DRAFT

Green-Duwamish Watershed Water Quality Assessment

Scope of Work

June 2002

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1 INTRODUCTION AND PURPOSE

This document presents the scope of work for King County's Green-Duwamish Watershed Water Quality Assessment (GD-WQA) Program. The primary goal of this project is to develop analytical tools for evaluating current and future water quality issues in the Green-Duwamish watershed and to provide water quality information to a variety of clients internal and external to King County's Department of Natural Resources and Parks (DNRP). The GD-WQA will assist wastewater capital planning (including the Combined Sewer Overflow (CSO) program and habitat conservation planning), WRIA 9 salmon conservation planning, stormwater management efforts, and the Department of Ecology's TMDL (Total Maximum Daily Load) program by collecting water quality information, developing a watershed model, and using the model to evaluate resource management options. The scope of work includes water quality and hydrologic monitoring, land use / land cover modeling, water quality and quantity modeling, best management practice (BMP) evaluation, and ecological and human health risk assessment.

The GD-WQA will coordinate with and work closely with the following clients for this project: (1) Wastewater Treatment Division's (WTD) CSO Program, (2) WTD's Habitat Conservation planning team, (3) the Water Resources Inventory Area (WRIA) 9 planning team, (4) King County Stormwater National Pollution Discharge Elimination System (NPDES) permitting, and (5) the Department of Ecology TMDL Program. It also is a pilot for exploring opportunities to integrate local activities in response to the Endangered Species Act and Clean Water Act.

1.1 Purpose

The specific purposes of this project are as follows:

- To assess existing water quality conditions and future water quality conditions for selected parameters, and evaluate best management practices for achieving Washington State water quality standards in the Green-Duwamish Watershed.
- To assess the 303(d) listed parameters of concern for the King County Wastewater Treatment Division (e.g. parameters that could influence future CSO permit requirements - fecal coliform/ enterococci/ *E.coli*, and metals), including the identification of sources of bacteria and metals throughout the watershed.
- To provide information to support the WTD Habitat Conservation Plan (HCP) and WRIA 9 salmon conservation planning efforts, including information on water quality as a factor of decline for salmonids.
- To provide technical information to the Department of Ecology to support development of TMDLs.
- To create a working watershed model that can be used as a tool for regional water quality assessment and planning now and into the future.

2 PROJECT OBJECTIVES

The overall objectives of the GD-WQA are as follows:

1. To develop a watershed runoff water quantity and quality model for the Green-Duwamish River and tributaries from the Tacoma diversion dam to the mouth of the Duwamish River.

2. To assess existing water quality conditions for various water quality parameters, including temperature, dissolved oxygen, sediment (suspended solids, turbidity), metals, and bacteria indicator organisms for the Green-Duwamish River and major tributaries from the Tacoma diversion dam to the mouth of the Duwamish River.

3. To predict future water quality conditions for the above parameters assuming (a) buildout according to the King County Comprehensive Plan and Growth Management Act, (b) with and without changes in management practices and abatement measures, and (c) intermediate development stages prior to complete buildout.

4. To assess existing and predict future loading of conventional parameters (temperature, dissolved oxygen, sediment), bacteria and metals to the study area from various land use / land cover types.

5. To evaluate effectiveness of various Best Management Practices (BMPs) for the control of parameters of concern in our current and future conditions analysis.

6. To assess the relative risk of bacteria and metals to aquatic life, wild life and people for the purpose of prioritizing spatial and temporal control of these parameters in the watershed.

7. To provide this technical assessment information to the Department of Ecology for their use in the development of TMDLs.

8. To work closely with the regional stakeholders, especially the cities and tribes in the Green-Duwamish watershed to obtain input on project design and implementation.

9. To coordinate with the sediment cleanup efforts in the Duwamish River (e.g. Superfund and CSO sediment project and the LDWG project).

