AS-BUILT REPORT

TECHNICAL INFORMATION REPORT

King County International Airport Emergency Drainage Basin #5 Stormwater Reroute

Prepared for

King County International Airport
7233 Perimeter Road
Seattle, Washington 98108

February 22, 2010

URS

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This document has been prepared under the supervision of a registered professional engineer.

EXPIRES: 04-08-11

Date Signed: FEB. 24, 2010

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1.0 PROJECT OVERVIEW

This Project Summary Report has been prepared in order to obtain after-the-fact permits for the Emergency Drainage Basin #5 Stormwater Reroute at King County International Airport (Airport). Construction activities occurred in late November and December 2009.

Following concerns specific to the stability of the right abutment of the Howard Hanson Dam, the US Army Corps of Engineers determined in 2009 that it was necessary to lower the maximum pool level for flood storage below the normal maximum operating elevation for the dam. The lowered capacity of the dam was expected to result in higher water levels in the Duwamish River during the fall and winter of 2009/2010. In anticipation of higher water levels in the Duwamish River, the Airport rerouted stormwater runoff from Storm Drainage Basin #5, which prior to this project drained directly into the Duwamish Waterway. The rerouted stormwater was connected to a portion of Storm Drainage Basin #2, and now flow to an existing onsite pump station and then to an outfall that is protected by a series of tide gates and tide valves designed to keep water from the Duwamish River from backing up onto the Airport.

The Airport is located in south Seattle, south of the city center between I-5 and the Duwamish Waterway. The Airport is bordered by Albro Place and South Norfolk Street on the north and south, respectively, and Airport Way South and East Marginal Way to the east and west. The site location map and project site plan are presented as Figures 1 and 2, respectively.

1.1 PRE-PROJECT SITE DESCRIPTION

The stormwater runoff reroute affected Storm Drainage Basin #5 and a portion of Drainage Basin #2. Please see Figure 2 for a Project Site Plan with basins delineated.

<u>Storm Drainage Basin #5 and Outfall #5</u>

Storm Drainage Basin #5 (Basin #5) is approximately 13.04 acres and consists primarily of asphalt and concrete pavement. There is a small grass area running along the Air Operations Area (AOA) fence, which in order to be conservative for this design, was considered as impervious area. From east to west, Basin #5 covers the area from the centerline of Taxiway Bravo, to the west edge of the Airport property at East Marginal Way S. From north to south, it covers the area from approximately 800 feet north of the Control Tower, to approximately 800 feet south of the Control Tower. The basin is generally level and uses catchbasin inlets, manholes, trough drains, and storm drain pipes to convey water by gravity to the City of Tukwila storm system and eventually to the Duwamish Waterway via a 24-inch storm drain (Outfall #5).

The storm drain line conveying flow to Outfall #5 is a 24-inch diameter reinforced concrete pipe (RCP). WH Pacific surveyed the portion of the system connected to the airport in September 2009 for the *Draft Outfalls Evaluation* (URS, 2009), but not the pipe system downstream of airport property, south of the Control Tower. The location of Outfall #5 where it discharges to the Duwamish River has not been able to be located in the field by URS or WH Pacific, during an August field visit or during the September survey. Therefore, the condition of the pipe and the presence of a tide valve are not known.

<u>Storm Drainage Basin #2 and Outfall #2</u>

The entire Storm Drainage Basin #2 is approximately 200 acres. From east to west, Basin #2 covers the area from the centerline of Runway 13R-31L, to the centerline of Taxiway Bravo. From north to south, it covers approximately the same length as Basin #5. The basin is generally level and uses catchbasin

inlets, manholes, edge drains, and storm drain pipes to convey water by gravity to a pump station, which eventually discharges to the Duwamish Waterway via a 48-inch storm drain (Outfall #2). The portion of Basin #2 that drains the west-midfield is approximately 22.24 acres and consists of asphalt and concrete pavement, as well as two large grassy swales between Taxiway Bravo and Runway 13R-31L, which for the purpose of this evaluation were considered as impervious area.

Outfall #2 is a 48-inch diameter corrugated metal pipe (CMP). The outfall at the river is supported by a timber structure and the outlet channel appears to be stable and free of debris. There is no tide valve at the river; however upstream, at the outfall of Pump Station #2, backflow is controlled using four 20-inch diameter duck bill style TideFlex, Series 37 valves. Since these valves were installed in 2005 they are expected to be in good condition. The pumps were replaced in 2004 and the pump station enclosure was moved to a below-ground structure in 2005, incorporating demolition of the above-ground structure and installation of removable lids.

1.2 PROJECT DESCRIPTION

The project to reroute the stormwater runoff from Basin #5 to Basin #2, as presented on the as-built drawings included in Appendix A, was completed in November and December 2009, and included the following work:

- Installed a new 72-inch diameter manhole east of Manhole 1808 in Basin #5, which tied-in to an existing 24-inch diameter clay storm drain that led to Outfall #5.
- Installed 192 feet of new 24-inch diameter RCP storm drain between the new 72-inch diameter manhole in Basin #5, and the existing 72-inch diameter catchbasin CB-4-G in Basin #2.
- Plugged the existing 24-inch diameter clay storm drain at MH-1-E to disconnect KCIA drainage from Outfall #5.

After completion of the project, stormwater runoff from Basin #5 now flows through the existing 24-inch diameter clay storm drain, into the new manhole, and then through the new 24-inch diameter RCP storm drain into the existing catchbasin CB-4-G structure, where it combines with runoff from a portion of Basin #2. The combined runoff then flows through the existing 36-inch diameter storm drain downstream of the catchbasin, to Pump Station #2, through the backflow valves, and then out to the Duwamish River through Outfall #2.

