Shannon & Wilson records. The records included logs of borings; geotechnical reports; and plans, cross sections, and profiles prepared for the existing bridge. We also obtained logs and reports of previous geotechnical and environmental explorations and investigations along and in the vicinity of the proposed corridor. These records were obtained from the files of Seattle's DPD and the Materials Lab of Seattle Public Utilities; the Seattle-Area Geologic Mapping Project; and from the Boeing Company. Surface and subsurface information that we reviewed were referenced to various vertical datums. All data was converted to the 1988 North American Vertical Datum (NAVD 88), which is the datum used throughout this report.

In addition to the procurement and review of this information, Mr. Ted Hopkins of Shannon & Wilson, Inc. performed a geologic site reconnaissance on August 7, 2002. During his reconnaissance, Mr. Hopkins noted such things as soil/rock exposures, cut and fill slopes, and evidence of slope instability, erosional areas, vegetational clues to geologic conditions, and evidence of ground and structural distress attributable to the Nisqually earthquake or poor subsurface conditions. The locations of mapped hazard and critical areas or areas with environmental constraints were identified from city and county regulatory maps.

Plans and profiles of proposed project alternatives were reviewed. Based on the proposed project alternatives, soils and geology impacts were assessed relative to cuts and fills, retaining walls, bridge foundations, landslides, construction, and utilities. Mitigation measures for these impacts are proposed and are included in this report.

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Chapter 5 Affected Environment

Chapter 5 describes the geologic and soils-related aspects of the physical environment in the project area that could be affected by the proposed actions. The discussion summarizes the regional and site geology, the geotechnical subsurface conditions, and historical changes related to ground modification during urbanization. In addition, geologic hazards and regulated critical areas associated with portions of the project area are discussed.

5.1 Project Area Description and General Topographic Setting

The South Park Bridge crosses the Duwamish Waterway near the southern limits of the City of Seattle. The project area is situated in the Duwamish Waterway floodplain, which is bounded by upland areas to the east and west. The topography in the vicinity of the project area is shown on Figure 15. The ground surface is generally flat lying with elevations between approximately 10 and 20 feet (NAVD 88). Two small rock knobs located near the south end of the project corridor rise upward to approximate elevations of 60 and 100 feet. The lowest point in the project area is the bottom of the Duwamish Waterway at an approximate elevation of –20 feet (NAVD 88).

Large industrial facilities (Boeing Plant 2) lie to either side of the project corridor across the bridge north of the Duwamish. South of the bridge is the community of South Park, which has a mix of commercial, industrial, and residential property. Along 14th Avenue S. are commercial retail and service businesses.

In the vicinity of the project area, the Duwamish Waterway is a channel dredged in the 1910s to straighten the natural meandering course of the Duwamish River (Phelps, 1978). Prior to straightening, the channel of the Duwamish River ran around the north end of the project area. It also may have meandered across most of the flood plain in the recent geologic past. Prior to its filling in the 1910s, an abandoned, former meander channel of the Duwamish existed just south of the existing South Park Bridge, between Dallas and Orr avenues S. The former channel was likely filled largely with spoils from the dredging of the waterway. Prior to its filling, the abandoned channel was a marsh, with much of the original channel depth already filled by natural processes with organic, fine-grained sediments and wood debris.

5.2 Geologic Conditions

Our understanding of the geology and subsurface conditions within the project area is based on previous subsurface explorations, published geologic information and maps, a field reconnaissance, and our previous work in the surrounding area. The locations of borings used to understand the geology along the project corridor are shown on

Figure 15. The following sections discuss the general geology and subsurface conditions along the project corridor.

5.2.1 Regional Geology

The project area is located in the Duwamish Waterway valley, a broad, glacially carved trough bounded by upland areas to the east and west. The upland areas are underlain by glacial and non-glacial sediments deposited during or subsequent to six or more Pleistocene glacial episodes. The most recent glaciation in the Seattle area, termed the Vashon Stade of the Fraser glaciation, ended approximately 13,500 years ago. The Duwamish Waterway valley was left as a deep trough that was subsequently filled with Holocene sediments.

During the Vashon Stade, the ground was topographically depressed from the weight of ice up to 3,000 feet thick. During the height of the glaciation, sea level was as much as 300 feet lower than the present-day sea level because so much of the earth's water was stored as glacial ice. After retreat of the ice from the area, the ground surface rebounded relatively quickly and was near its present position about 9,000 to 10,000 years ago. As the large ice sheets melted, the sea level rose slowly until it reached the present-day sea level approximately 5,000 years ago. As sea level rose, marine waters filled the trough. As the Duwamish Waterway delta advanced from the south, a thick sequence of estuarine (marine delta) and alluvial (river-deposited) sediments accumulated in the trough. The estuarine and alluvial sediments consist of sand, silt, clay, and organic material. These deposits are underlain by a relatively thin layer of glacial sediments that overlie Tertiary sedimentary and volcanic rock that, in places, extend to the ground surface. In more recent times, the Duwamish valley was extensively modified by human activity during residential and industrial development.

Bedrock outcrops are present in only a few locations in the Seattle area and occur south of an east-west line extending from the City of Bremerton to the west, to the south end of Lake Sammamish toward the east (Yount et al., 1985). In the last 15 years, this line has been identified as the Seattle Fault, now considered to be an active fault zone consisting of several faults at the ground surface. An active fault is one that is considered to have ruptured within the Holocene Epoch (about the past 10,000 years).

5.2.2 Geologic Units

The youngest deposits identified within the project area are Holocene fill, marsh, alluvium, and estuarine deposits. These recent, nonglacial soils were all deposited during the last 10,000 years.

Fill is soil placed by humans and it can have widely variable properties, depending on the material used as fill and whether the fill was placed in an engineered or nonengineered fashion. The fill within the project area consists of silty sand to gravelly sand with some sandy gravel. Most of the fill is likely to be nonengineered, having been placed hydraulically during dredging of the waterway.

Marsh deposits are fine-grained cohesive soils deposited in poorly drained areas across the historic floodplain. The marsh deposits identified along the project corridor may also include buried topsoil. The marsh deposits consist of very loose to loose silt and sandy silt to very soft to soft, silty clay to clayey silt. These soils commonly contain abundant organic material and may contain peaty material and wood debris.

Alluvium is soil deposited by streams and rivers and includes finer-grained overbank deposits. These soils range from very loose to dense and are composed of sand, silty sand, and gravelly sand. The relative density generally increases with depth. A significant thickness of alluvium lies beneath the corridor.

Estuarine deposits consist of fine-grained soils deposited in delta mudflats and floodplains where tidal marine waters are mixed with fresh water from rivers and streams. These deposits consist of very soft to stiff or very loose to medium dense silty clay to clayey silty sand. This unit commonly contains scattered organic debris. The estuarine deposits may interfinger with coarser-grained alluvial deposits.

Beneath the Holocene deposits are glacial deposits including till and glaciomarine drift. Both of these deposits have generally been overridden by glacial ice and are generally very dense or hard. These deposits were typically encountered in only the deeper borings along the alignment. The upper portions of these deposits may be less dense or hard and may have been reworked since deposition or represent a thin layer of recessional material deposited during recession of the glacial ice.

Till was deposited along the base of a glacial ice sheet as it advanced southward through the Puget Lowland. Till generally consists of gravelly, silty sand to silty, gravelly sand with nonplastic to low plasticity fines and is commonly referred to as "hardpan."

Glaciomarine drift was deposited in lakes or marine water by a combination of the slow settling of clay and silt particles in quiet waters, and the episodic and variable deposition of clastic debris from melting icebergs. The soils generally consist of poorly graded granular material with a clayey matrix. Glaciomarine drift can be similar in composition to till but is generally much more clayey.

Tertiary bedrock exists at variable depths beneath the project area and is exposed at the ground surface at the two rock knobs located near the south end of the project. The bedrock is part of the Blakely Formation and consists primarily of silty sandstone with some conglomerate.

5.2.3 Project Corridor Geology and Subsurface Conditions

The approximate distribution of geologic deposits and subsurface conditions beneath the project area is presented on the Generalized Subsurface Profile A-A’ shown on Figure 16.

The project corridor is generally underlain by relative soft or loose soils that extend to considerable depths in most places. More competent, glacial soils and bedrock underlie

these less competent soils. The depth to these more competent soils and rocks varies considerably along the corridor and in the vicinity of the project area. The subsurface conditions at the south end of the project area differ significantly from those along the rest of the corridor, in that competent soils and bedrock exist at relatively shallow depths along 14th Avenue S., south of S. Donovan Street, and bedrock exists at the ground surface at two rock knobs located to either side of 14th Avenue S., as shown on Figure 17.

The entire project corridor is underlain by fill to depths of about 7 to 12 feet below the existing ground surface, as shown on Figure 16. The fill encountered in the borings consists of very loose to medium dense, silty sand to gravelly sand with some sandy gravel. The fill was likely placed under a variety of circumstances over time and may vary considerably from that encountered in the borings. In addition to the filling of the abandoned Duwamish channel, most of the area was filled in the early 1900s to raise the grade above high tide level in order to improve conditions for farming and future residential and industrial development.

Much of the fill was likely placed hydraulically during dredging of the waterway. Therefore, the bulk of the fill is likely to consist of fine to medium sand with variable amounts of silt and layers of silt, sandy silt, and clayey silt to silty clay. Scattered to abundant wood debris, cobbles and boulders, and debris from human activity are also likely to exist.

In most places, the fill directly overlies fine-grained organic deposits consisting of organic silt, sandy silt to clayey silt with variable organic material, and peat. These marsh deposits are typically very loose to loose or very soft to soft and were between 1½ and 15 feet thick. These deposits likely include topsoil because the marsh deposits were at the ground surface prior to fill placement.

The marsh deposits are underlain by a relatively thick deposit of alluvium, which is as thick as 75 feet and extends down to elevations of zero to –70 feet. Based on the limited number of deep borings, the depth of the alluvium is greatest at and just to the north of the waterway. The alluvium generally consists of very loose to dense sand, silty sand, and gravelly sand. The relative density of the granular material generally increases with depth. The alluvium also contains seams and layers of finer-grained material, such as silt, clayey silt to silty clay, and organic deposits. These fine-grained deposits may be very soft to soft even at considerable depths.

The alluvium is underlain by generally cohesive estuarine deposits at and just to the north of the waterway. The estuarine deposits consist of very soft, clayey, sandy silt to medium dense, slightly clayey sand with some shells and gravel. The estuarine deposits were encountered in only two relatively close borings and had a thickness of about 13 to 20 feet. The nature and thickness of this material may differ elsewhere along the corridor.