3 STUDY AREA DESCRIPTION

The Green-Duwamish watershed experienced substantial modifications during the past century. Drainage from the Cedar and White Rivers was diverted from the Green-Duwamish system in the early 1900s. These diversions reduced the size of the watershed from about 1,600 square miles to its present size of 484 square miles (Figure 1). The Duwamish River was heavily modified by dredging and filling between 1905 and 1912. The Tacoma Water Supply Diversion Dam was built in 1913 to supply potable water to the City of Tacoma, and the Howard Hanson Dam was built in 1963 for flood control. During the last century, about 97 percent of the tidal wetlands of the system were filled or diked, and about 90 percent of the once-extensive floodplain were no longer inundated on a regular basis. Most of the banks are lined by levees on one or both sides below the Auburn Narrows in the Lower Green basin. Finally, water quality was degraded throughout the watershed by a variety of human activities, including substantial changes in land use. A detailed overview of these changes can be found in the Habitat Limiting Factors and Reconnaissance Assessment Report (Kerwin and Nelson 2000).

Figure 1. Watershed location.

The Green-Duwamish Watershed includes a drainage area of varied terrain and land use from forested headwater areas at the crest of the Cascade Mountains to the industrial and port facilities of the Duwamish estuary. The project study area

encompasses the Green-Duwamish watershed from the Tacoma Diversion Dam at river mile 61 to the mouth of the Duwamish River at Elliott Bay (Figure 2), an area of 261 square miles. The upper Green River Basin (an additional 231 square miles) is not included in the study area.

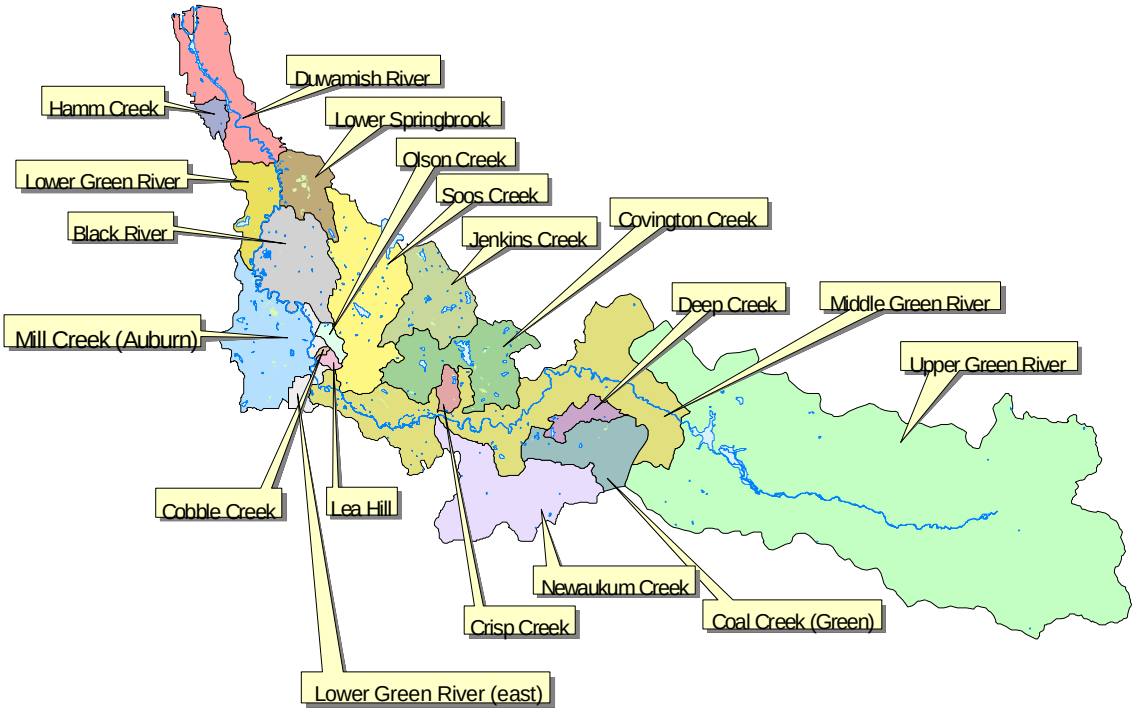


Figure 2. Green River subbasins.