Please see Appendix C, Construction Photo Log, for select photographs of project construction activities.

2.0 CONVEYANCE SYSTEM CAPACITY CALCULATIONS

2.1 NEW CONVEYANCE PIPE CAPACITY CALCULATION

Calculations were conducted in order to size the new pipe that now conveys the stormwater runoff from Basin #5 to Basin #2. First, the expected peak runoff flow rates for Basin #5 were calculated. The drainage area from Basin #5 is 13.04 acres. Although a small amount of this area is grass, to be conservative the entire area was considered to be impermeable pavement. The *King County Runoff Time Series (KCRTS)* model was used to evaluate the peak flows for various storm events. Per the King County Design Standards, all conveyance piping must have capacity for the 25-year storm, with consideration given to the 100-year storm. The resulting 25-year storm for Basin #5 has a peak flow of 11.74 cubic feet per second (cfs). The resulting 100-year storm has a peak flow of 15.38 cfs.

Next, the new conveyance pipe was sized using Bentley *FlowMaster* to calculate the maximum capacity of a 24-inch diameter pipe. A diameter of 24 inches was selected because the existing pipe upgradient of the new pipe is 24 inches in diameter, and it is not anticipated to be replaced. A design slope of 0.01 feet per foot (1 percent) was set for the new pipe, however the as-constructed slope is 0.0089 feet per foot (0.89 percent). The roughness coefficient was set at 0.013, correlating to a concrete pipe. The maximum capacity of a 24-inch diameter pipe, as constructed, is 21.34 cfs. Therefore, the new pipe is estimated to have enough capacity to convey the 25-year, and the 100-year storms.

Table 1: Summary of New Conveyance Pipe Capacity Calculations	
Basin #5 Impervious Area	13.04 acres
25-year Storm Peak Flow	11.74 cfs
100-year Storm Peak Flow	15.38 cfs
New Conveyance Pipe Diameter	24 inches
New Conveyance Pipe Slope	0.89 percent
New Conveyance Pipe Roughness Coefficient	0.013
Maximum New Conveyance Pipe Capacity	21.34 cfs

2.2 EXISTING DOWNSTREAM CONVEYANCE CAPACITY CALCULATION

To confirm that the additional stormwater runoff from Basin #5 would not negatively impact the existing downstream conveyance system in Basin #2, capacity calculations of the existing Basin #2 conveyance system were completed. First, the peak runoff flow rates for the Basin #5 area (13.04 acres) and the portion of Basin #2 that will be combined with Basin #5 (22.21 acres) were calculated using *KCRTS.* Although a significant amount of the area in Basin #2 is grass swale, to be conservative the entire area was considered to be impermeable pavement. The resulting 25-year storm for the combined areas has a peak flow of 31.76 cfs. The resulting 100-year storm has a peak flow of 41.59 cfs.

Next, the capacity of the existing 36-inch diameter conveyance pipe downstream of catchbasin CB-4-G was calculated using *FlowMaster*. The slope of the existing pipe is approximately 0.01 percent. The roughness coefficient was set at 0.013, correlating to a concrete pipe. The maximum capacity of the existing 36-inch diameter pipe is 6.67 cfs. Therefore, the existing pipe is expected to continue to surcharge during heavy storms, as it currently does due to the flat slope. The existing pipe is approximately 200 linear feet, resulting in less than 10 inches of surcharge in CB-4-G during the combined 100-year storm. This surcharge is not expected to result in flooding of the airport, since the catchbasin structure inverts are approximately 14 feet below the ground surface in this location.

Table 2: Summary of Existing Conveyance Pipe Capacity Calculations	
Basin #5 Impervious Area	13.04 acres
Portion of Basin #2 Impervious Area	22.21 acres
Total Drainage Area to Existing Conveyance Pipe	35.25 acres
25-year Storm Peak Flow	31.76 cfs
100-year Storm Peak Flow	41.59 cfs
Existing Conveyance Pipe Diameter	36 inches
Existing Conveyance Pipe Slope	0.01 percent
Existing Conveyance Pipe Roughness Coefficient	0.013
Maximum Existing Conveyance Pipe Capacity	6.67 cfs
Maximum Expected Surcharge during 100-year Storm Peak Flow	10 inches

3.0 UPSTREAM AND DOWNSTREAM DRAINAGE ANALYSES

3.1 PREVIOUS REPORTS

Upstream and downstream drainage analyses have been previously performed as part of the *Revised Technical Information Report for King County International Airport Runway 13R-31L Safety Area Project (As-Built)* (WH Pacific, 2005) and the *King County International Airport Storm Drainage Study* (Sajan, 1995).

Runoff from the upstream drainage areas in Basin #5 and Basin #2 will continue to flow through the existing onsite conveyance system. The runoff from Basin #5 was routed to join Basin #2.

The combined runoff and runoff from downstream drainage areas in Basin #2 will continue to be routed through the existing onsite conveyance system in Basin #2. Based on an evaluation of the pump station by Phil Newton of URS, the refurbished pump station (2005) does have sufficient capacity to handle the added runoff from Basin #5 for the 25-year, 24- hour storm, without resulting in conveyance system capacity issues prior to the pump station. An analysis was not performed on the 48-inch diameter line from the pump station to Outfall #2. In situations with high water levels in the Duwamish River, there is a possibility for the pump flows to cause access structures between the pump station and the river to overflow, due to the ability for the pump station's flow capacity to exceed the capacity of the outfall under high flow conditions. Please see the *Draft Outfalls Evaluation* (URS, 2009) for further discussion of the downstream analysis.

