EPA Grant Application: Puget Sound Watershed Management Assistance Program

Title: Development of a Stormwater Retrofit Plan for Water Resources Inventory Area (WRIA) 9 and Estimation of Costs for Retrofitting all Developed Lands of Puget Sound.

Puget Sound Watershed
WRIA 9 – Green/Duwamish River and Central Puget Sound watershed, excluding the areas upstream of the Howard Hansen Dam and the City of Seattle, 282 square miles.

Applicant information
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Total federal funds requested: $999,981. **Total non-federal match:** $337,786

Abstract – Stormwater is one of the biggest threats to Puget Sound. This project will develop a cost estimate and prioritization plan for systematically implementing stormwater BMPs and LID techniques in previously developed areas of WRIA 9. The estimate will be based on flow and water quality data, watershed models, the EPA's SUSTAIN model (**S**ystem for **U**rban **S**tormwater **T**reatment and **A**nalysis **IN**tegration), and stakeholder input. In-stream flow and water quality goals will be developed, and the combination of retrofits needed will be optimized to meet the in-stream goals at minimum cost. The study area includes the Green / Duwamish River and central Puget Sound watersheds in WRIA 9, excluding the area upstream of the Howard Hanson Dam and the City of Seattle. Planning level cost estimates for the Puget Sound basin will also be developed via extrapolation. Implementing stormwater retrofits in developed areas is prioritized in the 2020 Action Agenda.

Restriction on Association with ACORN - King County is not an affiliate, subsidiary, or an allied organization of Association of Community Organizations for Reform Now (ACORN).

Description of the Watershed

The study area includes the Green/Duwamish watershed and portions of the Central Puget Sound watershed that comprise Water Resources Inventory Area (WRIA 9), excluding the areas upstream of the Howard Hanson Dam and the City of Seattle. Vashon-Maury Island, which is technically in WRIA 15 but is included in WRIA 9 for planning and restoration purposes, is also excluded from the study area. In total, WRIA 9 comprises 536 mi^2. The Watershed Ecosystem Forum of WRIA 9 (the Forum) oversees efforts to improve watershed health and salmon habitat recovery in WRIA 9. The Forum includes representatives of all of the WRIA 9 partner governments and federal and state agencies, nonprofits, and business interests, some of which are enumerated below. WRIA 9 is one of the most diverse and productive watersheds in the Puget

Sound, with almost 5,000 acres (about 7.8 mi^2) designated for agriculture in an Agricultural Production District and more than 286 mi^2 of commercial forest land. At its mouth, the estuary is the industrial heart of Seattle and supports one of the largest container ports on the West Coast.

The total project study area (about 282mi^2) encompasses a large and growing population. The Puget Sound Regional Council has projected that the study area population will increase by about a quarter of a million people between 2000 and 2040, to just over 765,000 people in 2040. Along with unincorporated King County, there are 15 cities within the study area, (including the cities of Algona, Auburn, Black Diamond, Burien, Covington, Des Moines, Enumclaw, Federal Way, Kent, Maple Valley, Normandy Park, Renton, Seatac, and Tukwila) and the Muckleshoot Indian Reservation. Lands within the City of Seattle are not included in the study area because the vast majority of Seattle's lands within WRIA 9 are served by a combined sewer and stormwater system and CSO control programs are already underway in this area. The area of WRIA 9 upstream of the Howard Hanson Dam is not included in the study area because it is primarily forested and maintained for the City of Tacoma's water supply.

Within the study area, about 149 mi^2 (about 53%) are designated as urban and lie within the urban growth area while 133 mi^2 (about 47%) are designated as rural and fall outside of the urban growth area. Within the rural area, 65 mi^2 (about 23%) are zoned as forest production. About three-quarters of the urban lands in the study area were developed with no or ineffective stormwater controls. In addition, about 40 percent of the land within the urban growth area is impervious cover, such as roads, rooftops, and parking lots.

The study area is home to a wide array of wildlife; many species of which are threatened by stormwater-related pollution. Between 2,500 and 11,500 Chinook salmon and thousands of other salmonids migrate up the Green/Duwamish River every year to naturally spawn, using miles of good habitat on the mainstem and tributaries. Lakes and wetlands along the river host major populations of migratory and resident birds and other wildlife. Bear, elk, eagles and cougar roam the Cascade foothills and mountain peaks in the headwaters.

Description of the Threats or Emerging Problems

The study area is faced with a number of major threats, including:

- Uncontrolled stormwater runoff from the majority of developed lands;
- Increasing density and impervious surface area within the Urban Growth Area associated with ongoing development and population increases;
- Increasing pressure to convert agriculture and forest lands outside the Urban Growth Area to low-density residential development;
- Altered hydrology due land development, and the use of ineffective or no stormwater controls, resulting in flashier stream/river flows during storm events;
- Altered hydrology due to operations of the Howard Hanson Dam and increasing amounts of water withdrawals for consumptive uses;
- A degraded aquatic ecosystem that is not meeting water quality standards (temperature, dissolved oxygen, and other parameters);
- A loss of river and floodplain habitat, jeopardizing the second largest run of Chinook salmon in Puget Sound; and
- Future increased temperatures and altered hydrology associated with climate change.