The normally consolidated, nonglacial soils discussed above are underlain by more competent, glacial deposits that have likely been glacially overridden, and rock. These glacial soils consist of very stiff to hard, clayey silt to silty clay with some sand and

gravel (glaciomarine drift) to very dense, silty, gravelly sand to gravelly, silty sand (till). The upper portion of some of these deposits, however, is softer or less dense than typical (possibly weathered), and may not provide adequate bearing. This situation exists for the

Figure 16

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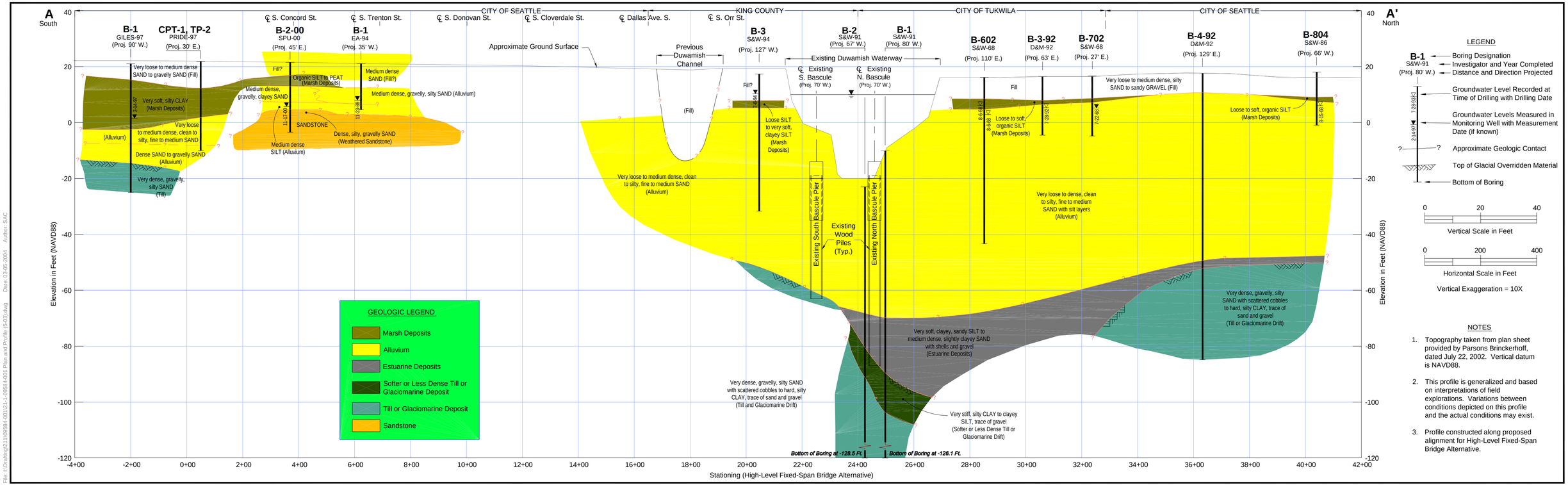

Figure 16

Generalized Subsurface Profile A-A'

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north bascule pier where the piles supporting the pier do not quite reach ground with adequate bearing (see Figure 16).

At the south end of the project corridor, two bedrock knobs rise about 60 to 100 feet (NAVD 88) above the general grade of the floodplain, as indicated on Figure 17. The south end of the proposed roadway improvements lies between the two bedrock knobs, and bedrock was encountered at an approximate depth of 17 feet in one of the borings located at the south end of the project corridor. Bedrock at relatively shallow depths likely exists elsewhere along 14th Avenue S. between S. Donovan Street and S. Henderson Street, but was not encountered in the relatively shallow borings located along that portion of the project.

The rock encountered in the boring and observed in exposures at the site consists of fine-grained, silty sandstone. Some conglomerate has been encountered in borings located away from the corridor. The sandstone likely has unconfined compressive strengths on the order of 1,000 to 7,000 pounds per square inch based on previous Shannon & Wilson studies with measurements on similar rock (Shannon & Wilson, 1999).

5.2.4 Soils

The Soil Conservation Service (SCS) classifies surficial soils based on characteristics that relate to soil development from the weathering of underlying parent material. Such soil classifications can be used, for example, to identify the underlying geologic material.

Soil information was obtained from the Soil Survey, King County Area (SCS, 1952 and 1973). The soil surveys do not include coverage of the project area because the surveys exclude urbanized areas, where soils commonly have been extensively modified. The coverage of the 1973 survey stops about 4 miles south of the site. The 1952 survey, however, extends northward to S. Henderson Street near the Project Action area. Northeast of the waterway, the survey extends northward to within about 300 feet of the city limits of Seattle and includes the land directly east of the bridge.

Based on the 1952 survey, the native soils at the project area, prior to any filling, consist of soils of the Puget Series and Puyallup Series. The Puget Series soils are likely to be silty clay loam, which occupy low, river bottom areas that are commonly inundated by floodwaters in the winter and spring. These soils are derived from finer-grained overbank material deposited during flooding. Both Puyallup silty loam and very fine sandy loam are mapped just south and east of the bridge. Puyallup fine sandy loam is also mapped nearby. These Puyallup Series soils are associated with natural levee deposits along river channels and in the vicinity of the project area lie between the Duwamish and finer-grained Puget Series soils.

The soils covering the bedrock knobs adjacent to the south end of the project area are mapped as Kitsap silt loam. These soils form on fine-grained, glacial lake and similar deposits (silt and clay). At the project area, these soils are likely thin deposits of silt and clay deposited during the last glaciation.

5.2.5 Groundwater Conditions

Groundwater levels in the recent Holocene deposits along the Duwamish Waterway are typically within about 10 to 12 feet of the ground surface at most of the project area, but drop off to as much as 20 feet below the ground surface at the south end of the project area. As the portion of the Duwamish Waterway at the project area is tidally influenced, groundwater in soils along the Duwamish fluctuates in response to the tides. A previous Shannon & Wilson study of the Boeing Plant 2 site, north of the bridge, indicated that the river level in this portion of the Duwamish Waterway is typically about 1 foot above the tide level in Puget Sound at Seattle. The study showed that the tidally related fluctuations at groundwater levels near the South Park Bridge are as much as 11 feet. The magnitudes of the fluctuations decrease away from the waterway and are as little as 4 feet where 16th Avenue S. intersects E. Marginal Way S. Similar magnitudes of groundwater fluctuations and a decrease to the south away from the waterway are expected on the south side of the project area.

5.3 Tectonics and Seismicity

The project area is located in a moderately active tectonic province that has been subjected to numerous earthquakes of low to moderate strength and occasionally to strong shocks during the brief 165-year record history in the Pacific Northwest. The tectonics and seismicity of the region are the result of the relative northeastward subduction of the Juan de Fuca Plate beneath the North American Plate. The convergence of these two plates results not only in east-west compressive strain (Lisowski, 1993), but also in dextral shear (right-hand), clockwise rotation, and north-south compression of the crustal blocks that form the leading edge of the North American Plate. It is estimated that the compression rate for these blocks is about 0.03 to 0.04 inch per year, and much of the compression may be occurring within the more fractured, northern Washington block that underlies the Puget Lowland.

Research suggests that the north-south compression of the block is being accommodated primarily beneath the Lowland by a series of west and northwest-trending thrust faults that extend to depths of about 12 miles. The thrust faults are presumably bounded by strike slip or shear zones on the east at the foot of the Cascade Mountains, and on the west along Hood Canal at the base of the Olympic Mountains.

The largest historic earthquakes that affected the region include the surface wave magnitude (Ms) 7.1 Olympia earthquake of April 13, 1949, the short-period body wave magnitude (m_b) 6.5 Seattle-Tacoma earthquake of April 29, 1965, and the recent February 28, 2001, moment magnitude (M_w) 6.8 Nisqually earthquake. All of these earthquakes resulted in ground shaking with maximum Modified Mercalli Intensities (MMI) of about VII to VIII in the Seattle area. These levels of ground shaking are the maximum vibratory ground motion estimated to have occurred along the project corridor during the 165 years of historical record, and are estimated to correspond to peak ground accelerations (PGAs) between about 0.10 and 0.15g. While actual recorded ground motions from the February 28, 2001, Nisqually earthquake in the vicinity of the project

area were generally in this range, PGA as high as 0.31g were recorded at Seward Park east of the project area, where bedrock is exposed at the ground surface.

Earthquake-induced geologic hazards that may affect any given site include liquefaction and related effects, landsliding, soft-soil ground motion amplification, and fault surface rupture. These earthquake-induced geologic hazards are discussed in the following section.

5.4 Geologic Hazards and Critical Areas

The regulated critical or sensitive areas, as defined by the various jurisdictions in the vicinity of the project area, are shown on Figure 17. The Critical Area and geological hazards are discussed below.

5.4.1 Faulting

The project area is located within the Seattle Fault zone, which cnsists of four or more east-west-trending faults that coalesce at depth to a master, south-dipping fault. This thrust fault zone, located just south of downtown Seattle (see Figure 18), is approximately 4 to 6 kilometers (2.5 to 4 miles) wide (north-south) and extends from the west end of the Kitsap Peninsula near Hood Canal, eastward to the Sammamish Plateau east of Lake Sammamish. The locations of the fault splays are largely determined from overwater seismic reflection profiles (Johnson et al., 1999) and high-resolution aeromagnetic surveys (Blakely et al., 2002), with some recent fault trenching studies by the U.S. Geological Survey (USGS) on the west side of Puget Sound on Bainbridge Island and the Kitsap Peninsula and on the east side of Puget Sound near the south end of Lake Sammamish. In most areas of Seattle and vicinity, fault splay locations have been extrapolated and are not precisely known. A southern splay of the Seattle Fault zone is shown approximately one-half mile south of the existing bridge (see Figure 18) on the recent published Geologic Map of Washington – Northwest Quadrant (Dragovich et al., 2002).

Recent geologic evidence indicates that ground surface rupture from movement on this fault zone occurred as recently as 1,100 years before present (BP). Preliminary estimates of recurrence rates for the Seattle Fault are on the order of thousands of years. In developing regional probabilistic ground motion maps (Frankel et al., 1996), the USGS assumed recurrence rates for large earthquakes on this fault on the order of 3,000 to 5,000 years with a slip rate of about 0.02 inch per year. However, more-recent research (Johnson et al., 1999) indicates that slip rate may be between 0.03 inch and 0.04 inch per year. Earthquake magnitudes up to 7.7 (Pratt et al., 1997) have been postulated for movement on this fault.