4.0 CONSTRUCTION STORMWATER POLLUTION PREVENTION

4.1 EROSION AND SEDIMENT CONTROL PLAN ANALYSIS & DESIGN

A construction stormwater pollution prevention plan was completed as part of the KCIA Emergency Drainage Basin #5 Stormwater Reroute project. Prior to construction, the contractor prepared a temporary erosion and sediment control (TESC) plan for the site. Both plans described above included elements discussed in the following sections and were required to be in compliance with Federal Aviation Administration (FAA) and Foreign Object Debris (FOD) requirements. FOD requirements for the KCIA are very stringent for the purpose of providing safe conditions for aircraft operations at the facility. The minimum TESC requirements are shown on sheet C1.01 of the project as-built drawings, included in Appendix A.

4.1.1 Erosion and Sediment Control Measures

The following categories of the ESC measures, as detailed in the King County *Erosion and Sediment Control Standards (ESCS)* and in compliance with the FOD requirements, were incorporated into the design and construction of the project:

- Project Limits – Project limits were secured at the end of each work day, including a temporary AOA security fence.

- Cover Measures – Cover measures in the form of plastic sheeting over stockpiles, erosion control blankets and mulch or straw over areas of exposed soils, and steel plates over trench excavations were provided as needed. Permanent stabilization was achieved with asphalt pavement and bonded fiber matrix hydroseeding.

- Perimeter Protection – Perimeter protection to filter sediment from sheetflow was not expected to be required for this project, because the areas of work are in existing paved surfaces.

- Traffic Area Stabilization – Stabilized construction entrances and parking areas were not expected to be required for this project, because the areas of work are accessible by existing paved surfaces. Paved surfaces adjacent to the work area were diligently swept.

- Surface Water Collection – A temporary settlement tank was located at the site for intercepted surface water from disturbed areas to be routed through prior to release from the site, but conditions were dry during construction and the settlement tank was not utilized.

- Dewatering Control – A temporary settlement tank was located at the site for settling groundwater generated by dewatering, but very little groundwater was encountered in the excavations, and no groundwater was removed from the excavations, so the settlement tank was not utilized.

- Dust Control – Preventative measures to minimize the wind transport of soil were addressed by the diligent sweeping of the work area, and covering exposed areas with steel plates, to minimize FOD impacts.

4.2 SPILL PLAN DESIGN

The contractor's work was performed in accordance with the requirements of the existing KCIA *Response to Spills Policy and Procedures* (KCIA, 2007).

5.0 OPERATIONS & MAINTENANCE MANUAL

No new drainage facilities were installed as part of this project. Existing drainage facilities at the Airport will be privately maintained by Airport maintenance staff in accordance with *SWDM Appendix A: Maintenance Requirements for Flow Control, Conveyance and WQ Facilities*. The King County *Maintenance Requirements for Flow Control, Conveyance and WQ Facilities* will be used as an O&M manual for the site. Onsite storm drains will be maintained per section D.3.5.3 of the *SWDM*.

6.0 REFERENCES

King County, Department of Natural Resources. *King County, Washington. Surface Water Design Manual (SWDM)*. January 24, 2005.

King County, Department of Natural Resources. *King County, Washington. King County Runoff Time Series(KCRTS) Model, Version 4.42d.* January 2006.

King County International Airport (KCIA). *Declaration of Covenant for Inspection and Maintenance of Stormwater Facilities and BMPs*. May 2007.

King County International Airport (KCIA). *Response to Spills Policy and Procedures.* June 15, 2007.

Sajan Inc. (Sajan). *King County International Airport Storm Drainage Study*. July 1995.

United States Federal Emergency Management Agency, Flood Insurance Rate Map. King County, Washington and Incorporated Areas. Map Number 53033C0645 F. May 16, 1995.

URS Corporation (URS). *Draft Outfalls Evaluation King County International Airport*, October 8, 2009.

WH Pacific. *Revised Technical Information Report for King County International Airport Runway 13R-31L Safety Area Project (As-Built).* December 2005.

