COMPLAINANT'S EXHIBIT 30

HYDROLOGIC ANALYSIS OF SPECIAL INTEREST AUTO WORKS INC.

Prepared for

US EPA Region 10

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LIST OF ACRONYMS AND ABBREVIATIONS

ac	acre
BMPs	Best Management Practices
cfs	cubic feet per second
Ecology	Washington State Department of Ecology
ft	feet
GIS	Geographic Information Systems
HSPF	Hydrologic Simulation Program – FORTRAN
IMPLND	impervious land segment
in	inch
LiDAR	light detecting and ranging
NCGC	National Cartography and Geospatial Center
NCDC	National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service (formerly SCS)
PERLND	pervious land segment
PET	potential evapotranspiration
SCS	Soil Conservation Service
Site	Special Interest Auto Works Inc.
SSURGO	Soil Survey Geographic Database
UCI	User's Control Input
USDA	United States Department of Agriculture
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
US gal	United States gallons
USGS	United States Geological Survey
UTC	Coordinated Universal Time
WBAN ID	Weather Bureau/Army/Navy identifier
WSDOT	Washington State Department of Transportation
WWHM	Western Washington Hydrology Model version 3

EXECUTIVE SUMMARY

The purpose of this report is to provide reasonable predictions of the frequency and volume of stormwater runoff discharging from the property occupied by Special Interest Auto Works Inc. A calibrated hydrologic model (WWHM), in conjunction with local weather data, was used to demonstrate when discharges occurred and the approximate volume of each discharge since Special Interest Auto Works Inc. (Special Interest) began operation[1]. The model used in this analysis is a peer-reviewed hydrologic model of Western Washington that employs the HSPF model framework, one of the most commonly used hydrologic models in the world. The weather data used as input to the model were provided by a professionally maintained weather station. The analysis included a series of conservative assumptions that under-estimated the amount of discharges from Special Interest Auto Works Inc. property (Special Interest site or Site).

Results from this analysis indicate that significant volumes of stormwater runoff repeatedly discharged from the Site. Between August 1, 2008 and July 15, 2012, there were 989 days in which stormwater runoff discharged from the Site. The model calculated between 1.6 million and 1.9 million US gallons of stormwater runoff discharged from the Site during that time. Based on my review of the Site topography, the general conditions at the Site, and my expertise in hydrology, all of the stormwater that discharges from the Site discharges to the Green River.

[1] For purposes of this modeling effort, I assumed a start date of August 1, 2008 because Respondent received its business license on some date in July of 2008. Though I could have run the model through the date on which Respondent obtained a permit (October 9, 2012), I chose July of 2012 as an end date to produce a conservative prediction of days of discharge to the benefit of the Respondent. Furthermore, the summer of 2012 was a particularly dry period in Western Washington and therefore discharges were unlikely to have occurred.

SUMMARY

- Based on historic satellite imagery, Special Interest site conditions that influence model assumptions remained relatively unchanged during the period beginning August 1, 2008 and ending July 15, 2012. Thus, Site condition factors used in the model are consistent throughout the entire modeled time period. These factors include, but are not limited to: disturbed area (i.e., vegetative cover), soil type, and topography. Measured rainfall data used as model input were highly variable during this period and accurately represent the local climatic conditions of the Site.
- Based on topographic contours, I divided the Special Interest site into three distinct drainage basins: A, B, and C. All three basins drain to the Green River.
- The findings of this report estimate that for the time period of August 1, 2008 to July 15, 2012, there were 989 days in which stormwater runoff discharged from Basins A and C of the Special Interest site. Considering model accuracy and confidence intervals for its predictions, there is strong evidence that there were at least 692 days of discharge, and as many as 1,286 days of discharge from the Site. However, the model's actual prediction was that there were 989 days in which stormwater runoff discharged from Basins A and C.
- Of the 989 days on which a discharge was simulated from Basins A and C, the average daily discharge volume was 1,825 United States gallons (US gal). The minimum and maximum daily discharge volumes were 0.06 and 72,053 US gal, respectively. Over 60% of the predicted discharges were greater than 105 US gal.
- Based on the present analysis, between 1.6 million and 1.9 million US gal of stormwater runoff discharged from the Site to the Green River during the period beginning on August 1, 2008 and ending July 15, 2012.
- United States Environmental Protection Agency (USEPA) inspectors visited the Site on February 24, 2012 and March 29, 2012. The discharges simulated for those dates were 828 and 8,370 US gal, respectively. Model results for these dates are consistent with USEPA inspector observations made at the Site on these dates.

1 INTRODUCTION

This report presents the results of calculations that quantify discharges from the Site during the four year period beginning August 1, 2008 and ending in July 15, 2012. This report used weather data and hydrologic modeling to demonstrate that local rainfall generated significant quantities of runoff from the property to the Green River.

2 PURPOSE

The purpose of this report is to determine how many days stormwater discharged from the Special Interest property into the Green River. This report calculates the runoff volumes and peak flow discharges from August 1, 2008 through July 15, 2012 (the "period of interest").

3 DESCRIPTION OF SITE CONDITIONS

Special Interest is an auto wrecking and parts facility owned and operated by Mr. Troy Peterson and is located at 25923 78th Ave S., Kent, WA (47°22'8.28"N, 122°14'9.18"W, Figure 1). The Site includes approximately 3.9 acres of urban soil located on property surrounded on three sides by the Green River; the Site shares its northern and western boundary with the banks of the Green River (King County 2014a). There are three buildings on the Site: a single mobile home unit at the entrance to the property along 78th Avenue South, an open-walled warehouse located in the center of the property, and a partially covered garage located at the west end of the Site. As of the writing of this document, there were no known stormwater conveyance systems or structural Best Management Practices (BMPs) at the Site to prevent contaminated stormwater runoff from discharging off site, to other adjacent properties, or directly to the Green River.

The Site forms a land platform elevated relative to the adjacent river with steep terrain that drops to the river on the northern border. Topographic lines indicate that the Site property immediately adjacent to the riverbank slopes to the north while the majority of the Site property slopes to the southwest (Figure 2). A wall dividing Special Interest from the neighboring property hinders water flow in this direction. As a result, water pools along the southwest edge of the Site. This pooled water eventually flows west downhill to the banks of

the Green River or seeps under the wall and migrates towards the river along the natural channel that existed before the land was filled and regraded for industrial activity.

Natural Resources Conservation Service (NRCS) soil survey units adjacent to the Site include Newberg silt loam (Ng), Oridia silt loam (Os), Pilchuck fine sandy loam (Pk), Puyallup fine sandy loam (Py), Renton silt loam (Re), and Woodinville silt loam (Wo). Special Interest property sits entirely on Urban land (Ur).

4 SITE INSPECTIONS

USEPA inspected the Site on two occasions. I compared the visual observations of the actual events that took place at the Site on the inspection dates to the simulated model output. These observations were consistent with the model output. This consistency is one of multiple factors that I used to evaluate the ability of the model to accurately estimate daily stormwater runoff events.

On February 24, 2012, oily water was observed pooling and flowing to the southwest corner of the Site. In the northwest corner of the Site, surface rills and mud depositions through the vegetation were observed leading under the fence in the direction of the bank of the Green River. Standing water was observed within the rills. The northeast portion of the Site had pooling water and mud deposition suggesting the area had at some point discharged water off the property in the direction of the Green River.

On March 29, 2012 EPA inspectors observed oily water pooling at the Site and flowing under fencing on the northeast side of the Site onto the bank of the Green River via a small rill. EPA inspectors conducted a dye test from the northeast corner of the Site in an attempt to track the discharge to the Green River. Dye was seen leaving the Site and flowing onto the steep bank of the river. It was not possible to continue to visually track the dye all the way through the thick blackberry vines to the water. Other stormwater flows were observed on the western side of the Site flowing in the direction of the Green River.

5 PROFESSIONAL BACKGROUND AND EXPERIENCE

This report was prepared by Daniel Marshalonis of the USEPA. This report and the expert opinions expressed in this report are based on Dr. Marshalonis' review and analyses of existing information found in the references cited in this report. His qualifications are summarized in this section.

5.1 Qualifications Summary

Daniel Marshalonis is the Technical Advisor for The Office of Water and Watersheds of Region 10 of the USEPA. He has more than 10 years of experience in ecological sampling design, risk assessment, source control evaluation, and contaminant transport in aquatic environments—particularly lakes, rivers, and estuaries. He is a recognized regional expert in areas including source control characterization, stormwater management using natural drainage systems, and hydrologic modeling. Dr. Marshalonis has written and developed, reviewed, and interpreted environmental models and their results for over 10 years. He has received both formal graduate training and formal job training in environmental modeling theory and application.

Dr. Marshalonis has a Doctor of Philosophy degree in Biology from the University of South Carolina, a Master of Science degree in Biology from the George Washington University, and a Bachelor of Arts degree in Biology from the University of Virginia.

5.2 Prior Case Experience: 2009 to present

Dr. Marshalonis serves as USEPA Region 10's water enforcement modeling expert, providing technical advice in aquatic modeling related to stormwater runoff enforcement. From 2009 to present, Dr. Marshalonis gave deposition and contributed to expert witness testimony reports for the following stormwater-related compliance and enforcement cases:

- Slip 4 Sediment Cleanup Allocation, Seattle, Washington
- Ash Grove Cement Company Stormwater Discharge Analysis, Seattle, Washington
- Loomis Property Stormwater Discharge Analysis, Haines, Alaska
- Rainier Park of Industry Division 4 Stormwater Loading Analysis, Sumner,

Washington

- W/T Land & Cattle Inc. Stormwater Discharge Analysis, Notus, Idaho
- Waste Management Stormwater Discharge Analysis, Seattle, Washington

6 MODELING APPROACH

This section describes the modeling approach that I used to estimate stormwater runoff from the Special Interest Site. I utilized the Hydrological Simulation Program – FORTRAN (HSPF) and Western Washington Hydrology Model version 3 (WWHM) Windows interface for HSPF in this study to compute stormwater runoff from the Site.

6.1 Model Overview

6.1.1 Description of HSPF Model

HSPF is a continuous simulation watershed model (continuous simulation models provide a time history of environmental conditions for the duration of a user-defined period). HSPF uses rainfall and evaporation time series data, as well as parameters related to land use patterns and soil characteristics, to simulate the hydrologic and water quality processes that occur in natural and man-made water systems. The result of an HSPF simulation includes a time history of the quantity of water transported over the land surface to surface waters and through various soil zones down to the groundwater aquifer(s).

HSPF represents a drainage basin with land segments and reaches. A land segment in HSPF is a parcel of land, either pervious or impervious, having distinctive and relatively uniform meteorological, physical (soil, cover, and slope), and hydrologic characteristics. Reaches represent the various components of the surface-water drainage network (e.g., streams, pipes, or, man-made channels). Land segments and reaches are connected with a network routine in HSPF to represent the spatial layout of a drainage basin as a whole.

HSPF uses a mass balance approach, or water budget, to account for all inflows to land segments and reaches as either outflow or change in storage. Inflows are (1) observed precipitation or (2) overland flow, interflow (defined as the shallow subsurface component of stormwater [Ecology 2012]), groundwater flow, or streamflow from other land segments or

reaches. Outflows are (1) evapotranspiration (defined as the sum of moisture lost to atmosphere via evaporation and plant transpiration), (2) overland flow, interflow, groundwater flow, or streamflow directed to other land segments or reaches, or (3) recharge to regional groundwater systems (inactive ground water). Changes in storage can be in any of the numerous defined storage components of the water budget, such as soil moisture, ground water, or a lake. HSPF requires records of precipitation and estimates of potential evapotranspiration (PET) to drive water budget computations.

6.1.2 Support for HSPF

Among professional hydrologists, HSPF is commonly considered one of the most complete and defensible hydrologic models for quantifying runoff and addressing water quality impairments associated with combined point and nonpoint sources currently in existence (National Research Council 2008; AQUA TERRA 2012). Three separate federal scientific agencies promote the use of HSPF through funding and training opportunities so the model continues to maintain its relevance and scientific credibility. Since its public release in 1980, ongoing HSPF development and maintenance activities have been jointly sponsored by USEPA and the United States Geological Survey (USGS). The United States Army Corps of Engineers (USACOE) also supports HSPF through their Watershed Modeling System software. Because of its popularity and support, HSPF has been applied throughout North America and in numerous countries and climatic regimes around the world by the academic, public, and private sectors. As of July 30, 2012, there were 163 peer-reviewed scientific articles on Web of Science (Thomson Reuters 2012) that include the keyword "HSPF." A comprehensive list of seminal HSPF references can be found in Donigian (2005).

6.1.3 Description of WWHM Model

WWHM is an HSPF-based Windows interface custom-developed for the Washington State Department of Ecology by Clear Creek Solutions Inc. and AQUA TERRA Consultants (Beyerlein et al. 2005). WWHM was created to provide information to NPDES municipal stormwater permittees within Washington State to assist them in achieving compliance with the state's hydrologic performance standard (Ecology 2012). (Note: This performance standard requires permittees to minimize both the magnitude of stormwater discharges and the number of occurrences of such discharges. WWHM was specifically designed to provide

this information.) WWHM is commonly used among professional engineers and hydrologists in the State of Washington to find solutions to complex hydrologic questions (King County 2012, Ecology 2012, J. Burkey personal communication on 26 February 2014). In essence, WWHM is a Microsoft Windows interface that allows users to easily run HSPF algorithms without having to operate the HSPF model in the FORTRAN programming language. By default, WWHM automatically includes regional meteorological data for Western Washington so users do not have to acquire those data themselves, but the user can utilize auxiliary datasets if necessary. Furthermore, WWHM includes regionally calibrated parameter values specific for Western Washington (see Appendix A). Thus, WWHM is a unique application of the general HSPF model that is purposely and specifically calibrated for the Western Washington region.

6.1.4 Support for WWHM

An Independent Science Panel was convened on request of the Governor of the state of Washington to evaluate, among other things, the scientific credibility of WWHM for use in Ecology's Western Washington municipal stormwater permits. The Panel, which consisted of five nationally recognized scientists with expertise in stream ecology and hydrology, enlisted five additional national experts who had no prior involvement in WWHM's development to provide comment and expert review. The Panel concluded that "Ecology's use of the HSPF model and its derivative, the WWHM, is appropriate and consistent with the existing scientific information. The use of continuous modeling represents the most advanced use of scientific modeling in hydrological forecasting and is superior to single event modeling for stormwater…" (ISP 2003).

For stormwater runoff forecasting purposes, continuous simulation models like HSPF and WWHM are superior to event-based models, which limit simulation time domains to a single storm event and cover only the time of rainfall and runoff generation and routing for that single event. Continuous models include simulation of storm and inter-storm periods during a designated time period, thus tracking soil moisture budgets up to, during, and after an entire series of individual storm events. Because continuous models track water over a long period of time, they are capable of, and in fact do consider antecedent soil moisture conditions and storage capacity in runoff calculations, both of which are critical for

understanding the generation of stormwater runoff from the landscape (National Research Council 2008).

6.1.5 HSPF – WWHM Equivalency

WWHM and HSPF utilize identical calculations and produce identical results if applied using the same input data and parameter values. I used WWHM for this analysis instead of HSPF directly for two reasons. First, WWHM's interface is more user-friendly than HSPF. Second, WWHM is already calibrated to the Western Washington region, and that calibration has received thorough peer review from and subsequent support from state and federal agencies (Ecology and USGS), outside contractors with extensive HSPF calibration experience in Washington State (Clear Creek Solutions Inc.), and the original HSPF developers (AQUA TERRA Consultants). Hereafter, unless specifically referenced by name, both HSPF and WWHM will be considered as identical and interchangeably referred to as "the model."

6.2 Data Input Parameters and Assumptions

I incorporated data supplied by USEPA, as well as NRCS and National Oceanic and Atmospheric Administration (NOAA) databases to identify precipitation and evaporation data as well as soil, topography, and land cover parameters. I entered the data into the model to calculate stormwater runoff during the period of interest. I discuss the major categories of necessary input variables in detail below.

6.2.1 Climate Data

I acquired precipitation data for the hydrologic model from NOAA's National Climatic Data Center (NCDC 2012). I selected the SeaTac International Airport (NCDC WBAN ID 24233) rain gauge for this analysis because of its close proximity to the Site (approximately 6 miles to the north) and relatively complete dataset during the period of interest (August 1, 2008 to July 15 2012). I completed a quality assurance and control check for the entire dataset. Consistent with the NCDC, I presented all data in Coordinated Universal Time (UTC). To be conservative I assumed it did not rain during hours where data were missing from the time series. Therefore, I populated any missing precipitation data with zero values.

I acquired monthly pan evaporation data from the Washington State University Puyallup Research and Extension Center pan evaporation station in Puyallup, Washington (WSU, 2012). The evaporation time series used in my model was developed from the available daily record for water years 1960 through 1997. While this period preceded the period of interest for this project, there is very little variability in pan evaporation over time and between years. As a result, any year chosen for evaporation data input is likely interchangeable and should be considered just as representative of the long term trend as any other year. For this analysis, I chose the pan evaporation data for water year 1960 to represent this long term trend my model. I multiplied pan evaporation data by a pan evaporation coefficient of 0.76 to convert the data to potential evapotranspiration (PET) values which are used by the model (NOAA, 1982). I disaggregated the resultant monthly PET data to hourly values in order to align with the precipitation data used in the model. This approach is consistent with the evaporation data generation procedures used by Ecology and Clear Creek Solutions Inc. in the creation of the WWHM PET time series. In other words, I chose these data because they were the default values in the WWHM model.

6.2.2 Topography

I acquired light detection and ranging (LiDAR) data from the Puget Sound LiDAR Consortium (PSLC 2000) to estimate the direction of surface water flow (Figure 2) and to divide the property into distinct drainage sub-basins based on the predicted flow patterns (Figure 3). Topographic contour lines generated from LiDAR data indicate that the Site property immediately adjacent to the riverbank (Basin A and Basin C) slopes to the north while the majority of the Site property slopes to the southwest (Basin B). Topographic contour line patterns indicate that Basins A and C drain directly to the Green River. The topographic lines associated with Basin B indicate water drains to the southwest. Because there is a solid concrete wall dividing the Site from the property to the south, pooled surface water that would naturally drain from Basin B to the Green River accumulates along the concrete wall near the western side of the Site. Water appears to accumulate there until it reaches a certain depth, at which point it flows into Basin A and subsequently flows downhill to the Green River or it seeps under the wall and migrates towards the river along the natural channel that existed before the land was filled and regraded for industrial activity.

6.2.3 Soil Data

Figure 4 shows available soil data in the general vicinity of the Site from the Soil Survey Geographic Database (SSURGO 2012). SSURGO is an online repository of digital soil data produced and distributed by the Natural Resources Conservation Service (NRCS) – National Cartography and Geospatial Center (NCGC). Table 1 contains the hydrologic description for each soil group's dominant component, as well as Hydrologic Soil Group classification and an estimate of the soil's compaction resistance. SSURGO data classifies the Site as "urban land" which is defined as land mostly covered by streets, parking lots, buildings, and other structures of urban areas (USDA 1993). Riparian soils in the vicinity of the Site are classified as Pilchuck loamy fine sand (Pk) or Oridia silty loam (Os), which are described as having moderately high to high runoff potential. All of the soils are described as having one or more features that favor the formation of a compacted layer indicating that they are likely to experience compaction over time (SSURGO 2012). I am unaware of any site-specific soil analysis performed at the Site that would be relevant to the period of interest.

Figure 5 shows the NRCS soil units in the vicinity of the Site located within the USDA soil texture triangle. Soil texture is a qualitative classification tool in which soil classes are identified by the way a soil sample feels in one's hand (Thien 1979). The USDA soil texture triangle relates soil classes based on texture to the relative portions of sand, silt, and clay within the soil. For example, a soil that is comprised of more than 40 percent clay and less than 50 percent sand would be described as clay. More importantly, soil texture based on soil composition is related to the Hydrologic Soil Group classification (USDA 2007). Hydrologic Soil Groups (A, B, C, and D) describe the ability of a soil class to infiltrate water; Type A soils have low runoff potential when thoroughly wet while Type D soils have high runoff potential when thoroughly wet. Type B and C soils have intermediate runoff potential when compared to Type A and Type D soils.

Figure 5A shows the NRCS soil units in the vicinity of the Site as black dots within their respective soil class of the soil texture triangle. Figure 5B shows the soil texture triangle with USDA Hydrologic Soil Groups overlain. The majority of the soil units in the vicinity of the Site are classified as Type C soils according to the USDA soil texture triangle.

Based on the aforementioned soil information, I assumed Site soils behave as Type C soils. Type C soils are defined by The Soil Survey Manual criteria as having moderate saturated hydraulic conductivity and internal free water that occurs in deeper substrates (USDA 1993). Type C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately coarse textures. These soils have a moderate rate of water transmission (0.05-0.15 inches per hour).

Soil compaction from construction and industrial activities is a primary reason that runoff rates are higher on developed areas than on undeveloped (or forested, or rural) areas (Yang and Zhang 2011). Soil must have adequate pore space to allow for the transport and storage of air and water. When soils are compacted, the amount of pore space within the soil column decreases. The decrease in pore space reduces the soil's ability to infiltrate and store runoff, impedes root growth, limits nutrient uptake in vegetation, and reduces biological diversity and activity in the soil (Soil Quality Institute, 2000). The compacted soil then more closely resembles an impervious surface rather than a pervious surface (Schueler, 2000 and Wignosta et al. 1994).

Equipment activity on construction and industrial sites can severely compact soil, eliminating soil pore structure six to eight inches below the ground surface. Compaction can extend as deep as three feet depending on soil type, soil moisture, and total axle load of the equipment (DeJong-Hughes et al. 2001, Hinman 2005). Schueler et al. (1986) found that the first pass by heavy machinery on undisturbed soil causes 70 to 90% of the total soil compaction that the machine is capable of achieving while Gregory et al. (2006) found soil infiltration rates were reduced by 70 to 99 percent as a result of urban soil compaction. Due to the nature of historic activities occurring at the Site (heavy vehicle traffic, bulk material handling and storage, etc.), and because aerial imagery indicates that such activity occurred over the vast majority of the property, it is highly likely that surface and subsurface soil compaction has occurred over the majority of the Site footprint, effectively causing the pervious areas of the Site to behave hydrologically as impervious surface (Hinman 2005). This is consistent with the presence of extensive surface standing water ("ponding") at the Site observed onsite during wet weather conditions. This is also consistent with the

characterization of soils in the vicinity of the Site as having a low resistance to compaction (SSURGO 2012). Therefore, I modeled all of the soil at the Site as compacted Type C soil.

6.2.4 Land Use Conditions

Aerial imagery taken August 2006 (Figure 6A) shows the Site as predominantly turf-covered property with occasional small trees or shrubs and three buildings that currently exist on location. In the August 2006 photograph there are no cars parked on the property. In contrast, aerial imagery of the Site taken on some date between June - August 2007 (King County 2014b, c), as well as imagery taken from January 2009 to the present (Digital Globe 2012), consistently shows the majority of the Site covered with bare dirt amongst rows of automobiles with occasional patches of turf (<5% coverage). Because I was not able to find any aerial imagery of the Site between August 2007 and January 2009, I assumed that the June - August 2007 imagery was representative of Site conditions from August 2007 to January 2009.

6.3 Simulations

6.3.1 Site Schematic

While the King County tax parcel database lists the Site as 3.9 acres, I included in the model schematic only the portion of the Site that is within the fenced perimeter and that has likely been used for business operation. I determined, using Geographic Information Systems (GIS) software, that the business fence line encompasses a total of 3.6 acres of riparian property along the Green River. LiDAR contour lines were used to divide the property into three distinct drainage basins (Figure 3). Basins A and C drain north directly to the banks of the Green River, while Basin B drains to the southwest to the Green River. Aerial imagery of the Site (Digital Globe 2012) was used to divide each of the Site's basins into pervious and impervious land segments using GIS software. Within Basin B, approximately 0.1 acres are covered by buildings and other impervious cover. The remaining 3.5 acres of the Site is open lot area and is predominantly bare soil. Turf cover is present near the fence line of the Site's northern boundary and surrounding the business' office building located in the northeast corner of the property. The majority of the lot area is covered by rows of automobiles and various auto parts lying on the bare ground. To properly assess the generation of stormwater

from the Site alone, I assumed there was zero off-site drainage contributing runoff to the Site from other land within the watershed.

Based on topography, historical and current aerial imagery, and soil data for the areas surrounding the Site, I modeled Basins A and C as flat (0-5% slope) with compacted Type C soil and with no vegetative coverage (i.e., bare dirt). By assuming these land segments were flat, my analysis underestimates stormwater runoff compared to if the land was modeled as bare dirt with some slope. Basin B was modeled in the same manner except that the portion of its land occupied by buildings was modeled as impervious cover with zero slope (i.e., flat building rooftop). The land characteristic values used to simulate stormwater runoff from the Special Interest site are presented in Table 2.

6.3.2 Simulation Period

The model created for this analysis used an hourly time step, meaning that every hour during the simulation the model recalculates the various flows and storage of water over land and through the soil column down to the groundwater reservoir. In other words, the model tracks all the water in the modeled environment throughout the entire simulation.

In continuous hydrologic models, the simulation must begin with some chosen level of initial moisture in the soil and other storage compartments. The choice of initial soil moisture condition has a critical influence on whether subsequent moisture added to the environment will infiltrate into the ground or pool on the ground surface and generate stormwater runoff. This is commonly referred to by modelers as "boundary condition error." To avoid any influence from the model's initial moisture state (i.e. antecedent condition) on model output, modelers typically run a simulation for some interval before the selected period of interest. This is known as "allowing a model to spin-up." By allowing the model to run for this spin-up time, any influence from inaccuracies in the initial soil condition assumption can be minimized. In order to overcome any potential boundary condition error, 1) I chose to begin the model simulation approximately one and a half years before the period of interest, and 2) I chose to begin the model simulation assuming that all components in the model environment had zero water storage. While assumption #1 is common modeling practice, I

made assumption #2 purposefully acknowledging that it was not accurate; I did so to ensure that any error went in the favor of the Respondent.

For this analysis, the period of interest runs from the first day of the month after the date when Special Interest first gained a valid business license (August 1, 2008) until July 15, 2012. To reduce potential boundary condition errors associated with initial conditions, I started the model simulation on January 1, 2007; thus, the simulation was allowed to run for 578 days before evaluating model results. During the period of interest (August 1, 2008 to July 15, 2012), the model generated runoff predictions for approximately 35,000 hourly points in time.

