South Park Bridge Replacement Offsite Analysis Field Inspection

Study Area Definition

A field inspection analysis was performed on December 31, 2008 for the South Park Bridge Replacement project. The inspection was conducted with the intent of evaluating one mile upstream and downstream of the proposed project to determine the conditions of the existing drainage patterns and discharge locations. The investigation was conducted keeping in mind how the proposed improvements could potentially impact the existing drainage patterns and conditions. The field visit was performed to meet and exceed the requirements established in the King County Surface Water Design Manual (2005, page 1-21, section 1.2.2). Due to fencing, security barriers, and lack of permission to cross private properties, the shoreline was not walked the full mile up and downstream of the project vicinity. Visual inspection of the shoreline and outfalls were performed from the limited area open for pedestrian access, up on the bridge, and from vantage points across the waterway to the opposite shoreline. Photographs were taken to document field observations and findings. Where access was available adjacent to the waterway, the area was walked. However, much of the waterway was not accessible for pedestrian use and the field investigation was restricted to the right of way and roadway adjacent to the waterway. The roadways up and downstream of the project location were driven in an attempt to find alternative access locations to walk the waterway. However, the roadways are cut off by Boeing (up and downstream) on the east side of the waterway and all access to the shoreline is restricted. On the west side of the waterway, South Sullivan Street “dead ends” at a City of Seattle water quality treatment facility and Boeing facilities. Since the limited access did not fulfill all of the requirements of the up and downstream analysis for the project, record information provided by Boeing will be used to supplement the field investigation and document up and downstream characteristics of the waterway.

The field visit was performed by Jim Rhodes and Tony Marti. The day was cold and breezy just after a significant snow storm that affected the entire Puget Sound. The only remaining snow was in compacted icy piles or balls (snow men) in a few private yards. The public right of way was free and clear of snow and ice. Some areas still had sand on the side of the road from ice and sanding operations. The temperature was approximately 40 degrees Fahrenheit. Recent rains had washed away any traces of snow, but clearly highlighted drainage deficiencies on public and private property.

During the field visit, the following information was investigated and photographed:

- Checking existing survey documentation.
- Identifying elements requiring additional survey investigation.
- Field verifying established basin boundaries and sub-basin boundaries.
- Identifying the field conditions for pervious and impervious areas.
- Identifying existing signs of drainage problems associated with on and off-site properties.
- Checking drainage patterns for signs of erosion, flooding, and ponding.
- Evaluating upstream and downstream parcels that may affect site drainage characteristics.
- Evaluating upstream and downstream parcels that may be affected by the proposed project.
- Evaluating existing off-site water draining into the project area.
- Evaluating project water that may be draining off-site.
- Evaluating existing outfalls and other drainage characteristics within the project vicinity.

Appendix A of the Hydraulics/Stormwater Pollution Prevention Plan Technical Information Report contains exhibits showing the project limits, basins, sub-basins, as well as existing and proposed drainage

characteristics. Appendix L contains basin summary maps showing critical areas, flood plain information, groundwater aquifer maps, and other drainage area boundaries.

Resource Review

The project lies within the designated floodway for the Duwamish Waterway. Slightly upstream on the Boeing side of the river is an area designated as part of the 100-year flood plain. A net rise analysis has been performed for the project to address water surface elevations impacted as part of this project. Shoreline restoration and grading is planned for the project to maintain a zero net rise condition for the area to prevent up and downstream areas within the 100-year flood zone from impacts caused by the project. Within the project limits, commercial water quality treatment facilities are not reported or documented. However, up and downstream of the project commercial water quality treatment facilities are present. The Port of Seattle has a large well maintained water quality treatment facility three blocks upstream of the project. On the north side, Boeing has various flow control and oil treatment appurtenances for water quality treatment.

Drainage complaints have been submitted to the County and are logged in the GIS special data base for some of the residential lots between Dallas Avenue South and South Orr Street. Specific complaints could not be found, however, several of the reported parcels were investigated during the field visit and did show evidence of long term drainage issues. It was also noticed that private owners were not making any effort to correct drainage deficiencies on private property. Photographs in this report are intended to help illustrate specific drainage issues and concerns within the project area.