5.4.2 Liquefaction

Soil liquefaction is a phenomena in which pore pressure in loose, saturated, granular soils increases during ground shaking to a level near the initial effective stress, thus resulting

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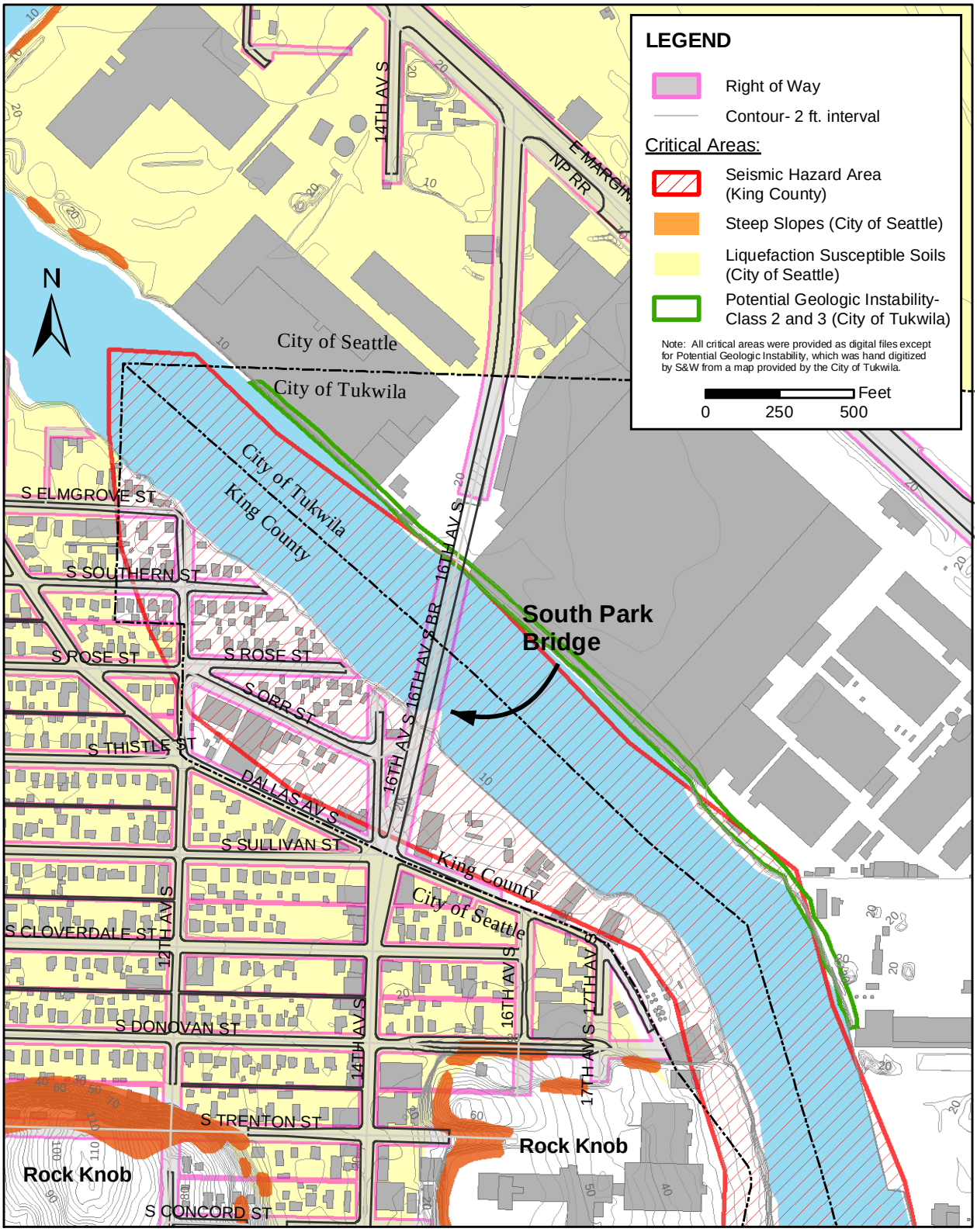

Figure 17

Critical Areas Map

Figure 18

Fault Location Map

in a reduction of shear strength of the soil (a quicksand-like condition). As a result of this reduction in shear strength during liquefaction, ground settlement, lateral spreading (ground movement on very gentle slopes) and landsliding may occur. Due to the reduced soil strengths, vertical and lateral foundation resistance may also be significantly reduced.

Liquefaction hazard mapping studies for the greater Seattle-Tacoma region identify alluvium and non-engineered fills as having moderate to high liquefaction susceptibilities (Grant et al, 1992; Palmer, 1992; and Shannon & Wilson, Inc., 1993)

The 1998 Load and Resistance Factor Design (LRFD) Bridge Design Specifications, as outlined by the American Association of State Highway and Transportation Officials (AASHTO), indicates that the bridge design and evaluation should be based on earthquake ground motions with a 10 percent chance of exceedance in 50 years (475-year return period). The USGS indicates that for a recurrence interval of 475 years, the site peak ground acceleration (PGA) is 0.33g (Frankel et al., 1996).

The previous subsurface explorations along the project corridor confirm the presence of potentially liquefiable alluvial and non-engineered fill soils. For 475-year-return-period ground motions and based on available subsurface data, we estimate that potentially liquefiable deposits could extend to an approximate depth of 35 feet within as well as south of the Duwamish Waterway. North of the waterway, these deposits could extend to an approximate depth of 50 feet. These estimated depths of potentially liquefiable deposits are in general agreement with the results of previous liquefaction studies of the project area performed by PanGeo (PanGeo, 2001) and by Shannon & Wilson (Shannon & Wilson, 1994 and 1991).

After the Nisqually earthquake that occurred in February 2001, evidence of liquefaction, such as ground settlement, sand boils, and surface cracking, was observed on the south side of the Duwamish Waterway, along the south approach of the South Park Bridge. The observed ground surface cracks were generally oriented parallel to the waterway bank, which may indicate that some lateral spreading may have occurred as a result of liquefaction. Such lateral spreading could have induced undesirable lateral loads on the existing pile foundations supporting bridge piers and bascules. The Nisqually earthquake also caused significant damage to the bridge structure. The movable span was rendered inoperable and had to be repaired; two bents along the south approach had to be underpinned and grout had to be injected to fill voids that had developed in the south approach embankment fill.

5.4.3 Slope Stability

Areas of potential slope instability observed within the project area were on the steep south and north banks of the Duwamish Waterway. In the proximity of the bridge, the steeper slopes bordering the waterway are typically on the order of 1½ horizontal to 1 vertical (1½ H:1V) but are as steep as ½ H:1V in places. These slopes have been protected with riprap or have been constructed with concrete rubble and are about 6 to 8

vertical feet in height. Most of these slopes appear stable under static condition, but some areas may be susceptible to failure. Liquefaction during a large earthquake could cause instability and potentially widespread ground movement along the waterway.

5.4.4 Soft-Soil Ground Motion Amplification

The type of near-surface soils can affect the level of earthquake ground shaking in an area. Amplification of the ground motion at various frequencies may occur for areas underlain by extensive deposits of relatively soft, cohesive soils. While the Holocene geologic units in the project area include cohesive soils (silt, clay, peat), these soils are typically medium stiff or stiffer and less than 20 feet thick. Consequently, high soft-soil ground motion amplification is not expected in the project area.

5.5 Critical Area Designations

Portions of the project area lie in unincorporated King County and in the cities of Seattle and Tukwila, each having its own regulated environmental critical or sensitive areas. Therefore, different portions of the project area fall within different critical areas. However, most of the critical area designations would apply to the entire corridor if each jurisdiction's regulations applied to the entire corridor.

The soils-related sensitive areas designations of the King County Sensitive Area Ordinance (SAO) consist of landslide, erosional, and seismic hazard areas. The SAO maps do not include incorporated areas of the county and, therefore, do not include portions of the project area that lie within the cities of Seattle or Tukwila. The portion of the project area that is in King County is designated as a seismic hazard area.

The City of Seattle has Environmentally Critical Areas. The areas of the project within Seattle city limits, at the north and south ends of the project corridor, are designated liquefaction-prone areas. Small areas along the sides of the two rock knobs at the south end of the project area and along the Duwamish Waterway away from the project area are designated steep slopes (slopes greater than 40 percent).

Per City of Tukwila Sensitive Areas maps, several areas along the alignment are designated as Areas of Potential Geologic Instability. These areas are steep slopes located along the north bank of the waterway and are designated as class 2 and 3 areas, where landslide potential is moderate to high. Although not mapped as such, the Areas of Potential Geologic Instability could include the entire project area within Tukwila because it is an area of potential seismic instability. Areas of potential seismic instability are those areas having soft soils or loose sand and a shallow groundwater table.

Because of critical or sensitive designations, the project will likely require exceptions, partial exemptions, or variances from the various jurisdictions. These procedures will likely require geotechnical studies that address potential impacts and design of the project to reduce impacts and the implementation of mitigation measures.

5.6 Unique Physical Features

Unique physical features within the project area are the Duwamish Waterway and the low bedrock knobs at the south end of the area. Both of these features are described in Sections 5.1 and 5.2.3, respectively. Otherwise, the Proposed Action area is located on relatively flat ground.

5.7 Staging Areas

Staging areas are locations that would be temporarily utilized during project construction and include sites for construction and staging. The proposed locations of construction and staging areas are shown on Figure 14. These sites include two temporary docks to be utilized during construction of the Rehabilitation and replacement alternatives and are located immediately downstream of the proposed bridge alternatives on either side of the waterway.

Also, two potential staging areas for project construction have been identified. These staging areas are located on either side of the waterway, one landward of each of the two temporary docks. The staging areas would be utilized for storage of equipment and material, and assembly of structural or temporary support components.

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This chapter discusses possible direct, secondary, and cumulative impacts to the soils- and geology-related aspects of the environment that could result from the proposed actions. These impacts would be related to the effect of the operation and/or construction of new or rehabilitated structures proposed in the project alternatives on the existing features in the project area. These impacts include those related to construction activities for removal of the existing structure.

Based on an alternative development and screening study performed by Parsons Brinckerhoff, Inc. (PB), five project alternatives were selected for environmental review. The five proposed project alternatives include a No Action Alternative, a Rehabilitation Alternative, and three replacement bridge alternatives (Bascule, Mid-Level Fixed-Span, and High-Level Fixed-Span bridge alternatives).

The No Action Alternative assumes that the existing bridge would be closed, demolished, and removed at some time in the future. For the Rehabilitation Alternative, the existing bridge would remain in place. Its structural components would be reinforced or replaced and the equipment used to operate the bridge would be refurbished or replaced. The new bridge for all three replacement alternatives would follow the same horizontal alignment to be located approximately 80 feet, center-to-center, west (downstream) of the existing bridge.