6.4 Model Calibration and Evaluation

The model used in this report rests on the foundational work of previous model development specific for Western Washington, which included extensive calibration, evaluation, and peer review. I took this foundation and made additional adjustments to customize the model to the Site. In that process, I considered local factors specifically related to the Site, Site inspection information, and included conservative factors to increase confidence in runoff predictions (i.e., that actual runoff was likely equal to or greater than predicted runoff). Section 6.4.1 discusses the general process of model calibration and evaluation while Section 6.4.2 discusses the default calibration of WWHM. Section 6.4.3 discusses specific parameter changes that I made to more accurately represent the hydrology of the Special Interest Site. Section 6.4.4 discusses similarities and differences between model predictions and USEPA Site inspection observations. Finally, Section 6.4.5 discusses similarities between model simulated annual water balance information and literature values for Western Washington.

6.4.1 Approach

Calibration is the process of revising model input parameters so that model output matches observed data. In both HSPF and WWHM, calibration is required for parameters that cannot be measured or evaluated from topographic, climatic, or soil-related physical characteristics of the watershed. For example, four parameters (Upper Zone Nominal Soil Moisture Storage [UZSN], Lower Zone Nominal Soil Moisture Storage [LZSN], Index to

Infiltration Capacity [INFILT], and Interflow Inflow Parameter [INTFW]) are not measurable physical processes and are always determined through the calibration process. Appendix A includes a complete description of model parameters.

Model evaluation is an extension of the calibration process. Typically, a model is first calibrated using a portion of the available data; evaluation occurs when the calibrated model is then run on a different data set and model results are compared to observed data. The evaluation process tests that the model can reproduce a variety of environmental conditions, not only those present during the calibration period. Its purpose is to assure that the calibrated model reasonably captures all the variables and conditions which can affect model results.

It should be noted that no calibration procedure can cause a model to exactly replicate observed data. Calibration should result in parameter values that produce the best overall agreement between simulated and observed values throughout the calibration period. In practice, the model calibration/evaluation process can be viewed as a systematic analysis of errors or differences between model predictions and field observations.

Table 3 lists general calibration/evaluation tolerances or targets that have been provided to model users as part of HSPF training workshops over the past 10 years (Donigian 2000, 2002 and Duda et al. 2012). The values in the table provide general guidance, in terms of the percent mean errors or differences between simulated and observed values, so that users can gauge what level of agreement or accuracy (i.e. very good, good, fair) may be expected from the model application. The caveats at the bottom of the table indicate that (1) the tolerance ranges should be applied to the average of all values and not individual events and that (2) daily estimates may show larger errors when compared to seasonal or annual estimates and should still be considered acceptable.

6.4.2 Default Calibration

WWHM is a derivative application of HSPF calibrated specifically for the hydrologic conditions in Western Washington. Parameter values used in WWHM were originally calibrated by the USGS (Dinicola 1990) and later evaluated through a subsequent USGS study

(Dinicola 2001). Additional calibration work was performed by AQUA TERRA Consultants prior to approval of the final calibrated model by Ecology for regulatory use in Western Washington. The final version of the calibrated WWHM was deemed "appropriate and consistent with the existing scientific information" by an independent science panel consisting of nationally known experts in stormwater issues (ISP 2003).

6.4.3 Site-specific Parameter Modifications

I carefully reviewed the default WWHM parameter values in order to evaluate their appropriateness for characterizing the hydrologic response of the Site. By default, WWHM does not include a parameter set that specifically represents the bare and compacted dirt found on the majority of the Site. Based on Site inspection information and the my experience modeling stormwater runoff, specific WWHM default parameters (for Type C soils with lawn coverage and zero slope, or C LAWN FLAT) were modified to represent compacted bare dirt (Table 4).

Five parameters were modified to account for soil compaction at the Site. Parameter modifications were consistent with parameters representing bare compacted dirt found in other HSPF models and are consistent with HSPF parameter guidance (USEPA 2000):

- Upper Zone Nominal Soil Moisture Storage (UZSN) and Lower Zone Nominal Soil Moisture Storage (LZSN) were each decreased by 15 and 5 percent, respectively, to account for soil column compression from Site activities. Decreasing UZSN and LZSN results in reduced soil capacity to store water which is expected from soils that undergo compaction.
- The Interflow Inflow parameter (INTFW) is a coefficient that affects the timing of runoff by affecting the division of water between interflow and surface processes. Thus it affects the shape of the hydrograph, by shifting and delaying the flow to later in time, <u>but does not affect the volume of stormwater runoff</u>. INTFW was reduced from 6 to 1 to decrease the amount of interflow and increase the amount of overland flow. This modification increases the peak flows of runoff but decreases the time of discharge events (i.e., increases "flashiness") without affecting the volume of runoff. The resulting flashy hydrograph better represents runoff characteristics for

compacted soil. It also decreases the number of predicted days of discharge from the model.

- The Index to Infiltration Capacity (INFILT) is the parameter that effectively controls the overall division of the available moisture from precipitation (after interception) into surface and subsurface flow and storage components. Thus, high values of INFILT will produce more water that enters in the lower zone and groundwater, and result in higher baseflow to the stream; low values of INFILT will produce more upper zone and interflow storage water, and thus result in greater direct overland flow and interflow. INFILT was reduced from 0.03 to 0.027 (10 percent) to realistically represent the loss of infiltrative capacity that occurs when soils undergo compaction.
- The Interflow Recession Coefficient (IRC) was reduced from 0.5 to 0.25 to account for soil compaction. Whereas INTFW affects the volume of interflow, IRC affects the rate at which interflow is discharged from soil column storage. Thus it also affects the hydrograph shape in the 'falling' or recession region of the curve between the peak storm flow and baseflow. Lowering the value of IRC makes interflow recede faster, thereby reducing the duration of its discharge, which reduces the number of days of discharge from the Site predicted by the model.

A sixth parameter was modified to account for the absence of vegetation at the Site:

- Lower Zone Evapotranspiration Parameter (LZETP) affects evapotranspiration from the lower zone which represents the primary soil moisture storage and root zone of the soil profile. Decreasing LZETP reduces the opportunity for evapotranspirative moisture loss from the lower soil zone, which is primarily a function of vegetation's root activity. LZETP was reduced from 0.25 to 0.1 because the majority of the Site does not have vegetation; a value of 0.1 is recommended for barren soils (USEPA 2000).

WWHM's modified calibrated parameter set accurately represents how local weather patterns interact with the Site landscape. I specifically chose land cover, slope, and soil characteristics (and their associated parameter values) for inclusion in the Site model in order to conservatively underestimate the generation and timing of stormwater discharge from the

land to the river. The intent was to ensure any discrepancy between the model output and reality favored Special Interest Auto Salvage Inc.

More information on model parameter values and their selection can be found in Appendix A. For a full description of model parameters and typical ranges of parameter values, please see EPA's BASINS Technical Note 6: Estimating Hydrology and Hydraulic Parameters for HSPF (EPA 2000).

6.4.4 Comparison with Inspector Observations

USEPA inspected the Site on two occasions: February 24, 2012 from approximately 3:45-5:15pm and March 29, 2012 from approximately 9:15-11:15am. On both dates, inspectors visually observed overland flow across the land surface and surface ponding present at the Site. Inspectors did not visually observe a direct discharge to the Green River on February 24, 2012. On March 29, 2012, inspectors visually observed stormwater surface flow running from Basin C down the steep bank of the Green River. Inspectors did not attempt to quantify the flow volume.

The model-predicted daily runoff volume from Basins A and C on February 24, 2012 and March 29, 2012 was 828 and 8,370 US gal, respectively. Simulation results for these two dates are consistent with USEPA inspector observations that Site conditions were likely sufficient to generate stormwater discharges to the Green River. At the time of both inspections, it was raining and there were significant amounts of standing rain water on the ground and overland flows were seen throughout the property.

There are two main reasons that explain the apparent discrepancy between the model's prediction of stormwater discharge from the Site on February 24, 2012 and the lack of visually observable discharge during the inspector visit on that date:

1. The timing and intensity of the rain patterns on the two inspection days were different and led to different hydrologic responses. Precipitation data from February 24, 2012 show that the majority of the day's rain total (0.15 of the 0.17 inches) fell during the night after the inspectors had concluded their inspection activities. In

contrast, on March 29, 2012, it began raining in the morning and continued throughout the day and into the night. Furthermore, the precipitation total on March 29, 2012 was roughly five times greater (0.89 inches) than on February 24, 2012 (0.17 inches) with more intense hourly rain totals occurring during the storm event. The higher intensity of rain delivery, the greater overall total delivery of precipitation, and the earlier onset of heavy rains during the day all contributed to an increased likelihood of visually observing a direct stormwater discharge on March 29, 2012.

2. Antecedent soil moisture was lower during the first inspection than on the second. On the day prior to the first inspection (February 23, 2012) there was zero measurable rain and two days prior (February 22, 2012) there was 0.41 inches. The dry period prior to the February 24 rains meant that the soil was more likely to infiltrate the next day's precipitation and less likely to create overland runoff. In comparison, March 27 and 28, 2012 had measured precipitation values of 0.15 and 0.28 inches, respectively. The precipitation on March 29, 2012 fell on soils more laden with moisture, meaning the soil was less likely to infiltrate the additional water and more likely to generate overland runoff.

In summary, inspector observations of the Site from February 24, 2012 and March 29, 2012 corroborate the findings of the model output from those dates. This information provides confidence that the model reasonably represents the Site conditions accurately.

6.4.5 Comparison of Model Simulated Water Balance

Table 5 compares the simulated water balance from the Site model to literature values for other hydrologic modeling studies in Western Washington. The simulated water balance from my analysis falls within previous literature estimates of water balance estimates for Western Washington. This comparison is a consistency check with expected results, and shows that the model represents the simulated landscape in a reasonable manner. Based on this evaluation, the simulation in this report provides results that are logical and consistent with expected values.

7 RESULTS

The results of the Site hydrologic analysis are presented in Tables 6-8 and Figures 7-10. Table 6 summarizes the simulation results and provides ranges of reasonable values based on model accuracy estimates (see Section 8 for full discussion). Table 7 lists the monthly stormwater runoff volumes during the simulation period as well as the number of days within each month that a discharge was predicted. Table 8 lists the daily stormwater runoff volumes during the simulation period where a discharge from the Site was predicted. Figure 7 shows the time series for the total daily rainfall measurement observed and the estimated daily maximum peak stormwater runoff flow from Basins A + C. Figure 8 shows the time series for the total daily rainfall measurement observed and the estimated daily stormwater runoff volume from Basins A + C. Figure 9 shows the time series for the total daily rainfall measurement observed and the estimated daily maximum peak stormwater runoff flow from Basin B. Finally, Figure 10 shows the time series for the total daily rainfall measurement observed and the estimated daily stormwater runoff volume from Basin B.

The WWHM modeling results predict that significant quantities of runoff from the Site were discharged repeatedly during the period of interest (August 1, 2008 through July 15, 2012). For the period of interest, the model predicted that stormwater runoff volume was discharged from Basins A and C of the Site on 989 days. Of the 989 days of which a discharge is simulated, the average discharge volume from Basins A + C was 1,825 US gal. The minimum and maximum discharge volumes were 0.06 and 72,053 US gal, respectively. Over 60% of the predicted discharges were greater than 105 US gal. During the entire simulation period, the model estimated a total stormwater discharge of 1,804,924 US gal from Basins A + C of the Site. For context, this volume of runoff is equal to the volume of water found in three Olympic-sized swimming pools (assuming standard Olympic swimming pool dimensions of 164 ft by 82 ft by 6 ft deep).

There were 989 days in which discharges from Basin B were predicted. The average discharge volume from Basin B was 5,635 US gal. The minimum and maximum discharge volumes from Basin B were 0.17 and 217,420 US gal, respectively. The total estimated stormwater discharge from Basin B was 5,573,328 US gal, which is equal to the volume of water found in nine Olympic-sized swimming pools.

8 ACCURACY OF THE PREDICTIONS

Models are tools to help structure uncertain scientific information into inferences that help justify sound decision-making. The common misconception that any level of model uncertainty indicates the model is "wrong" leads many to discredit their usefulness completely, which is unfortunate and counter to consensus from the scientific community.

A number of basic truths are evident and are likely to be accepted by most modelers when modeling environmental systems (Duda et al. 2012 and Donigian 2002):

- Models are approximations of reality; they cannot precisely represent natural systems.
- There is no single, accepted statistic or test that determines whether or not a model is successfully evaluated.
- Both graphical comparisons and statistical tests are required in model calibration and evaluation.
- Models cannot be expected to be more accurate than the errors (confidence intervals) in the input and observed data.

Thus, a "weight of evidence" approach is most widely used and accepted when models are examined and judged for acceptance for these purposes. Simply put, the "weight of evidence" approach embodies the above truths and demands that multiple model comparisons, both graphical and statistical, be demonstrated in order to assess model performance, while recognizing inherent errors and uncertainty in the model, the input data, and the observations used to assess model acceptance.

8.1 Sources of Model Uncertainty

The calibration and evaluation process is an attempt to rectify discrepancies between model simulation output and observed data from the environment. The degree to which a model deviates from observed environmental data can be described as its "error." Generally speaking, model error can be introduced at multiple stages of the modeling process. Sources of uncertainty include:

- Errors associated with model input data (i.e., measurements of precipitation and evaporation)
- Errors associated with the selection of parameter values
- Errors associated with model algorithms (i.e., mathematical equations)
- Errors associated with field observations used to calibrate model (i.e., measurements of stream flow or runoff flow)
- Errors associated with calibration accuracy

The results of the calibration process help to identify the sources of error and provide potential remedies to reduce the total model error. In other words, it is possible to overcome issues with any of the aforementioned sources of error by compensating for them with parameter changes made during the calibration process. Though it is rarely possible to exactly match model simulation output to observed data, models can with confidence reasonably represent complex and dynamic hydrologic behavior with sufficient accuracy so that the model can be used for subsequent planning and decision-making (Duda et al. 2012). Further information regarding potential model error can be found in Donigian and Rao (1990).

8.2 Estimation of Site Model Reliability

Numerous studies have evaluated the accuracy of HSPF model predictions (Donigian 2005 and references therein). Generally, the studies conclude that HSPF models provide reasonable results with a flow prediction accuracy range reported within plus or minus (+/-) 25%. Because WWHM is a derivative of HSPF and produces identical results to the stand-alone HSPF software, these prediction accuracy ranges also hold true for WWHM.

Initial estimates of the USGS HSPF model evaluated for Western Washington show that root-mean-square-errors for annual runoff volume were approximately 9% and seasonal errors ranged from 17-23% (Dinicola 2001). Errors associated with individual storm events were approximately 29%. Dinicola (2001) also found that the evaluated model's errors were unbiased, equally tending to over- and under-predict the various hydrologic metrics examined in that study.

Comparing these error estimates to general evaluation targets for HSPF models found in Table 3 (see Section 6.4), one can classify the accuracy of the Western Washington HSPF model's calibration used in this analysis as "Very Good" for predicting annual flow values and "Fair" for predicting seasonal flow values. Daily runoff volume estimates can be classified as "Fair to Good", noting that larger deviations for daily values in any calibration are expected and acceptable due to inherent errors associated with model data input, specifically precipitation timing (Duda et al. 2012). As a result, the tolerances for error of daily flow values are wider to reflect this fact. To reiterate, the classifications used above are based on evaluation tolerances or targets provided to model users as part of HSPF training workshops over the past 10 years (Donigian, 2000) and reflect common tolerances accepted by many modeling professionals (Duda et al. 2012). Therefore, the calibration that I used in this analysis to determine daily flow estimates should be considered reliable.

To be conservative, I applied the error estimates from the evaluated HSPF model for Western Washington to the WWHM model used in this study. Using the uncertainty estimate from Dinicola (2001) for the WWHM model of the Site is reasonable given that the two models are essentially identical, differing by only a few parameters. Furthermore, I modified parameters to better represent the Site's specific characteristics and, as a result, any changes are expected to decrease overall model error. From Dinicola (2001), I assumed that the WWHM simulation results for the Site are within plus or minus 10% of the actual values for total runoff volume and plus or minus 30% of the actual values for daily runoff volume. In addition, for uncertainty in the number of days of discharge, I applied a 30% reduction "safety factor" of 0.7 to the simulated number of days of discharge (e.g., if the number of days was 10, the safety factor of 0.7 would result in a 30% reduction, or 10 x 0.7 = 7). This safety factor is also consistent with the individual storm event error estimates from Dinicola (2001).

Table 6 summarizes the simulation results and provides uncertainty ranges based on the assumptions above. Thus, the prediction of total simulated stormwater runoff volume from Basins A and C (combined) could be as low as 1,624,431 US gal and as high as 1,985,416 US gal. Likewise, the prediction of mean daily runoff volume from Basins A and C (combined) could be as low as 1,277 US gal and as high as 2,372 US gal. Finally, the prediction of the

number of days of discharge from Basins A and C (combined) could be as low as 692 and as high as 1,286.

The prediction of total simulated stormwater runoff volume from Basin B could be as low as 5,015,995 US gal and as high as 6,130,660 US gal. Likewise, the prediction of mean daily runoff volume from Basin B could be as low as 3,945 US gal and as high as 7,326 US gal. Finally, the prediction of the number of days of discharge from Basin B could be as low as 692 and as high as 1,286.

9 CONCLUSION

The purpose of this report is to predict the frequency and volume of stormwater runoff discharging from the property occupied by Special Interest. A calibrated hydrologic model (WWHM), in conjunction with local weather data, was used to demonstrate when discharges occurred and the approximate volume of each discharge since Special Interest began operating at the Site.

Results from this analysis show that significant volumes of stormwater runoff repeatedly discharged from the Special Interest site. Since August 1, 2008, there were 989 days in which stormwater runoff discharged from the Special Interest site. The model estimated between 1.6 million and 1.9 million US gallons of stormwater runoff discharged from the Special Interest property during that time. Based on my review of the Site topography, the general conditions at the Site, and my expertise in hydrology, all of the stormwater that discharges from the Special Interest property discharges to the Green River.

10 REFERENCES

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TABLES

Table 1
Soil Descriptions in the Vicinity of the Site

Name	Symbol	Hydrologic Soil Group	Soil Compaction Resistance	Dominant Condition Hydrologic Group Description
Pilchuck fine sandy loam	Pk	A[1], C[2]	Low resistance	Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted.
Renton silt loam	Re	C/D[1,2]	Low resistance	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted.
Oridia silt loam	Os	D[2,3]	Low resistance	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted.
Woodinville silt loam	Wo	B[2], C/D[1]	Low resistance	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted.
Puyallup fine sandy loam	Py	B[2,3]	Low resistance	Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded.
Newberg silt loam	Ng	B[2]	Low resistance	Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded.
Urban land	Ur	Not rated	Not rated	Null

Notes:
[1]: from USDA 1986. Appendix A containing Hydrologic Soil Group classifications updated January 1999.
[2]: from WSDOT 2011.
[3]: from King County 2004.

Hydrologic Soil Group classification listings in this table assume undisturbed soils with no compaction. Generally speaking, soil compaction shifts soil classification from Groups A and B to Groups C and D.

Some soils are listed in dual groups because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in a different group. For example, Renton soil is classified as C/D. This indicates that the drained Renton soil is in group C and the undrained soil is in group D.

Soil Compaction Resistance rates each soil for its resistance to compaction. Compaction is predominantly influenced by moisture content, depth to saturation, percent of sand, silt, and clay, soil structure, organic matter content, and content of coarse fragments. "High resistance" indicates that the soil has features that are very favorable to resisting compaction. "Moderate resistance" indicates that the soil has features that are favorable to resisting compaction. "Low resistance" indicates that the soil has one or more features that favor the formation of a compacted layer.

Hydrologic Group and Soil Compaction Resistance descriptions taken from the SSURGO database metadata.

Table 2
Site Historic and Current Land Use Conditions

Scenario	Sub-basin	Pervious/Impervious	Description	Area (ac)
Predevelopment	---	pervious	C soils, flat, fully forested	3.6
			Total	**3.6**
Current Condition	A	pervious	C soils, flat, bare dirt	0.4
	B	impervious	Roof tops, flat	0.1
	B	pervious	C soils, flat, bare dirt	2.6
	C	pervious	C soils, flat, bare dirt	0.5
			Total	**3.6**

Notes:

The current Site land segments described above correspond to IMPLND 4 and PERLND 16 used in the model. See Appendix A for the specific parameters associated with those land segments.

Table 3A
General Calibration and Evaluation Tolerances for HSPF Applications

	% Difference Between Simulated and Recorded Values		
	Very Good	**Good**	**Fair**
Hydrology/Flow	< 10	10 - 15	15 - 25
Sediment	< 20	20 - 30	30 - 45
Water Temperature	< 7	8 - 12	13 - 18
Water Quality/Nutrients	< 15	15 - 25	25 - 35
Pesticides/Toxics	< 20	20 - 30	30 - 40

Notes:
From Donigian 2000, 2002.
Values other than Hydrology are not relevant to this study but are presented for comparison purposes.
Caveats: Relevant to monthly and annual values; storm peaks may differ more and still be acceptable
Quality and detail of input and calibration data
Purpose of model application
Availability of alternative assessment procedures
Resource availability (i.e. time, money, personnel)

Table 3B
Evaluation Tolerances for HSPF Daily and Monthly Flows

R	← 0.75	—	0.80	—	0.85	—	0.90	—	0.95 →
R^2	←	0.6	—	0.7	—	0.8	—	0.9	→
Daily Flows	Poor		Fair		Good		Very Good		
Monthly Flows		Poor	|	Fair	|	Good	|	Very Good	

Notes:
From Duda et al. 2012.
Values for R^2 (coefficient of determination) indicate the percent difference between simulated and measured values and can be interpreted as how well the model predicts the measured data. Values range from 0 to 1 with values closer to 1 indicating a better model prediction.
Values for R (correlation coefficient) indicate the degree of linear dependence between simulated and measured data. Values range between +1 and −1, where 1 is total positive correlation, 0 is no correlation, and −1 is total negative correlation.

Table 4
Comparison of WWHM Default Parameters with Modified Values for Site Model

Parameter	Description	Reason for modification	Value		Possible range of values
			WWHM default	Modified	
			C Lawn Flat	C Compact Dirt Flat	
UZSN	Upper Zone Nominal Soil Moisture Storage	compaction	0.25	0.2125	0.05 - 2
LZSN	Lower Zone Nominal Soil Moisture Storage	compaction	4.5	4.275	2 - 15
INTFW	Interflow Inflow Parameter	compaction	6	1	1 - 10
LZETP	Lower Zone ET Parameter	lack of vegetation	0.25	0.1	0.1 – 0.9
INFILT	Index to Infiltration Capacity	compaction	0.03	0.027	0.001 – 0.5
IRC	Interflow Recession Parameter	compaction	0.5	0.25	0.3 – 0.85

Notes:

Parameters were selected for modification based on the author's best professional judgment.

Parameters were modified from default values for Type C soils with full lawn coverage and zero slope (i.e., C Lawn Flat).

The land segment descriptions C Lawn Flat corresponds PERLND 16 in the model. Parameters identified in this table were changed and are shown in Appendix A as C Compact Dirt Flat. See Appendix A for the entire parameter set associated with this land segment.

Possible range of parameter values from USEPA 2000.

Table 5
Average Annual Expected and Simulated Water Balance

Component	Expected Range	Simulated
Moisture Supply	25 – 60	44
Total Runoff	0 – 27	27
Total ET	12 – 23	15
Deep Recharge	1-29	2

Notes:
Units for water cycle components in inches.
Expected Range values taken from Beyerlein 1999 and Vaccaro et al. 1998.
Simulated water balance data are proportionally similar to results in King County 2009.

Table 6
Summary of Simulated Discharge Results

Area	Value Type	Total Runoff Volume	Mean Daily Runoff Volume	# of Days of Discharge
Basin A	Simulated	802,190	811	989
	Range	721,971 - 882,409	568 - 1,054	692 - 1,286
Basin B	Simulated	5,573,328	5,635	989
	Range	5,015,995 - 6,130,660	3,945 - 7,326	692 - 1,286
Basin C	Simulated	1,002,736	1,014	989
	Range	902,463 - 1,103,010	710 - 1,318	692 - 1,286
A + C	Simulated	1,804,924	1,825	989
	Range	1,624,431 - 1,985,416	1,277 - 2,372	692 - 1,286

Notes:
Units for total and mean daily runoff volume in US gal.