Conversion of forest cover to impervious surfaces, lawns, and pastures/fields causes significant hydrologic alterations which result in changes in the quantity, quality, and timing of stormwater runoff discharged from these altered areas. These hydrologic alterations result in a "flashier" system, where stream and river flows increase quickly in even the smallest rain storms, and there is an increase in stormwater peak flows and volumes. In turn, these changes result in a significant increase in the discharge of pollutants from motor vehicle use and other human activities that are picked up by runoff and transported to nearby receiving waters, causing a multitude of impacts to receiving waters. Documented impacts include increased peak flows; erosion and sedimentation of stream channel features essential to fish life stages; excessive velocities that impede fish migration and wash away food sources; increased flashiness; decreased low flows that decrease habitat and strand fish; loss of groundwater recharge critical to summer water supply for both fish and humans; and degradation of water quality leading to lethal and sub-lethal effects on fish and threats to human health. These threats were thoroughly described in the WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment Report, where land development, habitat alterations, and water quality were highlighted as contributing to the decline of salmonids in the watershed.

Efforts to address these impacts have largely focused on regulations that require individual stormwater controls on new development sites. These typically consist of "flow controls" (e.g., detention facilities) to limit the peak rates and duration of discharge and "water quality controls" (i.e., treatment facilities) to remove pollutants from the runoff prior to discharge (e.g., 50% solids removal). Initial stormwater control efforts began in the late 1970s with the application of simplistically-designed flow controls. These early controls were found during the 1980s to be ineffective at preventing impacts. Substantially expanded and improved controls were adopted and required for new development in the early 1990s, though similar controls were not required for previously developed lands. In addition, other types of flow controls that resemble what are now called low impact development (LID) techniques began to be successfully used as well. These included clearing limits in rural areas, reduced road widths, and single family roof downspout infiltration and dispersion controls. Water quality controls such as wetponds and biofiltration swales were also applied for the first time in the 1990s.

Unfortunately, roughly more than three quarters of the developed land in King County was built out prior to 1990 using no stormwater control methods or the ineffective initial methods developed in the 1970s. A similar proportion of developed land in WRIA 9 was also built out during this time with no or relatively little flow control and virtually no water quality control. As inferred from the Puget Sound Action Agenda, the lack of stormwater controls in older developed areas is one of the most significant water quality problems affecting Puget Sound.

Project Need

Significance of Project The current NPDES Municipal Stormwater Permits requires municipalities to have a stormwater management program to reduce pollutant discharge to the maximum extent practicable. Unfortunately, the permit requirements focus primarily on preventing existing stormwater impacts from getting worse through the regulation of new development and through illicit discharge prevention, facility maintenance, and education. There is no provision in the permit to systematically eliminate existing ongoing impacts associated with the original land cover conversion in older developed areas

Past basin planning efforts to quantify stormwater impacts and necessary mitigation also focused mainly on preventing further flow impairments from new development. These efforts emphasized controlling the high flow portion of the flow regime (i.e., flows higher than that necessary to move stream bed gravels). No planning efforts have been conducted to identify the type and cost of mitigation necessary to achieve flows that are more representative of normative conditions and that meet water quality standards. Such an effort would need to also address changes that would occur due to redevelopment of previously developed areas to accommodate population increases.

This project takes a landscape level approach to quantify stormwater management options and costs for existing development, including evaluation of retrofits and development in a densely populated, multijurisdictional watershed in the South Central Action Area of Puget Sound. The recent availability of the USEPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) model greatly reduces the level of effort required to assess stormwater mitigation needs across the landscape. SUSTAIN was developed specifically to facilitate the selection and placement of stormwater management BMPs and LID techniques to improve flow and water quality conditions to enable them to meet watershed goals. SUSTAIN includes an optimization feature that allows for designing an optimized suite of stormwater improvements that result in achievement of the watershed goals at the lowest anticipated cost. This project will be a pilot test case for the use of SUSTAIN for future application in the Puget Sound region. Information about SUSTAIN is available at: http://www.epa.gov/ednnrmrl/models/sustain/index.html.

Problem Priority The impact of unmanaged stormwater has been widely acknowledged to be a substantial contributor to decline in the health of Puget Sound. Within the study area, altered hydrology and poor water quality are widely documented and cited as important contributing causes to declines in fish populations. This project aims to address this high priority problem by providing the first evaluation of possible approaches and costs estimates to retrofit previously-developed lands with improved stormwater management techniques at a watershed scale. This project will specifically account for the impacts of climate change and population growth anticipated to occur within the study area, and the associated development of previously undeveloped lands and redevelopment of previously developed lands.

Puget Sound Action Agenda Priorities Addressed

Priority B: Restore the ecosystem processes, structures, and functions that sustain Puget Sound. This project will identify the most cost-effective actions necessary to retrofit stormwater systems to restore flow and water quality in the study area to project-defined targets, and provide planning-level cost estimates for the Puget Sound region. The retrofit plan numbers and types of stormwater BMPs and LID techniques that represent "restoration activities [that] focus on improving underlying functions of the ecosystem, and work efficiently on projects that are likely to have large-scale and long-lasting returns." (Puget Sound Action Agenda, page 41)

Priority C: Prevent water pollution at its source. Implementation of the stormwater retrofit approaches identified in this project will result in in-stream flows and water quality that meet catchment-specific goals. This is in keeping with the Action Agenda's statement that "We must also improve the management of stormwater runoff." (Puget Sound Action Agenda, page 46) to improve water quality.