The criteria established in the King County Stormwater Design Manual, 2005 (KCSWDM) have been followed for a Level 1 analysis. Portions of the site are somewhat inaccessible due to security fencing, gates, tides, and limited public roadway access. Areas available for public access were walked and visually inspected for potential lack of capacity of the existing drainage system, downstream drainage problems, scouring, bank sloughing, habitat characteristics, pervious and impervious surface use, existing pipe conditions, drainage structure conditions, and verify drainage areas. Local owners/tenants were not contacted for verification of existing drainage problems. Observed drainage problems were photographed and documented in the report.

Site Specific Observations

The following is an itemized listing of photographs documenting observed drainage characteristics and issues within the project vicinity. The following numbers correlate to the attached exhibit documenting the photograph number and direction the picture was taken:

1) Photograph of the existing gravel driveway graded to drain toward Dallas Avenue S. on parcel number 2185001045. The existing gravel driveway is graded behind the "bar" to drain from the brick road west around the building and discharge onto Dallas Avenue South. The left corner is the existing "bar" and straight ahead is the elevated parcel 7883607340. The existing bar drains away from the building toward the raised tire stops adjacent to Dallas Avenue South. Dallas Avenue south drains west toward existing catch basins and combined storm/sewer system.

2) This photo is looking east up Dallas Avenue S. toward the intersection with 14th Avenue South. To the left of the picture, the existing sidewalk is broken and unusable due to the tree roots. The gutter on the left side of the street is a "thickened edge" gutter one foot wide and raided approximately one tenth of a foot to channel water toward a catch basin. On the right is parcel 7883607340 that is elevated above the existing street and drains mostly toward South Sullivan Street. This photo also represents the wet gutter areas that are not well draining. This location is the approximate location for matching between the existing and proposed construction. The standing water on both sides of the street is indicative of flat gutter grades and an inadequate number/spacing for inlets.

3) This photograph is a close-up of the faulted concrete "flat-work" adjacent to the driveway and un-kept flow line. These two trees may need to be removed as part of the project to correct the drainage condition. The roadway is concrete and the panels around these trees may need to be removed due to roots growing under the roadway.

4) This photograph was taken two lots west of the "bar." This parcel does not drain onto the roadway and the thickened edge of pavement is the only barrier separating roadway water from the existing parcel. The existing driveway is muddy and shows signs of saturation due to the lack of on-site drainage. An existing concrete ramp is graded to the basement and is overgrown with moss. The right corner post of the building is showing significant signs of rotting and deterioration on the siding indicating a long term drainage problem with this property. The cracked walkway also indicates long term settlement on the property. We could not determine from a field visit if drainage plays a part in settlement issues on this lot.

5) This photograph shows the thickened edge of the roadway and the slope of the gravel surface away from the road. Since private parcels drain away from the roadway, they will not be included in the tributary areas for the storm drainage design or considered off-site areas for the project. The roadway drainage seems to drain toward the intersection shown in the distance (away from the project).

6) This photograph shows the relationship between the roadway, property to the left and right. It should be noted, the property to the left is draining directly toward the property on the right. The house on the right shows significant signs of disrepair and damage due to water including rotten posts, siding, and swampy yard area.

7) This photograph is intended to show the formed drainage channel separating the building from the parking lot. This picture shows the formed concrete "V" channel discharging directly toward the adjacent private residence. The grassed area drains directly toward the adjacent properties house. The paved parking area drains toward the street and westward away from the project area.

8) This photograph shows the cleared lot adjacent to parcel 7883607340. Based on the remaining concrete driveway and wooden buried beam, and drainage structure, this lot used to have a structure in this location. An existing catch basin or cleanout is still in place and a concrete pipe is buried inside the catch basin. The pipe size is approximately 6 inches in diameter and verification of any connection location to an existing system could not be determined.

9) This photograph shows a general state of disrepair in the project vicinity and the general observed attempt to resolve drainage issues in the neighborhood. Some private residences have downspouts that connect to underground yard drains. We were unable to determine if the yard drains connected to the public system or were infiltration type trenches going to septic systems. In one location (not shown) we were able to identify a 4 inch PVC pipe connecting from a private residence into the public catch basin. Most parcels within the project vicinity are lower than the street or alley and seem to infiltrate runoff.