Table 7
Simulated Monthly Discharge Results

Year	Month	Total (US gal)		# days of Discharge
		Basin B	Basins A + C	
2008	August	35,639	10,540	20
	September	1,354	84	7
	October	13,267	3,288	23
	November	291,219	95,157	27
	December	122,808	39,159	31
2008 Total		**464,286**	**148,228**	**108**
2009	January	287,517	94,772	18
	February	27,142	8,388	12
	March	118,981	38,329	30
	April	100,696	32,516	27
	May	79,642	25,069	23
	June	-	-	0
	July	-	-	0
	August	2,016	139	9
	September	25,390	7,663	14
	October	195,605	63,219	21
	November	404,927	132,366	30
	December	94,294	30,393	21
2009 Total		**1,336,210**	**432,853**	**205**
2010	January	266,731	87,053	31
	February	119,884	38,675	27
	March	125,411	40,729	24
	April	86,455	27,886	29
	May	12,663	3,165	24
	June	29,379	8,971	23
	July	5	0	1
	August	888	37	4
	September	165,256	53,505	25
	October	196,584	63,716	20
	November	195,598	63,503	30
	December	484,959	159,875	31
2010 Total		**1,683,815**	**547,116**	**269**
2011	January	201,168	65,608	31
	February	105,122	34,136	28
	March	253,957	83,017	31
	April	142,585	46,437	27
	May	84,598	27,205	24
	June	1,627	124	16
	July	729	50	4
	August	-	-	0
	September	5,086	958	10

Year	Month	Total (US gal)		# days of Discharge
		Basin B	Basins A + C	
	October	84,496	26,696	28
	November	220,223	71,848	29
	December	85,022	27,639	15
2011 Total		**1,184,613**	**383,718**	**243**
2012	January	328,243	107,323	31
	February	149,365	48,701	29
	March	306,398	100,137	31
	April	51,658	16,303	25
	May	31,545	9,648	20
	June	36,642	10,872	25
	July	552	23	3
2012 Total		**904,403**	**293,008**	**164**
Grand Total		**5,573,328**	**1,804,924**	**989**

Table 8
Simulated Daily Discharge Results

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
1	8/1/2008	2.6	148.9	3.2	5.8
2	8/2/2008	1.7	20.0	2.2	3.9
3	8/3/2008	0.4	3.5	0.5	0.8
4	8/10/2008	7.1	363.5	8.9	16.0
5	8/11/2008	1.6	13.0	2.0	3.6
6	8/12/2008	0.3	2.7	0.4	0.7
7	8/18/2008	1.2	45.0	1.5	2.7
8	8/19/2008	1.0	65.2	1.2	2.2
9	8/20/2008	126.3	2,492.3	157.8	284.1
10	8/21/2008	1,017.2	7,372.7	1,271.5	2,288.8
11	8/22/2008	190.9	1,244.6	238.6	429.6
12	8/23/2008	47.7	311.0	59.7	107.4
13	8/24/2008	252.5	2,308.5	315.6	568.1
14	8/25/2008	2,479.6	17,502.0	3,099.5	5,579.1
15	8/26/2008	340.7	2,218.9	425.9	766.7
16	8/27/2008	150.8	1,114.3	188.5	339.3
17	8/28/2008	47.1	310.4	58.9	106.1
18	8/29/2008	11.8	77.4	14.7	26.5
19	8/30/2008	2.9	19.9	3.7	6.6
20	8/31/2008	0.7	4.8	0.9	1.7
21	9/1/2008	0.0	0.3	0.0	0.1
22	9/20/2008	9.4	562.7	11.7	21.1
23	9/21/2008	20.0	708.8	24.9	44.9
24	9/22/2008	5.9	43.4	7.4	13.4
25	9/23/2008	1.5	10.5	1.9	3.3
26	9/24/2008	0.3	2.7	0.4	0.6
27	9/26/2008	0.2	25.5	0.2	0.4
28	10/3/2008	2.7	220.6	3.3	6.0
29	10/4/2008	100.1	1,912.6	125.1	225.2
30	10/5/2008	45.3	313.9	56.6	102.0
31	10/6/2008	50.4	448.3	63.0	113.4
32	10/7/2008	481.8	3,739.7	602.2	1,084.0
33	10/8/2008	90.3	590.6	112.8	203.1
34	10/9/2008	22.6	147.4	28.2	50.8
35	10/10/2008	5.6	37.4	7.1	12.7
36	10/11/2008	1.4	9.2	1.8	3.2
37	10/12/2008	0.3	1.7	0.3	0.6
38	10/16/2008	23.0	306.5	28.8	51.8
39	10/17/2008	11.4	80.7	14.2	25.6
40	10/18/2008	71.7	721.6	89.6	161.3
41	10/19/2008	24.5	163.2	30.6	55.1
42	10/20/2008	163.5	1,388.2	204.4	367.9

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
43	10/21/2008	180.3	1,297.7	225.4	405.7
44	10/22/2008	44.7	292.7	55.9	100.6
45	10/23/2008	28.2	251.6	35.2	63.4
46	10/24/2008	17.0	117.9	21.2	38.2
47	10/25/2008	4.2	28.6	5.3	9.6
48	10/26/2008	1.1	7.8	1.3	2.4
49	10/27/2008	0.1	0.9	0.2	0.3
50	10/31/2008	91.5	1,188.6	114.3	205.8
51	11/1/2008	132.8	934.7	166.0	298.8
52	11/2/2008	734.7	5,714.3	918.4	1,653.1
53	11/3/2008	868.4	6,291.9	1,085.5	1,953.9
54	11/4/2008	4,018.6	28,157.0	5,023.3	9,041.9
55	11/5/2008	929.2	6,055.3	1,161.5	2,090.7
56	11/6/2008	4,271.7	29,826.0	5,339.7	9,611.4
57	11/7/2008	20,078.0	136,590.0	25,098.0	45,176.0
58	11/8/2008	2,108.2	14,195.0	2,635.2	4,743.3
59	11/9/2008	761.8	5,133.3	952.2	1,714.0
60	11/10/2008	325.1	2,299.3	406.4	731.5
61	11/11/2008	452.2	3,318.6	565.3	1,017.5
62	11/12/2008	5,690.8	39,713.0	7,113.5	12,804.0
63	11/13/2008	1,294.5	8,667.1	1,618.1	2,912.6
64	11/14/2008	358.7	2,346.2	448.3	807.0
65	11/15/2008	89.7	584.2	112.1	201.8
66	11/16/2008	22.4	146.1	28.0	50.4
67	11/17/2008	5.6	37.0	7.0	12.6
68	11/18/2008	1.4	9.1	1.8	3.2
69	11/19/2008	0.3	1.7	0.3	0.6
70	11/20/2008	17.3	185.7	21.6	38.8
71	11/21/2008	38.0	289.6	47.5	85.4
72	11/22/2008	63.0	513.3	78.8	141.8
73	11/23/2008	20.2	134.0	25.2	45.4
74	11/24/2008	5.0	33.4	6.3	11.3
75	11/25/2008	1.3	8.9	1.6	2.8
76	11/26/2008	0.2	1.4	0.3	0.5
77	11/30/2008	2.9	32.7	3.6	6.4
78	12/1/2008	1.1	11.0	1.3	2.4
79	12/2/2008	279.4	2,214.4	349.2	628.6
80	12/3/2008	82.8	554.6	103.5	186.4
81	12/4/2008	20.7	135.9	25.9	46.6
82	12/5/2008	5.2	34.1	6.5	11.6
83	12/6/2008	1.3	9.0	1.6	2.9
84	12/7/2008	2.6	22.4	3.3	5.9
85	12/8/2008	2.4	30.0	2.9	5.3
86	12/9/2008	3.9	78.4	4.9	8.8
87	12/10/2008	15.5	183.6	19.3	34.8
88	12/11/2008	10.6	101.3	13.3	23.9
89	12/12/2008	678.0	5,073.0	847.6	1,525.6

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
90	12/13/2008	3,657.6	25,531.0	4,572.0	8,229.6
91	12/14/2008	1,368.9	9,389.4	1,711.1	3,080.0
92	12/15/2008	421.2	2,743.4	526.5	947.7
93	12/16/2008	105.3	685.4	131.6	236.9
94	12/17/2008	26.3	171.9	32.9	59.2
95	12/18/2008	226.4	1,853.8	283.0	509.5
96	12/19/2008	376.7	2,514.4	470.9	847.5
97	12/20/2008	94.2	614.3	117.8	212.0
98	12/21/2008	514.8	3,930.6	643.5	1,158.3
99	12/22/2008	645.0	4,678.5	806.2	1,451.2
100	12/23/2008	176.4	1,151.1	220.5	396.9
101	12/24/2008	1,252.9	9,065.7	1,566.1	2,819.0
102	12/25/2008	933.9	6,411.2	1,167.4	2,101.3
103	12/26/2008	867.3	6,258.2	1,084.1	1,951.4
104	12/27/2008	930.4	6,711.6	1,163.1	2,093.5
105	12/28/2008	1,549.7	10,889.0	1,937.2	3,486.9
106	12/29/2008	1,926.0	13,450.0	2,407.5	4,333.5
107	12/30/2008	725.3	4,742.6	906.6	1,631.8
108	12/31/2008	502.3	3,568.1	627.8	1,130.1
109	1/1/2009	3,465.8	24,280.0	4,332.2	7,798.0
110	1/2/2009	1,613.2	11,103.0	2,016.5	3,629.8
111	1/3/2009	530.6	3,459.6	663.2	1,193.8
112	1/4/2009	132.7	863.4	165.8	298.5
113	1/5/2009	3,527.2	24,370.0	4,408.9	7,936.1
114	1/6/2009	801.2	5,703.2	1,001.5	1,802.7
115	1/7/2009	12,069.0	82,873.0	15,086.0	27,155.0
116	1/8/2009	17,876.0	120,750.0	22,345.0	40,220.0
117	1/9/2009	1,159.4	7,541.3	1,449.2	2,608.6
118	1/10/2009	289.8	1,884.8	362.3	652.1
119	1/11/2009	316.0	2,285.7	395.0	711.0
120	1/12/2009	115.8	766.1	144.7	260.5
121	1/13/2009	162.5	1,226.8	203.1	365.6
122	1/14/2009	47.0	308.6	58.8	105.8
123	1/15/2009	11.8	77.1	14.7	26.5
124	1/16/2009	2.9	19.8	3.7	6.6
125	1/17/2009	0.7	4.8	0.9	1.7
126	1/18/2009	0.0	0.3	0.0	0.1
127	2/10/2009	3.6	118.6	4.5	8.1
128	2/11/2009	51.5	681.9	64.4	115.9
129	2/12/2009	13.7	92.1	17.2	30.9
130	2/13/2009	3.4	23.0	4.3	7.7
131	2/14/2009	0.9	6.3	1.1	1.9
132	2/15/2009	0.1	0.5	0.1	0.2
133	2/23/2009	20.7	271.4	25.9	46.7
134	2/24/2009	528.6	4,284.9	660.8	1,189.4
135	2/25/2009	947.2	6,970.9	1,184.0	2,131.2
136	2/26/2009	1,594.8	11,020.0	1,993.5	3,588.3

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
137	2/27/2009	450.7	2,939.2	563.4	1,014.1
138	2/28/2009	112.7	733.5	140.9	253.5
139	3/1/2009	120.0	895.8	150.0	270.0
140	3/2/2009	819.0	5,881.2	1,023.7	1,842.7
141	3/3/2009	653.5	4,573.6	816.9	1,470.5
142	3/4/2009	689.8	4,747.2	862.2	1,551.9
143	3/5/2009	163.6	1,068.3	204.5	368.1
144	3/6/2009	41.0	269.8	51.3	92.3
145	3/7/2009	10.3	67.3	12.8	23.1
146	3/8/2009	33.6	287.7	42.0	75.7
147	3/9/2009	3,467.0	23,951.0	4,333.7	7,800.7
148	3/10/2009	512.6	3,387.1	640.8	1,153.4
149	3/11/2009	128.2	834.9	160.2	288.4
150	3/12/2009	32.0	208.8	40.1	72.1
151	3/13/2009	8.0	52.7	10.0	18.0
152	3/14/2009	542.0	4,141.3	677.5	1,219.6
153	3/15/2009	3,018.4	21,273.0	3,773.1	6,791.5
154	3/16/2009	2,156.7	14,978.0	2,695.8	4,852.5
155	3/17/2009	2,284.6	15,750.0	2,855.8	5,140.4
156	3/18/2009	650.9	4,272.2	813.7	1,464.6
157	3/19/2009	162.4	1,057.4	203.0	365.4
158	3/20/2009	110.0	850.6	137.5	247.4
159	3/21/2009	205.9	1,411.1	257.3	463.2
160	3/22/2009	51.4	336.1	64.2	115.7
161	3/23/2009	12.9	84.0	16.1	28.9
162	3/24/2009	3.2	21.5	4.0	7.2
163	3/25/2009	0.8	5.2	1.0	1.8
164	3/26/2009	0.1	0.4	0.1	0.1
165	3/28/2009	37.2	488.1	46.5	83.6
166	3/29/2009	788.5	5,773.6	985.6	1,774.1
167	3/30/2009	221.8	1,448.2	277.2	499.0
168	3/31/2009	109.9	864.7	137.4	247.2
169	4/1/2009	529.1	3,927.0	661.4	1,190.4
170	4/2/2009	1,143.3	8,096.2	1,429.2	2,572.5
171	4/3/2009	6,767.1	46,205.0	8,458.9	15,226.0
172	4/4/2009	622.7	4,057.2	778.4	1,401.1
173	4/5/2009	155.7	1,013.0	194.6	350.3
174	4/6/2009	38.9	253.4	48.6	87.6
175	4/7/2009	9.7	63.8	12.2	21.9
176	4/8/2009	2.4	15.8	3.0	5.5
177	4/9/2009	0.6	3.9	0.7	1.3
178	4/12/2009	961.7	7,721.6	1,202.1	2,163.8
179	4/13/2009	1,790.8	12,180.0	2,238.5	4,029.2
180	4/14/2009	1,404.2	9,716.3	1,755.3	3,159.5
181	4/15/2009	309.1	2,012.8	386.4	695.5
182	4/16/2009	77.3	503.0	96.6	173.9
183	4/17/2009	287.8	2,216.4	359.7	647.5

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
184	4/18/2009	191.8	1,256.5	239.7	431.5
185	4/19/2009	47.9	312.7	59.9	107.9
186	4/20/2009	12.0	78.3	15.0	27.0
187	4/21/2009	3.0	20.0	3.7	6.7
188	4/22/2009	0.7	4.9	0.9	1.7
189	4/23/2009	59.8	751.9	74.7	134.6
190	4/24/2009	26.7	185.6	33.3	60.0
191	4/25/2009	6.7	44.6	8.3	15.0
192	4/26/2009	1.7	11.2	2.1	3.8
193	4/27/2009	0.3	2.8	0.4	0.8
194	4/28/2009	0.6	38.4	0.8	1.4
195	4/29/2009	0.0	4.3	0.1	0.1
196	5/3/2009	14.5	529.3	18.2	32.7
197	5/4/2009	3.3	24.4	4.1	7.4
198	5/5/2009	1,502.4	11,550.0	1,878.1	3,380.5
199	5/6/2009	4,310.3	30,055.0	5,387.9	9,698.1
200	5/7/2009	1,970.0	13,092.0	2,462.5	4,432.5
201	5/8/2009	499.5	3,250.3	624.4	1,123.9
202	5/9/2009	124.9	812.4	156.1	281.0
203	5/10/2009	31.2	203.7	39.0	70.2
204	5/11/2009	7.8	50.7	9.8	17.6
205	5/12/2009	2.0	12.7	2.4	4.4
206	5/13/2009	1.1	81.0	1.4	2.5
207	5/14/2009	1,281.4	9,936.4	1,601.7	2,883.1
208	5/15/2009	496.7	3,243.7	620.9	1,117.6
209	5/16/2009	124.2	808.5	155.2	279.4
210	5/17/2009	31.0	202.2	38.8	69.9
211	5/18/2009	7.8	51.0	9.7	17.5
212	5/19/2009	463.6	3,881.2	579.5	1,043.0
213	5/20/2009	196.8	1,377.3	246.0	442.7
214	5/21/2009	55.2	361.3	69.0	124.1
215	5/22/2009	13.8	90.3	17.2	31.0
216	5/23/2009	3.4	23.1	4.3	7.8
217	5/24/2009	0.9	5.6	1.1	1.9
218	5/25/2009	0.1	0.5	0.1	0.2
219	8/11/2009	13.7	790.3	17.1	30.8
220	8/12/2009	11.2	210.7	14.0	25.3
221	8/13/2009	4.5	39.5	5.6	10.1
222	8/14/2009	5.5	171.0	6.9	12.4
223	8/15/2009	1.5	12.1	1.9	3.4
224	8/16/2009	0.3	2.5	0.4	0.6
225	8/29/2009	12.5	694.3	15.7	28.2
226	8/30/2009	10.0	77.9	12.5	22.5
227	8/31/2009	2.5	17.5	3.1	5.6
228	9/1/2009	0.6	4.5	0.8	1.4
229	9/3/2009	0.1	24.8	0.2	0.3
230	9/5/2009	6.0	392.8	7.6	13.6

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
231	9/6/2009	2,730.8	20,077.0	3,413.5	6,144.4
232	9/7/2009	487.4	3,239.2	609.3	1,096.7
233	9/8/2009	121.6	792.7	152.1	273.7
234	9/9/2009	30.4	198.2	38.0	68.4
235	9/10/2009	7.6	50.1	9.5	17.1
236	9/11/2009	1.9	12.4	2.4	4.3
237	9/12/2009	0.4	2.7	0.5	1.0
238	9/19/2009	9.1	519.9	11.3	20.4
239	9/20/2009	7.3	59.5	9.1	16.4
240	9/21/2009	1.8	13.0	2.3	4.1
241	9/22/2009	0.4	2.9	0.5	0.9
242	10/3/2009	5.9	260.7	7.4	13.3
243	10/4/2009	2.0	16.4	2.5	4.5
244	10/5/2009	0.5	3.7	0.6	1.0
245	10/14/2009	87.1	1,920.8	108.9	196.1
246	10/15/2009	101.3	867.0	126.6	227.9
247	10/16/2009	1,340.8	9,803.7	1,676.0	3,016.8
248	10/17/2009	9,800.8	67,489.0	12,251.0	22,052.0
249	10/18/2009	2,436.6	16,583.0	3,045.7	5,482.3
250	10/19/2009	660.9	4,301.3	826.1	1,487.0
251	10/20/2009	165.2	1,074.8	206.5	371.7
252	10/21/2009	95.8	740.2	119.7	215.5
253	10/22/2009	99.6	670.2	124.6	224.2
254	10/23/2009	828.3	6,337.8	1,035.3	1,863.6
255	10/24/2009	544.9	3,578.9	681.2	1,226.1
256	10/25/2009	136.2	887.2	170.3	306.5
257	10/26/2009	8,529.1	58,582.0	10,661.0	19,190.0
258	10/27/2009	1,055.4	6,893.1	1,319.2	2,374.5
259	10/28/2009	263.8	1,716.6	329.8	593.6
260	10/29/2009	672.9	5,041.1	841.1	1,513.9
261	10/30/2009	371.3	2,425.0	464.1	835.5
262	10/31/2009	899.2	6,412.5	1,124.0	2,023.1
263	11/1/2009	251.9	1,644.2	314.9	566.8
264	11/2/2009	63.0	410.3	78.7	141.7
265	11/3/2009	15.7	103.2	19.7	35.4
266	11/4/2009	3.9	25.6	4.9	8.9
267	11/5/2009	86.0	762.7	107.4	193.4
268	11/6/2009	2,196.7	15,739.0	2,745.9	4,942.6
269	11/7/2009	10,345.0	71,232.0	12,932.0	23,277.0
270	11/8/2009	2,748.9	18,669.0	3,436.1	6,185.1
271	11/9/2009	770.7	5,239.8	963.4	1,734.1
272	11/10/2009	1,876.4	13,040.0	2,345.5	4,221.9
273	11/11/2009	1,468.4	10,269.0	1,835.5	3,303.9
274	11/12/2009	342.6	2,281.7	428.2	770.8
275	11/13/2009	461.7	3,409.7	577.1	1,038.8
276	11/14/2009	323.0	2,125.1	403.7	726.6
277	11/15/2009	774.9	5,836.0	968.6	1,743.5

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
278	11/16/2009	2,155.4	14,871.0	2,694.3	4,849.7
279	11/17/2009	6,461.5	44,352.0	8,076.9	14,538.0
280	11/18/2009	1,381.0	9,368.8	1,726.2	3,107.1
281	11/19/2009	4,036.9	27,966.0	5,046.1	9,083.0
282	11/20/2009	2,292.4	15,713.0	2,865.6	5,158.0
283	11/21/2009	868.4	5,682.1	1,085.5	1,953.9
284	11/22/2009	5,406.9	37,374.0	6,758.6	12,165.0
285	11/23/2009	1,045.6	6,820.8	1,307.0	2,352.6
286	11/24/2009	681.5	4,953.9	851.9	1,533.4
287	11/25/2009	354.3	2,339.4	442.9	797.2
288	11/26/2009	9,250.1	63,458.0	11,563.0	20,813.0
289	11/27/2009	2,484.5	16,803.0	3,105.6	5,590.1
290	11/28/2009	519.5	3,380.6	649.4	1,168.9
291	11/29/2009	129.9	845.0	162.4	292.2
292	11/30/2009	32.5	211.8	40.6	73.1
293	12/1/2009	574.2	4,076.3	717.8	1,292.0
294	12/2/2009	103.8	677.3	129.7	233.4
295	12/3/2009	25.9	169.2	32.4	58.4
296	12/4/2009	6.5	42.8	8.1	14.6
297	12/5/2009	1.6	10.5	2.0	3.6
298	12/6/2009	0.3	2.1	0.4	0.7
299	12/15/2009	1,898.5	13,695.0	2,373.1	4,271.6
300	12/16/2009	1,894.2	13,455.0	2,367.7	4,261.9
301	12/17/2009	1,709.8	11,704.0	2,137.3	3,847.1
302	12/18/2009	461.3	3,003.7	576.6	1,037.8
303	12/19/2009	928.0	6,682.8	1,160.0	2,088.0
304	12/20/2009	852.4	5,934.9	1,065.5	1,917.9
305	12/21/2009	3,687.4	25,598.0	4,609.3	8,296.7
306	12/22/2009	839.3	5,484.7	1,049.1	1,888.3
307	12/23/2009	211.3	1,377.3	264.1	475.3
308	12/24/2009	52.8	344.1	66.0	118.8
309	12/25/2009	13.2	86.6	16.5	29.7
310	12/26/2009	3.3	21.5	4.1	7.4
311	12/27/2009	0.8	5.4	1.0	1.9
312	12/28/2009	0.1	0.4	0.1	0.2
313	12/31/2009	243.3	1,922.4	304.2	547.5
314	1/1/2010	876.2	6,332.0	1,095.3	1,971.5
315	1/2/2010	1,429.2	10,080.0	1,786.5	3,215.7
316	1/3/2010	417.9	2,725.6	522.4	940.3
317	1/4/2010	4,955.3	34,383.0	6,194.1	11,149.0
318	1/5/2010	1,997.6	13,726.0	2,497.0	4,494.6
319	1/6/2010	628.7	4,103.3	785.8	1,414.5
320	1/7/2010	157.2	1,023.0	196.5	353.6
321	1/8/2010	639.7	4,831.9	799.6	1,439.3
322	1/9/2010	4,481.0	30,738.0	5,601.2	10,082.0
323	1/10/2010	565.8	3,686.3	707.2	1,273.0
324	1/11/2010	7,478.1	51,394.0	9,347.6	16,826.0

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
325	1/12/2010	3,001.4	20,787.0	3,751.8	6,753.2
326	1/13/2010	2,243.3	15,113.0	2,804.1	5,047.4
327	1/14/2010	1,852.1	12,851.0	2,315.1	4,167.2
328	1/15/2010	3,213.5	22,269.0	4,016.8	7,230.3
329	1/16/2010	1,312.0	8,583.6	1,640.1	2,952.1
330	1/17/2010	420.6	2,896.3	525.8	946.4
331	1/18/2010	352.0	2,451.3	440.0	792.0
332	1/19/2010	97.0	633.4	121.3	218.2
333	1/20/2010	24.2	158.3	30.3	54.6
334	1/21/2010	6.1	40.1	7.6	13.6
335	1/22/2010	1.5	9.9	1.9	3.4
336	1/23/2010	0.3	1.9	0.4	0.7
337	1/24/2010	95.2	785.6	119.0	214.1
338	1/25/2010	1,704.5	11,908.0	2,130.6	3,835.1
339	1/26/2010	331.8	2,162.2	414.7	746.4
340	1/27/2010	82.9	540.0	103.7	186.6
341	1/28/2010	20.7	135.6	25.9	46.7
342	1/29/2010	5.2	33.7	6.5	11.7
343	1/30/2010	28.2	294.9	35.2	63.4
344	1/31/2010	271.2	2,052.8	339.0	610.2
345	2/1/2010	142.6	935.0	178.3	320.9
346	2/2/2010	132.6	989.6	165.7	298.2
347	2/3/2010	486.1	3,539.9	607.6	1,093.7
348	2/4/2010	922.5	6,361.4	1,153.1	2,075.5
349	2/5/2010	476.3	3,395.6	595.4	1,071.8
350	2/6/2010	204.0	1,335.1	255.0	459.0
351	2/7/2010	1,196.1	8,512.1	1,495.1	2,691.3
352	2/8/2010	438.9	2,860.9	548.7	987.6
353	2/9/2010	109.7	714.3	137.2	246.9
354	2/10/2010	27.4	179.2	34.3	61.7
355	2/11/2010	386.3	2,892.1	482.9	869.1
356	2/12/2010	1,190.7	8,479.3	1,488.4	2,679.0
357	2/13/2010	1,331.5	9,301.1	1,664.4	2,995.9
358	2/14/2010	3,457.8	23,924.0	4,322.2	7,779.9
359	2/15/2010	874.7	5,696.6	1,093.3	1,968.0
360	2/16/2010	1,161.3	8,175.9	1,451.6	2,613.0
361	2/17/2010	418.9	2,732.4	523.7	942.6
362	2/18/2010	104.7	681.9	130.9	235.7
363	2/19/2010	26.2	171.1	32.7	58.9
364	2/20/2010	6.5	42.5	8.2	14.7
365	2/21/2010	1.6	10.6	2.0	3.7
366	2/22/2010	0.3	2.1	0.4	0.7
367	2/24/2010	701.2	5,388.2	876.5	1,577.7
368	2/25/2010	736.7	5,027.3	920.9	1,657.6
369	2/26/2010	1,117.6	7,902.2	1,397.0	2,514.6
370	2/27/2010	1,107.2	7,797.8	1,384.0	2,491.2
371	2/28/2010	429.3	2,836.0	536.6	965.9