Figure 1: Site Location Map

33761844 01.cdr

SOURCE: USGS 7.5 minute topographic quadrangle, Seattle South, Washington, 1983

0 1 2

Scale in Miles

Job No. 33761844

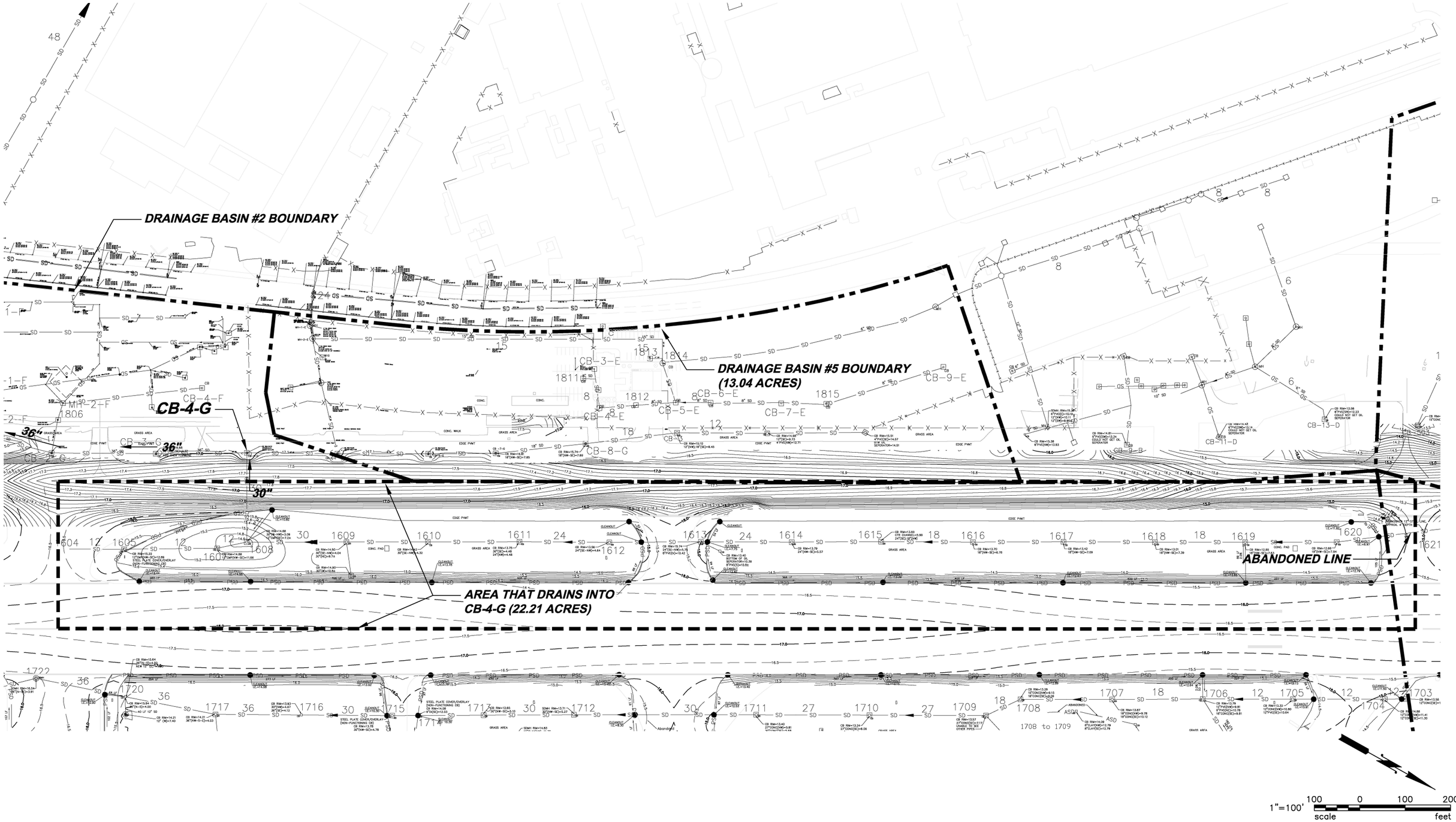
Figure 1

Site Location Map

URS

Technical Information Report
KCIA Emergency Drainage Basin #5 - Stormwater Reroute
Seattle, Washington

Figure 2: Project Site Plan



URS CENTURY SQUARE 1501 4TH AVENUE, SUITE 1400 SEATTLE, WA 98101 PHONE: (206) 438-2700 FAX: (206) 438-2699	DESIGNED: B. OCHILTREE DRAWN: J. SILL CHECKED: P. NEWTON APPROVED: P. NEWTON		REVISION No. / REVISION DATE / DESCRIPTION	King County **KING COUNTY INTERNATIONAL AIRPORT** **BOEING FIELD SEATTLE, WASHINGTON**	PROJECT TITLE: KCIA EMERGENCY DRAINAGE BASIN #5 STORMWATER REROUTE SHEET TITLE: PROJECT SITE PLAN SCALE: AS SHOWN DATE: OCTOBER 19, 2009

FAA AIP NO.:

CONTRACT NO.: E00131E08

SHEET NO.: FIGURE 2

FILE NAME: K:\Architecture\KCIA\E00131E08 - 2009 to 2011\03 Work Orders\WO 09-09-UIC Drainage Basin 5 Stormwater Mods\06 Design\CAD\Z_AREAS.dwg PLOTTED: Wednesday, October 14, 2009 - 3:54pm USER: Jacob_Sill

APPENDIX A: PROJECT AS-BUILT DRAWINGS

APPENDIX B: STORMWATER DESIGN CALCULATIONS

URS CALCULATION COVER SHEET

Project Name:	*KCIA Emergency Drainage Basin #5 Reroute*	**Project Number:**	*337618[redacted]44*
Project Location:	*King County Int'l Airport, Seattle, WA*	**Client Name:**	*King County International Airport*
PM Name:	*Daniel Tauber*	**PIC Name:**	

Identifying Information

This section is to be completed by the Project Manager.

Assigned Checker: *Carla Talich* / Phil Newton

Calculation to be checked: *KCIA Emergency Drainage Basin #5 Rerout Conveyance Calculations*

Calculation Originator: *Becca Ochiltree*

Checker's comments required by: *10-19-09*

Submitted by: PHILIP G. NEWTON — Oct. 19. 2009

Project Manager Signature — **Date**

Checker Report

This Section is to be completed by the Checker.

Check box A **or** B:

A. ☐ All items have been found to be correct. Checker has no comments.

Checker Signature — **Date**

or

B. ☒ Checker's comments have been provided on:

- ☒ Calculation
- ☐ Comment and Disposition Form (Form 3-5 (MM))
- ☐ Other _____

This section is to be completed after verification of comment incorporation, if box B is checked off above.

Check box C **or** D and E:

C. ☒ Back-check of Checker's comments has been performed by Originator AND all issues have been resolved between Originator and Checker.

or

D. ☐ Unresolved issues have been submitted to the Project Manager, Principal-in-Charge or designee for resolution.

and

E. ☐ Verification of correct incorporation of resolved comments into final document is complete.

PHILIP G. NEWTON — Oct. 19, 2009

Checker Signature — **Date**

APPROVAL and DISTRIBUTION

*To be signed after box A **or** E are completed.*

☒ The Calculation Check has been completed. Any significant issues not resolved between the Checker and the Originator have been resolved by the Approver.

