ATTACHMENT 1

East Waterway

Storm Drain and Combined Sewer Solids Loading Analysis
August 2011 Update

City of Seattle
Seattle Public Utilities

Table of Contents

Tables

Figures

Appendices

SUMMARY OF REVISIONS

This report is an update of the September 2008 East Waterway (EW) lateral load report (Northwest Hydraulic Consultants 2008). Changes from the 2008 report are summarized below:

- Drainage basin boundaries for Port-owned storm drains have been revised based on updated information on drainage infrastructure provided by the Port of Seattle (Port). Specific changes include:
  - Basin B-11. Previous mapping from Port did not include areas outside of Port property that are connected to this system. These areas have been added. In addition, the T18 portion of the basin has been modified to reflect changes received from the Port.
  - Basin B-38 has been removed from the study, because Port determined that outfall is located in the Lower Duwamish study area.
  - Basin B-1 delineation has been modified based on Port drainage system mapping.
  - The railroad bridge (BR-6) just south of the West Seattle Bridge and the Port's access road (BR-2) have been added.
  - The bridge at the head of Slip 27 has been added (BR-27).
  - Other bridge and apron basins not included in the 2008 loading analysis have now been incorporated, including: A-7, A-23, A-24, A-26, A-27, A-28, A-29, A-30, A-32, A-33, BR-39, BR-6.

  Changes in drainage basin areas resulting from the revised basin delineations are summarized in Table 1. The updates to the drainage basin boundaries resulted in an overall reduction in basin area of about 6.4 acres (less than one percent change).

- Drainage basin boundaries for the S Lander St CSO/SD and S Hinds St CSO/SD have been revised based on updated information from recent field investigations and drainage maps compiled by Seattle Public Utilities (SPU).

- The S Connecticut St separated storm drain basin has been removed from the study because runoff from this basin enters Elliott Bay just outside of the EW study area boundary and information collected to date indicates that this basin would not contribute significant pollutant loads to the EW.

- Basins B-40, B-41, B-42, B-43 were identified as City-owned storm drain basins in the 2008 report. However, because these areas drain land entirely owned/occupied by the U.S. Coast Guard, these systems are now identified as Coast Guard drains. SPU is currently working to transfer ownership of these storm drain systems to the U.S. Coast Guard.

- Total suspended solids data have been updated to incorporate recent stormwater data from the Portland Harbor project and from SPU NPDES monitoring efforts. In addition, the method used to calculate land use representative TSS concentrations has been modified to improve accuracy.

- EW sediment trap results have been included in the particle size distribution (PSD) analysis, along with the data compiled for stormwater suspended solids samples to provide a range of inputs for the particle transport model.

- CSO volume estimates have been updated to include monitoring data from 2008 and 2009.

The methodology used to calculate annual stormwater volumes and TSS loads is unchanged from the 2008 report. For completeness, this information is repeated in this updated report (Appendix A).

INTRODUCTION

This report summarizes the analyses of stormwater and City combined sewer overflow (CSO) discharges to the East Waterway (EW) completed by SPU for use in the particle transport model for the EW remedial investigation. Annual discharge volume and TSS loads were estimated for all storm drain outfalls and the City CSO at S Hinds St. In addition, available data from SPU source sampling efforts were compiled to estimate the concentrations of chemicals of concern associated with the particulates discharged from these outfalls. Data used in the analyses include:

- King County parcel land use data from the City GIS system.
- Surficial geology data for the Seattle area (Goetz et.al., 2005).
- Rainfall data from Seattle rain gage #15 located at 4401 E Marginal Way S, for years 1978-2007.
- Total suspended solids concentrations in stormwater compiled from studies conducted in western Washington and Oregon (Appendix B).
- Particle size distribution (PSD) data from East Waterway source tracing/characterization samples and data compiled from stormwater samples collected throughout the U.S.

Methods used to calculate suspended solids loads are described in the following sections.

FLOW ESTIMATES

Flow is an important component of the solids load calculations. Neither SPU nor the Port routinely monitor flow from its storm drain outfalls, so a hydrologic model was used to estimate the volume of stormwater discharged to the EW.

In 1999, SPU initiated a flow monitoring program to measure the frequency and volume of overflows from City-owned CSOs. Data from 2000-2009 were used to estimate the volume of overflows from the City-owned CSO in the EW study area (S Hinds St CSO/SD).

Stormwater

The annual volume of stormwater discharged to the EW was estimated from land use, soil type, slope, and rainfall using a simplified Hydrologic Simulation Program-Fortran (HSPF) model (Northwest Hydraulic Consultants 2008). This model calculates runoff volumes per unit area for individual land use, slope, and soil combinations based on regional Puget Sound input parameters and local rainfall data. Runoff volumes have been updated to incorporate changes in basin boundaries. Assumptions and data used in the analysis have not changed from the 2008 analysis. A detailed description of the flow calculations is provided in Appendix A.

Drainage Basin Characteristics

Stormwater runoff from approximately 787 acres of land along the east side of Harbor Island and in the industrial area south of downtown Seattle drains to the EW via a combination of City, Port, and private storm drain systems, as well as direct discharges from apron areas immediately adjacent to the waterway. Drainage basin boundaries for City-owned storm drains were delineated using City GIS utility and topographic data supplemented with site-specific drainage plans where available. Drainage basin boundaries for Port-owned storm drains were provided by the Port.

Basin boundaries have been updated since the Final Initial Source Evaluation and Data Gaps Memorandum was completed (SEDGM; Anchor and Windward 2009). Figure 1 shows original basin delineations from the SEDGM. Updated basin delineations are shown in Figure 2.

Land use in the EW drainage area was determined based on parcel data from King County. Figure 3 shows the distribution of land use in the separated storm drain basin. The area west of I-5 is predominately industrial with a small number of commercial and vacant lots. The portion of the S Lander St drainage basin that lies east of I-5 contains a mixture of residential (single and multi-family) with a small amount of commercial property. Land use characteristics are summarized in Table 2.

Surficial geology maps developed by the University of Washington (Goetz et.al., 2005) were used to characterize soil conditions in the basin. Individual geologic deposits were grouped into the following categories (see Appendix C for details):

- Alluvium
- Till
- Outwash
- Wetland soil.

Using GIS, the soil and parcel information were then overlaid to break down the drainage basin into individual land use and soil types for the runoff analysis. All areas were modeled as moderate slope.

Stormwater Discharge Locations

Locations of the 38 storm drains discharging to the EW are shown in Figure 4. The majority of these outfalls serve nearshore areas along the waterway. The S Lander St system is the largest storm drain in the EW, serving approximately 442 acres. The Seattle municipal storm drain system accounts for approximately 66 percent of the EW drainage, while the POS property drains 32 percent of the basin (Table 3). The remaining outfalls are from small private waterfront storm drain systems.

Stormwater Flow Calculations

Annual stormwater runoff volumes were calculated for each individual outfall as well as for bridges and aprons that drain directly to the waterway. Flow estimates were completed for a typical wet year (2002), dry year (1993), and average year (1986) based on 1978-2007 rainfall records from SPU’s rain gage #15 located at 4401 E Marginal Way S (Figure 5). Because the S Lander St CSO/SD system in the EW is partially and not fully separated, the runoff volumes estimated by the HSPF model had to be adjusted to account for areas that continue to drain to the combined sewer system. For the purposes of this analysis, the S Lander St separated storm drain basin was divided into two subbasins:

- East of I-5 (east Lander)
- West of I-5 (west Lander).

The City of Seattle is served by combined, separated, and partially separated drainage/wastewater systems. In combined areas, stormwater runoff and sanitary sewage are collected and conveyed in a single pipe. In separated areas, stormwater and sanitary sewage are carried in totally separate pipes. However, partially separated areas are served by a combination of separated storm drains and combined sewer systems. In these areas, stormwater runoff can discharge to both systems. Depending on how the separation occurred, in areas that were initially combined and later separated (e.g., Lander system), the roadways are often connected to a new storm drain system, while drainage structures (e.g., inlets, catch basins, and sand boxes) outside the public right-of-way are left connected to the combined sewer system. Without dye testing the individual catch basins, it can be difficult to determine which areas are connected to which system.

Based on discussions with SPU staff familiar with historic separation projects and the City's drainage system, it was assumed that all of the right-of-way and varying percentages of the areas outside of the right-of-way are connected to the storm drain system. Available SPU GIS information was used to estimate the amount of land on private parcels outside of the right-of-way, is connected to the separated storm drain system. The layout of existing drainage systems for all of the private parcels is not available in the SPU GIS system. Therefore, to account for uncertainty, a range of values was developed. In the east Lander sub-basin, it was estimated that between 25 and 75 percent of the areas outside the ROW are connected to the storm drain system. In the west Lander sub-basin, it was estimated that between 15 and 65 percent are connected to the storm drain system.

CSOs

Figure 6 shows the combined sewer service area within the EW study area (approximately 4,840 acres). The City of Seattle operates one CSO in the EW, the S Hinds St CSO/SD outfall (NPDES #107). The S Hinds St combined sewer system serves an area of approximately 45 acres located on Terminals 30 and 104 (Figure 6). Land use in the combined sewer service area is shown in Figure 7 and summarized in Table 4. The combined sewer service area contains a larger proportion of residential development (35 percent) and lower proportion of industrial/commercial property (26 percent) than the separated storm drain basin (4 and 78 percent, respectively).

SPU has monitored overflow frequency and volumes in the S Hinds St CSO since 1998. Annual overflow volumes range from 0 to 34 million gallons (Table 5). The maximum overflow occurred in 2004, with the majority of the overflow occurring during two separate events (January 7 and January 29, 2004) with total rainfall amounts of 1.83 and 1.54 inches, respectively. These large overflow volumes are not consistent with the small service area contributing to the S Hinds St CSO. SPU is working with King County to model the combined sewer system in this area to determine whether the overflows recorded at this location could be caused by overflows from the Elliott Bay Interceptor. For this analysis, the January 2004 overflows were replaced with the average of overflow events occurring during storm events larger than 1 inch during 2007-2010. This three-year time period was used because since 2007, SPU has conducted more rigorous validation of flow monitoring data. Detailed information on CSOs at the S Hinds St outfall is provided in Appendix D.

SUSPENDED SOLIDS LOADS

Solids loads are calculated by multiplying the annual runoff volumes by representative TSS concentrations based on land use. SPU has not measured TSS in the discharges from storm drains or City CSOs in the EW. To estimate loads, available suspended solids data from other similar sources were compiled and evaluated.

Stormwater

The data set used for the earlier EW (Northwest Hydraulic Consultants 2008) solids loading analysis was expanded to incorporate new data from ongoing SPU NPDES stormwater sampling (SPU 2011) and stormwater characterization data from the Portland Harbor Superfund site (Sanders 2011). Data from over 850 stormwater samples collected from 85 different sites in western Washington and Oregon were compiled and analyzed to determine representative TSS concentrations in urban stormwater. Data used in the analysis are provided in Appendix B. These data include samples analyzed for TSS using Standard Method 2540D and using the suspended solids content (SSC) method recommended by the U.S. Geological Survey (Gray et.al, 2000). Because the TSS and SSC results were comparable, all data were combined for the analysis.

Land use-weighted average TSS concentrations were calculated to account for variations in the quality of stormwater runoff from different types of development in the EW. Most of the regional stormwater samples were collected from mixed use areas and could not be used directly to calculate land-use weighted values. Data from the National Stormwater Quality Database (NSQD version 3) were used to develop a weighting factor that could be applied to the regional data for this purpose (Pitt et. al., 2004). The NSQD data set was queried to extract only those data that represent a single land use (e.g., single family residential, multi-family residential, commercial, industrial, vacant/park, and roadways). A total of 4,291 TSS samples were extracted from the NSQD data base.

A weighting factor was calculated using the median TSS values for each land use category. The single family residential category was selected as the base for the weighting factor. The land use weighting factor was calculated by dividing the median value for each land use type by the median value for single family residential land use:

Single family residential:	1.00
Multi-family residential:	1.27
Commercial:	1.23
Industrial:	1.25
Vacant/Park:	0.30
Roadway:	1.50

This weighting factor was then applied to the mixed use regional data set to develop TSS concentrations for individual land use types. Details are provided in Appendix B.

A range of TSS input values are needed for the PTM model sensitivity analysis. Base case, low, and high values were developed using the land use-weighted TSS concentrations from the regional data set. The high and low ranges are based on the 25^{th} and 75^{th} percentile concentration. A trimmed mean value was used to estimate a base case TSS concentration (Helsel and Hirsch 2002). A trimmed mean was selected for the base case to account for the fact that the TSS data are skewed. As a result, a relatively few high values greatly affect the mean value. The trimmed mean simply removes a set percentage of the values at the low and high end of the data set to adjust for data extremes. For this analysis, a 10 percent trimmed mean was used.

The Port provided data from NPDES monitoring conducted by tenants in 2005-2009 on Terminals 18, 25, and 30, which indicates that the TSS for industrial land use may not be representative of runoff from terminal areas, which are nearly 100 percent paved (Takasaki 2011). TSS concentrations in 26 samples ranged from 6 to 42 mg/L, with an average of about 19 mg/L. Consequently, the Port recommended that a different data set be used for Port terminal areas. For terminal areas, available data from Portland Harbor stormwater monitoring sites that were mostly paved (greater than 90 percent impervious) and select regional data from parking lots were compiled and evaluated. A total of 141 samples fit the criteria for Port terminal areas. The trimmed mean for these data (43 mg/L) is less than the value used for other industrial areas in the EW study area (74 mg/L).

TSS concentrations used in the solids loading analysis are summarized in Table 6.

The land use weighted TSS concentrations were then multiplied by the annual stormwater volumes calculated for each land use category to determine solids loading at each outfall. The total stormwater solids loading to the EW is estimated to range from about 36 to 180 Mton/year, with a base case of approximately 76-100 Mton/yr. Solids loading results for each outfall are summarized in Tables 7, 8, and 9.

CSOs

The City has not sampled discharges from the S Hinds St CSO in the EW, although data are available for other City CSOs from recent monitoring conducted as part of the City's NPDES CSO permit. In 2008-2010, SPU collected samples from 15 CSOs in the City (Herrera 2010). Up to four samples were collected from each outfall during the monitoring period. TSS concentrations ranged from 7-87 mg/L and averaged about 32 mg/L (Figure 9). As shown in Table 10, land use for most of the City CSOs is primarily residential with only a small proportion of commercial/industrial property (0-14 percent). None of the CSOs monitored by SPU serve a largely industrial area like the S Hinds St CSO.

King County has collected 21 samples from the Hanford #2 CSO (1996-2009) and seven from the Lander CSO (2008-2009) (Williston 2010). The TSS concentrations for the pooled data from these two CSOs range from 36-156 mg/L TSS with an average of about 88 mg/L. As shown in Table 11, the TSS concentrations in City CSOs are significantly lower than the concentrations measured in samples collected from King County CSOs. It is unclear why TSS concentrations in City CSOs are lower than County CSOs. Possible factors include:

- Differences in sampling procedures. City samples were collected during CSO events, when overflows were occurring. King County collected samples when pipes were 60 percent full (King County 2009). As a result, City samples may contain a larger proportion of stormwater than County samples, which could result in lower TSS concentrations.
- Differences in land use in the combined sewer service areas. The City CSOs that were monitored served primarily residential areas. Only two of the CSOs contained more than 10 percent industrial/commercial property (CSO 99 and

CSO 147A). King County's Lander CSO serves a primarily commercial/industrial area. Land use in the Hanford #2 CSO service area is mixed, but industrial and commercial development account for 10 percent and 16 percent of the area, respectively (see Table 4).

For the purpose of the sediment loading analysis, it is recommended that the King County CSO data be used to characterize TSS concentrations in the City's S Hinds St CSO, because land use in the CSOs monitored by King County is more comparable to the conditions in the S Hinds St CSO service area. This will provide a conservative estimate of TSS loading from the City CSO.

With an average annual overflow volume of approximately 900,000 gallons and an average TSS concentration of about 32 mg/L, the annual TSS load from the City CSO at S Hinds St is estimated at approximately 240 lbs/year.

PARTICLE SIZE DISTRIBUTION

Information on particle size distribution (PSD) for stormwater and CSO discharges to the EW is needed for the particle transport model. The model tracks the following four classes of particles (Anchor QEA and Coast & Harbor Engineering 2011).

- Gravel-medium sand: >250 µm
- Fine sand: 62-250 µm
- Coarse-medium silt: 15.6-62 µm
- Fine silt and clay: <15.6 µm

Solids discharged from storm drains and CSOs are typically comprised of two components, the suspended fraction and a heavier fraction often referred to as bedload. Bedload material typically does not become fully entrained in the water column during storm events. Instead, this material moves along the bottom of the pipe as previously deposited sediment is scoured from the pipe during larger storm events.

The PSD of suspended solids in stormwater discharges to the EW are not available, but PSD is routinely analyzed in the source tracing samples collected by SPU (catch basin grabs, inline grabs, and sediment traps). Catch basin sediments are grab samples collected from the sump at the bottom of the structure. These structures are intended to prevent debris from blocking the downstream pipe system. Although catch basins often capture fine sands and silt, they are not expected to be highly effective in trapping fine silt and clay particles. Inline sediment samples are simply grabs collected from relatively quiescent areas within the piped drainage system, such as maintenance holes or other inline structures. Like catch basins, inline samples also contain a relatively low proportion of fine-grained material. Sediment traps passively collect samples of settleable material that passes by the station. Because traps are installed near the bottom of the pipe or maintenance hole, these samples likely contain a mixture of suspended solids and bedload material.

In the previous EW solids loading report (Northwest Hydraulic Consultants 2008) and in the LDW lateral load analysis (SPU 2008), data from stormwater samples collected at 18 sites across the U.S. were compiled to characterize the PSD for the particle/sediment transport models (Appendix E). Suspended solids in stormwater typically contain a large proportion of fine silts and clays that do not readily settle. Therefore, these particles are unlikely to deposit in the nearshore sediment and may be transported beyond the East Waterway. To capture a representative range in PSD for the particle transport model, it is recommended that both the suspended solids and the bedload characteristics be evaluated.

The PSD data from all EW source tracing samples are compared with the LDW source data, and the national stormwater solids data in Figure 10. PSD in the EW and LDW source samples are similar. The stormwater samples contain the largest proportion of fine silts and clays (44 percent average) and the smallest proportion of coarse grained particles (8.4 percent average) compared to the EW source sediment samples (12.4 percent and 31.8 percent average, respectively). For the particle transport model, it is recommended that PSD for the EW sediment traps be used to bracket the likely range in PSD conditions. Sediment trap PSD will provide a relatively conservative assessment of recontamination potential in the vicinity of the individual storm drain outfalls.

REFERENCES

Anchor QEA and Coast & Harbor Engineering. 2011. East Waterway Operable Unit supplemental remedial investigation/feasibility study, draft sediment transport evaluation report. Prepared for U.S. Environmental Protection Agency by Anchor QEA, Seattle, WA and Coast & Harbor Engineering, Edmonds, WA.

Anchor and Integral. 2007. Portland Harbor RI/FS, Round 3A stormwater sampling rationale. Prepared for The Lower Willamette Group by Anchor Environmental, LLC, Seattle, WA and Integral Consulting, Inc., Mercer Island, WA.

Goetz Troost, K., D.B. Booth, A.P. Wisher, and S.A. Shimel. 2005. The geologic map of Seattle, a progress report. USGS Open File Report 2005-1252. Prepared in cooperation with the City of Seattle and the Pacific Northwest Center for Geological Mapping Studies at the Department of Earth and Space Sciences, University of Washington, Seattle, WA.

Gray, J.R., G.D. Glysson, L.M. Turcios, and G.E. Schwarz. 2000. Comparability of suspended-sediment concentration and total suspended solids data. USGS Water Resources Investigation Report 00-4191. U.S. Geological Survey, Reston, VA.

Herrera. 2007. Analysis of total suspended loads in the Lower Duwamish Waterway. Prepared for Seattle Public Utilities by Herrera Environmental Consultants, Inc., Seattle, WA.

Herrera. 2010. Seattle combined sewer overflow supplemental characterization study. Prepared for Seattle Public Utilities by Herrera Environmental Consultants, Inc., Seattle, WA.

Helsel, D.R. and R.M Hirsch. 2002. Statistical methods in water resources. In Techniques of Water-Resources Investigations of the United States Geological Survey, Book 4, Chapter A3. Hydrologic Analysis and Interpretation. U.S. Geological Survey, Reston, VA.

King County. 2009. Duwamish River basin combined sewer overflow report for samples collected from September 2007 to April 2009. King County Department of Natural Resources and Parks, Water and Land Resources Division, Science Section, Seattle, Washington.

Northwest Hydraulic Consultants. 2008. Memorandum for East Waterway runoff and water quality. Prepared for Seattle Public Utilities by Northwest Hydraulic Consultants, Inc, Tukwila, WA.

Pitt, R., A. Maestre, R. Morquecho, T Brown, T Schueler, K Cappiella, P Sturm, and C Swann. 2004. Findings from the National Stormwater Quality Database (NSQD). Department of Civil and Environmental Engineerging, University of Alabama, Tuscaloosa, AL and Center for Watershed Protection, Ellicott City, MD.

Sanders, D. 2011. Personal communication (email to Beth Schmoyer, Seattle Public Utilities, with Portland Harbor stormwater monitoring data). City of Portland Bureau of Environmental Services, Portland, OR.

SPU. 2008. Lower Duwamish Waterway lateral load analysis for stormwater and city-owned CSOs, July 2008 update. Prepared by Seattle Public Utilities, Seattle, WA.

Takasaki, K. 2011. Personal communication (email to Beth Schmoyer, Seattle Public Utilities with Terminal 18, 25, and 30 stormwater monitoring results from tenants). Port of Seattle, Seattle, WA.

Williston, Debra. December 2010. Personal communication (email, to Beth Schmoyer, Seattle Public Utilities regarding TSS data for East Waterway CSOs), King County Water and Land Resources Division, Toxicology and Contaminant Assessment Group, Seattle, WA.

Tables

Table 1: Summary of changes in basin areas from 2008 report.

Basin/Outfall	Owner	Area (acres)		Change	Explanation
		2008 Report[a]	2011 Update		
B-1	Port	1.1	1.6	1	Basin boundaries revised based on information from Port
B-11	Port	52.1	48.1	-4	Boundaries adjusted to include areas outside of Terminal 18 that drain to this outfall and part of basin determined to drain to the West Waterway
B-25	SPU	5.2	4.2	-1	Some areas previously identified are not connected to this outfall
B-30	Port	7	6.7	-0.3	Areas previously identified as terminal are actually open water and have been removed from basin
B-38	Port	1.3	0	-1.3	Port determined that this area discharges to the Duwamish Waterway rather than the East Waterway
B-40	Coast Guard	3.4	3.3	-0.1	Areas previously identified as terminal are actually open water and have been removed from basin
BR-6	SPU	0	0.3	0.3	Bridge added as new basin
BR-27	Port	0	0.2	0.2	Bridge added as new basin
A-7, A-23, A-24, A-26, A-27, A-28, A-30, A-32, A-33	Port	0	9.5	9.5	Basin not included in 2008 analysis
S Connecticut St SD	SPU	13.6	0	-13.6	Storm drain discharges to Elliott Bay outside of the EW study area and source tracing data indicated pollutant levels relatively low
S Lander St CSO/SD[b]	SPU	447.6	438.4	-9.2	Boundaries modified based on review of information from SPU GIS and business inspections
S Hinds St CSO/SD[b]	SPU	26.4	39.5	13.1	Area previously identified as connected to the combined sewer system found to discharge to the separated storm drain system at S Hinds St.
Total				-6.4	

a. Northwest Hydraulic Consultants (2008)

b. Separated storm drain basin discharging to shared CSO/SD outfall.

Table 2. Land use in East Waterway separated storm drain basins.

Outfall	Commercial	Industrial	Single family residential	Multi-family residential	Right-of-way	Vacant/Park	Total
City							
B-4	0.00	3.69	0.00	0.00	3.41	0.00	7.11
B-5	0.00	0.77	0.00	0.00	1.38	0.00	2.15
B-21	0.00	12.98	0.00	0.00	0.00	0.00	12.98
B-25	2.52	1.58	0.00	0.00	0.10	0.00	4.20
B-36	0.00	1.65	0.00	0.00	3.69	0.00	5.35
BR-4	0.00	0.21	0.00	0.00	1.02	0.00	1.23
BR-5	0.00	0.00	0.00	0.00	1.61	0.00	1.61
BR-34	0.00	0.00	0.00	0.00	0.95	0.00	0.95
S Hinds St CSO/SD	0.00	27.40	0.00	0.00	12.10	0.00	39.50
S Lander St CSO/SD	66.76	222.70	19.45	15.79	110.98	2.65	438.34
City Total	***69.28***	***270.99***	***19.45***	***15.79***	***135.25***	***2.65***	***513.42***
Port							
B-1	0.00	1.58	0.00	0.00	0.00	0.00	1.58
B-7	0.00	13.93	0.00	0.00	0.00	0.00	13.93
B-10	0.00	7.23	0.00	0.00	0.00	0.00	7.23
B-11	0.00	48.14	0.00	0.00	0.00	0.00	48.14
B-12	0.00	6.53	0.00	0.00	0.00	0.00	6.53
B-13	0.00	6.22	0.00	0.00	0.00	0.00	6.22
B-14	0.00	1.52	0.00	0.00	0.00	0.00	1.52
B-16	0.00	4.41	0.00	0.00	0.00	0.00	4.41
B-17	0.00	2.14	0.00	0.00	0.00	0.00	2.14
B-18	0.00	7.41	0.00	0.00	0.00	0.00	7.41
B-19	0.00	5.04	0.00	0.00	0.00	0.00	5.04
B-22	0.00	11.99	0.00	0.00	0.00	0.00	11.99
B-23	0.00	10.95	0.00	0.00	0.00	0.00	10.95
B-24	0.00	8.86	0.00	0.00	0.00	0.00	8.86
B-26	0.00	13.41	0.00	0.00	0.00	0.00	13.41
B-27	0.00	7.35	0.00	0.00	0.00	0.00	7.35
B-28	0.00	3.59	0.00	0.00	0.00	0.00	3.59
B-29	0.00	8.75	0.00	0.00	0.00	0.00	8.75
B-30	0.00	6.69	0.00	0.00	0.00	0.00	6.69
B-31	0.00	9.61	0.00	0.00	0.00	0.00	9.61
B-32	0.00	3.73	0.00	0.00	0.00	0.00	3.73
B-33	0.00	12.11	0.00	0.00	0.00	0.00	12.11
B-34	0.00	13.33	0.00	0.00	0.00	0.00	13.33
B-37	0.00	6.41	0.00	0.00	0.00	0.00	6.41
B-39	0.00	2.08	0.00	0.00	0.00	0.00	2.08
S Lander St CSO/SD	0.00	3.62	0.00	0.00	0.00	0.00	3.62
A-7	0.00	1.16	0.00	0.00	0.00	0.00	1.16
A-10	0.00	2.28	0.00	0.00	0.00	0.00	2.28
A-12	0.00	1.98	0.00	0.00	0.00	0.00	1.98
A-13	0.00	0.47	0.00	0.00	0.00	0.00	0.47
A-14	0.00	1.04	0.00	0.00	0.00	0.00	1.04
A-16	0.00	0.66	0.00	0.00	0.00	0.00	0.66
A-17	0.00	0.68	0.00	0.00	0.00	0.00	0.68
A-18	0.00	1.20	0.00	0.00	0.00	0.00	1.20
A-19	0.00	1.89	0.00	0.00	0.00	0.00	1.89
A-22	0.00	2.01	0.00	0.00	0.00	0.00	2.01
A-23	0.00	2.05	0.00	0.00	0.00	0.00	2.05
A-24	0.00	2.29	0.00	0.00	0.00	0.00	2.29
A-26	0.00	0.60	0.00	0.00	0.00	0.00	0.60
A-27	0.00	1.70	0.00	0.00	0.00	0.00	1.70
A-28	0.00	1.50	0.00	0.00	0.00	0.00	1.50
A-29	0.00	1.15	0.00	0.00	0.00	0.00	1.15
A-30	0.00	1.30	0.00	0.00	0.00	0.00	1.30
A-31	0.00	0.76	0.00	0.00	0.00	0.00	0.76
A-32	0.00	0.80	0.00	0.00	0.00	0.00	0.80
A-33	0.00	2.19	0.00	0.00	0.00	0.00	2.19
BR-2	0.00	0.27	0.00	0.00	0.00	0.00	0.27
BR-39	0.00	1.24	0.00	0.00	0.01	0.00	1.25
Port Total	***0.00***	***255.82***	***0.00***	***0.00***	***0.01***	***0.00***	***255.83***
Private							
A-6	0.00	3.16	0.00	0.00	0.00	0.00	3.16
Coast Guard							
B-40	3.24	0.02	0.00	0.00	0.00	0.00	3.26
B-41	0.02	5.42	0.00	0.00	0.03	0.00	5.46
B-42	0.00	0.46	0.00	0.00	0.00	0.00	0.46
B-43	0.00	5.74	0.00	0.00	0.00	0.00	5.74
Coast Guard Total	***3.25***	***11.64***	***0.00***	***0.00***	***0.03***	***0.00***	***14.93***
EW TOTAL	**72.54**	**541.61**	**19.45**	**15.79**	**135.29**	**2.65**	**787.34**

Table 3. Land use in East Waterway separated storm drain basins (by ownership/jurisdiction).

Land use (%)	City	Port	Private	Coast Guard	EW Total
Commercial	13%	0%	0%	22%	9%
Industrial	53%	100%	100%	78%	69%
Single family residential	4%	0%	0%	0%	2%
Multi-family residential	3%	0%	0%	0%	2%
Right-of-way	26%	0%	0%	0%	17%
Vacant/Park	1%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%

Table 4: Land use in East Waterway combined sewer service area.

Land use	Area	Percent
Commercial	782	16%
Industrial	483	10%
Multi-family residential	376	8%
Park/open/vacant	378	8%
Right-of-way	1,618	32%
Single family residential	1,359	27%
Total	4,996	100%

Table 5: Annual overflows from S Hinds St CSO (#107).

	Count	Duration (hrs)	Volume (gal)	Rainfall (in)	Storm Duration	Volume (gal)[a]
1998	4	42	192,817	3.84	75	192,817
1999	6	17	110,025	4.07	83	110,025
2000	1	8	45,173	1.31	14	45,173
2001	6	59	604,013	11.79	383	604,013
2002	5	29	107,358	8.47	338	107,358
2003	1	8	20,591	2.13	46	20,591
2004[a]	7	62	33,665,103	8.48	301	1,511,174
2005	1	12	617,204	0.33	31	617,204
2006	0	0	0	0	0	0
2007	1	29	2,008,192	6.34	178	2,008,192
2008	2	13	627,357	2.61	56	627,357
2009	11	67	3,379,938	17.83	591	3,379,938
2010	9	52	2,802,705	14.70	436	2,802,705

a. Modifed large outliers for January 2004 storms. Used average of all storms greater than 1" from 2007 through 2010.

Summary statistics:

Count	10
25th percentile	60,719
Min	42
Max	3,379,938
Median	610,609
75th percentile	1,290,220
Mean	892,100
10th percentile	18,532
90th percentile	2,145,367

Table 6: Stormwater TSS concentrations by land use.

	Low (25th percentile)	Base Case (10% trimmed mean)	High (75th percentile)
Single-family residential	24	48	70
Multi-family residential	39	68	101
Commercial	32	58	84
Industrial[a]	35	74	114
Industrial (Port)[b]	20	43	60
Vacant/park	8	13	18
Right-of-way	33	71	103

Units = mg/L

a. For industrial land use in all SPU drainage basins, except B-21, plus Port Basin B-34 and all private basins.

b. For all Port terminal areas, except B-34, plus SPU basin (B-21)

Table 7: Runoff and solids loading estimates for model base case.

SPU basins

Basin	Area (Acres)	Outfall coordinates [1]		Runoff (million gallons/year)			TSS load (lbs/year) [2]			TSS load (metric tons/year) [3]		
		X coordinate	Y coordinate	Average Year (1986)	Dry Year (1993)	Wet Year (2002)	Average Year (1986)	Dry Year (1993)	Wet Year (2002)	Average Year (1986)	Dry Year (1993)	Wet Year (2002)
B-21	12.98	1,267,025.76	216,799.42	8.7	7.3	11	3,100	2,600	3,800	1.4	1.2	1.7
B-25	4.20	1,268,053.11	218,669.74	2.7	2.3	3.3	1,500	1,200	1,800	0.7	0.5	0.8
B-36	5.35	1,267,380.50	212,096.91	3.3	2.8	4.1	2,000	1,700	2,500	0.9	0.8	1.1
B-4	7.11	1,266,960.50	211,998.11	4.6	3.8	5.6	2,800	2,330	3,400	1.3	1.1	1.5
B-5	2.15	1,266,985.87	212,222.84	1.4	1.2	1.7	830	690	1,000	0.4	0.3	0.5
Lander [4,5] (low)	438.34	1,267,839.97	215,762.30	120	99	150	70,000	58,000	86,000	32	26	39
Lander [4,5] (high)	438.34	1,267,839.97	215,762.30	220	190	270	130,000	109,000	160,000	59	49	73
Hinds	39.50	1,267,870.96	212,912.61	25	21	31	15,000	13,000	19,000	6.8	5.9	8.6
BR-34	0.95	NA [6]	NA [6]	0.6	0.5	0.7	350	290	430	0.2	0.1	0.2
BR-4	1.23	NA [6]	NA [6]	0.8	0.6	1.0	460	390	570	0.2	0.2	0.3
BR-5	1.61	NA [6]	NA [6]	1.0	0.8	1.2	590	500	740	0.3	0.2	0.3
TOTAL (low)	**513**			**170**	**140**	**210**	**97,000**	**81,000**	**119,000**	**44**	**37**	**54**
TOTAL (high)	**513**			**270**	**230**	**330**	**157,000**	**132,000**	**193,000**	**71**	**60**	**88**

Private basins

Basin	Area (Acres)	Outfall coordinates [1]		Runoff (million gallons/year)			TSS load (lbs/year) [2]			TSS load (metric tons/year) [3]		
		X coordinate	Y coordinate	Average Year (1986)	Dry Year (1993)	Wet Year (2002)	Average Year (1986)	Dry Year (1993)	Wet Year (2002)	Average Year (1986)	Dry Year (1993)	Wet Year (2002)
A-6	3.16	1,267,133.00	212,871.00	2.1	1.8	2.6	1,300	1,100	1,600	0.6	0.5	0.7
B-40	3.26	1,268,082.43	218,293.18	2.0	1.7	2.5	990	830	1,200	0.4	0.4	0.5
B-41	5.46	1,268,032.50	218,704.86	3.6	3.1	4.5	1,890	1,900	2,700	0.9	0.9	1.2
B-42	0.46	1,268,376.87	218,781.63	0.3	0.3	0.4	190	160	230	0.1	0.1	0.1
B-43	5.74	1,268,824.23	218,875.21	3.8	3.2	4.7	2,400	2,000	2,900	1.1	0.9	1.3
TOTAL	**18.1**			**12**	**10**	**15**	**6,700**	**6,000**	**8,700**	**3.0**	**2.7**	**3.9**

TSS = total suspended solids

1. North American horizontal datum 1983,1991
2. Calculated using mean value (see Table 6)
3. Metric ton = 2,204.62 lbs
4. Lander basin includes areas east and west sub-basins that drain to the separated storm drain system at S Lander St CSO/SD. Port property located within the S Lander St basin is addressed below under Port basins.
5. Low and high values are provided for partially separated areas to account for the uncertainty in the amount of area that was disconnected from the combined system. In industrial section of the basin (Lander West), the amount of disconnection for parcels outside the public right-of-way was estimated at 25-75 percent. For the primarily residential areas (Lander East), the range was estimated at 15-65 percent, based on SPU GIS data. Public rights-of-way are assumed to be 100 percent disconnected.
6. Runoff from bridges and aprons discharges directly to the waterway via scuppers or deck drains. There is no single outfall.

Table 7: Runoff and solids loading estimates for model base case.