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
372	3/1/2010	107.3	699.4	134.2	241.5
373	3/2/2010	26.8	174.9	33.5	60.4
374	3/3/2010	6.7	44.2	8.4	15.1
375	3/4/2010	1.7	10.9	2.1	3.8
376	3/5/2010	0.4	2.3	0.4	0.8
377	3/8/2010	1.7	14.8	2.2	3.9
378	3/9/2010	2.1	25.1	2.6	4.7
379	3/10/2010	2.0	23.1	2.5	4.5
380	3/11/2010	48.4	567.1	60.5	108.9
381	3/12/2010	4,671.2	32,663.0	5,838.9	10,510.0
382	3/13/2010	1,091.2	7,110.4	1,364.0	2,455.2
383	3/14/2010	272.8	1,774.6	341.0	613.8
384	3/15/2010	68.2	443.7	85.2	153.5
385	3/16/2010	17.1	111.4	21.3	38.4
386	3/17/2010	4.3	27.7	5.3	9.6
387	3/18/2010	1.1	6.9	1.3	2.4
388	3/19/2010	0.1	0.9	0.2	0.3
389	3/25/2010	63.1	889.9	78.9	142.1
390	3/26/2010	1,201.5	8,650.5	1,501.8	2,703.3
391	3/27/2010	197.5	1,287.1	246.9	444.4
392	3/28/2010	851.8	5,929.0	1,064.7	1,916.5
393	3/29/2010	4,538.2	31,498.0	5,672.7	10,211.0
394	3/30/2010	3,925.2	26,804.0	4,906.6	8,831.8
395	3/31/2010	1,001.7	6,652.2	1,252.1	2,253.8
396	4/1/2010	258.1	1,680.4	322.6	580.7
397	4/2/2010	1,260.3	8,931.0	1,575.3	2,835.6
398	4/3/2010	2,834.8	19,461.0	3,543.4	6,378.2
399	4/4/2010	825.2	5,534.6	1,031.4	1,856.6
400	4/5/2010	401.8	2,746.1	502.2	904.0
401	4/6/2010	240.5	1,663.1	300.6	541.0
402	4/7/2010	79.8	534.3	99.7	179.5
403	4/8/2010	99.1	713.5	123.9	223.0
404	4/9/2010	24.6	162.8	30.7	55.3
405	4/10/2010	6.1	40.6	7.7	13.8
406	4/11/2010	1.5	10.7	1.9	3.5
407	4/12/2010	0.3	1.9	0.4	0.7
408	4/13/2010	6.0	126.6	7.5	13.6
409	4/14/2010	4.2	36.8	5.3	9.5
410	4/15/2010	1.1	8.0	1.3	2.4
411	4/16/2010	0.1	1.8	0.2	0.3
412	4/18/2010	39.6	609.4	49.4	89.0
413	4/19/2010	10.5	71.9	13.1	23.6
414	4/20/2010	2.6	17.8	3.3	5.9
415	4/21/2010	3,808.6	26,919.0	4,760.8	8,569.4
416	4/22/2010	672.7	4,389.9	840.8	1,513.5
417	4/23/2010	168.2	1,094.5	210.2	378.4
418	4/24/2010	42.0	273.7	52.6	94.6

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
419	4/25/2010	10.5	68.9	13.1	23.6
420	4/26/2010	2.6	17.1	3.3	5.9
421	4/27/2010	405.0	3,180.9	506.3	911.3
422	4/28/2010	702.8	4,835.3	878.5	1,581.3
423	4/29/2010	384.1	2,663.4	480.1	864.1
424	4/30/2010	101.2	660.5	126.5	227.7
425	5/1/2010	25.3	165.1	31.6	56.9
426	5/2/2010	6.3	41.8	7.9	14.2
427	5/3/2010	372.2	3,003.1	465.3	837.5
428	5/4/2010	96.0	630.2	120.1	216.1
429	5/5/2010	24.6	162.4	30.7	55.3
430	5/6/2010	6.7	50.7	8.4	15.1
431	5/7/2010	1.7	11.9	2.1	3.8
432	5/8/2010	0.4	3.1	0.4	0.8
433	5/10/2010	5.3	183.2	6.6	11.9
434	5/11/2010	2.5	28.1	3.2	5.7
435	5/12/2010	0.6	5.3	0.8	1.4
436	5/18/2010	0.0	1.9	0.0	0.1
437	5/19/2010	1.7	150.1	2.1	3.9
438	5/20/2010	11.4	367.1	14.2	25.6
439	5/21/2010	12.1	410.1	15.2	27.3
440	5/22/2010	3.2	26.2	3.9	7.1
441	5/23/2010	0.8	6.0	1.0	1.8
442	5/24/2010	0.1	1.2	0.1	0.1
443	5/26/2010	4.8	235.3	5.9	10.7
444	5/27/2010	7.8	113.6	9.8	17.6
445	5/28/2010	147.7	1,966.1	184.6	332.3
446	5/29/2010	204.9	1,378.6	256.2	461.1
447	5/30/2010	51.2	334.8	64.0	115.3
448	5/31/2010	419.5	3,386.9	524.4	943.9
449	6/1/2010	309.2	2,041.5	386.4	695.6
450	6/2/2010	925.2	6,899.7	1,156.4	2,081.6
451	6/3/2010	551.2	3,613.2	689.0	1,240.1
452	6/4/2010	220.9	1,607.0	276.1	497.0
453	6/5/2010	105.3	693.9	131.6	236.8
454	6/6/2010	217.9	1,879.8	272.4	490.3
455	6/7/2010	131.7	869.6	164.6	296.2
456	6/8/2010	32.9	215.2	41.1	74.1
457	6/9/2010	633.2	4,951.4	791.5	1,424.8
458	6/10/2010	468.7	3,323.3	585.8	1,054.5
459	6/11/2010	248.2	1,627.8	310.2	558.4
460	6/12/2010	62.0	404.6	77.6	139.6
461	6/13/2010	15.5	101.2	19.4	34.9
462	6/14/2010	3.9	25.8	4.8	8.7
463	6/15/2010	1.0	6.3	1.2	2.2
464	6/16/2010	30.2	692.6	37.7	67.9
465	6/17/2010	14.8	104.8	18.5	33.3

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
466	6/18/2010	3.7	25.1	4.6	8.3
467	6/19/2010	0.9	6.9	1.2	2.1
468	6/20/2010	3.4	183.0	4.2	7.6
469	6/21/2010	5.7	92.9	7.2	12.9
470	6/22/2010	1.4	11.2	1.8	3.2
471	6/23/2010	0.3	2.2	0.3	0.6
472	7/2/2010	0.0	5.3	0.0	0.1
473	8/8/2010	5.7	198.8	7.1	12.9
474	8/9/2010	1.3	11.1	1.7	3.0
475	8/10/2010	0.2	2.1	0.3	0.5
476	8/31/2010	9.2	676.3	11.5	20.8
477	9/1/2010	9.6	84.8	12.0	21.7
478	9/2/2010	2.4	17.1	3.0	5.4
479	9/3/2010	0.6	4.3	0.7	1.3
480	9/8/2010	666.1	5,882.4	832.6	1,498.7
481	9/9/2010	179.0	1,176.2	223.8	402.8
482	9/10/2010	44.8	292.2	55.9	100.7
483	9/11/2010	11.2	73.1	14.0	25.2
484	9/12/2010	2.8	18.7	3.5	6.3
485	9/13/2010	0.7	4.5	0.9	1.6
486	9/14/2010	0.0	0.2	0.0	0.1
487	9/16/2010	6.0	429.9	7.5	13.5
488	9/17/2010	799.5	6,279.5	999.4	1,798.9
489	9/18/2010	15,102.0	102,890.0	18,878.0	33,980.0
490	9/19/2010	4,645.2	32,079.0	5,806.5	10,452.0
491	9/20/2010	1,012.3	6,609.1	1,265.4	2,277.7
492	9/21/2010	253.1	1,646.6	316.4	569.4
493	9/22/2010	63.3	411.7	79.1	142.4
494	9/23/2010	84.2	832.8	105.2	189.4
495	9/24/2010	99.0	676.4	123.8	222.8
496	9/25/2010	24.8	162.6	30.9	55.7
497	9/26/2010	432.4	3,449.6	540.5	972.9
498	9/27/2010	256.7	1,685.8	320.9	577.6
499	9/28/2010	64.2	418.5	80.2	144.4
500	9/29/2010	16.0	104.7	20.1	36.1
501	9/30/2010	4.0	26.6	5.0	9.0
502	10/1/2010	1.0	6.5	1.3	2.3
503	10/2/2010	0.1	0.8	0.2	0.3
504	10/9/2010	56.1	1,268.3	70.2	126.3
505	10/10/2010	10,123.0	69,964.0	12,653.0	22,776.0
506	10/11/2010	1,278.2	8,385.4	1,597.8	2,876.0
507	10/12/2010	322.2	2,097.3	402.8	725.0
508	10/13/2010	80.6	524.3	100.7	181.3
509	10/14/2010	20.1	131.6	25.2	45.3
510	10/15/2010	20.7	171.8	25.9	46.7
511	10/16/2010	5.9	40.5	7.4	13.3
512	10/17/2010	1.5	10.1	1.8	3.3

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
513	10/18/2010	0.3	2.5	0.4	0.6
514	10/24/2010	2,119.5	15,827.0	2,649.4	4,768.9
515	10/25/2010	7,330.6	50,715.0	9,163.3	16,494.0
516	10/26/2010	3,434.2	23,196.0	4,292.7	7,726.9
517	10/27/2010	1,019.7	6,698.3	1,274.6	2,294.2
518	10/28/2010	257.0	1,683.5	321.3	578.3
519	10/29/2010	77.2	524.4	96.4	173.6
520	10/30/2010	435.2	3,298.1	543.9	979.1
521	10/31/2010	1,735.3	12,039.0	2,169.1	3,904.4
522	11/1/2010	12,420.0	84,676.0	15,525.0	27,945.0
523	11/2/2010	1,935.4	12,881.0	2,419.2	4,354.6
524	11/3/2010	468.3	3,048.5	585.4	1,053.7
525	11/4/2010	117.1	761.8	146.4	263.4
526	11/5/2010	29.3	191.0	36.6	65.9
527	11/6/2010	725.8	5,469.1	907.3	1,633.1
528	11/7/2010	3,478.1	24,050.0	4,347.6	7,825.7
529	11/8/2010	653.7	4,321.0	817.1	1,470.8
530	11/9/2010	497.5	3,590.8	621.8	1,119.3
531	11/10/2010	430.8	2,936.3	538.5	969.2
532	11/11/2010	110.8	725.5	138.5	249.4
533	11/12/2010	560.5	3,955.2	700.7	1,261.2
534	11/13/2010	143.0	1,016.1	178.8	321.8
535	11/14/2010	867.3	6,415.3	1,084.2	1,951.5
536	11/15/2010	473.8	3,294.7	592.3	1,066.1
537	11/16/2010	424.5	2,975.5	530.6	955.1
538	11/17/2010	188.5	1,448.8	235.6	424.1
539	11/18/2010	675.8	4,906.7	844.7	1,520.5
540	11/19/2010	390.6	2,680.3	488.2	878.8
541	11/20/2010	200.3	1,392.7	250.4	450.7
542	11/21/2010	50.3	329.1	62.9	113.2
543	11/22/2010	61.8	531.5	77.2	139.0
544	11/23/2010	225.4	1,608.0	281.8	507.2
545	11/24/2010	56.1	367.3	70.1	126.2
546	11/25/2010	14.0	91.8	17.5	31.6
547	11/26/2010	139.0	1,117.3	173.8	312.8
548	11/27/2010	598.2	4,289.0	747.7	1,345.9
549	11/28/2010	156.3	1,037.8	195.4	351.8
550	11/29/2010	40.7	268.2	50.9	91.7
551	11/30/2010	2,090.6	15,222.0	2,613.3	4,703.9
552	12/1/2010	1,375.1	9,178.0	1,718.8	3,093.9
553	12/2/2010	347.8	2,263.5	434.8	782.6
554	12/3/2010	87.0	565.8	108.7	195.6
555	12/4/2010	21.7	142.0	27.2	48.9
556	12/5/2010	5.4	35.3	6.8	12.2
557	12/6/2010	1.4	8.8	1.7	3.1
558	12/7/2010	0.2	1.6	0.3	0.5
559	12/8/2010	3,638.6	25,522.0	4,548.3	8,187.0

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
560	12/9/2010	3,706.8	25,503.0	4,633.5	8,340.3
561	12/10/2010	3,627.2	24,675.0	4,534.0	8,161.2
562	12/11/2010	1,824.0	12,483.0	2,279.9	4,103.9
563	12/12/2010	32,023.0	217,420.0	40,029.0	72,053.0
564	12/13/2010	2,550.0	16,925.0	3,187.5	5,737.5
565	12/14/2010	6,095.6	41,861.0	7,619.5	13,715.0
566	12/15/2010	3,811.4	25,701.0	4,764.2	8,575.6
567	12/16/2010	763.7	5,256.8	954.6	1,718.2
568	12/17/2010	210.4	1,374.7	263.0	473.4
569	12/18/2010	72.2	498.1	90.3	162.5
570	12/19/2010	264.0	1,912.6	330.0	594.1
571	12/20/2010	401.5	2,847.4	501.9	903.4
572	12/21/2010	142.3	958.8	177.9	320.2
573	12/22/2010	35.6	234.1	44.5	80.2
574	12/23/2010	704.5	5,031.0	880.7	1,585.2
575	12/24/2010	640.4	4,458.9	800.5	1,440.9
576	12/25/2010	2,808.5	19,698.0	3,510.7	6,319.2
577	12/26/2010	1,872.8	12,708.0	2,341.0	4,213.7
578	12/27/2010	783.2	5,511.5	979.1	1,762.3
579	12/28/2010	2,436.8	16,782.0	3,046.0	5,482.7
580	12/29/2010	497.8	3,353.6	622.2	1,120.0
581	12/30/2010	244.8	1,646.6	306.0	550.8
582	12/31/2010	61.5	402.0	76.9	138.4
583	1/1/2011	15.4	100.5	19.2	34.6
584	1/2/2011	3.8	25.6	4.8	8.7
585	1/3/2011	1.0	6.2	1.2	2.2
586	1/4/2011	0.1	0.7	0.1	0.2
587	1/5/2011	56.6	444.3	70.7	127.3
588	1/6/2011	77.7	605.7	97.2	174.9
589	1/7/2011	1,211.0	8,895.2	1,513.8	2,724.8
590	1/8/2011	991.9	6,664.7	1,239.9	2,231.8
591	1/9/2011	274.5	1,812.2	343.1	617.5
592	1/10/2011	69.2	451.5	86.5	155.6
593	1/11/2011	17.3	112.9	21.6	38.9
594	1/12/2011	4,173.2	29,362.0	5,216.4	9,389.6
595	1/13/2011	7,085.7	48,517.0	8,857.2	15,943.0
596	1/14/2011	3,170.6	21,538.0	3,963.2	7,133.8
597	1/15/2011	1,762.4	11,845.0	2,202.9	3,965.3
598	1/16/2011	3,373.8	23,443.0	4,217.3	7,591.1
599	1/17/2011	1,123.3	7,465.4	1,404.1	2,527.3
600	1/18/2011	321.4	2,135.2	401.7	723.0
601	1/19/2011	215.0	1,482.6	268.8	483.8
602	1/20/2011	53.8	351.7	67.2	121.0
603	1/21/2011	1,905.2	13,474.0	2,381.5	4,286.6
604	1/22/2011	752.1	4,917.9	940.2	1,692.3
605	1/23/2011	187.7	1,221.4	234.6	422.2
606	1/24/2011	300.6	2,281.0	375.8	676.4

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
607	1/25/2011	435.5	2,995.1	544.3	979.8
608	1/26/2011	111.5	727.4	139.4	250.9
609	1/27/2011	27.9	181.8	34.8	62.7
610	1/28/2011	7.0	46.0	8.7	15.7
611	1/29/2011	621.2	4,720.8	776.6	1,397.8
612	1/30/2011	650.4	4,284.4	813.0	1,463.4
613	1/31/2011	162.6	1,058.8	203.3	365.9
614	2/1/2011	40.7	264.7	50.8	91.5
615	2/2/2011	10.2	66.7	12.7	22.9
616	2/3/2011	2.5	16.5	3.2	5.7
617	2/4/2011	0.6	4.1	0.8	1.4
618	2/5/2011	18.0	170.0	22.5	40.6
619	2/6/2011	221.0	1,718.6	276.3	497.3
620	2/7/2011	758.6	5,300.8	948.3	1,706.9
621	2/8/2011	247.0	1,691.5	308.7	555.7
622	2/9/2011	64.4	421.2	80.5	145.0
623	2/10/2011	16.1	105.3	20.1	36.2
624	2/11/2011	4.0	26.8	5.0	9.1
625	2/12/2011	1.0	6.5	1.3	2.3
626	2/13/2011	1,865.0	13,000.0	2,331.2	4,196.2
627	2/14/2011	1,977.3	14,113.0	2,471.6	4,448.9
628	2/15/2011	2,594.9	17,558.0	3,243.6	5,838.5
629	2/16/2011	645.3	4,287.6	806.6	1,452.0
630	2/17/2011	525.6	3,728.6	657.0	1,182.7
631	2/18/2011	259.0	1,692.9	323.8	582.8
632	2/19/2011	64.8	422.0	81.0	145.7
633	2/20/2011	16.2	106.1	20.2	36.4
634	2/21/2011	4.0	26.3	5.1	9.1
635	2/22/2011	1.0	6.6	1.3	2.3
636	2/23/2011	0.1	0.8	0.2	0.3
637	2/24/2011	815.5	5,723.3	1,019.4	1,834.9
638	2/25/2011	194.5	1,268.6	243.2	437.7
639	2/26/2011	48.6	316.9	60.8	109.4
640	2/27/2011	12.2	79.8	15.2	27.4
641	2/28/2011	4,763.1	32,999.0	5,953.9	10,717.0
642	3/1/2011	964.9	6,562.6	1,206.1	2,171.1
643	3/2/2011	890.5	6,170.0	1,113.1	2,003.6
644	3/3/2011	587.3	4,135.5	734.1	1,321.4
645	3/4/2011	605.7	4,116.4	757.1	1,362.8
646	3/5/2011	462.5	3,235.4	578.1	1,040.6
647	3/6/2011	129.7	847.1	162.2	291.9
648	3/7/2011	32.4	211.6	40.5	73.0
649	3/8/2011	94.4	730.1	118.0	212.4
650	3/9/2011	4,835.6	33,478.0	6,044.5	10,880.0
651	3/10/2011	10,974.0	74,405.0	13,717.0	24,691.0
652	3/11/2011	1,275.5	8,416.9	1,594.3	2,869.8
653	3/12/2011	1,500.2	10,427.0	1,875.3	3,375.5

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
654	3/13/2011	1,276.9	8,813.2	1,596.1	2,873.0
655	3/14/2011	1,669.6	11,549.0	2,087.0	3,756.6
656	3/15/2011	996.1	6,907.0	1,245.1	2,241.3
657	3/16/2011	1,230.0	8,606.6	1,537.4	2,767.4
658	3/17/2011	443.8	2,894.8	554.7	998.5
659	3/18/2011	110.9	722.3	138.7	249.6
660	3/19/2011	926.7	6,481.5	1,158.3	2,085.0
661	3/20/2011	187.0	1,218.3	233.7	420.6
662	3/21/2011	46.7	304.5	58.4	105.2
663	3/22/2011	11.7	76.7	14.6	26.3
664	3/23/2011	2.9	19.0	3.7	6.6
665	3/24/2011	0.7	4.7	0.9	1.6
666	3/25/2011	1,044.7	7,565.5	1,305.9	2,350.6
667	3/26/2011	1,040.1	7,283.2	1,300.2	2,340.3
668	3/27/2011	1,007.5	7,095.5	1,259.3	2,266.8
669	3/28/2011	866.2	5,864.8	1,082.8	1,949.0
670	3/29/2011	658.6	4,682.4	823.3	1,481.9
671	3/30/2011	663.6	4,810.3	829.5	1,493.1
672	3/31/2011	2,360.2	16,322.0	2,950.3	5,310.6
673	4/1/2011	3,869.2	26,516.0	4,836.5	8,705.7
674	4/2/2011	6,358.5	43,412.0	7,948.1	14,307.0
675	4/3/2011	1,605.0	10,635.0	2,006.2	3,611.2
676	4/4/2011	479.8	3,300.9	599.7	1,079.5
677	4/5/2011	808.0	5,661.5	1,010.0	1,818.0
678	4/6/2011	747.1	5,186.7	933.9	1,681.0
679	4/7/2011	587.0	4,092.4	733.7	1,320.7
680	4/8/2011	206.8	1,352.9	258.5	465.3
681	4/9/2011	51.7	337.1	64.6	116.3
682	4/10/2011	12.9	84.9	16.2	29.1
683	4/11/2011	30.4	237.4	38.0	68.4
684	4/12/2011	13.2	89.3	16.6	29.8
685	4/13/2011	3.3	22.2	4.1	7.4
686	4/14/2011	928.7	6,664.0	1,160.9	2,089.5
687	4/15/2011	974.9	6,710.8	1,218.6	2,193.5
688	4/16/2011	323.7	2,271.5	404.7	728.4
689	4/17/2011	126.1	826.7	157.7	283.8
690	4/18/2011	31.5	205.9	39.4	70.9
691	4/19/2011	7.9	52.1	9.9	17.7
692	4/20/2011	2.0	12.8	2.5	4.4
693	4/21/2011	0.5	2.9	0.6	1.0
694	4/25/2011	693.8	5,875.5	867.3	1,561.1
695	4/26/2011	477.9	3,152.5	597.3	1,075.2
696	4/27/2011	119.9	783.6	149.9	269.8
697	4/28/2011	1,783.1	12,497.0	2,228.8	4,011.9
698	4/29/2011	310.5	2,023.5	388.1	698.5
699	4/30/2011	85.1	578.1	106.4	191.5
700	5/1/2011	24.6	166.6	30.8	55.4

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
701	5/2/2011	34.5	348.0	43.1	77.6
702	5/3/2011	44.5	316.1	55.6	100.0
703	5/4/2011	11.1	73.8	13.9	25.0
704	5/5/2011	2.8	18.5	3.5	6.3
705	5/6/2011	0.7	5.1	0.9	1.6
706	5/7/2011	0.2	24.8	0.2	0.4
707	5/11/2011	2.7	281.8	3.3	6.0
708	5/12/2011	66.7	875.3	83.3	150.0
709	5/13/2011	17.6	117.3	22.0	39.6
710	5/14/2011	4.4	29.3	5.5	9.9
711	5/15/2011	9,550.0	66,392.0	11,938.0	21,488.0
712	5/16/2011	1,717.6	11,216.0	2,147.0	3,864.7
713	5/17/2011	429.4	2,793.0	536.8	966.2
714	5/18/2011	107.4	698.3	134.2	241.5
715	5/19/2011	26.8	175.1	33.5	60.4
716	5/20/2011	6.7	43.6	8.4	15.1
717	5/21/2011	1.7	10.9	2.1	3.8
718	5/22/2011	0.4	2.3	0.4	0.8
719	5/25/2011	4.4	143.6	5.5	9.9
720	5/26/2011	29.4	815.3	36.8	66.2
721	5/27/2011	5.6	39.5	7.0	12.7
722	5/28/2011	1.4	9.8	1.8	3.2
723	5/29/2011	0.3	2.4	0.3	0.6
724	6/2/2011	4.6	203.9	5.8	10.4
725	6/3/2011	2.2	19.6	2.8	5.1
726	6/4/2011	0.5	4.4	0.7	1.2
727	6/7/2011	0.8	82.8	1.0	1.7
728	6/8/2011	7.2	237.8	9.0	16.2
729	6/9/2011	1.6	12.8	2.0	3.6
730	6/10/2011	0.3	2.7	0.4	0.7
731	6/18/2011	7.7	432.7	9.6	17.4
732	6/19/2011	14.2	322.7	17.7	31.8
733	6/20/2011	4.6	34.5	5.7	10.3
734	6/21/2011	1.1	8.2	1.4	2.6
735	6/22/2011	0.2	1.9	0.2	0.4
736	6/24/2011	0.6	25.8	0.7	1.3
737	6/25/2011	7.8	222.1	9.8	17.6
738	6/26/2011	1.5	12.7	1.9	3.4
739	6/27/2011	0.3	2.5	0.4	0.6
740	7/16/2011	10.4	635.3	13.0	23.5
741	7/17/2011	9.1	73.5	11.3	20.4
742	7/18/2011	2.3	16.0	2.8	5.1
743	7/19/2011	0.5	3.9	0.7	1.2
744	9/18/2011	14.0	725.0	17.5	31.6
745	9/19/2011	9.3	175.8	11.6	20.9
746	9/20/2011	2.1	17.2	2.7	4.8
747	9/21/2011	0.5	3.9	0.6	1.1

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
748	9/25/2011	4.5	175.3	5.7	10.2
749	9/26/2011	109.8	2,048.2	137.2	247.0
750	9/27/2011	215.1	1,478.2	268.9	484.0
751	9/28/2011	53.8	351.6	67.2	121.0
752	9/29/2011	13.4	87.9	16.8	30.3
753	9/30/2011	3.4	22.5	4.2	7.6
754	10/1/2011	0.8	5.5	1.1	1.9
755	10/2/2011	0.1	0.5	0.1	0.2
756	10/3/2011	160.4	1,813.0	200.5	360.8
757	10/4/2011	64.4	538.1	80.5	144.8
758	10/5/2011	51.6	478.8	64.5	116.1
759	10/6/2011	179.4	1,515.0	224.3	403.7
760	10/7/2011	98.4	697.5	123.0	221.3
761	10/8/2011	38.7	260.6	48.4	87.1
762	10/9/2011	59.0	522.0	73.8	132.8
763	10/10/2011	75.5	571.9	94.3	169.8
764	10/11/2011	3,732.4	26,468.0	4,665.5	8,397.8
765	10/12/2011	2,022.3	13,744.0	2,527.9	4,550.2
766	10/13/2011	447.2	2,910.7	559.0	1,006.2
767	10/14/2011	111.8	727.5	139.8	251.6
768	10/15/2011	28.0	182.4	34.9	62.9
769	10/16/2011	7.0	45.4	8.7	15.7
770	10/17/2011	1.7	11.4	2.2	3.9
771	10/18/2011	0.4	2.4	0.5	0.8
772	10/22/2011	989.8	7,703.4	1,237.3	2,227.1
773	10/23/2011	874.2	5,945.3	1,092.7	1,966.9
774	10/24/2011	213.6	1,390.9	267.0	480.6
775	10/25/2011	53.4	347.7	66.7	120.2
776	10/26/2011	13.4	87.5	16.7	30.0
777	10/27/2011	3.3	21.7	4.2	7.5
778	10/28/2011	1,310.7	9,289.0	1,638.4	2,949.1
779	10/29/2011	792.9	5,452.6	991.1	1,784.0
780	10/30/2011	346.6	2,525.5	433.2	779.8
781	10/31/2011	188.1	1,237.8	235.1	423.3
782	11/1/2011	47.0	307.0	58.8	105.8
783	11/2/2011	11.8	76.8	14.7	26.5
784	11/3/2011	1,504.2	10,537.0	1,880.2	3,384.4
785	11/4/2011	216.2	1,446.3	270.3	486.5
786	11/5/2011	63.1	425.1	78.9	141.9
787	11/6/2011	15.8	103.8	19.7	35.5
788	11/7/2011	3.9	26.0	4.9	8.9
789	11/8/2011	1.0	7.0	1.2	2.2
790	11/9/2011	0.1	0.8	0.2	0.3
791	11/11/2011	167.5	1,346.6	209.4	376.9
792	11/12/2011	305.1	2,219.0	381.3	686.4
793	11/13/2011	710.4	5,120.6	888.0	1,598.4
794	11/14/2011	176.3	1,151.3	220.4	396.8