10) This is looking west on Sullivan Avenue South showing the curb and gutter condition, the general water ponding and spotting in the flat gutter grades. Some of the driveways on this street drain onto the street from the back of walk. In general, private lots drain from the back of walk into the lot and away from the road. It could not be determined if the water was infiltrating naturally, into french drains, or other underground private drainage systems. A few parking garages have roof drains that discharge onto the sidewalk and into the street. This photograph is at the proposed project limit/ connection location. The street gutters are draining west (away in the picture) and off-site.

11) This is an existing parking lot and driveway access onto Sullivan Avenue South. The parking lot has large potholes that are approximately three to four inches deep. The cause of the significant potholing is unknown and cannot be determined with a field visit. We were unable to determine if the potholing was caused by drainage problems, traffic loading, settling, or other unobserved issues.

12) Photograph from S. Sullivan Street looking north showing the private property grading draining into the lot rather than out onto the South Sullivan Street. The garage downspout is draining into the public right-of-way. However, Sullivan Street drains away from the project limits, and this off-site water will not impact the proposed improvements.

13) This photograph is directly across the street from picture number 12 and looking south from S. Sullivan Street. The driveway drains from the house into the driveway, and from the house back into the private lot. No standing water is present, but in the lower right hand corner of the picture the grass planter strip has been damaged by tire ruts. The soil is very wet to saturated with water and was not able to resist rutting under the tire pressure. There does not seem to be any private sprinkler systems in the grass planter areas.

14) This is looking east toward 14th Avenue South from S. Sullivan Street. The curb and gutter does not drain very well due to flat grades. The muddy debris and settled particulates in the gutter pan indicates slow moving water and/or standing water allowing settlement in the gutter pan.

15) This is looking east from Dallas Avenue South across the bottom of the bridge approach. The existing roadway is concrete, well sloped and crowned to provide good drainage through the intersections.

16) This picture is looking west toward the County Line Bar. The drainage flow line is under the white van approximately 10 feet from the edge of the building. Existing catch basins collect the water and convey it in the combined storm/sewer system. The existing surface within the project is a combination of concrete, asphalt, exposed earth, gravel, and grass.

17) This is the gore area at the bottom of the bridge that drains into the existing catch basins and combined storm/sewer system. There is not any curb and gutter on the bridge. The walk seems to be cast integral with the roadway and has small 2 inch diameter pipe scuppers. The scuppers were plugged with sand during the field visit. The maintenance program in place for unplugging the scuppers has not been investigated. We are assuming all water from the abutments is draining down into the catch basins located at the bottom of the approaches.

18) This is the Boeing side of the bridge looking south. The bridge approaches drain down into the catch basin at the bottom of the grade. The roadway is crowned in the middle of the road and slopes at approximately 2% toward the fog line/ flow line. The curb line is not the flow line and drains away from Boeing toward the catch basin in the street. In a sense the roadway section forms a "W."

19) This photograph of the brick road is looking south toward the river from the south end of the bridge. The existing brick road is crowned to drain to the left and right. On the right (west side of the road), the water drains down into a low hole under the bridge. Standing water was observed under the bridge abutment wall. Two catch basins are located under the bridge. The catch basins have not been surveyed. The pipe connections, direction of flows, and depth of the pipes needs to be determined for the storm drain design.

20) This photograph is the same location as picture number 19, looking south. The natural drainage pattern is toward the bottom left of the picture and down into the area under the bridge.

21) Photograph of the gravel driveway behind the County Line Bar draining behind the building toward Dallas Avenue South. It is possible some of the water surface drains toward the boat repair yard.

22) This picture shows the vertical elevation drop from the brick road down into the private lot adjacent to the bridge and abutment walls where the ponding was observed.

23) The brick road looking toward the Duwamish Waterway shows signs of settling. The existing roadway is crowned and even parabolic in some locations. No standing water was observed on the brick.

24) This is looking west on S. Orr Street. One residence has the yard drain connecting into the public drainage system. This street does not have any curb and gutter or barrier separating surface flows from private and public property. However, most of the properties seem to be lower than the roadway. On the Duwamish Waterway side of the street (right), the properties seem to drain into the Waterway. The roadway is cracked and does have some water ponding on the surface. This road seems to surface drain toward the bridge and the Duwamish Waterway, but the conveyance system drains toward the combined storm/sewer system.