Port basins

Basin	Area (Acres)	Outfall coordinates [1] X coordinate	Y coordinate	Runoff (million gallons/year) Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (lbs/year) [2] Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (metric tons/year) [3] Average Year (1986)	Dry Year (1993)	Wet Year (2002)
B-1	1.58	1,266,887.46	211,399.22	1.1	0.9	1.3	380	320	460	0.2	0.1	0.2
B-10	7.23	1,266,968.30	214,087.50	4.8	4.1	5.9	1,700	1,500	2,100	0.8	0.7	1.0
B-11	48.14	1,266,995.91	214,238.77	32	27	39	12,000	10,000	14,000	5.4	4.5	6.4
B-12	6.53	1,266,956.70	214,443.80	4.4	3.7	5.3	1,600	1,300	1,900	0.7	0.6	0.9
B-13	6.22	1,267,027.00	214,961.90	4.1	3.5	5.1	1,500	1,300	1,800	0.7	0.6	0.8
B-14	1.52	1,267,051.30	215,033.60	1.0	0.9	1.2	360	310	440	0.2	0.1	0.2
B-16	4.41	1,266,993.70	215,373.60	2.9	2.5	3.6	1,100	890	1,290	0.5	0.4	0.6
B-17	2.14	1,267,002.40	215,678.30	1.4	1.2	1.7	510	430	630	0.2	0.2	0.3
B-18	7.41	1,266,983.00	215,983.87	4.9	4.2	6.0	1,800	1,500	2,200	0.8	0.7	1.0
B-19	5.04	1,267,000.61	216,655.64	3.4	2.8	4.1	1,200	1,000	1,500	0.5	0.5	0.7
B-22	11.99	1,266,996.20	217,188.40	8.0	6.7	9.8	2,900	2,400	3,500	1.3	1.1	1.6
B-23	10.95	1,267,011.30	217,914.40	7.3	6.1	8.9	2,600	2,200	3,200	1.2	1.0	1.5
B-24	8.86	1,267,046.27	218,573.28	5.9	5.0	7.2	2,100	1,800	2,600	1.0	0.8	1.2
B-26	13.41	1,268,013.00	217,447.20	8.9	7.5	11	3,200	2,700	3,900	1.5	1.2	1.8
B-27	7.35	1,268,014.70	216,941.70	4.9	4.1	6.0	1,800	1,500	2,100	0.8	0.7	1.0
B-28	3.59	1,268,001.70	216,332.40	2.4	2.0	2.9	860	720	1,050	0.4	0.3	0.5
B-29	8.75	1,268,024.30	215,844.00	5.8	4.9	7.1	2,100	1,800	2,600	1.0	0.8	1.2
B-30	6.69	1,268,481.10	214,909.20	4.5	3.8	5.5	1,600	1,300	2,000	0.7	0.6	0.9
B-31/BR-27	9.81	1,267,827.60	214,382.65	6.5	5.5	8.0	2,300	2,000	2,900	1.0	0.9	1.3
B-32	3.73	1,267,816.51	214,084.19	2.5	2.1	3.0	890	750	1,090	0.4	0.3	0.5
B-33	12.11	1,267,802.40	213,205.40	8.1	6.8	9.9	2,900	2,400	3,500	1.3	1.1	1.6
B-34	13.33	1,267,445.56	212,282.86	8.8	7.4	11	5,400	4,600	6,600	2.4	2.1	3.0
B-37	6.41	1,267,196.82	211,561.15	4.2	3.6	5.2	1,500	1,300	1,900	0.7	0.6	0.9
B-39	2.08	1,267,224.50	211,803.70	1.4	1.2	1.7	500	420	610	0.2	0.2	0.3
B-7	13.93	1,266,941.40	212,971.90	9.3	7.8	11	3,300	2,800	4,100	1.5	1.3	1.9
Lander [4]	3.62	1,267,839.97	215,762.30	2.4	2.0	2.9	860	730	1,060	0.4	0.3	0.5
A-7	1.16	NA [6]	NA [6]	0.8	0.6	0.9	280	230	340	0.1	0.1	0.2
A-10	2.28	NA [6]	NA [6]	1.5	1.3	1.9	550	460	670	0.2	0.2	0.3
A-12	1.98	NA [6]	NA [6]	1.3	1.1	1.6	470	400	580	0.2	0.2	0.3
A-13	0.47	NA [6]	NA [6]	0.3	0.3	0.4	110	90	140	0.0	0.0	0.1
A-14	1.04	NA [6]	NA [6]	0.7	0.6	0.8	250	210	300	0.1	0.1	0.1
A-16	0.66	NA [6]	NA [6]	0.4	0.4	0.5	160	130	190	0.1	0.1	0.1
A-17	0.68	NA [6]	NA [6]	0.5	0.4	0.6	160	140	200	0.1	0.1	0.1
A-18	1.20	NA [6]	NA [6]	0.8	0.7	1.0	290	240	350	0.1	0.1	0.2
A-19	1.89	NA [6]	NA [6]	1.3	1.1	1.5	450	380	550	0.2	0.2	0.2
A-22	2.01	NA [6]	NA [6]	1.3	1.1	1.6	480	410	590	0.2	0.2	0.3
A-23	2.05	NA [6]	NA [6]	1.4	1.1	1.7	490	410	600	0.2	0.2	0.3
A-24	2.29	NA [6]	NA [6]	1.5	1.3	1.9	550	460	670	0.2	0.2	0.3
A-26	0.60	NA [6]	NA [6]	0.4	0.3	0.5	140	120	170	0.1	0.1	0.1
A-27	1.70	NA [6]	NA [6]	1.1	1.0	1.4	410	340	500	0.2	0.2	0.2
A-28	1.50	NA [6]	NA [6]	1.0	0.8	1.2	360	300	440	0.2	0.1	0.2
A-29	1.15	NA [6]	NA [6]	0.8	0.6	0.9	270	230	340	0.1	0.1	0.2
A-30	1.30	NA [6]	NA [6]	0.9	0.7	1.1	310	260	380	0.1	0.1	0.2
A-31	0.76	NA [6]	NA [6]	0.5	0.4	0.6	180	150	220	0.1	0.1	0.1
A-32	0.80	NA [6]	NA [6]	0.5	0.5	0.7	190	160	230	0.1	0.1	0.1
A-33	2.19	NA [6]	NA [6]	1.5	1.2	1.8	520	440	640	0.2	0.2	0.3
BR-39	1.25	NA [6]	NA [6]	0.8	0.8	1.0	520	430	630	0.2	0.2	0.3
BR-2	0.27	1,266,955.62	211,835.26	0.2	0.1	0.2	64	54	78	0.0	0.0	0.0
TOTAL PORT	**256**			**170**	**140**	**210**	**64,000**	**54,000**	**78,000**	**29**	**25**	**35**

Table 8: Storm drain solids loading summary (low range).

SPU basins

Basin	Area (acres)	Outfall coordinates [1] X coordinate	Y coordinate	Runoff (million gallons/year) Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (lbs/year) [2] Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (metric tons/year) [3] Average Year (1986)	Dry Year (1993)	Wet Year (2002)
B-21	12.98	1,267,025.76	216,799.42	8.7	7.3	11	1,400	1,200	1,800	0.6	0.5	0.8
B-25	4.20	1,268,053.11	218,669.74	2.7	2.3	3.3	720	610	890	0.3	0.3	0.4
B-36	5.35	1,267,380.50	212,096.91	3.3	2.8	4.1	940	790	1,200	0.4	0.4	0.5
B-4	7.11	1,266,960.50	211,998.11	4.6	3.8	5.6	1,300	1,100	1,600	0.6	0.5	0.7
B-5	2.15	1,266,985.87	212,222.84	1.4	1.2	1.7	390	330	480	0.2	0.1	0.2
Lander [4,5] (low)	438.34	1,267,839.97	215,762.30	120	100	150	33,000	28,000	41,000	15	13	19
Lander [4,5] (high)	438.34	1,267,839.97	215,762.30	220	190	270	62,000	52,000	76,000	28	24	34
Hinds	39.50	1,267,870.96	212,912.61	25	21	31	7,100	6,000	8,700	3.2	2.7	3.9
BR-34	0.95	NA[6]	NA[6]	0.6	0.5	0.7	170	140	210	0.08	0.06	0.10
BR-4	1.23	NA[6]	NA[6]	0.8	0.6	1.0	220	180	270	0.10	0.08	0.12
BR-5	1.61	NA[6]	NA[6]	1.0	0.8	1.2	280	240	350	0.13	0.11	0.16
TOTAL (low)	**513**			**170**	**140**	**210**	**46,000**	**39,000**	**56,000**	**21**	**18**	**26**
TOTAL (high)	**513**			**270**	**230**	**330**	**75,000**	**63,000**	**91,000**	**34**	**28**	**42**

Private basins

Basin	Area (acres)	Outfall coordinates [1] X coordinate	Y coordinate	Runoff (million gallons/year) Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (lbs/year)[2] Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (metric tons/year)[3] Average Year (1986)	Dry Year (1993)	Wet Year (2002)
A-6	3.16	1,267,133.00	212,871.00	2.1	1.8	2.6	600	500	730	0.3	0.2	0.3
B-40	3.26	1,268,082.43	218,293.18	2.0	1.7	2.5	530	440	650	0.2	0.2	0.3
B-41	5.46	1,268,032.50	218,704.86	3.6	3.1	4.5	870	870	1,260	0.4	0.4	0.6
B-42	0.46	1,268,376.87	218,781.63	0.3	0.3	0.4	87	73	107	0.0	0.0	0.0
B-43	5.74	1,268,824.23	218,875.21	3.8	3.2	4.7	1,100	900	1,300	0.5	0.4	0.6
TOTAL	**18.1**			**12**	**10**	**15**	**3,200**	**2,800**	**4,100**	**1.5**	**1.3**	**1.9**

TSS = total suspended solids

1. North American horizontal datum 1983,1991
2. Calculated using 25th percentile TSS value (see Table 6)
3. Metric ton = 2,204.62 lbs
4. Lander basin includes areas east and west sub-basins that drain to the separated storm drain system at S Lander St CSO/SD. Port property located within the S Lander St basin is addressed under Port basins.
5. Low and high values are provided for partially separated areas to account for the uncertainty in the amount of area that was disconnected from the combined system. In industrial section of the basin (Lander West), the amount of disconnection for parcels outside the public right-of-way was estimated at 25-75 percent. For the primarily residential areas (Lander East), the range was estimated at 15-65 percent, based on SPU GIS data. Public rights-of-way are assumed to be 100 percent disconnected.

6. Runoff from bridges and aprons discharges directly to the waterway via scuppers or deck drains. There is no single outfall.

Table 8: Storm drain solids loading summary (low range).

Port basins

Basin	Area (acres)	Outfall coordinates [1]		Runoff (million gallons/year)			TSS load (lbs/year)[2]			TSS load (metric tons/year)[3]		
		X coordinate	Y coordinate	Average Year (1986)	Dry Year (1993)	Wet Year (2002)	Average Year (1986)	Dry Year (1993)	Wet Year (2002)	Average Year (1986)	Dry Year (1993)	Wet Year (2002)
B-1	1.58	1,266,887.46	211,399.22	1.1	0.9	1.3	180	150	220	0.1	0.1	0.1
B-10	7.23	1,266,968.30	214,087.50	4.8	4.1	5.9	800	680	980	0.4	0.3	0.4
B-11	48.14	1,266,995.91	214,238.77	32	27	39	5,400	4,500	6,500	2.4	2.0	2.9
B-12	6.53	1,266,956.70	214,443.80	4.4	3.7	5.3	730	610	890	0.3	0.3	0.4
B-13	6.22	1,267,027.00	214,961.90	4.1	3.5	5.1	690	580	850	0.3	0.3	0.4
B-14	1.52	1,267,051.30	215,033.60	1.0	0.9	1.2	170	140	210	0.1	0.1	0.1
B-16	4.41	1,266,993.70	215,373.60	2.9	2.5	3.6	490	410	600	0.2	0.2	0.3
B-17	2.14	1,267,002.40	215,678.30	1.4	1.2	1.7	240	200	290	0.1	0.1	0.1
B-18	7.41	1,266,983.00	215,983.87	4.9	4.2	6.0	820	690	1,010	0.4	0.3	0.5
B-19	5.04	1,267,000.61	216,655.64	3.4	2.8	4.1	560	470	690	0.3	0.2	0.3
B-22	11.99	1,266,996.20	217,188.40	8.0	6.7	9.8	1,300	1,100	1,600	0.6	0.5	0.7
B-23	10.95	1,267,011.30	217,914.40	7.3	6.1	8.9	1,200	1,000	1,500	0.5	0.5	0.7
B-24	8.86	1,267,046.27	218,573.28	5.9	5.0	7.2	990	830	1,200	0.4	0.4	0.5
B-26	13.41	1,268,013.00	217,447.20	8.9	7.5	11	1,500	1,300	1,800	0.7	0.6	0.8
B-27	7.35	1,268,014.70	216,941.70	4.9	4.1	6.0	820	690	1,000	0.4	0.3	0.5
B-28	3.59	1,268,001.70	216,332.40	2.4	2.0	2.9	400	340	490	0.2	0.2	0.2
B-29	8.75	1,268,024.30	215,844.00	5.8	4.9	7.1	970	820	1,190	0.4	0.4	0.5
B-30	6.69	1,268,481.10	214,909.20	4.5	3.8	5.5	740	630	910	0.3	0.3	0.4
B-31/BR-27	9.81	1,267,827.60	214,382.65	6.5	5.5	8.0	1,100	900	1,300	0.5	0.4	0.6
B-32	3.73	1,267,816.51	214,084.19	2.5	2.1	3.0	410	350	510	0.2	0.2	0.2
B-33	12.11	1,267,802.40	213,205.40	8.1	6.8	9.9	1,300	1,100	1,600	0.6	0.5	0.7
B-34	13.33	1,267,445.56	212,282.86	8.8	7.4	11	2,500	2,100	3,000	1.1	1.0	1.4
B-37	6.41	1,267,196.82	211,561.15	4.2	3.6	5.2	710	590	860	0.3	0.3	0.4
B-39	2.08	1,267,224.50	211,803.70	1.4	1.2	1.7	230	190	280	0.1	0.1	0.1
B-7	13.93	1,266,941.40	212,971.90	9.3	7.8	11	1,500	1,300	1,900	0.7	0.6	0.9
Lander [4]	3.62	1,267,839.97	215,762.30	2.4	2.0	2.9	400	340	490	0.2	0.2	0.2
A-7	1.16	NA[6]	NA[6]	0.8	0.6	0.9	130	110	160	0.1	0.0	0.1
A-10	2.28	NA[6]	NA[6]	1.5	1.3	1.9	250	210	310	0.1	0.1	0.1
A-12	1.98	NA[6]	NA[6]	1.3	1.1	1.6	220	190	270	0.1	0.1	0.1
A-13	0.47	NA[6]	NA[6]	0.3	0.3	0.4	52	44	64	0.0	0.0	0.0
A-14	1.04	NA[6]	NA[6]	0.7	0.6	0.8	120	100	140	0.1	0.0	0.1
A-16	0.66	NA[6]	NA[6]	0.4	0.4	0.5	73	62	89	0.0	0.0	0.0
A-17	0.68	NA[6]	NA[6]	0.5	0.4	0.6	76	64	93	0.0	0.0	0.0
A-18	1.20	NA[6]	NA[6]	0.8	0.7	1.0	130	110	160	0.1	0.0	0.1
A-19	1.89	NA[6]	NA[6]	1.3	1.1	1.5	210	180	260	0.1	0.1	0.1
A-22	2.01	NA[6]	NA[6]	1.3	1.1	1.6	220	190	270	0.1	0.1	0.1
A-23	2.05	NA[6]	NA[6]	1.4	1.1	1.7	230	190	280	0.1	0.1	0.1
A-24	2.29	NA[6]	NA[6]	1.5	1.3	1.9	250	210	310	0.1	0.1	0.1
A-26	0.60	NA[6]	NA[6]	0.4	0.3	0.5	67	56	81	0.0	0.0	0.0
A-27	1.70	NA[6]	NA[6]	1.1	1.0	1.4	190	160	230	0.1	0.1	0.1
A-28	1.50	NA[6]	NA[6]	1.0	0.8	1.2	170	140	200	0.1	0.1	0.1
A-29	1.15	NA[6]	NA[6]	0.8	0.6	0.9	130	110	160	0.1	0.0	0.1
A-30	1.30	NA[6]	NA[6]	0.9	0.7	1.1	150	120	180	0.1	0.1	0.1
A-31	0.76	NA[6]	NA[6]	0.5	0.4	0.6	85	71	104	0.0	0.0	0.0
A-32	0.80	NA[6]	NA[6]	0.5	0.5	0.7	89	75	109	0.0	0.0	0.0
A-33	2.19	NA[6]	NA[6]	1.5	1.2	1.8	240	200	300	0.1	0.1	0.1
BR-39	1.25	NA[6]	NA[6]	0.8	0.8	1.0	240	200	290	0.1	0.1	0.1
BR-2	0.27	1,266,955.62	211,835.26	0.2	0.1	0.2	30	25	36	0.0	0.0	0.0
TOTAL PORT	**256**			**170**	**140**	**210**	**30,000**	**25,000**	**36,000**	**13**	**11**	**16**

Table 9: Runoff and solids loading estimates (high range).

SPU basins

Basin	Area (acres)	Outfall coordinates [1] X coordinate	Y coordinate	Runoff (million gallons/year) Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (lbs/year) [2] Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (metric tons/year) [3] Average Year (1986)	Dry Year (1993)	Wet Year (2002)
B-21	12.98	1,267,025.76	216,799.42	8.7	7.3	11	4,300	3,600	5,300	2.0	1.6	2.4
B-25	4.20	1,268,053.11	218,669.74	2.7	2.3	3.3	2,200	1,800	2,700	1.0	0.8	1.2
B-36	5.35	1,267,380.50	212,096.91	3.3	2.8	4.1	2,700	2,200	3,300	1.2	1.0	1.5
B-4	7.11	1,266,960.50	211,998.11	4.6	3.8	5.6	3,900	3,300	4,800	1.8	1.5	2.2
B-5	2.15	1,266,985.87	212,222.84	1.4	1.2	1.7	1,100	940	1,400	0.5	0.4	0.6
Lander [4,5] (low)	438.34	1,267,839.97	215,762.30	120	100	150	94,000	79,000	116,000	43	36	53
Lander [4,5] (high)	438.34	1,267,839.97	215,762.30	220	190	270	188,000	158,000	231,000	85	72	105
Hinds	39.50	1,267,870.96	212,912.61	25	21	31	23,000	19,000	28,000	10	8.6	13
BR-34	0.95	NA[6]	NA[6]	0.6	0.5	0.7	420	350	520	0.2	0.2	0.2
BR-4	1.23	NA[6]	NA[6]	0.8	0.6	1.0	590	500	730	0.3	0.2	0.3
BR-5	1.61	NA[6]	NA[6]	1.0	0.8	1.2	720	600	890	0.3	0.3	0.4
TOTAL (low)	**513**			**170**	**140**	**210**	**133,000**	**111,000**	**164,000**	**60**	**50**	**74**
TOTAL (high)	**513**			**270**	**230**	**330**	**227,000**	**190,000**	**279,000**	**103**	**86**	**126**

Private basins

Basin	Area (acres)	Outfall coordinates [1] X coordinate	Y coordinate	Runoff (million gallons/year) Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (lbs/year) [2] Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (metric tons/year) [3] Average Year (1986)	Dry Year (1993)	Wet Year (2002)
A-6	3.16	1,267,133.00	212,871.00	2.1	1.8	2.6	2,100	1,700	2,500	1.0	0.8	1.1
B-40	3.26	1,268,082.43	218,293.18	2.0	1.7	2.5	1,400	1,200	1,800	0.6	0.5	0.8
B-41	5.46	1,268,032.50	218,704.86	3.6	3.1	4.5	3,000	3,000	4,300	1.4	1.4	2.0
B-42	0.46	1,268,376.87	218,781.63	0.3	0.3	0.4	300	250	370	0.1	0.1	0.2
B-43	5.74	1,268,824.23	218,875.21	3.8	3.2	4.7	3,700	3,100	4,600	1.7	1.4	2.1
TOTAL	**18.1**			**12**	**10**	**15**	**11,000**	**9,300**	**14,000**	**5.0**	**4.2**	**6.4**

TSS = total suspended solids

1. North American horizontal datum 1983,1991
2. Calculated using 75th percentile TSS value (see Table 6)
3. Metric ton = 2,204.62 lbs
4. Lander basin includes areas east and west sub-basins that drain to the separated storm drain system at S Lander St CSO/SD. Port property located within the S Lander St basin is addressed under Port basins.
5. Low and high values are provided for partially separated areas to account for the uncertainty in the amount of area that was disconnected from the combined system. In industrial section of the basin (Lander West), the amount of disconnection for parcels outside the public right-of-way was estimated at 25-75 percent. For the primarily residential areas (Lander East), the range was estimated at 15-65 percent, based on SPU GIS data. Public rights-of-way are assumed to be 100 percent disconnected.
6. Runoff from bridges and aprons discharges directly to the waterway via scuppers or deck drains. There is no single outfall.

Table 9: Runoff and solids loading estimates (high range).

Port basins

Basin	Area (acres)	Outfall coordinates [1] X coordinate	Y coordinate	Runoff (million gallons/year) Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (lbs/year) [2] Average Year (1986)	Dry Year (1993)	Wet Year (2002)	TSS load (metric tons/year) [3] Average Year (1986)	Dry Year (1993)	Wet Year (2002)
B-1	1.58	1,266,887.46	211,399.22	1.1	0.9	1.3	530	440	650	0.2	0.2	0.3
B-10	7.23	1,266,968.30	214,087.50	4.8	4.1	5.9	2,400	2,000	3,000	1.1	0.9	1.4
B-11	48.14	1,266,995.91	214,238.77	32	27	39	16,000	14,000	20,000	7.3	6.4	9.1
B-12	6.53	1,266,956.70	214,443.80	4.4	3.7	5.3	2,200	1,800	2,700	1.0	0.8	1.2
B-13	6.22	1,267,027.00	214,961.90	4.1	3.5	5.1	2,100	1,700	2,500	1.0	0.8	1.1
B-14	1.52	1,267,051.30	215,033.60	1.0	0.9	1.2	510	430	620	0.2	0.2	0.3
B-16	4.41	1,266,993.70	215,373.60	2.9	2.5	3.6	1,500	1,200	1,800	0.7	0.5	0.8
B-17	2.14	1,267,002.40	215,678.30	1.4	1.2	1.7	710	600	870	0.3	0.3	0.4
B-18	7.41	1,266,983.00	215,983.87	4.9	4.2	6.0	2,500	2,100	3,000	1.1	1.0	1.4
B-19	5.04	1,267,000.61	216,655.64	3.4	2.8	4.1	1,700	1,400	2,100	0.8	0.6	1.0
B-22	11.99	1,266,996.20	217,188.40	8.0	6.7	9.8	4,000	3,400	4,900	1.8	1.5	2.2
B-23	10.95	1,267,011.30	217,914.40	7.3	6.1	8.9	3,700	3,100	4,500	1.7	1.4	2.0
B-24	8.86	1,267,046.27	218,573.28	5.9	5.0	7.2	3,000	2,500	3,600	1.4	1.1	1.6
B-26	13.41	1,268,013.00	217,447.20	8.9	7.5	11	4,500	3,800	5,500	2.0	1.7	2.5
B-27	7.35	1,268,014.70	216,941.70	4.9	4.1	6.0	2,500	2,100	3,000	1.1	1.0	1.4
B-28	3.59	1,268,001.70	216,332.40	2.4	2.0	2.9	1,200	1,000	1,500	0.5	0.5	0.7
B-29	8.75	1,268,024.30	215,844.00	5.8	4.9	7.1	2,900	2,500	3,600	1.3	1.1	1.6
B-30	6.69	1,268,481.10	214,909.20	4.5	3.8	5.5	2,200	1,900	2,700	1.0	0.9	1.2
B-31/BR-27	9.81	1,267,827.60	214,382.65	6.5	5.5	8.0	3,300	2,800	4,000	1.5	1.3	1.8
B-32	3.73	1,267,816.51	214,084.19	2.5	2.1	3.0	1,200	1,000	1,500	0.5	0.5	0.7
B-33	12.11	1,267,802.40	213,205.40	8.1	6.8	9.9	4,000	3,400	4,900	1.8	1.5	2.2
B-34	13.33	1,267,445.56	212,282.86	8.8	7.4	11	8,600	7,200	10,500	3.9	3.3	4.8
B-37	6.41	1,267,196.82	211,561.15	4.2	3.6	5.2	2,100	1,800	2,600	1.0	0.8	1.2
B-39	2.08	1,267,224.50	211,803.70	1.4	1.2	1.7	690	580	850	0.3	0.3	0.4
B-7	13.93	1,266,941.40	212,971.90	9.3	7.8	11	4,600	3,900	5,700	2.1	1.8	2.6
Lander [4]	3.62	1,267,839.97	215,762.30	2.4	2.0	2.9	1,200	1,000	1,500	0.5	0.5	0.7
A-7	1.16	NA[6]	NA[6]	0.8	0.6	0.9	390	330	470	0.2	0.1	0.2
A-10	2.28	NA[6]	NA[6]	1.5	1.3	1.9	760	640	930	0.3	0.3	0.4
A-12	1.98	NA[6]	NA[6]	1.3	1.1	1.6	660	560	810	0.3	0.3	0.4
A-13	0.47	NA[6]	NA[6]	0.3	0.3	0.4	160	130	190	0.1	0.1	0.1
A-14	1.04	NA[6]	NA[6]	0.7	0.6	0.8	350	290	420	0.2	0.1	0.2
A-16	0.66	NA[6]	NA[6]	0.4	0.4	0.5	220	180	270	0.1	0.1	0.1
A-17	0.68	NA[6]	NA[6]	0.5	0.4	0.6	230	190	280	0.1	0.1	0.1
A-18	1.20	NA[6]	NA[6]	0.8	0.7	1.0	400	340	490	0.2	0.2	0.2
A-19	1.89	NA[6]	NA[6]	1.3	1.1	1.5	630	530	770	0.3	0.2	0.3
A-22	2.01	NA[6]	NA[6]	1.3	1.1	1.6	670	570	820	0.3	0.3	0.4
A-23	2.05	NA[6]	NA[6]	1.4	1.1	1.7	680	580	840	0.3	0.3	0.4
A-24	2.29	NA[6]	NA[6]	1.5	1.3	1.9	760	640	930	0.3	0.3	0.4
A-26	0.60	NA[6]	NA[6]	0.4	0.3	0.5	200	170	240	0.1	0.1	0.1
A-27	1.70	NA[6]	NA[6]	1.1	1.0	1.4	570	480	690	0.3	0.2	0.3
A-28	1.50	NA[6]	NA[6]	1.0	0.8	1.2	500	420	610	0.2	0.2	0.3
A-29	1.15	NA[6]	NA[6]	0.8	0.6	0.9	380	320	470	0.2	0.1	0.2
A-30	1.30	NA[6]	NA[6]	0.9	0.7	1.1	440	370	530	0.2	0.2	0.2
A-31	0.76	NA[6]	NA[6]	0.5	0.4	0.6	250	210	310	0.1	0.1	0.1
A-32	0.80	NA[6]	NA[6]	0.5	0.5	0.7	270	230	330	0.1	0.1	0.1
A-33	2.19	NA[6]	NA[6]	1.5	1.2	1.8	730	610	890	0.3	0.3	0.4
BR-39	1.25	NA[6]	NA[6]	0.8	0.8	1.0	810	680	990	0.4	0.3	0.4
BR-2	0.27	1,266,955.62	211,835.26	0.2	0.1	0.2	90	80	110	0.0	0.0	0.0
TOTAL	**256**			**170**	**140**	**210**	**90,000**	**76,000**	**110,000**	**41**	**35**	**50**

Table 10: Land use in CSOs monitored by SPU.

CSO	Area (acres)	Commercial	Industrial	Multi-family	Single-family	School	Undeveloped	ROW
13A	614	2%	2%	1%	57%	3%	4%	32%
18A	925	11%	0%	7%	80%	4%	5%	44%
28	21	0%	0%	0%	2%	0%	0%	1%
31	6	0%	0%	0%	0%	0%	0%	0%
41B	94	0%	0%	0%	9%	0%	0%	6%
43	75	0%	0%	0%	7%	0%	0%	4%
44B	262	0%	0%	0%	18%	0%	18%	6%
47B	950	8%	0%	6%	86%	7%	12%	35%
99	180	2%	3%	2%	6%	0%	7%	8%
147A	196	3%	2%	4%	9%	1%	1%	13%
150/151	394	5%	0%	6%	30%	1%	2%	21%
152	676	3%	0%	9%	60%	1%	1%	36%
169	184	2%	0%	2%	15%	0%	1%	10%
171	179	1%	0%	4%	63%	5%	2%	25%
174	324	2%	1%	10%	18%	1%	1%	20%

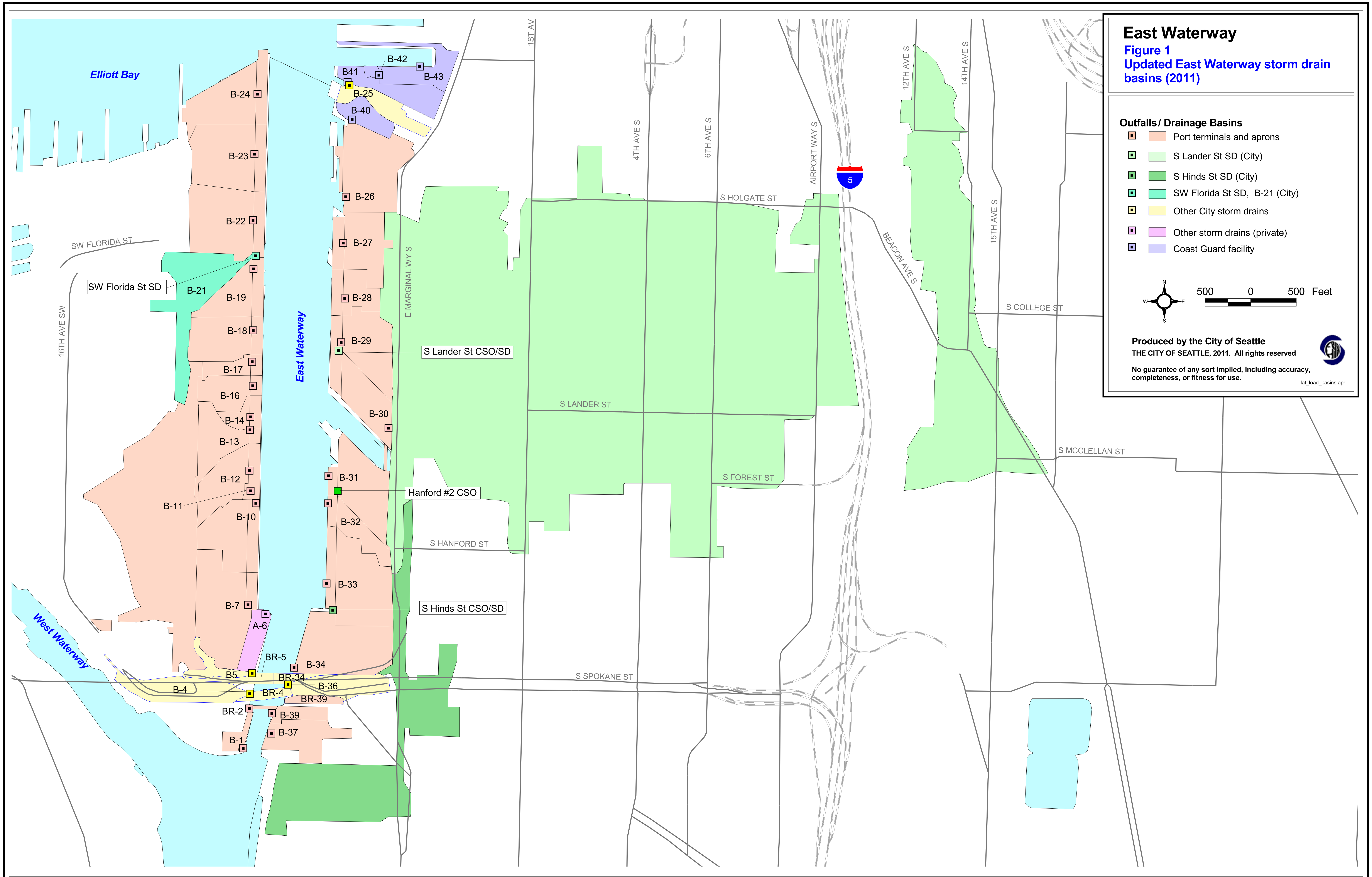
Table 11: Comparison of TSS from King County and SPU CSOs.

	King County[1]	SPU[2]
Number of samples	28	42
Min	36	7
Max	156	87
25th percentile	66	16
Median	95	27
75th percentile	108	45
Mean	88	32
Geomean	83	26

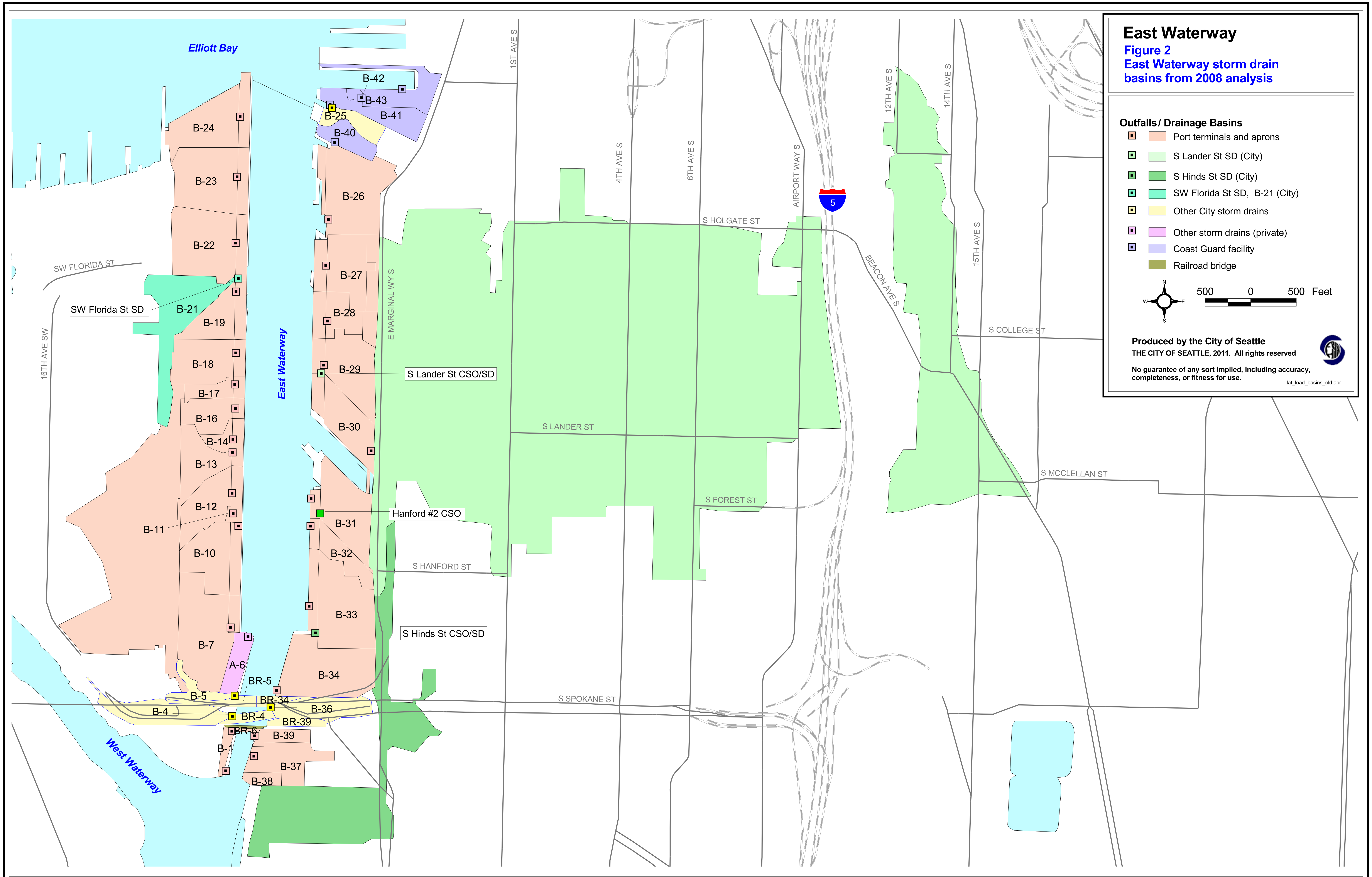
Units: TSS in mg/L.

1. 1998-2009 samples from Hanford #2 and Lander CSOs (Williston 2010)
2. 2007-2010 samples from 15 CSOs in City system. None discharge to the EW.