Summer flows in the river, gauged at Auburn, are in the range of 250 cubic feet per second (cfs). Winter flows average about 1,500 to 2,000 cfs, with peaks of more than 10,000 cfs during storm events and a controlled maximum of 12,000 cfs just downstream of the Soos Creek confluence. The study area has a population of about 324,000 (Kerwin and Nelson 2000). Extensive population growth is occurring in the Soos Creek basin in unincorporated King County and within the cities of Kent, Covington and Maple Valley. Salmonid species present in the watershed include chinook, chum, coho, sockeye, and pink salmon, bull trout and cutthroat trout (Kerwin and Nelson 2000).

The Green River is a highly controlled system. In addition to the existing controls, other planned projects will further control and divert more waters from the Green River System. These include the ACOE Active Water Storage (using more storage during spring to augment summer flows), and Tacoma Public Utilities Pipeline 5 project (diverting up to an additional 100 cfs). The respective operational procedures for the projects are not yet finalized at this time, but most likely will operate under

some form of adaptive management dependent on downstream effects to the middle and lower Green River1.

The Upper Green River subwatershed (47% of the basin, but not included in the study area) is comprised of mountainous, forested areas that drain to Howard Hanson Reservoir where the US Army Corps of Engineers (ACOE) operates a dam to control floods and augment in-stream flows. Downstream of the dam, the City of Tacoma operates a diversion dam to divert water for their municipal water supply.

The Middle Green River subwatershed drains 35% of the total basin area. Major tributaries in the middle Green include Newaukum Creek draining the Enumclaw plateau and Soos Creek draining the Covington upland. Land use/land cover is mixed and includes forests, agricultural, residential, and commercial areas. The Green-Duwamish valley dominates the lower portion of the watershed (18% of the basin). Land use/land cover is mixed but includes substantial commercial and industrial areas within the cities of Auburn, Kent, Renton, Tukwila, and Seattle.

The Middle Green River (approximately 30 miles in length) is the most unconstrained segment of the mainstem channel system. Consequently, avulsions (or changes in channel direction) are occurring where meandering is allowed. The two largest tributaries that drain into the middle Green, Newaukum Creek (28 square miles) and Soos Creek (60 square miles), are distinctly different. Newaukum Creek is mostly flat agriculture and pasture with a dense set of unidentified diversion ditches creating a complex drainage network, with no significant lakes. In contrast, Soos Creek has multiple lakes with groundwater linkages, significant amounts of medium/high density development, and some pasturelands. The geology of the two tributaries is also different with Newaukum underlain with mostly Osceola Mudflow (Holocene) and Soos Creek underlain by a mixture of till, outwash, and some bedrock. In addition to these two tributaries, there are approximately 18 square miles of area (Deep Creek and Coal Creek) that primarily contribute subsurface flows into the Green River.

The Lower Green differs from the Middle Green with even higher levels of development and hydromodifications. Approximately 90% of the Lower Green watershed is developed, with 65% of that being urban commercial land use. As a result of the various flood protection plans, most of the commercial and rural developments rely on the built-up levee/revetment system. There are two significant tributaries in the Lower Green River Watershed, including Mill Creek (Mullen Slough) and the Black River (Springbrook Creek). Both tributaries experience backwater effects during high flow conditions in the Green River. Moreover, the Black River has a pump station that evacuates the ponding water into the Green River. Mill Creek discharges through a one-way valve (flap gate) system. As a result, under large flow events in the Green River, both the Black River and Mill Creek do not discharge into the Green River, resulting in localized flooding within their respective subbasins.

The Duwamish/Elliot Bay estuary is the lowest reach of the Green River watershed and is under significant tidal influence from Puget Sound. Tidal waters have been

1 Tacoma Public Utility – Habitat Conservation Plan (December 1999)

observed to cause flow reversal as much as 13 miles upstream from the estuary confluence. Associated with this flow reversal is a salinity wedge that extends up to 9 miles upstream from the estuary confluence, depending on Green River flow rates and tidal magnitude. Land use/cover in the Duwamish is 96 percent developed, primarily consisting of commercial and industrial uses.