Considering the close proximity of the proposed horizontal alignments for the Rehabilitation Alternative and three replacement bridge alternatives, impacts related to these alternatives are anticipated to be similar. The magnitude of impacts is likely to be greater, however, with increasing area of construction and disturbance. The extent of construction for each alternative is indicated on Figure 14.

6.1 Operation Direct Impacts

6.1.1 General

Long-term soils- and geology-related impacts could occur during normal operations of the South Park Bridge. For the No Action Alternative, the only operation impacts would be related to the new fill that would be placed after removal of structural elements of the existing bridge. The three replacement alternatives would have the same operation impact because they also would require removal of the existing bridge after the construction of the new bridge is complete.

The Rehabilitation and replacement alternatives would be designed based on the available subsurface information, design procedures and criteria approved by KCDOT, and the existing site conditions. If subsurface conditions at the site are different from those disclosed during the field explorations, or site conditions change during the life of the

project, future impacts to the site could occur. As discussed in Section 5.4.2, the Rehabilitation and replacement alternatives would be designed for a soft rock peak ground acceleration (PGA) of 0.33g. However, if an earthquake occurs that results in a higher site PGA than 0.33g, site structures may be impacted.

Operation impacts are discussed in the following sections.

6.1.2 Seismic Considerations

The project area crosses recent fill and Holocene deposits that are susceptible to liquefaction and associated effects. The effects of liquefaction may include loss of bearing capacity for shallow foundations, reduction in lateral and vertical capacities of deep foundations, ground surface settlements, lateral spreading and embankment instability or slumping.

Considering the current structural state of the existing bridge, and the fact that the existing timber piles supporting its north pier are likely bearing within the Holocene deposits, the effects of liquefaction could have the most impact on the No Action Alternative.

6.1.3 Bridge

Stabilizing the existing bascule piers as proposed under the Rehabilitation Alternative and constructing the new bridge structures included in the three replacement alternatives would involve installing deep foundations that bear in the underlying glacial deposits and/or bedrock. No soils- or geology-related direct impacts are anticipated for the Rehabilitation and replacement alternatives. For the No Action Alternative, prior to removal of the existing bridge, the existing timber piles supporting the bridge, especially the piles supporting the north bascule pier, may experience additional settlement resulting in additional damage to the existing bridge structure.

6.1.4 New Fill

Widening existing approaches for the Rehabilitation Alternative and new approaches for the replacement alternatives would require as much as 15 feet of structural fill. Because of the limited right-of-way, retaining walls are under consideration to retain the fills needed for construction of the north and south approaches of the project. For the No Action Alternative and the three replacement alternatives, new fill would be required to backfill areas where the structural elements of the existing bridge would be removed.

As discussed previously, soft Holocene deposits are present along some sections of the project corridor. In these sections, the new fill could cause settlements on the order of 4 to 6 inches during the first few years after construction resulting in pavement distress, drainage problems, and other roadway problems. In areas where peat and soil deposits containing numerous organics are present, an additional secondary compression could result in long-term ongoing settlement problems. The secondary compression could be

on the order of 0.5 to 1.5 inches. If utilities are located near or beneath the proposed fills, settlement of these utilities could occur resulting in possible damage to them.

6.1.5 Permanent Drainage

Increased impervious surface area resulting from the Rehabilitation and replacement alternatives will result in increased water flow to the existing stormwater system. For further discussion of impacts resulting from increased flow, refer to the Water Resources Technical Report.

6.2 Construction Activity Direct Impacts

6.2.1 General

Construction activity impacts differ from the operation impacts discussed in the previous section in that the duration of the impact takes place during construction or within a short period of time after construction. Construction impacts do not exist in the long term. For the No Action and replacement alternatives, construction activities would include removal of existing bridge and fill placement in areas occupied by the bridge. For the rehabilitation and replacement alternatives, the anticipated construction activities include fill placement, retaining walls, and bridges. The construction activities for the project alternatives would result in short-term soils and geology related impacts to the project area. These construction impacts are discussed in the following sections.

6.2.2 Erosion and Sediment Control

Construction of the project alternatives would require land clearing, grubbing, removal of topsoil, and other site preparation work. Since the project area is located mostly within the existing bridge alignment, the construction would create fewer impacts to the environment than those that occurred during the original grading and construction of the existing South Park Bridge. The areas beneath the proposed fills and structures that have not already been cleared during construction of the original bridge would be cleared and grubbed of all vegetation and debris and stripped of all organic topsoil. The area of land needing to be cleared is expected to be small. The debris resulting from clearing and stripping would be removed from the project area or stockpiled for later use in landscaped areas. This material would not be suitable for reuse as structural fill because of the high organic content.

The prepared ground surface would have high erosion potential if exposed during the rainy season or in the presence of surface water. Any areas that are disturbed during construction would be subject to increased erosion if proper control measures were not incorporated into the design. The surface water flow across exposed soil would remove sediment and deposit it in downslope areas. The amount of erosion and sedimentation would depend on the amount of soil exposed and/or disturbed, weather conditions, and/or groundwater conditions, and the erosion control measures implemented. The surface soil

could erode and drain into stormwater drains, into existing culverts, and/or onto adjacent properties or streets.

Within construction areas, the tires and tracks of heavy equipment may sink into the soft surface soil if no work pad is present. The tires of the construction vehicles could also carry soil onto roadways when leaving construction areas.

6.2.3 Fill Embankments

Fill embankments constructed over the recent Holocene deposits could experience settlement. Settlement of fill embankments for approaches could impact underlying and adjacent utilities or structures as well as walls or structures constructed on the fill embankment.

6.2.4 Deep Foundations

Because of the depth of loose/soft soils and the anticipated bridge loads, deep foundations would be required to support the new bridge structures for the Rehabilitation and replacement alternatives. Deep foundations would also be required to support the temporary dock required during construction. Drilled shafts are proposed to support the new bridge structures. Impacts associated with these foundation types are discussed below.

Drilled shafts could be installed with equipment that causes relatively little vibration. Because of the depth of soft soil at the site, open-hole excavation methods would be difficult. Caving or sloughing of soil within the open-hole excavations could impact adjacent structures and buried utilities.

A temporary dock would be used for construction within the river for rehabilitation and replacement alternatives. Driven steel piles are proposed for the temporary dock. Pile driving for construction of the temporary dock would result in noise and vibration impacts to the project area and vicinity. The vibration caused by driving the piles through the soils at the site could impact existing facilities located within around 50 feet of the driving operations. These impacts could consist of settlement, cracking of pavements or structures, and/or slope failures. Piles driven to support the temporary dock would be cut off at mudline level after bridge rehabilitation or replacement is completed.

For the Rehabilitation and Bascule Bridge Alternatives, a cofferdam would be required for construction of the cap around the new foundation. Depending on the extent of fine sediments encountered and disturbed during in-river construction for cofferdam and temporary dock related work, water quality of the Duwamish Waterway could be temporarily degraded.

6.2.5 Drainage in Construction Areas

During construction, poor drainage practices could result in drainage of surface water onto unstable slopes. This could result in slope instability of the riverbank, erosion, or other adverse impacts to adjacent properties.

6.2.6 Pavements

Construction traffic may cause settlement, potholes, cracks or other distress to existing adjacent roadways that were not designed for loads of heavy construction equipment.

6.2.7 Staging Areas

Driven steel piles are proposed for the temporary dock. Pile driving for construction of the temporary docks would result in noise and vibration impacts to the project area and vicinity. The vibration caused by driving the piles through the soils at the site could impact existing facilities located within around 50 feet of the driving operations. These impacts could consist of settlement, cracking of pavements or structures, and/or slope failures. The temporary dock piles would be cut off at mudline after bridge rehabilitation or replacement is complete.

Poor drainage practices at either the temporary docks or staging areas located adjacent to the waterway could result in drainage of surface water onto unstable slopes. This could result in slope instability of the riverbank, erosion, or other adverse impacts to adjacent properties.

6.3 Secondary and Cumulative Impacts

6.3.1 Secondary Impacts

Secondary impacts are defined as impacts that are "caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable" (40 CFR 1508.8). These impacts, which usually result from the initial action, include changes in land use, water quality, social issues, and population density.

No adverse soils-related, secondary impacts of the no-action alternative are anticipated.

Sediment from erosion or slope instability of the riverbank could be discharged into existing drainage features for the rehabilitation or replacement alternatives. Also, construction traffic and operations could affect existing adjacent roadways.

Impacts associated with hazardous material and proposed river sediment cap are discussed in the Hazardous Waste Technical Report.

6.3.2 Cumulative Impacts

Cumulative impacts are those that "result from incremental consequences of an action when added to other past and reasonably foreseeable future actions." The cumulative effects of an action may be undetectable when viewed in the individual context of direct, and even indirect impacts but can, nonetheless, add to other disturbances and eventually lead to a measurable environmental change.

Cumulative impacts are not anticipated for the no-action alternative.

The planned or ongoing neighboring projects that could contribute to anticipated cumulative impacts include:

1. Duwamish Sediment Remediation/Cap: As part of the Boeing Plant 2 Resource and Conservation Recover Act (RCRA) project, the Boeing Company is expected to implement a sediment cap in the project vicinity. The sediment cap is designed to improve water quality in the Duwamish Waterway.

2. Duwamish Dredging: The Army Corps of Engineers performs periodic dredging of the Duwamish Waterway as corrective action intended to maintain the navigability of the channel.

3. Lower Duwamish Waterway (LDW) Superfund Cleanup: Since 2000, the Environmental Protection Agency (EPA) has begun to oversee cleanup actions within the LDW Superfund site. If cleanup activities proceed as planned, the cleanup actions for the waterway are anticipated to finish in 2004.

4. Riverfront Improvements: Specific information regarding the proposed improvements is not known at this time.

5. Planned Street Improvement: Specific information regarding the proposed improvements is not known at this time.

Based on available information, no adverse cumulative impacts are anticipated with these projects and the South Park Bridge project. Coordination should be performed with adjacent projects. The effects of cumulative impacts should be evaluated and design and construction procedures altered where necessary.

Impacts associated with hazardous material and proposed river sediment cap are discussed in the Hazardous Waste Technical Report.

Chapter 7 Mitigation

Chapter 7 discusses possible measures that would be undertaken to mitigate the possible impacts of the proposed project alternatives as discussed in Chapter 6. These measures include mitigation of operation and construction direct impacts as well as mitigation of secondary and cumulative impacts.