Figures

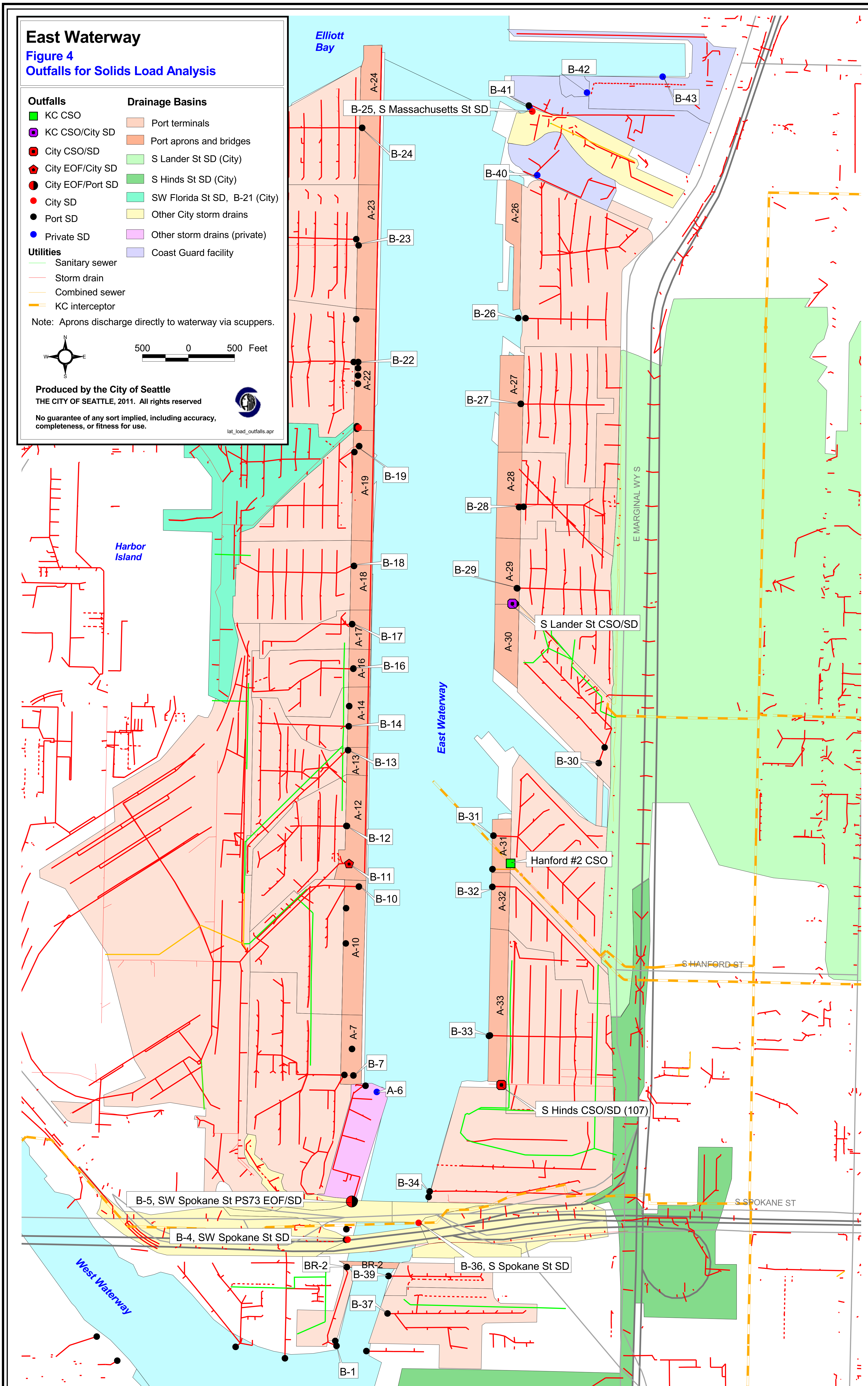


East Waterway
Figure 1
Updated East Waterway storm drain basins (2011)
Outfalls / Drainage Basins
Port terminals and aprons
S Lander St SD (City)
S Hinds St SD (City)
SW Florida St SD, B-21 (City)
Other City storm drains
Other storm drains (private)
Coast Guard facility
500 0 500 Feet
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
lat_load_basins.apr
Elliott Bay
East Waterway
West Waterway
SW Florida St SD
S Lander St CSO/SD
Hanford #2 CSO
S Hinds St CSO/SD
SW FLORIDA ST
16TH AVE SW
1ST AV
4TH AVE S
6TH AVE S
AIRPORT WAY S
12TH AVE S
14TH AVE S
15TH AVE S
E MARGINAL WY S
S HOLGATE ST
BEACON AVE S
S COLLEGE ST
S LANDER ST
S MCCLELLAN ST
S FOREST ST
S HANFORD ST
S SPOKANE ST
5
B-42
B41
B-43
B-25
B-40
B-24
B-23
B-26
B-22
B-27
B-21
B-19
B-28
B-18
B-29
B-17
B-16
B-14
B-30
B-13
B-12
B-31
B-11
B-10
B-32
B-33
B-7
A-6
BR-5
B-34
B5
BR-34
B-36
B-4
BR-4
BR-39
BR-2
B-39
B-37
B-1



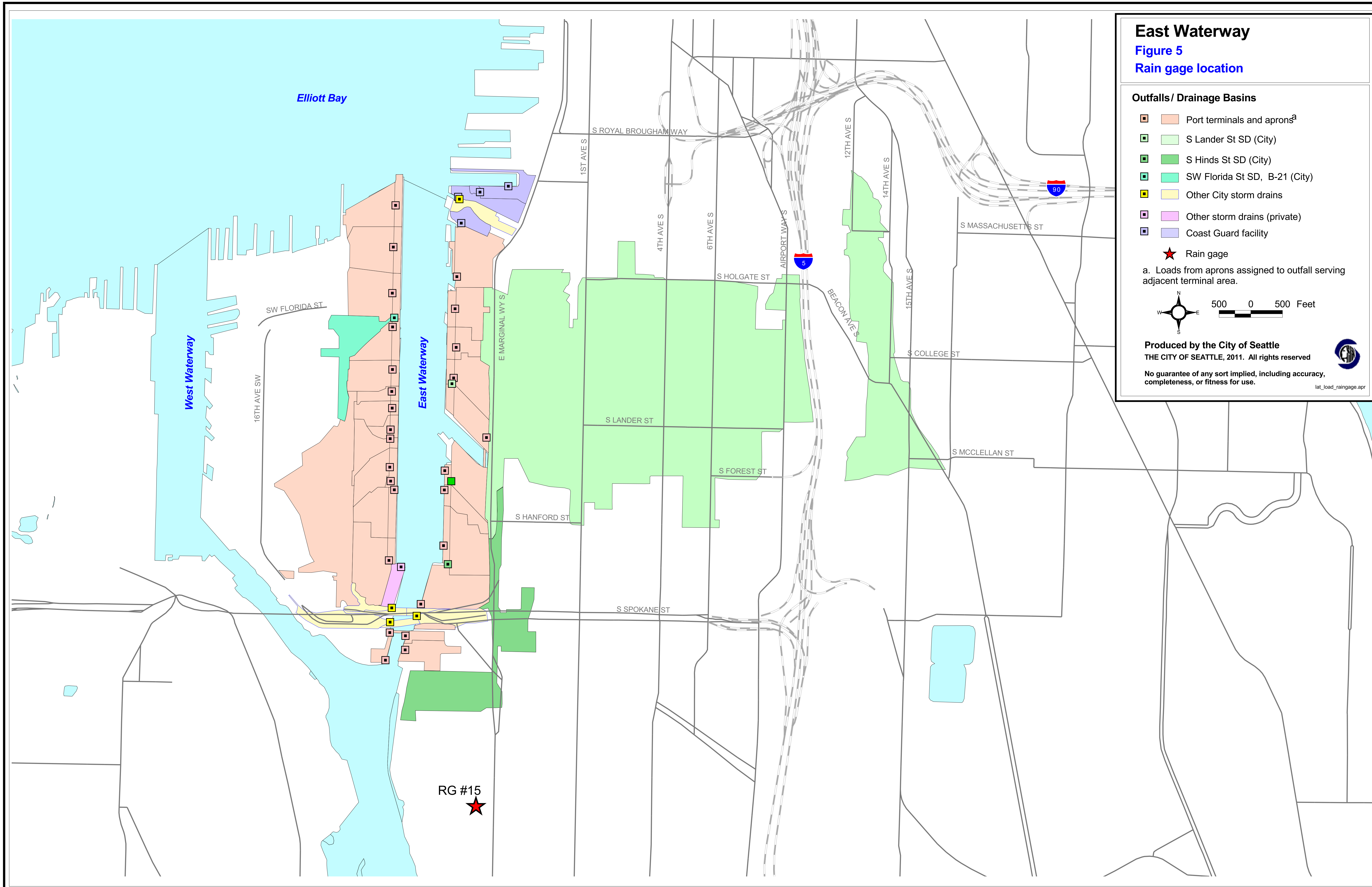
East Waterway
Figure 2
East Waterway storm drain basins from 2008 analysis
Outfalls / Drainage Basins
Port terminals and aprons
S Lander St SD (City)
S Hinds St SD (City)
SW Florida St SD, B-21 (City)
Other City storm drains
Other storm drains (private)
Coast Guard facility
Railroad bridge
500 0 500 Feet
N
S
E
W
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
lat_load_basins_old.apr
Elliott Bay
East Waterway
West Waterway
SW Florida St SD
S Lander St CSO/SD
Hanford #2 CSO
S Hinds St CSO/SD
SW FLORIDA ST
16TH AVE SW
1ST AVE S
4TH AVE S
6TH AVE S
AIRPORT WAY S
12TH AVE S
14TH AVE S
15TH AVE S
E MARGINAL WY S
BEACON AVE S
S HOLGATE ST
S LANDER ST
S FOREST ST
S HANFORD ST
S SPOKANE ST
S COLLEGE ST
S MCCLELLAN ST
5
B-42
B-43
B-41
B-25
B-40
B-24
B-23
B-26
B-22
B-27
B-21
B-19
B-28
B-18
B-29
B-17
B-16
B-30
B-14
B-13
B-12
B-31
B-11
B-10
B-32
B-33
B-7
A-6
B-34
BR-5
B-5
BR-34
B-4
BR-4
B-36
BR-39
BR-6
B-39
B-1
B-37
B-38


East Waterway
Figure 3
Land use in the separated storm drain basin
Legend
Land use
Commercial
Industrial
Single family residential
Multi-family residential
Open, vacant, parks
Public right-of-way
500 0 500 Feet
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
lat_load_basins_landuse.apr
Elliott Bay
East Waterway
West Waterway
E MARGINAL WY S
COLORADO AVE S
S HOLGATE ST
S WALKER ST
S STACY ST
S LANDER ST
S FOREST ST
S HANFORD ST
S SPOKANE ST
4TH AVE S
6TH AVE S
AIRPORT WAY S
12TH AVE S
13TH AVE S
14TH AVE S
15TH AVE S
BEACON AVE S
S MCCLELLAN ST
5

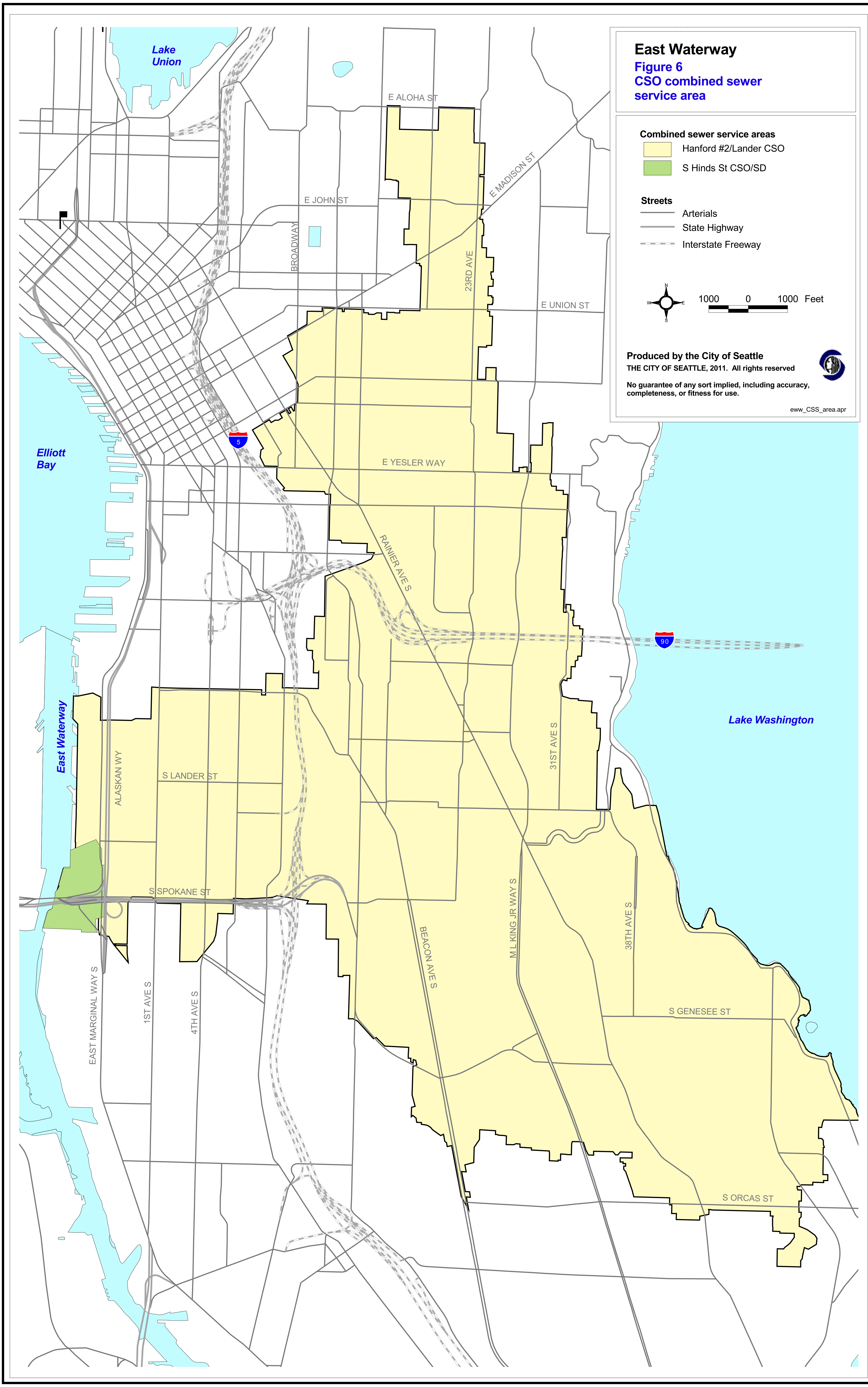


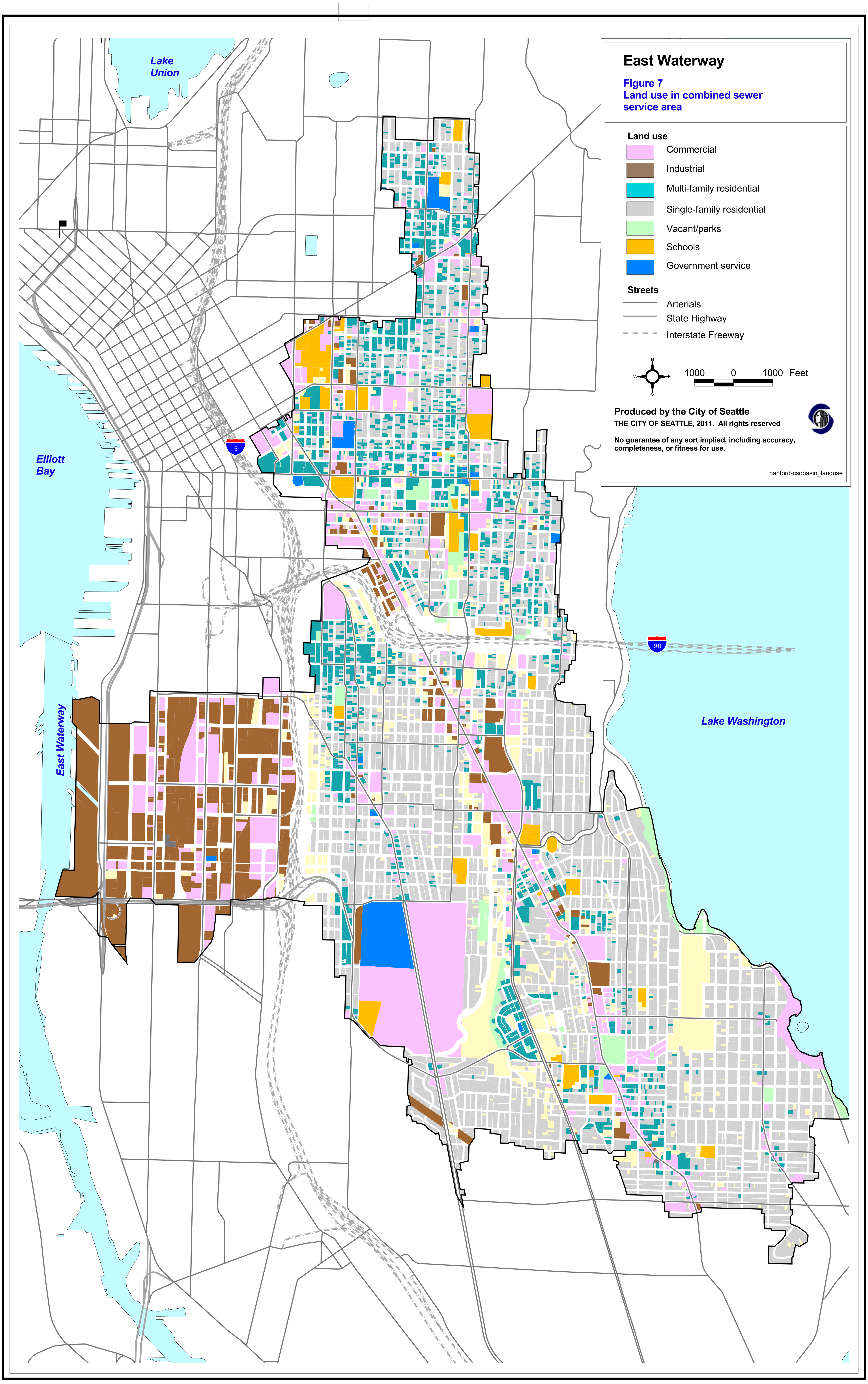
East Waterway

Figure 4
Outfalls for Solids Load Analysis



East Waterway
Figure 5
Rain gage location
Outfalls / Drainage Basins
Port terminals and aprons[a]
S Lander St SD (City)
S Hinds St SD (City)
SW Florida St SD, B-21 (City)
Other City storm drains
Other storm drains (private)
Coast Guard facility
Rain gage
a. Loads from aprons assigned to outfall serving adjacent terminal area.
500 0 500 Feet
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
lat_load_raingage.apr
Elliott Bay
West Waterway
East Waterway
RG #15
SW FLORIDA ST
16TH AVE SW
E MARGINAL WY S
S ROYAL BROUGHAM WAY
1ST AVE S
4TH AVE S
6TH AVE S
AIRPORT WAY S
12TH AVE S
14TH AVE S
15TH AVE S
BEACON AVE S
S HOLGATE ST
S MASSACHUSETTS ST
S COLLEGE ST
S LANDER ST
S FOREST ST
S MCCLELLAN ST
S HANFORD ST
S SPOKANE ST
5
90


East Waterway
Figure 6
CSO combined sewer service area
Combined sewer service areas
Hanford #2/Lander CSO
S Hinds St CSO/SD
Streets
Arterials
State Highway
Interstate Freeway
N
S
E
W
1000
0
1000
Feet
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
eww_CSS_area.apr
Lake Union
Elliott Bay
East Waterway
Lake Washington
E ALOHA ST
E JOHN ST
BROADWAY
E MADISON ST
23RD AVE
E UNION ST
5
E YESLER WAY
RAINIER AVE S
90
31ST AVE S
ALASKAN WY
S LANDER ST
S SPOKANE ST
BEACON AVE S
M L KING JR WAY S
38TH AVE S
S GENESEE ST
S ORCAS ST
EAST MARGINAL WAY S
1ST AVE S
4TH AVE S


East Waterway
Figure 7
Land use in combined sewer service area
Land use
Commercial
Industrial
Multi-family residential
Single-family residential
Vacant/parks
Schools
Government service
Streets
Arterials
State Highway
Interstate Freeway
1000 0 1000 Feet
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
hanford-csobasin_landuse
Lake Union
Elliott Bay
East Waterway
Lake Washington
5
90

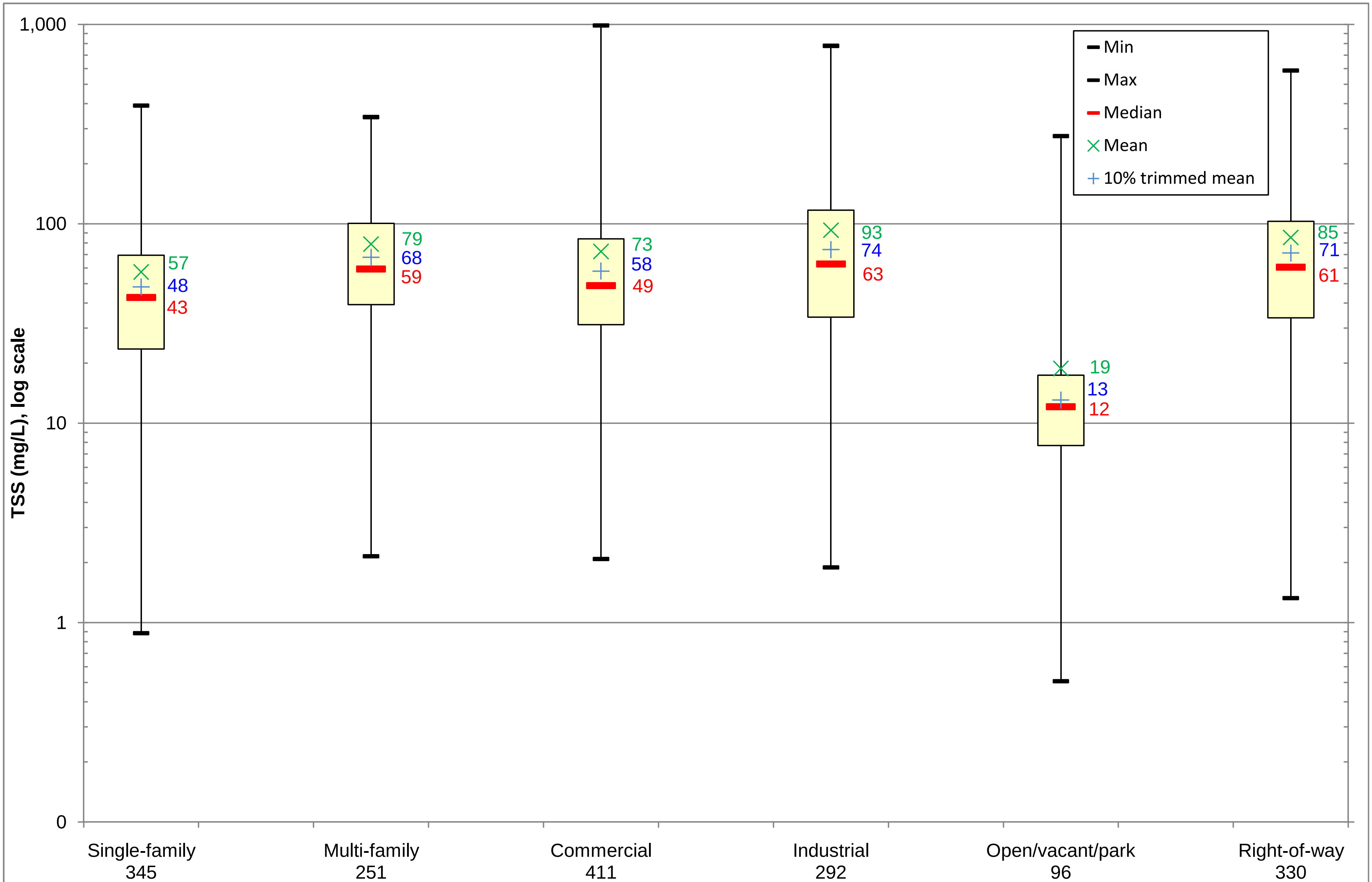


Figure 8: Box plot of TSS concentrations by land use.

Compiled TSS data DSA 040607_SyntheticValues_v1c.xlsx PTM box

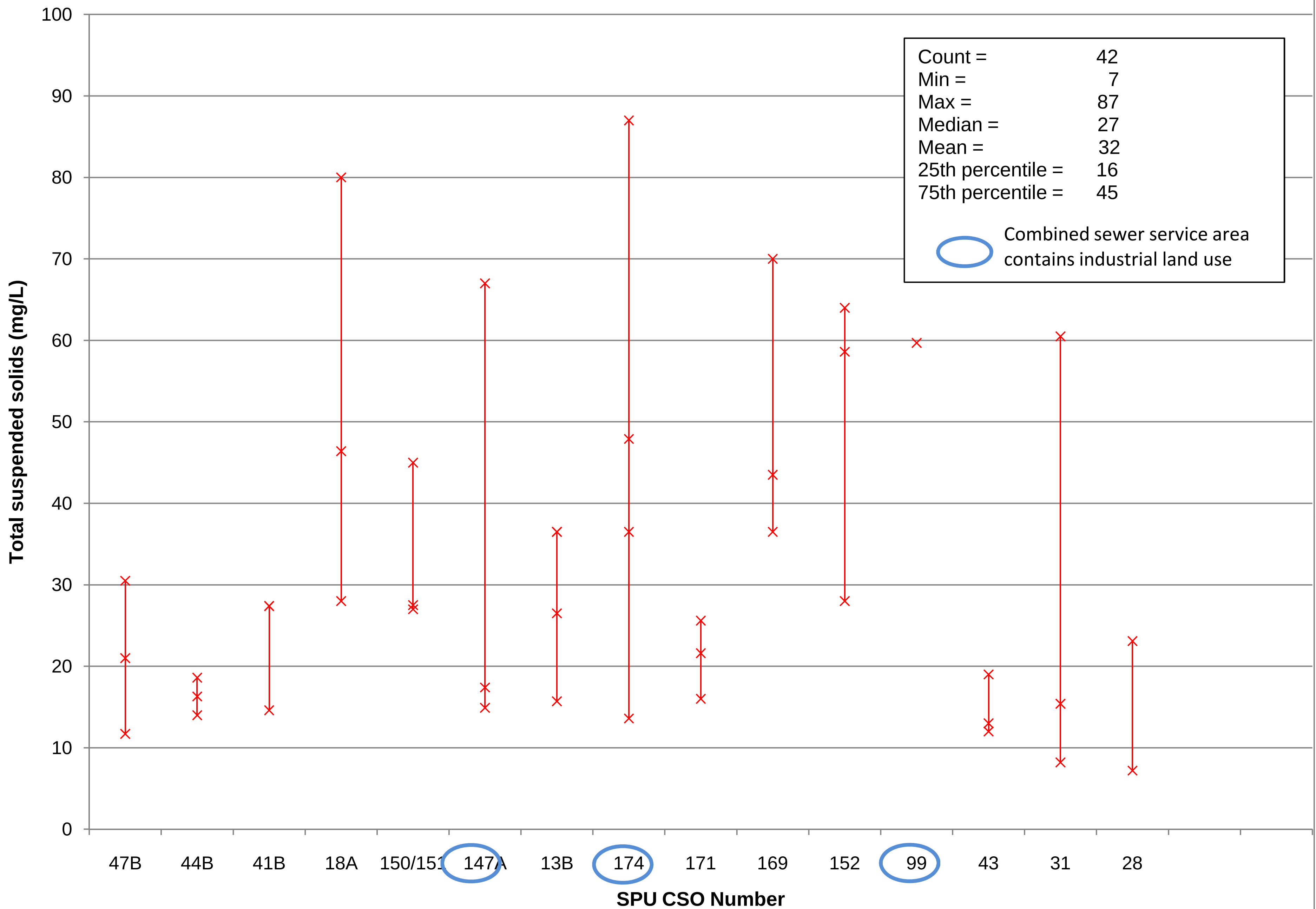
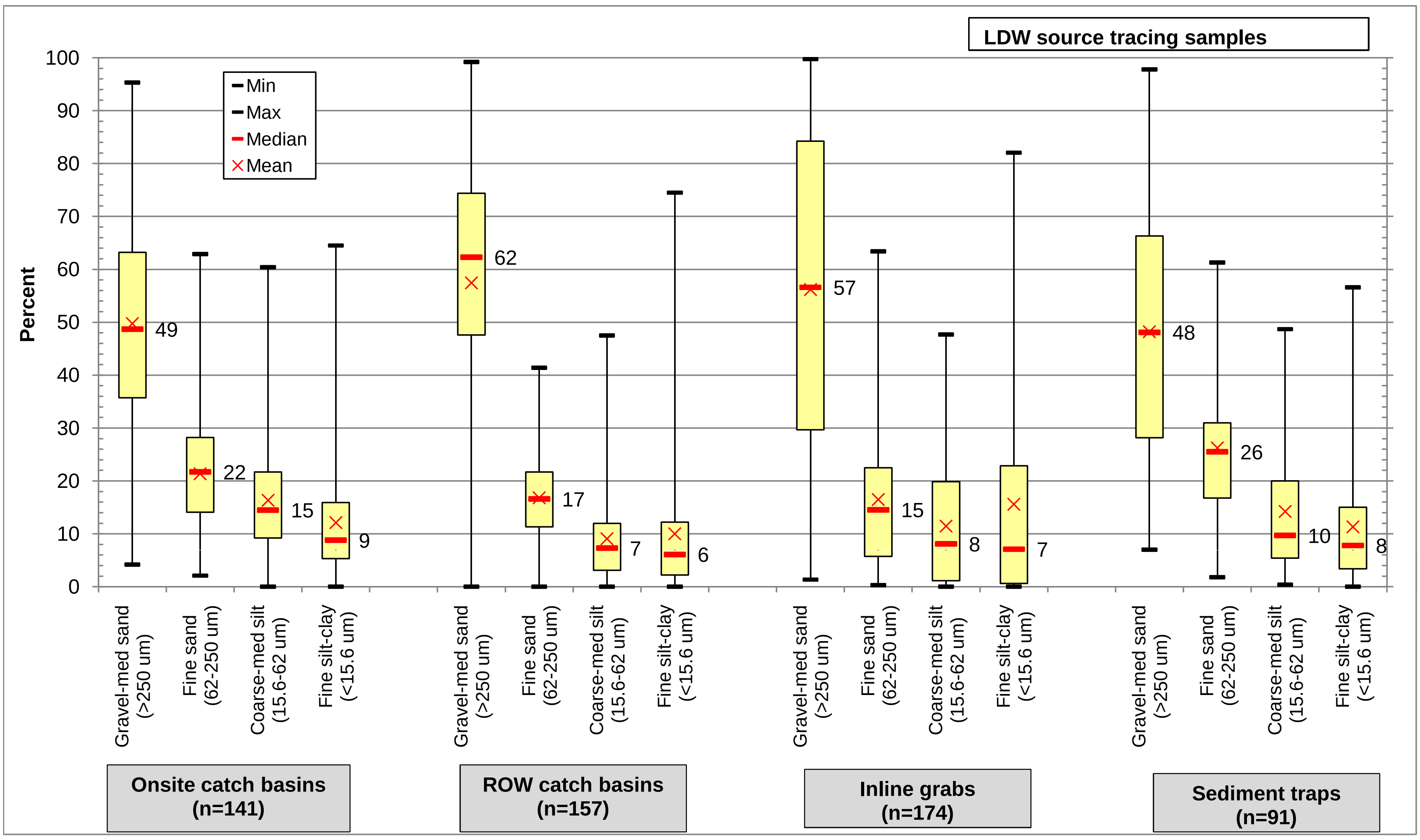
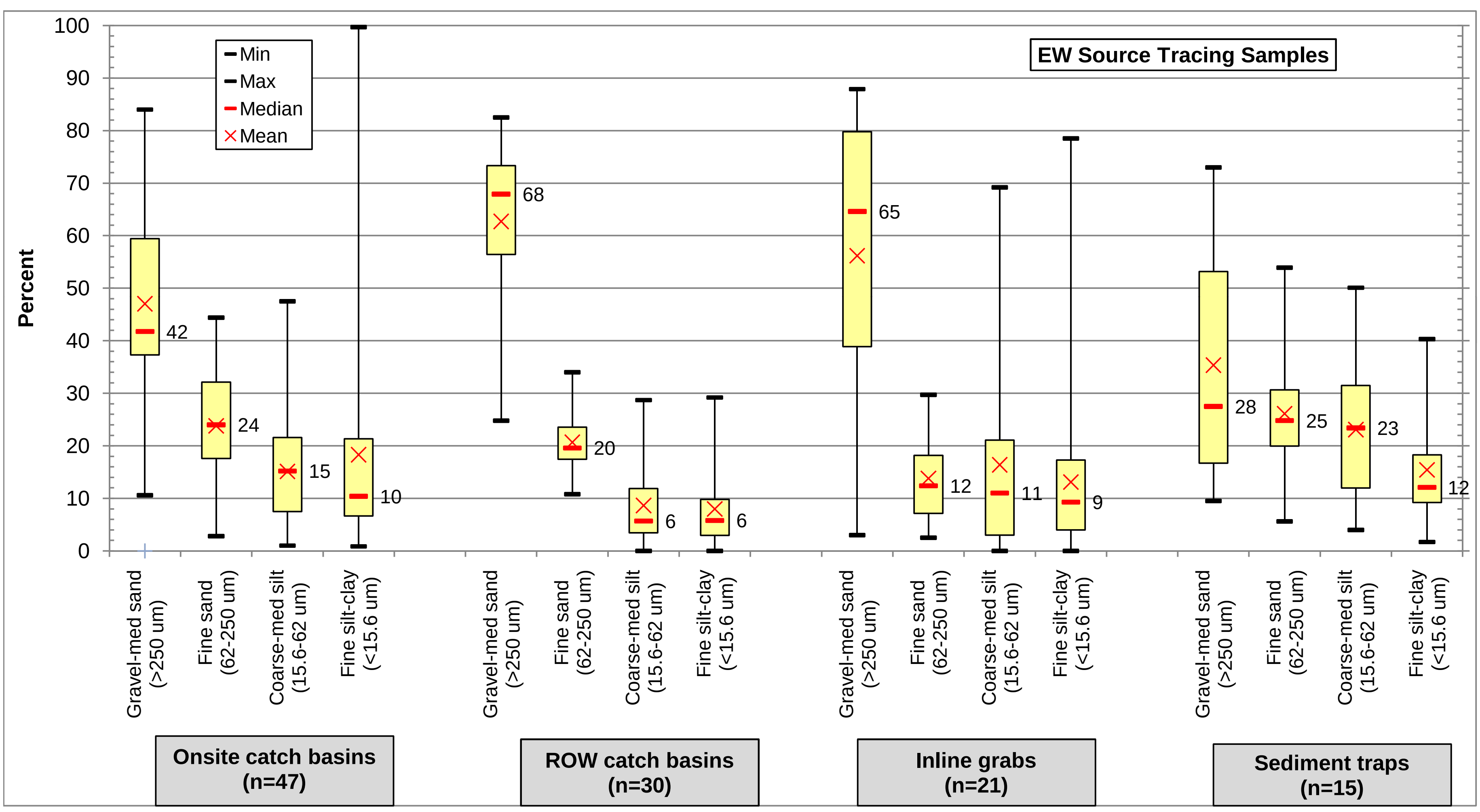


Figure 9: Total suspended solids in Seattle CSOs

SPU_CSO_study_2008-2010.xlsx TSS plot





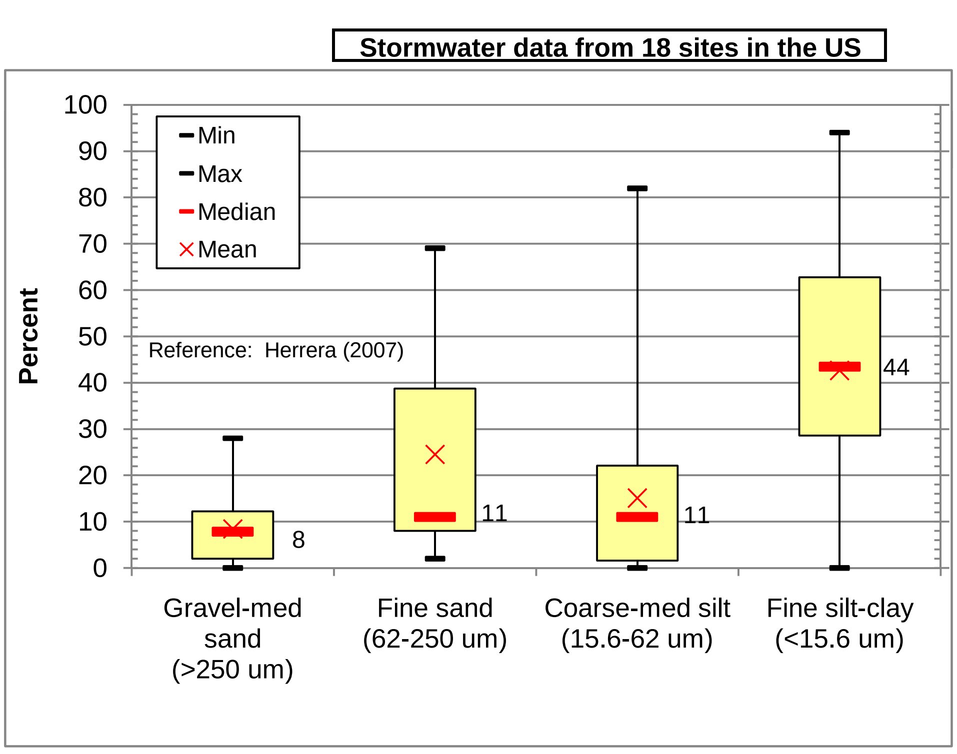


Figure 10: Comparison of PSD in stormwater and East Waterway and Lower Duwamish Waterway source samples.