4 PROJECT MANAGEMENT

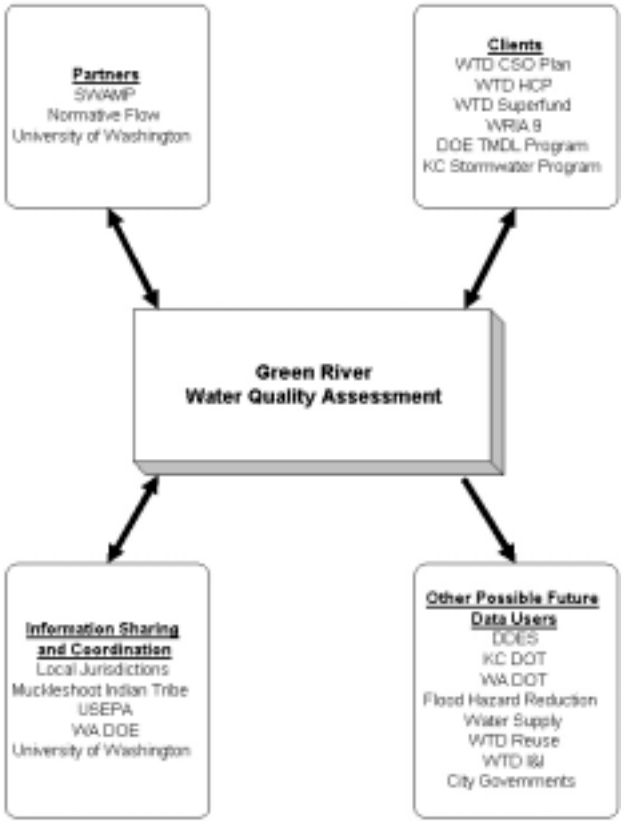
This section describes project management, including coordination, the project team, and the project budget.

4.1 Project Coordination

Coordination with other programs also working in the study area is an essential component of the GD-WQA. The GD-WQA team will work closely with the CSO Program, WTD HCP team, WRIA 9 planning team, stormwater NPDES program, and the Department of Ecology. This coordination will minimize duplication of work, ensure that necessary technical work is carried out, and that the deliverables satisfy the needs of the clients within funding constraints. The GD-WQA will not have its own stakeholder and public involvement process but instead will work with existing public involvement efforts including but not limited to the CSO plan update, the HCP and WRIA 9 planning efforts and Ecology's TMDL stakeholder process as requested. Regular meetings are held with the Green-Duwamish cities (the GD-WQA Technical Work Group) to inform them and seek input on work products. An overview of the GD-WQA project coordination relationships is presented in Figure 3.

This section describes the various project components that are being coordinated with other programs and agencies to maximize efficiencies and minimize costs, and ensuring use of best available science. Coordination with experts and stakeholders is also vital to this project.

Figure 3. Project Coordination Relationships



4.1.1 Sammamish-Washington Analysis and Modeling Program (SWAMP)

The primary purpose of King County's SWAMP project is to assist wastewater capital planning, habitat conservation planning, and WRIA planning efforts by collecting information, developing a set of scientific tools to better understand the Sammamish/Washington watershed system (including the Cedar and Sammamish Rivers), and using the tools to explore resource management options. Given the parallel objectives of the SWAMP and the GD-WQA projects, and their geographic proximity, the efforts of both projects will be closely coordinated.

As an example of this coordination, the budgets for both projects have been combined into one freshwater budget. This will facilitate the sharing of resources on contracts that will serve both projects, such as the watershed modeling contract. In addition, the managers of both projects will meet regularly for updates and to make joint decisions that affect both programs. This coordination also includes shared staff, joint decisions on tools for analysis, and shared data management efforts. Furthermore, sampling efforts will be coordinated in order to meet the needs of both programs and to facilitate the sharing of data.

4.1.2 Normative Flow Project

King County's normative flow project is working closely with the GD-WQA by developing an ecological model linked to the hydrological and water quality models being developed as part of the GD-WQA and SWAMP projects. The goal of the project is to promote salmon conservation and ecosystem integrity within King County, develop and employ Normative Flow concepts to influence policies and programs and optimize management actions that affect or respond to river and stream flow conditions. Normative flow is a flow regime that resembles the natural flow regime sufficiently to sustain all life stages of a diverse suite of native species, including salmonid populations. The Green-Duwamish watershed model will provide a key tool for use in the normative flow project.

