King County

LANDMARKS COMMISSION

Certificate of Appropriateness Application

for

South Park Bridge (No. 3179)
Proposed Replacement
(CIP 300197)

Application date: November 1, 2007

Submitted by:

King County
Road Services Division

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King County

LANDMARKS. COMMIS.SION

Certificate of Appropriateness Application

SUBMITTAL DATE: November 1, 2007 DATE RECEIVED:

Property Name: South Park Bridge (No. 3179)
Address: 16th Avenue South spanning the Duwamish Waterway
City: Tukwila and Unincorporated King County (shared)

Applicant: King County Road Services Division (Attn: Jim Sussex)
Address: 201 S. Jackson Street (M/S KSC-TR-0231)
City: Seattle State: WA Zip: 98104
Phone: 206-296-8737
Email: jim.sussex@kingcounty.gov

Owner: King County Road Services Division (Attn: Tim Lane)
Address: 201 S. Jackson Street
City: Seattle State: WA Zip: 98104
Phone: 206-296-3708
Email: tim.lane@kingcounty.gov

Is the project likely to receive Federal or State financial assistance? Yes
If so, please indicate the source: Federal Highway Administration and Bridge Replacement Advisory Committee.

Does the project require a building permit? No

Project Summary: Replace the South Park Bridge No. 3179 with a new bascule bridge located downstream (westerly) of the existing structure. The existing bridge would be demolished. Historic resource mitigation would include HAER documentation and mitigation determined with community input.

Please describe the project in detail on a separate sheet. Refer to the COA instructions sheet for additional submittal requirements.

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South Park Bridge (No. 3179) - Proposed Replacement (CIP 300197) Certificate of Appropriateness Application

Executive Summary

King County proposes to replace the existing South Park Bridge to address the functional deficiencies, deteriorated condition and increasing seismic vulnerability of the historic South Park Bridge and to maintain the transportation link provided by the existing bridge. The South Park Bridge is located on 16th Avenue South over the Duwamish Waterway between the community of South Park and unincorporated King County on the south side of the bridge.

The bridge is the only operational example of a Scherzer rolling-lift bridge in Washington; the 76-year-old bridge is listed on the National Register of Historic Places, the Washington Heritage Register, and the King County Landmark Register. Per King County Code Chapter 20.62, Protection and Preservation of Landmarks, Landmark Sites and Districts, any alteration to a King County landmark requires a Certificate of Appropriateness (COA), a written authorization issued by the King County Landmarks Commission permitting an alteration to a designated landmark.

In support of the COA application, the King County Road Services Division (RSD) draws on the analysis of alternatives that was conducted for the South Park Bridge Project Draft Environmental Impact Statement (DEIS) issued in September 2005. Alternatives evaluated include:

- No Action alternative with future closure and demolition of the existing bridge
- Rehabilitation alternative considering two options for rehabilitating the bridge in its current location
- Demolition and replacement with a new bridge

Taking no action would ultimately necessitate closing and demolishing the bridge, resulting in the loss of a waterway crossing that is an important transportation corridor, a designated truck route which accommodates approximately 20,000 vehicles per day (14% are commercial trucks), and is part of a regional principal arterial linking key south Seattle area travel routes between East Marginal Way South and SR-99. There are no rehabilitation options without the loss of historic elements and alterations which do not meet the Secretary of the Interior's Standards for Rehabilitation. Relocation was evaluated for the purposes of the COA. Relocating a bridge of this size and specific movable configuration makes reusing the bridge at another site very expensive and impractical. Demolition and replacement of the bridge with another bascule bridge is the appropriate alternative.

In order to move forward with project planning and project development process, RSD is seeking approval from the King County Landmarks Commission to demolish the South Park Bridge and implement historic resource mitigation. Demolition of the bridge is anticipated to take place in 2012, as soon as the new bridge is open to traffic.

South Park Bridge (No. 3179) - Proposed Replacement (CIP 300197) Certificate of Appropriateness Application[1]

1.0 Project Description

1.1 Proposal

RSD proposes to demolish and replace the South Park Bridge (No. 3179). This proposal is in response to the significant deteriorated condition and seismic vulnerability of the bridge.

1.2 Location and Site Description

The historic South Park Bridge is located in an industrial area four miles south of downtown Seattle near the upstream limits of heavy industrial uses along the Duwamish Waterway. The bridge crosses the Duwamish Waterway at 14th/16th Avenue South in the northeastern quarter of Section 32, Township 24N, Range 4E (see Figure 1).

North of South Park Bridge is the industrial Georgetown area of Seattle and the King County International Airport (also known as Boeing Field). South of the bridge is the South Park community. The bridge replacement project area encompasses a corridor defined by 16th Avenue South between East Marginal Way South and the South Park Bridge, and then along 14th Avenue South between the bridge and South Cloverdale Street. With the exception of the Boeing Company facilities to the north, residences and businesses in the project area are largely located in the South Park neighborhood within unincorporated King County and Seattle at the south end of the bridge.

The bridge project area encompasses three local government jurisdictions—City of Seattle, City of Tukwila, and King County (see Figure 2). From the center of the Duwamish Waterway, the north portion of the South Park Bridge and north approach structures are within the City of Tukwila. 16th Avenue South then crosses into the City of Seattle prior to intersecting with East Marginal Way South. From the center of the Duwamish Waterway to Dallas Avenue South, the bridge and its approach lie within unincorporated King County. 14th Avenue South then crosses into the City of Seattle to the south. The bridge is jointly owned by King County and the City of Tukwila.

Land uses in the project area are a mixture of residential, retail commercial and industrial uses. The Boeing Company's facilities dominate the north side of the Duwamish Waterway. On the south side, retail commercial and light industrial land uses are located on 14th Avenue South and along the south bank of the Duwamish Waterway upstream of the South Park Bridge. The 14th Avenue South corridor south of the bridge is part of the

[1] Unless noted otherwise, information in this application comes from Parsons Brinckerhoff Quade & Douglas, Inc. (2005).

business district for the South Park neighborhood centered at the intersection of 14th Avenue South and South Cloverdale Street. These businesses are generally in buildings that have no front setbacks and extend all the way to the sidewalk. Single-family residences make up the rest of the project area.