PHILIP G NEWTON — Oct. 19. 2009

Project Manager, Principal-in-Charge or Designee Signature — **Date**

Distribution:

Project Central File – Quality folder

Problem Statement

Background:

Following concerns specific to the stability of the right abutment of the Howard Hanson Dam, the US Army Corps of Engineers has determined that it is necessary to lower the maximum pool level for flood storage below the normal maximum operating elevation for the dam. The lowered capacity of the dam is expected to result in higher water levels in the Duwamish River during the fall and winter of 2009/2010. In anticipation of higher water levels in the Duwamish River, the Airport is proposing to reroute stormwater runoff from Storm Drainage Basin #5 (Basin #5), which currently drains directly into the Duwamish Waterway. The rerouted stormwater would be connected to a portion of Storm Drainage Basin #2 (Basin #2), and flow to an existing onsite pump station and then to an outfall that is protected by a series of tide gates and tide valves designed to keep water from the Duwamish River from backing up onto the Airport. This calculation package was completed to both size the new conveyance pipe from Basin #5 to Basin #2, and to verify that the existing downstream conveyance pipe in Basin #2 will have the capacity to handle the additional flows from Basin #5.

Methodology:

New Conveyance Pipe Capacity Calculation:

Calculations were conducted in order to size the new pipe that will convey the stormwater runoff from Basin #5 to Basin #2. First, the expected peak runoff flow rates for Basin #5 were calculated. The drainage area from Basin #5 is 13.04 acres. Although a small amount of this area is grass, to be conservative the entire area was considered to be impermeable pavement. The *King County Runoff Time Series (KCRTS)* model was used to evaluate the peak flows for various storm events. Per the King County Design Standards, all conveyance piping must have capacity for the 25-year storm, with consideration given to the 100-year storm. The resulting 25-year storm for Basin #5 has a peak flow of 11.74 cubic feet per second (cfs). The resulting 100-year storm has a peak flow of 15.38 cfs.

Next, the new conveyance pipe was sized using Bentley *FlowMaster* to calculate the maximum capacity of a 24-inch diameter pipe. A diameter of 24 inches was selected because the existing pipe upgradient of the new pipe is 24 inches in diameter, and it is not anticipated to be replaced. A design slope of 0.01 feet per feet (1 percent) was set for the new pipe. The roughness coefficient was set at 0.013, correlating to a concrete pipe. The maximum capacity of a 24-inch diameter pipe with these characteristics is 22.62 cfs. Therefore, the new pipe is estimated to have enough capacity to handle the 25-year and 100-year storms.

Table 1: Summary of New Conveyance Pipe Capacity Calculations						
Basin #5 Impervious Area	25-year Storm Peak Flow	100-year Storm Peak Flow	New Conveyance Pipe Diameter	New Conveyance Pipe Slope	New Conveyance Pipe Roughness Coefficient	Maximum New Conveyance Pipe Capacity
13.04 acres	11.74 cfs	15.38 cfs	24 inches	1 percent	0.013	22.62 cfs

Existing Downstream Conveyance Pipe Capacity Calculation:

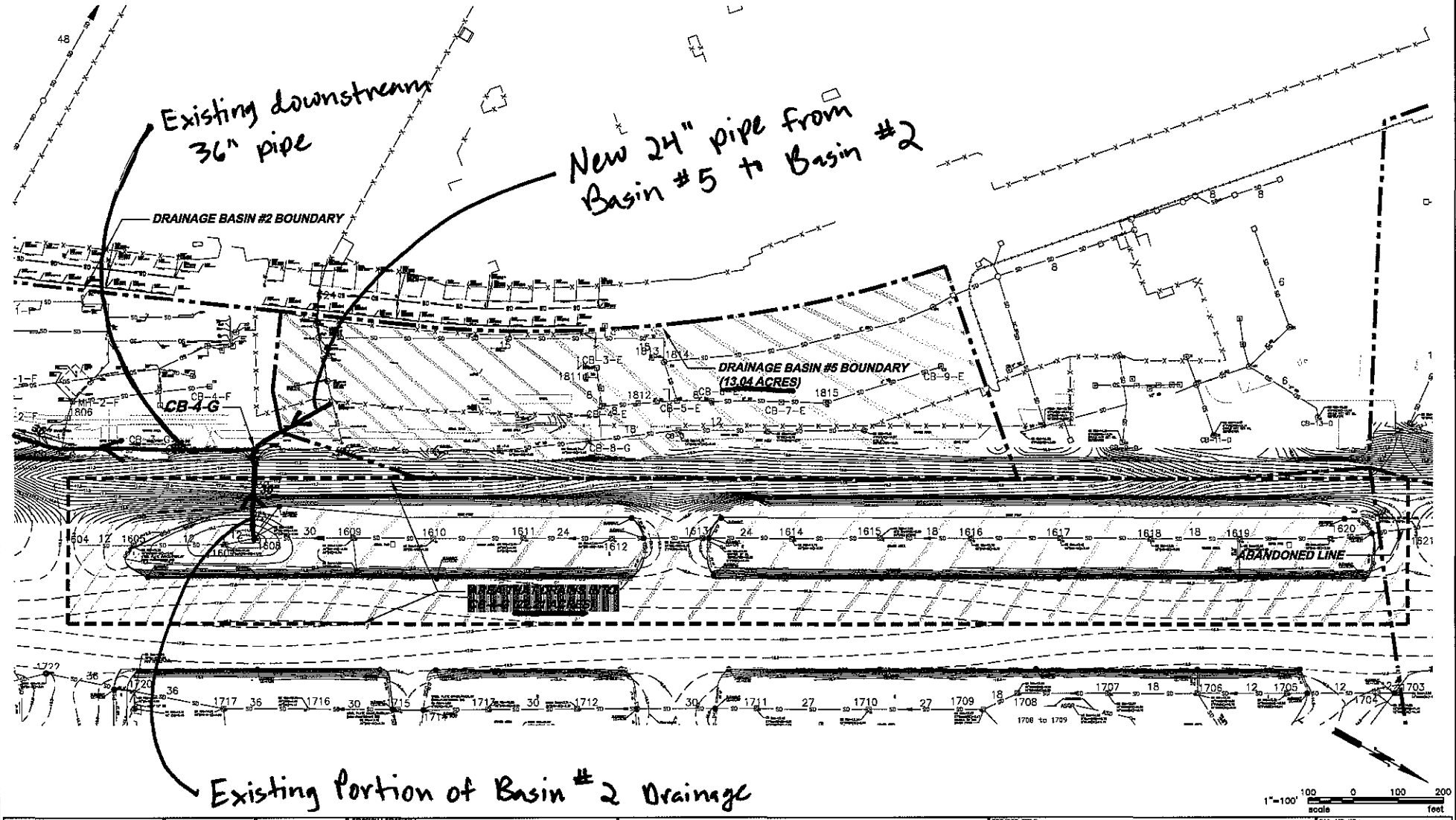
To confirm that the additional stormwater runoff from Basin #5 would not negatively impact the existing downstream conveyance system in Basin #2, capacity calculations of the existing downstream conveyance system were completed. First, the peak runoff flow rates for the Basin #5 area (13.04 acres) and the portion of Basin #2 that will be combined with Basin #5 (22.21 acres) were calculated using *KCRTS*. Although a significant amount of the area in Basin #2 is grass swale, to be conservative the entire area was considered to be impermeable pavement. The resulting 25-year storm for the combined areas has a peak flow of 31.76 cfs. The resulting 100-year storm has a peak flow of 41.59 cfs.