25) This picture is looking west on South Thistle Street from under the bridge up toward the brick road and the intersection with South Orr Street. The elevation of the building on the right is significantly higher than the street elevation. The property on the left drains under the bridge toward two catch basins that are in King County right of way under the bridge. Access to the catch basins was blocked by a fence. On the right, the surface water runoff drains into the outfall near the boat ramp.

26) This is looking up the private boat ramp toward the marina building and intersection with South Thistle Street. The brick catch basin and 24 inch diameter corrugated aluminum pipe outfall is located right of the picture. The fence is King County fencing under the bridge.

27) This is the left side of the private boat ramp looking up toward the marina building and intersection with South Thistle Street. To the left of the boat ramp is an ecology block wall constructed on the marina/channel bank. Much of the bank is unprotected within the marina. Based on visual observations only, the water within the marina was "calmer" than the waterway. The calmer water is most likely due to the water velocity damping caused by the docks and boats.

28) This is an example of the shoreline within the marina. The ecology blocks are constructed on the waterway slope. The slope is unprotected in some places, and has rock in others. The occurrence of rock and exposed earth is not consistent. The green growth on the blocks indicates constant exposure to water. The moss is present well above the prevailing high water elevation and indicates the presence of water draining through the block wall from under South Thistle Street and the marina boat yard.

29) The boat yard and marina is paved and drains into local catch basins. The catch basins have down-turned elbows to trap oils and sediment from marina boat construction activities. The level of contamination, water quality treatment, and capacity to contain source pollutants was not determined during this field visit. For the purposes of this report and storm drainage design, we will assume off-site water will be treated and clean prior to discharge into the public right of way or conveyance system

30) Within the marina access road, two old pile were observed to be protruding from the pavement. One pile was protruding and one was punching the pavement up. The pile were cut flat on the top and the parking lot/access road was paved over the pile. The extents of the abandoned pile system is unknown.

31) This is a picture of a private off-site marina catch basin with a down-turned elbow in it. Without quantifying the contamination present, there seems to be a lot of oil and "muck" in the structure.

32) This is a close up picture of the public outfall catch basin. The outfall is a 12 inch corrugated aluminum pipe in seemingly good condition. A perforation study, soils corrosion testing, and time to perforation study have not been performed for this pipe to determine actual pipe conditions and characteristics. However, the pipe was not bent, oxidized, or deformed in any way and sounded "good" when struck with a hammer leading us to believe it was in "good condition." When we pulled the lid off of the catch basin we found the entire structure to be constructed of brick and mortar with an inlet pipe pointing toward the brick road, and the same size outlet pipe pointing toward the waterway.

33) Picture of the existing south basin outfall, varying slope protection, and bridge pier.

34) The shoreline south of the marina boat ramp is grassy in the upland area, and muddy with concrete slope protection. The concrete pieces do not lock together well and leave significant areas of the bank exposed for erosion. The concrete pieces seem to average four to six inches thick and two to three feet in "diameter" (if diameter can be used loosely). The boat ramp can be seen in the middle of the picture under the bridge.

35) Further downstream, at the end of the brick road, the shoreline becomes steeper, and rock stabilized. The rock seems to leave less voids exposing earth/mud for erosion.

36) The existing marina building has roof drains that discharge directly into the “alley/roadway” adjacent to the bridge via 4 inch diameter high density polyethylene pipe. The roof of the entire building will be estimated for off-site flows into the project for the purposes of sizing the conveyance system.

37) The Tire Factory building roof drains into the "alley/roadway" via 4 inch diameter high density poly ethylene corrugated black pipe. Note the pavement crack at the discharge location.

38) The Tire Factory paved loading and parking area as well as roof surface drain into the public right of way. The water seems to drain (north) toward the waterway. This will be treated as off-site water and included for the design of the conveyance system only.

39) This is looking north down the ally/roadway toward the marina and public outfall. The alley/roadway drains toward the waterway.

40) This is a picture of one of the catch basins under the existing bridge. This is graded in an attempt to drain the low spot at the abutment walls. The catch basin is surrounded with quarry spalls to help stabilize the ditch path.

41) This is a picture looking west up Dallas Avenue South. The Tire Factory is on the left. The paved loading and parking area seems to drain toward the edge of the roadway and west into the combined storm/sewer system. A catch basin with down-turned elbow was found at the corner of the building indicating water quality treatment prior to connection to the combined storm/sewer system.