Priority D: Work together as a coordinated system on priority actions. The participation of the many partners in this project, and the watershed-wide approach ensure that this project fulfills

the mandate to "Conduct planning, implementation, and decision-making in an integrated way and with an ecosystem perspective." (Puget Sound Action Agenda, page 56)
The following excerpts from the South Central Puget Sound Action Area Status and Threats also support this project. *"Currently, polluted stormwater and industrial discharges that originate in South Central Puget Sound are some of the biggest threats to ecosystem health. Freshwater quality has been impaired in local streams from the metals and hydrocarbons that wash from roads and parking lots. Endocrine disrupting compounds from pharmaceuticals and personal care products have been found in water samples in King County."*

Interconnectedness with Other Efforts This project is directly connected to other efforts to preserve and restore the water quality, hydrology and natural resources, including fish and shellfish, wetlands and flood plains in the study area. The WRIA 9 Salmon Conservation Plan recommends a number of ecosystem improvements and other actions aimed at recovery of Chinook salmon, which are listed as threatened under the Endangered Species Act. This plan was prepared and is being implemented by the WRIA 9 Watershed Ecosystem Forum, a partnership of 17 municipalities. A stormwater retrofit plan for the watershed will add much needed definition to the conservation plan's recommendations to improve stormwater management, restore flows to project-defined targets, and improve water quality. As described later in this work plan, the Forum will provide input throughout the life of this project.

The 2007 Phase I and II NPDES General Municipal Stormwater Permits require nearly all municipalities in King County to implement a stormwater management program for protecting the water quality and beneficial uses of receiving waters. The permits do not require the development of a systematic stormwater retrofit program for previously developed areas. This project will therefore complement the permit requirements, and fill a large knowledge and planning gap.

Project Plan

Addressing Impacts of Growth The study area population is projected to grow by about a quarter of a million people between 2000 and 2040. This population increase will result in the conversion of additional land for urban use, and the redevelopment of previously developed land for higher density use. This project will specifically address this issue by identifying the stormwater BMPs and LID techniques necessary to achieve project-defined in-stream flow and water quality goals in 2040 based on the anticipated 2040 population levels and climate change.

Framework for Watershed Planning The project addresses Stages 1 and 2 of Ecology's Framework for Planning at the Watershed scale. Stage 1 of the framework (i.e., characterize watershed processes) is addressed by measuring and modeling flows and water quality and setting catchment area flow and water quality goals. Stage 2 of the framework (i.e., prescribe solutions) is addressed by quantifying and costing out the extent and composition of stormwater BMPs and LID techniques necessary to meet catchment area flow and water quality goals. The completion of this plan will allow for all jurisdictions in the study area to move forward with Stage 3 of the framework (i.e., take action) in a coordinated and cost-effective manner by siting, designing and implementing specific stormwater BMPs and LID techniques to retrofit existing development. It is anticipated that flow and water quality monitoring will continue throughout the study area, ensuring that Stage 4 of the framework is completed (i.e., monitor effectiveness of solutions). It is also anticipated that the stormwater retrofit plan will be reviewed and updated based on these results (Stage 5 – feedback for improvement or adaptive management).

Project Innovation This project is innovative for two key reasons:

1. The recent availability of SUSTAIN has the potential to greatly reduce the level of effort needed to assess, quantify, and optimize the cost of stormwater BMPs and LID techniques needed to meet catchment-specific flow and water quality goals. This project will be the first application of SUSTAIN in the region at the watershed scale, and will serve as a pilot for other watersheds.
2. Past efforts to quantify stormwater impacts and necessary mitigations have primarily focused on preventing further degradation associated with new development, or to a limited degree, on controlling only the peak, high flows associated with existing development. These efforts did not address the full spectrum of flow and water quality characteristics necessary for watershed health, nor have they compiled cost estimates for implementing the stormwater BMPs and LID techniques necessary for meeting catchment-specific flow and water quality goals. This project will address these shortcomings by combining a variety of disparate data sets and tools into one comprehensive analysis.

Description of Activities This project will identify the most cost-effective combination of stormwater BMPs and LID techniques needed to meet project-defined, catchment-specific in-stream flow and water quality goals in WRIA 9, excluding the upper watershed above Howard Hanson dam and the City of Seattle, develop a prioritized retrofit plan for the study area, and extrapolate the results to estimate planning level costs to retrofit developed lands in the Puget Sound region. Data used to support the watershed modeling will include stream/river flow and water quality measurements (including new flow and water quality data collected to fill spatial data gaps), existing land use/land cover, future land use/land cover based on population projections, surficial geology, historic climatic data, and future climate projections. The watershed modeling output will be used, along with catchment-specific flow and water quality goals that will be developed during this project, as input to the SUSTAIN model to help define the most cost-effective combinations of stormwater BMPs and LID techniques needed to meet the goals. This work will be conducted under the guidance of a multijurisdictional project management team, and will benefit from input from the WRIA 9 Forum, Department of Ecology, and the Muckleshoot Indian Tribe.

Project Components

Task 1 Quality Assurance Project Plan Timeline: July 2010 – September 2010. Milestones: Sampling design and an EPA-approved quality assurance project plan (QAPP); landowner permissions to access sampling locations secured; sites selected for monitoring. Description: The project QAPP will be prepared following EPA guidance and submitted to EPA for review. EPA comments on the draft QAPP will be addressed and review will continue until the plan is approved by the EPA. The approved QAPP will be reviewed and updated as needed.