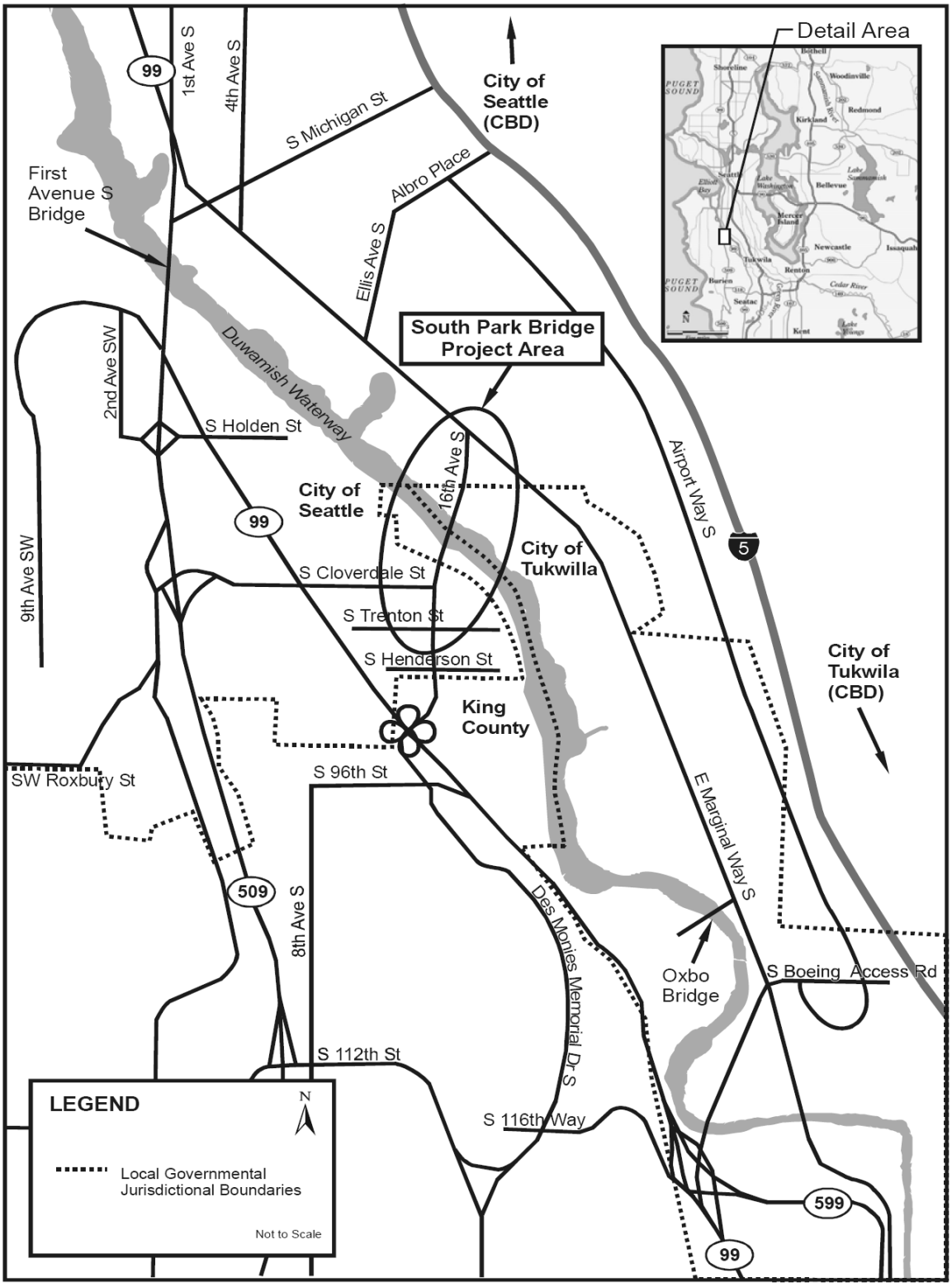

Figure 1: South Park Bridge Vicinity Map

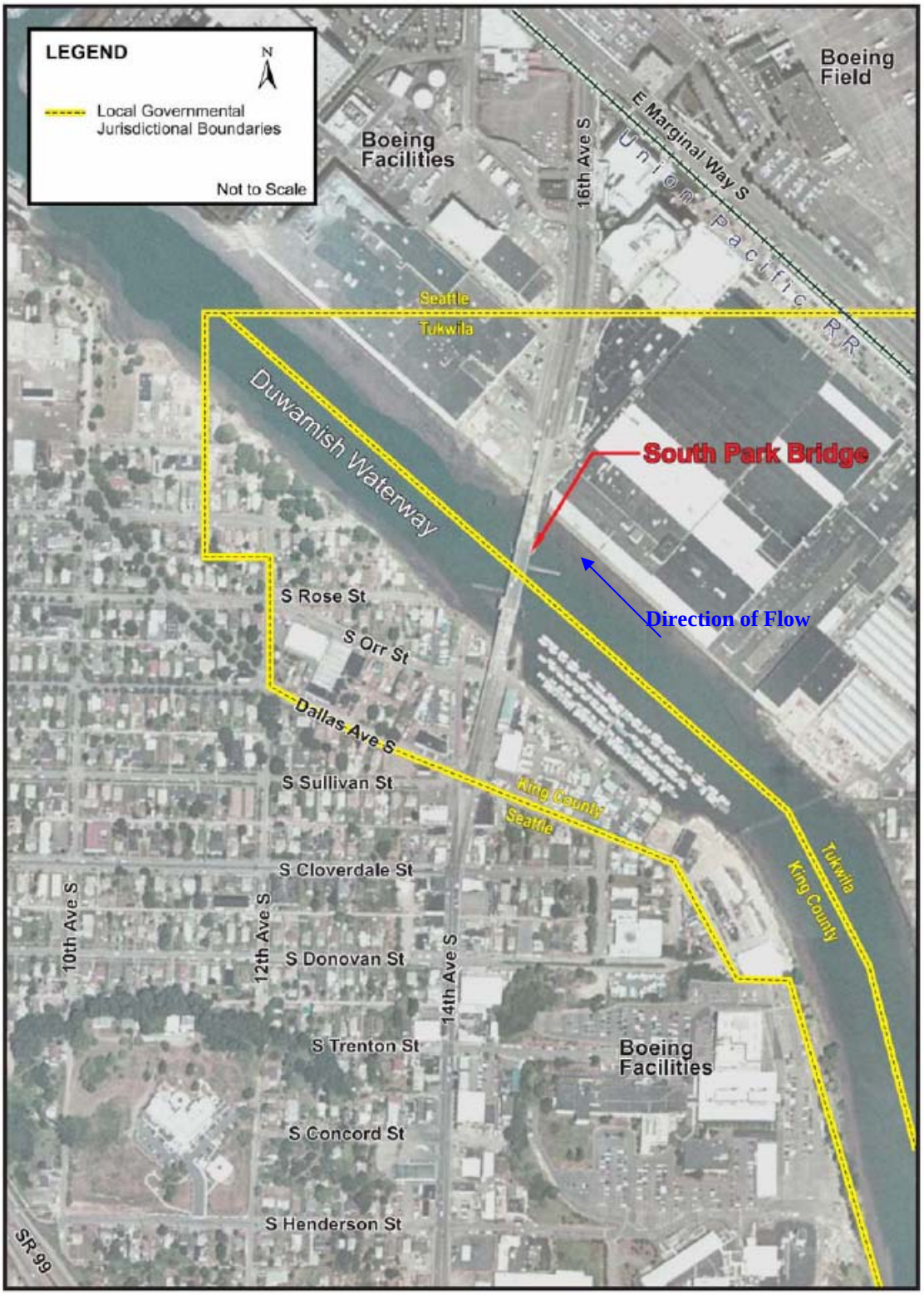

Figure 2: Project Area Street Map[2]

[2] From PB Americas, Inc., et al (2007)

1.3 Existing Bridge Appearance and Design

South Park Bridge is a double-leaf bascule (bascule is French for balance or see-saw) bridge, or "drawbridge." Photos 1 and 2 and Figure 3 provide an overview of the bridge's appearance and design.

Photo 1: South Park Bridge looking north from downstream side of the south riverbank.

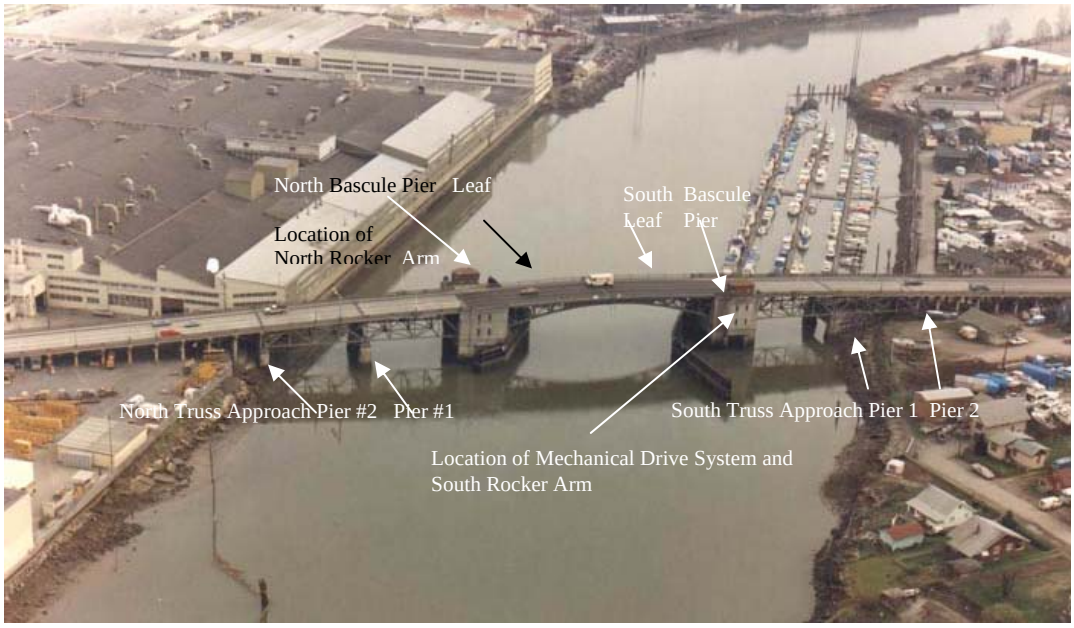

Photo 2: South Park Bridge (Aerial View from the West)

The South Park Bridge is a Scherzer rolling lift, double-leaf bascule movable span. The bridge is the only Scherzer rolling lift bascule bridge in Washington State (Palmer and Palmer 1996). Photo 2 shows the bridge with main features labeled. Each side of the bridge is flanked by two steel truss approach spans and 12 concrete approach slabs. 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 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 5-foot sidewalks on both sides. Reinforced concrete piers founded on timber piling support the steel approach spans. Two large in-water piers (Bascule Piers) support the counter weights, track supports, and racks for the rolling lift. The attached towers house the operating machinery, electrical equipment, and operator control room.

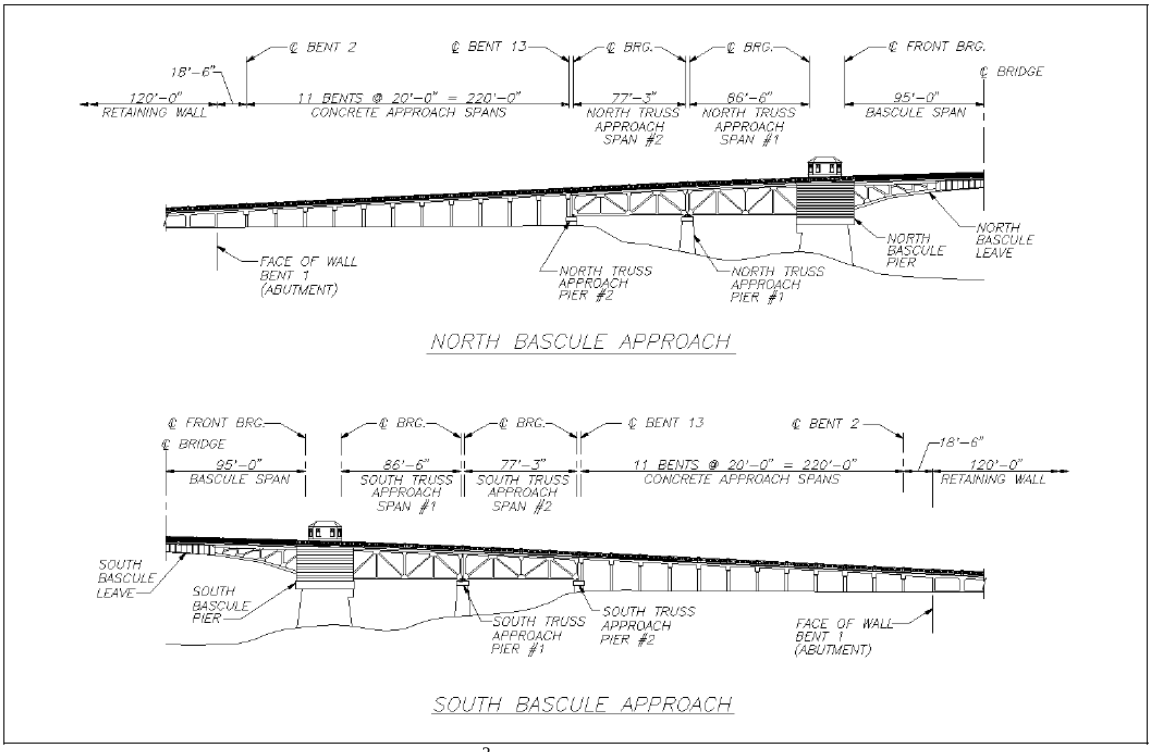

Figure 3: Existing South Park Bridge Plan[3]

For more design figures, refer to Appendix A.