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
795	11/15/2011	44.1	287.4	55.1	99.2
796	11/16/2011	362.4	2,820.1	453.0	815.3
797	11/17/2011	1,499.0	10,533.0	1,873.7	3,372.6
798	11/18/2011	1,420.8	10,015.0	1,776.0	3,196.7
799	11/19/2011	405.0	2,663.2	506.3	911.3
800	11/20/2011	101.3	659.8	126.6	227.8
801	11/21/2011	568.8	4,219.0	711.0	1,279.8
802	11/22/2011	6,319.6	43,689.0	7,899.5	14,219.0
803	11/23/2011	11,744.0	80,021.0	14,680.0	26,424.0
804	11/24/2011	1,622.4	10,806.0	2,028.0	3,650.4
805	11/25/2011	1,258.7	8,580.7	1,573.3	2,832.0
806	11/26/2011	289.2	1,882.4	361.5	650.7
807	11/27/2011	1,801.3	12,804.0	2,251.6	4,053.0
808	11/28/2011	893.5	5,877.6	1,116.8	2,010.3
809	11/29/2011	223.4	1,453.9	279.2	502.6
810	11/30/2011	156.7	1,143.6	195.9	352.7
811	12/1/2011	52.4	344.0	65.5	117.8
812	12/2/2011	13.1	85.8	16.4	29.5
813	12/3/2011	3.3	22.0	4.1	7.4
814	12/4/2011	0.8	5.3	1.0	1.8
815	12/5/2011	0.1	0.4	0.1	0.1
816	12/18/2011	26.3	370.7	32.9	59.2
817	12/19/2011	34.1	244.1	42.7	76.8
818	12/20/2011	8.5	57.0	10.7	19.2
819	12/21/2011	2.1	14.3	2.7	4.8
820	12/22/2011	0.5	3.8	0.6	1.1
821	12/27/2011	56.5	678.5	70.7	127.2
822	12/28/2011	5,214.4	36,391.0	6,518.0	11,732.0
823	12/29/2011	4,581.8	31,005.0	5,727.2	10,309.0
824	12/30/2011	1,789.7	12,538.0	2,237.1	4,026.7
825	12/31/2011	500.6	3,261.5	625.7	1,126.2
826	1/1/2012	125.1	814.4	156.4	281.6
827	1/2/2012	32.7	213.8	40.8	73.5
828	1/3/2012	2,429.9	16,795.0	3,037.4	5,467.3
829	1/4/2012	4,630.7	31,756.0	5,788.3	10,419.0
830	1/5/2012	1,937.4	13,201.0	2,421.7	4,359.1
831	1/6/2012	439.9	2,875.6	549.8	989.7
832	1/7/2012	231.9	1,673.1	289.9	521.8
833	1/8/2012	61.0	399.1	76.2	137.2
834	1/9/2012	15.2	99.7	19.0	34.3
835	1/10/2012	438.2	3,200.0	547.8	986.0
836	1/11/2012	149.3	978.8	186.7	336.0
837	1/12/2012	37.3	243.7	46.7	84.0
838	1/13/2012	9.3	61.5	11.7	21.0
839	1/14/2012	110.7	883.0	138.3	249.0
840	1/15/2012	583.9	4,210.0	729.9	1,313.9
841	1/16/2012	495.7	3,332.9	619.6	1,115.3

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
842	1/17/2012	1,094.3	8,058.4	1,367.9	2,462.2
843	1/18/2012	4,623.6	32,111.0	5,779.5	10,403.0
844	1/19/2012	8,528.8	58,380.0	10,661.0	19,190.0
845	1/20/2012	3,306.9	22,446.0	4,133.6	7,440.5
846	1/21/2012	3,015.6	20,624.0	3,769.5	6,785.2
847	1/22/2012	974.4	6,639.2	1,218.0	2,192.3
848	1/23/2012	858.7	5,831.9	1,073.3	1,932.0
849	1/24/2012	512.2	3,707.7	640.2	1,152.4
850	1/25/2012	1,449.8	10,307.0	1,812.3	3,262.1
851	1/26/2012	1,962.6	13,576.0	2,453.2	4,415.8
852	1/27/2012	665.6	4,340.9	832.0	1,497.6
853	1/28/2012	166.4	1,082.9	208.0	374.4
854	1/29/2012	2,642.6	18,709.0	3,303.3	5,945.9
855	1/30/2012	5,254.2	35,704.0	6,567.7	11,822.0
856	1/31/2012	915.3	5,987.4	1,144.1	2,059.4
857	2/1/2012	3,484.9	24,161.0	4,356.1	7,840.9
858	2/2/2012	774.9	5,058.4	968.6	1,743.4
859	2/3/2012	193.7	1,260.6	242.1	435.9
860	2/4/2012	48.4	315.2	60.5	109.0
861	2/5/2012	12.1	79.3	15.1	27.2
862	2/6/2012	3.0	19.7	3.8	6.8
863	2/7/2012	0.8	4.9	0.9	1.7
864	2/8/2012	1.6	11.4	2.0	3.6
865	2/9/2012	47.3	485.8	59.1	106.4
866	2/10/2012	77.6	544.7	97.0	174.5
867	2/11/2012	352.2	2,581.4	440.2	792.4
868	2/12/2012	103.1	681.3	128.9	232.0
869	2/13/2012	1,778.8	12,816.0	2,223.5	4,002.3
870	2/14/2012	1,024.4	6,907.5	1,280.4	2,304.8
871	2/15/2012	391.0	2,597.2	488.8	879.8
872	2/16/2012	125.1	877.7	156.3	281.4
873	2/17/2012	743.9	5,169.6	929.9	1,673.7
874	2/18/2012	4,603.6	31,981.0	5,754.5	10,358.0
875	2/19/2012	960.9	6,289.4	1,201.1	2,162.0
876	2/20/2012	240.7	1,567.0	300.9	541.7
877	2/21/2012	214.8	1,567.8	268.5	483.3
878	2/22/2012	2,456.8	17,008.0	3,071.1	5,527.9
879	2/23/2012	545.8	3,567.4	682.2	1,228.0
880	2/24/2012	367.9	2,519.4	459.8	827.7
881	2/25/2012	2,368.7	16,324.0	2,960.9	5,329.6
882	2/26/2012	331.5	2,181.3	414.3	745.8
883	2/27/2012	102.8	685.1	128.5	231.3
884	2/28/2012	25.7	168.4	32.1	57.8
885	2/29/2012	263.2	1,934.8	329.1	592.3
886	3/1/2012	95.6	656.1	119.4	215.0
887	3/2/2012	24.3	160.1	30.4	54.8
888	3/3/2012	6.1	40.0	7.6	13.7

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
889	3/4/2012	1.5	10.5	1.9	3.4
890	3/5/2012	530.8	3,864.1	663.5	1,194.3
891	3/6/2012	373.7	2,450.5	467.2	840.9
892	3/7/2012	93.4	608.8	116.8	210.2
893	3/8/2012	23.4	152.3	29.2	52.6
894	3/9/2012	5.8	38.5	7.3	13.1
895	3/10/2012	238.8	2,016.3	298.5	537.4
896	3/11/2012	4,363.1	30,306.0	5,453.9	9,817.0
897	3/12/2012	1,047.0	7,044.2	1,308.7	2,355.7
898	3/13/2012	6,401.4	43,941.0	8,001.8	14,403.0
899	3/14/2012	2,571.8	17,645.0	3,214.8	5,786.6
900	3/15/2012	6,631.6	45,724.0	8,289.5	14,921.0
901	3/16/2012	3,617.6	24,672.0	4,522.0	8,139.7
902	3/17/2012	2,813.6	19,290.0	3,516.9	6,330.5
903	3/18/2012	1,288.8	8,622.6	1,611.0	2,899.9
904	3/19/2012	425.1	2,779.1	531.4	956.5
905	3/20/2012	235.2	1,662.9	294.0	529.2
906	3/21/2012	360.8	2,554.1	451.0	811.9
907	3/22/2012	806.4	5,663.6	1,008.0	1,814.4
908	3/23/2012	276.1	1,801.5	345.2	621.3
909	3/24/2012	69.0	449.7	86.3	155.3
910	3/25/2012	17.3	113.0	21.6	38.8
911	3/26/2012	4.3	28.0	5.4	9.7
912	3/27/2012	1.1	7.0	1.3	2.4
913	3/28/2012	44.7	437.9	55.9	100.7
914	3/29/2012	3,719.9	26,239.0	4,649.8	8,369.7
915	3/30/2012	4,455.6	30,445.0	5,569.6	10,025.0
916	3/31/2012	3,961.6	26,975.0	4,951.9	8,913.5
917	4/1/2012	1,059.2	7,064.2	1,324.0	2,383.1
918	4/2/2012	305.6	2,009.7	382.0	687.5
919	4/3/2012	76.4	498.1	95.5	171.9
920	4/4/2012	19.1	124.6	23.9	43.0
921	4/5/2012	224.4	1,683.5	280.5	504.9
922	4/6/2012	170.5	1,123.0	213.1	383.5
923	4/7/2012	42.6	278.3	53.3	95.9
924	4/8/2012	10.7	69.7	13.3	24.0
925	4/9/2012	2.7	17.9	3.3	6.0
926	4/10/2012	0.7	4.3	0.8	1.5
927	4/16/2012	32.3	797.4	40.4	72.8
928	4/17/2012	30.7	217.2	38.3	69.0
929	4/18/2012	14.1	143.6	17.6	31.6
930	4/19/2012	19.8	202.8	24.7	44.5
931	4/20/2012	1,790.4	13,086.0	2,238.0	4,028.3
932	4/21/2012	548.4	3,579.3	685.5	1,233.9
933	4/22/2012	137.1	892.4	171.4	308.5
934	4/23/2012	34.3	223.2	42.8	77.1
935	4/24/2012	8.6	56.3	10.7	19.3

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
936	4/25/2012	49.7	485.7	62.1	111.8
937	4/26/2012	1,510.5	11,051.0	1,888.1	3,398.6
938	4/27/2012	459.1	2,992.7	573.9	1,032.9
939	4/28/2012	114.8	747.1	143.5	258.2
940	4/29/2012	28.7	187.4	35.9	64.6
941	4/30/2012	556.1	4,122.7	695.1	1,251.2
942	5/1/2012	304.6	2,013.6	380.8	685.4
943	5/2/2012	76.2	496.7	95.2	171.4
944	5/3/2012	491.1	4,003.4	613.9	1,105.0
945	5/4/2012	1,991.8	13,689.0	2,489.7	4,481.5
946	5/5/2012	339.3	2,208.5	424.1	763.4
947	5/6/2012	84.8	552.0	106.0	190.9
948	5/7/2012	21.2	138.6	26.5	47.7
949	5/8/2012	5.3	34.5	6.6	11.9
950	5/9/2012	1.3	8.6	1.7	3.0
951	5/10/2012	0.2	1.5	0.3	0.5
952	5/20/2012	2.1	108.1	2.6	4.7
953	5/21/2012	87.3	1,890.9	109.1	196.3
954	5/22/2012	195.3	1,535.2	244.1	439.3
955	5/23/2012	533.6	3,791.5	667.0	1,200.6
956	5/24/2012	113.5	740.2	141.9	255.3
957	5/25/2012	28.4	185.0	35.5	63.8
958	5/26/2012	7.1	46.8	8.9	16.0
959	5/27/2012	1.8	11.5	2.2	4.0
960	5/28/2012	0.4	2.5	0.5	0.9
961	5/31/2012	2.9	87.4	3.6	6.5
962	6/1/2012	6.1	235.9	7.6	13.7
963	6/2/2012	4.1	63.2	5.2	9.3
964	6/3/2012	1.0	9.2	1.3	2.3
965	6/4/2012	0.1	1.5	0.2	0.3
966	6/5/2012	112.6	1,914.7	140.7	253.3
967	6/6/2012	151.4	1,053.6	189.3	340.7
968	6/7/2012	1,936.0	14,034.0	2,419.9	4,355.9
969	6/8/2012	850.8	5,621.8	1,063.5	1,914.4
970	6/9/2012	214.4	1,396.9	268.0	482.3
971	6/10/2012	53.6	349.1	67.0	120.6
972	6/11/2012	13.4	87.8	16.7	30.1
973	6/12/2012	3.3	21.8	4.2	7.5
974	6/13/2012	0.8	5.4	1.0	1.9
975	6/14/2012	0.1	0.5	0.1	0.2
976	6/18/2012	2.3	111.0	2.8	5.1
977	6/19/2012	2.6	28.3	3.3	5.9
978	6/20/2012	0.7	5.5	0.8	1.5
979	6/22/2012	10.4	804.6	13.0	23.4
980	6/23/2012	855.7	6,837.8	1,069.6	1,925.3
981	6/24/2012	459.7	3,061.9	574.6	1,034.3
982	6/25/2012	114.9	749.0	143.7	258.6

Event #	Date	Daily Stormwater Discharge Volume (US gal)			
		Basin A	Basin B	Basin C	Basin A + C
983	6/26/2012	28.7	187.3	35.9	64.6
984	6/27/2012	7.2	47.3	9.0	16.2
985	6/28/2012	1.8	11.7	2.2	4.0
986	6/29/2012	0.4	2.5	0.5	0.9
987	7/3/2012	6.7	520.2	8.4	15.1
988	7/4/2012	2.7	26.0	3.4	6.0
989	7/5/2012	0.7	5.4	0.8	1.5

Notes:
Highlighted rows indicate dates of USEPA inspection events.
Days with zero discharge are not reported.

FIGURES

Figure 1. Special Interest site and SeaTac International Airport rain gauge locations. Red line indicates Site boundary. Blue lines indicate footprint of buildings modeled as impervious surface. All other land within the Site boundary was modeled as pervious. All boundaries are approximate.

Special Interest Auto Salvage

Figure 2. LiDAR imagery and topographic contour lines of bare earth at Site. Note: LiDAR data were generated before the installation of a concrete wall along the southern perimeter of the Site. Lines represent locations of equivalent elevation. Arrows indicate the direction of expected surface runoff. Site boundary line is approximate. Units: ft = feet.

Special Interest Auto Salvage

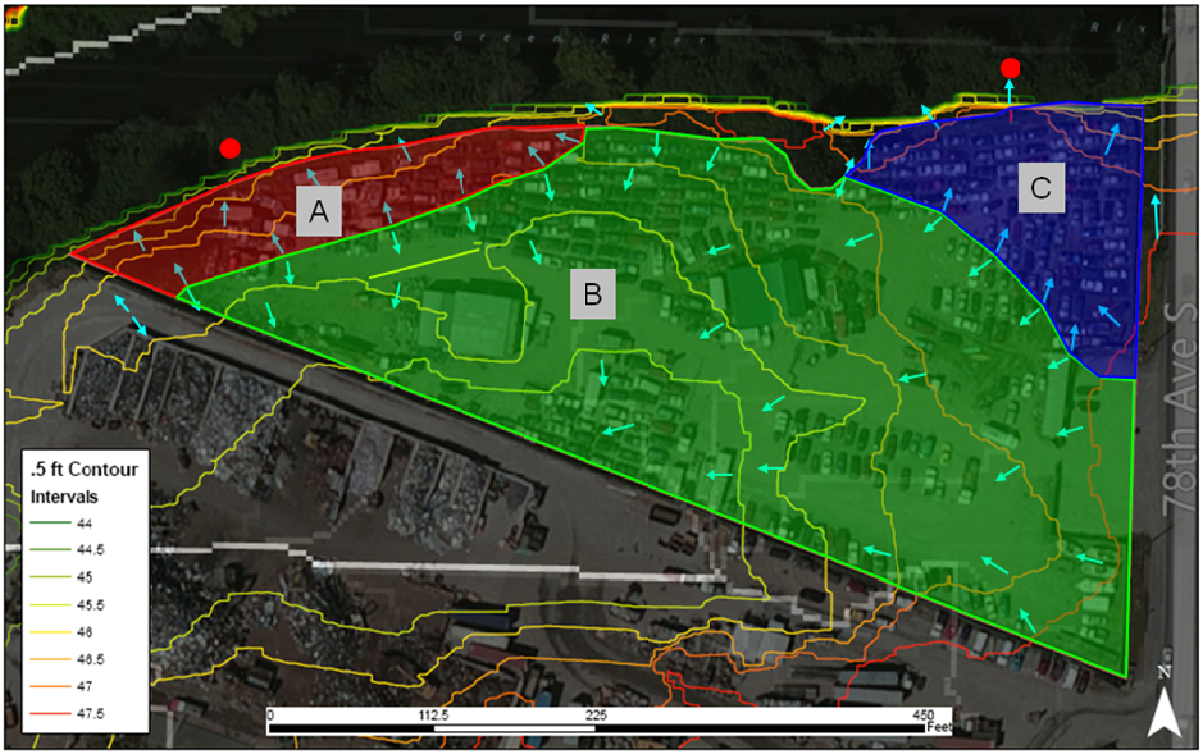

Figure 3. Surface drainage areas based on LiDAR-generated topographic contour lines of bare earth at Site. Note: LiDAR data were generated before the installation of a concrete wall along the southern perimeter of the Site and so current flow lines near the south are approximate. Lines represent locations of equivalent elevation. Arrows indicate the direction of expected surface runoff. Dots indicate locations where inspectors observed evidence of discharge points to the Green River. Site boundary line is approximate. Units: ft = feet.

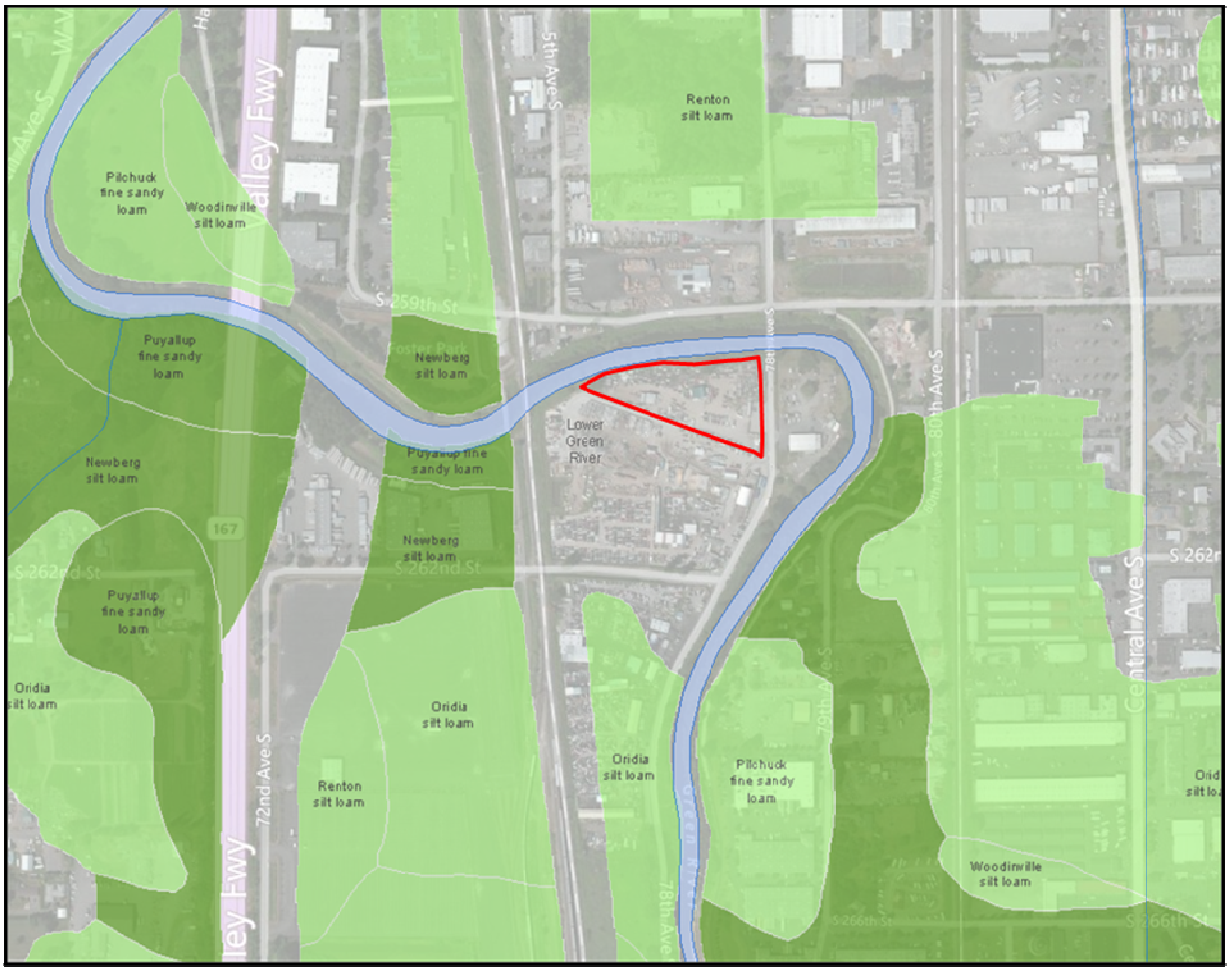

Figure 4. Distribution of the NRCS soil units in the vicinity of the Site. Note: areas with no soil polygon shading are listed as Urban land in the SSURGO database. Red line indicates approximate Site boundary.

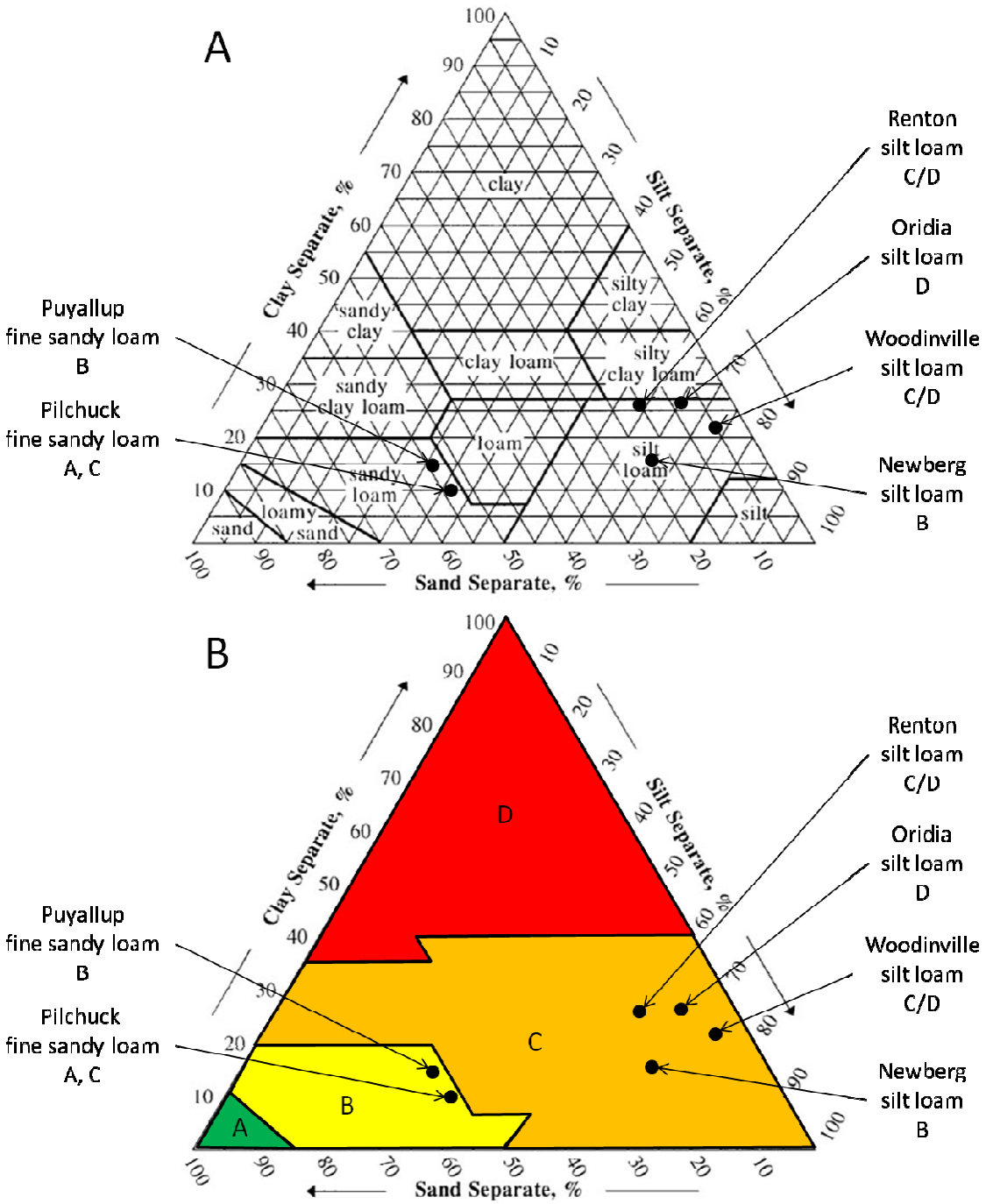

Figure 5. USDA soil texture triangle and Hydrologic Soil Group classification for NRCS soil units in the vicinity of the Site. Figure 5A shows the NRCS soil units in the vicinity of Special Interest as black dots within their respective soil class based on soil composition. Figure 5B shows the soil texture triangle with USDA Hydrologic Soil Groups overlain. Note: NRCS soil unit labels are listed with their Hydrologic Soil Group classification from Table 1 of this report.