4.1.3 Wastewater Treatment Division

The King County Wastewater Treatment Division is providing funding for the GD-WQA and represents one of the major clients. Specific projects being conducted within the Wastewater Treatment Division that will use information generated by the GD-WQA include the CSO control project, the Habitat Conservation Plan, Wastewater Reuse, and possibly the Duwamish River sediment superfund project.

Two representatives from the Wastewater Treatment Division are members of the GD-WQA team. This direct participation ensures that WTD management is aware of methods and results of the GD-WQA, and also allows for feedback to and from the project and WTD. In addition, specific client briefings are anticipated to discuss various aspects of the GD-WQA with WTD management.

4.1.4 Department of Ecology

King County will provide all water quality data and the developed models to the Department of Ecology to use as needed for the development of TMDLs. The Department of Ecology developed a draft Quality Assurance Project Plan for the Green-Duwamish TMDL effort. Ecology staff was a member of the Green-Duwamish WQA team in the recent past and will be afforded that opportunity in the future. As with other stakeholders, Ecology also has the opportunity to comment on the selection and development of the models.

4.1.5 Stormwater NPDES Program

King County is required to implement a comprehensive stormwater management program as part of its NPDES municipal stormwater permit. The primary purpose of the permit is to establish a framework for meeting the goals of the Clean Water Act (CWA), namely, to provide for the protection and propagation of fish, shellfish, and wildlife and provide for recreation in and on the water. King County's stormwater program strives to meet the CWA goals and protect designated uses. The geographic focus of King County's stormwater program is the unincorporated areas. Results from the Green-Duwamish WQA will help King County identify the major water quality challenges threatening our ability to protect designated uses, as well as assist in identifying priorities and strategies to implement high priority actions to diminish these threats.

4.1.6 Local Jurisdictions and Agencies

Input from local jurisdictions is obtained via the GD-WQA Technical Work Group, facilitated by Lorin Reinelt (Assistant Project Manager). Participants of the Work Group include the cities of Seattle, Renton, Auburn, Kent, Tacoma, Tukwila, Covington, Department of Ecology, and U.S. Environmental Protection Agency. The Muckleshoot Indian Tribe (MIT) also tracks the process, but has chosen not to directly participate. The Work Group meets approximately once per month to provide peer review of and comment on decisions and documents developed by the GD-WQA Team. The GD-WQA Team will give consideration to the input received from the Work Group; however, the GD-WQA Team will retain final decision-making authority.

4.1.7 University of Washington

The GD-WQA Team will coordinate with the University of Washington as it continues to develop various models, including land use models (e.g., UrbanSim), regional weather models (e.g., MM5), global climate change models, and watershed models (e.g., Distributed Hydrology Soil Vegetation Model, or DHSVM). Most of these models are incorporated into the University's PRISM (Puget Sound Regional Synthesis Model) project. As these models are developed, there may be components that are incorporated into the Green WQA model.

UrbanSim is a model being designed to forecast 25 years into the future the effects of today's housing, land use, economic and transportation decisions. UrbanSim is predicted to be set up and calibrated in about 2004 to 2006. The DHSVM model takes predicted rainfall amounts, distributes the rainwater over the landscape and predicts river flow resulting from the runoff. The water runoff predicted by the DHSVM model can be fed into to a water allocation model to analyze the impact of water flow on water resource management practices in our region. The DHSVM model will be used in this study for the Upper Green River subwatershed.

Coordination with the University of Washington is also occurring as part of the sampling and analysis portion of the project. The GD-WQA Team is exploring coordination on issues ranging from benthic macroinvertebrate sampling, dissolved oxygen studies in Mill Creek, and fine-scale within-storm water quality variability.

4.1.8 Muckleshoot Indian Tribe (MIT)

For several years, the King County Environmental Laboratory (KCEL) analyzed water quality samples collected by the MIT in the Soos and Newaukum subbasins. Any data analyzed at the KCEL will be used in the GD-WQA, as well as any reports generated by MIT. Furthermore, as with the local jurisdictions, input from the MIT is obtained via the GD-WQA Technical Work Group.

4.1.9 WRIA 9 Steering committee

The GD-WQA Team will coordinate with the WRIA 9 Steering Committee to ensure that the needs of the Strategic Assessment and Comprehensive Salmon Conservation Plan are considered as part of the project. Lorin Reinelt, Assistant Project Manager, is a member of two WRIA 9 Steering Committee Sub-committees, the Planning

Work Group and the Technical Committee. Specifically, the Technical Committee will provide input on studies and modeling of water quality parameters that are relevant to salmon conservation and recovery.