Next, the capacity of the existing 36-inch diameter conveyance pipe downstream of catchbasin CB-4-G was calculated using *FlowMaster*. The slope of the existing pipe is approximately 0.01 percent. The roughness coefficient was set at 0.013, correlating to a concrete pipe. The maximum capacity of the existing 36-inch diameter pipe is 6.67 cfs. Therefore, the existing pipe is expected to continue to surcharge during heavy storms, as it currently does due to the flat slope. The existing pipe is approximately 200 linear feet, resulting in less than 10 inches of surcharge in CB-4-G during the combined 100-year storm. This surcharge is not expected to result in flooding of the airport, since the catchbasin structure inverts are approximately 14 feet below the ground surface in this location.

Table 2: Summary of Existing Conveyance Pipe Capacity Calculations								
Basin #5 Impervious Area	Portion of Basin #2 Impervious Area	Total Drainage Area to Existing Conveyance Pipe	25-year Storm Peak Flow	100-year Storm Peak Flow	Existing Conveyance Pipe Diameter	Existing Conveyance Pipe Slope	Existing Conveyance Pipe Roughness Coefficient	Maximum Existing Conveyance Pipe Capacity
13.04 acres	22.21 acres	35.25 acres	31.76 cfs	41.59 cfs	36 inches	0.0001 percent	0.013	6.67 cfs

Conclusions:

The new 24-inch diameter conveyance pipe from Basin #5 to Basin #2 is estimated to have enough capacity to handle the 25-year and 100-year storms. The existing 36-inch diameter conveyance pipe carrying the combined flows from Basin #5 and a portion of Basin #2 is estimated to surcharge CB-4-G a maximum of 10 inches under the 100-year storm, which is not anticipated to cause flooding problems, since the catchbasin structure is approximately 14 feet below ground surface.



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APPROVED:	P. NEWTON

REVISION No.	REVISION DATE	DESCRIPTION

King County
KING COUNTY INTERNATIONAL AIRPORT
BOEING FIELD SEATTLE, WASHINGTON

PROJECT TITLE:	KCIA EMERGENCY DRAINAGE BASIN #5 STORMWATER REROUTE
SHEET TITLE:	PROJECT SITE PLAN
SCALE:	AS SHOWN
DATE:	OCTOBER 19, 2009
FAA AIP NO.:	
CONTRACT NO.:	E00131E08
SHEET NO.:	FIGURE 2

Drainage Basin #5
13.04 ac impervious

predev

Flow Frequency Analysis
Time Series File:predev.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
6.21	6	8/27/01 18:00	15.38	1	100.00	0.990
4.33	8	9/17/02 17:45	→ 11.74	2	25.00	0.960
11.74	2	12/08/02 17:15	8.43	3	10.00	0.900
5.00	7	8/23/04 14:30	6.94	4	5.00	0.800
6.58	5	10/28/04 16:00	6.58	5	3.00	0.667
6.94	4	10/27/05 10:45	6.21	6	2.00	0.500
8.43	3	10/25/06 22:45	5.00	7	1.30	0.231
15.38	1	1/09/08 6:30	4.33	8	1.10	0.091
Computed Peaks			14.17		50.00	0.980

Worksheet for New 24" Pipe

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Normal Depth	2.00	ft
Diameter	2.00	ft

Results

Discharge	22.62	ft^3/s
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Hydraulic Radius	0.50	ft
Top Width	0.00	ft
Critical Depth	1.69	ft
Percent Full	100.0	%
Critical Slope	0.00946	ft/ft
Velocity	7.20	ft/s
Velocity Head	0.81	ft
Specific Energy	2.81	ft
Froude Number	0.00	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.01000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for New 24" Pipe