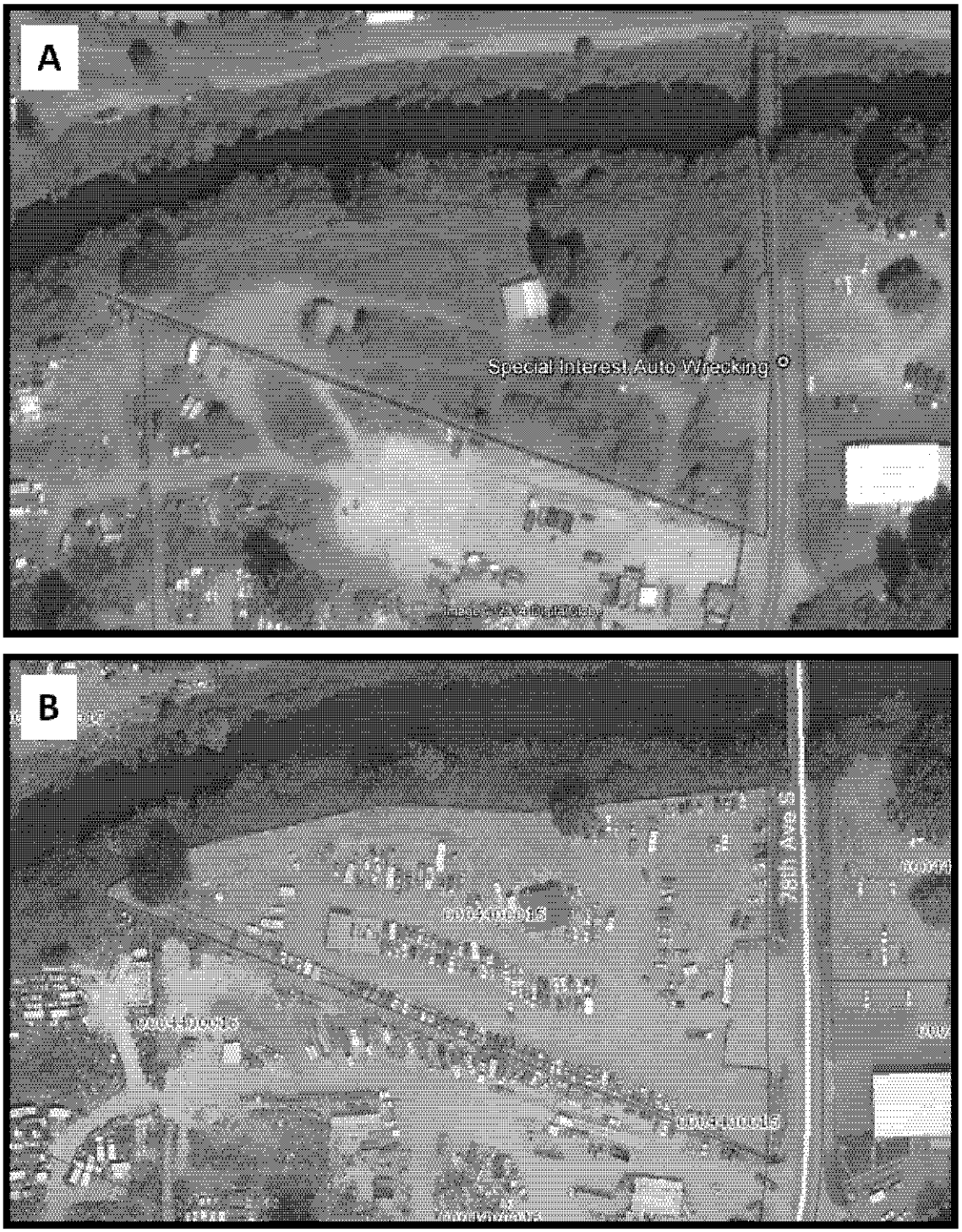

Figure 6. Historical aerial imagery of the Site. Figure 6A shows currently existing buildings were also present. Image taken August 19, 2006. Red line indicates approximate Site boundary used in model. Figure 6B shows Site cleared and automobiles stored on the property. Image taken June - August 2007. Brown line indicates tax parcel boundary.

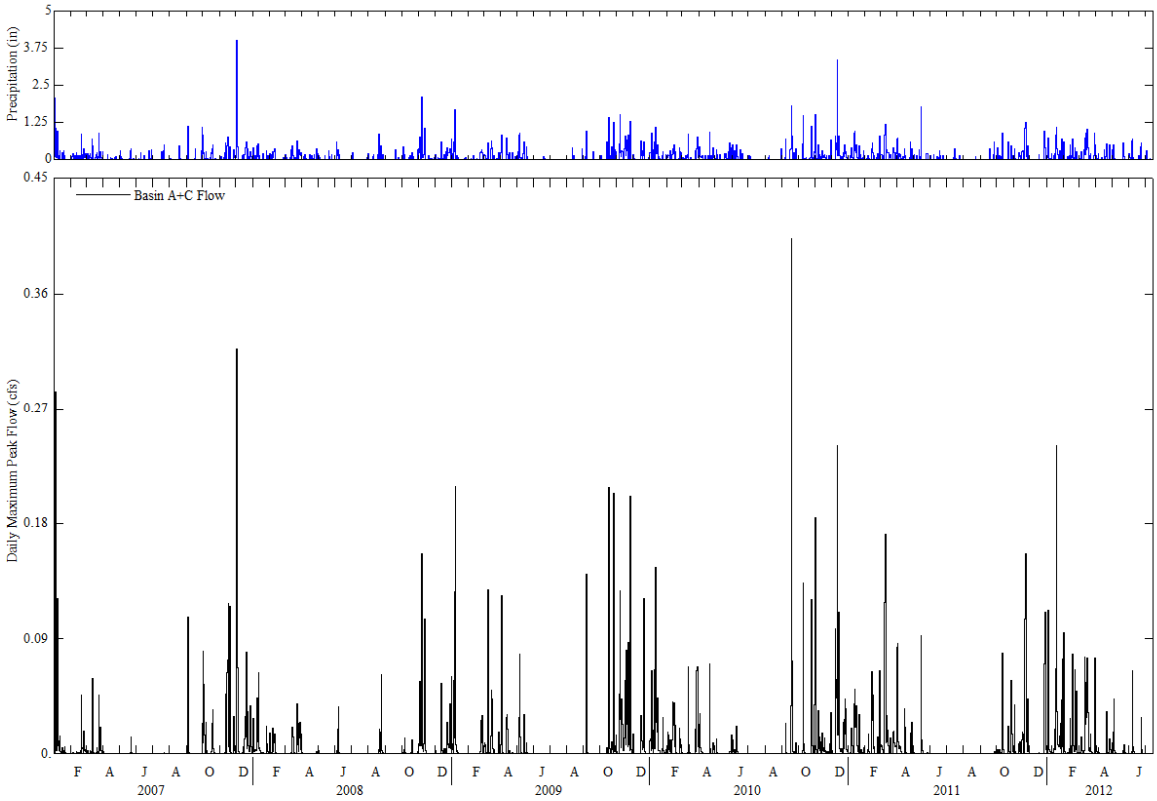

Figure 7. Observed precipitation and simulated hydrograph of daily maximum peak stormwater runoff flow from Basins A + C. Blue line indicates the total daily rainfall measurement observed. Black line indicates the daily maximum peak stormwater discharge flow (i.e., runoff) simulated. Units: in = inch, cfs = cubic feet per second.

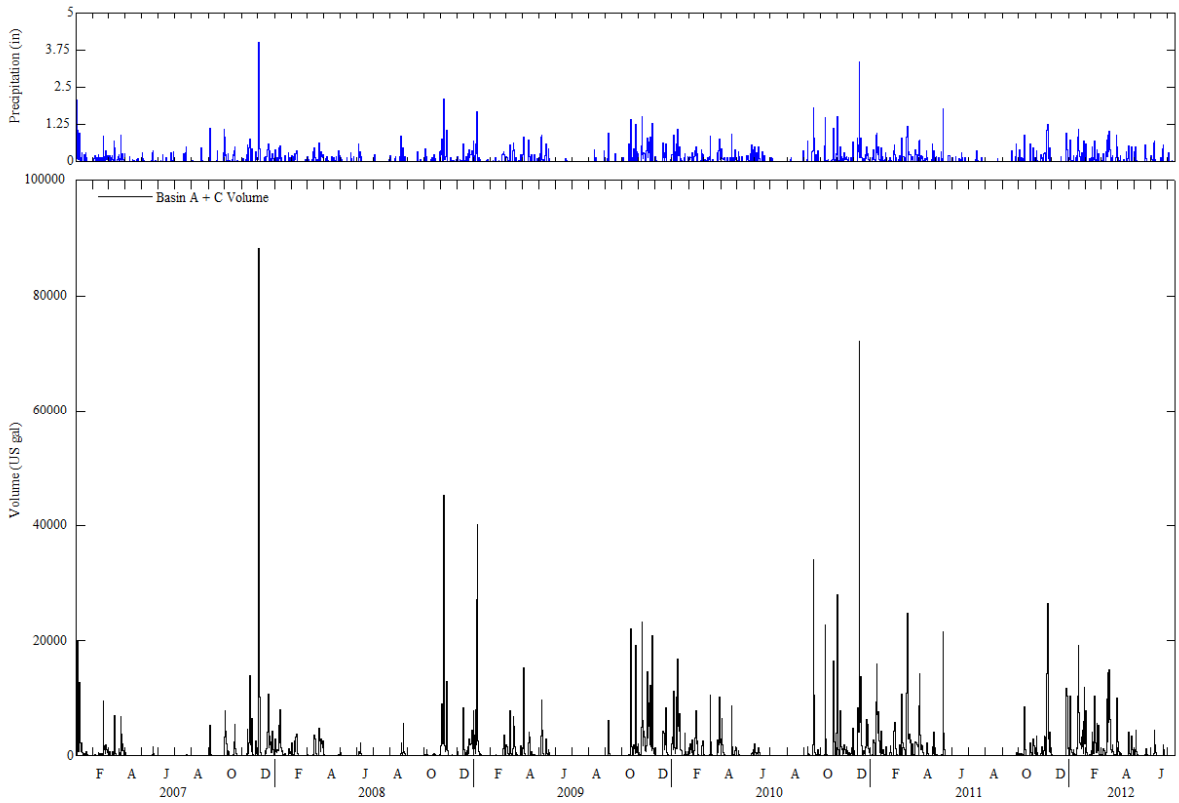

Figure 8. Observed precipitation and simulated hydrograph of daily stormwater runoff volume from Basins A + C. Blue line indicates the daily total rainfall measurement observed. Black line indicates the daily stormwater discharge volume simulated. Units: in = inch, US gal = US gallons.

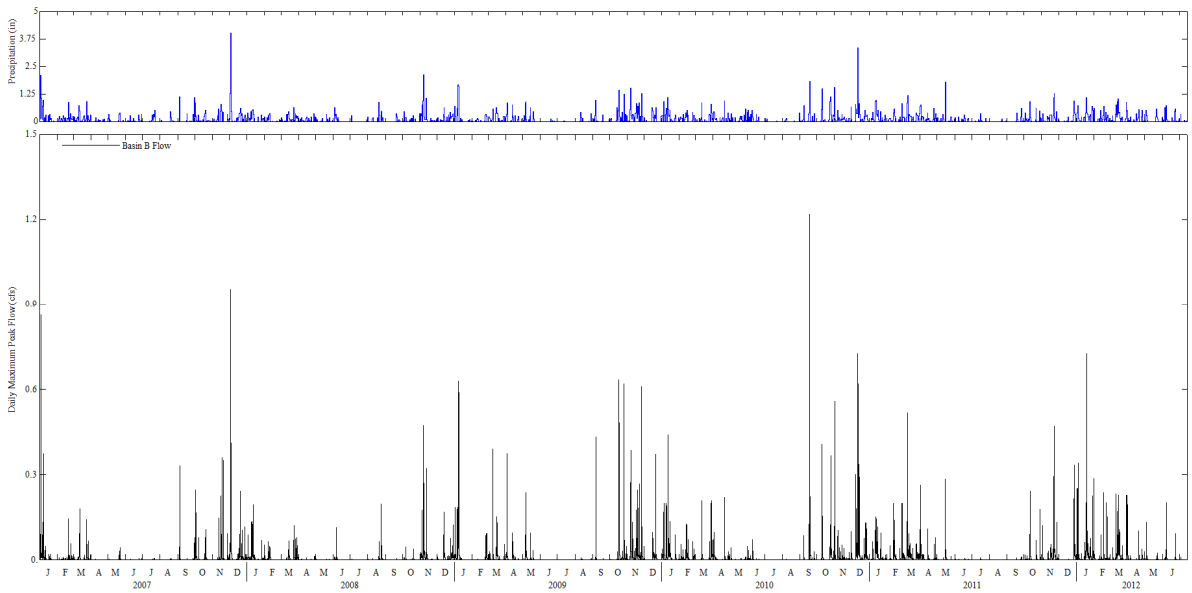

Figure 9. Observed precipitation and simulated hydrograph of daily maximum peak stormwater runoff flow from Basin B. Blue line indicates the total daily rainfall measurement observed. Black line indicates the daily maximum peak stormwater discharge flow (i.e., runoff) simulated. Units: in = inch, cfs = cubic feet per second.

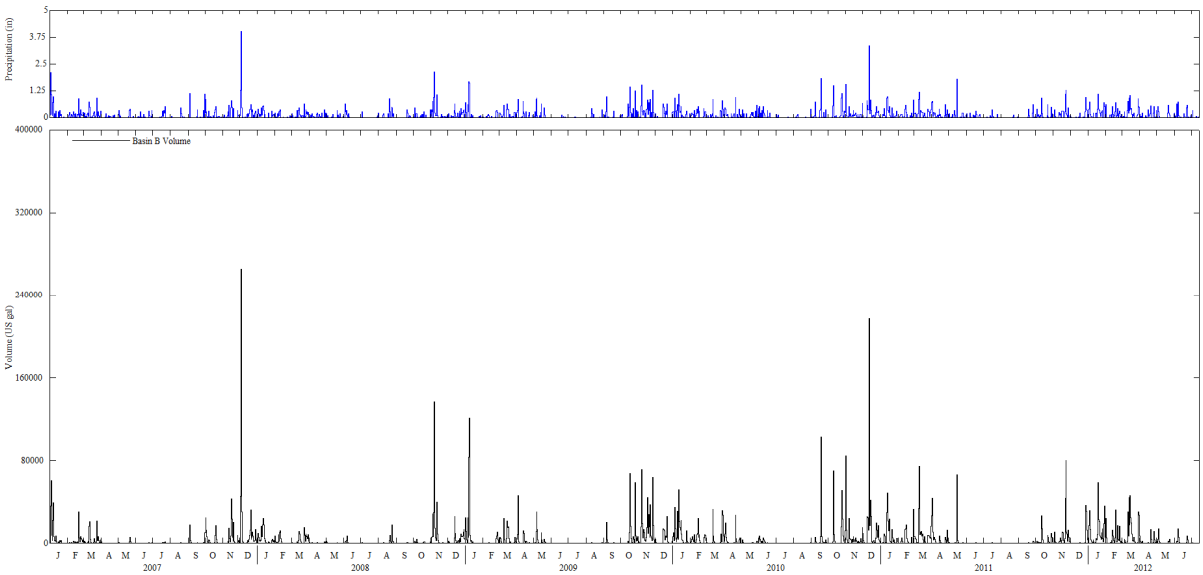

Figure 10. Observed precipitation and simulated hydrograph of daily stormwater runoff volume from Basin B. Blue line indicates the daily total rainfall measurement observed. Black line indicates the daily stormwater discharge volume simulated. Units: in = inch, US gal = US gallons.

APPENDIX A
HSPF PARAMETER VALUES

WWHM was designed by Ecology, AQUA TERRA Consultants, and Clear Creek Solutions, Inc. (the successor to the Washington offices of AQUA TERRA Consultants). Development of WWHM was funded by the Washington State Department of Ecology Contract No. C0500104. Parameterization of the HSPF model that drives WWHM was calibrated specifically for Western Washington by professional staff at USGS, AQUA TERRA and Clear Creek Solutions and approved by Ecology for regulatory use in the state's NPDES Permit Program.

Additional information regarding model calibration and parameterization can be found in the WWHM user manual:

Clear Creek Solutions. 2006. Western Washington Hydrology Model Version 3.0 User Manual. Olympia, WA.

Default WWHM HSPF pervious and impervious parameter values are based on the following USGS reports:

Dinicola, R.S. 2001. Validation of a Numerical Modeling Method for Simulating Rainfall-Runoff Relations for Headwater Basins in Western King and Snohomish Counties, Washington. U.S. Geological Survey, USGS Water Supply Paper No. 2495. Prepared in Cooperation with the King County Department of Public Works, and Department of Planning and Community Development. United States Geological Survey. Tacoma, WA.

Dinicola, R.S. 1990. Characterization and Simulation of Rainfall-Runoff Relations for Headwater Basins in Western King and Snohomish Counties, Washington. Water-Resources Investigations Report 89-4052. United States Geological Survey. Tacoma, WA.

Some default WWHM HSPF parameter values have been modified from the values listed in the USGS reports. These modifications are based on the professional judgment and experience of Clear Creek Solutions staff in modeling Western Washington watersheds with HSPF. Subsequent modifications to default WWHM parameters that were made by the

author are discussed in Section 6.4.3 of this report and are shown in PERLND 16 in Tables A.1 – A.4 below.

HSPF parameter documentation is found in the document:

Bicknell, B.R., J.C. Imhoff, J.L. Kittle Jr., T.H. Jobes, and A.S. Donigian Jr. 2001. Hydrological Simulation Program – Fortran, User's Manual for Version 12. AQUA TERRA Consultants. Mountain View, CA.

Table A.1
HSPF Pervious Parameter Values Part I

PERLND No.	Soil	Vegetation/Surface	Slope	LZSN	INFILT	LSUR	SLSUR	KVARY
1	A/B	Forest	Flat	5	2	400	0.05	0.3
2	A/B	Forest	Moderate	5	2	400	0.1	0.3
3	A/B	Forest	Steep	5	2	400	0.15	0.3
4	A/B	Pasture	Flat	5	1.5	400	0.05	0.3
5	A/B	Pasture	Moderate	5	1.5	400	0.1	0.3
6	A/B	Pasture	Steep	5	1.5	400	0.15	0.3
7	A/B	Lawn	Flat	5	0.8	400	0.05	0.3
8	A/B	Lawn	Moderate	5	0.8	400	0.1	0.3
9	A/B	Lawn	Steep	5	0.8	400	0.15	0.3
10	C	Forest	Flat	4.5	0.08	400	0.05	0.5
11	C	Forest	Moderate	4.5	0.08	400	0.1	0.5
12	C	Forest	Steep	4.5	0.08	400	0.15	0.5
13	C	Pasture	Flat	4.5	0.06	400	0.05	0.5
14	C	Pasture	Moderate	4.5	0.06	400	0.1	0.5
15	C	Pasture	Steep	4.5	0.06	400	0.15	0.5
16	C	Compact Dirt	Flat	4.275	0.027	400	0.05	0.5
17	C	Lawn	Moderate	4.5	0.03	400	0.1	0.5
18	C	Lawn	Steep	4.5	0.03	400	0.15	0.5
19	Saturated	Forest	Flat	4	2	100	0.001	0.5
20	Saturated	Forest	Moderate	4	2	100	0.01	0.5
21	Saturated	Forest	Steep	4	2	100	0.1	0.5
22	Saturated	Pasture	Flat	4	1.8	100	0.001	0.5
23	Saturated	Pasture	Moderate	4	1.8	100	0.01	0.5
24	Saturated	Pasture	Steep	4	1.8	100	0.1	0.5
25	Saturated	Lawn	Flat	4	1	100	0.001	0.5
26	Saturated	Lawn	Moderate	4	1	100	0.01	0.5
27	Saturated	Lawn	Steep	4	1	100	0.1	0.5
28	C	Impervious dispersed on lawn	Flat	4.5	0.03	400	0.05	0.5
29	C	Impervious dispersed on lawn	Moderate	4.5	0.03	400	0.1	0.5
30	C	Impervious dispersed on lawn	Steep	4.5	0.03	400	0.15	0.5
31	A/B	Impervious infiltrated on lawn	Flat	5	0.8	400	0.05	0.3
32	A/B	Impervious infiltrated on lawn	Moderate	5	0.8	400	0.1	0.3
33	A/B	Impervious infiltrated on lawn	Steep	5	0.8	400	0.15	0.3
34	Saturated	Impervious dispersed on lawn	Flat	4	1	100	0.001	0.5
35	Saturated	Impervious dispersed on lawn	Moderate	4	1	100	0.01	0.5
36	Saturated	Impervious dispersed on lawn	Steep	4	1	100	0.1	0.5

Notes:

LZSN	Lower Zone Storage Nominal (inches)
INFILT	Infiltration (inches per hour)
LSUR	Length of surface flow path (feet)
SLSUR	Slope of surface flow path (feet/feet)
KVARY	Variable groundwater recession

Table A.2
HSPF Pervious Parameter Values Part II

PERLND No.	AGWRC	INFEXP	INFILD	DEEPFR	BASETP	AGWETP	CEPSC	UZSN	NSUR
1	0.996	2	2	0	0	0	0.2	0.5	0.35
2	0.996	2	2	0	0	0	0.2	0.5	0.35
3	0.996	2	2	0	0	0	0.2	0.5	0.35
4	0.996	2	2	0	0	0	0.15	0.5	0.3
5	0.996	2	2	0	0	0	0.15	0.5	0.3
6	0.996	2	2	0	0	0	0.15	0.5	0.3
7	0.996	2	2	0	0	0	0.1	0.5	0.25
8	0.996	2	2	0	0	0	0.1	0.5	0.25
9	0.996	2	2	0	0	0	0.1	0.5	0.25
10	0.996	2	2	0	0	0	0.2	0.5	0.35
11	0.996	2	2	0	0	0	0.2	0.5	0.35
12	0.996	2	2	0	0	0	0.2	0.3	0.35
13	0.996	2	2	0	0	0	0.15	0.4	0.3
14	0.996	2	2	0	0	0	0.15	0.4	0.3
15	0.996	2	2	0	0	0	0.15	0.25	0.3
16	0.996	2	2	0	0	0	0.1	0.2125	0.25
17	0.996	2	2	0	0	0	0.1	0.25	0.25
18	0.996	2	2	0	0	0	0.1	0.15	0.25
19	0.996	10	2	0	0	0.7	0.2	3	0.5
20	0.996	10	2	0	0	0.7	0.2	3	0.5
21	0.996	10	2	0	0	0.7	0.2	3	0.5
22	0.996	10	2	0	0	0.5	0.15	3	0.5
23	0.996	10	2	0	0	0.5	0.15	3	0.5
24	0.996	10	2	0	0	0.5	0.15	3	0.5
25	0.996	10	2	0	0	0.35	0.1	3	0.5
26	0.996	10	2	0	0	0.35	0.1	3	0.5
27	0.996	10	2	0	0	0.35	0.1	3	0.5
28	0.996	2	2	0	0	0	0.1	0.25	0.25
29	0.996	2	2	0	0	0	0.1	0.25	0.25
30	0.996	2	2	0	0	0	0.1	0.15	0.25
31	0.996	2	2	0	0	0	0.1	0.5	0.25
32	0.996	2	2	0	0	0	0.1	0.5	0.25
33	0.996	2	2	0	0	0	0.1	0.5	0.25
34	0.996	10	2	0	0	0.35	0.1	3	0.5
35	0.996	10	2	0	0	0.35	0.1	3	0.5
36	0.996	10	2	0	0	0.35	0.1	3	0.5

Notes:

AGWRC	Active Groundwater Recession Constant (per day)
INFEXP	Infiltration Exponent
INFILD	Infiltration ratio (maximum to mean)
DEEPFR	Fraction of groundwater to deep aquifer or inactive storage
BASETP	Base flow (from groundwater) Evapotranspiration fraction
AGWETP	Active Groundwater Evapotranspiration fraction
CEPSC	Interception storage (inches)
UZSN	Upper Zone Storage Nominal (inches)
NSUR	Surface roughness (Manning's n)

Table A.3
HSPF Pervious Parameter Values Part III

PERLND No.	INTFW	IRC	LZETP	MELEV	BELV	GWDATM	PCW	PGW	UPGW	STABNO	SRRC	SREXP
1	0	0.7	0.7	400	0	0	0.35	0.38	0.45	1	0.1	0
2	0	0.7	0.7	400	0	0	0.35	0.38	0.45	1	0.1	0
3	0	0.7	0.7	400	0	0	0.35	0.38	0.45	1	0.1	0
4	0	0.7	0.4	400	0	0	0.33	0.35	0.42	1	0.1	0
5	0	0.7	0.4	400	0	0	0.33	0.35	0.42	1	0.1	0
6	0	0.7	0.4	400	0	0	0.33	0.35	0.42	1	0.1	0
7	0	0.7	0.25	400	0	0	0.31	0.33	0.4	1	0.1	0
8	0	0.7	0.25	400	0	0	0.31	0.33	0.4	1	0.1	0
9	0	0.7	0.25	400	0	0	0.31	0.33	0.4	1	0.1	0
10	6	0.5	0.7	400	0	0	0.2	0.23	0.28	1	0.1	0
11	6	0.5	0.7	400	0	0	0.2	0.23	0.28	1	0.1	0
12	6	0.3	0.7	400	0	0	0.2	0.23	0.28	1	0.1	0
13	6	0.5	0.4	400	0	0	0.18	0.2	0.25	1	0.1	0
14	6	0.5	0.4	400	0	0	0.18	0.2	0.25	1	0.1	0
15	6	0.3	0.4	400	0	0	0.18	0.2	0.25	1	0.1	0
16	1	0.25	0.1	400	0	0	0.15	0.17	0.2	1	0.1	0
17	6	0.5	0.25	400	0	0	0.15	0.17	0.2	1	0.1	0
18	6	0.3	0.25	400	0	0	0.15	0.17	0.2	1	0.1	0
19	1	0.7	0.8	400	0	0	0.17	0.2	0.25	1	0.1	0
20	1	0.7	0.8	400	0	0	0.17	0.2	0.25	1	0.1	0
21	1	0.7	0.8	400	0	0	0.17	0.2	0.25	1	0.1	0
22	1	0.7	0.6	400	0	0	0.15	0.17	0.22	1	0.1	0
23	1	0.7	0.6	400	0	0	0.15	0.17	0.22	1	0.1	0
24	1	0.7	0.6	400	0	0	0.15	0.17	0.22	1	0.1	0
25	1	0.7	0.4	400	0	0	0.12	0.15	0.18	1	0.1	0
26	1	0.7	0.4	400	0	0	0.12	0.15	0.18	1	0.1	0
27	1	0.7	0.4	400	0	0	0.12	0.15	0.18	1	0.1	0
28	6	0.5	0.25	400	0	0	0.15	0.17	0.2	1	0.1	0
29	6	0.5	0.25	400	0	0	0.15	0.17	0.2	1	0.1	0
30	6	0.3	0.25	400	0	0	0.15	0.17	0.2	1	0.1	0
31	0	0.7	0.25	400	0	0	0.31	0.33	0.4	1	0.1	0
32	0	0.7	0.25	400	0	0	0.31	0.33	0.4	1	0.1	0
33	0	0.7	0.25	400	0	0	0.31	0.33	0.4	1	0.1	0
34	1	0.7	0.4	400	0	0	0.12	0.15	0.18	1	0.1	0
35	1	0.7	0.4	400	0	0	0.12	0.15	0.18	1	0.1	0
36	1	0.7	0.4	400	0	0	0.12	0.15	0.18	1	0.1	0