42) Continuing east past the Tire Factory on Dallas Avenue South, the marina has a paved driveway access and roadway into a boat yard. During the field visit, we observed on several occasions the movement of materials and equipment from one yard to another. This drains toward the waterway and marina conveyance system.

43) Further east up Dallas Avenue South, the road "dead ends" at a City of Seattle Public Utilities Treatment Facility. The area is fenced and signed for no admittance, the surrounding area shows significant man-made improvements to protect inlets and provide surface water quality treatment.

44) The site has underground extraction pipes, curbs, catch basins, manholes, control structures, and vaults, material storage areas, and is graded to contain water. The site does not drain into our project and is approximately one-half mile upstream of the project limits. This site will not be accounted for in the design of the project storm drainage system.

45) Between the marina and the City of Seattle treatment facility, the Port of Seattle has a parcel of land that is directly adjacent to the Duwamish Waterway upstream of the project. The site is paved, and seems to drain toward the street and the waterway. Since surface water does not drain into the project vicinity, it will not be accounted for in the design of the project storm drainage or water quality treatment facility. Records of ground water contamination have been provided by King County and do not provide on-site indication of contamination.

46) This is on the left side of the Dallas Avenue South looking west toward the intersection with 14th Avenue South. A two foot piece of concrete drains away from the building and toward the asphalt driveway. The driveway is warped to drain. The street side of the sidewalk is higher than the building side of the walk and water drains from the sidewalk toward the building. This will be evaluated during the design process.

47) Turning the corner and looking south along 14th Avenue South, the sidewalk drains toward the street. The buildings do not seem to drain into the street and will not be included as on or off-site area contributing to the drainage system for the proposed project. The existing curb and gutter seems to be "fairly flat" and has water ponding in the gutter pan as well as debris scattered along the flow line. This is indicative of flat grades, and low flowing gutter velocities. Adjacent to the light pole (center of picture) is an alley entrance and bus shelter. We drove the alley and noticed the properties were not draining into the alley and into the street. The drainage characteristics around the bus shelter and further up the street were not investigated due to the type of local wildlife/activities in the area at the time of the field visit. Pictures were not obtained because we ran out of "memory" and did not want to attract additional attention.

48) This is a picture of the area between South Sullivan Street and South Cloverdale Street taken from across the street. The buildings have roof drains and the parcels are graded to drain toward the public right of way from the building face. The drainage boundary will be considered the face of buildings.

49) In front of the building on the southwest corner of the intersection of 14th Avenue South and the alley between South Sullivan Street and South Cloverdale Street, the sidewalk is broken, sinking, and eroding from underneath the surface.

50) Close up photograph showing where the surface water is under-cutting the sidewalk.

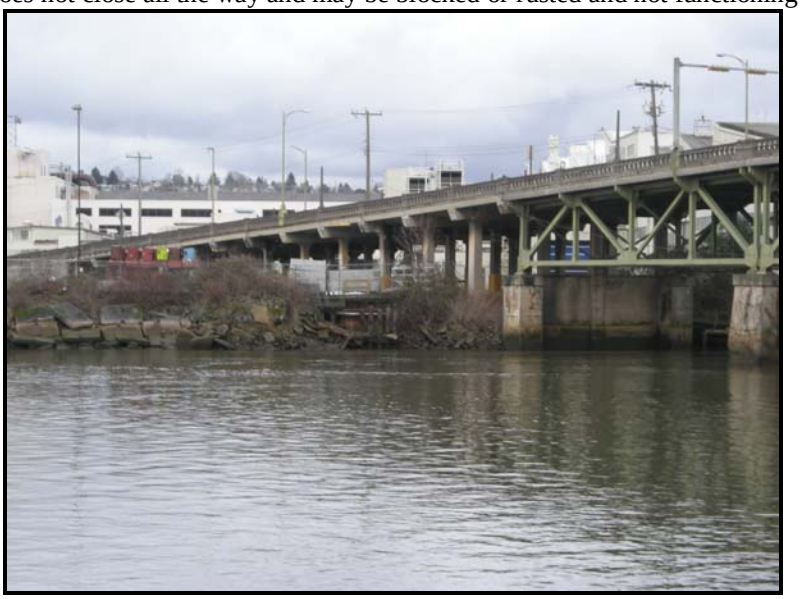
51) Approximately fifty feet back into the alley are two storm drainage grate inlets. One of the grates is in place and "solid," the other is missing. Storm water runoff seems to be draining under the existing building. The hole is approximately 3 feet long and a foot and a half wide. Alcoholic beverage cans and bottles of all shapes and sizes have been stuffed into the hole over a long period of time preventing us from seeing under the building. Based on the visual observation between the two inlets, we believe water is currently draining under the building. Where it goes from there is a mystery. Based on the condition of the existing sewer drain on the outside of the building, the interior has had several remodels, or renovations to the interior. The sewer drain plumbing is not well supported, joints are not well glued, not insulated, and not well maintained.