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.69	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00946	ft/ft

As-Built 24" Pipe KCIA

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00890	ft/ft
Normal Depth	2.00	ft
Diameter	2.00	ft

Results

Discharge as-built	21.34	ft^3/s
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Hydraulic Radius	0.50	ft
Top Width	0.00	ft
Critical Depth	1.65	ft
Percent Full	100.0	%
Critical Slope	0.00877	ft/ft
Velocity	6.79	ft/s
Velocity Head	0.72	ft
Specific Energy	2.72	ft
Froude Number	0.00	
Maximum Discharge	22.96	ft^3/s
Discharge Full	21.34	ft^3/s
Slope Full	0.00890	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

As-Built 24" Pipe KCIA

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.65	ft
Channel Slope	0.00890	ft/ft
Critical Slope	0.00877	ft/ft

Combined Drainage Basin #5 and
Portion of Drainage Basin #2

Combined

22.24 ac impervious

Flow Frequency Analysis
Time Series File:combined.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
16.79	6	8/27/01 18:00	41.59	1	100.00	0.990
11.74	8	9/17/02 17:45	31.76	2	25.00	0.960
31.76	2	12/08/02 17:15	22.77	3	10.00	0.900
13.52	7	8/23/04 14:30	18.78	4	5.00	0.800
17.78	5	10/28/04 16:00	17.78	5	3.00	0.667
18.78	4	10/27/05 10:45	16.79	6	2.00	0.500
22.77	3	10/25/06 22:45	13.52	7	1.30	0.231
41.59	1	1/09/08 6:30	11.74	8	1.10	0.091
Computed Peaks			38.32		50.00	0.980

Worksheet for Existing 36" Pipe

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00010	ft/ft
Normal Depth	3.00	ft
Diameter	3.00	ft

Results

Discharge	6.67	ft^3/s
Flow Area	7.07	ft^2
Wetted Perimeter	9.42	ft
Hydraulic Radius	0.75	ft
Top Width	0.00	ft
Critical Depth	0.81	ft
Percent Full	100.0	%
Critical Slope	0.00390	ft/ft
Velocity	0.94	ft/s
Velocity Head	0.01	ft
Specific Energy	3.01	ft
Froude Number	0.00	
Maximum Discharge	7.17	ft^3/s
Discharge Full	6.67	ft^3/s
Slope Full	0.00010	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for Existing 36" Pipe

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	3.00	ft
Critical Depth	0.81	ft
Channel Slope	0.00010	ft/ft
Critical Slope	0.00390	ft/ft

Worksheet for Surcharge Under 100-year Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Slope

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00397	ft/ft
Normal Depth	3.00	ft
Diameter	3.00	ft
Discharge	42.00	ft³/s

x 200 ft = 0.794 ft surcharge
≅ 10 inches

Results

Channel Slope	0.00397	ft/ft
Normal Depth	3.00	ft
Flow Area	7.07	ft²
Wetted Perimeter	9.42	ft
Hydraulic Radius	0.75	ft
Top Width	0.00	ft
Critical Depth	2.11	ft
Percent Full	100.0	%
Critical Slope	0.00558	ft/ft
Velocity	5.94	ft/s
Velocity Head	0.55	ft
Specific Energy	3.55	ft
Froude Number	0.00	
Maximum Discharge	45.18	ft³/s
Discharge Full	42.00	ft³/s
Slope Full	0.00397	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Worksheet for Surcharge Under 100-year Storm

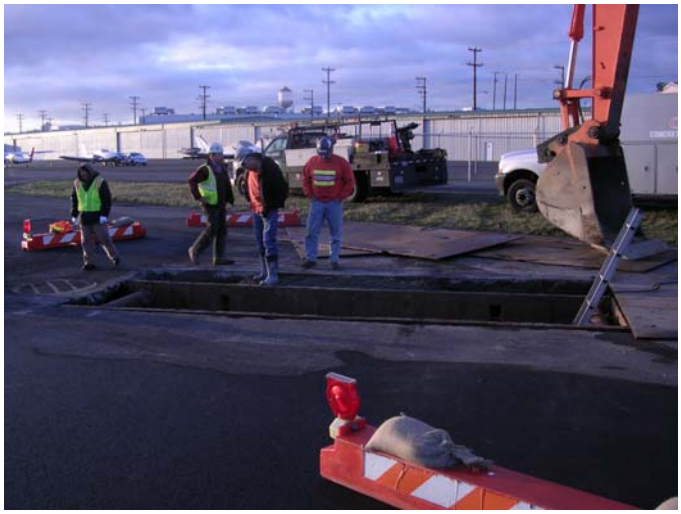
GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.00	ft
Critical Depth	2.11	ft
Channel Slope	0.00397	ft/ft
Critical Slope	0.00558	ft/ft

APPENDIX C: CONSTRUCTION PHOTO LOG

Appendix C – Construction Photo Log

Date: November 23 - 30, 2009
Work Completed: TESC measures in place. Saw cut, excavate, and place trench box adjacent to CB-4-G. Cover with road plates at end of work day.



Date: December 1, 2009
Work Completed: Core CB-4-G structure, install and backfill first lengths of 24” RCP pipe.

Trench box in place, pipe bedding material in place below pipe and gravel around perimeter of trench box.

Coring machine shown adjacent to and above existing storm line.

First length of pipe on downstream end mortared into existing manhole structure.

Trench box and backfill to top of pipe at downstream manhole.

Date: December 2, 2009
Work Completed: Continue to excavate and move trench box to set next lengths of 24" RCP pipe. Backfill and compact.

Establishing grade for additional pipe sections using both internal laser and external instruments.