Appendix A:

Stormwater Volume Calculations
(Northwest Hydraulic Consultants 2008)

MEMORANDUM

northwest hydraulic consultants inc.

16300 christensen road, suite 350
tukwila, washington 98188-3418
(206) 241-6000
fax no. (206) 439-2420

DATE: September 11, 2008

TO: Beth Schmoyer and Peter Rude, Seattle Public Utilities

FROM: Sam Gould and David Hartley, Northwest Hydraulic Consultants, Inc. (**nhc**)

SUBJECT: East Waterway Runoff and Water Quality

This memorandum summarizes the work performed by Northwest Hydraulic Consultants (**nhc**) for Seattle Public Utilities (SPU) with respect to East Waterway runoff and water quality. **nhc**'s contribution to this project included rainfall analysis, HSPF unit runoff simulation, runoff volume calculations, and total suspended solids (TSS) calculations.

Rainfall Analysis
For the Lower Duwamish Water Way Solids Loading Study **nhc** selected a wet, average and dry year based on annual rainfall depths at rain gauges 15, 16, 17 and SEA-TAC (**nhc** 2007). The water years selected are listed below.

Wet:	2002
Average:	1986
Dry:	1993

For this study the period of record has been extended to include calendar years 2006 – 2007. In order to see if the addition of these years should result in a change to the selected wet, average, and dry years, the annual rainfall depth at rain gauge 15 was calculated for the period of record of water year 1978 through 2007. These values were then ranked and put into five bins as can be seen in Table 1. From this table it can be seen that the 2002, 1986 and 1993 still adequately represent wet, average, and dry years.

HSPF Unit Runoff/Interflow Simulation
For the HSPF rainfall runoff simulations time series data from only one rain gauge is needed. The locations of rain gauge 15, 16, and 17 and the drainage basins are shown in Figure 1. Rain gauge 15 was chosen based on its close proximity to the East Waterway storm water basins. A basic HSPF model was created using pervious land segments (PERLNDs) with runoff characteristics representative of the different regional soil-vegetation-slope combinations. The 5-minute precipitation time series for rain gauge 15 and Puyallup evaporation record between calendar years 1978 and 2007 were applied to the regional parameter PERLNDs. The unit depth of annual and monthly surface runoff and interflow were tabulated for each PERLND type.

Land Use/Land Cover Calculations
SPU provided **nhc** with GIS layers containing land use, soil type, and basin delineations for the study area. The soil type layer was produced by the USGS in 2006 (Goetz 2006).

The basins were separated into SPU, Port of Seattle (POS), and private basins. Basins were merged together that had runoff going to the same outfall and fell into the same ownership category (i.e. an SPU basin would not be merged with a POS or private basin).

As directed by SPU, the land use types were consolidated into six categories: single family housing, multifamily housing, commercial, industrial, vacant/park, and open forest. For the small percentage of parcels that did not have a land use defined in the GIS layer provided, a land use was assigned based on an examination of 2002 USGS and 2006 USDA orthophotos. The soil types were consolidated into four categories (till, outwash, alluvium, and wetland). Areas mapped as "modified" soils were considered to have the same characteristics as till. A GIS overlay analysis was then performed to calculate the areas of different soil-land use complexes in each basin. Areas within the basin that were not covered by the land use layer were considered to be right of way (RoW). A GIS overlay analysis was performed with the RoW and soil type layers to determine the area of RoW with each soil type in each basin. RoW was divided into Residential RoW and Industrial/Commercial RoW based on the percentage of Residential and Commercial/Industrial land use for each soil type in each basin. The basin delineation and soil-land use complexes are shown in Figures 2 and 3. As can be seen in Figure 3 all of the study area is designated as till with the exception of 5.5 acres of outwash in the East Lander basin. Tables 2 through 6 show a break down of land use and soil type for each basin that was modeled.

For hydrologic calculations, land uses were decomposed into characteristic land cover components consisting of effective impervious, grass, and forest areas. The same land use - land cover assumptions as used in the Lower Duwamish Waterway Solids Loading Analysis (**nhc** 2007) were used in this study. The land use - land cover assumptions are summarized in Table 7.

The assumed land use - land cover assumptions were used to calculated the unit runoff and interflow for the different land use types using the HSPF land cover results. Monthly and annual unit runoff from the different land cover types (presented as millions of gallons per acre) can be found in the accompanying Excel spreadsheets.

Runoff Volume Calculations

Total areas of the different land cover types were calculated by **nhc** for each basin. These tabulated areas were used in conjunction with the unit runoff/interflow volumes for the different land use categories to calculate runoff volumes. In partially separated areas, runoff can be discharged to both the storm drain and the combined sewer systems. In most partially separated areas in the city, the roadways are typically plumbed to the storm drain system, while areas outside the public right-of-way can be plumbed to either the storm or the combined systems. Information about onsite drainage systems in the Lander East/West drainage basins from SPU's GIS system was reviewed to identify parcels that are currently connected to the storm drain system and discharge to the East Waterway. Because the SPU GIS coverage for onsite drainage systems is incomplete, this analysis represents the minimum area connected to the separate storm drain system. In addition, as properties redevelop, runoff from onsite areas will likely be plumbed to the storm drain rather than the combined sewer system. To develop a high end value for the runoff estimates, it was assumed that up to 50 percent of the remaining parcels could eventually connect to the storm drain system. Assumptions regarding areas connected to the storm drain system in each basin that were used in the runoff model are summarized in Table 8.

The resulting annual runoff volumes for water years 2000 through 2007 as well as the wet, average and dry years for each basin can be found in Tables 9 through 14. Tabulation of the monthly and annual runoff volumes for each basin broken down by land use and soil type for the entire period of record from 1978 through 2007 can be found in the accompanying Excel spreadsheets. Since only two soil types, till and outwash, were found in the basins only land cover with these soil types are shown in the Excel runoff tables.

Total Suspended Solids Calculations

The TSS calculations were made according to the method used in the 2007 Herrera study *Analysis of Total Solids Loading in the Lower Duwamish Waterway*. The runoff was first calculated for six land use types: right of way, industrial, multifamily residential, commercial, open space, and single family residential. This was done by adding Commercial/Industrial Right of Way runoff with Residential Right of Way runoff to calculate right of way runoff. Then Open Forest runoff and Parks/ Open Space/ Vacant runoff were added together to calculate open space runoff. For all land use types both surface runoff and interflow were included in the runoff calculation. After the runoff for each land use was determined, the TSS for each land use was calculated by multiplying the runoff by the appropriate TSS concentration for each land use shown in Table 15 (Herrera 2007). The resulting annual TSS values for each basin for water years 2000 through 2007 as well as the wet, average and dry years can be found in Tables 9 through 14. Tabulation of the monthly and annual TSS for each basin broken down by land use can be found in the accompanying Excel spreadsheets. A summary of the total runoff and TSS loading for each ownership category for dry, average, and wet years can be found in Table 16.

References

Northwest Hydraulic Consultants, Summary of Rain Gauge Analysis of the Lower Duwamish Waterway Solids Loading Analysis Study, January 2007, prepared for Seattle Public Utilities.

Goetz Troost, K., D.B. Booth, A.P. Wisher, and S.A. Shimel, The geologic map of Seattle, a progress report, USGS Open File Report 2005-1252, 2006, prepared in cooperation with the City of Seattle and the Pacific Northwest Center for Geological Mapping Studies at the Department of Earth and Space Sciences, University of Washington, Seattle, WA.

Herrera Environmental Consultants, Analysis of Total Suspended Solids Loading in the Lower Duwamish Waterway, April 2007, prepared for Seattle Public Utilities.

Table 1 Precipitation Analysis for Seattle Rain Gauge 15

		RG15	
		Annual	
	nth Largest	W. Year	Inches
	1	1999	44.6
	2	1983	44.2
Very Wet	3	1996	44.0
	4	1980	42.6
	5	1997	42.2
	6	1982	41.4
	7	2007	41.4
	8	1984	38.3
Wet	9	**2002**	**37.5**
	10	1991	35.5
	11	1995	35.4
	12	2006	34.3
	13	1981	33.0
	14	**1986**	**32.4**
Average	15	1990	31.8
	16	1987	31.7
	17	2000	30.6
	18	2005	30.5
	19	1998	29.7
	20	1989	29.4
Dry	21	2004	28.9
	22	1985	28.5
	23	1992	27.9
	24	**1993**	**27.2**
	25	2003	27.2
Very Dry	26	1988	26.6
	27	1979	24.8
	28	1994	23.3
	29	2001	23.0

Table 2 SPU Basins Land Use Soil Complexes

		Till (acres)								Outwash (acres)							
Basin 1)	Area (acre)	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial
B-21	13.0	0.0	0.0	0.1	7.0	0.4	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-25	3.0	0.0	0.0	2.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-36	5.3	0.0	0.0	0.5	0.1	1.1	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-4	7.1	0.0	0.0	0.4	0.0	3.3	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-5	2.2	0.0	0.0	0.0	0.8	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-40	3.4	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-41	5.5	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-42	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-43	5.7	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
East Lander	76.3	16.9	15.9	6.1	0.4	3.3	0.0	23.6	4.7	1.1	1.8	0.1	0.0	0.1	0.0	2.1	0.1
Hinds	26.4	0.0	0.0	1.5	14.5	0.2	0.0	0.0	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lander West	371.3	0.0	0.0	80.6	168.3	5.7	0.0	0.0	116.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1) Only till and outwash were present in the Study Area so all other soil types are not reported.

Table 3 SPU Bridges Land Use Soil Complexes

		Till (acres)								Outwash (acres)							
Basin 1)	Area (acre)	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial
B-34	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-4	1.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-5	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1) Only till and outwash were present in the Study Area so all other soil types are not reported.

Table 4 POS Basins Land Use Soil Complexes

		Till (acres)								Outwash (acres)							
Basin 1)	Area (acre)	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial
B-1	1.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-10	7.2	0.0	0.0	0.1	6.7	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-11_a	16.5	0.0	0.0	0.0	15.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-11_b	46.3	0.0	0.0	0.0	23.2	4.0	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-11_c	12.6	0.0	0.0	0.0	8.3	2.1	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-11_d	5.8	0.0	0.0	0.0	3.6	1.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-12	6.5	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-13	6.2	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-14	1.5	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-16	4.4	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-17	2.1	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-18	7.4	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-19	5.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-22	12.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-23	10.9	0.0	0.0	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-24	8.9	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-25	2.2	0.0	0.0	0.4	1.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-26	12.7	0.0	0.0	0.0	0.6	7.7	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-27	7.3	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-28	3.6	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-29	8.7	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-30	7.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-31	9.6	0.0	0.0	0.0	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-32	3.7	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-33	12.1	0.0	0.0	0.0	11.9	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-34	13.3	0.0	0.0	0.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-37	6.4	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-38	1.3	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-39	2.1	0.0	0.0	0.0	1.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B-7	13.9	0.0	0.0	0.0	13.9	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lander	3.6	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1) Only till and outwash were present in the Study Area so all other soil types are not reported.

Table 5 POS Aprons Land Use Soil Complexes

		Till (acres)								Outwash (acres)							
Basin 1)	Area (acre)	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial
A-10	2.3	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-12	2.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-13	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-14	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-16	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-17	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-18	1.2	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-19	1.9	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-22	2.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-31	0.8	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1) Only till and outwash were present in the Study Area so all other soil types are not reported.

Table 6 Private Basins Land Use Soil Complexes

		Till (acres)								Outwash (acres)							
Basin 1)	Area (acre)	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial	Single Family	Multi-Family	Commercial	Industrial	Parks/ Open Space/ Vacant	Forested Open Space	RoW Residential	RoW Commercial/ Industrial
A-6	3.2	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1) Only till and outwash were present in the Study Area so all other soil types are not reported.

Table 7 Land Use - Land Cover Assumptions

Landuse	Total Impervious Area (TIA)	Effective Impervious Area % (EIA)	Adopted Land Cover Assumptions		
			EIA	Forest	Grass
Single Family	48%	80%	39%	0%	61%
Multi-Family	86%	90%	78%	0%	22%
Commercial	82%	100%	82%	0%	18%
Industrial	94%	100%	94%	0%	6%
Parks/Open Space/Vacant	25%	70%	18%	0%	83%
Forested Open Space	0%	0%	0%	100%	0%
RoW Residential	50%	100%	50%	0%	50%
RoW Commercial/Industrial	80%	100%	80%	0%	20%

Table 8 Assumed Percent of Area Connected to Storm Drain System for Partially Separated Basins

	Low	High
Lander West		
ROW	100%	100%
Non-ROW	25%	75%
Lander East		
ROW	100%	100%
Non-ROW	15%	65%

Table 9 Runoff and TSS from SPU Basins For Water Years 1986, 1993 and 2000-2007 (Low Runoff Assumption from Partially Separated Basins)

		Annual Runoff in million gallons										Annual Average TSS in lbs									
Basin	Area (acre)	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007
B-21	13.0	8.29	6.96	7.67	4.99	10.22	6.92	7.03	7.20	8.83	11.21	5,753	4,830	5,325	3,465	7,094	4,801	4,880	5,003	6,128	7,778
B-25	3.0	1.90	1.60	1.76	1.14	2.35	1.59	1.61	1.65	2.03	2.58	1,257	1,055	1,164	751	1,554	1,049	1,063	1,090	1,340	1,703
B-36	5.3	3.10	2.58	2.87	1.73	3.90	2.59	2.54	2.61	3.31	4.27	2,115	1,766	1,962	1,190	2,659	1,766	1,742	1,790	2,260	2,909
B-4	7.1	3.73	3.09	3.47	1.89	4.81	3.11	2.94	3.03	4.00	5.25	2,445	2,028	2,273	1,265	3,139	2,042	1,943	2,004	2,621	3,426
B-5	2.2	1.37	1.15	1.27	0.82	1.69	1.14	1.16	1.19	1.46	1.85	960	806	889	576	1,185	801	813	834	1,023	1,299
B-40	3.4	2.10	1.76	1.95	1.25	2.60	1.75	1.77	1.82	2.24	2.85	1,376	1,153	1,274	816	1,704	1,148	1,159	1,189	1,467	1,868
B-41	5.5	3.68	3.10	3.41	2.28	4.50	3.07	3.16	3.24	3.92	4.94	2,540	2,138	2,349	1,574	3,105	2,119	2,182	2,235	2,702	3,408
B-42	0.5	0.31	0.26	0.28	0.19	0.38	0.26	0.26	0.27	0.33	0.41	212	179	196	132	260	177	183	187	226	285
B-43	5.7	3.83	3.22	3.54	2.37	4.68	3.19	3.29	3.37	4.07	5.13	2,639	2,221	2,440	1,636	3,226	2,202	2,268	2,322	2,807	3,541
East Lander[1]	76.3	19.64	16.31	18.25	10.33	25.12	16.40	15.72	16.20	21.05	27.44	13,525	11,233	12,565	7,127	17,288	11,295	10,833	11,161	14,490	18,885
Hinds	26.4	17.00	14.28	15.74	10.30	20.93	14.19	14.46	14.82	18.11	22.95	11,797	9,908	10,917	7,145	14,523	9,845	10,032	10,282	12,564	15,926
Lander West[2]	371.3	113.57	95.25	105.15	67.63	140.50	94.79	95.86	98.31	121.05	153.99	79,086	66,332	73,226	47,107	97,839	66,010	66,759	68,466	84,294	107,231
Total	519.7	178.52	149.56	165.35	104.92	221.70	149.01	149.80	153.71	190.39	242.88	123,705	103,649	114,580	72,785	153,578	103,257	103,857	106,562	131,923	168,259

1) East Lander is a partially separated basin. For the low runoff assumption it was assumed that 100% of the runoff from RoW and 15% of the runoff from all non RoW parcels is routed to the East Waterway.
2) Lander West is a partially separated basin. For the low runoff assumption it was assumed that 100% of the runoff from RoW and 25% of the runoff from all non RoW parcels is routed to the East Waterway.

Table 10 Runoff and TSS from SPU Basins For Water Years 1986, 1993 and 2000-2007 (High Runoff Assumption from Partially Separated Basins)

		Annual Runoff in million gallons										Annual Average TSS in lbs									
Basin	Area (acre)	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007
B-21	13.0	8.29	6.96	7.67	4.99	10.22	6.92	7.03	7.20	8.83	11.21	5,753	4,830	5,325	3,465	7,094	4,801	4,880	5,003	6,128	7,778
B-25	3.0	1.90	1.60	1.76	1.14	2.35	1.59	1.61	1.65	2.03	2.58	1,257	1,055	1,164	751	1,554	1,049	1,063	1,090	1,340	1,703
B-36	5.3	3.10	2.58	2.87	1.73	3.90	2.59	2.54	2.61	3.31	4.27	2,115	1,766	1,962	1,190	2,659	1,766	1,742	1,790	2,260	2,909
B-4	7.1	3.73	3.09	3.47	1.89	4.81	3.11	2.94	3.03	4.00	5.25	2,445	2,028	2,273	1,265	3,139	2,042	1,943	2,004	2,621	3,426
B-5	2.2	1.37	1.15	1.27	0.82	1.69	1.14	1.16	1.19	1.46	1.85	960	806	889	576	1,185	801	813	834	1,023	1,299
B-40	3.4	2.10	1.76	1.95	1.25	2.60	1.75	1.77	1.82	2.24	2.85	1,376	1,153	1,274	816	1,704	1,148	1,159	1,189	1,467	1,868
B-41	5.5	3.68	3.10	3.41	2.28	4.50	3.07	3.16	3.24	3.92	4.94	2,540	2,138	2,349	1,574	3,105	2,119	2,182	2,235	2,702	3,408
B-42	0.5	0.31	0.26	0.28	0.19	0.38	0.26	0.26	0.27	0.33	0.41	212	179	196	132	260	177	183	187	226	285
B-43	5.7	3.83	3.22	3.54	2.37	4.68	3.19	3.29	3.37	4.07	5.13	2,639	2,221	2,440	1,636	3,226	2,202	2,268	2,322	2,807	3,541
East Lander[1]	76.3	31.98	26.57	29.71	16.93	40.83	26.70	25.66	26.43	34.25	44.61	21,027	17,477	19,530	11,190	26,812	17,559	16,911	17,416	22,519	29,295
Hinds	26.4	17.00	14.28	15.74	10.30	20.93	14.19	14.46	14.82	18.11	22.95	11,797	9,908	10,917	7,145	14,523	9,845	10,032	10,282	12,564	15,926
Lander West[2]	371.3	196.06	164.56	181.48	117.78	241.94	163.63	166.13	170.32	208.88	265.24	134,962	113,285	124,928	81,126	166,524	112,642	114,388	117,272	143,789	182,564
Total	519.7	273.34	229.12	253.14	161.66	338.85	228.15	230.01	235.96	291.43	371.30	187,083	156,846	173,246	110,866	231,786	156,153	157,564	161,624	199,447	254,002

1) East Lander is a partially separated basin. For the high runoff assumption it was assumed that 100% of the runoff from RoW and 65% of the runoff from all non RoW parcels is routed to the East Waterway.
2) Lander West is a partially separated basin. For the high runoff assumption it was assumed that 100% of the runoff from RoW and 75% of the runoff from all non RoW parcels is routed to the East Waterway.

Table 11 Runoff and TSS from SPU Bridges For Water Years 1986, 1993 and 2000-2007

		Annual Runoff in million gallons										Annual Average TSS in lbs									
Basin	Area (acre)	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007
B-34	0.9	0.58	0.49	0.54	0.34	0.72	0.48	0.49	0.50	0.62	0.79	408	342	378	238	508	341	342	351	436	557
B-4	1.2	0.72	0.60	0.67	0.41	0.91	0.60	0.59	0.61	0.77	1.00	499	417	463	282	627	417	412	423	533	686
B-5	1.6	0.99	0.83	0.92	0.58	1.24	0.83	0.83	0.85	1.06	1.35	701	587	650	411	872	585	587	603	748	955
Total	3.8	2.30	1.92	2.13	1.32	2.87	1.92	1.91	1.96	2.45	3.14	1,609	1,346	1,491	931	2,007	1,343	1,341	1,377	1,717	2,198

Table 12 Runoff and TSS from POS Basins For Water Years 1986, 1993 and 2000-2007

		Annual Runoff in million gallons										Annual Average TSS in lbs									
Basin	Area (acre)	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007
B-1	1.1	0.71	0.59	0.65	0.44	0.86	0.59	0.61	0.62	0.75	0.95	487	410	451	302	596	407	419	429	518	654
B-10	7.2	4.80	4.04	4.44	2.96	5.87	4.00	4.12	4.22	5.10	6.44	3,311	2,786	3,063	2,046	4,052	2,763	2,842	2,910	3,523	4,447
B-11_a	16.5	10.95	9.22	10.13	6.76	13.41	9.14	9.40	9.62	11.66	14.71	7,571	6,370	7,003	4,674	9,269	6,319	6,494	6,651	8,057	10,171
B-11_b	46.3	28.97	24.29	26.83	17.16	35.90	24.18	24.39	25.02	30.88	39.33	19,999	16,771	18,518	11,890	24,754	16,692	16,868	17,300	21,317	27,129
B-11_c	12.6	7.79	6.52	7.22	4.56	9.68	6.50	6.53	6.70	8.31	10.61	5,296	4,438	4,905	3,124	6,570	4,421	4,451	4,567	5,647	7,199
B-11_d	5.8	3.55	2.98	3.29	2.07	4.43	2.97	2.97	3.05	3.79	4.85	2,415	2,023	2,237	1,417	3,000	2,016	2,025	2,078	2,576	3,287
B-12	6.5	4.35	3.66	4.03	2.70	5.32	3.63	3.74	3.83	4.63	5.84	3,002	2,527	2,776	1,861	3,670	2,505	2,580	2,642	3,194	4,028
B-13	6.2	4.14	3.49	3.83	2.57	5.07	3.46	3.56	3.65	4.41	5.56	2,858	2,406	2,643	1,771	3,495	2,385	2,456	2,515	3,041	3,836
B-14	1.5	1.01	0.85	0.93	0.63	1.24	0.84	0.87	0.89	1.08	1.36	697	587	645	432	852	582	599	614	742	935
B-16	4.4	2.94	2.48	2.72	1.82	3.60	2.45	2.53	2.59	3.13	3.95	2,029	1,708	1,876	1,258	2,480	1,693	1,744	1,785	2,158	2,722
B-17	2.1	1.43	1.20	1.32	0.88	1.74	1.19	1.23	1.26	1.52	1.91	984	828	910	610	1,203	821	846	866	1,047	1,320
B-18	7.4	4.93	4.15	4.56	3.06	6.03	4.12	4.24	4.34	5.25	6.62	3,403	2,864	3,147	2,108	4,162	2,840	2,924	2,994	3,621	4,567
B-19	5.0	3.36	2.83	3.10	2.08	4.10	2.80	2.88	2.95	3.57	4.50	2,315	1,949	2,141	1,435	2,831	1,932	1,990	2,038	2,463	3,107
B-22	12.0	7.99	6.72	7.39	4.95	9.77	6.67	6.87	7.03	8.50	10.72	5,511	4,638	5,096	3,417	6,737	4,599	4,736	4,850	5,863	7,394
B-23	10.9	7.30	6.14	6.75	4.52	8.92	6.09	6.27	6.42	7.76	9.79	5,032	4,235	4,654	3,120	6,152	4,199	4,325	4,429	5,354	6,752
B-24	8.9	5.90	4.97	5.46	3.66	7.22	4.93	5.07	5.20	6.28	7.92	4,072	3,428	3,766	2,525	4,979	3,398	3,500	3,584	4,333	5,464
B-25	2.2	1.45	1.22	1.34	0.89	1.78	1.21	1.24	1.27	1.55	1.95	995	837	921	610	1,221	831	851	872	1,060	1,340
B-26	12.7	6.32	5.21	5.89	3.02	8.27	5.28	4.87	5.03	6.80	9.01	4,043	3,340	3,764	1,976	5,262	3,378	3,141	3,245	4,345	5,734
B-27	7.3	4.90	4.12	4.53	3.04	5.99	4.09	4.21	4.31	5.21	6.57	3,378	2,843	3,124	2,094	4,130	2,819	2,903	2,973	3,594	4,533
B-28	3.6	2.35	1.98	2.17	1.44	2.88	1.96	2.01	2.06	2.50	3.16	1,631	1,372	1,509	999	2,002	1,361	1,394	1,428	1,737	2,196
B-29	8.7	5.79	4.87	5.36	3.57	7.09	4.83	4.97	5.09	6.16	7.78	4,004	3,368	3,703	2,470	4,902	3,341	3,433	3,516	4,260	5,379
B-30	7.0	4.68	3.94	4.33	2.90	5.72	3.90	4.02	4.11	4.98	6.28	3,225	2,714	2,983	1,999	3,944	2,692	2,771	2,838	3,431	4,328
B-31	9.6	6.41	5.39	5.93	3.97	7.84	5.35	5.51	5.64	6.82	8.60	4,420	3,720	4,088	2,740	5,404	3,689	3,799	3,890	4,703	5,931
B-32	1.1	0.71	0.59	0.65	0.44	0.86	0.59	0.61	0.62	0.75	0.95	487	410	451	302	596	407	419	429	518	654
B-33	12.1	8.06	6.78	7.45	4.99	9.86	6.73	6.93	7.09	8.58	10.82	5,561	4,680	5,143	3,446	6,801	4,641	4,778	4,893	5,917	7,463
B-34	13.3	8.88	7.47	8.21	5.50	10.85	7.41	7.63	7.81	9.45	11.91	6,124	5,154	5,663	3,797	7,487	5,110	5,263	5,389	6,515	8,217
B-37	6.4	4.27	3.59	3.95	2.65	5.22	3.56	3.67	3.76	4.54	5.73	2,945	2,479	2,723	1,826	3,600	2,458	2,531	2,592	3,133	3,951
B-38	1.3	0.87	0.74	0.81	0.54	1.07	0.73	0.75	0.77	0.93	1.17	603	507	557	374	737	503	518	530	641	809
B-39	2.1	1.33	1.12	1.23	0.80	1.64	1.11	1.13	1.16	1.42	1.80	906	761	838	548	1,115	756	770	789	965	1,223
B-7	13.9	9.28	7.81	8.58	5.75	11.35	7.75	7.98	8.17	9.88	12.46	6,403	5,389	5,922	3,969	7,829	5,344	5,503	5,635	6,812	8,592
Lander	3.6	2.42	2.03	2.23	1.50	2.95	2.02	2.08	2.13	2.57	3.24	1,667	1,403	1,542	1,033	2,039	1,391	1,432	1,467	1,774	2,238
Total	259.8	167.84	141.00	155.32	101.83	206.53	140.08	142.85	146.40	178.74	226.50	115,379	96,945	106,763	70,172	141,870	96,292	98,304	100,738	122,858	155,598

Table 13 Runoff and TSS from POS Aprons For Water Years 1986, 1993 and 2000-2007

		Annual Runoff in million gallons										Annual Average TSS in lbs									
Basin	Area (acre)	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007
A-10	2.3	1.52	1.28	1.41	0.94	1.86	1.27	1.31	1.34	1.62	2.04	1,050	884	971	651	1,284	877	903	924	1,117	1,409
A-12	2.0	1.32	1.11	1.22	0.82	1.61	1.10	1.13	1.16	1.40	1.77	911	767	842	565	1,113	760	783	802	969	1,222
A-13	0.5	0.31	0.26	0.29	0.19	0.38	0.26	0.27	0.28	0.33	0.42	216	182	200	134	264	180	186	190	230	290
A-14	1.0	0.69	0.58	0.64	0.43	0.84	0.58	0.59	0.61	0.73	0.93	476	401	441	295	582	398	409	419	507	639
A-16	0.7	0.44	0.37	0.41	0.27	0.54	0.37	0.38	0.39	0.47	0.59	302	254	280	187	370	252	260	266	322	406
A-17	0.7	0.46	0.38	0.42	0.28	0.56	0.38	0.39	0.40	0.49	0.61	315	265	291	195	385	263	270	277	335	422
A-18	1.2	0.80	0.68	0.74	0.50	0.98	0.67	0.69	0.71	0.85	1.08	553	466	512	343	677	462	476	487	589	742
A-19	1.9	1.27	1.07	1.17	0.78	1.55	1.06	1.09	1.11	1.35	1.70	873	735	807	541	1,067	728	750	768	929	1,171
A-22	2.0	1.34	1.13	1.24	0.83	1.64	1.12	1.15	1.18	1.43	1.80	925	779	856	574	1,131	772	795	814	984	1,241
A-31	0.8	0.54	0.45	0.50	0.33	0.66	0.45	0.46	0.47	0.57	0.72	370	312	342	230	453	309	318	326	394	497
Total	13.0	8.69	7.31	8.03	5.39	10.62	7.25	7.47	7.65	9.24	11.66	5,992	5,043	5,542	3,715	7,326	5,001	5,150	5,274	6,375	8,040

Table 14 Runoff and TSS from Private Basins For Water Years 1986, 1993 and 2000-2007

		Annual Runoff in million gallons										Annual Average TSS in lbs									
Basin	Area (acre)	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007	1986 (Average)	1993 (Dry)	2000	2001	2002 (Wet)	2003	2004	2005	2006	2007
A-6	3.2	2.10	1.77	1.94	1.30	2.57	1.75	1.80	1.85	2.24	2.82	1,450	1,221	1,341	898	1,774	1,210	1,246	1,276	1,543	1,947
Total	3.2	2.10	1.77	1.94	1.30	2.57	1.75	1.80	1.85	2.24	2.82	1,450	1,221	1,341	898	1,774	1,210	1,246	1,276	1,543	1,947

Table 15 TSS Concentrations in mg/L (Herrera 2007)

Land Use	RoW	Industrial	MFR	Commercial	Open	SFR
Concentration (mg/L)	84.9	82.8	79.9	78.6	68.9	62.1

Table 16 Summary of Runoff and TSS Load For Each Ownership Category

			Runoff			TSS Load		
	Area	TSS	Dry WY	Average WY	Wet WY	Dry WY	Average WY	Wet WY
Ownership Category	ac	mg/L	Mgal/yr	Mgal/yr	Mgal/yr	lbs/yr	lbs/yr	lbs/yr
SPU Basins Low Runoff Assumption[1]	519.7	83.2	149.56	178.52	221.70	103,649	123,705	153,578
SPU Bridges And Aprons	3.8	84.1	1.92	2.30	2.87	1,346	1,609	2,007
Total[1]	523.5	83.2	151.48	180.82	224.57	104,995	125,314	155,585
SPU Basins High Runoff Assumption[2]	519.7	82.1	229.12	273.34	338.85	156,846	187,083	231,786
SPU Bridges And Aprons	3.8	84.1	1.92	2.30	2.87	1,346	1,609	2,007
Total[2]	523.5	82.2	231.05	275.64	341.72	158,192	188,692	233,793
POS Basins	259.8	82.5	141.00	167.84	206.53	96,945	115,379	141,870
POS Aprons	13.0	82.8	7.31	8.69	10.62	5,043	5,992	7,326
Total	272.9	82.5	148.31	176.53	217.15	101,988	121,371	149,196
Private Basins	3.2	82.8	1.77	2.10	2.57	1,221	1,450	1,774

1) Low runoff assumption from non ROW land use in partially separated basins (East and West Lander)
2) High runoff assumption from non ROW land use in partially separated basins (East and West Lander)

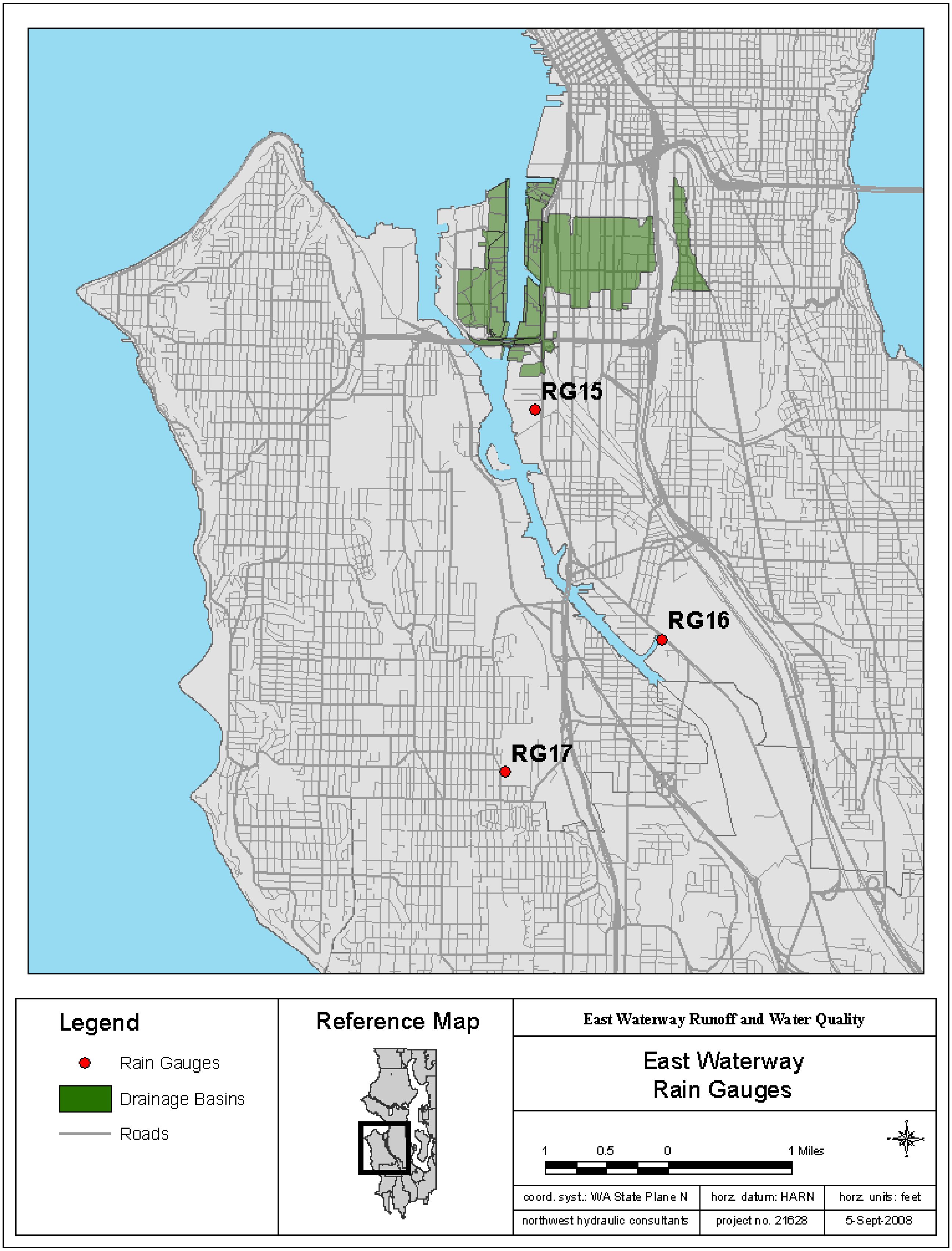

RG15
RG16
RG17
Legend
Rain Gauges
Drainage Basins
Roads
Reference Map
East Waterway Runoff and Water Quality
East Waterway
Rain Gauges
1 0.5 0 1 Miles
coord. syst.: WA State Plane N
horz. datum: HARN
horz. units: feet
northwest hydraulic consultants
project no. 21628
5-Sept-2008