7.1 Mitigation for Operation Direct Impacts

7.1.1 General

Mitigation measures for the operation direct impacts of the proposed project alternatives are based on the site information and standard design and construction procedures in use at the time of this report. All operation direct impacts discussed could be mitigated, as discussed in the following sections. The soils- and geology-related features for the proposed project alternatives would be evaluated by an experienced geotechnical engineer who would provide appropriate design recommendations considering the subsurface conditions in the project area as disclosed by the field explorations. These design recommendations would take into account the operation direct impacts of the proposed project alternatives and provide for adequate mitigation for these impacts unless otherwise directed by KCDOT.

As stated previously, the Rehabilitation and replacement alternatives would be designed based on the available subsurface information, design procedures and criteria approved by KCDOT, and the existing site conditions. To adequately define subsurface conditions for the features included in the Rehabilitation and replacement alternatives, additional subsurface data should be collected. In general, a geotechnical investigation should be completed to support the preliminary design of the project alternative. Subsurface information should be obtained at a minimum spacing of 200 feet along the proposed alignment of the selected preferred alternative to provide adequate subsurface information for design studies. This would partially mitigate the potential of unknown subsurface conditions affecting the construction or life of the project alternative.

Adequate subsurface information would help better evaluate potential of liquefaction and its extent, which allows for a better design of measures to mitigate liquefaction and lateral spreading along the project corridor. Adequate subsurface information would also help develop better evaluation of the axial and lateral capacities of the foundations to support the rehabilitated or replaced bride piers, allowing more appropriate sizing of these foundations. It would also allow for the determination of better settlement estimates of the bridge foundations and embankment fills and thus provide more appropriate measures to mitigate the settlements.

7.1.2 Seismic Considerations

The Project Activity features should be designed considering the seismicity of the site and AASHTO criteria, presented in the Sixteenth Edition of AASHTO Code (1996), for seismic design. A site-specific response spectrum could be developed for structural design, as the Soil Profile Types in the AASHTO code do not specifically characterize the actual subsurface conditions at the site. A site-specific response spectrum will require development of a subsurface soil model and appropriate earthquake time histories to run through the model. Shear wave velocity measurements of the subsurface soils at the site should be made, and the dynamic soil properties used in the model should be based on these measurements. Earthquake time histories to run through the model should be consistent with ground motion parameters and seismic hazard deaggregation from USGS regional probabilistic ground motion studies for ground motion risk levels consistent with AASHTO criteria.

Potential liquefaction of Holocene deposits could be mitigated using ground improvements. Soil improvement techniques may include densification by vibration (e.g., deep dynamic compaction, vibratory probe); densification by displacement and reinforcement (e.g., vibro-replacement stone columns, compaction grouting); grouting and admixtures (e.g., jet grouting, deep mixing); and vibration and drainage (e.g., earthquake drains). Selection of the appropriate ground improvement techniques depend upon a number of issues including the soil type (especially fines content), level of improvement required, area and depth to be improved, settlement potential of the ground surface, proximity of adjacent existing structures, and cost. In the vicinity of the project site, a number of ground improvement projects have used compaction grouting or stone columns. Due to concern regarding the affect of vibrations during installation of stone columns on the existing bridge, this technique may not be appropriate for this project.

Therefore, earthquake drains or compaction grouting could be the most feasible ground improvement technique for the project site. These ground improvement techniques also generate little, if any, spoils when installed. This additional benefit would significantly reduce the potential for removal of contaminated spoils during installation. Preconstruction surveys of existing structures within about 50 feet of ground improvement installation and continuous survey monitoring during installation would be required, depending on the potential for surface ground settlement and movement from the selected ground improvement technique. If the extent of ground improvements is significant, grouting and admixtures method (e.g., jet grouting and deep soil mixing) would also be appropriate for this project. These methods generally have higher mobilization costs.

Earthquake Drains are large-flow capacity vertical drains (typically 3 to 8 inches in diameter) wrapped with a geotextile filter fabric. Typical spacing of Earthquake Drains ranges from about 3 to 6 feet on centers. They are typically installed by inserting a tubular steel mandrel containing the drain into the ground, using static force and large vibration. Once the design depth is reached, the mandrel is withdrawn, leaving the Earthquake Drain in place. While the vibration during installation provides some densification of the soils surrounding the drain, the primary function of the drain is to

provide a path for rapid dissipation of excess pore pressures that may develop in the soil as a result of earthquake ground shaking. For this project, where vibrations would be detrimental to the existing bridge and other adjacent structures, Earthquake Drains can be installed with drilling equipment or static crowd. Provided that the Earthquake Drains are properly designed and installed to prevent liquefaction under the design earthquake ground motions, the drains should effectively preclude liquefaction-induced lateral spreading in the improved ground areas and reduce potential settlements.

Compaction grouting is the controlled, high-pressure injection of a low-slump grout into a soil to create a bulb of grout that displaces and compacts or densifies the surrounding soils. The grout is injected into the ground typically by installation (drilling and/or pushing) a series of 3- to 4-inch-diameter steel grout pipes into the ground. The grout pipe is typically installed to the bottom of the zone of soil identified for improvement. Once the grout pipe is installed to the pre-determined depth, the pipe is pulled back up towards the ground surface a few inches to dislodge a sacrificial tip at the end of the grout pipe that kept soil from entering the grout pipe during installation. The grout is then pumped under pressure to develop a bulb of grout around the tip of the pipe that displaces and densifies the surrounding soil. The grout pipe is pulled back towards the ground surface as the grouting occurs to provide a continuous grout column. To develop an areal zone of improved ground, compaction grout columns are typically installed in a sequenced, square or triangular pattern about 6 to 10 feet on center.

7.1.3 Bridge

No mitigation is proposed.

7.1.4 New Fill

Due to right-of-way issues, retaining walls would be required to retain new fill for the approaches for the Rehabilitation and replacement alternatives. In order to tolerate settlements at the site, the proposed approach walls could consist of Mechanically Stabilized Earth (MSE).

Undesirable settlement due to new fill to be used for constructing approaches and for backfilling areas currently occupied by the existing bridge could be reduced by using lightweight fill. Lightweight fill material would reduce additional vertical stress on underlying compressible soils. Lightweight fill material, such as Expanded Styrofoam (EPS) blocks or air-entrained concrete, are typically benign products and can support most load demands with correct design and installation.

Undesirable settlement due to secondary compression of peat and organic soils could be mitigated by removing and replacing the unsuitable soils and/or by performing ground improvements. Existing utilities located beneath or near proposed new fill may be relocated if load and settlements would cause damage to the utilities.

7.1.5 Permanent Drainage

Permanent drainage facilities for slopes, walls, fills, etc., should be designed for the capacities anticipated. Vaults may be required in some areas to reduce sediment loads of the drainage water. All permanent drainage systems should be installed so that water does not overflow and/or is not directed onto slopes or other areas that may be sensitive to erosion or landsliding. Mitigation of impacts for stormwater runoff are further discussed in the Water Quality Technical Report.

7.2 Mitigation for Construction Activity Direct Impacts

7.2.1 General

The Proposed Action would be constructed in accordance with KCDOT guidelines. The following sections address the mitigation for each of the construction impacts discussed in the previous section.

7.2.2 Erosion and Sediment Transport

Construction best management practices (BMPs), such as construction staging barrier berms, filter fabric fences, temporary sediment detention basins, and use of slope coverings to contain sediment onsite, would be effective in protecting water resources and reducing erosion from areas with cuts, fills, and/or excavations. Erosion control measures suitable to the site conditions would be included as part of the project alternatives design. Temporary erosion and sediment control plans would be prepared for approval in accordance with BMPs included in the current WSDOT Highway Runoff Manual. Erosion control measures would include vegetative and structural controls. Other controls that could be implemented include restriction of work activities to the dry season and limiting access to the site.

Vegetative Controls

Areas disturbed during construction, that will not be paved or otherwise permanently covered, would be revegetated to minimize erosion. Revegetation methods would include covering cleared or graded areas and excavation or embankment slopes with jute or other netting as well as mulching or hydroseeding, as appropriate to minimize erosion and encourage revegetation.

Structural Controls

Structural controls consist of artificial means of preventing sediment from leaving the construction area. Parking and staging areas for vehicles and equipment could be covered with a gravel work pad where appropriate to prevent the disturbance and erosion of the underlying soil. Silt fences would be placed around disturbed areas to filter sediment from unconcentrated surface-water runoff. Straw bales would be placed in

paths of concentrated runoff to filter sediment. Temporary ditches, berms, and sedimentation ponds would be constructed to collect runoff so that entrained sediment could settle out of the water prior to being released into the stormwater system or the Duwamish Waterway. Cleaning tires and tracks on heavy equipment before they leave the site would also help retain sediment on site. In addition, truck loads should be covered to mitigate sediment deposit onto roadways.

Stormwater Treatment

Proposed mitigation measures would comply with temporary stormwater design and treatment procedures based on the current version of the WSDOT Highway Runoff Manual. Such procedures follow the National Pollutant Discharge Elimination System (NPDES) guidelines administered by the Department of Ecology. The stormwater design would also satisfy King County's management plans. The WSDOT guidelines require approval of a Stormwater Site Plan and a Temporary Erosion Sediment Control Plan (TESC) prior to construction. The erosion and sediment control measures would be in place before any demolition, clearing, grading or construction.

7.2.3 Fill Embankments

In order to tolerate anticipated settlements, MSE wall systems would be used to retain the fill. Lightweight fill material could also be used to reduce additional vertical stress on underlying compressible soils. Where lightweight fill is used, the structures should be monitored for vertical settlement at regular intervals during the construction period.

7.2.4 Deep Foundations

Drilled shafts would be used to support the new Rehabilitation or replacement bridge. To mitigate potential caving of the soil in the excavated holes, casing would be used in the upper, unstable soils. Following installation of the drilled shaft, the casing would be removed and areas around the concrete shaft grouted to remove potential voids. To minimize migration of potentially contaminated material, the drilled shaft casing could be left in place and cut off above the mud line. Issues associated with hazardous material are discussed in the Hazardous Waste Technical Report. Drilled shafts would reduce the quantity of contaminated spoils that would require additional expenses for handling and disposal. Contamination is generally concentrated and most severe in the upper 10 to 20 feet of the surface above the groundwater table or mudline. While driven piles would not generate significant spoils, excavation of the pile cap for the bridge foundation would result in significantly greater volume of potentially contaminated spoils than the drilled shafts.

Adequate drainage from all excavation should be provided to further mitigate soil instability and erosion.

Driven piles would be used to support the temporary docks. To mitigate noise and vibration, low vibration and noise pile-driving equipment could be selected.