1.4 Purpose and Need for Replacing South Park Bridge

The purpose and need for replacing the South Park Bridge is to best address the bridge's significantly deteriorated condition and seismic vulnerability, and to preserve the vital link in the regional transportation network that the bridge provides.

[3] From Parsons Brinckerhoff (2003)

Deteriorated Condition

In spite of substantial ongoing maintenance and repairs, the South Park Bridge has suffered considerable deterioration over the past 76 years. The long-term stability of the entire bridge is at risk because the supporting piles of the north bascule pier (see Figure 4) did not reach the dense supporting material.

This condition has resulted in movement of both bridge piers over the decades, which, in turn, has caused misalignment of the movable bascule leaves. Consequently, the center lock and guide tracks require ongoing modifications and adjustments to allow the bridge to continue to operate properly. This movement has also caused cracking in the bascule piers (see Photo 3). In addition, poor-quality concrete used in the original construction of the bridge is causing chemical deterioration of structural elements (see Photo 4).

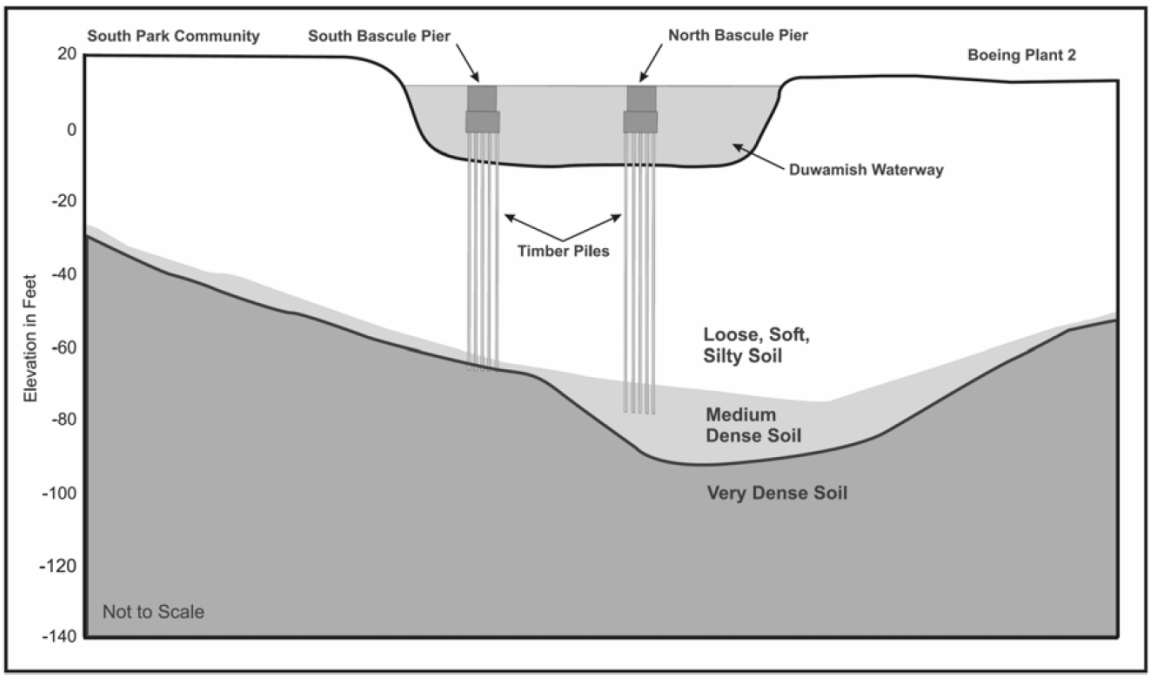

Figure 4: North Bascule Pier Shallow Timber Piles

Photo 3: North Bascule Pier Wall Cracks[4]

Photo 4: North Approach Pier Spalling[5]

[4] From King County (2007)
[5] From King County (2007)

A 2002 bridge inspection conducted by King County reported that the bridge condition was given a sufficiency rating of 4 out of a possible 100 (King County, 2002). The "4" sufficiency rating for South Park Bridge was among the lowest ratings given any bridge structure in Washington in 2006.

Design Deficiencies and Seismic Vulnerability

The condition of the bridge worsened significantly as a result of the Nisqually Earthquake in February 2001. An example of damage to the bridge from the earthquake is shown in Photo 5. Despite $740,000 in subsequent repairs, the bridge has been operationally less reliable since the earthquake. Furthermore, the bridge—which is located along the Seattle Fault Zone—remains vulnerable to future seismic events.

In addition, the design of the existing South Park Bridge does not meet current roadway design standards. The overall bridge width—including lane widths, shoulders, and sidewalks—should be 68 feet according to current design standards. The existing bridge width is only 52 feet. The lanes are too narrow and there are no roadway shoulders between the traffic lanes and the bridge sidewalks. There is no center median providing space between the two directions of traffic. The electrical control system is nearly all original and out of code. These and other deficiencies highlight the dated design standards that need to be addressed in either the design of a new bridge or rehabilitation of the existing bridge.

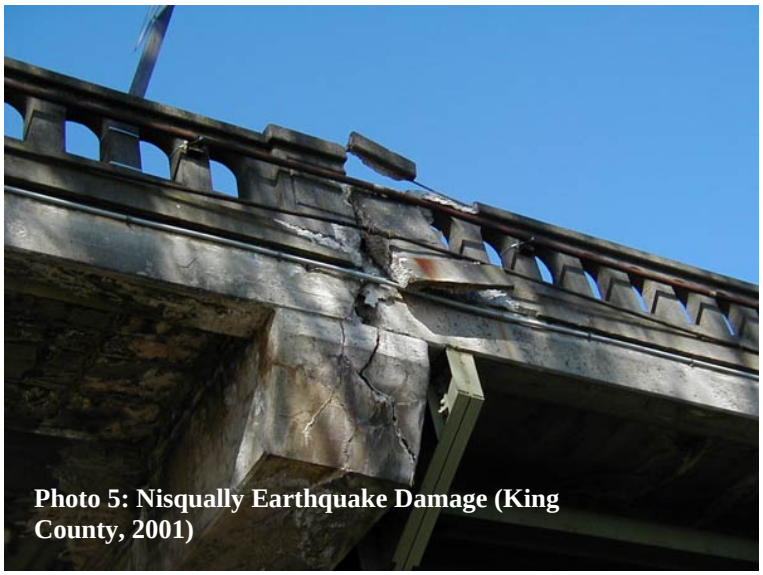

Photo 5: Nisqually Earthquake Damage (King County, 2001)

Transportation Link

Finally, replacement is needed to accommodate future traffic along an important transportation corridor. The South Park Bridge, which accommodates approximately 20,000 vehicles per day, is part of a regional principal arterial linking key south Seattle area travel routes between East Marginal Way South and SR-99. It is also serves as a King County-designated truck route and as a corridor for several bus routes.

1.5 Proposed Action[6]

King County proposes to build a double-leaf, trunnion bascule bridge located west and downstream to replace the existing structure. The construction of a new bascule bridge was selected as the preferred alternative following the evaluation of five alternatives in the Draft EIS. The specific type of bascule bridge and alignment was selected based on

[6] Information for this section from PB Americas, Inc., et al., (2007)

additional engineering work that was done in support of the Final EIS. The engineering and design for the preferred alternative continues to reflect the input that has been received from stakeholders' groups, including the South Park community, the Seattle Department of Transportation, the Washington State Department of Transportation (WSDOT), and King County.

The proposed structure is a low-level bascule bridge with two approach span structures of approximately 306 feet each and a double-leaf bascule span of 227 feet between trunnions or axles (Figure 5). The vertical clearance in the closed position would be 34 feet from the Mean High Water level to the bottom of the bascule truss, and the channel

Figure 5: New South Park Bridge 3-D CAD Design

width will be 125 feet between the fenders. The proposed bascule lift span will consist of steel trusses operated by a leaf drive system with mechanical load sharing. The span drive machinery would be located between the bascule trusses terminating with a rack and pinion (gears) at each bascule truss. Two electric motors would provide power to operate each leaf. Current design details include bascule pier footings supported on 16 eight-foot-diameter drilled shafts embedded well into the deep glacial soils. Each of the proposed approach structures consists of two spans with an intermediate pier on drilled shafts. Each span has a cast-in-place slab supported by prestressed girders.

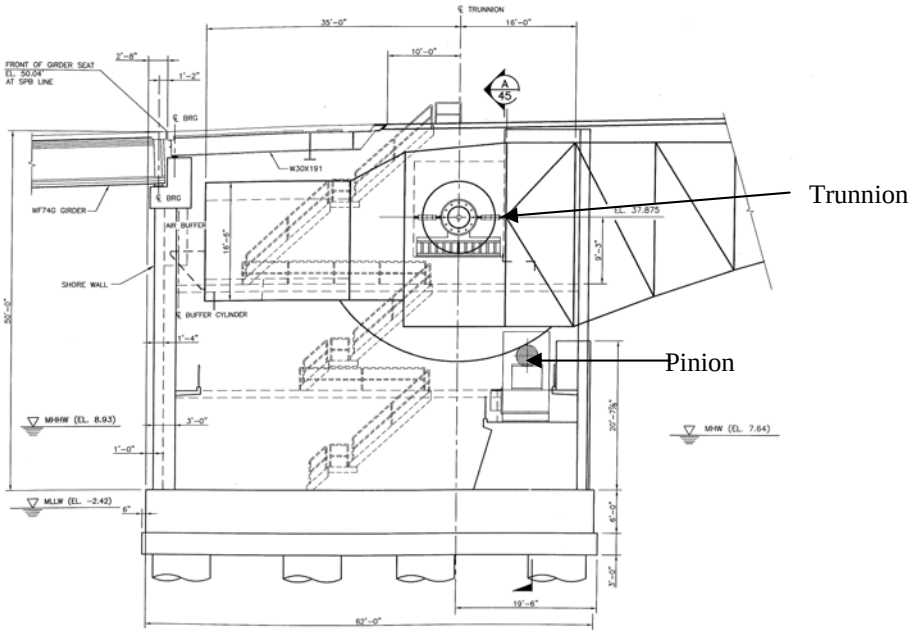

Figure 6: Cross Section of New Bascule Pier Showing Trunnion (axle) and Pinion Gears

2.0 Bridge History and Historic Features

The South Park Bridge is a King County Landmark (King County owned part designated December 19, 1996), Washington State Heritage Register site (June 1980) and listed on the National Register of Historic Places (September 7, 1982). The bridge has been called the 14th Avenue South Bridge, the 14th/16th Avenue South Bridge, and South Park Bridge. For the purposes of this report, it will be called the South Park Bridge. The historic designation refers to the bridge portion of the structure and does not cover the concrete approach structures and retaining walls.