Figure 1

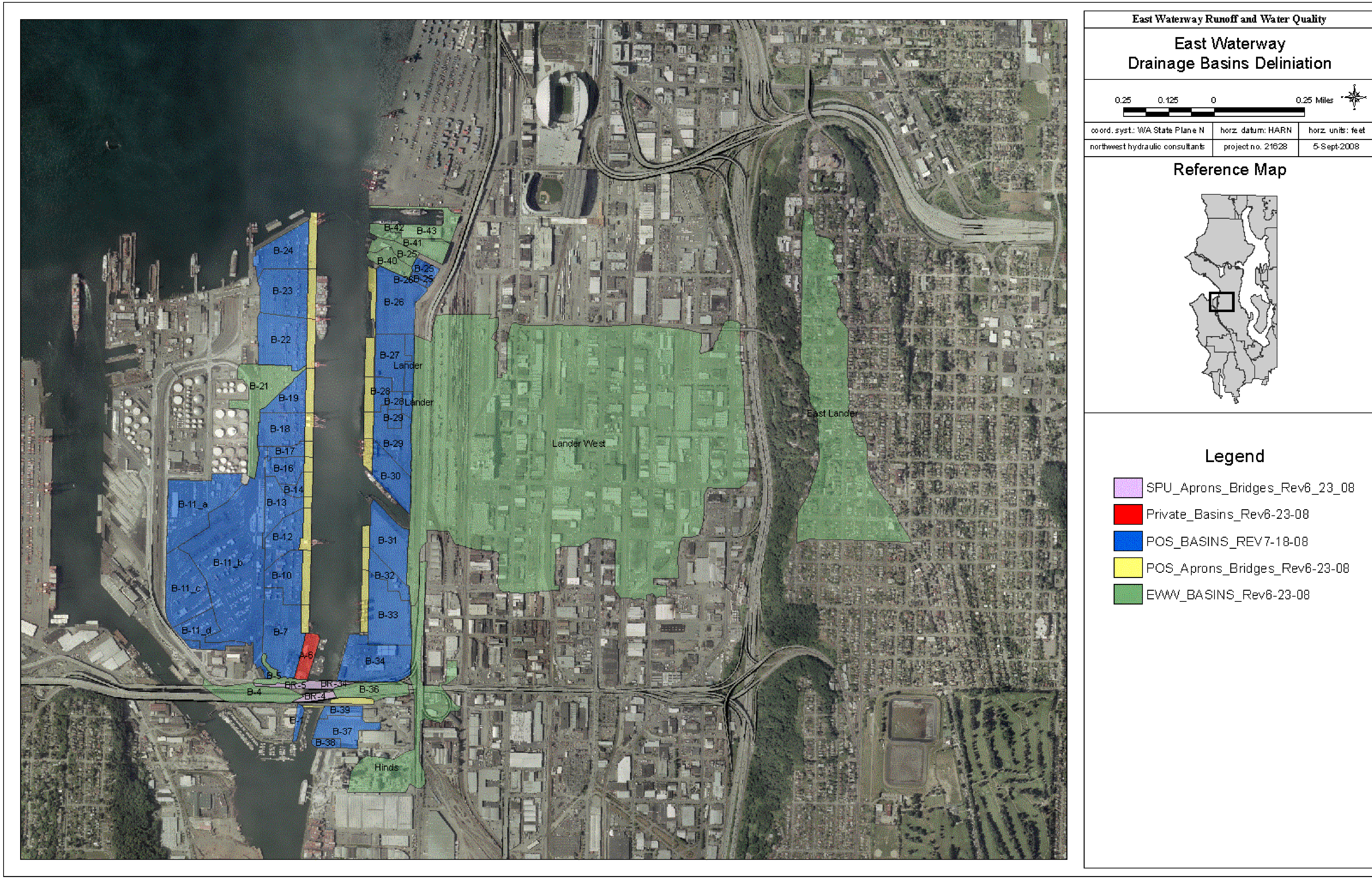

East Waterway Runoff and Water Quality
East Waterway
Drainage Basins Deliniation
0.25 0.125 0 0.25 Miles
coord. syst.: WA State Plane N
horz. datum: HARN
horz. units: feet
northwest hydraulic consultants
project no. 21628
5-Sept-2008
Reference Map
Legend
SPU_Aprons_Bridges_Rev6_23_08
Private_Basins_Rev6-23-08
POS_BASINS_REV7-18-08
POS_Aprons_Bridges_Rev6-23-08
EWW_BASINS_Rev6-23-08
Lander West
East Lander
Lander
Hinds
B-24
B-23
B-22
B-21
B-19
B-18
B-17
B-16
B-14
B-13
B-12
B-11_a
B-11_b
B-11_c
B-11_d
B-10
B-7
B-6
B-5
B-4
B-1
B-42
B-43
B-41
B-40
B-25
B-26
B-27
B-28
B-29
B-30
B-31
B-32
B-33
B-34
B-36
B-37
B-38
B-39
BR-5
BR-34
BR-4

Figure 2

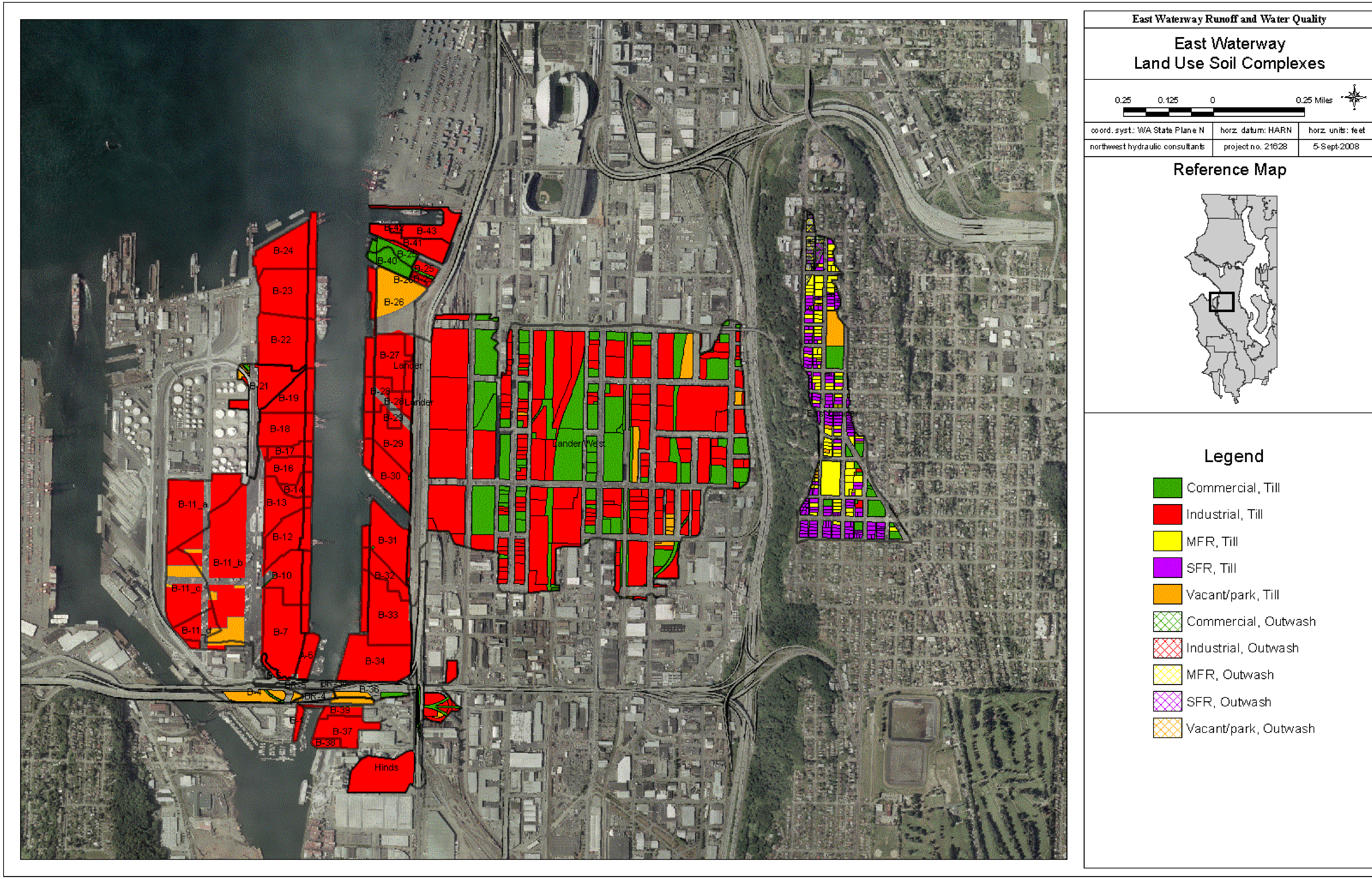

East Waterway Runoff and Water Quality
East Waterway
Land Use Soil Complexes
0.25
0.125
0
0.25 Miles
coord. syst.: WA State Plane N
horz. datum: HARN
horz. units: feet
northwest hydraulic consultants
project no. 21628
5-Sept-2008
Reference Map
Legend
Commercial, Till
Industrial, Till
MFR, Till
SFR, Till
Vacant/park, Till
Commercial, Outwash
Industrial, Outwash
MFR, Outwash
SFR, Outwash
Vacant/park, Outwash
B-24
B-23
B-22
B-21
B-19
B-18
B-17
B-16
B-14
B-13
B-12
B-10
B-7
B-11_a
B-11_b
B-11_c
B-11_d
B-43
B-41
B-40
B-26
B-27
Lander
B-29
B-30
B-31
B-32
B-33
B-34
B-36
B-39
B-37
Hinds

Figure 3

Appendix B:

Total Suspended Solids Analysis

INTRODUCTION

Total suspended solids (TSS) data for stormwater and combined sewer overflow (CSO) discharges are needed to estimate solids loading to the East Waterway (EW) for the particle transport model that is being used to evaluate recontamination potential. TSS data are available for CSOs from samples collected by King County and Seattle Public Utilities (SPU). These data have been compiled to determine appropriate TSS concentrations for the EW solids loading analysis. There are no site specific TSS data for storm drains discharging to the EW. Therefore, data from other similar sources have been compiled and used to assess solids loads from storm drains.

AVAILABLE TSS DATA

Herrera (2007) compiled TSS data from stormwater samples collected in western Washington for use in the Lower Duwamish lateral loads analysis (SPU 2008). Approximately 500 stormwater samples from 24 studies in western Washington and Oregon were used in the analysis. Sources of TSS information are summarized in Table B-1. This regional data set has been expanded for the EW analysis to incorporate 2007-2008 samples collected for the Portland Harbor Superfund investigation (Sanders 2011) and the SPU NPDES stormwater monitoring program (SPU 2011).

The Portland Harbor data set includes 235 samples from 53 stations in the Portland area. Samples were collected to isolate specific land use types so that representative pollutant concentrations could be identified and used in chemical loading model (Anchor and Integral 2007). Land use and sampling information are provided in Table B-2.

In 2010, SPU initiated a stormwater monitoring program as required under its National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit. Under the permit, Seattle is required to monitor stormwater quality from three land use types (residential, commercial, and industrial) and to evaluate the performance of structural stormwater best management practices (BMP) in Seattle. Stormwater characterization sampling is being conducted at the following locations:

- Norfolk (industrial)
- Venema (residential)
- University (commercial).

Land use conditions and sampling information for each monitoring station are provided in Table B-3.

BMP monitoring is being conducted at two Stormfilter® catch basin installations on California Ave SW in West Seattle. Influent and effluent samples are collected to assess the performance of this system. Only the 22 influent samples have been compiled for use in the EW solids loading analysis.

This new information expands the regional TSS data set to a total of 826 stormwater samples. A box plot of TSS by study is presented in Figure B-1. The various studies have been grouped into the following categories:

- Tacoma: 191 samples from end-of-pipe samples collected at seven storm drains in the Thea Foss Waterway (Tacoma 2008).

- Contech BMP: 103 samples from Stormfilter performance studies at six locations in western Washington and Oregon (influent samples only, Contech 2004, 2006).
- SPU NDS: 62 samples from natural drainage system performance studies in Broadview and Venema neighborhoods (WA).
- SPU BMP: 47 samples from three hydrodynamic separator installations in Seattle (influent samples only).
- SPU NPDES: 67 samples from three stormwater characterization stations and two Stormfilter installations in Seattle (influent samples only).
- Portland Harbor: 235 samples from 53 stations in Portland.
- Highway BMP: 50 samples from 3 stations in Mill Creek and Auburn (WA).
- Bellevue: 65 samples from the Lakemont residential development (WA).

TSS concentrations were highly variable, ranging from <10 mg/L to nearly 1,000 mg/L. However, as shown in Figure B-1, the median and average values for most of the studies was fairly comparable, with median TSS concentrations ranging from about 40 to 60 mg/L and average TSS concentrations ranging from 60-80 mg/L. The highway BMP (median TSS of 88 mg/L and average TSS of 114 mg/L) and the Bellevue study (median TSS of 20 mg/L and average TSS of 36 mg/L) were somewhat different than the other studies.

LAND USE CALCULATIONS

The regional data set covers a wide variety of land use conditions, ranging from relatively undeveloped to highly urbanized conditions. A few of the regional samples were collected form areas that represent a single land use, but most were collected from mixed use areas. To aid in applying the regional data set to the EW drainage basin, data from the National Stormwater Quality Data Base (NSQD version 3) were compiled to evaluate potential land use differences in TSS concentrations (Pitt et. al., 2004). The NSQD data set includes stormwater samples collected from stations across the country. The data set was queried to extract only those samples that represent a single land use (e.g., single family residential, multi-family residential, commercial, industrial, vacant/park, and roadways). Results from the approximately 4,300 samples, presented in Figure B-2, indicate that there is some variability in TSS by land use. Higher median/mean TSS concentrations generally occurred in samples collected from industrial areas, while lower concentrations were observed in samples collected from open space/undeveloped areas. TSS concentrations in runoff from residential, commercial, and roadways was fairly similar.

The NSQD data were used to develop a weighting factor that could be applied to the regional data to develop TSS concentrations for individual land use categories. The weighting factor was calculated using the median TSS values for each land use category from the NSQD data set. The single family residential category was selected as the base for the weighting factor. The land use weighting factor was calculated by dividing the median value for each land use type by the median value for single family residential land use:

Single family residential:	1.00
Multi-family residential:	1.27
Commercial:	1.23
Industrial:	1.25
Open/Vacant/Park:	0.30
Roadway:	1.50

This weighting factor was then applied to the mixed use regional data set to develop TSS concentrations for individual land use types. The regional TSS sample results were deconstructed to separate data into TSS by land use by applying the weighting factor to the relative distribution of land use in the drainage basin represented by each sampling station. First, the total TSS was divided by the sum of the products of the percent land use in each category and the weighting factor to calculate a base TSS value. Then the TSS for other land use categories were calculated by multiplying the base TSS by the appropriate land use weighting factor. An example of the calculations is provided below:

- TSS in sample: 55 mg/L
- Land use: 55% residential, 10 % commercial, 5% open/park, 30 percent right-of-way

$$Base\ TSS = \frac{55}{[(0.55 * 1) + (0.1 * 1.23) + (0.05 * 0.3) + (0.3 * 1.5)]}$$

= 48.3 mg/L

The weighting factors are then applied to calculate the TSS for each land use category:

Land Use	Weighting Factor	TSS (mg/L)
Residential	1.00	48
Commercial	1.23	59
Open/park	0.30	14
Right-of-way	1.50	72

These calculations were performed for each sample in the regional data set. Results are summarized in Figure B-3. Summary statistics are provided in Table B-3.

A range of TSS input values are needed for the PTM model sensitivity analysis. Base case, low, and high values were developed using the land use-weighted TSS concentrations from the regional data set. The high and low ranges are based on the 25th and 75th percentile concentration. A trimmed mean value was used to estimate a base case TSS concentration (Helsel and Hirsch 2002). A trimmed mean was selected for the base case to account for the fact that the TSS data are skewed. As a result, a relatively few high values greatly affect the mean value. The trimmed mean simply removes a set percentage of the values at the low and high end of the data set to adjust for data extremes. For this analysis, a 10 percent trimmed mean was used.

The Port provided data from NPDES monitoring conducted by tenants in 2005-2009 on Terminals 18, 25, and 30, which indicates that the TSS for industrial land use calculated from the regional data set may not be representative of runoff from terminal areas, which are nearly 100 percent paved (Takasaki 2011). TSS concentrations in 26 samples from terminal areas ranged from 6 to 42 mg/L, with an average of about 19 mg/L. Consequently, the Port recommended that a different data set be used for Port terminal areas. For terminal areas, available data from Portland Harbor stormwater monitoring sites that were mostly paved (greater than 90 percent impervious) and select regional data from parking lots were compiled and evaluated. A total of 141 samples fit the criteria for Port terminal areas (Table B-4). The trimmed mean for these data (43 mg/L) is less than the value used for other industrial areas in the EW study area (74 mg/L).

TSS concentrations used in the solids loading analysis are summarized in Table B-5.

REFERENCES

Anchor and Integral. 2007. Portland Harbor RI/FS, Round 3A stormwater sampling rationale. Prepared for The Lower Willamette Group by Anchor Environmental, LLC, Seattle, WA and Integral Consulting, Inc., Mercer Island, WA.

Bellevue and Shapiro. 1999. Lakemont storm water treatment facility monitoring porgram, final report. Prepared for Washington State Department of Ecology by Bellevue Utilities Department, Bellevue, WA and Shapiro and Associates, Inc., Seattle, WA.

Chapman, C. 2006. Performance monitoring or an urban stormwater treatment system. Masters thesis. University of Washington, Department of Civil Engineering, Seattle, WA

Contech. 2004. Performance of the stormwater management Stormfilter relative to Ecology performance goals for basic treatment. Prepared by Contech Stormwater Solutions, Portland, OR.

Contech. 2006. November 21, 2006. Unpublished Contech Stormfilter inflow data provided to Herrera Environmental Consultants, Inc. by Sean Darcy, Contech Stormwater Solutions, Inc., Portland, OR.

Tacoma. 2008. Thea Foss and Wheeler-Osgood Waterways: 2007 stormwater source control report. Prepared for U.S. Environmental Protection Agency by City of Tacoma, WA.

Engstrom, A.M. 2004. Characterizing water quality of urban stormwater runoff: Interactions of heavy metals and solids in Seattle residential catchments. Master’s thesis. University of Washington, Department of Civil Engineering, Seattle, WA.

Helsel, D.R. and R.M Hirsch. 2002. Statistical methods in water resources. In Techniques of Water-Resources Investigations of the United States Geological Survey, Book 4, Chapter A3. Hydrologic Analysis and Interpretation. U.S. Geological Survey, Reston, VA.

Herrera. 2007. Technical Memorandum: Analysis of total suspended solids loading in the Lower Duwamish Waterway. Prepared for Seattle Public Utilities by Herrera Environmental Consultants, Inc., Seattle, WA.

Pitt, R., A. Maestre, R. Morquecho, T Brown, T Schueler, K Cappiella, P Sturm, and C Swann. 2004. Findings from the National Stormwater Quality Database (NSQD). Department of Civil and Environmental Engineerging, University of Alabama, Tuscaloosa, AL and Center for Watershed Protection, Ellicott City, MD (downloaded from http://rpitt.eng.ua.edu/Research/ms4/mainms4.shtml).

Sanders, D. 2011. Personal communication (email to Beth Schmoyer, Seattle Public Utilities, with Portland Harbor stormwater monitoring data). City of Portland Bureau of Environmental Services, Portland, OR.

SPU. 2008. Lower Duwamish Waterway lateral load analysis for stormwater and city-owned CSOs, July 2008 update. Prepared by Seattle Public Utilities, Seattle, WA.

SPU. 2011. City of Seattle 2010 NPDES Phase 1 municipal stormwater permit: Stormwater monitoring report (Attachment C). Seattle Public Utilities, Seattle, WA.

Tacoma. 2007. Thea Foss and Wheeler-Osgood Waterways: 2007 stormwater source control report. Prepared for U.S. Environmental Protection Agency by City of Tacoma, WA.

Tacoma and Taylor. 2006. EvTEC ultra-urban stormwater technology evaluation: Stormwater Management Stormfilter. Prepared by City of Tacoma, WA and Taylor Associates., Inc., Seattle, WA.

Takasaki, K. 2011. Personal communication (email to Beth Schmoyer, Seattle Public Utilities with Terminal 18, 25, and 30 stormwater monitoring results from tenants). Port of Seattle, Seattle, WA.

Taylor and SPU. 2005. Stormwater treatment technologies: An evaluation of pollutant removal performance. Prepared by Taylor Associates, Inc., Seattle, WA and Seattle Public Utilities, Seattle, WA.

WSDOT. 2006. 2006 Stormwater report. Prepared by Washington State Department of Transportation, Olympia, WA.

Appendix B: Tables

Table B-1: Land use and sample counts for TSS data used in the 2008 solids loading analysis.

Station ID	Location	Reference	Basin Area (acres)	Percent Impervious	Description	Industrial, total	Commercial	Residential, total	SFR	MFR	Parks/Open Space	Transportation /ROW	No. of samples
Data used in 2008 study													
NW120th St and 4th Ave NW (NS007)	Seattle, WA	Enstrom 2004, Chapman 2006	69.5	44%	Residential	0%	0%	67%	59%	7%	2%	31%	14
NW 110th St and Palatine Ave N (NS001)	Seattle, WA	Chapman 2006	10		Residential	0%	0%	64%	50%	14%	7%	30%	27
NW122nd St and Ridgemont Ave N	Seattle, WA	Engstrom 2004			Residential	0%	0%	65%	53%	12%	4%	31%	14
NW107th St and 4th Ave NW	Seattle, WA	Engstrom 2004	33.6	42%	Residential	0%	0%	66%	58%	8%	2%	32%	7
Downstream Defender BMP	Seattle, WA	Taylor and SPU 2005	208	35%	Highway, commercial, residential	0%	8%	44%	41%	3%	7%	42%	20
Stormceptor BMP	Seattle, WA	Taylor and SPU 2005	0.8	100%	Parking lot	0%	100%	0%	0%	0%	0%	0%	7
Vortechs BMP	Seattle, WA	Taylor and SPU 2005	25		Residential	0%	9%	52%	47%	5%	3%	36%	20
WSDOT Stormfilter	Seattle, WA	Tacoma and Taylor 2008	31.6	72%	Highway, vacant, residential	0%	0%	0%	0%	0%	0%	100%	18
Lakemont sand filter (Station 1 inlet)	Bellevue, WA	Bellevue and Shapiro 1999	252		Residential, commercial	0%	0%	0%	85%	0%	0%	15%	65
Contech Tualatin	Tualatin, OR	Contech 2006			Commercial	0%	100%	0%	0%	0%	0%	0%	12
Contech University Pl (TSS)	University Place, WA	Contech 2006		100%	Parking lot-department store	0%	100%	0%	0%	0%	0%	0%	18
Contech Vancouver (SSC)	Vancouver, WA	Contech 2004	4	100%	Parking lot-shopping mall	0%	100%	0%	0%	0%	0%	0%	21
Contech Portland	Portland, OR	Contech 2006			Parking lot-shopping mall	0%	100%	0%	0%	0%	0%	0%	27
Contech Lake Stevens	Lake Stevens, WA	Contech 2004	0.29	>90%	Road and bridge	0%	0%	0%	0%	0%	0%	100%	13
Contech Olympia	Olympia, WA	Contech 2006		100%	Parking-business	0%	100%	0%	0%	0%	0%	0%	14
Outfall 230	Tacoma, WA	Tacoma 2007	513		Commercial, residential	0%	59%	41%	31%	11%	0%	0%	31
Outfall 235	Tacoma, WA	Tacoma 2007	181		Commercial, residential	0%	70%	30%	24%	6%	0%	0%	33
Outfall 237A	Tacoma, WA	Tacoma 2007	2,794		Commercial, industrial, residential	18%	18%	65%	60%	5%	0%	0%	15
Outfall 237B	Tacoma, WA	Tacoma 2007	1,821		Residential	1%	12%	87%	82%	6%	0%	0%	33
Outfall 243	Tacoma, WA	Tacoma 2007	52.6		Commercial, industrial	100%	0%	0%	0%	0%	0%	0%	24
Outfall 245	Tacoma, WA	Tacoma 2007	36		Industrial	100%	0%	0%	0%	0%	0%	0%	29
Outfall 254	Tacoma, WA	Tacoma 2007	51.3		Industrial	100%	0%	0%	0%	0%	0%	0%	26
Herrera EE, SR167	Auburn, WA	Herrera 2006a	NA		Highway	0%	0%	0%	0%	0%	0%	100%	25
Herrera CAVFS I5, MP184	Mill Creek, WA	WSDOT 2006	0.5		Highway	0%	0%	0%	0%	0%	0%	100%	7
Total													520

Table B-2: Land use and sample counts for the additional TSS data used in the 2011 solids loading analysis.

Station ID	Location	Reference	Basin Area (acres)	Percent Impervious	Description	Industrial, total	Commercial	Residential, total	SFR	MFR	Parks/Open Space	Transportation /ROW	No. of samples
Data added for 2011 analysis													
45_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	4
46_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	4
47_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	4
48_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Residential	0%	0%	100%	NA	NA	0%	0%	4
50_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
52_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
52A_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
53_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Residential	0%	0%	100%	NA	NA	0%	0%	3
53A_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	3
53A_SW2[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	1
HWY 30A	Portland, OR	Sanders 2011	4.7	92%	Highway	61%	0%	0%	NA	NA	0%	39%	4
HWY 30B	Portland, OR	Sanders 2011	4.8	97%	Highway	3%	0%	0%	NA	NA	0%	97%	5
M1_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
M2_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
M3_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
OF-16	Portland, OR	Sanders 2011	41.8	89%	Mixed industrial/highway	89%	0%	0%	NA	NA	0%	11%	5
OF-18	Portland, OR	Sanders 2011	413	31%	Open space, heavy industrial, highway	33%	0%	0%	NA	NA	3%	1%	5
OF-19	Portland, OR	Sanders 2011	486	22%	Open space, heavy industrial	28%	0%	0%	NA	NA	3%	2%	17
OF-22	Portland, OR	Sanders 2011	94.3	66%	Petroleum storage/undeveloped	72%	0%	0%	NA	NA	1%	2%	4
OF-22B	Portland, OR	Sanders 2011	31.6	38%	Chemical manufacturing	74%	0%	0%	NA	NA	26%	0%	5
OF-22C	Portland, OR	Sanders 2011	715	0%	Open space/forested	0%	0%	0%	NA	NA	16%	0%	7
OF-22D	Portland, OR	Sanders 2011			Parks/open space	0%	0%	0%	NA	NA	100%	0%	4
OF-49	Portland, OR	Sanders 2011	32.7	50%	Residential street	4%	0%	88%	NA	NA	5%	1%	4
OF-52C/Basin T	Portland, OR	Sanders 2011	21.5	95%	Paved parking lot	99%	0%	0%	NA	NA	1%	0%	4
OF-53	Portland, OR	Sanders 2011	21.3	53%	Residential street	4%	0%	95%	NA	NA	1%	0%	3
OF-M1	Portland, OR	Sanders 2011	71.1	74%	Various light industrial	98%	0%	0%	NA	NA	1%	0%	4
OF-M2	Portland, OR	Sanders 2011	91.3	81%	Trucking and distribution	99%	0%	0%	NA	NA	0%	0%	4
S1_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	4
S2_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
S5_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Light industrial	0%	100%	0%	NA	NA	0%	0%	4
S6_SW1[a]	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	4
St. Johns Bridge	Portland, OR	Sanders 2011	1.3	62%	Highway	23%	0%	0%	NA	NA	0%	77%	7
WLCGED07MH2	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	3
WLCGED07SV1	Portland, OR	Sanders 2011	NA	NA	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	3
WR-107	Portland, OR	Sanders 2011	8.1	35%	Manufactured gas plant	100%	0%	0%	NA	NA	0%	0%	5
WR-123	Portland, OR	Sanders 2011	75.9	80%	Heavy industrial-metals	100%	0%	0%	NA	NA	0%	0%	6
WR-14	Portland, OR	Sanders 2011	1.5	95%	Bulk fuel	100%	0%	0%	NA	NA	0%	0%	5
WR-142	Portland, OR	Sanders 2011	0.5	100%	Barge and railroad car manufacture	100%	0%	0%	NA	NA	0%	0%	6
WR-145	Portland, OR	Sanders 2011	0.7	100%	Barge and railroad car manufacture	100%	0%	0%	NA	NA	0%	0%	1
WR-147	Portland, OR	Sanders 2011	5.0	63%	Metals handling	100%	0%	0%	NA	NA	0%	0%	5
WR-161	Portland, OR	Sanders 2011	0.8	100%	Ship maintenance and repair	100%	0%	0%	NA	NA	0%	0%	6
WR-169/Basin D	Portland, OR	Sanders 2011	16.9	95%	Paved auto receiving yard	87%	0%	0%	NA	NA	13%	0%	4
WR-177/Basin M	Portland, OR	Sanders 2011	29.8	55%	Cark parking, liquid bulk storage	92%	0%	0%	NA	NA	8%	0%	4
WR-181/Basin Q	Portland, OR	Sanders 2011	18.3	60%	Vacant/former grain storage	100%	0%	0%	NA	NA	0%	0%	3
WR-183/Basin R	Portland, OR	Sanders 2011	15.1	20%	Grain storage/transport	100%	0%	0%	NA	NA	0%	0%	3
WR-20/Basin L	Portland, OR	Sanders 2011	16.6	22%	Bulk storage	98%	0%	0%	NA	NA	2%	0%	4
WR-218	Portland, OR	Sanders 2011	66.7	45%	Railyard	95%	0%	0%	NA	NA	0%	0%	4
WR-22	Portland, OR	Sanders 2011	51.9	48%	Steel manufacturing	100%	0%	0%	NA	NA	0%	0%	5
WR-384	Portland, OR	Sanders 2011	10.3	81%	Heavy industrial	100%	0%	0%	NA	NA	0%	0%	5
WR-4	Portland, OR	Sanders 2011	2.0	100%	Manufacturing	100%	0%	0%	NA	NA	0%	0%	3
WR-67	Portland, OR	Sanders 2011	5.9	97%	Industrial	100%	0%	0%	NA	NA	0%	0%	6
WR-96	Portland, OR	Sanders 2011	1.8	100%	Chemical manufacturing	100%	0%	0%	NA	NA	0%	0%	6
Yeon Mixed Use	Portland, OR	Sanders 2011	17.6	92%	Mixed	100%	0%	0%	NA	NA	0%	0%	3
University/C1	Seattle, WA	SPU 2011	187	NA	Commercial, residential	0%	41%	20%	7%	13%	2%	37%	21
Venema/R1	Seattle, WA	SPU 2011	157	NA	Residential, commercial	0%	3%	66%	61%	6%	0%	30%	12
Norfolk/I1	Seattle, WA	SPU 2011	214	NA	Industrial, commercial, residential	3%	33%	25%	24%	1%	15%	18%	12
CBSF1-IN Stormfilter, Calif Ave SW	Seattle, WA	SPU 2011	<1	100%	Arterial	0%	0%	0%	0%	0%	0%	100%	12
CBSF2-IN Stormfilter, Calif Ave SW	Seattle, WA	SPU 2011	<1	100%	Arterial	0%	0%	0%	0%	0%	0%	100%	10
Subtotal													302

a. Grab sample

Table B-3: Summary statistics for land use TSS calculations.

	Single-family	Multi-family	Commercial	Industrial	Open/park/vacant	Right-of-way
Total count	345	251	411	292	96	330
Trim count	276	195	329	230	75	266
25th percentile	24	39	31	34	8	34
Min	1	2	2	2	1	1
Max	391	343	987	780	275	587
Median	43	59	49	63	12	61
75th percentile	70	101	84	117	17	103
Mean	57	79	73	93	19	85
10th percentile	9	24	16	14	4	13
90th percentile	126	162	149	199	30	194
10% trimmed mean	48	68	58	74	13	71

Table B-4: Summary statistics for land use TSS calculations.

	Single-family	Multi-family	Commercial	Industrial	Open/park/vacant	Right-of-way
Total count	342	251	407	278	95	326
Trim count	276	195	329	230	75	266
25th percentile	24	39	32	35	8	33
Min	1	2	2	2	1	1
Max	391	343	987	780	275	587
Median	43	59	49	63	12	61
75th percentile	70	101	84	114	18	103
Mean	57	79	73	92	19	85
10th percentile	9	24	16	15	4	13
90th percentile	126	162	149	194	31	194
10% trimmed mean	48	68	58	74	13	71

Table B-5: Stormwater TSS concentrations by land use.

	Total Samples	Trimmed Samples	Low (25th percentile)	Base Case (10% trimmed mean)	High (75th percentile)
Single-family residential	342	276	24	48	70
Multi-family residential	251	195	39	68	101
Commercial	407	329	32	58	84
Industrial[a]	230	278	35	74	114
Industrial (Port)[b]	141	113	20	43	60
Vacant/park	95	75	8	13	18
Right-of-way	326	266	33	71	103

Units = mg/L

a. For industrial land use in all SPU drainage basins, except B-21, plus Port Basin B-34 and all private basins.

b. For all Port terminal areas, except B-34, plus SPU basin (B-21)

Appendix B: Figures

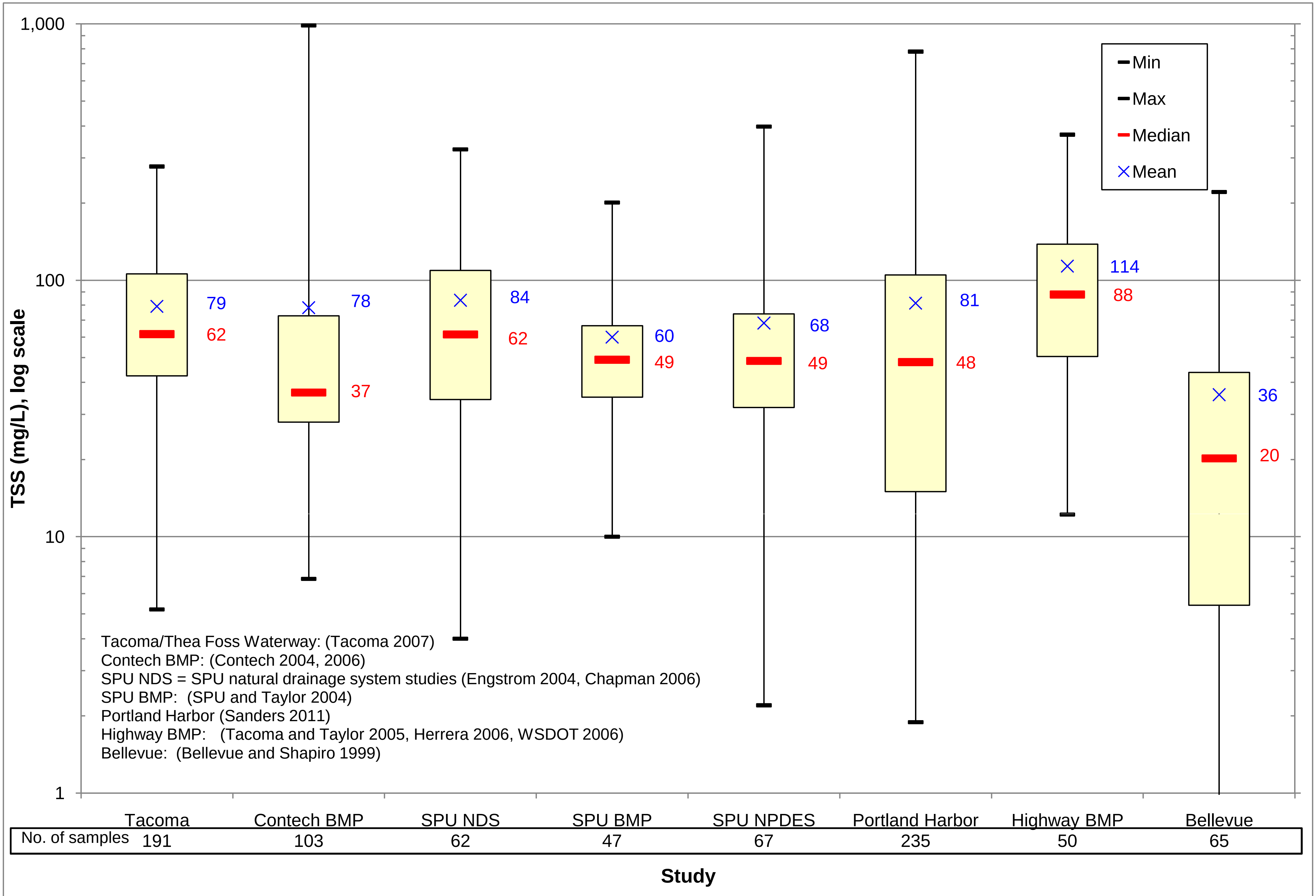


Figure B-1: Box plot of TSS for each study area.