Notes:

INTFW	Interflow index
IRC	Interflow Recession Constant (per day)
LZETP	Lower Zone Evapotranspiration fraction
MELEV	Mean surface elevation of the land segment (feet)
BELV	Base elevation for active groundwater (feet)
GWDATM	Datum for the groundwater elevation (feet)
PCW	Cohesion Water Porosity (fraction)
PGW	Gravitational Water Porosity (fraction)
UPGW	Upper Gravitational Water porosity (fraction)
STABNO	User's number for the FTABLE in the FTABLES block which contains the outflow properties from the surface storage
SRRC	Surface Runoff Recession Constant (per hour)
SREXP	Surface Runoff Exponent

Table A.4
HSPF Pervious Parameter Values Part IV

PERLND No.	IFWSC	DELTA	UELFAC	LELFAC	CEPS	SURS	UZS	IFWS	LZS	AGWS	GWVS
1	4	0.2	4	2.5	0	0	0	0	3	1	0
2	4	0.2	4	2.5	0	0	0	0	3	1	0
3	4	0.2	4	2.5	0	0	0	0	3	1	0
4	4	0.2	4	2.5	0	0	0	0	3	1	0
5	4	0.2	4	2.5	0	0	0	0	3	1	0
6	4	0.2	4	2.5	0	0	0	0	3	1	0
7	4	0.2	4	2.5	0	0	0	0	3	1	0
8	4	0.2	4	2.5	0	0	0	0	3	1	0
9	4	0.2	4	2.5	0	0	0	0	3	1	0
10	4	0.2	4	2.5	0	0	0	0	2.5	1	0
11	4	0.2	4	2.5	0	0	0	0	2.5	1	0
12	4	0.2	4	2.5	0	0	0	0	2.5	1	0
13	4	0.2	4	2.5	0	0	0	0	2.5	1	0
14	4	0.2	4	2.5	0	0	0	0	2.5	1	0
15	4	0.2	4	2.5	0	0	0	0	2.5	1	0
16	4	0.2	4	2.5	0	0	0	0	2.5	1	0
17	4	0.2	4	2.5	0	0	0	0	2.5	1	0
18	4	0.2	4	2.5	0	0	0	0	2.5	1	0
19	4	0.2	4	2.5	0	0	0	0	4.2	1	0
20	4	0.2	4	2.5	0	0	0	0	4.2	1	0
21	4	0.2	4	2.5	0	0	0	0	4.2	1	0
22	4	0.2	4	2.5	0	0	0	0	4.2	1	0
23	4	0.2	4	2.5	0	0	0	0	4.2	1	0
24	4	0.2	4	2.5	0	0	0	0	4.2	1	0
25	4	0.2	4	2.5	0	0	0	0	4.2	1	0
26	4	0.2	4	2.5	0	0	0	0	4.2	1	0
27	4	0.2	4	2.5	0	0	0	0	4.2	1	0
28	4	0.2	4	2.5	0	0	0	0	2.5	1	0
29	4	0.2	4	2.5	0	0	0	0	2.5	1	0
30	4	0.2	4	2.5	0	0	0	0	2.5	1	0
31	4	0.2	4	2.5	0	0	0	0	3	1	0
32	4	0.2	4	2.5	0	0	0	0	3	1	0
33	4	0.2	4	2.5	0	0	0	0	3	1	0
34	4	0.2	4	2.5	0	0	0	0	4.2	1	0
35	4	0.2	4	2.5	0	0	0	0	4.2	1	0
36	4	0.2	4	2.5	0	0	0	0	4.2	1	0

Notes:

IFWSC	Maximum Interflow Storage Capacity when the groundwater elevation is greater than the upper influence elevation (inches)
DELTA	groundwater tolerance level used to determine transition between regions when high water table conditions are being simulated
UELFAC	multiplier on UZSN which gives the upper zone capacity
LELFAC	multiplier on LZSN which gives the lower zone capacity
CEPS	Initial interception storage (inches)
SURS	Initial surface runoff (inches)
UZS	Initial Upper Zone Storage (inches)
IFWS	Initial interflow (inches)
LZS	Initial Lower Zone Storage (inches)
AGWS	Initial Active Groundwater storage (inches)
GWVS	Initial Groundwater Vertical Slope (feet/feet)

Table A.5
HSPF Impervious Parameter Values

IMPLND No.	Impervious Surface	Slope	LSUR	SLSUR	NSUR	RETSC	RETS	SURS
1	Roads	Flat	400	0.01	0.1	0.1	0	0
2	Roads	Moderate	400	0.05	0.1	0.08	0	0
3	Roads	Steep	400	0.1	0.1	0.05	0	0
4	Roofs	Flat	400	0.01	0.1	0.1	0	0
5	Driveways	Flat	400	0.01	0.1	0.1	0	0
6	Driveways	Moderate	400	0.05	0.1	0.08	0	0
7	Driveways	Steep	400	0.1	0.1	0.05	0	0
8	Sidewalks	Flat	400	0.01	0.1	0.1	0	0
9	Sidewalks	Moderate	400	0.05	0.1	0.08	0	0
10	Sidewalks	Steep	400	0.1	0.1	0.05	0	0
11	Parking	Flat	400	0.01	0.1	0.1	0	0
12	Parking	Moderate	400	0.05	0.1	0.08	0	0
13	Parking	Steep	400	0.1	0.1	0.05	0	0
14	Pond	Flat	400	0.01	0.1	0.1	0	0

Notes:

LSUR Length of surface flow path (feet) for impervious area
SLSUR Slope of surface flow path (feet/feet) for impervious area
NSUR Surface roughness (Manning's n) for impervious area
RETSC Surface retention storage (inches) for impervious area

APPENDIX B
WWHM UCI FILE

Hydrologic and water quality modeling with HSPF (and WWHM) involves managing large volumes of data. Among that data are parameters describing watershed characteristics, which often are derived from Geographic Information Systems (GIS) layers such as basin boundaries and land uses. Other parameters specify simulation options within HSPF. All of these parameters are input to HSPF by means of a text file, known as the User Control Input (UCI) file, containing a series of tightly formatted records. The values on the records must be formatted precisely, and the records must themselves be arranged in a preordained order for HSPF to understand.

Creating a new HSPF or WWHM project means creating a new UCI file, since all model project information is stored in the UCI file. Once the user initiates a model simulation, the model begins reading and interpreting the UCI file. The UCI file is valuable for the following reasons:

1. The UCI file shows, with complete transparency, the exact model processes executed, the way the model schematic was created to mathematically recreate the physical environment, and all the parameter values used in the model, as well as any other special modifications to the model or model calculations