The historic significance of the South Park Bridge is based on the distinctive bridge type, its association with people of local and national significance and the bridge's role in local transportation history.

2.1 Significant Bridge Type and Structure[7]

The South Park Bridge is a Scherzer rolling lift, double-leaf bascule movable span. Scherzer lift bridges are not a common type of bascule vehicular bridge and the South Park Bridge is the only example of a Scherzer lift bridge in Washington. Intact examples of rolling lift bascule bridges are highly significant. Of the highest level of significance (Parsons Brinkerhoff, 2005) within this category are early (late nineteenth to early twentieth century) examples of the type. The character-defining features are the steel trusses across the navigable channel that retain the features of the bridge type, and rigidly connected large steel rockers that have a weight at the rear to counterbalance the truss

[7] The following text is modified from the King County Landmark registration form by Palmer and Palmer in 1996.

span. The rockers are cast in the form of a segment of a circle describing an arc of ninety degrees.

Photo 6 and 7: Base of the rocker and level track with lugs (left) Center lock system (right) (King County).

The rockers support the leaf arm and roll away from the navigable channel on a smooth and level track. To provide horizontal stability, lugs on the track engage in slots on the underside of the rockers (Photos 6 and 8) where the center of rotation (and gravity) moves away from the opening as the span swings upward. Additionally, with the Scherzer the arm moves backward as it moves upward, thus providing a maximum channel width for navigation with minimum span length (Vaughtan, 1991). When the bridge is in the closed position, a center-lock mechanism (Photo 7) transfers loads between the two leaves of the span. This center-lock mechanism is a simple tongue and groove system that has no moving parts. Balance is an important part of the operation. The load of the bridge is balanced by counter weights in the piers.

Photo 8: Rocker and leaf arm shown during construction in 1930 (King County Archives)

The span drive system is made up of motors, primary reducers, differentials, open reduction gearing, and drive rack and pinion.

Photo 9: Bascule leaf room and span drive machinery in the South Bascule Pier (King County).

The substructure of the bridge is composed of steel rebar reinforced poured concrete. The two bascule piers support the counterweights, operating machinery, and the operator's control room. The east and west bascule pier walls are 11 feet thick unreinforced concrete structures. The north and south bascule walls are three- to four-foot-thick lightly reinforced concrete wall structures.

The opened bridge provides a water channel that is 118 feet wide. The overall length of the bridge including its approaches is 1,285 feet. The lengths of the approaches are 86 feet, 6 inches long on the north and 77 feet, 3 inches long on the south. Abutments, piers and pylons are steel girders (I-beams) and trusses. Those steel components located beneath center span and approaches are painted green. Both concrete abutments supporting the center span have one-over-one windows on the eastern and western sides. The windows include a mix of original and replacement glass. Vertical rows of wooden pilings (dolphins) standing in the water through the bridge-passage act as bumpers for boat traffic. Concrete pylons beneath both bridge approaches are square with chamfered corners and square corbels.

The width of the roadbed is 38 feet from curb to curb comprising four lanes of two-way traffic. The roadbed has a four-percent gradient from each approach meeting at a high point in the center of the bridge. The steel open grid roadbed in the center span has a center opening. The roadbed on the north and south approaches is concrete. Both concrete roadway approaches meet two 95-foot steel grid leaves which comprise the center span. Two traffic crossing arms appear at each end of the center span.

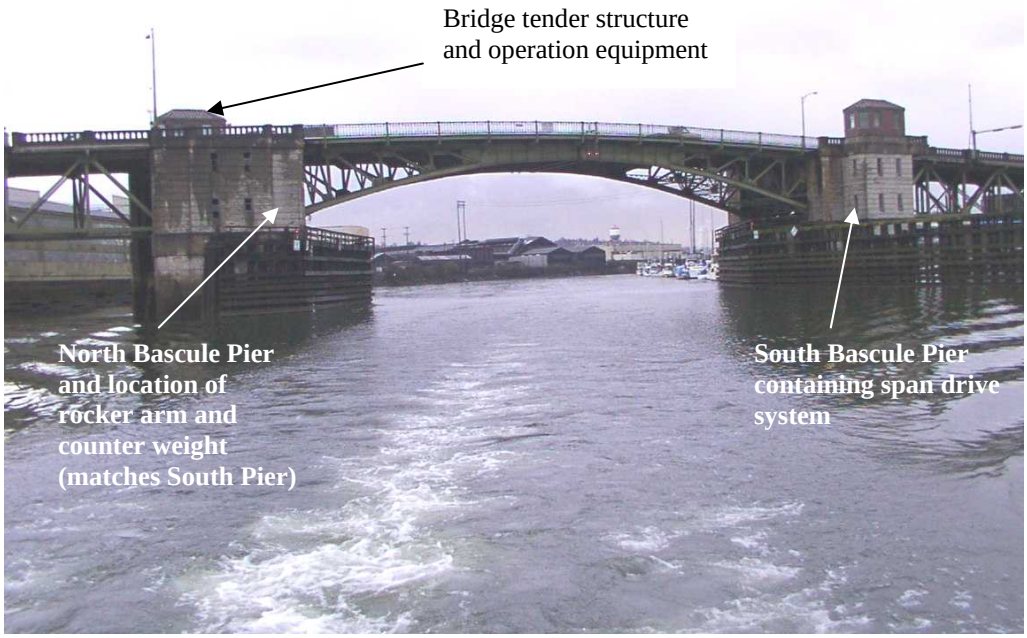

Photo 10: Bridge profile looking east (King County).

Concrete pedestrian walkways are six feet, seven inches wide and appear on both sides of the roadbed along the approaches. Pedestrian walkways along the center span are steel grids filled in with concrete. Extensions of the pedestrian walkways are built into the approaches. A steel balustrade is installed along the pedestrian walkway in the center span. A concrete balustrade appears on both the north and south approaches with large square embellishments approximately every 20 feet.

One-story, single room, brick, bridge tender structures are located on top of the poured concrete two-story abutments on the northeast and southwest sides of the center span. Both bridge tender structures are identical (only the north is active) rectangular buildings with three sided end resulting in eight sides. They both have hip roofs sheathed in red tile. They also have three-over-one transom windows on all sides with some replacement windows. These windows have decorative concrete sills and vertical brick lintels.

A metal plaque on the west side of the northern bridge tender reads:

Bridge No. 1393-A
Duwamish River
King County
1930
Commissioners: Don H. Evans, W. B. Brinton, Wm. Brown
County Engineer: Thomas D. Hunt, Chief Deputy: D.L. Evans
Contractor: Puget Sound Bridge & Dredging Company

Original concrete light posts with missing light fixtures remain along the concrete balustrade. Replacement metal light posts bearing lights are interspersed between the original concrete light posts.

2.2 Significant People Associated with Bridge Design and Construction[8]

The bridge design was first patented by William Scherzer (1858-1893) in 1893, but following his death the patent was taken over by his brother Albert (1865-1916), who also founded the Scherzer Rolling Lift Bridge Company. Scherzer rolling lifts were popular from the early 1900s well into mid-century because of their simplicity and the fact that they were quick to open, required a small amount of power for operation and allowed a large opening for shipping.

The South Park Bridge construction specifications and plans were written by Scherzer Rolling Lift Bridge Company with modifications by Don H. Evans, King County Bridge Engineer and member of the King County Council. Correspondence between King County and Scherzer about designing the bridge date from February of 1926 but refer to an earlier letter in 1925. The King County Landmark registration form notes that Don H. Evans lobbied for the Scherzer-style. Letters from Scherzer to King County were signed by Craig P. Hazelet as the Chief Engineer and General Manager. The Scherzer firm remained active during the bridge construction responding to design questions and issues that arose during construction.

Photo 11: South Park Bridge Under Construction showing bascule leaf (King County Archives)

The construction contract was awarded to Pacific Sound Bridge and Dredging Company, (PSBDC) a prominent construction and engineering firm that started its Seattle branch in 1889. PSBDC, (now Lockheed Shipbuilding and Construction Company) also worked on filling Harbor Island, construction of the Lake Washington Floating Bridge, the Dexter Horton Building and dredging and fill from the Duwamish Waterway to the King County Airport site for development of the Airport.

The South Park Bridge contract was awarded for $481,181.00 and incurred additional costs of $55,877.46 in change orders. The Construction Engineer was Daniel Evans, Don's brother and assistant County Engineer. Construction started in November of 1929 and the bridge was open to traffic on March 21, 1931.

[8] Information on Scherzer Rolling Lift Bridge Company and history from NCHRP 25-25 (2005).