Task 2 Project Management Team Timeline: July 2010 – December 2013. Milestones: Establish Project Management Team (Sept. 2010) to provide technical oversight throughout the project. Description: A Project Management Team (PMT) comprised of stormwater managers from King County, other jurisdictions in the study area, and Department of Ecology will be assembled (see Partnering for a list of entities committed to participating on the PMT). The PMT will meet quarterly during the second half of 2010 and during 2011 and monthly during 2012 and 2013. The PMT will be responsible for directing the technical aspects of the data collection and reporting, the setting of in-stream flow and water quality goals, the watershed modeling, the SUSTAIN modeling, and development of the retrofit plan.

Task 3 Coordination with the WRIA 9 Watershed Ecosystem Forum Timeline: July 2010 – December 2013. Milestones: Annual briefing of the WRIA 9 Forum in 2010, 2011, and 2012, and quarterly in 2013. Description: The WRIA 9 Watershed Ecosystem Forum is a multijurisdiction and multistakeholder committee made up of elected officials and technical staff and coordinates efforts related to salmon recovery in WRIA 9. The forum is the key decision-making body for salmon recovery in WRIA 9. The project will leverage this existing structure to avoid developing a separate stakeholder committee for this project. Project updates will be presented to the Forum on a routine basis, and their input solicited throughout the life of the project. The PMT will coordinate with the Forum representatives and WRIA 9 staff during development of the prioritized retrofit plan, with an aim towards developing a final plan that can be endorsed by the Forum for the governments in WRIA 9 at the end of this project.

Task 4 Existing Data Review Timeline: July 2010 – May 2011. Milestones: Deliver existing data review report by May, 2011. Description: Existing stream/river flow and water quality data that define current conditions and are necessary for calibration of the watershed models will be compiled and organized. Data to be compiled includes precipitation, stream flow, stream water quality, land use and land cover, stormwater facility maps, and other atmospheric conditions to estimate evaporation and vegetative transpiration. All data sets will be reviewed for data quality and appropriateness for use.

Task 5 New Data Collection and Report Timeline: November 2010 – December 2011. Milestones: Collect continuous monitoring data by February, 2011. Collect survey of low-flow data by September, 2011. Complete data report by December, 2011. Description: The USGS and King County collectively maintain over 30 stream flow gages in WRIA 9. However, even with this extensive gage network, gage data are not available or insufficient for model calibration for some basins. To address this data gap, stream gages will be deployed at priority new sites during the wet season of 2010/2011 (~Nov. 2010 – Feb. 2011). Turbidity and specific conductance meters will also be deployed at both the existing gage locations and the new sites occupied to fill data gaps to support model calibration. Instantaneous summer base flow measurements at the priority new gaging sites will also be made in July-October 2011. Channel information needed for model calibration will also be gathered. Data will be made available via King County's database and web site at: http://green.kingcounty.gov/wlr/waterres/hydrology/.

Task 6 Development of In-Stream Flow and Water Quality Goals Timeline: Sept 2010 – May 2012. Milestones: Complete literature review by September, 2011. Complete goals report by May, 2012. Description: Catchment-specific in-stream flow and water quality goals will be developed for each location where flow and water quality data are available. The water quality goals will be based on Washington State Water Quality Standards. It is anticipated that the flow-related goals will be based on various hydrologic metrics that measure the degree of basin flashiness, including but not limited to High Pulse Count, High Pulse Duration, High Pulse Range, TQmean, Flow Reversals, R-B Index. These flow metrics have been found to be related to biological community health (DeGasperi, C., H. Berge, K. Whiting, J. Burkey, J. Cassin, and R. Fuerstenberg. 2009. Linking Hydrologic Alteration to Biological Impairment in Urbanizing Streams of the Puget Lowland, Washington, USA, Jnl Amer. Water Res. Assoc., Vol. 45, No. 2; available at: http://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/normative-flow/0904-lowland-streams-hydrology-biology.pdf). A literature review on the relationship between flow, water quality and beneficial uses will be completed, followed by a report describing the in-stream flow and water quality goals for this project.

Task 7 Watershed Modeling and Report Timeline: January 2011 – May 2012. Milestones: Complete modeling and report by May, 2012. Description: To develop relationships between land use and land cover, weather, and stream flow and water quality the study area will be modeled using two well-established watershed models: EPA's watershed modeling platform – Hydrologic Simulation Program – Fortran (HSPF), and the University of Washington's (UW) Distributed Hydrology Soil Vegetation Model (DHSVM).

The watershed modeling conducted for this project will build upon the modeling currently being conducted under an existing research project in WRIA 9 funded by National Oceanographic and Atmospheric Administration (NOAA). This project will be completed by December 2010. In this project, the HSPF and DHSVM models developed under the NOAA project will be further calibrated to include the new data collected by this study area and will be expanded to include the Central Puget Sound watershed drainages within the study area. Flows and water quality will be assessed under three conditions, idealized fully-forested, current land use/land cover, and 2040 land use/land cover and climate change. A watershed model report will be prepared that presents the model inputs, model calibration, and the model outputs.

Task 8 SUSTAIN Modeling and Report Timeline: June 2011 – September 2012. Milestones: Complete modeling and report by September, 2012. Description: The SUSTAIN model will be used to evaluate approaches and costs for stormwater retrofits necessary to achieve the project-defined flow and water quality goals within each catchment in the study area. Using SUSTAIN, combinations of stormwater BMPs and LID techniques will be evaluated within each catchment. An optimal combination of stormwater BMPs and LID techniques will be developed for each catchment that meets the flow and water quality goals at the minimum estimated cost. As appropriate, based on review of the SUSTAIN model, locally derived cost estimates, flow control estimates, and or water quality treatment estimates may be considered in this task. A SUSTAIN modeling report will be prepared.