Alternatively, non-displacement piles could be selected to support the temporary dock, which would result in lower vibrations. Predrilling prior to pile driving could also reduce vibration levels. Predrilling would generate spoils that are potentially contaminated and may require casing as discussed in the drilled shaft support above. If temporary casing is used during shaft construction, the pulled casing should be cleaned of potentially contaminated soil and water that may adhere to the casing. Preconstruction surveys of existing structures located within about 50 feet of pile driving and vibration monitoring during pile driving would be required to monitor and mitigate potential damage to adjacent sensitive structures and/or utilities. Monitoring of these instruments before and during construction would identify if any adverse impacts were being experienced by these structures/utilities. Mitigation of noise due to pile driving is discussed further in the Noise Technical Report.

By implementing proper construction methods during cofferdam and/or temporary dock construction within the Duwamish Waterway, the risk of sediments entering the surrounding waters would be substantially reduced.

Construction BMPs, such as those discussed in Section 7.2.2, would be effective in protecting water resources and reducing erosion or landsliding of steep slope areas. Drainage water from temporary construction or staging areas should be directed into suitable drainage features. No water should be allowed to drain out over existing slopes or into adjacent excavations or subgrade areas for fill and/or pavement. Additional discussions on mitigation measures to protect water resources are presented in the Water Resources Technical Report.

7.2.5 Drainage in Construction Areas

All fill and pavement areas should be sloped to drain away from construction areas to prevent ponding of water and softening of subgrade soils. Drainage water from construction areas should be directed into suitable drainage features. No water should be allowed to drain out over existing slopes, into excavations, or onto subgrade areas for fill and/or pavement.

7.2.6 Pavements

Soft subgrades identified beneath existing roadways should be removed and replaced with structural fill. Portions of existing roadways identified with inadequate pavement sections to handle construction traffic should be removed and replaced with a pavement section of appropriate thickness.

7.2.7 Staging Areas

Driven piles would be used to support the temporary docks. To mitigate noise and vibration, low vibration and noise pile-driving equipment could be selected. Alternatively, non-displacement piles could be selected to support the temporary dock, which would result in lower vibrations. Predrilling prior to pile driving could also reduce

vibration levels. Preconstruction surveys of existing structures located within about 50 feet of pile driving and vibration monitoring during pile driving would be required to monitor and mitigate potential damage to adjacent sensitive structures and/or utilities. Monitoring of these instruments before and during construction would identify if any adverse impacts were being experienced by these structures/utilities. Mitigation of noise due to pile driving is discussed further in the Noise Technical Report.

By implementing proper construction methods during temporary dock construction within the Duwamish Waterway, the risk of sediments entering the surrounding waters would be substantially reduced. Construction BMPs, such as those discussed in Section 7.2.2, would be effective in protecting water resources and reducing erosion or landsliding of steep slope areas. Drainage water from temporary construction or staging areas should be directed into suitable drainage features. No water should be allowed to drain out over existing slopes or into adjacent excavations or subgrade areas for fill and/or pavement.

7.3 Mitigation for Secondary and Cumulative Impacts

7.3.1 Mitigation for Secondary Impacts

Mitigation measures described under “Structural Controls” in Section 7.2.2 could be used to mitigate the secondary impacts described in Section 6.3.1.

7.3.2 Mitigation for Cumulative Impacts

No cumulative impacts from the South Park Bridge Project are anticipated. However, coordination should be performed between the Proposed Action and neighboring projects that may be under construction within the same general time period.

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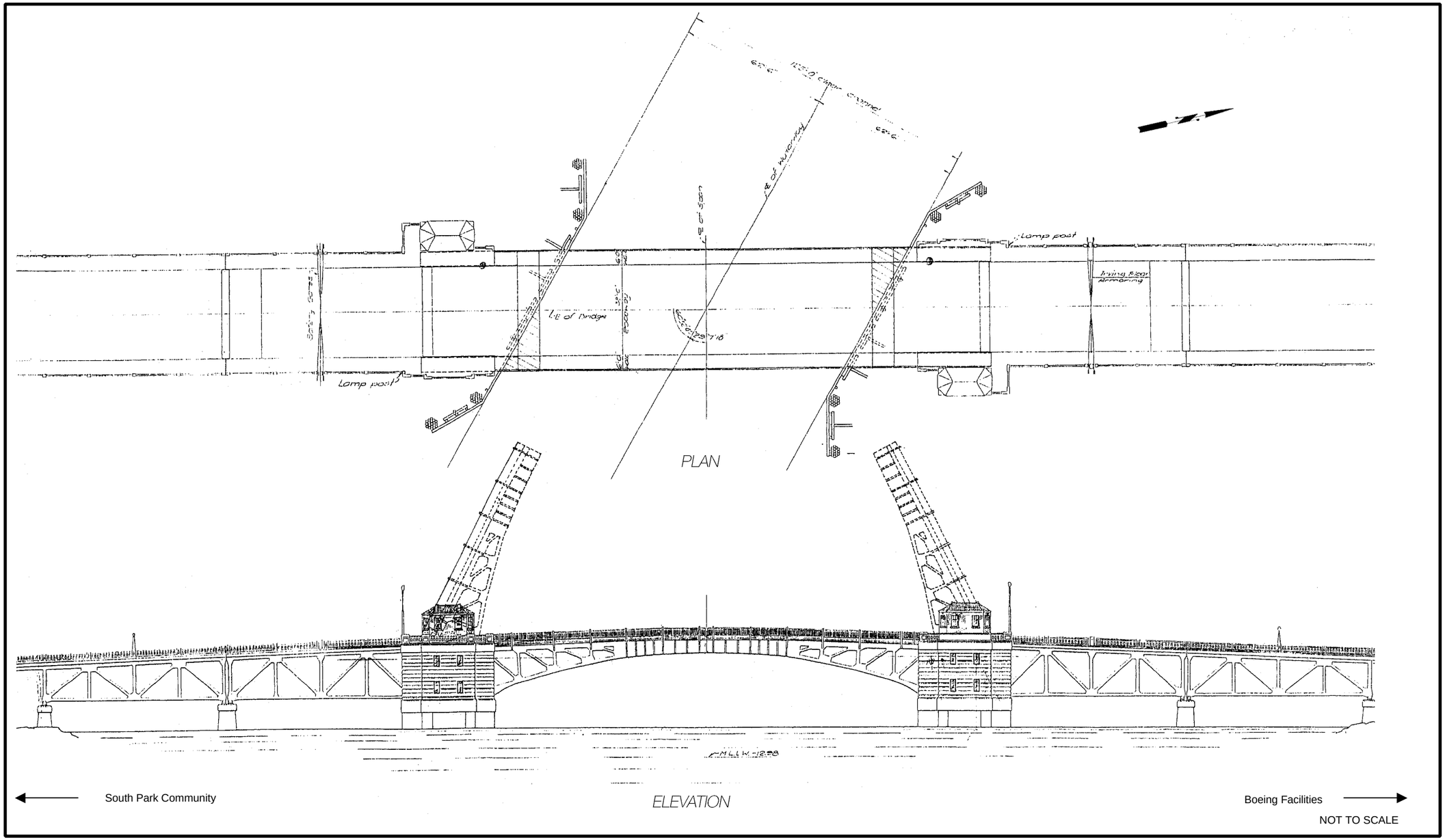