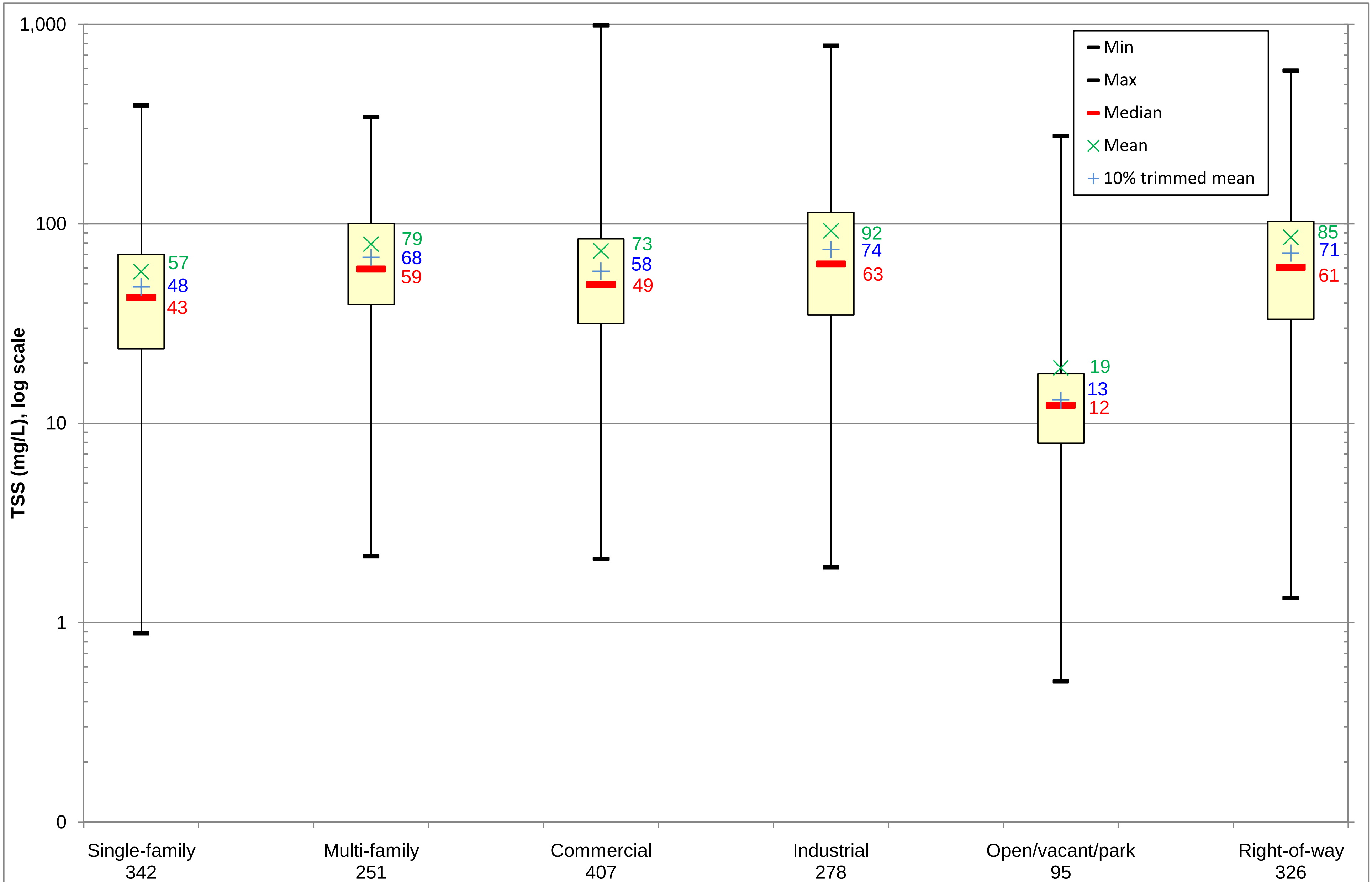
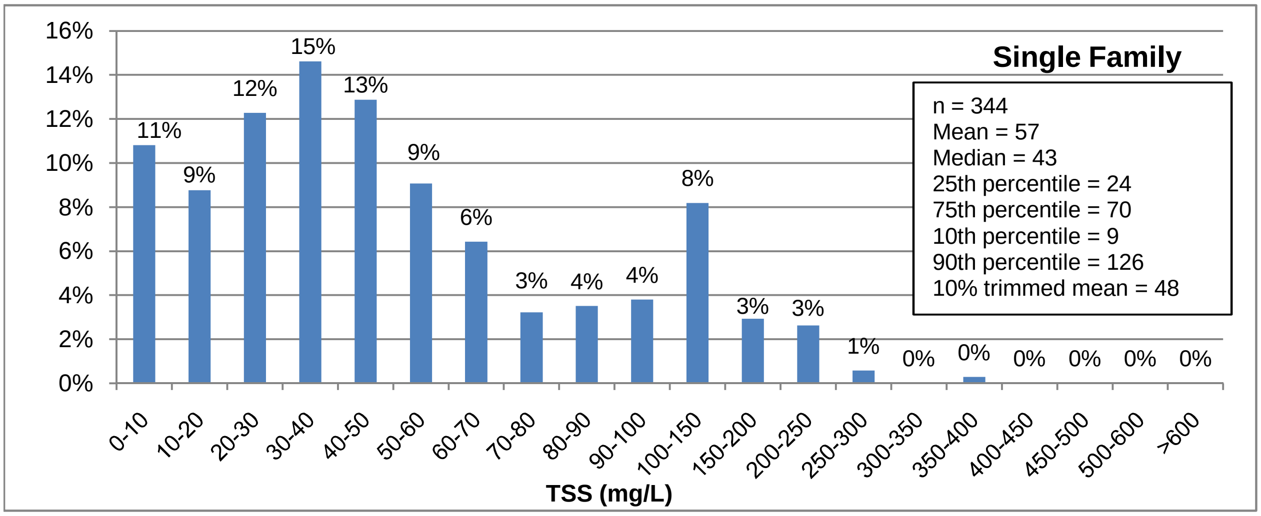
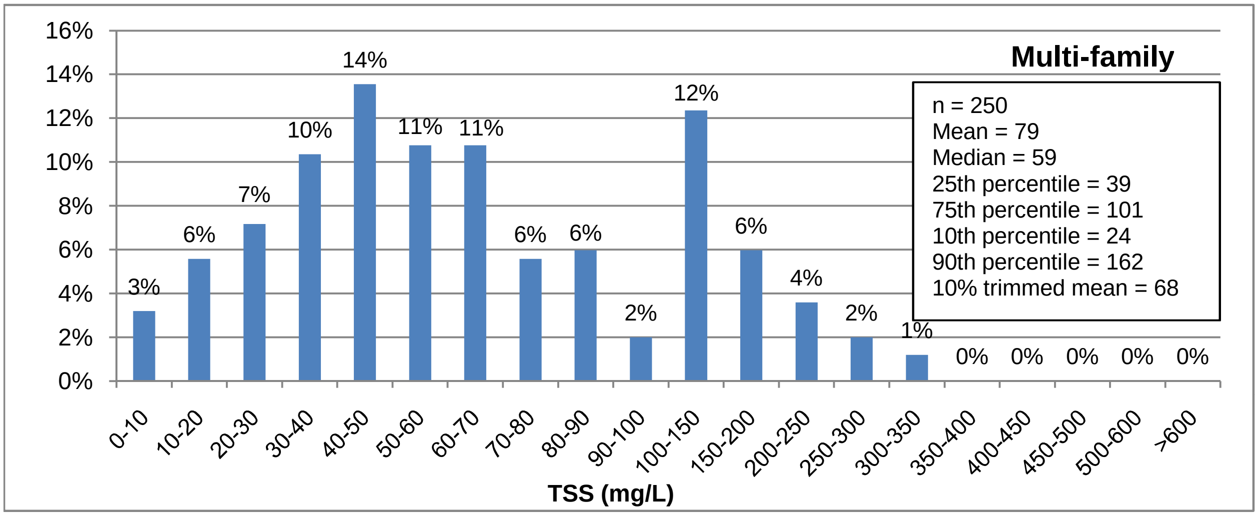


Figure B-2: Box plot of TSS concentrations by land use.

Compiled TSS data DSA 040607_SyntheticValues_v1c.xlsx PTM box

Figure B-3: TSS histograms by land use.





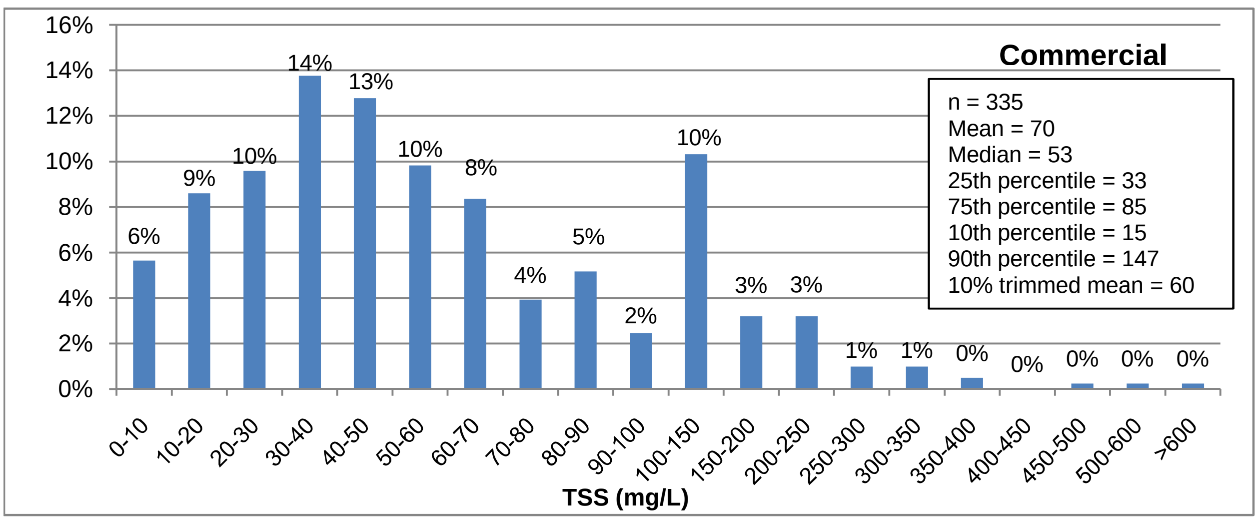
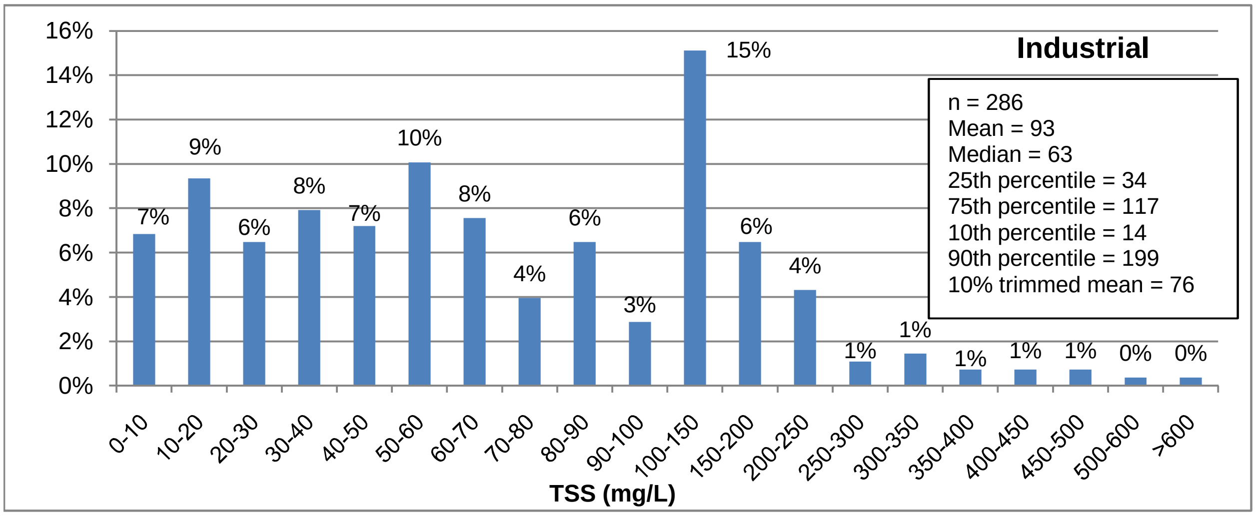
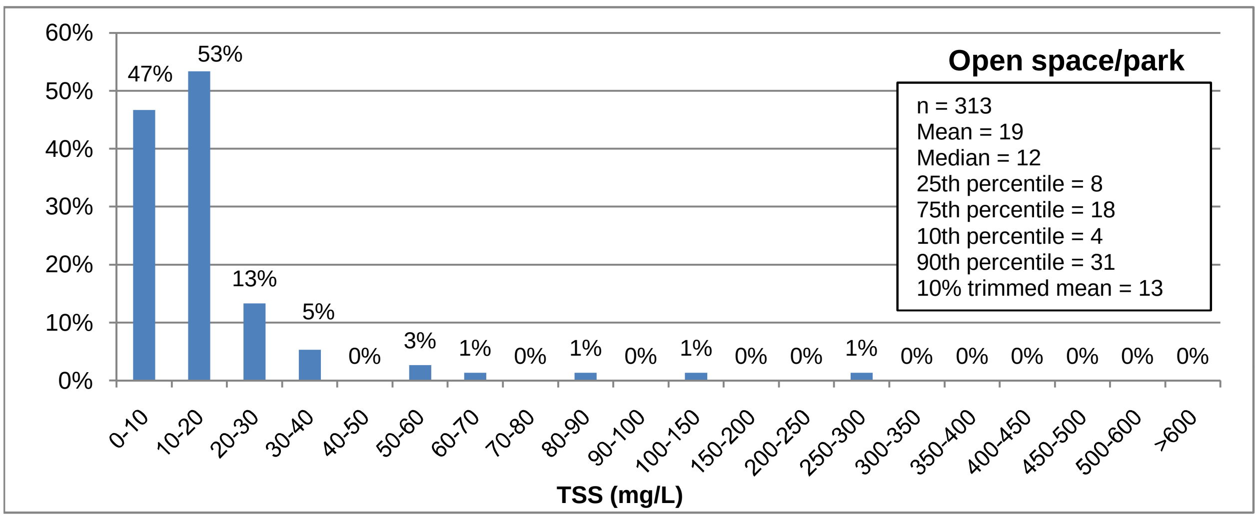


Figure B-3: TSS histograms by land use.





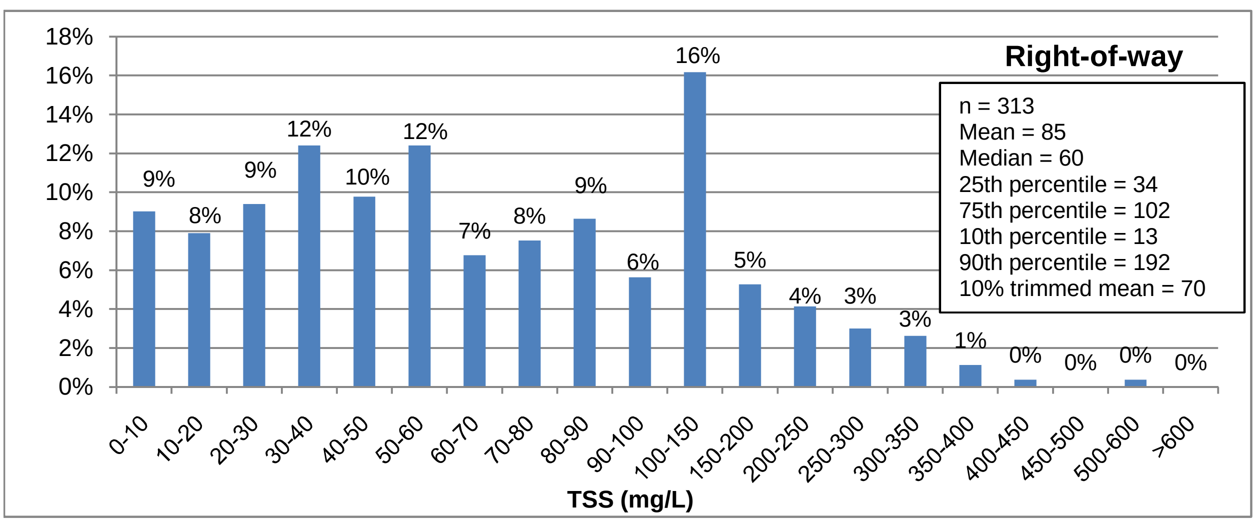
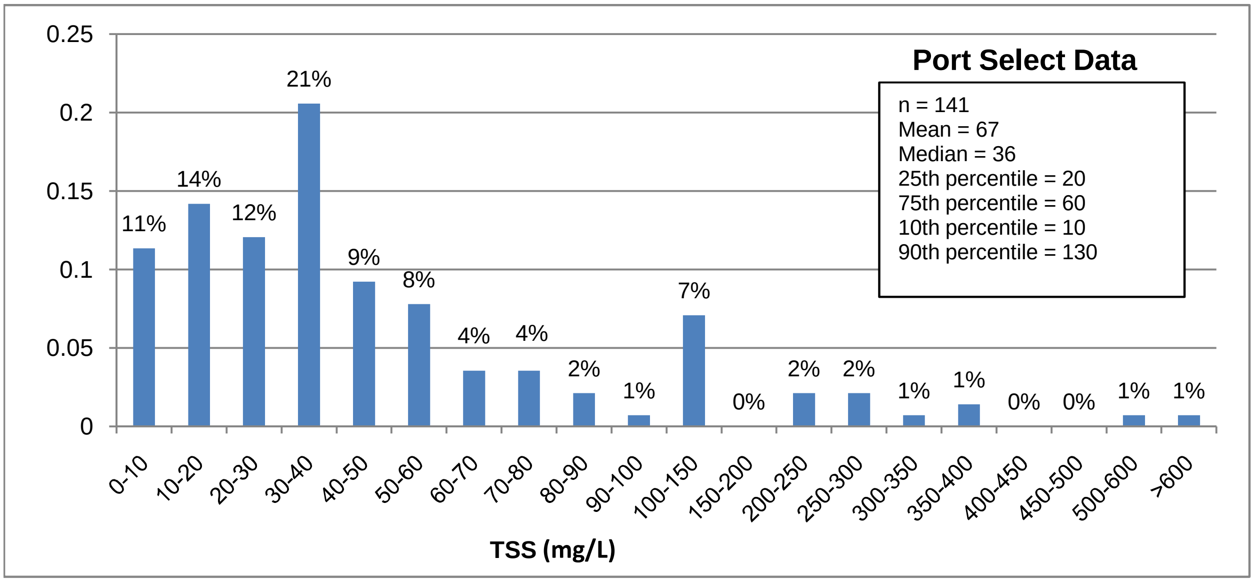


Figure B-3: TSS histograms by land use.



Includes TSS and SSC data for stormwater samples collected in western Washington and Oregon
Land use TSS values estimated using National Stormater Quality Database (Pitt et.al., 2004)
Note: 2 outliers excluded (2,300 mg/L at industrial site--broken pipe and 744 mg/L at highway site--sanding event).

Appendix C:
Surface Geology Data

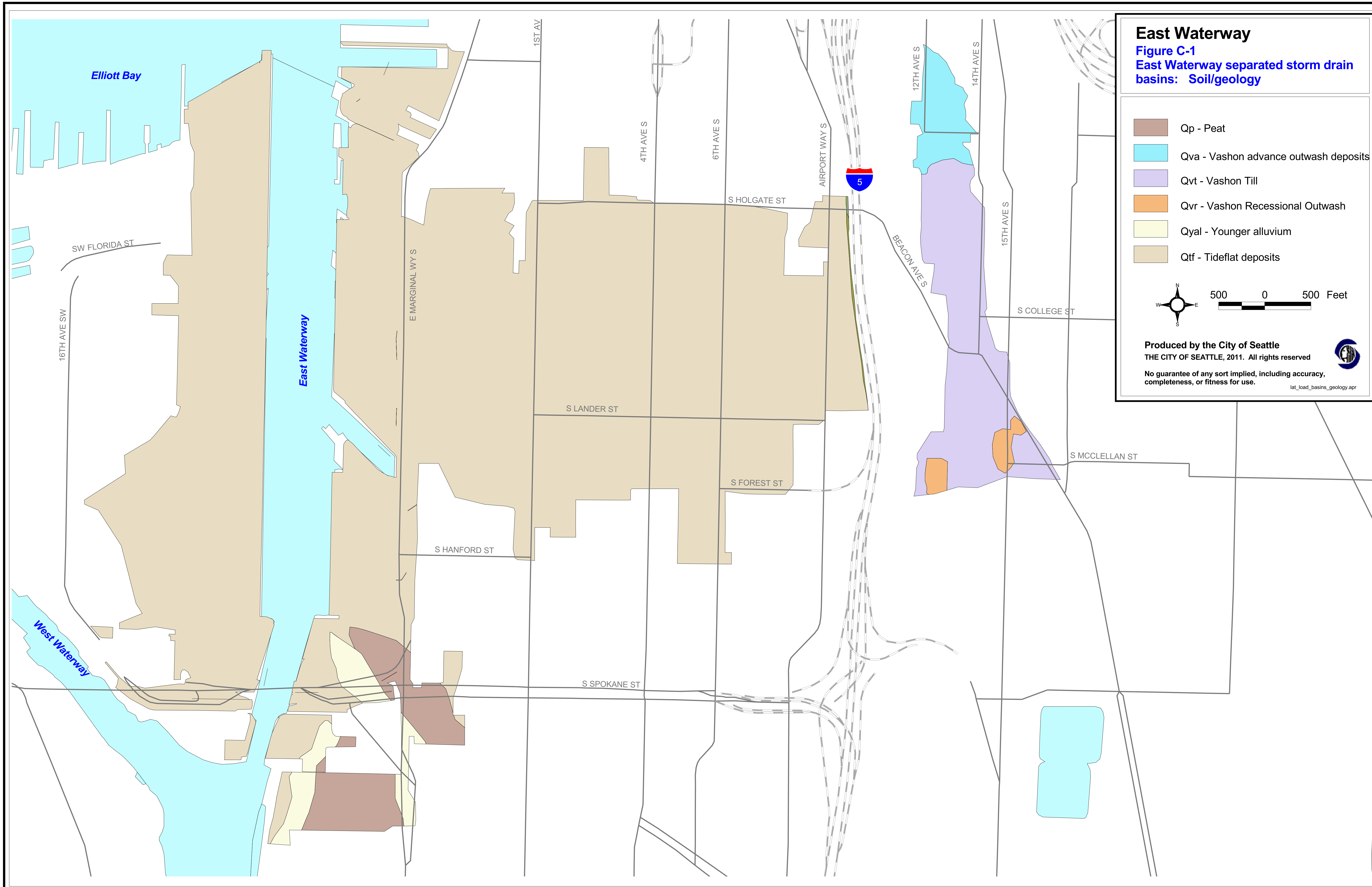

East Waterway
Figure C-1
East Waterway separated storm drain basins: Soil/geology
Qp - Peat
Qva - Vashon advance outwash deposits
Qvt - Vashon Till
Qvr - Vashon Recessional Outwash
Qyal - Younger alluvium
Qtf - Tideflat deposits
500 0 500 Feet
Produced by the City of Seattle
THE CITY OF SEATTLE, 2011. All rights reserved
No guarantee of any sort implied, including accuracy, completeness, or fitness for use.
lat_load_basins_geology.apr
Elliott Bay
East Waterway
West Waterway
SW FLORIDA ST
16TH AVE SW
E MARGINAL WY S
1ST AV
4TH AVE S
6TH AVE S
AIRPORT WAY S
12TH AVE S
14TH AVE S
15TH AVE S
BEACON AVE S
S HOLGATE ST
S COLLEGE ST
S LANDER ST
S MCCLELLAN ST
S FOREST ST
S HANFORD ST
S SPOKANE ST
5

Table C-1: East Waterway separated storm drain basin, soil/geology classification for HSPF model.

Symbol	Description	More_description	Hydrologic_Class
Qvt	Vashon till	Compact diamict of silt, sand, and subrounded to well-rounded gravel, glacially transported and deposited under ice	Till
Qva	Vashon advance outwash deposits	Well-sorted sand and gravel deposited by streams issuing from advancing ice sheet	Outwash
Qvr	Vashon recessional outwash	Stratified sand and gravel, moderately sorted to well sorted, and less common silty sand and silt.	Outwash
Qyal	Younger alluvium	Sand, silt, gravel, and cobbles deposited by streams and running water	Alluvium
Qp	Peat		Wetland soil
Qtf	Tideflat deposits	Silt, sand, and organic sediment and detritus with some shells, historically exposed in broad coastal benches at low tide and now fill covered.	Till

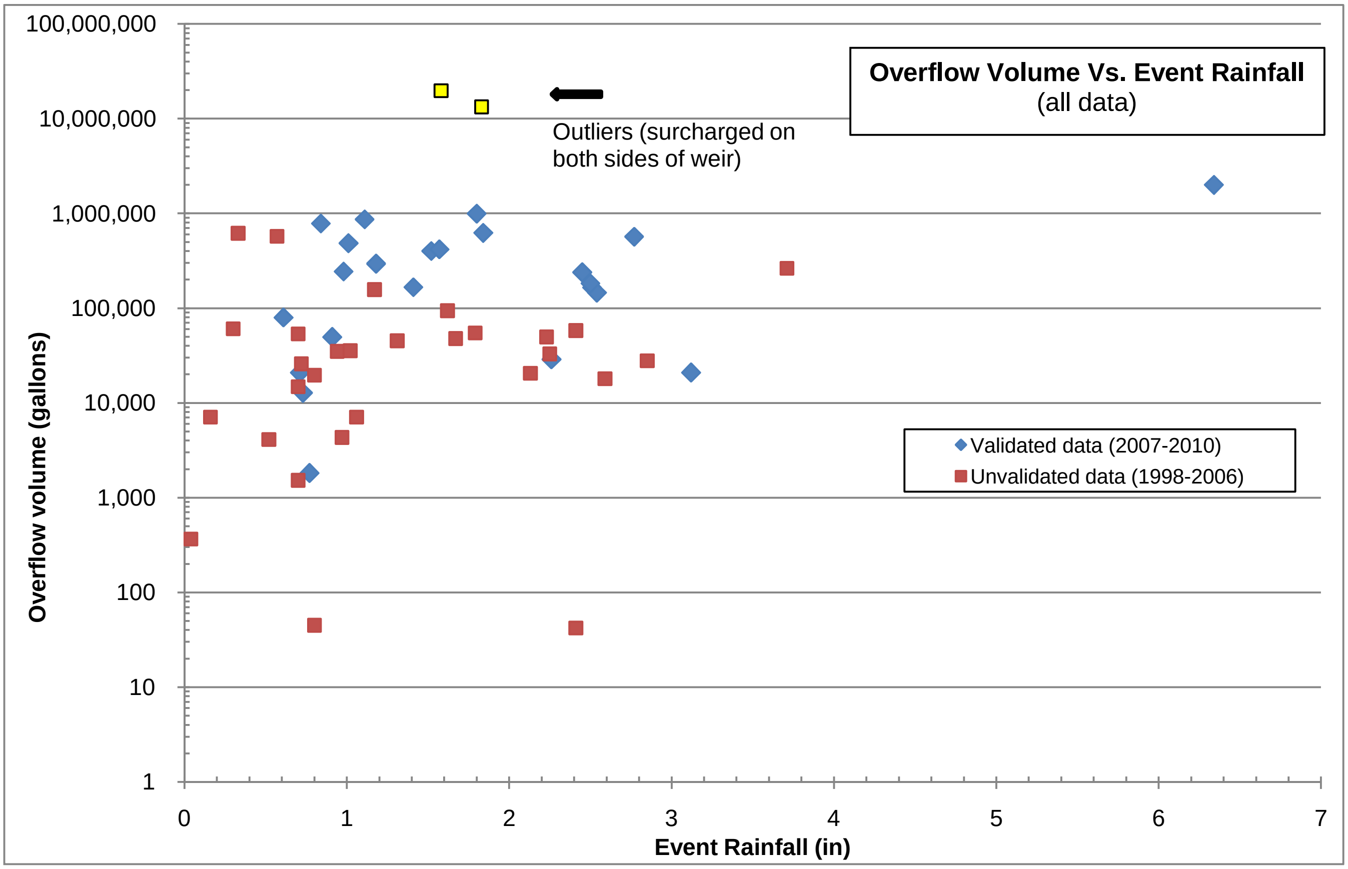
Appendix D:

S Hinds St CSO/SD combined sewer overflow records

Table D-1: S Hinds St CSO/SD(#107) combined sewer overflow records (1998-2010).

Date	CSO #	Rainfall (inches)	Storm Duration (hours)	Overflow Duration (hrs)	Volume (gallons)	Volume (ft^3)	Volume (Mgal)	Volume Minus Outliers (gallons)
12/02/98	107	0.70	15.4	7.0	53,503	7,153	0.05	53,503
12/13/98	107	1.62	34.9	23.0	93,855	12,547	0.09	93,855
12/25/98	107	0.80	9.8	4.0	19,588	2,619	0.02	19,588
12/27/98	107	0.72	15.4	8.0	25,871	3,459	0.03	25,871
01/17/99	107	0.94	22.8	8.0	35,007	4,680	0.04	35,007
01/18/99	107	0.52	13.1	2.0	4,108	549	0.00	4,108
01/20/99	107	0.04	2.8	1.0	365	49	0.00	365
01/21/99	107	0.16	8.6	2.0	7,076	946	0.01	7,076
02/27/99	107	1.02	16.6	10.0	35,586	4,757	0.04	35,586
11/11/99	107	2.85	55.2	4.0	27,883	3,728	0.03	27,883
02/01/00	107	1.31	14.4	8.0	45,173	6,039	0.05	45,173
06/11/01	107	1.17	44.4	5.0	157,002	20,990	0.16	157,002
08/22/01	107	1.79	63.1	6.0	54,862	7,335	0.05	54,862
11/13/01	107	3.71	108.2	25.0	263,820	35,270	0.26	263,820
11/19/01	107	2.59	89.7	3.0	17,962	2,401	0.02	17,962
12/13/01	107	0.30	40.6	8.0	60,656	8,109	0.06	60,656
12/16/01	107	2.23	37.5	12.0	49,711	6,646	0.05	49,711
01/02/02	107	0.70	46.6	2.0	14,798	1,978	0.01	14,798
01/03/02	107	0.70	46.6	1.0	1,522	203	0.00	1,522
01/05/02	107	2.41	80.3	1.0	42	6	0.00	42
01/06/02	107	2.41	80.3	18.0	58,122	7,770	0.06	58,122
01/25/02	107	2.25	84.3	7.0	32,874	4,395	0.03	32,874
10/20/03	107	2.13	46.0	8.0	20,591	2,753	0.02	20,591
01/07/04	107	**1.83**	85	23.0	**13,322,604**	1,781,099	13.32	439,685
01/29/04	107	**1.58**	67	26.0	**19,710,696**	2,635,123	19.71	439,685
10/08/04	107	0.80	30	1.0	45	6	0.00	45
10/17/04	107	0.57	29	4.0	572,604	76,551	0.57	572,604
12/08/04	107	0.97	34	3.0	4,323	578	0.00	4,323
12/10/04	107	1.67	38	3.0	47,740	6,382	0.05	47,740
12/11/04	107	1.06	18	2.0	7,091	948	0.01	7,091
03/27/05	107	0.33	31.0	12.0	617,204	82,514	0.62	617,204
12/02/07	107	**6.34**	178.0	29.0	2,008,192	268,475	2.01	2,008,192
03/23/08	107	0.77	27.0	1.0	1,820	243	0.00	1,820
11/06/08	107	1.84	29.0	12.0	625,537	83,628	0.63	625,537
01/07/09	107	2.51	79.9	5.8	165,998	22,192	0.17	165,998
04/02/09	107	0.98	59.6	1.8	244,327	32,664	0.24	244,327
05/05/09	107	1.52	67.7	2.5	402,134	53,761	0.40	402,134
10/14/09	107	0.73	28.7	1.0	12,772	1,708	0.01	12,772
10/16/09	107	2.45	96.4	16.0	239,803	32,059	0.24	239,803
10/26/09	107	1.01	22.5	4.9	486,610	65,055	0.49	486,610
11/06/09	107	2.54	49.3	12.6	146,038	19,524	0.15	146,038
11/16/09	107	1.57	50.1	13.0	418,365	55,931	0.42	418,365
11/19/09	107	2.50	105.9	2.1	183,001	24,465	0.18	183,001
11/22/09	107	0.84	13.6	3.1	785,230	104,977	0.79	785,230
11/26/09	107	1.18	17.4	3.8	295,660	39,527	0.30	295,660
01/04/10	107	0.61	14.7	1.3	79,758	10,663	0.08	79,758
01/08/10	107	0.91	23.3	1.6	49,692	6,643	0.05	49,692
01/11/10	107	1.11	19.7	6.1	868,057	116,051	0.87	868,057
01/13/10	107	2.26	71.2	1.0	28,842	3,856	0.03	28,842
01/15/10	107	3.12	112.9	1.7	20,952	2,801	0.02	20,952
04/21/10	107	0.71	27.8	1.1	20,883	2,792	0.02	20,883
09/17/10	107	2.77	85.2	28.7	569,936	76,195	0.57	569,936
10/09/10	107	1.41	27.6	3.0	166,775	22,296	0.17	166,775
11/01/10	107	1.80	53.9	7.9	997,810	133,397	1.00	997,810

No documentation of data quality from contractor. Data quality unknown.



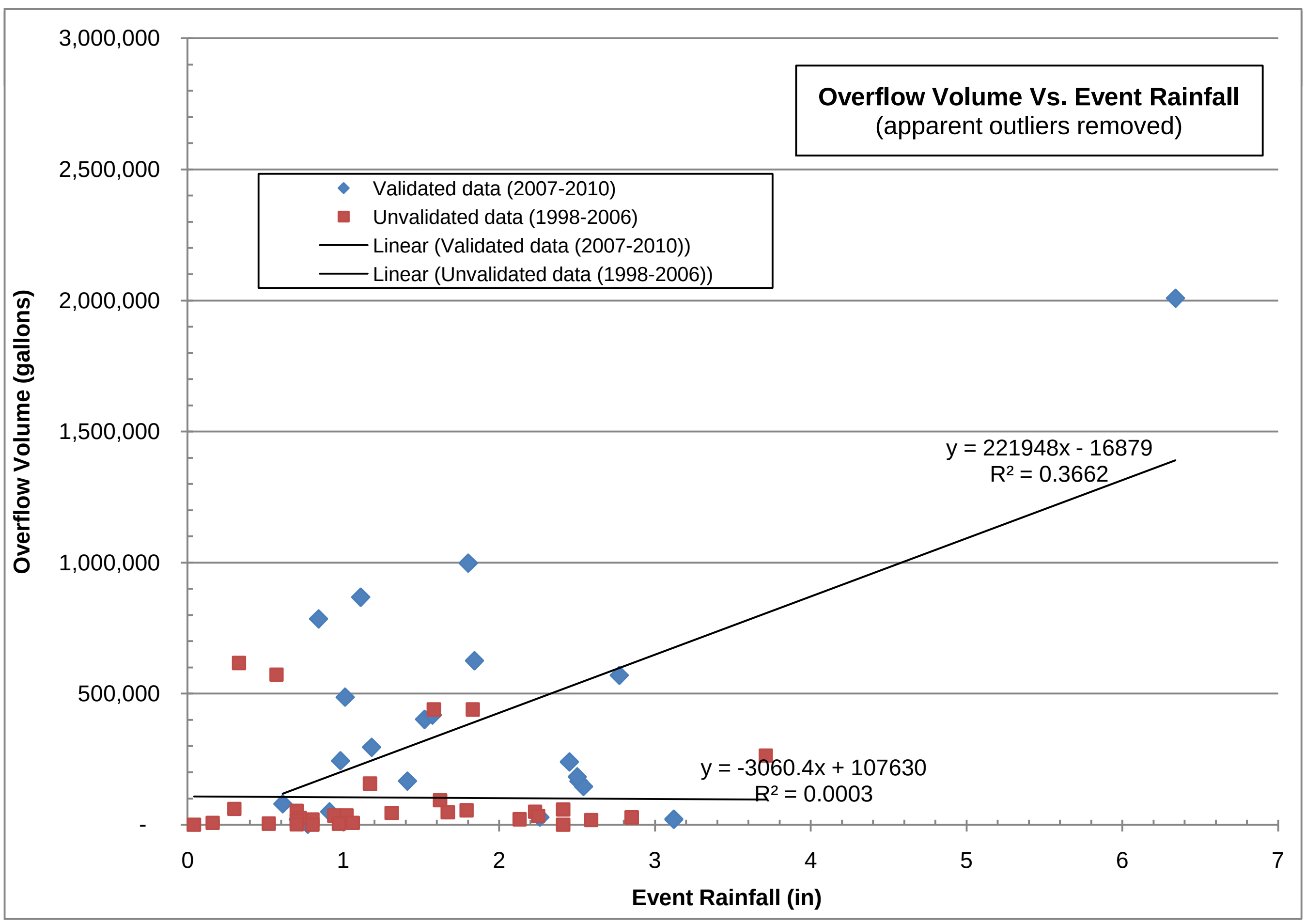


Figure D-1: S Hinds St CSO overflow versus rainfall scatter plots.