Task 9 Watershed Retrofit Plan Report Timeline: September 2012 – June 2013. Milestones: Complete watershed retrofit plan report by June, 2013. Description: A report will be prepared that outlines the extent, composition, priority, and estimated cost of stormwater retrofitting needed in each catchment to meet flow and water quality goals. The report will also outline and prioritize the next steps needed to implement stormwater retrofit projects across the study area. The prioritization will consider level of urban impacts, costs of retrofits, potential biological benefits, and funding availability. The stormwater retrofit plan for the study area will serve as the basis for development of future funding strategies and project implementation. The PMT will coordinate with the Forum representatives and its staff to during development of the prioritized retrofit plan, with an aim towards developing a final plan that can be endorsed by the Forum for the governments in WRIA 9 at the end of this project.

Task 10 Stormwater Retrofit Cost Estimate for Puget Sound and Report Timeline: May 2013 – December 2013. Milestones: Complete cost estimate and report by December, 2013. Description: Based on the optimized costs of stormwater BMPs and LID techniques needed to meet the in-stream flow and water quality goals in the study area, a planning-level cost estimate will be prepared for the Puget Sound region. This estimate will be extrapolated from the study area based on the square miles of different land uses within the Puget Sound watershed. The cost estimates, in combination with the watershed Retrofit Plan Report, will inform the development of a systematic stormwater retrofit strategy for Puget Sound. A report will be prepared.

Task 11 Outreach and Communication Timeline: July 2010 – December 2013. Milestones: Establish project web site by September, 2010. Host public meetings in November, 2010, 2011, 2012, and 2013. Send quarterly project e-mail updates to interested parties starting in January, 2011. Complete project result presentation by December, 2013. Description: Outreach and communication is an essential component of this project. The outreach and communication strategy will use multiple approaches to ensure that input from interested stakeholders is gathered in a timely and efficient manner, and that information generated is disseminated and opened for comment appropriately. The activities described in under Project Components in Task 2 (work with a multijurisdiction PMT) and Task 3 (coordinate with the WRIA 9 Watershed Ecosystem Forum) are critical components of the outreach and communication strategy. Routine coordination will also occur with Ecology's stormwater program staff, Puget Sound Partnership staff, and with staff from the Muckelshoot Indian Tribe. Project results will be presented to the Puget Sound Science Panel, the Puget Sound Leadership Council, the Puget Sound Ecosystem Coordination Board, Ecology's management team, and to the Puget Sound Stormwater Monitoring Work Group. To ensure that project results are understandable, a specific effort will be undertaken to visualize the output of the watershed and SUSTAIN models. Finally, the project will also use a project website, public meetings, and quarterly e-mail updates as part of the outreach strategy.

Task 12 Project Management Timeline: July 2010 – December 2013. Milestones: Reports to EPA as required by the grant. Description: This task includes tracking the project scope, schedule, budget and quality, coordinating the project team, developing and processing contracts, agreements, and invoices, and reporting to EPA as required by the grant.

Partnering

King County will partner with the UW, multiple jurisdictions, the Muckleshoot Indian Tribe, the Washington State Department of Ecology, and the WRIA 9 Forum.

University of Washington (in kind match ~$20k): UW Researchers will lead development of the water quantity and quality goals for the study, development of the DHSVM watershed model, development of the SUSTAIN model, and visualization of the model output. Dr. Erkan Istanbulluoglu and Dr. Bob Edmonds are principal investigators, and Dr. Rich Horner and Dr. Jeff Richey are contributing investigators.

Cities of Auburn, Covington, and SeaTac (in kind match ~$5k each): Stormwater managers from these three cities will participate in the project management team that provides technical guidance, oversight, and review for the project.

Cities of Black Diamond, Burien, Des Moines, Federal Way, Kent, Maple Valley, Normandy Park, Renton, and Tukwila (no match): Stormwater managers from these cities support this project and will participate as their budgets allow by providing input and reviewing products.

Muckleshoot Indian Tribe (no match): Staff from the Muckleshoot Indian Tribe will participate as their time and budget allows by providing input and reviewing products.

Department of Ecology (no match): Staff from the Washington State Department of Ecology will participate in the project management team, provide input at each stage of the project, and review project deliverables.

WRIA 9 Forum (no match): The WRIA 9 Forum will be briefed and provide input at all stages of the project. The Forum has representatives from each jurisdiction within the WRIA, along with state and federal agencies, tribes, businesses, and environmental groups.

Anticipated Outputs and Outcomes

Outputs from the implementation of this project include:

1. Flow and water quality data throughout the study area.
2. Modeled flow and water quality conditions in the rivers and streams in the study area for idealized fully forested conditions, current conditions, and anticipated 2040 conditions considering population growth and climate change.
3. Development of stream flow and water quality goals throughout WRIA 9.
4. Descriptions of the magnitudes and types of stormwater retrofits needed to achieve the in-stream flow and water quality goals, and their estimated costs.
5. Development of a prioritized watershed scale stormwater retrofit plan.
6. Preparation of a planning-level cost estimate to implement stormwater retrofit projects throughout the Puget Sound region.

Science, policy, and public awareness outcomes expected include:

Short Term: (1) Increase awareness of the importance of implementing stormwater retrofit projects to achieve the Puget Sound Partnership's Action Agenda, and (2) Improved coordination between stormwater managers and other interested parties.