2.3 Significant Transportation History and Bridge Location[9]

Between 1913-1931 bascule bridge design became popular in Washington State. The Salmon Bay Great Northern Railroad Bridge became the first bascule bridge in Washington State and the Seattle area. Constructed in 1913 just west of the site that would become the Ballard Locks, this crossing consisted of a single-leaf trunnion-type span. The following year witnessed construction of a trunnion-type bascule bridge designed to carry automobiles across the Ebey Slough in Everett. The most concentrated period of bascule bridge construction in Washington State took place between 1915-1919 during the Lake Washington Ship Canal project. The City of Seattle erected three double-leaf trunnion spans (Ballard, Fremont, and University bridges) for the canal project. By 1925, the double-leaf trunnion Montlake Bridge had been added to the Ship Canal crossings. Three years later, engineers from Chicago erected a Strauss-style trunnion double-leaf bascule bridge over the Hoquiam River. The South Park Bridge constructed across the Duwamish River in 1930-1931 served as the final installment in the chapter of historic movable bascule bridges of Washington State and the only Scherzer bascule bridge built in Washington.

Between 1913 and 1920, 1.3 miles of the meandering river were straightened into what is now known as the Duwamish Waterway. These efforts channelized the river and converted it to a maintained waterway for boat traffic. A wooden truss swing bridge at 14th Avenue South was built in 1914 and was one of the first bridges across the new Duwamish Waterway. The Scherzer rolling lift bascule bridge became the favored replacement for swing spans in many parts of the United States; and, as was the case for this bridge, the bascule bridge replaced the wooden truss swing bridge. The location of this older wooden swing bridge was immediately west of the current bridge alignment such that the southern terminus of the previous bridge connected to the old brick road that currently exists between the Duwamish Waterway and Dallas Avenue South.

2.4 Bridge Alterations

Most alterations have occurred during repairs made to the structure. The following text summarizes the major alterations. A more complete list of repairs is included in Section 3.2, Repair History. The bridge's roadbed was resurfaced with blacktop in 1944. The timber deck was replaced with steel grading in 1955. It was painted in 1959. The bridge suffered earthquake damage on April 29, 1965 when a concrete portion of the south approach was dislodged. More recently the Nisqually Earthquake damaged railings and walls. In 1975, all four sidewalks on both approaches were replaced, and in 1976 the concrete on the deck rails and beams was patched. Loudspeakers were installed in 1976 to enable bridge tenders to be heard by people on the river below. On January 16, 1977 the bridge failed to open during rain. The power failure was due to water seepage into electrical conduits. In June, 1977 the structure was washed, sandblasted and painted with three coats of paint. In 1982, the pier protection fenders in the river channel were

[9] The following text is taken from the King County Landmark registration form by Palmer and Palmer in 1996.

[11] From PB Americas, Inc., et al., (2007)

reconstructed. Mechanical drive systems and motors were replaced or rehabilitated in 1950 and 1995 to 1998. Both towers were rehabilitated and new lighting installed in 1997 and 2000. None of these alterations have changed the historic character of the structure.

3.0 Present Condition

3.1 Features and damage

Despite ongoing maintenance and repairs, the South Park Bridge has deteriorated significantly over the past 76 years. Existing problems worsened significantly following the Nisqually Earthquake in February 2001. The bridge remains vulnerable to future seismic events. A 2006 bridge inspection conducted by King County to National Bridge Inspections Standards (NBIS) resulted in an existing condition rating of 4 out of a possible score of 100 (based on U.S. Federal Highway Administration criteria). This is among the lowest ratings given to any bridge structure in the State of Washington and places the bridge in the "Structurally Deficient" category.[11]

Deficiencies of particular concern include (see Photo 2 for location of each feature):[12]

Bascule Pier Foundations

Original pile-driving records indicate that the timber piles under the north bascule pier were not driven to refusal in the glacial till. The pilings were driven short of this layer by approximately ten to 20 feet. The existing wood piles supporting the north and south bascule pier foundations are reported to have been originally designed for an allowable load of 22 to 30 tons each. Although the south pier meets these requirements, testing of the north bascule pier estimates the allowable pile capacities at about six to 12 tons, which is much less than the required design loads of 22 to 30 tons. Over time, differential settlement between the two bascule piers has contributed to bascule leaf operation problems, including leaf misalignment. Compounding issues result from the existence of liquefiable soils beneath the bridge, which may lead to horizontal displacement and vertical settling, either of which would render the bridge inoperable.

Bascule Piers

South Park Bridge's substructure was rated as 3 out of 8 in 2002, which is considered in "Serious Condition" according to the National Bridge Inspections Standards. A "3" rating is described by: "Loss of section, deterioration, spalling or scour has seriously affected primary structural components. Local failures are possible." The overall condition of the submerged section of the two bascule piers ranges from fair to poor. Evidence of significant deterioration in the form of cracking, spalling, and efflorescence is found in both piers. Additionally, studies have found that the reinforcement in the bascule pier walls does not meet current seismic design requirements.

[12] From Parsons Brinckerhoff (2003)

Bascule Leaves

South Park Bridge's bascule leaves, including its superstructure and deck, are rated "Fair Condition." According to National Bridge Inspections Standards, "Fair Condition" is defined as "all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour."

Steel Approach Truss Pier Foundations

Shannon and Wilson (2007) determined the South Park Bridge is subject to soil liquefaction risk. Liquefiable soils in the Duwamish River Valley may be subject to lateral displacement (lateral spreading) as great as 30 feet. Vertical settlement for these areas may also be as much as one and a half feet.

Steel Approach Truss Piers

As with the bascule piers, the substructure associated with the steel approach truss piers is rated as "Serious Condition." The deterioration of the steel truss approach piers has been confirmed visually and with testing.

Steel Approach Trusses

A "Fair Condition" rating for the structure and deck includes the steel approach trusses. The steel truss approaches do not have a complete lateral load path to bring the lateral earthquake load from the deck level to the supports at the bascule pier.

Mechanical System

The South Park Bridge incorporates a later design of thicker rolled plate treads. Nonetheless, the lugs and pockets on the existing bridge treads are no longer aligned, and numerous repairs have been performed to help realign the bridge. There are large areas of local damage at the tread plate (a flat steel track on which the rocker rolls) contact surfaces (picture at right). At least one alignment pocket is cracked (NW track) at the segmental track mounted along the circumference of the rocker, due to excessive stresses from a past misalignment problem. Due to the wear experienced over the life of the bridge, several gears

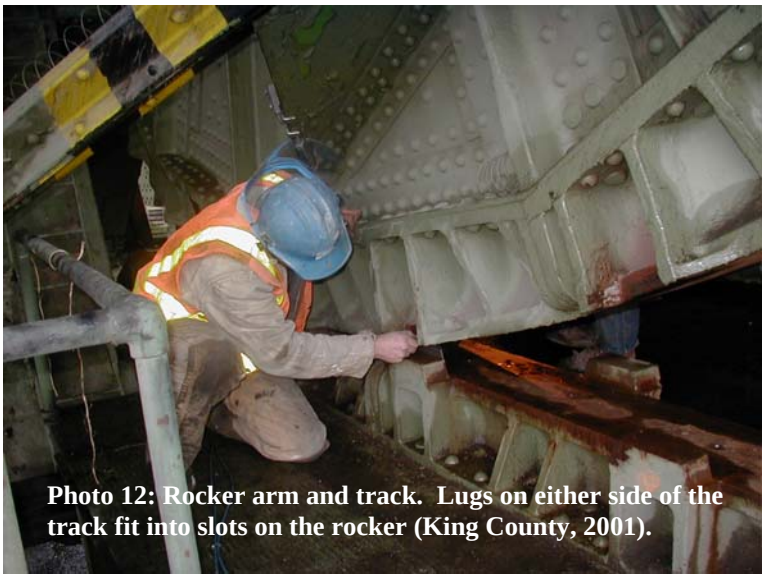

Photo 12: Rocker arm and track. Lugs on either side of the track fit into slots on the rocker (King County, 2001).

appear (photo 13) to be close to marginal in their tooth strengths. Three of four pinions have worn, which may indicate they are overstressed at maximum load.

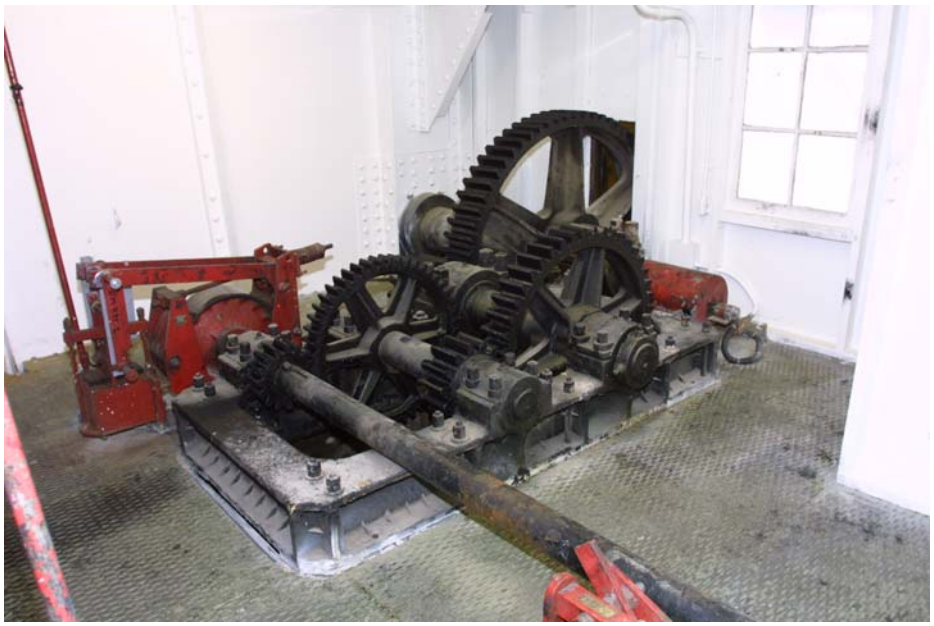

Photo 13: Pinion Gears (King County, 2002)

Electrical System

The South Park Bridge's existing electrical power and control system equipment is mostly original. Most of the electrical conduit and raceways are original and many show signs of corrosion. Original conduits are embedded in cracked concrete walls and are subject to moisture intrusion. Because many replacement parts can no longer be obtained, repairs require innovative and non-standard repairs by electricians. In addition, many conductors currently have no wire numbers, which makes it difficult to troubleshoot operation and control problems. Original wiring has brittle insulation that can easily crack if disturbed, increasing the scope of minor repairs.