Hinds_CSO_statistics-bs.xlsx event scatters

Appendix E:
Particle Size Distribution Data

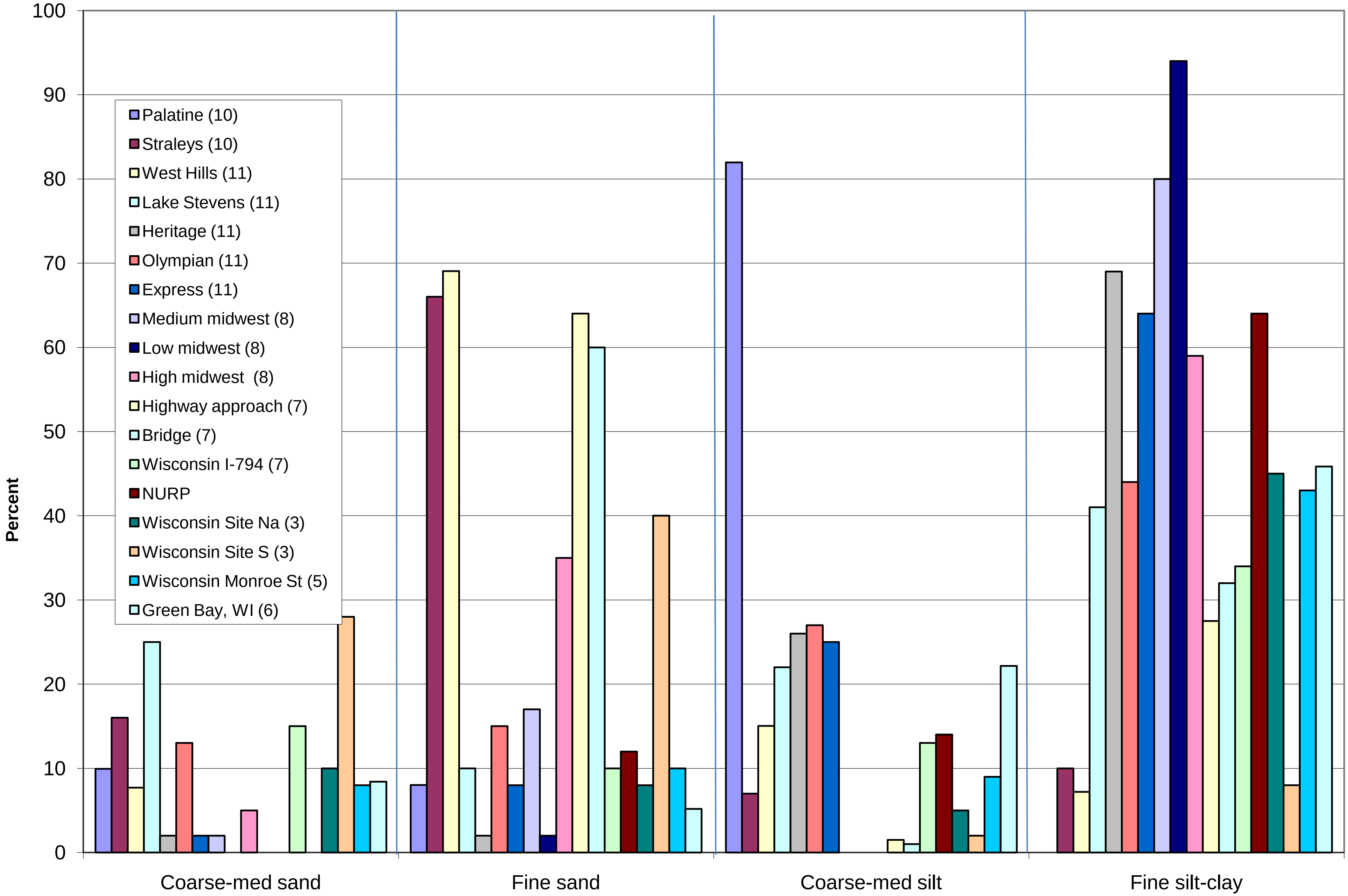


Figure E-1: PSD in urban stormwater samples collected in the U.S.

psd analysis-v2.xls Chart1 (2)

References

1 Ahearn, D. 2007. Personal communication (email data for PSD analysis on 12 stormwater samples collected from SR 167 to Beth Schmoyer, Seattle Public Utilities). Herrera Environmental Consultants, Inc., Seattle, WA

2 Anta, J., E. Pena, J. Suarez, and J. Cagiao. 2006. A BMP selection process based on the granulometry of runoff solids in a separate urban catchment, Water SA 32(3): 419-428.

3 Bannerman, R., J. Horwatch, and J. Bachhuber. 2004. Preliminary look at method for sizing proprietary sediment settling devices. Http://dnr.wi.gov/org/water/wm/nps/stormwater/post-constr/proprietarydevices.pdf

4 Breault, R.F., K.P. Smith, and J.R. Sorenson. 2005. Residential street-dirt accumulation rates and chemical composition, and removal efficiencies by mechanical- and vacuum-type sweepers, New Bedford, Massachusetts, 2003-2004. Special Investigations Report 2005-5184. U.S. Geological Survey, Reston, VA.

5 HDR. 1993. Combined sewer system SFO compliance interim control measures study. Prepared for City of Portland, Bureau of Environmental Services by HDR Engineering, Inc. in association with CH2H Hill, Inc., Brown and Caldwell Consultants, OTAK, and LTI-Limno Tech, Inc., Lake Oswego, OR.

6 Horwatich, J.A, S.R. Corsi, and R.T. Bannerman. 2004. Effectiveness of a pressurized stormwater filtration system in Green Bay, Wisconsin: A study for the Environmental Technology Verification Program of the U.S. Environmental Protection Agency. Scientific Investigations Report 2004-5222. U.S. Geological Survey, Madison, WI.

7 Karamalegos, A. M., M.E. Barrett, D.F. Lawler, and J.F. Malina. 2005. Particle size distribution of highway runoff and modification through stormwater treatment. CRWR Online Report 05-10. University of Texas at Austin, Center for Research in Water Resources, Austin, TX.

8 Morquecho, R. 2005. Pollutant associations with particulates in stormwater. Doctoral Thesis, University of Alabama, Tuscaloosa, AL.

9 Waschbusch, R.J. 2003. Data and methods of a 1999-2000 street sweeping study on an urban freeway in Milwaukee County, Wisconsin. OFR 03-93. U.S. Geological Survey, Middleton, WI.

10 Wigginton, B. 2002. Personal communication (email stormwater data to Beth Schmoyer, Seattle Public Utilities), Stormwater Management, Inc., (now Contech Stormwater Solutions), Portland, OR.

12 Driscoll, E.D., D.DiToro, D. Gaboury, and P. Shelley. 1986. Methodology for analysis of detention basins for control of urban runoff quality. EPA 440/5-87-001. Prepared for Office of Water Regulations and Standards, Criteria and Standards Division, U.S. Environmental Protection Agency, by Woodward-Clyde Consultants, Walnut Creek, CA.

13 Lee, B., Y. Shimizu, T. Matsuda, and S. Matui. 2005. Characterization of polycyclic aromatic hydrocarbons (PAHs) in different size fractions in deposited road particles (DRPs) from Lake Biwa area, Japan. Environ. Sci. Technol. 39: 7402-7409.

14 Sansalone, J.J. and S.G. Buchberger. 1997. Partitioning and first flush of metals in urban roadway stormwater. Journal of Environmental Engineering. 123(2): 134-143.

ATTACHMENT 2

Memorandum

To: Anchor QEA LLC

CC: Jeff Stern, Bruce Nairn, Doug Hotchkiss, Kym Takasaki, Pete Rude

From: Debra Williston, King County DNRP

Date: 12/22/2010

Re: King County East Waterway (EW) Combine Sewer Overflow Total Suspended Solids and Discharge Data for use in EW Supplemental Remedial Investigation and Sediment Transport Modeling Efforts

---

This memo outlines the total suspended solids (TSS) data and discharge frequency and volume data from King County Combine Sewer Overflows (CSOs) that discharge into the East Waterway (EW). The two King County CSOs that discharge into EW are Hanford #2 and Lander. These data are being submitted to support the EW Supplemental Remedial Investigation (SRI) and sediment transport modeling efforts.

TSS Data

The TSS data for the two King County CSOs in EW are included as Attachment A to this memo and summary statistics are presented below. All TSS data are based on Standard Method 2540-D (using standard 1 µ filter).

TSS (mg/L) Summary Stats	
86	average
81	geomean
36.4	min
156	max
94.5	median
65.3	25th percentile
106	75th percentile
109.2	90th percentile
27	count

Data from Hanford #2 CSO includes eight sampling events collected between 1996-1997 for the King County Water Quality Assessment of the Duwamish River and Elliott Bay (King County 1999), two sampling events in 2004, and 10 sampling events collected from 2007-2009 as part of the most recent characterization of King County Duwamish River CSOs (King County 2007). There are a total of 14 duplicate samples collected during these events. All duplicate results were first averaged prior to calculating summary statistics shown above.

Data for Lander CSO includes seven sampling events collected from 2008-2009 as part of the most recent characterization of King County Duwamish River CSOs (King County 2007).

King County recommends the same TSS concentrations be applied to both Hanford #2 and Lander CSOs. This is because the two basins are connected, there is a smaller dataset available for Lander to calculate TSS loads, and what data are available do not suggest higher TSS loads than Hanford #2. King County reviewed TSS data for other CSOs within the Duwamish Basin and found some basins have higher than average TSS concentrations than Hanford #2 and Lander, and therefore, we do not feel it would be appropriate to use the TSS dataset from all Duwamish CSO basins combined.

Discharge Frequency and Volume Data

King County event frequency and volume discharge data for the County's two EW CSOs (Hanford #2 and Lander) and for Kingdome CSO, which is just north of the EW are presented in Table 1. Table 1 presents overall average frequency and volumes for each of these CSOs for the period of June 2000-December 2009. Table 2 presents frequency and volume for each CSO by year. Table 3 presents monthly average frequencies and volumes for each CSO. The annual average data was derived from the data presented in Table 3.

If you have any questions regarding these data, please let me know.

King County. 1999. King County Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay; Appendix A: Problem Formulation, Analysis Plan, and Field Sampling Work Plan A3: Field Sampling Work Plan. Prepared by Parametrix, Inc. and King County DNR, Seattle, WA.

King County. 2007. Duwamish River Basin Combined Sewer Overflow Survey Sampling and Analysis Plan. Prepared by King County DNRP, Seattle, WA.

Table 1. Annual Average CSO Frequencies and Volumes for 2000-2009 period for Discharges to the East Waterway and Vicinity.

Station	Annual Average CSO Discharge Frequency (June 2000-Dec2009) (events/year)	Annual Average CSO Discharge Volume (June 2000-Dec2009) (million gallons/year)
Hanford #2	13.6	74.3
Kingdome (a)	6.2	17.4
Lander	6.7	39.8

(a) Value is based on data from Nov. 2004-Dec.2009. Prior to the 1988 separation project, the combined system overflowed at the Connecticut regulator (but discharged to same outfall location). CSO discharge monitoring data from the 1998-2003 monitoring periods are not available. Kingdome discharges reported as not measured from June 2005-Nov. 2006

Table 2. Yearly CSO Volume and Event Frequency Summary for Discharges to the EW and vicinity.

Station	Discharge Number	1981-1983 Baseline		2001 (Jan-Dec)		2002 (Jan-Dec)		2003 (Jan-Dec)		2004 (Jan-Dec)	
		Vol. (mg)	Events	Vol. (mg)	Events	Vol. (mg)	Events	Vol. (mg)	Events	Vol. (mg)	Events
Connecticut/Kingdome (a)	029	90	23	1.42	3	1.15	1	0.00	0	1.26	2
Hanford #2	031	644	63	91.15	8	77.10	10	57.93	12	78.23	16
Lander	030	143	22	15.49	7	38.97	9	112.60	8	2.04	2

(a) Values shown represent totals listed in annual reports for discharge #029, including "Connecticut" and "Kingdome" discharges.
Highlighted values are different than those printed in the CSO Annual Report because they are only for Hanford #2 and are not a combination of Hanford #1 and Hanford #2.

Table 2. Yearly CSO Volume and Event Frequency Summary for Discharges to the EW and vicinity.

Station	Discharge Number	2005 (Jan-Dec)		2006 (Jan-Dec)		2007 (Jan-Dec)		2008 (Jan-Dec)		2009 (Jan-Dec)	
		Vol. (mg)	Events	Vol. (mg)	Events	Vol. (mg)	Events	Vol. (mg)	Events	Vol. (mg)	Events
Connecticut/Kingdome (a)	029	27.25	5	17.60	4	28.55	5	0.23	1	3.54	8
Hanford #2	031	91.33	15	183.06	26	65.60	12	23.94	8	36.34	17
Lander	030	15.53	2	43.73	13	41.51	4	4.07	3	111.67	16

Table 3. Monthly Average CSO Event Frequency and Volume Summary for Discharges to the EW and Vicinity.

June 2000-May 2009

Station	DSN	Year	June	July	August	September	October	November	December	January	February	March
CSO Discharge Frequency (# events)												
Connecticut	29	1999-2000	0	0	0	0	0	0	0	0	0	0
Connecticut	29	2000-2001	0	0	0	0	0	0	0	0	0	0
Connecticut	29	2001-2002	0	0	0	0	2	0	1	1	0	0
Connecticut	29	2002-2003	0	0	0	0	0	0	0	0	0	0
Kingdome		2003-2004	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Kingdome		2004-2005	NM	NM	NM	NM	NM	0	2	2	1	1
Kingdome		2005-2006	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Kingdome		2006-2007	NM	NM	NM	NM	NM	NM	4	3	0	0
Kingdome		2007-2008	0	0	0	0	0	0	1	0	0	0
Kingdome		2008-2009	0	0	0	0	0	1	0	1	0	0
Kingdome		2009	0	0	0	1	2	3	0			
Average			0	0	0	0.333333333	0.666666667	1	1.4	1.5	0.25	0.25
Hanford #2	31	1999-2000	1	0	0	0	0	5	3	2	3	3
Hanford #2	31	2000-2001	1	0	0	0	2	2	1	2	0	0
Hanford #2	31	2001-2002	0	0	0	0	1	3	2	3	2	1
Hanford #2	31	2002-2003	1	0	0	0	0	1	1	8	0	1
Hanford #2	31	2003-2004	0	0	0	0	0	2	1	3	1	1
Hanford #2	31	2004-2005	0	0	3	1	2	1	2	1	1	1
Hanford #2	31	2005-2006	1	0	0	0	1	5	2	6	2	1
Hanford #2	31	2006-2007	2	0	0	0	0	10	4	3	0	0
Hanford #2	31	2007-2008	0	0	0	2	0	3	2	1	0	2
Hanford #2	31	2008-2009	0	0	2	0	0	2	1	1	0	0
Hanford #2	31	2009	0	0	0	1	3	6	1			
Average			0.5	0	0.5	0.4	0.9	3.5	1.7	3.111111111	0.666666667	0.777777778
Lander St. #2	30	1999-2000	0	0	0	0	0	3	2	1	0	0
Lander St. #2	30	2000-2001	0	0	0	0	0	0	0	0	0	0
Lander St. #2	30	2001-2002	0	0	1	0	0	4	2	3	2	1
Lander St. #2	30	2002-2003	1	0	0	0	0	0	1	3	0	1
Lander St. #2	30	2003-2004	0	0	0	0	2	2	0	1	0	0
Lander St. #2	30	2004-2005	0	0	0	0	0	0	1	1	0	0
Lander St. #2	30	2005-2006	0	0	0	0	0	0	1	3	1	0
Lander St. #2	30	2006-2007	0	0	0	0	0	5	4	2	0	0
Lander St. #2	30	2007-2008	0	0	0	0	0	0	1	0	0	1
Lander St. #2	30	2008-2009	0	0	0	0	0	2	0	2	0	0
Lander St. #2	30	2009	0	0	0	1	3	5	1			
Average			0.1	0	0.1	0.1	0.5	1.8	1.1	1.666666667	0.333333333	0.333333333

Table 3. Monthly Average CSO Event Frequency and Volume Summary for Discharges to the EW and Vicinity.

June 2000-May 2009

Station	DSN	Year	April	May	Total	Baseline (1981-1983)
CSO Discharge Frequency (# events)						
Connecticut	29	1999-2000	0	0	0	34
Connecticut	29	2000-2001	0	0	0	
Connecticut	29	2001-2002	0	0	4	29
Connecticut	29	2002-2003	0	0	0	23
Kingdome		2003-2004	NM	NM	NM	
Kingdome		2004-2005	0	1	7	
Kingdome		2005-2006	NM	NM	0	
Kingdome		2006-2007	0	1	8	
Kingdome		2007-2008	0	0	1	
Kingdome		2008-2009	0	1	3	
Kingdome		2009			6	
Average			0	0.75	6.15	
Hanford #2	31	1999-2000	0	0	17	40
Hanford #2	31	2000-2001	0	0	8	
Hanford #2	31	2001-2002	1	0	13	
Hanford #2	31	2002-2003	0	0	12	
Hanford #2	31	2003-2004	0	2	10	
Hanford #2	31	2004-2005	2	1	15	28
Hanford #2	31	2005-2006	1	0	19	28
Hanford #2	31	2006-2007	0	2	21	
Hanford #2	31	2007-2008	0	0	10	
Hanford #2	31	2008-2009	2	3	11	
Hanford #2	31	2009			11	
Average			0.666666667	0.888888889	13.61	
Lander St. #2	30	1999-2000	0	0	6	29
Lander St. #2	30	2000-2001	0	0	0	
Lander St. #2	30	2001-2002	1	0	14	26
Lander St. #2	30	2002-2003	0	0	6	22
Lander St. #2	30	2003-2004	0	0	5	22
Lander St. #2	30	2004-2005	0	0	2	26
Lander St. #2	30	2005-2006	0	0	5	26
Lander St. #2	30	2006-2007	0	1	12	
Lander St. #2	30	2007-2008	0	0	2	
Lander St. #2	30	2008-2009	2	2	8	
Lander St. #2	30	2009			10	
Average			0.333333333	0.333333333	6.7	

Table 3. Monthly Average CSO Event Frequency and Volume Summary for Discharges to the EW and Vicinity.

June 2000-May 2009

Station	DSN	Year	June	July	August	September	October	November	December	January	February	March
CSO Discharge Volume (million gallons)												
Station	**DSN**	**Year**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**January**	**February**	**March**
Connecticut	29	1999-2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Connecticut	29	2000-2001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Connecticut	29	2001-2002	<0.01	<0.01	<0.01	<0.01	1.34	<0.01	0.08	1.15	<0.01	<0.01
Connecticut	29	2002-2003	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Kingdome		2003-2004	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Kingdome		2004-2005	NM	NM	NM	NM	NM	0.00	1.26	18.45	2.74	5.91
Kingdome		2005-2006	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Kingdome		2006-2007	NM	NM	NM	NM	NM	NM	17.60	0.84	0.00	0.00
Kingdome		2007-2008	0.00	0.00	0.00	0.00	0.00	0.00	27.62	0.00	0.00	0.00
Kingdome		2008-2009	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.27	0.00	0.00
Kingdome		2009	0.00	0.00	0.00	0.13	1.55	0.21	0.00			
Average			0.00	0.00	0.00	0.04	0.52	0.11	9.30	4.89	0.69	1.48
Hanford #2	31	1999-2000	9.34	0.00	0.00	0.00	0.00	17.70	5.61	0.41	11.21	2.21
Hanford #2	31	2000-2001	0.65	0.00	0.00	0.00	1.96	1.43	0.83	3.30	0.00	0.00
Hanford #2	31	2001-2002	0.00	0.00	0.00	0.00	0.66	49.11	38.08	28.79	22.79	5.48
Hanford #2	31	2002-2003	0.01	0.00	0.00	0.00	0.00	1.08	14.16	34.12	0.00	7.01
Hanford #2	31	2003-2004	0.00	0.00	0.00	0.00	0.00	16.03	0.77	38.04	3.19	1.31
Hanford #2	31	2004-2005	0.00	0.00	6.85	0.84	2.34	5.66	18.27	23.46	2.65	11.55
Hanford #2	31	2005-2006	0.46	0.00	0.00	0.00	1.82	13.64	30.58	67.50	3.69	0.01
Hanford #2	31	2006-2007	0.91	0.00	0.00	0.00	0.00	64.49	45.85	21.61	0.00	0.00
Hanford #2	31	2007-2008	0.00	0.00	0.00	3.58	0.00	2.80	35.64	0.73	0.00	1.79
Hanford #2	31	2008-2009	0.00	0.00	1.62	0.00	0.00	17.52	2.28	0.67	0.00	0.00
Hanford #2	31	2009	0.00	0.00	0.00	0.35	3.52	27.61	0.46			
Average			0.20	0.00	0.85	0.48	1.03	19.94	18.69	24.25	3.59	3.02
Lander St. #2	30	1999-2000	0.00	0.00	0.00	0.00	0.00	0.62	0.53	0.04	0.00	0.00
Lander St. #2	30	2000-2001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lander St. #2	30	2001-2002	0.00	0.00	0.93	0.00	0.00	13.38	1.17	30.22	4.65	1.85
Lander St. #2	30	2002-2003	0.88	0.00	0.00	0.00	0.00	0.00	0.43	16.93	0.00	6.11
Lander St. #2	30	2003-2004	0.00	0.00	0.00	0.00	79.58	9.98	0.00	1.97	0.00	0.00
Lander St. #2	30	2004-2005	0.00	0.00	0.00	0.00	0.00	0.00	0.07	4.25	0.00	0.00
Lander St. #2	30	2005-2006	0.00	0.00	0.00	0.00	0.00	0.00	11.29	12.45	2.70	0.00
Lander St. #2	30	2006-2007	0.00	0.00	0.00	0.00	0.00	12.92	15.67	10.65	0.00	0.00
Lander St. #2	30	2007-2008	0.00	0.00	0.00	0.00	0.00	0.00	30.16	0.00	0.00	2.40
Lander St. #2	30	2008-2009	0	0	0	0	0	1.67	0	2.11	0	0
Lander St. #2	30	2009	0	0	0	0.01	5.52	84.38	6.38			
Average			0.09	0.00	0.09	0.00	8.51	12.23	6.52	8.73	0.82	1.15

DSN - Discharge Serial Number
CSO - Combined Sewer Overflow
NM - not measured

Table 3. Monthly Average CSO Event Frequency and Volume Summary for Discharges to the EW and Vicinity.

June 2000-May 2009

Station	DSN	Year	April	May	Total	Baseline (1981-1983)
CSO Discharge Volume (million gallons)						

Station	DSN	Year	April	May	Total	Baseline (1981-1983)
Connecticut	29	1999-2000	0.00	0.00	0.00	90
Connecticut	29	2000-2001	0.00	0.00	0.00	
Connecticut	29	2001-2002	<0.01	<0.01	2.57	90
Connecticut	29	2002-2003	<0.01	<0.01	0.00	90
Kingdome		2003-2004	NM	NM	0.00	
Kingdome		2004-2005	0.00	0.16	28.51	
Kingdome		2005-2006	NM	NM	0.00	
Kingdome		2006-2007	0.00	0.10	18.54	
Kingdome		2007-2008	0.00	0.00	27.62	
Kingdome		2008-2009	0.00	1.38	1.89	
Kingdome		2009			1.89	
Average			0.00	0.41	17.43	
Hanford #2	31	1999-2000	0.00	0.00	46.48	644
Hanford #2	31	2000-2001	0.00	0.00	8.17	
Hanford #2	31	2001-2002	4.79	0.00	149.70	
Hanford #2	31	2002-2003	0.00	0.00	56.38	
Hanford #2	31	2003-2004	0.00	1.73	61.07	
Hanford #2	31	2004-2005	5.33	1.84	78.78	
Hanford #2	31	2005-2006	0.61	0.00	118.33	
Hanford #2	31	2006-2007	0.00	1.97	134.83	
Hanford #2	31	2007-2008	0.00	0.00	44.55	
Hanford #2	31	2008-2009	1.31	2.42	25.82	
Hanford #2	31	2009			31.94	
Average			1.34	0.88	74.26	
Lander St. #2	30	1999-2000	0.00	0.00	1.19	143
Lander St. #2	30	2000-2001	0.00	0.00	0.00	
Lander St. #2	30	2001-2002	0.94	0.00	53.15	143
Lander St. #2	30	2002-2003	0.00	0.00	24.35	143
Lander St. #2	30	2003-2004	0.00	0.00	91.53	143
Lander St. #2	30	2004-2005	0.00	0.00	4.32	143
Lander St. #2	30	2005-2006	0.00	0.00	26.44	143
Lander St. #2	30	2006-2007	0.00	0.71	39.94	
Lander St. #2	30	2007-2008	0.00	0.00	32.56	
Lander St. #2	30	2008-2009	3.78	9.49	17.04	
Lander St. #2	30	2009			96.29	
Average			0.52	1.13	39.80	

DSN - Discharge Serial Number
CSO - Combined Sewer Overflow
NM - not measured

Attachment A: King County TSS Data (all 1.0 µ method) for Hanford #2 and Lander CSOs

SITE	LOCATOR	COLLECTDATE	TIMESPAN	SAMPLE NUM	PARMNAME	NUMVALUE	UNITS	MDL	RDL	Value with Dups averaged
Hanford #2	CS030	12/2/2007 11:24	2	L44133-3	Total Suspended Solids	79	mg/L	5	10	67.85
Hanford #2	CS030	12/2/2007 11:24	2	L44133-4	Total Suspended Solids	56.7	mg/L	3.3	6.7	
Hanford #2	CS030	8/20/2008 1:35	1	L45811-3	Total Suspended Solids	53	mg/L	5	10	53
Hanford #2	CS030	11/4/2008 5:34	2	L46418-3	Total Suspended Solids	62.5	mg/L	2.5	5	62.5
Hanford #2	CS030	11/6/2008 16:05	2	L46918-3	Total Suspended Solids	156	mg/L	5	10	156
Hanford #2	CS030	4/2/2009 19:28	0.5	L47597-3	Total Suspended Solids	109	mg/L	7.1	14	94.5
Hanford #2	CS030	4/2/2009 19:28	0.5	L47597-4	Total Suspended Solids	80	mg/L	6.3	13	
Hanford #2	CS030	4/12/2009 17:13	2	L47834-1	Total Suspended Solids	34	mg/L	3.3	6.7	36.35
Hanford #2	CS030	4/12/2009 17:13	2	L47834-2	Total Suspended Solids	38.7	mg/L	3.3	6.7	
Hanford #2	CS030	5/5/2009 5:02	1	L48009-2	Total Suspended Solids	106	mg/L	5	10	108
Hanford #2	CS030	5/5/2009 5:02	1	L48009-3	Total Suspended Solids	110	mg/L	5	10	
Hanford #2	CS030	9/6/2009 12:02	1.75	L49003-1	Total Suspended Solids	108	mg/L	4.2	8.3	108
Hanford #2	CS030	11/6/2009 3:38	2	L49556-3	Total Suspended Solids	94.7	mg/L	3.3	6.7	94.7
Hanford #2	CS030	12/21/2009 9:04	1.5	L49832-1	Total Suspended Solids	46	mg/L	2.5	5	46
Lander	LANDER II REG	6/3/2008 9:09	2	L44912-6	Total Suspended Solids	109	mg/L	5	10	109
Lander	LANDER II REG	8/20/2008 1:01	2	L45811-6	Total Suspended Solids	38	mg/L	5	10	38
Lander	LANDER II REG	11/4/2008 4:14	2	L46418-6	Total Suspended Solids	51.5	mg/L	2.5	5	51.5
Lander	LANDER II REG	11/6/2008 15:42	2	L46918-6	Total Suspended Solids	84.2	mg/L	4.2	8.3	84.2
Lander	LANDER II REG	4/12/2009 16:42	2	L47834-3	Total Suspended Solids	72.7	mg/L	3.3	6.7	72.7
Lander	LANDER II REG	5/2/2009 22:12	1.5	L47992-2	Total Suspended Solids	80.8	mg/L	4.2	8.3	80.8
Lander	LANDER II REG	5/4/2009 21:09	2	L48009-5	Total Suspended Solids	65	mg/L	5	10	65

Attachment A: King County TSS Data (all 1.0 µ method) for Hanford #2 and Lander CSOs

SITE	LOCATOR	COLLECTDATE	TIMESPAN	SAMPLE NUM	PARMNAME	NUMVALUE	UNITS	MDL	RDL	Value with Dups averaged
Hanford #2	CS030	1/29/2004 8:08	2.5	L30881-2	Total Suspended Solids	122	mg/L	5	10	118
Hanford #2	CS030	1/29/2004 8:08	2.5	L30881-3	Total Suspended Solids	114	mg/L	5	10	
Hanford #2	CS030	5/26/2004 10:21	1.75	L31912-2	Total Suspended Solids	106	mg/L	5	10	104
Hanford #2	CS030	5/26/2004 10:21	1.75	L31912-3	Total Suspended Solids	102	mg/L	5	10	
Hanford #2	CS030	10/28/1996 12:00	2.5	L9820-1	Total Suspended Solids	84.7	mg/L	0.5	1	89.25
Hanford #2	CS030	10/28/1996 12:00	2.5	L9820-2	Total Suspended Solids	93.8	mg/L	0.5	1	
Hanford #2	CS030	12/4/1996 14:04	3	L10025-7	Total Suspended Solids	97	mg/L	0.5	1	99.5
Hanford #2	CS030	12/4/1996 14:04	3	L10025-8	Total Suspended Solids	102	mg/L	0.5	1	
Hanford #2	CS030	1/27/1997 20:55	1	L10292-3	Total Suspended Solids	97.3	mg/L	0.5	1	98.15
Hanford #2	CS030	1/27/1997 20:55	1	L10292-4	Total Suspended Solids	99	mg/L	0.5	1	
Hanford #2	CS030	1/30/1997 3:45	2.5	L10322-3	Total Suspended Solids	93.3	mg/L	0.5	1	95.35
Hanford #2	CS030	1/30/1997 3:45	2.5	L10322-4	Total Suspended Solids	97.4	mg/L	0.5	1	
Hanford #2	CS030	3/1/1997 10:24	3.5	L10524-3	Total Suspended Solids	128	mg/L	0.5	1	107.95
Hanford #2	CS030	3/1/1997 10:24	3.5	L10524-4	Total Suspended Solids	87.9	mg/L	0.5	1	
Hanford #2	CS030	3/7/1997 1:50	2	L10588-3	Total Suspended Solids	65.6	mg/L	0.5	1	65.6
Hanford #2	CS030	3/15/1997 10:59	3	L10645-3	Total Suspended Solids	114	mg/L	0.5	1	109.5
Hanford #2	CS030	3/15/1997 10:59	3	L10645-4	Total Suspended Solids	105	mg/L	0.5	1	
Hanford #2	CS030	4/19/1997 19:18	3	L10939-7	Total Suspended Solids	90.6	mg/L	0.5	1	95.8
Hanford #2	CS030	4/19/1997 19:18	3	L10939-8	Total Suspended Solids	101	mg/L	0.5	1	
Hanford #2	CS030	5/31/1997 7:40	3	L11233-7	Total Suspended Solids	143	mg/L	0.5	1	148
Hanford #2	CS030	5/31/1997 7:40	3	L11233-8	Total Suspended Solids	153	mg/L	0.5	1	

Attachment A: King County TSS Data (all 1.0 µ method) for Hanford #2 and Lander CSOs

Collect Date	All EW Data
12/2/2007	67.8
8/20/2008	53
11/4/2008	62.5
11/6/2008	156
4/2/2009	94.5
4/12/2009	36.4
5/5/2009	108
9/6/2009	108
11/6/2009	94.7
12/21/2009	46
6/3/2008	109
8/20/2008	38
11/4/2008	51.5
11/6/2008	84.2
4/12/2009	72.7
5/2/2009	80.8
5/4/2009	65
1/29/2004	118
5/26/2004	104
10/28/1996	89.2
12/4/1996	99.5
1/27/1995	98.2
1/30/1997	95.4
3/1/1997	108
3/7/1997	65.6
3/15/1997	109.5
4/19/1997	95.8

TSS (mg/L) Summary Stats	
86	average
81	geomean
36.4	min
156	max
94.5	median
65.3	25th percentile
106	75th percentile
109.2	90th percentile
27	count

TABLES F-1 TO F-3

Stormwater runoff and solids loading estimates for EWW storm drain basins (25th percentile estimate; TSS values updated 2/7/2011)

Runoff and TSS from SPU Basins (Low Runoff Assumption for Partially Separated Basins)[1]

		Outfall Coordinates[3]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-21	12.98	1,267,025.76	216,799.42	8.65	7.28	10.58	1,444.23	1,215.55	1,765.61	0.66	0.55	0.80
B-25	4.20	1,268,053.11	218,669.74	2.69	2.26	3.32	723.95	607.93	892.05	0.33	0.28	0.40
B-36	5.35	1,267,380.50	212,096.91	3.32	2.77	4.09	940.79	787.21	1,160.18	0.43	0.36	0.53
B-4	7.11	1,266,960.50	211,998.11	4.58	3.85	5.64	1,299.08	1,091.13	1,599.51	0.59	0.49	0.73
B-5	2.15	1,266,985.87	212,222.84	1.37	1.15	1.69	389.12	326.59	480.30	0.18	0.15	0.22
Lander[4] (SPU)	438.34	1,267,839.97	215,762.30	118.25	99.23	146.06	33,218.79	27,877.84	41,019.14	15.07	12.65	18.61
Hinds	39.50	1,267,870.96	212,912.61	24.99	20.99	30.57	7,090.27	5,956.38	8,674.67	3.22	2.70	3.93
total	509.62			163.84	137.53	201.95	45,106.24	37,862.64	55,591.47	20.46	17.17	25.22

1. Low and high values are provided to account for the uncertainty in how much area outside the right-of-way has been disconnected from the combined sewer and plumbed to the drainage system in partially separated areas. Low corresponds to 25 percent for Lander West and 15 percent for Lander East, and high corresponds to 75 percent for Lander West and 65 percent for Lander East.
2. Metric Ton = 2,204.62 lbs
3. Horizontal North American Datum of 1983,1991 adjustment
4. Lander drainage basin includes east and west sub-basins that discharge to the Lander St outfall; the Port Lander sub-basin is addressed in the POS Basins table below.

Runoff and TSS from SPU Basins (High Runoff Assumption for Partially Separated Basins)[1]

		Outfall Coordinates[3]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate[3]	Y coordinate[3]	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-21	12.98	1,267,025.76	216,799.42	8.65	7.28	10.58	1,444.23	1,215.55	1,765.61	0.66	0.55	0.80
B-25	4.20	1,268,053.11	218,669.74	2.69	2.26	3.32	723.95	607.93	892.05	0.33	0.28	0.40
B-36	5.35	1,267,380.50	212,096.91	3.32	2.77	4.09	940.79	787.21	1,160.18	0.43	0.36	0.53
B-4	7.11	1,266,960.50	211,998.11	4.58	3.85	5.64	1,299.08	1,091.13	1,599.51	0.59	0.49	0.73
B-5	2.15	1,266,985.87	212,222.84	1.37	1.15	1.69	389.12	326.59	480.30	0.18	0.15	0.22
Lander[4] (SPU)	438.34	1,267,839.97	215,762.30	222.70	186.98	274.59	62,056.74	52,113.65	76,455.34	28.15	23.64	34.68
Hinds	39.50	1,267,870.96	212,912.61	24.99	20.99	30.57	7,090.27	5,956.38	8,674.67	3.22	2.70	3.93
total	509.62			268.30	225.28	330.47	73,944.19	62,098.45	91,027.66	33.54	28.17	41.29

1. Low and high values are provided to account for the uncertainty in how much area outside the right-of-way has been disconnected from the combined sewer and plumbed to the drainage system in partially separated areas. Low corresponds to 25 percent for Lander West and 15 percent for Lander East, and high corresponds to 75 percent for Lander West and 65 percent for Lander East.
2. Metric Ton = 2,204.62 lbs
3. Horizontal North American Datum of 1983,1991 adjustment
4. Lander drainage basin includes east and west sub-basins that discharge to the Lander St outfall; the Port Lander sub-basin is addressed in the POS Basins table below.