2. With the UCI file, anyone can reproduce the exact model output used in this report

The UCI file created for the WWHM model used in this report begins on Page B-3.

```
*** Created by Daniel Marshalonis 8/28/12 for Special Interest***
*** Site was divided into three basins: A, B, C***
*** Each basin was modeled with outflows as separate POC***
*** POC1=Basin A SURO, POC2=Basin A IFWO, POC3=Basin A SURO+IFWO, etc.***
RUN

GLOBAL
  WWHM3 model simulation
  START       2007 01 01        END    2012 07 14
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   SI081712DMDIRT.wdm
MESSU      25   PreSI081712DMDIRT.MES
           27   PreSI081712DMDIRT.L61
           28   PreSI081712DMDIRT.L62
           30   poc1.dat
           31   poc2.dat
           32   poc3.dat
           33   poc4.dat
           34   poc5.dat
           35   poc6.dat
           36   poc7.dat
           37   poc8.dat
           38   poc9.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      16
      IMPLND       4
      COPY       501
      COPY       502
      COPY       503
      COPY       504
      COPY       505
      COPY       506
      COPY       507
      COPY       508
      COPY       509
      DISPLY       1
      DISPLY       2
      DISPLY       3
      DISPLY       4
      DISPLY       5
      DISPLY       6
      DISPLY       7
      DISPLY       8
      DISPLY       9
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  A Overland           MAX                    1    2   30    9
```

```
    2        Basin  A Interflow          MAX                    1    2   31    9
    3        Basin  A SW                 MAX                    1    2   32    9
    4        Basin  B Overland           MAX                    1    2   33    9
    5        Basin  B Interflow          MAX                    1    2   34    9
    6        Basin  B SW                 MAX                    1    2   35    9
    7        Basin  C Overland           MAX                    1    2   36    9
    8        Basin  C Interflow          MAX                    1    2   37    9
    9        Basin  C SW                 MAX                    1    2   38    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
  501         1    1
  502         1    1
  503         1    1
  504         1    1
  505         1    1
  506         1    1
  507         1    1
  508         1    1
  509         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
   16     C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   16         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1
```

```
  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   16              0     4.275     0.027       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   16            0.1    0.2125      0.25         1      0.25       0.1
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   16              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    4      ROOF TOPS FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    4         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
```

```
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  A Overland***
PERLND  16                        0.4     COPY   501     12
Basin  A Interflow***
PERLND  16                        0.4     COPY   502     13
Basin  A SW***
PERLND  16                        0.4     COPY   503     12
PERLND  16                        0.4     COPY   503     13
Basin  B Overland***
PERLND  16                        2.6     COPY   504     12
IMPLND   4                        0.1     COPY   504     15
Basin  B Interflow***
PERLND  16                        2.6     COPY   505     13
IMPLND   4                        0.1     COPY   505     15
Basin  B SW***
PERLND  16                        2.6     COPY   506     12
PERLND  16                        2.6     COPY   506     13
IMPLND   4                        0.1     COPY   506     15
Basin  C Overland***
PERLND  16                        0.5     COPY   507     12
Basin  C Interflow***
PERLND  16                        0.5     COPY   508     13
Basin  C SW***
PERLND  16                        0.5     COPY   509     12
PERLND  16                        0.5     COPY   509     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   12.1        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   12.1        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   12.1        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   12.1        DISPLY   5     INPUT  TIMSER 1
COPY   506 OUTPUT MEAN   1 1   12.1        DISPLY   6     INPUT  TIMSER 1
COPY   507 OUTPUT MEAN   1 1   12.1        DISPLY   7     INPUT  TIMSER 1
COPY   508 OUTPUT MEAN   1 1   12.1        DISPLY   8     INPUT  TIMSER 1
```

```
COPY   509 OUTPUT MEAN   1 1   12.1        DISPLY   9     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1             PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1             IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76          PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76          IMPLND   1 999 EXTNL  PETINP
```

```
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     12.1      WDM    502 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     12.1      WDM    503 FLOW     ENGL      REPL
COPY   504 OUTPUT MEAN   1 1     12.1      WDM    504 FLOW     ENGL      REPL
COPY   505 OUTPUT MEAN   1 1     12.1      WDM    505 FLOW     ENGL      REPL
COPY   506 OUTPUT MEAN   1 1     12.1      WDM    506 FLOW     ENGL      REPL
COPY   507 OUTPUT MEAN   1 1     12.1      WDM    507 FLOW     ENGL      REPL
COPY   508 OUTPUT MEAN   1 1     12.1      WDM    508 FLOW     ENGL      REPL
COPY   509 OUTPUT MEAN   1 1     12.1      WDM    509 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

COMPLAINANT'S EXHIBIT 31

Dino Marshalonis, Ph.D.

Day Phone: 206-553-1519
Email: marshalonis.dino@epa.gov

PROFILE

Aquatic Modeler: Stormwater Scientist, watershed scale stormwater loading analysis, implementation/development of stormwater Best Management Practices (BMPs) and Low Impact Development (LID); expertise in freshwater and marine ecology, ecosystem ecology, aquatic biology, oceanography, community ecology, food webs, bioaccumulative compounds, ecotoxicology, ecological and human health risk assessment.

Technical Advisor: Represent Agency at scientific and regulatory workshops, meetings, and conferences; confer and build new relationships with federal and state agencies, Tribes, and non-governmental organizations; critique scientific merit of proposed federal regulations; interpret regulatory guidance and permitting. Recommend technical proposals and grant applications for federal funding.

Enforcement Specialist: Conduct analyses and prepare supporting documentation to clearly identify alleged violations of the Clean Water Act (CWA) based on associated elements of proof and supporting scientific evidence; create technical evaluations and documentation that are factually correct, comport to Agency policies and guidance and reflect sufficient analysis and regulatory interpretation to support effective decision-making; develop or obtain engineering, scientific or regulatory analysis to evaluate nature and extent of non compliance.

Writer and Speaker: Write budgets, protocols, status reports, peer-reviewed scientific articles, and chapters of technical books; critique scientific manuscripts; critique grant proposals; present complex scientific concepts to scientists, Tribes and Tribal delegates, the general public, and the media; instruct students; create and present seminars and workshops for non-technical individuals.

WORK EXPERIENCE

United States Environmental Protection Agency **8/2010-Present**
Office of Water and Watersheds
Seattle, WA US

TECHNICAL ADVISOR

TECHNICAL ADVISOR. Provide technical support to the Stormwater program in Office of Water and Watersheds (OWW) to ensure that direction and policies are relevant, progress is made, important project deadlines are met, information flows, communication is clear, and that the quality of work allows for appropriate EPA decisions and activities. Coordinate workload with relevant programs independently on a consulting basis.

EXPERT WITNESS FOR COMPLIANCE AND ENFORCEMENT. Provide technical expertise and support to Region 10's National Pollutant Discharge Elimination System (NPDES) Compliance Unit and Inspection & Enforcement Management Unit in the Office of Compliance and Enforcement (OCE) and Criminal Investigation Division (CID) to ensure strong, consistent, and effective enforcement of federal environmental laws region wide. Serve as Region 10's water enforcement modeling expert providing technical advice in aquatic modeling related to stormwater runoff enforcement. Develop and implement solutions to complex and sophisticated technical problems and offer suggestions for improvements independently without supervisory intervention. Coordinate work as appropriate with Office of Compliance and Enforcement (OCE), Office of Regional Council (ORC), Criminal Investigation Division (CID), and Department of Justice (DOJ). Work products include oral deposition, written expert witness reports, and oral testimony for civil and criminal trials. Provide technical review, comment, and oversight for negotiated consent decrees involving stormwater and Clean Water Act (CWA) violations.

NATIONAL STORMWATER RULEMAKING. Active participant in national rulemaking work group. Provide helpful rule language and practical insights on how to make rule easier to implement and more effective at preventing environmental impacts. Develop options for national

performance standard based on enforcement considerations. Communicate rule options and their impacts on Region 10 efforts to executive management. Review and comment on National Stormwater Calculator for use in National Stormwater Rulemaking.

STRENGTHEN STATE AND NATIONAL EPA NPDES PERMITS. Provide substantive feedback on performance standard for the Municipal Separate Storm Sewer System (MS4) stormwater permit to Washington State Department of Ecology (DOE) and the Puget Sound Partnership (PSP). Serve on technical committees in support of DOE's or PSP's work on stormwater including Washington State's Stormwater Monitoring Work Group. Represent Region 10 and/or Agency in regional, national and international meetings or conferences as an authority in stormwater management, including EPA's National Green Infrastructure Work Group, and EPA's National Water Quality Modelers Work Group. Provide technical language for EPA issued federal facility Municipal Separate Storm Sewer System (MS4) stormwater permits.

PUGET SOUND TEAM LIAISON. Provide technical stormwater expertise to relevant EPA programs including National Pollutant Discharge Elimination System (NPDES), Total Maximum Daily Load (TMDL), and watershed-focused work in Puget Sound. Serve as technical liaison for Puget Sound grants that have a modeling or stormwater focus. Review and comment on work plans, Quality Assurance Project Plans (QAPPs), progress reports, and outputs. Assist grantees in finding the appropriate EPA staff as substantive financial or administrative issues arise. Seek opportunities to collaborate with stakeholders working in Region 10 with similar goals. Learn new developments in stormwater Best Management Practices (BMPs), Low Impact Development (LID), and related approaches and provide input to regional programs on these issues. Develop and implement projects that test approaches to reduce stormwater impacts. Lead regional user group for EPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) model.

Anchor QEA LLC **9/2008-6/2010**
Seattle, WA US

CONSULTANT (STAFF SCIENTIST)
INTERPRET VIOLATIONS OF FEDERAL AND STATE REGULATIONS. Provided technical expertise and litigation support regarding violations of the Clean Water Act (CWA) and National Pollutant Discharge Elimination System (NPDES) permits within the Puget Sound watershed (Lower Duwamish Waterway). Allocated remediation costs based on historic and on-going stormwater contaminant sources. Modeled current and historic stormwater loading of polychlorinated biphenyls (PCBs), metals, and organic compounds. Evaluated failures in stormwater drainage networks to determine upland sources of contamination to aid in source control activities.

WATERSHED-SCALE STORMWATER ANALYSIS. Represented a multi-party client group which is working cooperatively with the U.S. Environmental Protection Agency (EPA) on approach and implementation of site-specific source control Best Management Practices (BMPs). Created stormwater loading model that evaluates land use types and the effectiveness of low impact development (LID). Analyzed stormwater monitoring data to assess changes over time. Prepared technical reports for the site's remedial investigation and feasibility study.

SCOPE DEVELOPMENT AND PROJECT MANAGEMENT. Developed detailed cost estimates for remediation alternatives at a variable land use harbor in British Columbia, Canada. Scoped potential remediation activities, including description, purpose, assumptions, and rationale for each action. Interacted directly with federal agencies and Tribes to inform scoping decisions. Managed government contracts and invoicing for project budgets ranging from $270,000 - $2,840,000.

REVIEW MONITORING DATA. Reviewed and interpreted water, tissue, and sediment chemistry monitoring data to predict ecological and human health risk changes resulting from alternative source control and remediation strategies and informed decision-making.

TECHNICAL EXPERTISE. Provided technical and strategic recommendations for addressing ecological and human health risks associated with dioxin-contaminated sediments from open-water disposal sites in Puget Sound. Presented technical justification for recommendations and the practical requirements for their implementation to the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Washington state Department of Ecology, and the Washington state Department of Natural

Resources), tribal representatives, and the public to build consensus agreements.

REVIEW NPDES PERMITTING. Analyzed water quality data to determine impacts of fish pens used in aquaculture on nutrient loading in a Washington state freshwater lake system. Compared water quality data to Total Maximum Daily Load (TMDL) values. Collaborated with Washington State Department of Ecology to determine whether a National Pollutant Discharge Elimination System (NPDES) permit should be developed.

RISK EVALUATION. Assessed the predictive ability of concentration-response models for sediment toxicity to benthic invertebrates for an ecological risk assessment at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund site contaminated with polychlorinated biphenyls (PCBs), organic compounds, and chlorinated organo-pesticides. Evaluated model theory based on suitability to site-specific conditions and appropriateness to existing data. Contributed to overall risk evaluation of the site to inform remediation strategy.

TEAM LEADER. Lead core collection team and sampling effort to delineate the horizontal and vertical nature and extent of mobile dense non-aqueous phase liquid contamination at a freshwater site in Seattle, WA.

IMPLEMENT BEST MANAGEMENT PRACTICES (BMPs). Performed a site-specific terrestrial ecological evaluation for the upland portion of a former log mill and storage and transportation facility in a Puget Sound watershed. Created wildlife bioaccumulation models for the protection of wildlife and terrestrial plants. Interpreted regulatory guidance and justified a conditional point of compliance.

EDUCATION

UNIVERSITY OF SOUTH CAROLINA, DEPARTMENT OF BIOLOGICAL SCIENCES
Columbia, SC US
Doctor of Philosophy – 5/2008
Advisor: James L. Pinckney, Ph.D. Dissertation: "Regulation of estuarine plankton communities and carbon flows by gelatinous zooplankton"

THE GEORGE WASHINGTON UNIVERSITY, DEPARTMENT OF BIOLOGICAL SCIENCES
Washington, DC US
Master of Science – 1/2004
Advisor: Robert E. Knowlton, Ph.D. Thesis: "Acute Effects of Permethrin on Four Populations of Grass Shrimp, *Palaemonetes pugio*"

UNIVERSITY OF VIRGINIA, DEPARTMENT OF BIOLOGY
Charlottesville, VA US
Bachelor of Arts – 5/2000

JOB RELATED TRAINING

Stormwater Chemistry Principles and Applications Workshop, 2013
Hydrologic Simulation Program – FORTRAN (HSPF) Workshop, 2012
Hydrologic Simulation Program – FORTRAN (HSPF) Calibration Training, 2012
U.S. Environmental Protection Agency (EPA) Winning Courtroom Confrontations Training, 2012
U.S. Environmental Protection Agency (EPA) Structuring Effective Meetings, 2012
U.S. Environmental Protection Agency (EPA) SUSTAIN Model Workshop, 2011
Western Washington Hydrology Model Workshop, 2011
Surface and Groundwater Quality Principles, Techniques, and Applications, 2011

PROFESSIONAL PUBLICATIONS

JOURNAL ARTICLES – PEER REVIEWED
Marshalonis, D., Pinckney J.L., Richardson T.L., and D.S. Wethey. Gelatinous zooplankton-mediated trophic cascades in an estuarine plankton food web model. *In preparation.*

Marshalonis, D., Richardson T.L., and J.L. Pinckney. Phytoplankton community structure and growth responses to predation by different size fractions of estuarine zooplankton. *In preparation*.

Clasen, J.L., Llopiz, J.K., Kissman, C.E.H., Marshalonis, D., and D.L. Pascual. The vulnerability of ecosystem trophic dynamics to anthropogenically induced environmental change: A comparative approach. *Eco-DAS VIII* Chapter 4, 2010, 47-66. DOI: 10.4319/ecodas.2010.978-0-9845591-1-4.47

Marshalonis, D. and J.L. Pinckney (2008) Grazing and assimilation rate estimates of hydromedusae from a temperate tidal creek system. *Hydrobiologia.* DOI: 10.1007/s10750-008-9334-z.

Marshalonis, D. and J.L. Pinckney (2007) Respiration rates of dominant hydromedusae in the North Inlet tidal estuary during winter and summer. *Journal of Plankton Research* 29(12): 1031-140

Richardson, T.L., Pinckney, J.L., Walker, E.A. and D.M. Marshalonis (2006) Photopigment radiolabelling as a tool for determining *in situ* growth rates of the toxic dinoflagellate, *Karenia brevis* (Dinophyceae). *European Journal of Phycology* 41(4): 415-423

Marshalonis, D., Knowlton, R.E. and H. Merchant (2006) Acute toxicity of permethrin to four populations of ovigerous grass shrimp, *Paleamonetes pugio* Holthius. *Bulletin of Environmental Contamination and Toxicology* 77(4): 543-550

FORMAL PRESENTATIONS

Marshalonis, D. LID and Idaho Stormwater Permits. Low Impact Development and Best Management Practices Workshop: American Society of Civil Engineers. Spokane, WA. October 2012. (Oral)

Marshalonis, D. Region 10 SUSTAIN User Group. Northwest Water Quality Modelers (NWMOD) Annual Meeting. Lacey, WA. May 2012. (Oral)

Marshalonis, D. and B. Fiedorczyk. Sustainable & Green Infrastructure: More than Cute Streets. Sustainable Communities Start with Healthy and Green Homes Workshop. Seattle, WA. February 2011.

Marshalonis, D. Spatially-explicit receptor exposure estimation. DMMP Dioxin Project Technical Workshop. Seattle, WA. June 2009. (Oral)

Marshalonis, D. Predator-prey interactions and trophodynamics: gelatinous zooplankton as a model. ECO-DĀS Symposium. Honolulu, HI. October 2008. (Oral)

Marshalonis, D. Regulation of estuarine plankton communities and carbon flows by gelatinous zooplankton. USC Department of Biological Sciences Seminar Series. Columbia, SC. December 2007. (Oral)

Marshalonis, D., Pinckney J.L., and T.L. Richardson. Metabolic and feeding rates of hydromedusae in the North Inlet estuary. 8th Annual Baruch Research Symposium. Georgetown, SC. April 2007. (Oral)

Marshalonis, D., Pinckney J.L., and T.L. Richardson. Hydromedusae metabolism and grazing impacts upon plankton communities in North Inlet, SC. Baruch Institute Symposium. Georgetown, SC. March 2007 (Oral)

Marshalonis, D., Pinckney J.L., and T.L. Richardson. Effects of hydromedusae grazing on phytoplankton community structure and function. American Society of Limnology and Oceanography. Santa Fe, NM. February 2007. (Oral)

Marshalonis, D. and J.L. Pinckney. Grazing and assimilation rate estimates of hydromedusae from a temperate tidal creek system: impacts on zooplankton populations. 41st European Marine Biology Symposium. Cork, Ireland. September 2006. (Poster)

Marshalonis, D. Grazing and assimilation rate estimates of hydromedusae from a temperate tidal creek system. Southeastern Estuarine Research Society Spring Meeting. St. Augustine, FL. March 2006. (Oral)

Pinckney J.L., Marshalonis, D., H.W. Paerl and L.M. Valdes. The use of phytoplankton photopigments as a bioindicator for the condition of estuarine ecosystems. The Estuarine Research Federation Annual Meeting. Norfolk, VA. October 2005. (Oral – stand in for J. Pinckney)

Marshalonis, D., Pinckney J.L., and T.L. Richardson. Effects of gelatinous zooplankton (Hydromedusae) predation on phytoplankton community composition in North Inlet estuary, SC. The Estuarine Research Federation Annual Meeting. Norfolk, VA. October 2005. (Poster)

Marshalonis, D. The environmental impacts of gelatinous zooplankton (Hydromedusae) on carbon dynamics of the North Inlet ecosystem. 6th Annual Baruch Research Symposium. Georgetown, SC. April 2005. (Oral)

Marshalonis, D., Knowlton, R.E. and H. Merchant. Acute effects of permethrin on four populations of grass shrimp, *Paleamonetes pugio*. The Society of Integrative and Comparative Biology Annual Meeting. San Diego, CA. January 2005. (Poster)

COMPLAINANT'S EXHIBIT 32

DOUGLAS C. BEYERLEIN, P.E., P.H., D.WRE
Principal Engineer
Clear Creek Solutions, Inc.
Mill Creek, WA

AREAS OF EXPERTISE

Hydrology, Stormwater Modeling, Water Resources Planning, Flood Studies, Expert Witness

EXPERIENCE

Mr. Beyerlein has 40 years of experience in numerous aspects of water resources planning, flood studies, and stormwater modeling.

Before co-founding Clear Creek Solutions Mr. Beyerlein worked for Hydrocomp and Anderson-Nichols in the San Francisco Bay Area and later Snohomish County Surface Water Management and AQUA TERRA Consultants in Everett, Washington.

As senior hydrologic engineer and engineering group supervisor for Snohomish County, Mr. Beyerlein helped to develop the surface water management program for the county. His responsibilities included watershed planning, streamflow and water quality monitoring, lake management, public education, flood control planning, development of county drainage code, and compliance with state and federal water quality laws.

He has experience with EPA's HSPF, the Army Corps of Engineers' HEC-1, HEC-2, HEC-5, and HEC-RAS models, and FEQ. Mr. Beyerlein has led the engineering community in the development of new, more accurate tools to analyze the impacts of land development on streams and fish habitat. As a result of his leadership, in 1999 his firm was awarded a contract by the Washington State Department of Ecology to develop the Western Washington Hydrology Model (WWHM) to accurately measure land development impacts and size stormwater facilities accordingly. He has taught WWHM to over 2000 engineers, planners, and reviewers throughout Western Washington.

Mr. Beyerlein teaches workshops on the theory and application of HSPF. His clients have included the U.S. Bureau of Reclamation, U.S. Natural Resources Conservation Service, Washington State Department of Ecology, King County, Snohomish County, Thurston County, and Clark County.

He has written and presented landmark stormwater papers including “Why Standard Stormwater Mitigation Doesn’t Work” and “Effective Impervious Area: The Real Enemy”.

Mr. Beyerlein is licensed as a Registered Professional Engineer in Washington and California and is certified as a Professional Hydrologist by the American Institute of Hydrology. He is also a member of the American Academy of Water Resources Engineers.

EDUCATION

University of Washington, BS Civil Engineering, 1972
University of Washington, MS Civil Engineering (Water Resources Program), 1973

REPRESENTATIVE ASSIGNMENTS

Seattle University Hydrology Instructor - Taught water resources in the Civil Engineering Department. Topics included precipitation and streamflow collection and analysis, groundwater, hydrologic and hydraulic flow routing, flood frequency analysis, and rainfall-runoff modeling.

Mystic Lake Court Case, King County, WA - Provided hydrologic analysis of lake elevation changes due to development of neighboring properties. Developed HSPF computer model of lake with and without development.

Burien Depression Analysis, King County, WA - Modeled flood elevations in natural depression draining neighborhood of 200 acres. Evaluated alternative proposed solutions including pumping and diversion of inflows.

East Lake Sammamish Wetland Hearing, King County, WA - Provided hydrologic analysis of wetland water level fluctuations and expert witness testimony for King County hearing for proposed development of wetland site. Demonstrated hydroperiod alterations exceed Puget Sound Wetlands and Stormwater Management Research Program guidelines.

HSPF Training Courses - Teaches HSPF theory and application in two-day training courses to engineers, planners, and scientists at government agencies and private consulting firms, including Washington State Department of Ecology, King County Surface Water Management, Snohomish County Surface Water Management, Thurston County Stormwater, City of Renton Surface Water Utility, CH2M Hill, Ebasco Environmental, David Evans and Associates, EMCON Northwest, Alpha Engineering, and KCM.

Dutch Hill Drainage Hearing, Snohomish County, WA - Provided expert testimony on drainage issues and wetland hydroperiod problems related to proposed development DNS hearing in Snohomish County.

Thurston County HSPF Applications, WA - Instructed county staff in the use of HSPF for watershed planning in four watersheds. Investigated the impacts of future conditions alternatives and proposed mitigation on streamflow.

FEMA Flood Insurance Studies - Used HEC-2 to determine the extent of flooding caused by the 10, 50, 100, and 500-year floods for rivers and streams in Riverside, Mendocino, and Humboldt counties, California. Studies included floodplain delineation, floodway computation, field surveys, and mapping.

City of Seattle Hydraulic Modeling On-Call Services – Mr. Beyerlein modeled the Venema drainage system as a test drainage area and evaluated the effectiveness of eco-roofs and bioretention swales in reducing stormwater runoff. He has instructed SPU staff in the application of WWHM3 for SPU projects.

WSDOT Runoff Distribution Analysis Study – Mr. Beyerlein conducted hydrologic modeling of variety of land uses using WWHM3 LID Analysis Tool to determine the runoff distribution of each to assist WSDOT in development of appropriate stormwater mitigation strategies.

WSDOE Western Washington Hydrology Model Version 3 (WWHM3) – Mr. Beyerlein was principal investigator in the development of WWHM3 use in sizing stormwater control facilities in Western Washington. WWHM3 is part of Ecology's Stormwater Management Manual for Western Washington.

AGCEF WWHM Workshops – Mr. Beyerlein has taught over 2000 engineers, planners, and scientists in the theory and application of the Western Washington Hydrology Model (WWHM), as part of the Associated General Contractors Education Foundation program.

Snohomish County Drainage Needs Report – Mr. Beyerlein updated existing or created new HSPF models for Sunnyside Creek, Martha Creek, North Creek, Lunds Gulch, and Norma Creek and evaluated future land use impacts on flood frequency and flow duration and proposed structural alternatives to solve identified flood problems in the watersheds.

King County Watershed Modeling Services – Mr. Beyerlein managed the construction and calibration of water quantity and quality models for two topographic basins – the Green-Duwamish and the Lake Washington-Ship Canal watersheds for King County Department of Natural Resources. These models support the two major projects, the Green-Duwamish Water Quality Assessment (GD WQA) and the Sammamish-Washington Analysis and Modeling Program (SWAMP). The primary purpose of the watershed water quality and quantity models is to support the GDWQA and SWAMP teams by simulating at a tributary level, surface and subsurface flow and associated physical, chemical, and biological loads to major receiving waters -- the Green River and Duwamish Estuary for the GDWQA and the major lakes for the SWAMP under a range of land use and infrastructure scenarios. Additionally these models provide a general tool for watershed analysis, management and educational outreach components of SWAMP and GDWQA, King County's ESA-response, aquatic resource protection, stormwater management programs, and ecological and human health risk assessment.

City of Everett Friar Creek Culvert Fish Passage Analysis – Mr. Beyerlein created the HSPF model of the Friar Creek watershed near Monroe for the City of Everett to evaluate fish passage issues related to culvert crossing of City's water supply pipeline.

May Creek Basin Plan, King County, WA - Hydrologic and hydraulic modeling of the May Creek Basin for King County and the City of Renton. Mapping of 100-year floodplain and zero-rise floodway plus identification of drainage problems and solutions in the watershed including the placement of stormwater control facilities.

Quilceda Creek Watershed Plan, Snohomish County, WA - Assisted county staff in the use of HSPF for watershed planning. Investigated the impacts of future conditions alternatives and proposed mitigation on streamflow.

North Creek Watershed Plan, Snohomish County, WA - Supervised the hydrologic analysis of flood flows in the North Creek watershed from Everett to Bothell. Provide technical data for FEMA North Creek Flood Insurance Study in neighboring King County.

San Pedro Creek Flood Court Case, San Mateo County, CA - Provided hydrologic analysis and expert witness testimony related to damages caused by the flood of 1982 in Pacifica, California.

COMPLAINANT'S EXHIBIT 33

Lloyd B. Oatis

9030 Ferncliff Ave
Bainbridge Island, WA 98110
206-780-1577 / 206-310-9281 (cell)

- **2002 to present**: Financial Analyst at EPA Region 10 office in Seattle under the SEE grantee program. Perform financial analyses with respect to inability to pay claims raised by respondents, defendants, PRPs and entities in non-compliance. Advise staff and management on economic benefit calculation issues, financial assurance and on other business related activities/issues. Have handled more than 100 Ability-to-Pay cases, 30 Economic Benefit cases and 25 financial assurance cases during above tenure.

- **1995 to 2001**: Senior Manager for Andersen Consulting/Accenture. Analyzed financial processes and systems for several multi-national companies (including three foreign based oil companies) and one federal government entity (Department of Interior – Minerals Management Service). Consulted with companies on financial strategies. Led teams that made recommendations and implemented solutions resulting in savings and efficiency to clients and extended business for firm from clients.

- **1966 to 1995**: Financial Manager and Analyst for Atlantic Richfield (ARCO) for 29 years. Responsibilities included:

  - Managed multiple financial and audit activities including financial audits, treasury activities, general accounting and joint ventures
  - Analyzed and managed financial activities for major Alaskan project activities including contract administration, all areas of accounting and information systems
  - Analyzed financial aspects of the largest oil and gas joint venture in the U.S. and was financial representative on negotiating team to form the joint venture agreement; developed early operating budgets and financial processes for ARCO Alaska.

- **Education**: Bachelor's Degree, Business Administration (Major: Accounting) - University of Texas, Austin

- Numerous professional affiliations including COPAS (an international Petroleum Accounting Society with over 4,000 members) - held several leadership positions including President.

COMPLAINANT'S EXHIBIT 34

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PROFESSIONAL EXPERIENCE:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, Environmental Engineer, Seattle, WA (1993-present). San Francisco (1987 – 1991). Duties include oversight of Washington's impaired waters (TMDL) program (14 years), including the development, review and approval of pollutant reduction strategies for impaired rivers throughout the state; and Clean Water Act policy development. Previous duties include developing NPDES permits, RCRA corrective action plans and CERCLA Remedial Investigation reports.

ROY F. WESTON, Environmental Engineer, Seattle, WA (1992-1993). Duties include developing a feasibility study for CERCLA sediment site contaminated with VOCs and metals.

CAMP DRESSER & MCKEE, Environmental Engineer, Walnut Creek, CA (1991-1992). Duties include design of groundwater and surface water sampling programs, and oversight of groundwater well installation.

EDUCATION:

UNIVERSITY OF MINNESOTA, INSTITUTE OF TECHNOLOGY, Minneapolis, Minnesota, B.S. Chemical Engineering (1987).

AUGSBURG COLLEGE, Minneapolis, Minnesota, B.A. Chemistry / Biology (1982).

HONORS/ AWARDS:

EPA Region 10 Leadership Award (2008); EPA Gold (2001) and Bronze (2011, 2010, 2002, 2000) Medals. Superior Accomplishment Award (1998).

PUBLICATIONS/ PRESENTATIONS:

"Addressing 303(d) Listed Waters through Total Maximum Daily Loads (TMDLs)" Washington Department of Ecology TMDL Training (Lacey, WA 2012)

Monschein, E. and L. Mann. 2007. *Category 4b – a regulatory alternative to TMDLs*. Proceedings: Water Environment Federation TMDL 2007 Conference, Bellevue, Washington, pp. 454-463.

"Overview of the TMDL Program" Alaska Department of Environmental Quality TMDL Program (Anchorage 2007)

COMPLAINANT'S EXHIBIT 35

RESUME OF BURT K. SHEPHARD

6322 172nd Street SW
Lynnwood, WA 98037
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(425) 359-2268 (cell)

AREAS OF EXPERTISE

Aquatic Chemistry, Aquatic Ecology, Aquatic Toxicology, Bioaccumulation, Ecological Risk Assessment, Limnology, Quality Assurance, Sediment Quality, Statistical Analysis, Tissue Residue Evaluations, Trace Metal Analysis, Water Quality, Zooplankton Ecology and Taxonomy.

EDUCATION

B.S. in Chemistry, 1974, Purdue University, West Lafayette, IN.

M.S. in Environmental Health, 1976, Purdue University, West Lafayette, IN. Thesis title: The Aquatic Chemistry of Cadmium in a Natural and in a Model Aquatic System.

Course work and preliminary examination completed for Ph.D. in Fisheries Biology, Iowa State University, 1986. Thesis title: The Effects of Acid Deposition and Elevated Trace Metal Concentrations on Zooplankton.

EXPERIENCE

January 2004 to present - Toxicologist, Risk Evaluation Unit, Office of Environmental Assessment, U.S. Environmental Protection Agency Region 10, Seattle, WA.

- Summarize, develop, review, and/or perform oversight on ecological risk assessment studies at hazardous waste sites.
- EPA ecological risk assessment task manager for two of the largest Superfund sites in EPA Region 10 (Portland Harbor, Upper Columbia River), as well as for several smaller Superfund sites.
- Assist regional and national program offices with development and evaluation of water quality criteria including ammonia, selenium and copper, as well as with sediment and tissue residue benchmarks.
- Review and evaluate food web models for Region 10.
- Serve on multiple regional and national EPA work groups that develop or improve EPA guidance documents and procedures, including an update of EPA national guidance for ecological risk screening level benchmarks for water and sediment.
- Prepared survey of copper effects on fish behavior as part of a biological evaluation of Oregon's water quality standards, which is widely used to evaluate copper effects on fish throughout the U.S.
- Successfully prepared and served as regional contact for a combined total of four EPA Office of Research and Development Regional Methods (RM) and Regional Applied

Research Effort (RARE) grant awards. These grants have resulted in development of toxicity testing methods for threatened and endangered snail and fairy shrimp species, and one is currently working to develop water column and sediment toxicity test methods for western U.S. resident freshwater mussel species. Ammonia results from one of the RM toxicity studies with a pebblesnail (*Fluminicola* sp.) forms part of the basis for EPA's 2013 national chronic ammonia aquatic life criterion.

July 1994 to January 2004 - Manager, Risk Analysis and Risk Management Group; previously Ecological Risk Assessor, URS Consultants, Seattle, WA.

- Manager for a group of human health and ecological risk assessors. Responsible for marketing group services to both internal URS clients and external industry and government clients. Performed staff evaluations and annual reviews.
- Prior to promotion to risk assessment group manager, served as project or task manager for numerous environmental and risk assessment projects, with primary responsibility for experimental design, statistical data analysis, report preparation, client contact, and agency consultation. Projects evaluated water, sediment and soil quality, toxicological impact of chemicals, and environmental effects of physical stressors and construction projects on multiple sites located in freshwater, estuarine and marine environments. Project manager for the Environmental Residue Effects Database (ERED, found at http://el.erdc.usace.army.mil/ered/), a joint USEPA – U.S. Army Corps of Engineers online database that compiles literature on contaminant concentrations in tissues associated with toxicity to aquatic and wildlife species, and which is currently widely used by ecological risk assessors worldwide.
- Provided both written and oral depositions in a natural resource damage assessment case in Commencement Bay, Washington.

January 1987 to June 1994: Aquatic Toxicologist, Harza Engineering Co., Chicago, IL.
Project manager or lead scientist for over 15 water quality and toxicological projects in freshwater, estuarine and marine systems.

- Responsible for all aspects of monitoring program design, field study preparation or technical review of project reports, presentation of results to clients, and new business development presentations. Studies determined impact of PCBs, pesticides, PAHs, trace metals, urban runoff, mining wastes, nutrients and eutrophication, and water resource construction projects on aquatic systems.
- Performed portions of exposure assessments, and human health and ecological risk assessments on three Federal Superfund sites.
- Provided expert witness testimony for two clients. Overseas experience includes work on environmental assessment, toxicity testing or water quality monitoring programs in Australia, Bangladesh, Jordan, Syria, Papua New Guinea, Indonesia, India and Mexico.

September 1982 to January 1987 - Graduate Teaching/Research Assistant, Dept. of Animal Ecology, Iowa State University, Ames, IA.

- Researched effects of low pH and elevated aluminum levels on the survival and reproduction of zooplankton under laboratory and field exposure conditions at Little Rock Lake, WI.

- Taught classes in basic ecology, fishery and limnological techniques, natural resource conservation, and ornithology.

Summer 1983: Summer intern, U.S. Environmental Protection Agency, Duluth, MN. Performed research on the effects of reduced pH and elevated aluminum concentrations on several zooplankton species.

Summer 1982: Environmental Specialist, Environmental Review Branch U.S. Environmental Protection Agency, Region 5, Chicago, IL. Reviewed and provided agency written comments on all environmental assessments and impact statements concerning small scale hydroelectric power development, as well as review and comment on other selected projects.

1980 – 1981: Technical Director, Analytical Chemistry Laboratory, Geomet Technologies, Inc., Melville, NY. Supervised and operated a small laboratory involved with water and sediment analyses.

- Implemented a major revision and upgrade of the laboratory quality assurance program.
- Successfully marketed an increase in the scope of work for the water chemistry portion of a pre-operational environmental statement of an east coast nuclear power plant.

1976 – 1979: Environmental Science and Engineering, Inc., Gainesville, FL.

- Biology Division, Aquatic biologist - assisted in the set-up and maintenance of an aquatic toxicology testing facility.
- Quality Assurance Supervisor, Chemistry Division - responsible for the design, implementation and operation of the laboratory quality assurance program.
- Chemistry Division, Environmental Chemist - responsible for portion of aquatic environmental impact statements for several regional section 208 programs under the Clean Water Act, and at a U.S. Navy nuclear submarine base. Also responsible for all laboratory heavy metal analyses and some analytical method development.

1976: Analytical Chemist, Cadmium Project, Purdue University, West Lafayette, IN. Responsible for some heavy metal analyses for a National Science Foundation sponsored project. Assisted in the development of analytical methods for determining heavy metal content of fish tissues.

1974 – 1976: Environmental Toxicology Fellow, Bionucleonics Dept., Purdue University, West Lafayette, IN. Thesis research involved measuring trace metal contamination in the water and sediment of Palestine Lake, IN. Developed procedures for the determination of the chemical speciation of cadmium in freshwater, and for the determination of chemical forms of heavy metals in lake sediments.

Summer 1973: Technician, Lancy Laboratories, Inc., Zelienople, PA. Responsibilities included chemical analysis of water and wastewater for metals and cyanide.

SELECTED HONORS AND AWARDS

Pacific Northwest Chapter, Society of Environmental Toxicology and Chemistry. Elected by membership to serve as chapter president, 2010.

Pacific Northwest Chapter, Society of Environmental Toxicology and Chemistry. Elected by membership to serve as member of Board of Directors, 2002 - 2011.

Pellston Workshop, Tissue Residue Approach in Ecological Risk Assessment, 2007. Invited to serve on an international workgroup that evaluated current status and future directions and needs of tissue residue criteria, standards and benchmarks in ecological risk assessment. Workgroup published findings in a peer reviewed journal in 2011.

Silver Medal for Superior Service, USEPA. For work as part of team that reached a settlement agreement with a responsible party on the Upper Columbia River hazardous substance site. The responsible party was located in Canada, requiring negotiations between a Canadian corporation and U.S. and Canadian government agencies.

Bronze Medal for Commendable Service, USEPA. A second honor for work as part of team that reached a settlement agreement with a responsible party on the Upper Columbia River hazardous substance site. The responsible party was located in Canada, requiring negotiations between a Canadian corporation and U.S. and Canadian government agencies.

Bronze Medal for Commendable Service, USEPA. For work on a complex NPDES permit at a pulp and paper manufacturer in Idaho, requiring development of a multiple year monitoring program to identify possible effects of effluent on receiving waters in the Clearwater and Snake Rivers. Results of monitoring resulted in fewer requirements for monitoring effluent impacts in future years.

Bronze Medal from Office of General Counsel, USEPA. A third honor for work as part of team that reached a settlement agreement with a responsible party on the Upper Columbia River hazardous substance site. The responsible party was located in Canada, requiring negotiations between a Canadian corporation and U.S. and Canadian government agencies.

COMPLAINANT'S EXHIBIT 36

2-52-A. Class II Administrative Penalty: Initiation of Action; Public Notice; Consultation With State; Negotiation and Signing Consent Agreements; and Assessing Penalties

1200 TN 350
5/11/94

1. **AUTHORITY.** Pursuant to Section 309(g) and 311 of the Clean Water Act (CWA), the authority to:
   a. Make findings of fact; propose penalty to be assessed; issue, amend, or withdraw Class II administrative complaints;
   b. Provide, or cause to be provided, public notice of proposed assessment and provide commentors with copies of orders entered on consent or on default;
   c. Consult with States, as required;
   d. Sign consent agreements between the Agency and the party against whom a Class II penalty is proposed to be assessed;
   e. Issue final orders assessing Class II penalties where no hearing is requested by the respondent or pursuant to a consent agreement; and
   f. Decide petitions by commentors to set aside final orders entered without a hearing and provide copies and/or notice of the decision.
2. **TO WHOM DELEGATED.** Regional Administrators, the Assistant Administrator for Enforcement and Compliance Assurance.
3. **LIMITATIONS.**
   a. The Regional Administrators may exercise the above authorities only for those cases initiated by the Regions.
   b. The Assistant Administrator for Enforcement and Compliance Assurance must notify the appropriate Regional Administrator or designee before exercising 1.a and must consult with Regional Administrators or designee before exercising authority 1.c; the Assistant Administrator for Enforcement and Compliance Assurance must consult with Regional Administrators or designee and notify the Assistant Administrator for Water before exercising authority 1.d.
   c. The Regional Administrator must consult with the Regional Counsel or his/her delegatee and obtain concurrence on legal sufficiency of documents to be issued before exercising authorities 1.a or 1.d.
   d. The Assistant Administrator for Enforcement and Compliance Assurance may only exercise authorities 1.a through 1.d, and may only exercise those authorities in multi-regional cases and cases of national significance.
   e. The Environmental Appeals Board may only exercise authorities 1.e and 1.f and only

in those cases initiated by Headquarters.

4. **REDELEGATION AUTHORITY.**
   a. Authority 1.f and the authority to issue consent orders under authority 1.e may not be redelegated. All other authorities may be redelegated to the Division Director level. Authorities 1.b and 1.c may be further redelegated to the staff level. The Assistant Administrator's authority to consult with States may be transferred to Regional Office employees, with the agreement of the Regional Administrator or his delegatee.
   b. Persons exercising authority 1.d may allow other appropriate EPA officers or employees to join as "co" or supplemental signatories.
5. **ADDITIONAL REFERENCES.**
   a. Section 309(g) and 311 of CWA.
   b. Chapter 1, Delegations 1-37 and 1-38 entitled "Hearings" and "Adjudicatory Proceedings".
   c. 40 CFR Part 22.

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DELEGATION OF AUTHORITY
CLEAN WATER ACT (CWA)

Class II Administrative Penalty: Initiation of Action; Public Notice; Consultation With State; Negotiation and Signing Consent Agreements; and Assessing Penalties

1. AUTHORITY. Under Sections 309(g) and 311 of the Clean Water Act (CWA), the authority to:

   a. make findings of fact; propose penalties to be assessed; and issue, amend, or withdraw Class II administrative complaints;

   b. provide, or cause to be provided, public notice of proposed assessments and provide commenters with copies of orders entered on consent or on default;

   c. consult with states, as required;

   d. sign consent agreements between EPA and the the party against whom a Class II penalty is proposed to be assessed;

   e. issue final orders assessing Class II penalties where no hearing is requested by the respondent or pursuant to a consent agreement; and

   f. decide petitions by commenters to set aside final orders entered without a hearing and provide copies and/or notice of the decisions.

2. TO WHOM DELEGATED.

   a. The authorities in 1.a. and 1.d. are delegated to:

      i. the Director, Office of Compliance and Enforcement or equivalent for Class II administrative penalty actions under Sections 309(g) and 311(b)(6) of the CWA;

      ii. the Director, Office of Ecosystems, Tribal and Public Affairs or equivalent for Class II administrative penalty actions under Section 309(g) of the CWA; and

   b. The authorities in 1.b. and 1.c. are delegated:

i. through the Director, Office of Compliance and Enforcement or equivalent and the Manager, NPDES Compliance Unit or equivalent to the staff level for Class II administrative penalty actions under Sections 309(g) and 311(b)(6) of the CWA;

ii. through the Director, Office of Ecosystems, Tribal and Public Affairs or equivalent and the Manager, Aquatic Resources Unit or equivalent to the staff level for Class II administrative penalty actions under Section 309(g) of the CWA;

iii. through the Regional Counsel and the Office of Regional Counsel Unit Managers to the staff level for Class II administrative penalty actions under Section 309(g) and 311(b)(6) of the CWA.

c. The authority of 1.e. is retained by the Regional Administrator and also is delegated to the Regional Judicial Officer in Region 10 under 40 C.F.R. § 22.18(b)(3).

d. The authority in 1.f. will be delegated to a Petition Officer on a case by case basis under 40 C.F.R. § 22.45.

3. LIMITATIONS.

a. Delegatees may exercise the above authorities only for those cases initiated by the Region.

b. The Regional Administrator or delegatee must consult with the Regional Counsel or his/her delegatee and obtain concurrence on legal sufficiency of documents to be issued before exercising authorities 1.a. or 1.d.

4. REDELEGATION AUTHORITY.

a. The authority in 1.a., 1.d., 1.e., and 1.f. may not be redelegated.

b. The authority in 1.b. and 1.c. may be redelegated.

5. SUPERSESSION. This delegation supersedes R10 2-52-A (5/28/04) and any prior delegation of the same authority.

6. ADDITIONAL REFERENCES.

a. Sections 309(g) and 311 of the CWA.

b. Delegation 1-37 (Hearings) and 1-38 (Adjudicatory Proceedings).

c. 40 C.F.R. Part 22.

d. Delegation 2-52-A (5/11/1994).

October 28, 2004
Date

/s/ Ronald A. Kreizenbeck
Ronald A. Kreizenbeck
Acting Regional Administrator

COMPLAINANT'S EXHIBIT 37

2012 Stormwater Manual for Western Washington, Ecology, *available at* https://fortress.wa.gov/ecy/publications/summarypages/1210030.html

COMPLAINANT'S EXHIBIT 38

Vehicle and Metal Recyclers: A guide for Implementing the ISGP Requirements (March 2011), *available at* https://fortress.wa.gov/ecy/publications/publications/94146.pdf