Photo 14: Main Electrical Relay Panel (King County, 2004)

Concrete Approach, Abutment Foundations Piers and Deck

While these features are not part of the historic structure, their condition contributes to overall condition problems for the bridge and need for

replacement.

The south earth-filled abutment settled after the Nisqually Earthquake in February 2001. Corrosion-induced cracking and spalling is evident on the north and south approaches. Cracks at the end of pier caps have progressed over the time, and numerous areas exhibit the reinforcing steel, which is in some cases significantly corroded. The concrete has undergone complete carbonation from the surface inward.[13] It is highly probably that the large deep cracks appearing along the pier caps and the numerous cracks perpendicular to the primary cracks are caused by expansive stresses. Cracks are especially apparent at every third bent, where defective expansion joints in the roadway have allowed water onto the cap beam. Alkali-silica reactions have contributed to distress in the form of cracks.

According to National Bridge Inspections Standards, the bridge deck is in "Fair Condition."

3.2 Repair History

Over the past ten years, maintenance costs (not including operation costs) for the South Park Bridge have averaged approximately $286,000 per year, comprising an estimated 18 percent of the King County total bridge maintenance budget. Numerous repairs have been conducted to the structure and a list of major repairs is noted below:

- North and South approach and main pier spall repairs in 1950, 1956 and 1970
- The north approach spans were moved to the north to correct conflict with moveable span in 1950
- Dirt removal from both moveable spans to restore proper leaf balance in 1997 and 2000
- Electrical Component replacement/repairs in 1989, 1994, 1996-1998, and 2000-2002
- Timber decking replaced with steel grating in 1950
- Cutting/welding structural steel at roller guides to keep moveable spans aligned in 1978, 1979, 1982, 1985, 1987, 2001, and 2002
- Pier protection rehabilitation in1982
- Main bascule piers laterally tensioned to prevent further pier separation in 1982
- Mechanical drive systems/rehabilitation and repairs in 1995, 1996, and 1997
- Motor room rehabilitation in 1950 and 1998

[13] Carbonation reduces the pH of the concrete, which in turn reduces its effectiveness to act as a protection barrier against corrosion.

- Bridge tower rehabilitation and light installation in 1997 and 2000
- Cutting/welding structural steel at tips of moveable spans to keep proper alignment in 1950, 1984, 1985, 1997, 2001 (twice), 2002, 2004, and 2005
- Concrete spall repairs on moveable span sidewalks in 2000
- Entire bridge repainted in 1959 and 1977
- Deck grating panels installed to improve clearances in 1950 and replaced with concrete deck in 1996
- Expansion Joints Replaced in 1990

This list does not include the repairs to the concrete approach spans that are not part of the historic designation.

3.3 Potential for Closure

The bridge is currently subject to closure for the following reasons:

- if its deteriorated conditions worsen to a degree that cannot be rectified;
- another earthquake is likely to cause damage resulting in emergency closure of the bridge;
- on-going movement of the bridge foundations could eventually cause the movable spans to become misaligned to the extent that repairs would not be feasible.

When closed, no vehicular, bicycle, or pedestrian traffic would be allowed to use the bridge. The U.S. Coast Guard regulates bridges that span navigable waterways such as the Duwamish Waterway. If the bridge is no longer operating, the U.S. Coast Guard regulations require demolition and removal of the bridge and associated pier protection structures.

4.0 Alternatives Evaluated

Based on the screening level evaluation of the preliminary alternatives and consideration of agency and public comment, a total of five alternatives were selected for detailed environmental review as part of the Draft EIS. The evaluation included the no-action alternative, two rehabilitation alternatives, two fixed-span bridges and replacement bascule bridge (like the existing bridge).

4.1 Engineering Alternatives Previously Considered but Rejected

King County has evaluated a number of engineering concepts to rehabilitate or replace the South Park Bridge over the past 15 years. Several alignments (centerline of a specific route) and conceptual engineering designs have been evaluated. In particular, a variety of preliminary alternatives were considered during the scoping and alternatives selection

phase of the South Park Bridge Project Draft EIS. Based on technical evaluations and input from both technical and community advisory groups comparing and contrasting these preliminary alternatives, King County determined that several of the preliminary alternatives were not feasible or practical alternatives for further consideration. These alternatives included:

- Low-level Fixed-span Bridge
- Vertical-lift Bridge
- Swing Bridge
- Tunnel

Screening criteria used to reject these four preliminary alternatives included regional mobility, local access, waterway navigation, community impacts, aquatic habitat protection, construction impacts, and cost.

The low-level fixed-span bridge was not desirable because its vertical clearance (approximately 35 feet) would severely limit the height of commercial and recreational boats that can currently travel upstream of the South Park Bridge. A vertical-lift or a swing bridge would involve substantial traffic impacts (10-15 minutes for each to operate as opposed to 4-6 minutes for a bascule bridge) and visual impacts (significantly tall operating structures). The swing bridge alternative would require realignment of the new bridge that was not considered practical due to the location of Boeing and the existing bridge. The tunnel concept was eliminated because the construction activities would cause potentially severe disturbance to known contaminated river-bottom soils and sediments, irrespective of using the cut-and-cover or boring construction methods. In addition, the long approach slopes for tunnel construction would affect a substantial number of properties in the South Park community and Boeing facility.

4.2 No Action/Closure

Evaluating the No Action alternative is required by both federal and state environmental regulations. Due to the existing poor condition of the bridge and its seismic vulnerability, No Action for this project assumes the existing bridge will close in 2010 (King County, 2007). Bridge closure and removal could occur earlier (1) if the bridge could no longer operate safely and reliably, (2) if maintenance costs become more than King County is willing or able to expend, or (3) if the bridge is damaged beyond repair due to an earthquake or other unforeseen event. Once closed, U.S. Coast Guard regulations would require that the inoperable bridge be removed.

4.3 Rehabilitation On-Site

The Rehabilitation Alternative would retain most of the historic character of the existing bridge, while ensuring the life of the rehabilitated bridge would be less but somewhat comparable to the anticipated 75-year life of a newly constructed bridge. New bascule piers would be constructed. Other bridge structural elements would be refurbished, repaired, or reconstructed. Existing historic bridge features of the bridge would be preserved to the greatest extent possible. The bridge deck would retain two standard

southbound lanes and one standard northbound lane. Sidewalks would be reconstructed on either side of the roadway pavement. New pier protection structures would be constructed to prevent vessels from hitting the bascule piers and to demarcate the 118-foot width of the Duwamish Waterway navigation channel under the bridge.

Two rehabilitation options were identified and evaluated[14]:

Rehabilitation Option 1: Preserve and reinforce most of the original substructures without removing the bascule leaves during construction to minimize interruption to vehicular, bicycle and pedestrian traffic. This option was not evaluated in the DEIS because additional columns and footings would be required in the river; the bridge appearance would be significantly altered by the addition of structural members to strengthen the piers; the necessary construction methods involved greater risk of differential settlement during construction; and uncertainties about the existing condition of the substructure concrete and footings would result in less predictable remaining service life.

Rehabilitation Option 2: Replace the bascule piers and foundations, concrete approach structures, and steel truss approach piers. The bascule leaves and approach trusses would be temporarily removed, refurbished and reinstalled during the construction. Some original bridge features would be reconstructed or preserved, including the bridge control tower, roadway balustrades, and the Scherzer rolling-lift mechanisms. While the structure would appear similar to the current condition, rehabilitation does not meet the Secretary of the Interior's Standards for a Certified Rehabilitation (36 CFR Part 67) because of the necessary removal and replacement of historic materials. This alternative is the second most expensive option at $74 million in the 2003 cost estimate (see Figure 5) and was not selected due to the need to close the bridge for up to 32 months during the reconstruction and the impacts to the community and regional transportation due to the closure.

4.4 Replacement

4.4.1 Mid-level Fixed-Span Bridge Alternative

The Mid-Level Fixed-Span Bridge Alternative would have a concrete bridge deck supported by a number of bridge piers. Some of the piers would be on land, but two would be in the water. The height of the bridge deck would be approximately 65 feet above the water and the length would be an estimated 1,660 feet abutment-to-abutment. The grade of the bridge deck would be approximately 8 percent for the two standard northbound and two standard southbound lanes. A combined 13-foot bike/pedestrian path would be constructed on the west side of the bridge but would connect with a zigzag design ramp at approximately South Orr Street to allow bicyclists and pedestrians to descend quickly to the street level below. The bridge touchdown would extend south of South Cloverdale Street such that the grade of the new roadway would be slightly above the existing level. Road improvements, however, would continue to allow direct access

[14] Analysis from the Rehabilitation Feasibility Study conducted as part of the South Park Bridge Draft EIS.

to the bridge from South Cloverdale Street. Like the Bascule Bridge Alternative, new pier protection structures would be constructed to define a 125-foot navigation channel under the bridge. This bridge height does not allow passage of the tallest marine vessels.