Runoff and TSS from SPU Bridges

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
BR-34	0.95			0.59	0.49	0.73	166.74	139.71	207.00	0.08	0.06	0.09
BR-4	1.23			0.77	0.65	0.96	219.84	184.36	272.16	0.10	0.08	0.12
BR-5	1.61			1.00	0.84	1.24	283.81	237.80	352.33	0.13	0.11	0.16
total	3.80			2.36	1.98	2.93	670.40	561.88	831.49	0.30	0.25	0.38

1. Horizontal North American Datum of 1983,1991 adjustment; basins with no X, Y coordinates do not drain to an outfall
2. Metric Ton = 2,204.62 lbs

Stormwater runoff and solids loading estimates for EWW storm drain basins (25th percentile estimate; TSS values updated 2/7/2011)

Runoff and TSS from POS Basins

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-1	1.58	1,266,887.46	211,399.22	1.05	0.89	1.29	175.96	148.10	215.11	0.08	0.07	0.10
B-10	7.23	1,266,968.30	214,087.50	4.82	4.06	5.89	804.65	677.24	983.71	0.36	0.31	0.45
B-11	48.14	1,266,995.91	214,238.77	32.08	27.00	39.22	5,355.44	4,507.46	6,547.18	2.43	2.04	2.97
B-12	6.53	1,266,956.70	214,443.80	4.35	3.66	5.32	726.47	611.44	888.12	0.33	0.28	0.40
B-13	6.22	1,267,027.00	214,961.90	4.15	3.49	5.07	692.01	582.44	846.00	0.31	0.26	0.38
B-14	1.52	1,267,051.30	215,033.60	1.01	0.85	1.24	168.70	141.99	206.25	0.08	0.06	0.09
B-16	4.41	1,266,993.70	215,373.60	2.94	2.48	3.60	490.97	413.23	600.22	0.22	0.19	0.27
B-17	2.14	1,267,002.40	215,678.30	1.43	1.20	1.74	238.08	200.38	291.06	0.11	0.09	0.13
B-18	7.41	1,266,983.00	215,983.87	4.94	4.16	6.04	824.18	693.68	1,007.58	0.37	0.31	0.46
B-19	5.04	1,267,000.61	216,655.64	3.36	2.83	4.11	560.58	471.82	685.33	0.25	0.21	0.31
B-22	11.99	1,266,996.20	217,188.40	7.99	6.72	9.77	1,333.63	1,122.47	1,630.40	0.60	0.51	0.74
B-23	10.95	1,267,011.30	217,914.40	7.30	6.14	8.92	1,217.71	1,024.90	1,488.68	0.55	0.46	0.68
B-24	8.86	1,267,046.27	218,573.28	5.90	4.97	7.22	985.46	829.42	1,204.75	0.45	0.38	0.55
B-26	13.41	1,268,013.00	217,447.20	8.94	7.52	10.92	1,491.49	1,255.33	1,823.39	0.68	0.57	0.83
B-27	7.35	1,268,014.70	216,941.70	4.90	4.12	5.99	817.26	687.86	999.13	0.37	0.31	0.45
B-28	3.59	1,268,001.70	216,332.40	2.40	2.02	2.93	399.88	336.56	488.86	0.18	0.15	0.22
B-29	8.75	1,268,024.30	215,844.00	5.83	4.91	7.13	972.93	818.88	1,189.44	0.44	0.37	0.54
B-30	6.69	1,268,481.10	214,909.20	4.46	3.75	5.45	744.15	626.32	909.74	0.34	0.28	0.41
B-31[3]	9.81	1,267,827.60	214,382.65	6.54	5.51	8.00	1,091.90	919.01	1,334.88	0.50	0.42	0.61
B-32	3.73	1,267,816.51	214,084.19	2.48	2.09	3.04	414.63	348.98	506.90	0.19	0.16	0.23
B-33	12.11	1,267,802.40	213,205.40	8.06	6.79	9.86	1,345.93	1,132.83	1,645.31	0.61	0.51	0.75
B-34	13.33	1,267,445.56	212,282.86	8.77	7.38	10.71	2,488.66	2,093.33	3,038.01	1.13	0.95	1.38
B-37	6.41	1,267,196.82	211,561.15	4.23	3.56	5.17	706.74	594.29	863.35	0.32	0.27	0.39
B-39	2.08	1,267,224.50	211,803.70	1.38	1.16	1.69	231.01	194.38	282.40	0.10	0.09	0.13
B-7	13.93	1,266,941.40	212,971.90	9.29	7.81	11.35	1,549.86	1,304.46	1,894.75	0.70	0.59	0.86
Lander (POS)[4]	3.62	1,267,839.97	215,762.30	2.41	2.03	2.95	402.29	338.59	491.81	0.18	0.15	0.22
total	226.80			151.01	127.09	184.59	26,230.58	22,075.38	32,062.35	11.90	10.01	14.54

1. Horizontal North American Datum of 1983,1991 adjustment
2. Metric Ton = 2,204.62 lbs
3. Basin B-31 includes basin BR-27
4. Lander (POS) sub-basin discharges to the Lander St outfall. Lander East and West (SPU) also discharge to this outfall, and are addressed in the SPU Basins table above

Runoff and TSS from POS Aprons

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
A-7	1.16			0.77	0.65	0.94	128.72	108.34	157.36	0.06	0.05	0.07
A-10	2.28			1.52	1.28	1.86	254.18	213.93	310.74	0.12	0.10	0.14
A-12	1.98			1.32	1.11	1.61	220.29	185.41	269.32	0.10	0.08	0.12
A-13	0.47			0.31	0.26	0.38	52.33	44.04	63.98	0.02	0.02	0.03
A-14	1.04			0.69	0.58	0.84	115.27	97.01	140.92	0.05	0.04	0.06
A-16	0.66			0.44	0.37	0.54	73.17	61.58	89.45	0.03	0.03	0.04
A-17	0.68			0.46	0.38	0.56	76.11	64.06	93.04	0.03	0.03	0.04
A-18	1.20			0.80	0.67	0.98	133.86	112.66	163.65	0.06	0.05	0.07
A-19	1.89			1.26	1.06	1.54	210.61	177.26	257.48	0.10	0.08	0.12
A-22	2.01			1.34	1.13	1.64	223.89	188.44	273.71	0.10	0.09	0.12
A-23	2.05			1.37	1.15	1.67	227.91	191.82	278.62	0.10	0.09	0.13
A-24	2.29			1.53	1.28	1.87	254.64	214.32	311.31	0.12	0.10	0.14
A-26	0.60			0.40	0.34	0.49	66.57	56.03	81.39	0.03	0.03	0.04
A-27	1.70			1.13	0.95	1.38	188.67	158.80	230.66	0.09	0.07	0.10
A-28	1.50			1.00	0.84	1.22	167.20	140.73	204.41	0.08	0.06	0.09
A-29	1.15			0.76	0.64	0.93	127.60	107.40	155.99	0.06	0.05	0.07
A-30	1.30			0.87	0.73	1.06	145.02	122.06	177.29	0.07	0.06	0.08
A-31	0.76			0.51	0.43	0.62	84.94	71.49	103.84	0.04	0.03	0.05
A-32	0.80			0.54	0.45	0.65	89.39	75.24	109.28	0.04	0.03	0.05
A-33	2.19			1.46	1.23	1.78	243.19	204.69	297.31	0.11	0.09	0.13
BR-39	1.25			0.83	0.83	1.02	236.69	199.21	289.39	0.11	0.09	0.13
BR-2	0.27	1,266,955.62	211,835.26	0.18	0.15	0.22	29.71	25.01	36.33	0.01	0.01	0.02
total	29.24			19.49	16.53	23.82	3,349.96	2,819.52	4,095.44	1.52	1.28	1.86

1. Horizontal North American Datum of 1983,1991 adjustment; basins with no X, Y coordinates do not drain to an outfall
2. Metric Ton = 2,204.62 lbs

Stormwater runoff and solids loading estimates for EWW storm drain basins (25th percentile estimate; TSS values updated 2/7/2011)

Runoff and TSS from Private Basins

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
A-6	3.16	1,267,133.00	212,871.00	2.10	1.77	2.57	597.30	502.72	730.22	0.27	0.23	0.33
B-40	3.26	1,268,082.43	218,293.18	2.04	1.71	2.53	528.33	442.97	654.46	0.24	0.20	0.30
B-41	5.46	1,268,032.50	218,704.86	3.64	3.06	4.45	869.02	869.02	1,262.46	0.39	0.39	0.57
B-42	0.46	1,268,376.87	218,781.63	0.31	0.26	0.38	87.30	73.48	106.73	0.04	0.03	0.05
B-43	5.74	1,268,824.23	218,875.21	3.83	3.22	4.68	1,085.50	913.62	1,327.05	0.49	0.41	0.60
total	18.08			11.92	10.02	14.60	3,167.45	2,801.81	4,080.92	1.44	1.27	1.85

1. Horizontal North American Datum of 1983,1991 adjustment
2. Metric Ton = 2,204.62 lbs

25th percentile estimate: TSS Concentrations in mg/L (All POS basins [except B-34], SPU basin: B-21)

Land Use	ROW	Industrial	MFR	Commercial	Open	SFR
Estimated Concentration (mg/L)	34	20	39	31	8	24

MFR= Mulitiple Family Residential, SFR= Single Family Residential

25th percentile estimate: TSS Concentrations in mg/L (All SPU basins [except B-21], POS basin B-34, all Private basins)

Land Use	ROW	Industrial	MFR	Commercial	Open	SFR
Estimated Concentration (mg/L)	34	34	39	31	8	24

Stormwater runoff and solids loading estimates for EWW storm drain basins (Base Case estimate; TSS values updated 2/7/2011)

Runoff and TSS from SPU Basins (Low Runoff Assumption for Partially Separated Basins)[1]

		Outfall Coordinates[3]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-21	12.98	1,267,025.76	216,799.42	8.65	7.28	10.58	3,105.09	2,613.43	3,796.06	1.41	1.19	1.72
B-25	4.20	1,268,053.11	218,669.74	2.69	2.26	3.32	1,449.33	1,217.23	1,785.00	0.66	0.55	0.81
B-36	5.35	1,267,380.50	212,096.91	3.32	2.77	4.09	1,992.07	1,666.98	2,456.30	0.90	0.76	1.11
B-4	7.11	1,266,960.50	211,998.11	4.58	3.85	5.64	2,774.44	2,330.43	3,415.52	1.26	1.06	1.55
B-5	2.15	1,266,985.87	212,222.84	1.37	1.15	1.69	825.47	692.86	1,018.75	0.37	0.31	0.46
Lander[4] (SPU)	438.34	1,267,839.97	215,762.30	118.25	99.23	146.06	69,548.30	58,369.41	85,863.49	31.55	26.48	38.95
Hinds	39.50	1,267,870.96	212,912.61	24.99	20.99	30.57	15,253.42	12,814.71	18,659.98	6.92	5.81	8.46
total	509.62			163.84	137.53	201.95	94,948.12	79,705.06	116,995.11	43.07	36.15	53.07

1. Low and high values are provided to account for the uncertainty in how much area outside the right-of-way has been disconnected from the combined sewer and plumbed to the drainage system in partially separated areas. Low corresponds to 25 percent for Lander West and 15 percent for Lander East, and high corresponds to 75 percent for Lander West and 65 percent for Lander East.
2. Metric Ton = 2,204.62 lbs
3. Horizontal North American Datum of 1983,1991 adjustment
4. Lander drainage basin includes east and west sub-basins that discharge to the Lander St outfall; the Port Lander sub-basin is addressed in the POS Basins table below.

Runoff and TSS from SPU Basins (High Runoff Assumption for Partially Separated Basins)[1]

		Outfall Coordinates[3]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate[3]	Y coordinate[3]	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-21	12.98	1,267,025.76	216,799.42	8.65	7.28	10.58	3,105.09	2,613.43	3,796.06	1.41	1.19	1.72
B-25	4.20	1,268,053.11	218,669.74	2.69	2.26	3.32	1,449.33	1,217.23	1,785.00	0.66	0.55	0.81
B-36	5.35	1,267,380.50	212,096.91	3.32	2.77	4.09	1,992.07	1,666.98	2,456.30	0.90	0.76	1.11
B-4	7.11	1,266,960.50	211,998.11	4.58	3.85	5.64	2,774.44	2,330.43	3,415.52	1.26	1.06	1.55
B-5	2.15	1,266,985.87	212,222.84	1.37	1.15	1.69	825.47	692.86	1,018.75	0.37	0.31	0.46
Lander[4] (SPU)	438.34	1,267,839.97	215,762.30	222.70	186.98	274.59	129,846.09	109,051.39	159,923.03	58.90	49.46	72.54
Hinds	39.50	1,267,870.96	212,912.61	24.99	20.99	30.57	15,253.42	12,814.71	18,659.98	6.92	5.81	8.46
total	509.62			268.30	225.28	330.47	155,245.91	130,387.03	191,054.65	70.42	59.14	86.66

1. Low and high values are provided to account for the uncertainty in how much area outside the right-of-way has been disconnected from the combined sewer and plumbed to the drainage system in partially separated areas. Low corresponds to 25 percent for Lander West and 15 percent for Lander East, and high corresponds to 75 percent for Lander West and 65 percent for Lander East.
2. Metric Ton = 2,204.62 lbs
3. Horizontal North American Datum of 1983,1991 adjustment
4. Lander drainage basin includes east and west sub-basins that discharge to the Lander St outfall; the Port Lander sub-basin is addressed in the POS Basins table below.

Runoff and TSS from SPU Bridges

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
BR-34	0.95			0.59	0.49	0.73	348.20	291.75	432.26	0.16	0.13	0.20
BR-4	1.23			0.77	0.65	0.96	462.62	387.96	572.66	0.21	0.18	0.26
BR-5	1.61			1.00	0.84	1.24	592.66	496.59	735.74	0.27	0.23	0.33
total	3.80			2.36	1.98	2.93	1,403.48	1,176.31	1,740.66	0.64	0.53	0.79

1. Horizontal North American Datum of 1983,1991 adjustment; basins with no X, Y coordinates do not drain to an outfall
2. Metric Ton = 2,204.62 lbs

Stormwater runoff and solids loading estimates for EWW storm drain basins (Base Case estimate; TSS values updated 2/7/2011)

Runoff and TSS from POS Basins

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-1	1.58	1,266,887.46	211,399.22	1.05	0.89	1.29	378.31	318.41	462.50	0.17	0.14	0.21
B-10	7.23	1,266,968.30	214,087.50	4.82	4.06	5.89	1,730.00	1,456.08	2,114.98	0.78	0.66	0.96
B-11	48.14	1,266,995.91	214,238.77	32.08	27.00	39.22	11,514.20	9,691.04	14,076.43	5.22	4.40	6.38
B-12	6.53	1,266,956.70	214,443.80	4.35	3.66	5.32	1,561.90	1,314.59	1,909.47	0.71	0.60	0.87
B-13	6.22	1,267,027.00	214,961.90	4.15	3.49	5.07	1,487.82	1,252.24	1,818.90	0.67	0.57	0.83
B-14	1.52	1,267,051.30	215,033.60	1.01	0.85	1.24	362.71	305.28	443.43	0.16	0.14	0.20
B-16	4.41	1,266,993.70	215,373.60	2.94	2.48	3.60	1,055.58	888.44	1,290.47	0.48	0.40	0.59
B-17	2.14	1,267,002.40	215,678.30	1.43	1.20	1.74	511.87	430.82	625.77	0.23	0.20	0.28
B-18	7.41	1,266,983.00	215,983.87	4.94	4.16	6.04	1,771.99	1,491.41	2,166.30	0.80	0.68	0.98
B-19	5.04	1,267,000.61	216,655.64	3.36	2.83	4.11	1,205.26	1,014.42	1,473.46	0.55	0.46	0.67
B-22	11.99	1,266,996.20	217,188.40	7.99	6.72	9.77	2,867.31	2,413.30	3,505.37	1.30	1.09	1.59
B-23	10.95	1,267,011.30	217,914.40	7.30	6.14	8.92	2,618.07	2,203.53	3,200.67	1.19	1.00	1.45
B-24	8.86	1,267,046.27	218,573.28	5.90	4.97	7.22	2,118.74	1,783.26	2,590.22	0.96	0.81	1.17
B-26	13.41	1,268,013.00	217,447.20	8.94	7.52	10.92	3,206.70	2,698.95	3,920.28	1.45	1.22	1.78
B-27	7.35	1,268,014.70	216,941.70	4.90	4.12	5.99	1,757.11	1,478.89	2,148.12	0.80	0.67	0.97
B-28	3.59	1,268,001.70	216,332.40	2.40	2.02	2.93	859.74	723.61	1,051.06	0.39	0.33	0.48
B-29	8.75	1,268,024.30	215,844.00	5.83	4.91	7.13	2,091.80	1,760.59	2,557.29	0.95	0.80	1.16
B-30	6.69	1,268,481.10	214,909.20	4.46	3.75	5.45	1,599.92	1,346.59	1,955.95	0.73	0.61	0.89
B-31[3]	9.81	1,267,827.60	214,382.65	6.54	5.51	8.00	2,347.59	1,975.87	2,869.99	1.06	0.90	1.30
B-32	3.73	1,267,816.51	214,084.19	2.48	2.09	3.04	891.45	750.30	1,089.83	0.40	0.34	0.49
B-33	12.11	1,267,802.40	213,205.40	8.06	6.79	9.86	2,893.76	2,435.58	3,537.41	1.31	1.10	1.60
B-34	13.33	1,267,445.56	212,282.86	8.77	7.38	10.71	5,416.50	4,556.07	6,612.13	2.46	2.07	3.00
B-37	6.41	1,267,196.82	211,561.15	4.23	3.56	5.17	1,519.48	1,277.72	1,856.20	0.69	0.58	0.84
B-39	2.08	1,267,224.50	211,803.70	1.38	1.16	1.69	496.68	417.92	607.15	0.23	0.19	0.28
B-7	13.93	1,266,941.40	212,971.90	9.29	7.81	11.35	3,332.20	2,804.58	4,073.71	1.51	1.27	1.85
Lander (POS)[4]	3.62	1,267,839.97	215,762.30	2.41	2.03	2.95	864.93	727.98	1,057.40	0.39	0.33	0.48
total	226.80			151.01	127.09	184.59	56,461.63	47,517.48	69,014.48	25.61	21.55	31.30

1. Horizontal North American Datum of 1983,1991 adjustment
2. Metric Ton = 2,204.62 lbs
3. Basin B-31 includes basin BR-27
4. Lander (POS) sub-basin discharges to the Lander St outfall. Lander East and West (SPU) also discharge to this outfall, and are addressed in the SPU Basins table above

Runoff and TSS from POS Aprons

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
A-7	1.16			0.77	0.65	0.94	276.74	232.92	338.32	0.13	0.11	0.15
A-10	2.28			1.52	1.28	1.86	546.48	459.95	668.09	0.25	0.21	0.30
A-12	1.98			1.32	1.11	1.61	473.63	398.64	579.03	0.21	0.18	0.26
A-13	0.47			0.31	0.26	0.38	112.51	94.70	137.55	0.05	0.04	0.06
A-14	1.04			0.69	0.58	0.84	247.82	208.58	302.97	0.11	0.09	0.14
A-16	0.66			0.44	0.37	0.54	157.31	132.40	192.31	0.07	0.06	0.09
A-17	0.68			0.46	0.38	0.56	163.63	137.72	200.04	0.07	0.06	0.09
A-18	1.20			0.80	0.67	0.98	287.80	242.23	351.84	0.13	0.11	0.16
A-19	1.89			1.26	1.06	1.54	452.81	381.11	553.58	0.21	0.17	0.25
A-22	2.01			1.34	1.13	1.64	481.36	405.14	588.47	0.22	0.18	0.27
A-23	2.05			1.37	1.15	1.67	490.00	412.41	599.03	0.22	0.19	0.27
A-24	2.29			1.53	1.28	1.87	547.48	460.80	669.31	0.25	0.21	0.30
A-26	0.60			0.40	0.34	0.49	143.13	120.47	174.98	0.06	0.05	0.08
A-27	1.70			1.13	0.95	1.38	405.65	341.42	495.92	0.18	0.15	0.22
A-28	1.50			1.00	0.84	1.22	359.49	302.57	439.48	0.16	0.14	0.20
A-29	1.15			0.76	0.64	0.93	274.34	230.90	335.39	0.12	0.10	0.15
A-30	1.30			0.87	0.73	1.06	311.79	262.42	381.17	0.14	0.12	0.17
A-31	0.76			0.51	0.43	0.62	182.61	153.70	223.25	0.08	0.07	0.10
A-32	0.80			0.54	0.45	0.65	192.19	161.76	234.96	0.09	0.07	0.11
A-33	2.19			1.46	1.23	1.78	522.86	440.07	639.22	0.24	0.20	0.29
BR-39	1.25			0.83	0.83	1.02	515.04	433.48	629.71	0.23	0.20	0.29
BR-2	0.27	1,266,955.62	211,835.26	0.18	0.15	0.22	63.88	53.77	78.10	0.03	0.02	0.04
total	29.24			19.49	16.53	23.82	7,208.56	6,067.14	8,812.71	3.27	2.75	4.00

1. Horizontal North American Datum of 1983,1991 adjustment; basins with no X, Y coordinates do not drain to an outfall
2. Metric Ton = 2,204.62 lbs

Stormwater runoff and solids loading estimates for EWW storm drain basins (Base Case estimate; TSS values updated 2/7/2011)

Runoff and TSS from Private Basins

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
A-6	3.16	1,267,133.00	212,871.00	2.10	1.77	2.57	1,300.01	1,094.17	1,589.30	0.59	0.50	0.72
B-40	3.26	1,268,082.43	218,293.18	2.04	1.71	2.53	989.75	829.85	1,226.01	0.45	0.38	0.56
B-41	5.46	1,268,032.50	218,704.86	3.64	3.06	4.45	1,890.30	1,890.30	2,746.09	0.86	0.86	1.25
B-42	0.46	1,268,376.87	218,781.63	0.31	0.26	0.38	190.01	159.93	232.30	0.09	0.07	0.11
B-43	5.74	1,268,824.23	218,875.21	3.83	3.22	4.68	2,362.56	1,988.47	2,888.29	1.07	0.90	1.31
total	18.08			11.92	10.02	14.60	6,732.63	5,962.71	8,681.99	3.05	2.70	3.94

1. Horizontal North American Datum of 1983,1991 adjustment
2. Metric Ton = 2,204.62 lbs

Base Case estimate: TSS Concentrations in mg/L (All POS basins [except B-34], SPU basin: B-21)

Land Use	ROW	Industrial	MFR	Commercial	Open	SFR
Estimated Concentration (mg/L)	71	43	68	58	13	48

MFR= Mulitiple Family Residential, SFR= Single Family Residential

Base Case estimate: TSS Concentrations in mg/L (All SPU basins [except B-21], POS basin B-34, all Private basins)

Land Use	ROW	Industrial	MFR	Commercial	Open	SFR
Estimated Concentration (mg/L)	71	74	68	58	13	48

Stormwater runoff and solids loading estimates for EWW storm drain basins (75th percentile estimate; TSS values updated 3/10/2011)

Runoff and TSS from SPU Basins (Low Runoff Assumption for Partially Separated Basins)[1]

		Outfall Coordinates[3]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-21	12.98	1,267,025.76	216,799.42	8.65	7.28	10.58	4,332.69	3,646.65	5,296.83	1.97	1.65	2.40
B-25	4.20	1,268,053.11	218,669.74	2.69	2.26	3.32	2,176.91	1,828.47	2,680.23	0.99	0.83	1.22
B-36	5.35	1,267,380.50	212,096.91	3.32	2.77	4.09	2,663.49	2,229.89	3,281.45	1.21	1.01	1.49
B-4	7.11	1,266,960.50	211,998.11	4.58	3.85	5.64	3,922.91	3,296.06	4,824.57	1.78	1.50	2.19
B-5	2.15	1,266,985.87	212,222.84	1.37	1.15	1.69	1,117.56	938.30	1,377.85	0.51	0.43	0.62
Lander[4] (SPU)	438.34	1,267,839.97	215,762.30	118.25	99.23	146.06	94,210.02	79,084.60	116,222.52	42.73	35.87	52.72
Hinds	39.50	1,267,870.96	212,912.61	24.99	20.99	30.57	22,556.03	18,955.43	27,575.91	10.23	8.60	12.51
total	509.62			163.84	137.53	201.95	130,979.61	109,979.39	161,259.36	59.41	49.89	73.15

1. Low and high values are provided to account for the uncertainty in how much area outside the right-of-way has been disconnected from the combined sewer and plumbed to the drainage system in partially separated areas. Low corresponds to 25 percent for Lander West and 15 percent for Lander East, and high corresponds to 75 percent for Lander West and 65 percent for Lander East.
2. Metric Ton = 2,204.62 lbs
3. Horizontal North American Datum of 1983,1991 adjustment
4. Lander drainage basin includes east and west sub-basins that discharge to the Lander St outfall; the Port Lander sub-basin is addressed in the POS Basins table below.

Runoff and TSS from SPU Basins (High Runoff Assumption for Partially Separated Basins)[1]

		Outfall Coordinates[3]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate[3]	Y coordinate[3]	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-21	12.98	1,267,025.76	216,799.42	8.65	7.28	10.58	4,332.69	3,646.65	5,296.83	1.97	1.65	2.40
B-25	4.20	1,268,053.11	218,669.74	2.69	2.26	3.32	2,176.91	1,828.47	2,680.23	0.99	0.83	1.22
B-36	5.35	1,267,380.50	212,096.91	3.32	2.77	4.09	2,663.49	2,229.89	3,281.45	1.21	1.01	1.49
B-4	7.11	1,266,960.50	211,998.11	4.58	3.85	5.64	3,922.91	3,296.06	4,824.57	1.78	1.50	2.19
B-5	2.15	1,266,985.87	212,222.84	1.37	1.15	1.69	1,117.56	938.30	1,377.85	0.51	0.43	0.62
Lander[4] (SPU)	438.34	1,267,839.97	215,762.30	222.70	186.98	274.59	187,734.56	157,701.21	231,058.76	85.16	71.53	104.81
Hinds	39.50	1,267,870.96	212,912.61	24.99	20.99	30.57	22,556.03	18,955.43	27,575.91	10.23	8.60	12.51
total	509.62			268.30	225.28	330.47	224,504.15	188,596.00	276,095.60	101.83	85.55	125.24

1. Low and high values are provided to account for the uncertainty in how much area outside the right-of-way has been disconnected from the combined sewer and plumbed to the drainage system in partially separated areas. Low corresponds to 25 percent for Lander West and 15 percent for Lander East, and high corresponds to 75 percent for Lander West and 65 percent for Lander East.
2. Metric Ton = 2,204.62 lbs
3. Horizontal North American Datum of 1983,1991 adjustment
4. Lander drainage basin includes east and west sub-basins that discharge to the Lander St outfall; the Port Lander sub-basin is addressed in the POS Basins table below.

Runoff and TSS from SPU Bridges

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
BR-34	0.95			0.59	0.49	0.73	421.76	353.39	523.58	0.19	0.16	0.24
BR-4	1.23			0.77	0.65	0.96	592.62	497.08	733.09	0.27	0.23	0.33
BR-5	1.61			1.00	0.84	1.24	717.87	601.51	891.19	0.33	0.27	0.40
total	3.80			2.36	1.98	2.93	1,732.26	1,451.98	2,147.86	0.79	0.66	0.97

1. Horizontal North American Datum of 1983,1991 adjustment; basins with no X, Y coordinates do not drain to an outfall
2. Metric Ton = 2,204.62 lbs

Stormwater runoff and solids loading estimates for EWW storm drain basins (75th percentile estimate; TSS values updated 3/10/2011)

Runoff and TSS from POS Basins

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
B-1	1.58	1,266,887.46	211,399.22	1.05	0.89	1.29	527.88	444.29	645.34	0.24	0.20	0.29
B-10	7.23	1,266,968.30	214,087.50	4.82	4.06	5.89	2,413.96	2,031.73	2,951.13	1.09	0.92	1.34
B-11	48.14	1,266,995.91	214,238.77	32.08	27.00	39.22	16,066.33	13,522.39	19,641.53	7.29	6.13	8.91
B-12	6.53	1,266,956.70	214,443.80	4.35	3.66	5.32	2,179.40	1,834.31	2,664.37	0.99	0.83	1.21
B-13	6.22	1,267,027.00	214,961.90	4.15	3.49	5.07	2,076.02	1,747.31	2,538.00	0.94	0.79	1.15
B-14	1.52	1,267,051.30	215,033.60	1.01	0.85	1.24	506.11	425.98	618.74	0.23	0.19	0.28
B-16	4.41	1,266,993.70	215,373.60	2.94	2.48	3.60	1,472.90	1,239.68	1,800.66	0.67	0.56	0.82
B-17	2.14	1,267,002.40	215,678.30	1.43	1.20	1.74	714.24	601.14	873.17	0.32	0.27	0.40
B-18	7.41	1,266,983.00	215,983.87	4.94	4.16	6.04	2,472.54	2,081.04	3,022.75	1.12	0.94	1.37
B-19	5.04	1,267,000.61	216,655.64	3.36	2.83	4.11	1,681.75	1,415.47	2,055.99	0.76	0.64	0.93
B-22	11.99	1,266,996.20	217,188.40	7.99	6.72	9.77	4,000.90	3,367.40	4,891.21	1.81	1.53	2.22
B-23	10.95	1,267,011.30	217,914.40	7.30	6.14	8.92	3,653.13	3,074.69	4,466.05	1.66	1.39	2.03
B-24	8.86	1,267,046.27	218,573.28	5.90	4.97	7.22	2,956.38	2,488.27	3,614.26	1.34	1.13	1.64
B-26	13.41	1,268,013.00	217,447.20	8.94	7.52	10.92	4,474.46	3,765.98	5,470.16	2.03	1.71	2.48
B-27	7.35	1,268,014.70	216,941.70	4.90	4.12	5.99	2,451.79	2,063.57	2,997.38	1.11	0.94	1.36
B-28	3.59	1,268,001.70	216,332.40	2.40	2.02	2.93	1,199.64	1,009.69	1,466.59	0.54	0.46	0.67
B-29	8.75	1,268,024.30	215,844.00	5.83	4.91	7.13	2,918.80	2,456.63	3,568.31	1.32	1.11	1.62
B-30	6.69	1,268,481.10	214,909.20	4.46	3.75	5.45	2,232.45	1,878.96	2,729.23	1.01	0.85	1.24
B-31[3]	9.81	1,267,827.60	214,382.65	6.54	5.51	8.00	3,275.70	2,757.03	4,004.64	1.49	1.25	1.82
B-32	3.73	1,267,816.51	214,084.19	2.48	2.09	3.04	1,243.89	1,046.93	1,520.69	0.56	0.47	0.69
B-33	12.11	1,267,802.40	213,205.40	8.06	6.79	9.86	4,037.80	3,398.49	4,935.93	1.83	1.54	2.24
B-34	13.33	1,267,445.56	212,282.86	8.77	7.38	10.71	8,563.92	7,203.52	10,454.32	3.88	3.27	4.74
B-37	6.41	1,267,196.82	211,561.15	4.23	3.56	5.17	2,120.21	1,782.87	2,590.05	0.96	0.81	1.17
B-39	2.08	1,267,224.50	211,803.70	1.38	1.16	1.69	693.04	583.15	847.19	0.31	0.26	0.38
B-7	13.93	1,266,941.40	212,971.90	9.29	7.81	11.35	4,649.58	3,913.37	5,684.25	2.11	1.78	2.58
Lander (POS)[4]	3.62	1,267,839.97	215,762.30	2.41	2.03	2.95	1,206.88	1,015.78	1,475.44	0.55	0.46	0.67
total	226.80			151.01	127.09	184.59	79,789.69	67,149.67	97,527.36	36.19	30.46	44.24

1. Horizontal North American Datum of 1983,1991 adjustment
2. Metric Ton = 2,204.62 lbs
3. Basin B-31 includes basin BR-27
4. Lander (POS) sub-basin discharges to the Lander St outfall. Lander East and West (SPU) also discharge to this outfall, and are addressed in the SPU Basins table above

Runoff and TSS from POS Aprons

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
A-7	1.16			0.77	0.65	0.94	386.15	325.01	472.08	0.18	0.15	0.21
A-10	2.28			1.52	1.28	1.86	762.53	641.79	932.22	0.35	0.29	0.42
A-12	1.98			1.32	1.11	1.61	660.88	556.24	807.95	0.30	0.25	0.37
A-13	0.47			0.31	0.26	0.38	156.99	132.13	191.93	0.07	0.06	0.09
A-14	1.04			0.69	0.58	0.84	345.80	291.04	422.75	0.16	0.13	0.19
A-16	0.66			0.44	0.37	0.54	219.50	184.74	268.34	0.10	0.08	0.12
A-17	0.68			0.46	0.38	0.56	228.32	192.17	279.12	0.10	0.09	0.13
A-18	1.20			0.80	0.67	0.98	401.58	337.99	490.94	0.18	0.15	0.22
A-19	1.89			1.26	1.06	1.54	631.83	531.79	772.43	0.29	0.24	0.35
A-22	2.01			1.34	1.13	1.64	671.66	565.31	821.12	0.30	0.26	0.37
A-23	2.05			1.37	1.15	1.67	683.72	575.46	835.86	0.31	0.26	0.38
A-24	2.29			1.53	1.28	1.87	763.93	642.97	933.93	0.35	0.29	0.42
A-26	0.60			0.40	0.34	0.49	199.72	168.09	244.16	0.09	0.08	0.11
A-27	1.70			1.13	0.95	1.38	566.02	476.40	691.98	0.26	0.22	0.31
A-28	1.50			1.00	0.84	1.22	501.61	422.19	613.23	0.23	0.19	0.28
A-29	1.15			0.76	0.64	0.93	382.80	322.19	467.98	0.17	0.15	0.21
A-30	1.30			0.87	0.73	1.06	435.05	366.17	531.86	0.20	0.17	0.24
A-31	0.76			0.51	0.43	0.62	254.81	214.46	311.51	0.12	0.10	0.14
A-32	0.80			0.54	0.45	0.65	268.17	225.71	327.85	0.12	0.10	0.15
A-33	2.19			1.46	1.23	1.78	729.58	614.06	891.93	0.33	0.28	0.40
BR-39	1.25			0.83	0.83	1.02	813.30	684.51	994.35	0.37	0.31	0.45
BR-2	0.27	1,266,955.62	211,835.26	0.18	0.15	0.22	89.14	75.03	108.98	0.04	0.03	0.05
total	29.24			19.49	16.53	23.82	10,153.09	8,545.44	12,412.50	4.61	3.88	5.63

1. Horizontal North American Datum of 1983,1991 adjustment; basins with no X, Y coordinates do not drain to an outfall
2. Metric Ton = 2,204.62 lbs

Stormwater runoff and solids loading estimates for EWW storm drain basins (75th percentile estimate; TSS values updated 3/10/2011)

Runoff and TSS from Private Basins

		Outfall Coordinates[1]		Annual Runoff in Million gallons			Annual Average TSS in lbs			Annual Average TSS in metric tons[2]		
Basin	Area (Acres)	X coordinate	Y coordinate	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)	1986 (Average Water Year)	1993 (Dry Water Year)	2002 (Wet Water Year)
A-6	3.16	1,267,133.00	212,871.00	2.10	1.77	2.57	2,055.42	1,729.96	2,512.81	0.93	0.78	1.14
B-40	3.26	1,268,082.43	218,293.18	2.04	1.71	2.53	1,434.63	1,202.86	1,777.07	0.65	0.55	0.81
B-41	5.46	1,268,032.50	218,704.86	3.64	3.06	4.45	2,984.44	2,984.44	4,335.46	1.35	1.35	1.97
B-42	0.46	1,268,376.87	218,781.63	0.31	0.26	0.38	300.43	252.86	367.28	0.14	0.11	0.17
B-43	5.74	1,268,824.23	218,875.21	3.83	3.22	4.68	3,735.40	3,143.94	4,566.63	1.69	1.43	2.07
total	18.08			11.92	10.02	14.60	10,510.31	9,314.05	13,559.24	4.77	4.22	6.15

1. Horizontal North American Datum of 1983,1991 adjustment
2. Metric Ton = 2,204.62 lbs

75th percentile estimate: TSS Concentrations in mg/L (All POS basins [except B-34], SPU basin: B-21)

Land Use	ROW	Industrial	MFR	Commercial	Open	SFR
Estimated Concentration (mg/L)	86	60	101	84	18	70

MFR= Mulitiple Family Residential, SFR= Single Family Residential

75th percentile estimate: TSS Concentrations in mg/L (All SPU basins [except B-21], POS basin B-34, all Private basins)

Land Use	ROW	Industrial	MFR	Commercial	Open	SFR
Estimated Concentration (mg/L)	86	117	101	84	18	70