Figure 2

Existing South Park Bridge

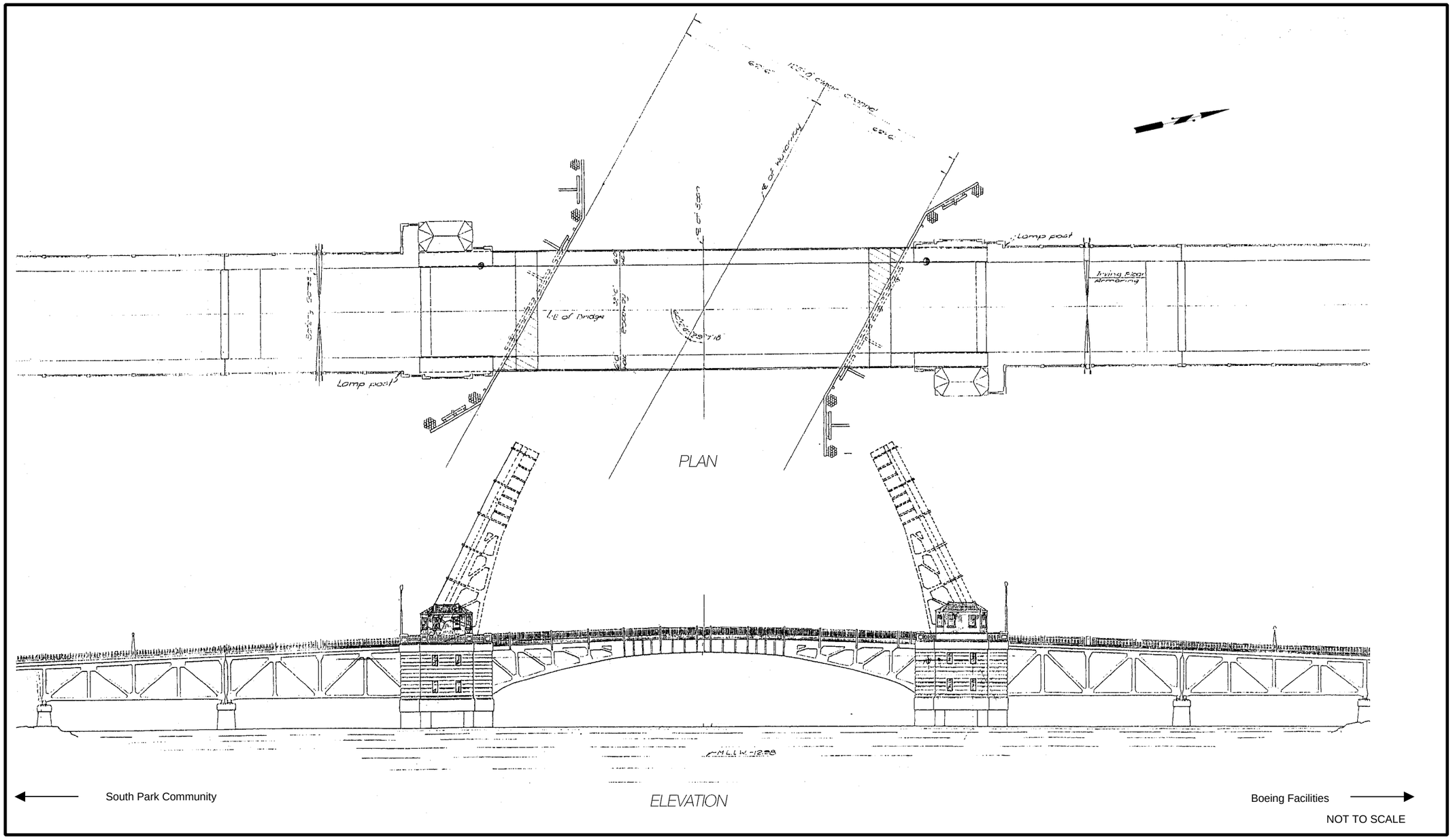
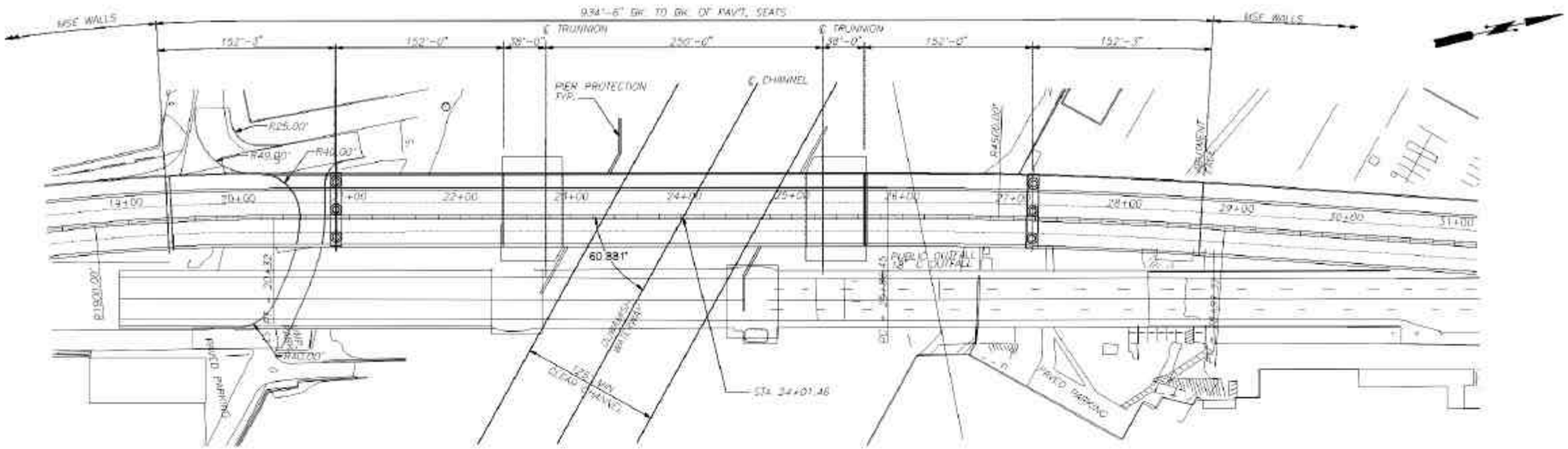
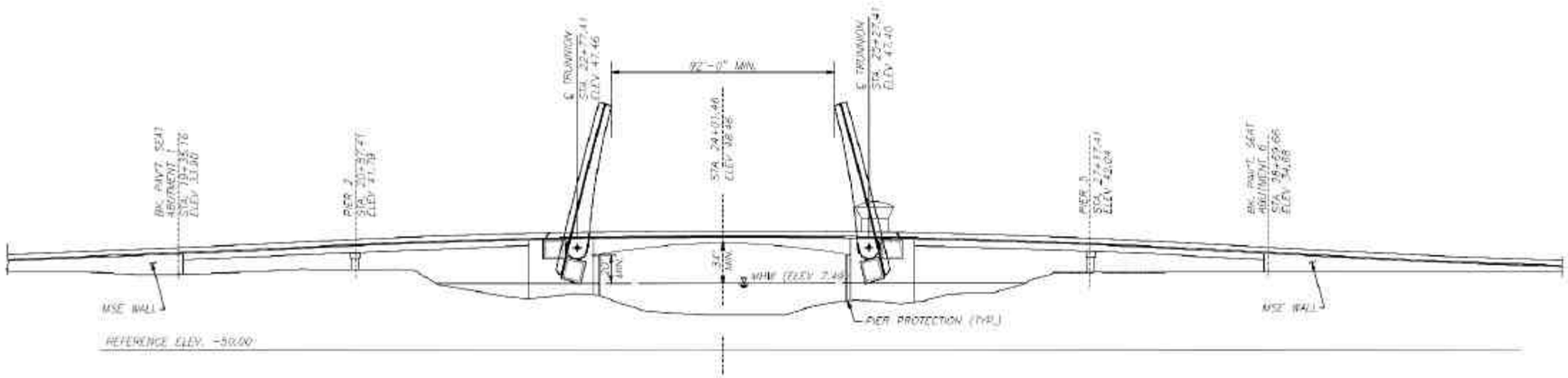