Interim: (1) Development of a set of monitoring and modeling tools available for future stormwater retrofit evaluations, (2) Increase understanding and planning for establishing a systematic stormwater retrofit program for the Puget Sound region, and (3) Increase understanding of the importance of improving stormwater controls during urban redevelopment projects.

Long Term: (1) Implementation of the most cost-effective stormwater retrofits under the auspices of a Puget Sound stormwater retrofit program, and (2) Improve streamflow and water quality conditions throughout Puget Sound through implementation of stormwater retrofits.

Monitoring and Measuring

The monitoring and measuring that will be conducted as part of this project is described in Task 3 under Project Components. This project will rely on an extensive, ongoing hydrologic monitoring system. This system includes weather, steam flow and stream water quality monitoring throughout the study area. Spatial coverage of the existing hydrologic monitoring program will be expanded to fill spatial data gaps to include smaller catchments throughout the study area. The additional monitoring will focus on continuous flow, specific conductance, and turbidity at an additional 10 to 20 locations in the study area. Monitoring will be conducted over a three-month period, starting in fall, 2010. Monitoring will be conducted using continuous sensors, resulting in time series data for a variety of locations in the WRIA. In addition, spot measurements of these parameters will be collected at these locations in summer, 2011, and turbidity and specific conductance will also be measured at the existing flow monitoring sites. Stream flow rating curves will be developed at each flow measurement site, ensuring accuracy of the stream gage measurements. The data collected will be used to calibrate the watershed models to smaller catchment sizes.

Outreach and Information Transfer

Outreach is a key component of this project and exists in each phase of the project. The outreach and communication strategy is designed to ensure that (1) there is stakeholder knowledge,

support and buy-in at each phase of the project, (2) the project is tightly linked to policy makers, and (3) information is transferred to all interested parties.

As described in Task 2, the project management team will be comprised of individuals from King County, UW, three other jurisdictions, and the Department of Ecology. As described in Task 3, the WRIA 9 Watershed Ecosystem Forum, the key decision-making body for the WRIA 9 salmon recovery efforts, will provide input and feedback to this project. As described in Task 11, public outreach will occur via the website, annual public meetings, and quarterly e-mail updates. Also described in Task 11 is the coordination with Ecology, the Muckleshoot Indian Tribe, and various councils, boards, and work groups.

Programmatic Capability and Past Performance

Environmental Results Past Performance

Cottage Lake Phosphorus Reduction ($291,728 CWA Sect. 319 state pass-through): Key elements: Shoreline buffer restoration on public & private lands, behavior change through education, social and environmental sampling. Performance benchmarks are integral to agreement deliverables. All performance benchmarks to date have been fully met. Post-test of behavioral change and trend analysis of phosphorus reduction due in 2009.

Model Low Impact Development Strategies for Big Box Retail Stores ($96,002 EPA/AWPP grant): Costco case study captured in a LID reference document (pub in 2007) with recommendations jointly developed by Costco and King County. As a result, Costco has initiated several LID measures nationwide. EPA Reg. 10 using knowledge gained to promote better site designs with Whole Foods and Kohls. EPA Reg. 10 enforcement exploring same LID practices for enforcement and compliance settlements and negotiations.

King County Shoreline Master Plan ($1.2 million NOAA/CZM state pass through): Assessed current land use, public access and ecological conditions with GIS landscape modeling tools to update 30-year old Shoreline Master Plan. Public and agency input included interactive web, award winning videos and workshops. All grant deliverables were met to the satisfaction of Ecology. Plan will help prioritize long term shoreline restoration and public access. Other cities use these tools for information collection and promoting countywide consistency in shoreline management.

Project Management Experience

Successful Completion and Management of Agreements: All grants are assigned a project manager responsible for coordinating/managing staff, partners & consultants, carrying out the scope of work, preparing programmatic reports and ensuring agreement conditions. A Business Finance Officer "interfaces" with the county accounting system, ensures budget compliance, tracks expenses and match and authorizes grant-related expenses. The county budget office Federal compliance specialist coordinates federal reporting and assures grant compliance with Federal regulations. The grant examples previously mentioned are meeting (or have) met or exceeded their required conditions.

History of Meeting Reporting Requirements Examples (see project description above): Cottage Lake: Quarterly reports of scope of work progress validate payment requests. Final report to include, among other deliverables, phosphorus study (state approved SAP & accredited lab) and quantified behavioral changes of sampled watershed residents. "Big Box" Project: Reference 84-page book co-edited with Costco consultants for large retail store LID practices with extensively illustrated prescriptions also web-available

(ftp://dnr.metrokc.gov/dnr/library/2007/kcr1968.pdf). Shoreline Master Plan: Planning document formally submitted to King County Council as reference for new SMA legislation

Institutional Qualifications King County has a demonstrated capability to manage complex planning processes addressing riparian habitat protection and restoration, flood facility siting and design, and growth management/land use. King County's staff includes natural resource scientists (seven of whom authored peer-reviewed papers in 2009), flood facility engineers, planners, watershed stewards, and agriculture/forestry experts. King County also has a strong track record of collecting, managing, and analyzing technical information and translating it into regulatory, policy, and project recommendations that then are implemented. King County has increasing experience in managing natural resource management issues in cooperation with cities and federal, tribal, and state agencies.