52) This is a close-up of the existing storm drain grate seemingly draining under the building. The dark stain and moss on the wall as well as the vegetation indicate water drains along the building wall and alley. The condition of the joists, insulation, studs, and other structural members of the building are unknown.

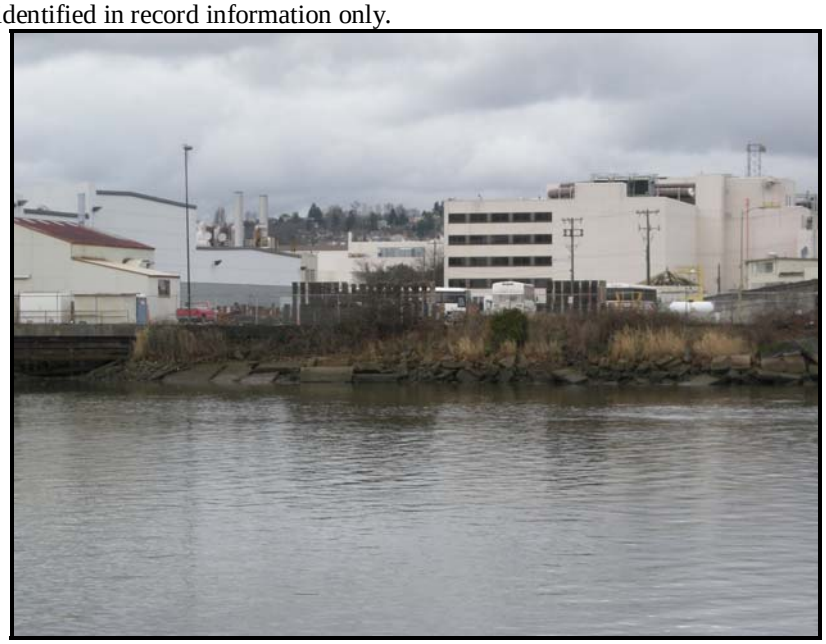
53) This is a close-up of the missing grate. The building does not seem to have any supports in this location.

54) This is a picture showing the "kinked" sewer cleanout wye fitting connection and the pipe. The cleanout plug was found in the open position and the pipe half full of leaves and debris. The small alder tree growing out of the crack between the wall and pipe indicate this plug has been open for at least one summer. This is a poorly maintained area of the building. We did not touch it or alter this condition in any way. Minimum maintenance responsibility should include capping the cleanout and pulling the tree.

55) Access to the Boeing and public outfalls were not possible on the north side of the waterway. This photograph shows the relationship of the slope, slope protection concrete against the existing Standard Oil Dock as well as the steel shoring and public outfall penetrating the shoring. The line of green growth on the concrete indicates the prevailing water elevation affected by the tide. The existing public outfall seems to be above the tide influenced area but has a tide flap on the pipe. The flap does not close all the way and may be blocked or rusted and not functioning properly.



56) This photograph shows the end of the earth and concrete shoring against the Standard Oil Dock now used by Boeing. The characteristics of the shore under the Boeing building were not examined due to the lack of access. The discharge locations under the building and from the roof were identified in record information only.



57) This photograph is further downstream and shows more of the shoreline that could be observed from the opposite shore. There are remnants of old pile still in the waterway. The use or condition of the pile could not be determined during the field visit. We have no validation for this statement, but the part of piling under the water is usually in better shape than the part exposed to the air. The end of the Boeing building and piling can be seen and the beginning of the concrete and rock shoreline begins.