Figure 6

Rehabilitation Alternative



PLAN



South Park Community

ELEVATION

Boeing Facilities

NOT TO SCALE

Figure 9

Bascule Bridge Alternative

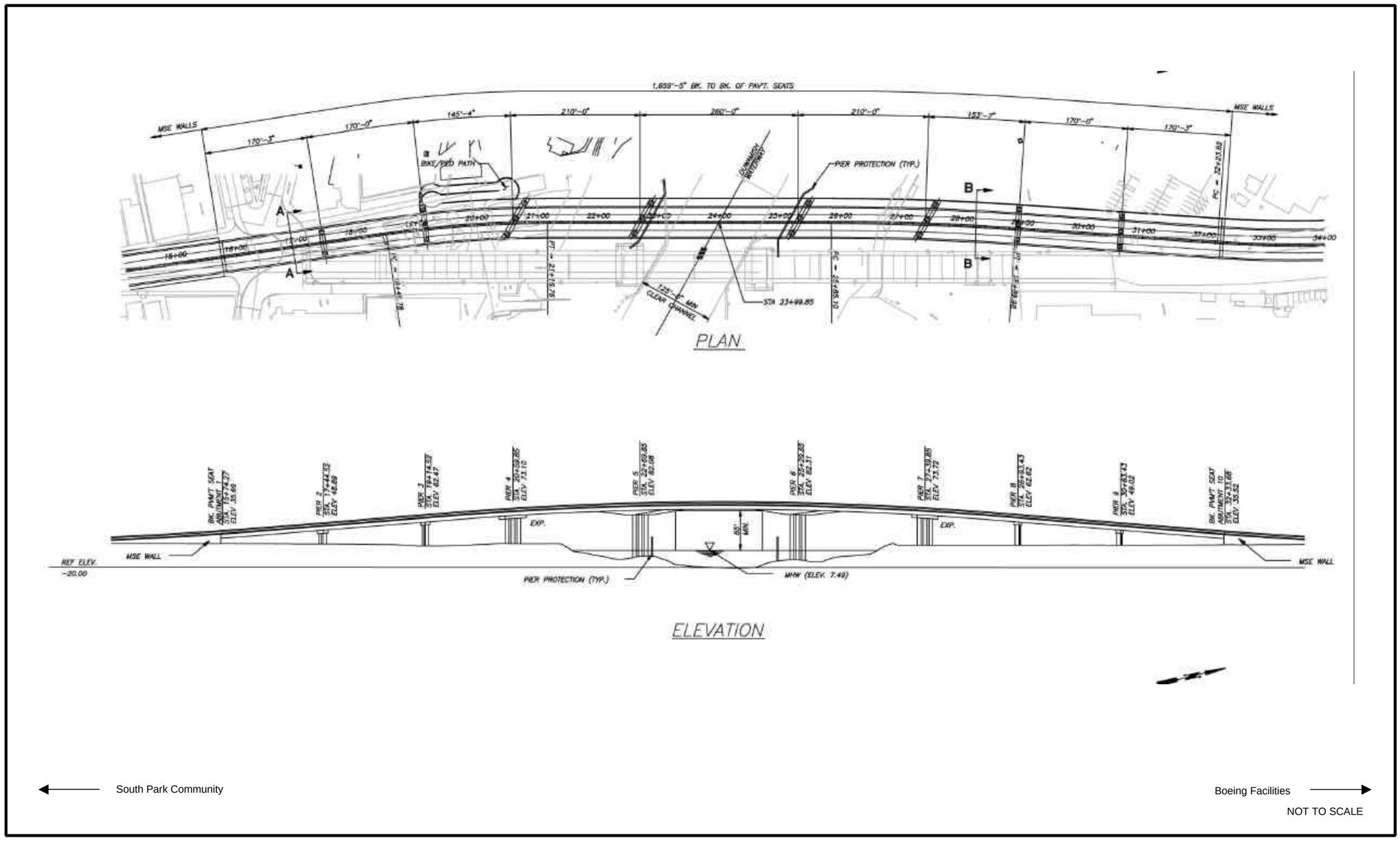


Figure 10

Mid-Level Fixed-Span Bridge Alternative

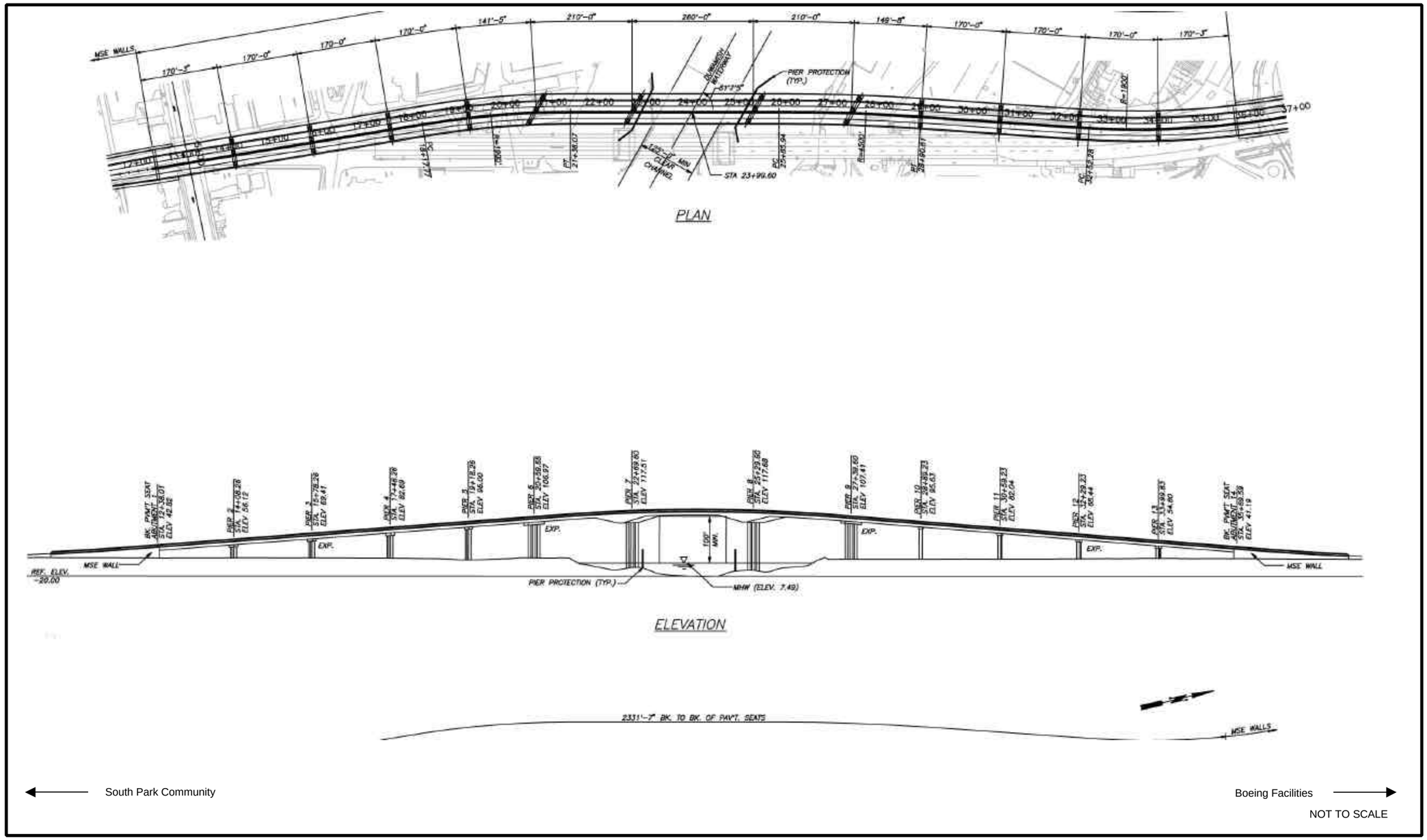


Figure 13

High-Level Fixed-Span Bridge Alternative

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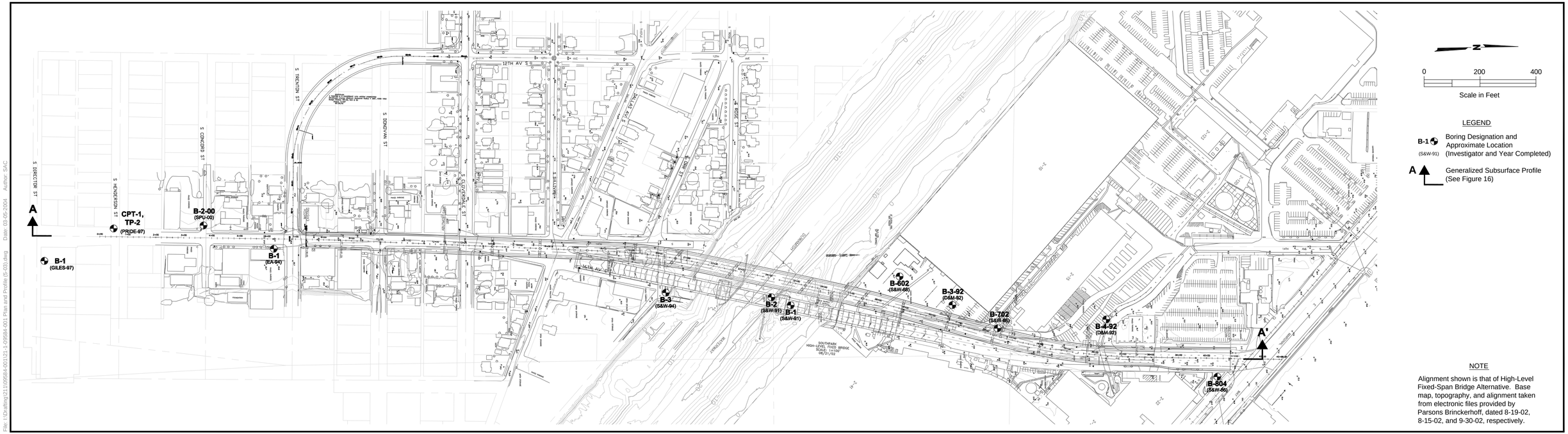

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Figure 15

Site and Exploration Plan

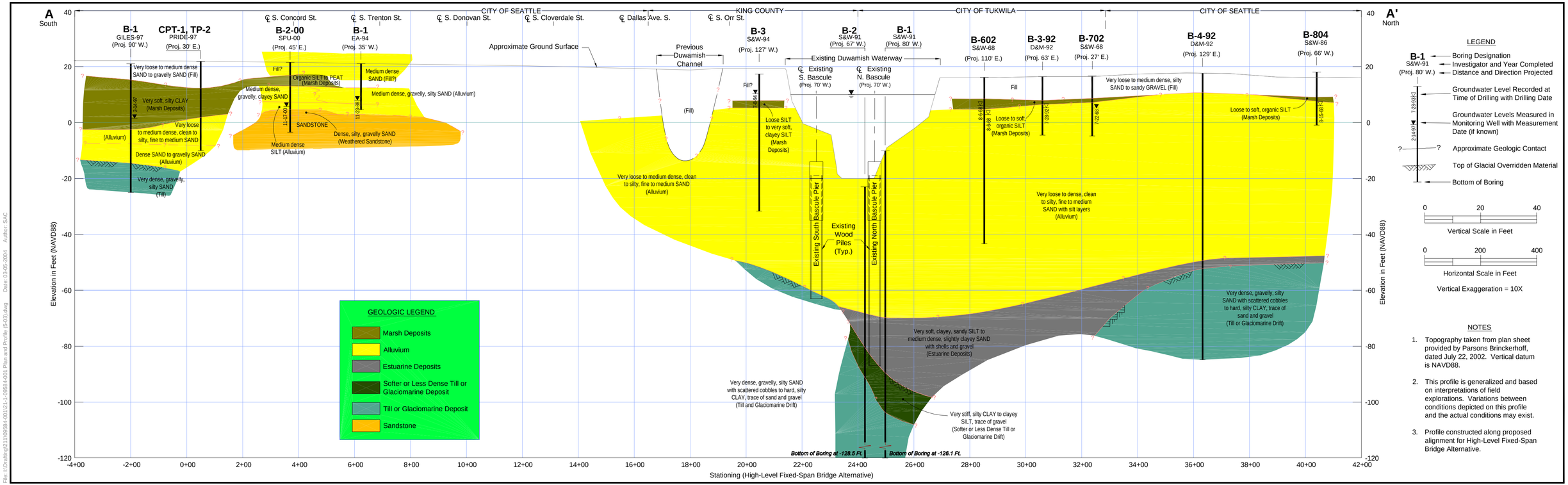

Figure 16

Generalized Subsurface Profile A-A'

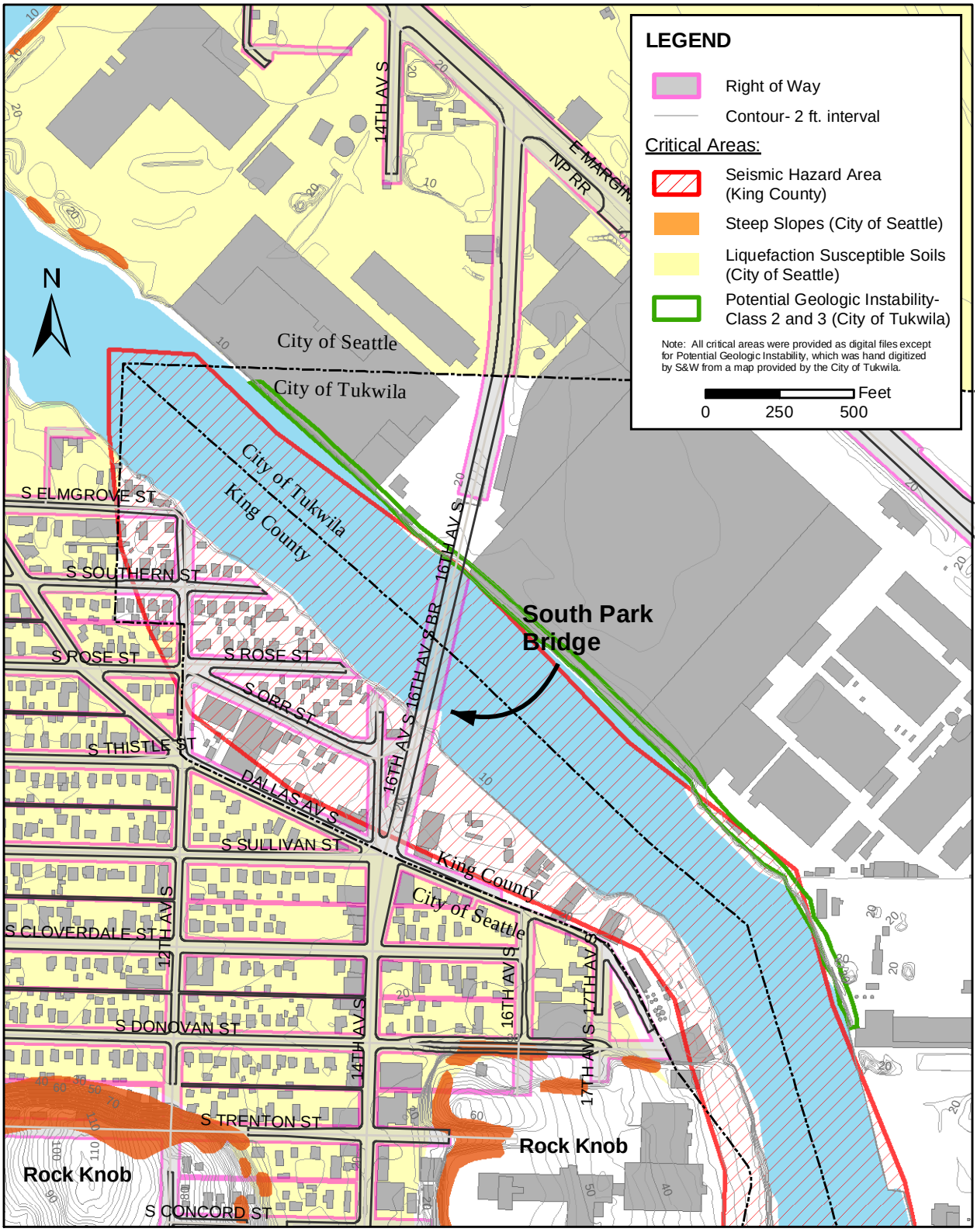

Figure 17

Critical Areas Map

Figure 18

Fault Location Map