4.4.2 High-level Fixed-Span Bridge Alternative

The High-Level Fixed-Span Bridge Alternative would have a solid bridge deck supported by a number of bridge piers, similar in design to the Mid-Level Fixed-Span Bridge Alternative. The maximum height of the bridge deck would be approximately 100 feet above the water and the length would be an estimated 2,332 feet abutment-to-abutment. The U.S. Coast Guard maintains the Duwamish Waterway as a navigable channel and, in a letter to King County dated June 10, 2002, they acknowledged that a fixed-span bridge alternative with a vertical clearance of a minimum of 100 feet to accommodate existing commercial and recreational boat traffic using the Duwamish Waterway would be acceptable. In addition, this fixed-span bridge alternative is required for comparative analysis to the movable Bascule Bridge Alternative per Federal Highway Administration regulations [Code of Federal Regulations, Chapter 23, Part 650.809]. This comparison is important especially considering the substantial difference in construction and operation costs between bascule and fixed-span bridges. The design of the High-Level Fixed-Span Bridge Alternative is similar to the 65-foot vertical clearance bridge. The grade of the bridge deck, however, would slightly exceed 8 percent for the two standard northbound and two standard southbound lanes. A 13-foot combined bike/pedestrian path would be constructed on the west side of the bridge for the entire length of the elevated portion of the bridge. Touchdown of the alternative would be just north of South Trenton Street. To continue to provide access to the bridge for the community, road improvements would extend on South Trenton Street west to 12th Avenue South and north to South Cloverdale Street. Finally, new pier protection structures would be constructed for the 125-foot channel in the same fashion as described for both the Bascule Bridge and Mid-Level Fixed-Span Bridge alternatives.

4.4.3 Bascule Bridge Alternative

The Bascule Bridge Alternative would involve construction of a new movable bridge that would be similar to the design of the existing bridge. At an estimated 920 feet abutment-to-abutment, this bridge would be only slightly longer than the existing bridge. The new bridge would have two bascule leaves that would open and close like a “drawbridge.” The new bridge deck would be concrete, not a grated deck (current bridge design). When closed, the bridge deck would be approximately 34 feet above the water. The grade of the bridge deck would be approximately 5 percent for the two standard northbound and two standard southbound lanes. A combined 13-foot bike/pedestrian path would be constructed on the west side of the bridge. The bridge touchdown would be at South Sullivan Street, but road improvements would extend to South Cloverdale Street. New pier protection structures would be constructed defining a 125-foot navigation channel under the bridge. This is the preferred alternative for replacing the South Park Bridge.

4.5 Preferred Alternative

The preferred and most appropriate alternative—replacing the existing South Park Bridge with a double-leaf, bascule bridge—was selected because it would have the least impact to the project area community while improving road safety and preserving the navigational channel. Comments from the public and other agencies reflected a strong preference toward a bascule bridge, primarily to minimize the disruption to the community and retain the character of the existing structure while maintaining the navigable waterway. The proposed bascule bridge will be designed according to current design standards, which will provide the following improvements:

- Allow the existing bridge to remain open during construction of the new bridge
- Comply with the current seismic code and the more stringent changes to the AASHTO seismic design specification that are expected to occur in the next few years
- Be constructed with foundations placed deep into glacial till to improve the bridge's sustainability during a seismic event and avoid the pier settlement problems
- Provide ground improvements to mitigate the effects of soil liquefaction during even a moderate seismic event
- Improve sightlines and stopping sight distance
- Provide roadway geometry, surface, markings and barriers that conform to current federal and local government standards
- Provide a safe combined pedestrian and bicyclist path on the bridge
- Provide a solid bridge deck permitting better collection of water, which will improve water quality at the site
- Improve visibility for drivers at the intersection of 14th Avenue South and South Dallas Street
- Provide state-of-the-art mechanical and electrical systems to improve operational control and reliability over the existing structure
- Improve life cycle costs of the bridge using better materials and a more robust design

The proposed replacement bridge will be constructed on the downstream (west) side and adjacent to the existing bridge. The alignment requires a slight bend in plan for the bridge to be built adjacent to the existing bridge while providing adequate clearance to keep the existing bridge in operation during construction of the new structure. This alignment was also chosen to provide adequate horizontal clearance between buildings belonging to the Boeing Company and the back for the sidewalk on the new bridge.

4.5.1 Cost Estimates for the No Action and Considered Build Alternatives as Indicated in the Draft EIS (September 2005)

Alternative	Total Construction Cost (2003 dollars)	Total Construction Cost (2008 dollars)	75-Year Total Operation & Maintenance Costs (2003 dollars)[1]
No Action	$7,000,000	$9 million	$0 [1]
Rehabilitation	$63,930,000	$74 million	$11 million
Bascule Bridge	$77,334,000	$90 million	$11 million
Mid-Level Fixed-Span Bridge	$61,523,000	$71 million	$2 million
High-Level Fixed-Span Bridge	$70,460,000	$82 million	$3 million

Figure 7: Cost Estimates for Considered Alternatives[15]

These estimates are useful for comparison purposes only. They were based on early engineering design and the cost of the 2003 construction market. A straight inflation rate of three percent was applied to calculate the 2008 construction costs. Construction costs have inflated at a much higher rate. There are significant changes in the estimates. For example, the current no action alternative is estimated between $9 and $20 million depending on whether or not the entire structure is removed or only the center bridge. The Bascule Bridge alternative is estimated at $150 million.

4.5.2 Required Permitting and Approval Agencies

A preliminary list of required federal, state, and local construction permits and approvals for the proposed project includes the following:

U.S. Army Corps of Engineers
Section 10 Permit
Section 106 Consultation
Section 404 Nationwide Permit

U.S. Coast Guard
General Bridge Act of 1946 (for bridge repair or replacement)

U.S. Federal Highway Administration
Section 106, 4(f) Compliance

U. S. Fish and Wildlife Service
ESA, Section 7 Consultation

U.S. National Marine Fisheries Service

[15] The operation and maintenance costs are the total amounts over the 75-year life of each of the bridge alternatives. These costs do not include the future annual operation and maintenance costs (averaging approximately $286,000 per year) for the existing bridge (from present until the existing bridge is demolished, or until construction were to start for the Rehabilitation Alternative).

ESA, Section 7 Consultation

Washington Department of Ecology
Water Quality 401 Certification
NPDES general permit for stormwater discharges
NPDES permit for construction activities
Coastal Zone Management Certification

Washington Department of Fish and Wildlife
Hydraulic Project Approval

Washington Office of Archaeology and Historic Preservation
Section 106 Review Consultation

Puget Sound Clean Air Agency
Demolition Notification (for structures containing asbestos)

King County
Shoreline Substantial Development Permit
Sensitive Areas Review
Public Agency and Utility Exception
Clearing and Grading Permit
Demolition Permit
Haul Road Agreement
Street Use Permit
Noise Variance for Nighttime Construction

City of Seattle
Public Agency and Utility Exception
Drainage Approval/Permit
Clearing and Grading Permit
Demolition Permit
Haul Road Agreement
Street Use Permit
Noise Variance for Nighttime Construction

City of Tukwila
Shoreline Substantial Development Permit
Sensitive Areas Review
Public Agency and Utility Exception
Clearing and Grading Permit
Demolition Permit
Haul Road Agreement
Street Use Permit
Noise Variance for Nighttime Construction

Port of Seattle
Easement to Construct over Duwamish Waterway Bedlands

4.6 Relocation

Reuse of the bridge in a new location is theoretically possible. Two examples of bascule bridge projects have been identified; one in Florida and one in Maryland. A bascule bridge in Florida (Royal Park Temporary Bascule Bridge) was reused in part. The Florida project (ASHE, 1998) removed the bridge from its failing foundation and placed it in a temporary location nearby to allow reconstruction of the foundation. A barge was used to float the bascule leaves off the foundation, move and place on the new foundation. This project was an emergency action and cost approximately $11.2 million. The Maryland example was a bridge replacement project for the Knapp Narrows Bridge (MDOT, 2003). The bridge was an overhead counter weight bascule span bridge 95 feet long and 20 feet wide. This small bridge was a single leaf. After an unsuccessful attempt to market it for re-use, it was placed along the entrance of the Chesapeake Bay Maritime Museum in St. Michaels, approximately five miles from its original location at Tilgman Island.

In comparison, the South Park Bridge is larger and relocating the South Park Bridge would involve most of the actions and costs associated with Rehabilitation Option 2 at $74 million. Additional costs not included in the rehabilitation option could include longer transportation, storage and additional permitting costs associated with a new location.

Challenges for reusing the South Park Bridge at a new location include:

- The estimated engineering cost (projected 2008 dollars) for rehabilitation and new foundations is $74 million. This cost does not include storage, transportation, and permitting in a new location.
- The piers were formed and poured around the mechanical and electrical mechanisms, necessitating demolition of the upper piers to remove many of the mechanical features. This action could damage the rocker arm and equipment.
- A new bridge location would have to match the span length of the bridge or be supplemented with additional spans.
- Permitting a new bridge on a river or waterway given the sensitive environmental constraints to shoreline development make the use of an old bridge in a new location a rare occurrence.
- The mechanisms and leaves are large and transportation options are limited for these items without further dismantling and impacts to the historic fabric of the structure.

Given the significant size of the bridge and the necessary equipment, storage, logistics, and cost, reusing the bridge at another site is not considered practicable.

5.0 Most Appropriate Action

5.1 Replacement with New Bascule Bridge and Demolition

Given the inability to correct the deteriorated condition of the structure and high expense of rehabilitating and reusing the bridge, demolition and replacing the bridge is needed to alleviate a threat to public health and safety.

RSD seeks approval from the King County Landmarks Commission for the following cumulative actions:

1) Demolish the existing South Park Bridge following construction of the new bridge; and

2) Implement historic resources mitigation as part of the 106 process.

5.2 Potential Historic Mitigation Options

5.2.1 HAER Documentation and;

5.2.2 Community Focus Group

Establish a Community Focus Group to develop and prioritize historical mitigation alternatives. Potential ideas include:

- Preservation of part of the bridge structure, gears, and/or mechanics at the Museum of History and Industry (MOHAI) in Seattle, or a suitable location in the South Park Community;

- Creation of South Park store front History Center featuring the bridge in the community or at the library;

- Re-use of salvaged railings, light standards, other elements in the community
- Display bridge parts along with a local history narrative related to the bridge and transportation corridor;

Remove the lead-based paint from a section of the bridge and tow it to a suitable location in Puget Sound or adjacent waters where it could be sunk to create an underwater habitat feature and a destination for sport divers.