Project Team Qualifications

King County: *Jim Simmonds* will serve as the project manager. He is the supervisor of King County's Water Quality and Quantity Unit and currently serves as chair of the Puget Sound Stormwater Monitoring Work Group. He has over 20 years of experience conducting and managing water quality and quantity investigations, and is an expert in integrating field investigations, modeling, and planning activities. *Curt Crawford* is the Manager of King County's Stormwater Services Section, with over 30 years experience in stormwater management, BMPs, and LID techniques. Curt will provide senior project oversight and review. *Curtis DeGasperi* obtained an MS from the UW Department of Environmental Engineering and Science with broad experience developing and applying hydrologic and water quality models. *Jeff Burkey* is a civil engineer with extensive expertise developing and applying HSPF watershed models, and has developed models throughout the study area. *David Funke* is the lead of King County's hydrologic gaging group, and *Dan T. Smith* is an expert hydrologic gager. *Giles Pettifor* is King County's NPDES Municipal Stormwater Permit Assistant Coordinator, responsible for coordinating permit compliance activities between jurisdictions and County agencies. *Steve Foley* is a senior engineer with extensive experience in stormwater planning and writing and implementing stormwater regulations for new development and for redevelopment. *Doug Navetski* is the supervisor of King County's Water Quality Compliance Unit and serves as King County's Primary Point of Contact for compliance with the NPDES Municipal Stormwater Permit. He is an expert in stormwater quality regulations and compliance. *David Batts* is a senior water quality engineer and has extensive experience assessing the effectiveness of stormwater BMPs and other management techniques.

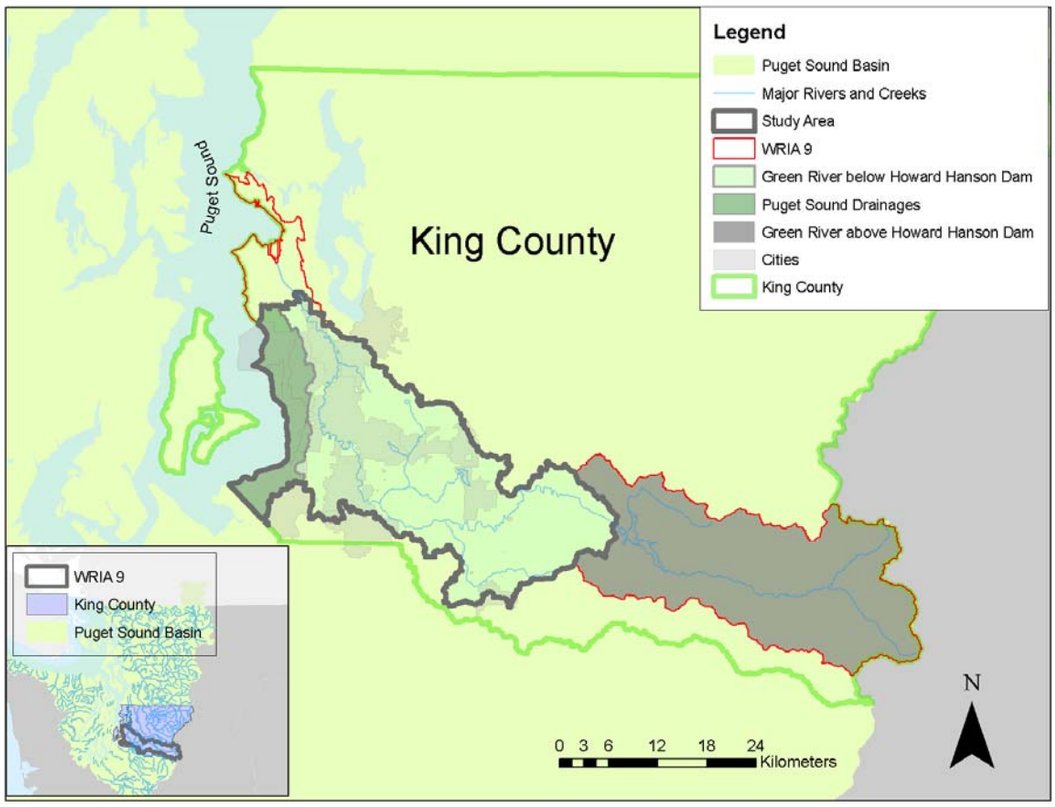
University of Washington: The UW is recognized as one of the leading research institutions in the United States. Researchers at the UW are especially noted and recognized as leading experts in watershed hydrology, stormwater impacts on hydrologic systems, and stormwater management. *Dr. Rich Horner* is a nationally-recognized expert on stormwater management and stormwater impacts on hydrologic systems. *Dr. Erkan Istanbulluoglu* is an expert watershed hydrologist and geomorphologist. *Dr. Jeff Richey* is a world-recognized expert in watershed hydrology and multidisciplinary watershed planning efforts. *Dr. Bob Edmonds* is an expert on the relationship between forest ecology and watershed hydrology.

Jurisdiction Partners: Partners at the Cities of Auburn, Covington, and SeaTac are experts in stormwater management and each have expert knowledge regarding local conditions. *Chris Thorn* is the Water Quality Programs Coordinator for the City of Auburn. He is the Phase II NPDES coordinator for the city, and has been involved in water quality issues in Auburn for

over 15 years. *Ben Parrish* is an Engineering Technician on the Surface Water Management Team for the City of Covington, and is an expert is designing, maintaining, and inspecting stormwater BMPs. *Don Robinett* is the Stormwater Compliance Manager for the City of SeaTac. He has over 15 years experience in the stormwater field and is an expert in LID techniques and erosion control techniques.