Date: December 3, 2009
Work Completed: Asphalt paving over installed pipe from CB-4-G within Taxiway Bravo. Continue excavation and 24” RCP installation, backfill and compaction using trench boxes.

Backfilled trench within AOA, looking back from existing structure forward to new drainage structure.

Paving completed.

Continue installing pipe using trench box, pipe zone material and backfill.

Compaction of trench zone.

Steel plates in place.

Date: December 4 – 6, 2009
Work Completed: Continue excavation and 24” RCP installation, backfill and compaction using trench boxes up to location of new 72” CB.

Date: December 7, 2009
Work Completed: Excavate location for placement of new 72” CB and expose existing 24” clay SD pipe. Sandy silt/clay held vertical cuts at site of new CB. Place nonwoven geotextile, approximately 1-foot lift of quarry spalls, and approximately 8-inch lift of pea gravel as bedding for new CB; compact. Install new 72” CB and final length of 24” RCP. Install approximately 6 feet of 24” RCP to connect existing clay SD pipe to new CB. Grout both CB pipe connections and next adjacent joint on existing clay SD pipe. Partially backfill excavation and place temporary fencing around excavation at the end of the day. In total, approximately 192 linear feet of 24” RCP installed from CB-4-G to new CB.

Quarry spalls at depth over geotextile.

Pea gravel over quarry spalls.

Setting new structure base on compacted gravel base.

Installing and lubricating gasket.

Mortar in new upstream pipe.

Connecting existing pipe to new structure with one length of new RCP.

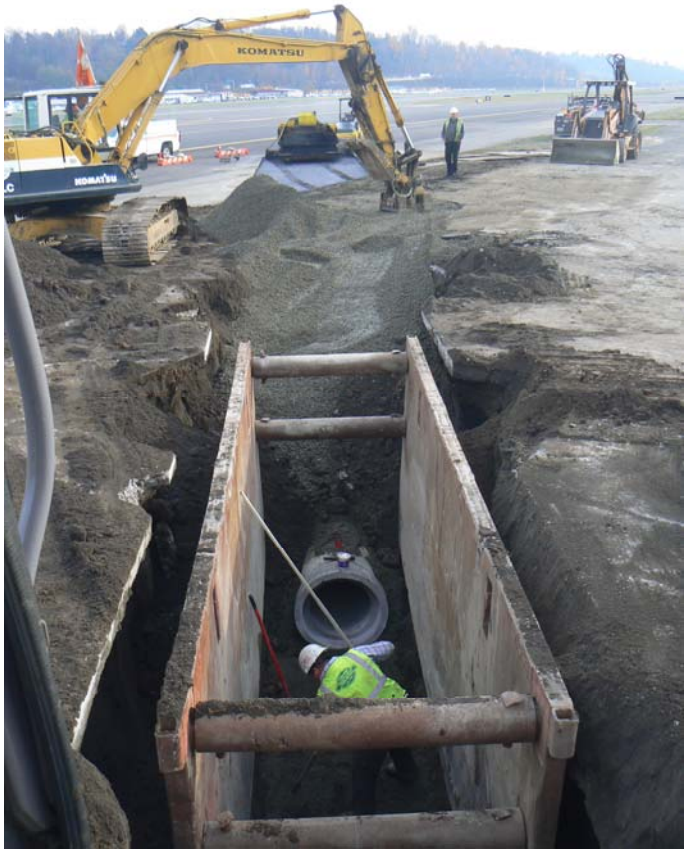
Mortar around new structure and exposed existing pipe.

Date: December 8, 2009
Work Completed: Place CB lid, backfill and compact around CB. Mark limits for asphalt restoration. Some existing pavement areas along trench were undermined during trenching (note last photo – chronologically out of sequence), so asphalt restoration limits were extended.

Hanson

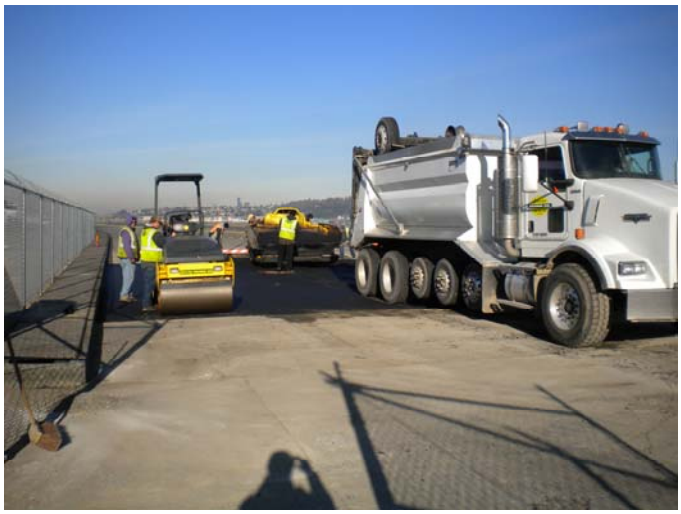
KOMATSU

Marking saw cut limits.



Date: December 9, 2009
Work Completed: Saw cut existing pavement at limits of asphalt restoration, prepare and compact subgrade for asphalt paving.

Date: December 10, 2009
Work Completed: Asphalt pave over remaining trench area (outside of Taxiway Bravo) and around new CB. Plug existing 24" clay SD pipe at MH-1-E with grout. Noted cracks and settling in existing 24" clay SD pipe, northeast of MH-1-E.



Plugging existing pipe.

Smooth grouted face of plug.

Date: December 10, 2009
Work Completed: Paving complete. Bonded fiber matrix hydroseeding applied over exposed soils. AOA fence and gate intact.

Date: February 10, 2010
Final site stabilization of hydroseeded area.