Incorporate design elements of old bridge in the new bascule bridge

Bridge Teaching Kit: A Teaching kit incorporates teacher lesson plans on bridge history, design, and construction to provide history, math, environmental and engineering education for South Park Schools.

14th Avenue bricks: Incorporate bricks from the bridge and 14th Avenue into sidewalk and landscaping associated with the new bridge and wetland mitigation site.

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Glossary of Terms

Bascule Pier Foundations — The bascule pier foundations include the concrete footing, the piling embedded in the footing, and the concrete tremie seal.

Bascule Piers — The bascule piers are thick reinforced concrete walls that support the rolling girder tracks, the bascule leaves, and one end of the steel truss approaches. The walls surround a large, deep counterweight pit. When the bridge rolls back in the open position, the counterweight sinks into the pit in the center of the pier. The bascule piers also contain the operator's house, where the controls that open and close the bridge are located.

Bascule Leaves — The bascule leaves form the movable span portion of the bridge. This includes the steel truss superstructure (which supports the deck and sidewalks), the steel rolling girders (which are part of the lift mechanism), and the counterweights. The existing bridge deck is an open-grated steel deck system. The motor rooms that drive the lift mechanism are also contained on each bascule leaf near the counterweights.

Steel Approach Truss Foundations — The pile cap and piling comprising the foundation support the steel approach spans.

Steel Approach Truss Piers — Steel approach truss piers support the truss and deck. The existing piers are lightly reinforced concrete.

Steel Approach Trusses — Steel approach trusses support the bridge approach deck.

Concrete Approach Foundations — Foundations for each concrete approach pier column consist of a square footing and four piles.

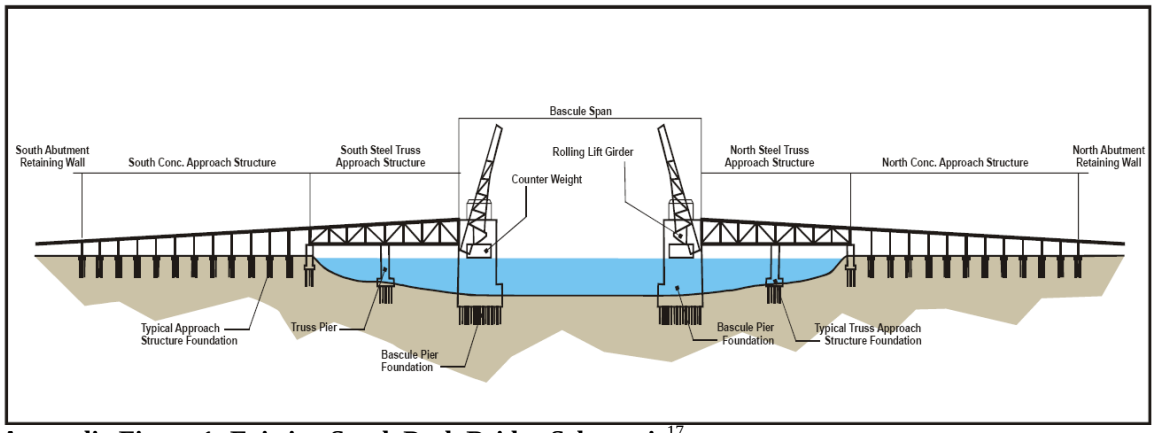
Concrete Approach Piers — Concrete piers support the concrete slabs. Each pier is comprised of three columns. Typical concrete approach pier columns are 22 inches square and lightly reinforced.

Concrete Approach Slabs —Six spans of concrete slabs supported on approach retaining walls form the concrete approach deck at each end of the bridge.

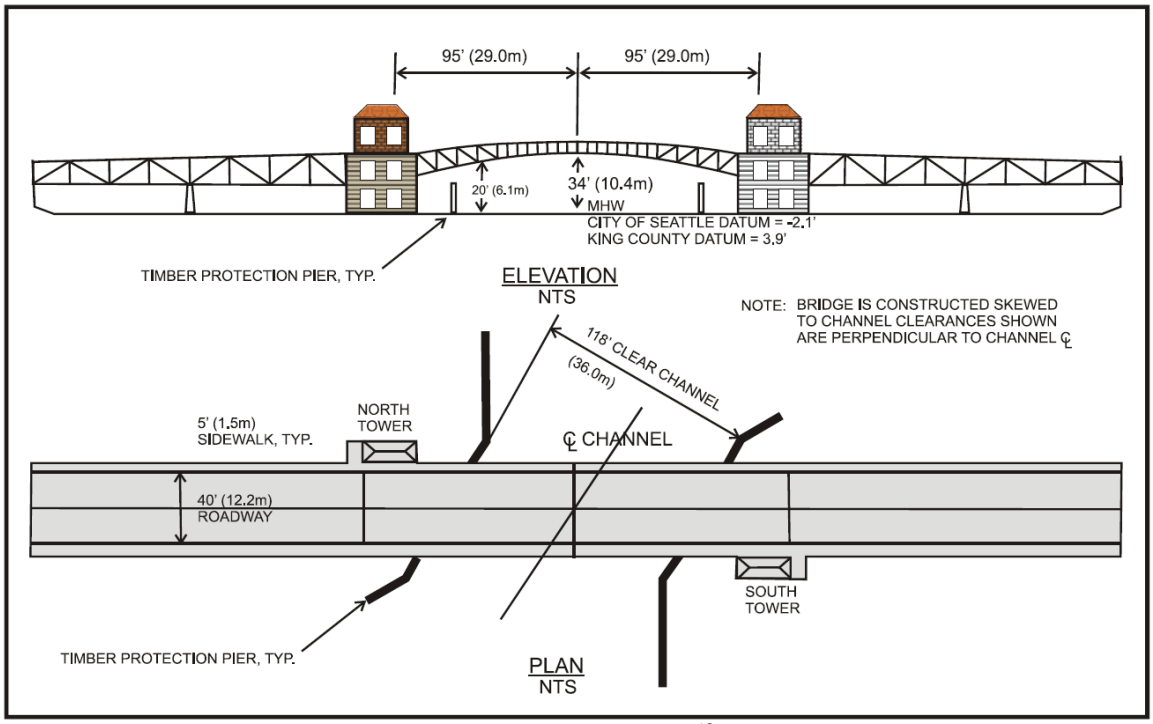
Abutments — Reinforced concrete structures that support the ends of the first (lowest) span of each concrete approach.

Retaining Walls — Reinforced concrete retaining walls hold retained fill between the abutment and the point at which the roadway returns to grade.

Appendix A: Additional Bridge Design Figures

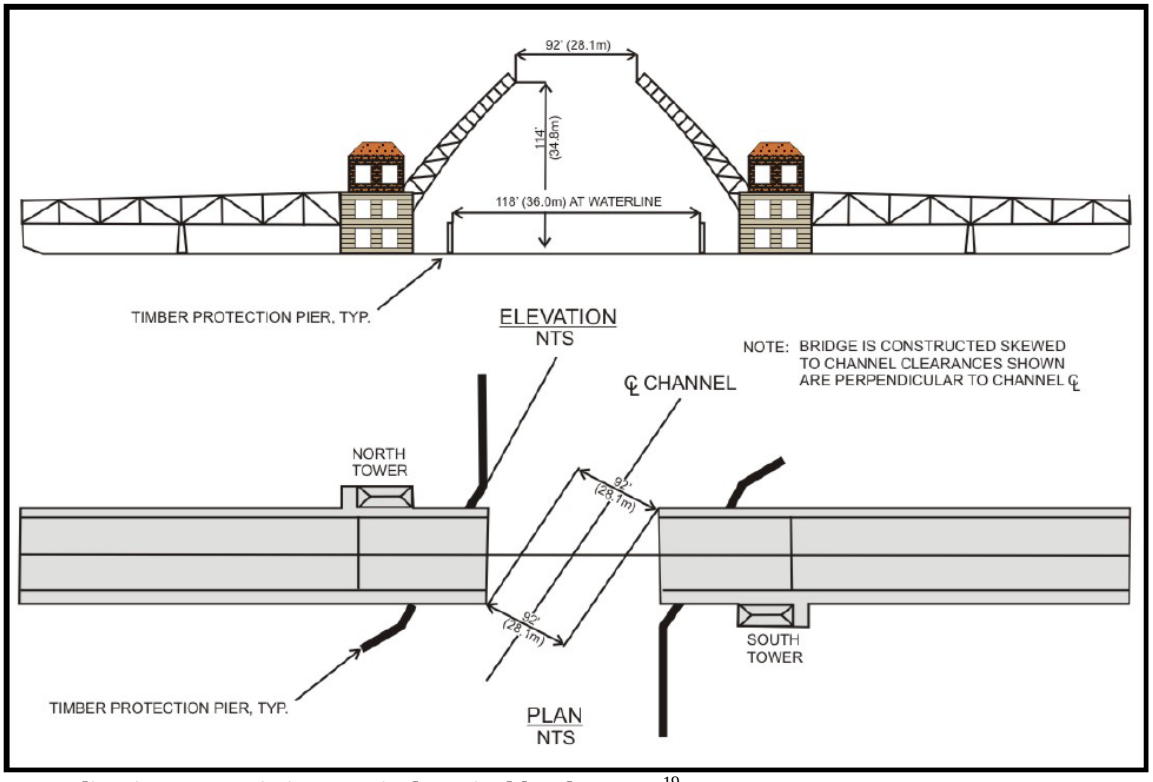


Appendix Figure 1: Existing South Park Bridge Schematic[17]



Appendix Figure 2: Existing Horizontal Navigable Clearance[18]

[17] From PB Americas, Inc., et al., (2007)
[18] Ibid.



Appendix Figure 3: Existing Vertical Navigable Clearance[19]

[19] From PB Americas, Inc., et al., (2007)

Appendix B: King County and Washington Landmark Documents