Watershed Map

The study area is WRIA 9 excluding the areas upstream of the Howard Hanson Dam and the City of Seattle.



Logic Model

Project: Development of a Stormwater Retrofit Plan for Water Resources Inventory Area (WRIA) 9, and Estimation of Costs for Retrofitting all Developed Lands of Puget Sound.

Link to EPA Strategic Plan	Resources/Input	Activities (and targets, if any)	Stated Outputs (with targets)	Anticipated Outcomes (with targets)	Baseline
Goal 2: Clean and Safe Water Objective 2.2: Protect Water Quality Sub-objective 2.2.1: Improve Water Quality on a Watershed Basis **Goal 4:** Healthy Communities and Ecosystems Objective 4.3: Restore and Protect Critical Ecosystems Sub-objective 4.3.1: Increase Wetlands Sub-objective 4.3.8: Restore and Protect the Puget Sound Basin	EPA Funds $999,981 Match Funds • King County $302,603 • University of Washington $19,977 • Other Jurisdictions (Auburn, Covington, SeaTac) $15,206	**Year 1:** Form Project Management Team (PMT) with stormwater managers from Jurisdictions within the study area. Develop QAPP Review of existing and collection of new data **Year 2:** Report on new data collected Develop watershed hydrologic models (HSPF & DHSVM) Conduct literature review of the relationship between in-stream flow, water quality, and beneficial uses. **Year 3:** Complete watershed	**Year 1:** PMT formed comprised of various officials and experts QAPP report detailing the architecture of data collection and analyses to be performed. Collection of atmospheric data, stream flow rates and water quality for the WRIA 9 study area Spatially explicit Land Use, Land Cover for theoretical forested watersheds, current conditions (circa 2009 or newer), and Puget Sound Region future land use using 2040 Vision Plan. **Year 2:**	**Short Term:** (1) Improved awareness of degraded (or improved) stream conditions using defined metrics and indicators, (2) understanding of efficacy of retrofit strategies under various landscape and climatic conditions, (3) greater understanding of forecasted future conditions, (4) preliminary understanding of likely costs to implement stormwater retrofits in the Puget Sound Region. **Interim:** (1) Greater comprehension of environmental conditions for the prioritization of limited resources, (2) a greatly reduced level of effort	Current stormwater strategies focus on mitigation of future development. Within King County, over three-quarters of development that has occurred did so prior to implantation of stormwater guidelines (1990 Design Manual) that have shown to be more successful in meeting intended goals. Prior stormwater strategic goals were naïve in predicting long term impacts. Even since the implementation of King County 1990 Design manual, understandings of the environment

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Link to EPA Strategic Plan	Resources/Input	Activities (and targets, if any)	Stated Outputs (with targets)	Anticipated Outcomes (with targets)	Baseline
		models Develop in-stream flow and water quality goals. Develop stormwater BMP and LID models (SUSTAIN) Develop visualization methods and tools for public outreach. **Year 4:** Validate model linkages Evaluate stormwater retrofit needs for meeting in-stream flow and water quality goals. Apply results in WRIA 9 to Puget Sound Region	Summary report on assembled existing and newly collected data Fifty percent of the watershed models are completed. Specific in-stream flow goals for each catchment modeled. **Year 3:** Develop suite of template stormwater mitigation facilities and technologies possibly including retention facilities, green roofs, rain gardens, other LID techniques for application in SUSTAIN modeling A set of HSPF watershed models calibrated to flow, turbidity/suspended solids, and copper. Specific in-stream	for future analyses that may be performed, (3) inform the development of a systematic stormwater retrofit strategy, (4)support the progression of implementation of the Puget Sound Action Agenda and NPDES permitting, (5) improve consistency between jurisdictions stormwater management plans **Long Term:** Improved stream habitat conditions in the Puget Sound region by (1) improving stormwater management in urban areas, (2) improving flow conditions in urban streams throughout the Puget Sound region, and (3) improving water quality conditions in urban streams throughout the Puget Sound region.	have improved and necessitated an evolution of design standards to this day. The amount of new BMPs and LID techniques needed to retrofit developed lands was coarsely evaluated in the 1990s in King County, but outside of King County these conditions are less known because fewer resources have been directed at assessment of conditions.

Project: Development of a Stormwater Retrofit Plan for Water Resources Inventory Area (WRIA) 9, and Estimation of Costs for Retrofitting all Developed Lands of Puget Sound.

Link to EPA Strategic Plan	Resources/Input	Activities (and targets, if any)	Stated Outputs (with targets)	Anticipated Outcomes (with targets)	Baseline
			flow and water quality goals for every delineated catchment in the study area. Development of SUSTAIN models begun. **Year 4:** A set of SUSTAIN models integrating calibrated HSPF models and the stormwater mitigation strategies Reports documenting model development and calibration accuracies. A large set of data characterizing the extent and types of stormwater controls, including costs, distributed within the study area sufficient to meet in-		

Project: Development of a Stormwater Retrofit Plan for Water Resources Inventory Area (WRIA) 9, and Estimation of Costs for Retrofitting all Developed Lands of Puget Sound.

Link to EPA Strategic Plan	Resources/Input	Activities (and targets, if any)	Stated Outputs (with targets)	Anticipated Outcomes (with targets)	Baseline
			stream flow and water quality goals. Using results from WRIA 9 study area, apply unit area costs to entire Puget Sound A Stormwater Retrofit Plan for WRIA 9, with applicability to entire Puget Sound region.		