58) Looking from the marina, across the waterway, upstream on the northeast side of the waterway, Boeing buildings are directly adjacent to the waterway and roof drain into the waterway. Drainage basin boundaries have been provided by Boeing showing existing conditions. Lots of questions remain regarding the Boeing facilities. A field survey was performed, historic record were examined, and Boeing as-builts were reviewed to piece together the conditions of the existing system. There seem to be inconsistencies between the documented record information and conditions observed in the field. In example, one outfall is documented as a 12 inch diameter concrete pipe and the surveyors found an 18 inch diameter steel pipe. Another outfall is in good condition and controlled with a weir, but the surveyors found an upstream manhole with a plugged hole in the direction of the outfall. Some of these will need to be resolved during construction.

59) This is a picture of the existing "18 inch diameter concrete pipe." The metal tide flap on the end does not close completely. The pipe is supported by braces between four pile. The pipe penetrates and extends well beyond the metal shoring material under the fence line. A smaller service pipe can be seen crossing over the outfall along the top of the metal shoring system. The pipe function is unknown, but is most likely associated with the Boeing parcel.

60) A better picture angle on the northwest side of the bridge showing the public outfall, pile, metal shoring, un-insulated Boeing service lines, and green growth indicating the high water elevation.

61) This is a picture on the northeast side of the bridge of a Boeing outfall. The existing survey information reports an upstream manhole that has been blocked making this line abandoned. Tom Colligan with Floyd-Snider (Boeing consultant) reported in a phone conversation 01/09/09 that the structure on the end is a weir control. The pipe is not thought to be plugged or filled with controlled density fill material and the validity of the system being abandoned is uncertain. A small PVC pipe extends from under the Boeing building and also discharges into the waterway.

62) This picture is on the northwest side of the bridge looking across the Boeing parking area and under-crossing adjacent to the shoreline and waterway. The entire surface is paved and graded toward catch basins. Due to the large flat areas, standing water was observed in many locations across the parking area. This picture is close to the location for the new bridge alignment. Note the small patch of remaining snow in the lower left corner. Plowing may have dislodged the wheel stops.

63) This is a better picture under the existing bridge looking toward the south side of the project.

64) This picture is an area that may be used for temporary construction staging and storage during the construction of the bridge. Shallow standing water pools indicate flat grades and undefined drainage patterns. Part of the established driving corridor seems to be concrete, not asphalt.

65) The surface drainage seems to be from the right of way toward the street on both sides of the road. Public catch basins and conveyance system connected to the public outfall are located along the edge of traveled way.

66) This is looking from the existing bridge north toward East Marginal Way on/or close to the proposed bridge alignment from the northwest end of the existing bridge.

67) This is a picture looking south toward the waterway from the existing northeast side of the bridge. The curb line is higher then the roadway and drains toward the flow line at the edge of traveled way. The roadway typical section forms a "W" in this area.

Not pictured is the intersection of East Marginal Way and 16th Avenue South. East Marginal Way seems to drain westward away from the project. A combined storm/sewer system runs parallel with East Marginal Way and is thought to convey water away from the site. Surface water cannot cross the existing railroad tracks separating 16th Avenue South from East Marginal Way. For the purposes of this drainage evaluation, the tracks will be the northern most limit of the basin boundary. Off-site Boeing water does not seem to drain into the project. However, Boeing water is collected and conveyed into the public storm system discharging at the public outfall. Based on the field walk, very little of the north part of the project is pervious area. What minor amount of pervious area there is seems to be "hard packed" material. For the purposes of designing conveyance systems, the entire north basin will be considered impervious surface.

In conclusion, the project is two separate basins divided by the Duwamish Waterway. The north basin is a fully impervious area through a heavily commercial portion of the Boeing industrial area. The south basin is a mixed residential, commercial, and retail area with a mix of pervious and impervious surfaces. No signs of historic flooding were observed during the visit even though the area is in a federally regulated flood plain region. Based on the "green" rocks and concrete, the waterway seems to have a fairly constant elevation with a relatively consistent tide level.

Several locations were identified within the south basin showing uncorrected long term drainage problems. Specific locations have been photographed and identified in this report. Conditions will need to be evaluated on a case specific basis during the design process.