4.2 Project Team

The GD-WQA project managers will work with a project team to complete this project. The project team will be augmented by private consultants, hired for this project, and other resources within King County. The team will coordinate with and incorporate data collection and analysis by other agencies and the academic community, as appropriate.

Table 1. King County Project Team Members and Roles.

Name	Role
John Brooker	Benthic Macroinvertebrate/Data Evaluation
Jeff Burkey	Hydrologic/Water Quality Modeling
Betsy Cooper	WTD Programs
Vacant position	Ecology Liaison/TMDLs
Curtis DeGasperi	Water Quality Modeling (WTD)
David Funke	Stream Gaging
Colleen Gaoloch	GIS Analyst
Fritz Grothkopp	Environmental Lab
Doug Henderson	Ecological Risk Assessment
Eric Ferguson	Groundwater
Sue Meyer	WTD HCP
Bruce Nairn	Water Quality Modeling
Lorin Reinelt	Assistant Project Manager/WRIA 9 Liaison
Jim Simmonds	Project Manager
Stephanie Hess	Field Sampling

The project team will meet weekly or bi-weekly as the primary means of project coordination. This project will make extensive use of e-mail to transfer information between team members. A subdirectory is set up on a server accessible to all team members. To facilitate decision-making, *ad hoc* sub-teams will form to address specific technical issues such as monitoring and modeling.

4.3 Budget

The overall lifetime project budget of the GD-WQA is estimated at $5.7 million. The GD-WQA is funded as part of the Freshwater Program from Wastewater Capital project funding. Estimated annual budgets are shown in Table 2. A small grant of $56,000 was also received from the Department of Ecology to support the initial phase of this project.

Table 2. Budget for the Green-Duwamish Water Quality Assessment

Year	Budget
2000/2001	$968,422
2002	$1,343,555
2003	$1,452,933
2004	$1,305,486
2005	$1,010,780
2006	$637,657
Total	$5,749,410

5 TECHNICAL ASSESSMENT

This section contains a description of the scientific and technical assessment work necessary to carry out the GD-WQA project and address the project objectives.

5.1 Assessment of Existing Water Quality Conditions

This task involves an assessment of water quality conditions in the Green-Duwamish watershed from existing water quality reports and from analysis of water quality data collected during the past four years (1996-1999) by the King County Streams Monitoring Program, the Muckleshoot Indian Tribe, and the City of Tacoma.

This task will be carried out in two phases. The first phase focuses on water quality parameters that may cause direct toxicity or harm to salmonids. These parameters include temperature, dissolved oxygen (DO), total suspended solids (TSS), pH, ammonia, metals and organic chemicals. The second phase includes water quality parameters such as bacteria that are relevant for human health.

The specific objectives of the Phase 1 assessment are to:

- Identify subbasins and streams with impaired water quality and what parameters are causing the impairment (e.g., parameters on 303d list);
- Identify subbasins and streams with good water quality;
- Determine which water quality parameters (e.g., temperature, dissolved oxygen, sediment, pH, metals, organics) are factors of decline for salmonids (this will be done by reach or subbasin and categorized as a possible, probable, unlikely, or unknown factor of decline);
- Identify trends in water quality conditions, where possible;
- Summarize water quality impairment based on Washington State's 303(d) listings; and
- Identify major water quality data gaps for potential future investigations.

Deliverables/Outcome: Phase 1 – Habitat Limiting Factors and Reconnaissance Assessment Report. Part II, Chapter 1.2 Water Quality; Phase 2 – Addenda to Habitat Limiting Factors and Reconnaissance Assessment Report and/or technical memoranda.

Schedule: Phase 1 – December 2000; Phase 2 – June 2002

5.2 Water Quality Reconnaissance Sampling

A reconnaissance storm monitoring program is proposed for early 2001 (between approximately January and May) to collect storm water quality data that will provide input to improve the design of the overall monitoring program and help in model selection and development. The reconnaissance sampling program will focus on storm and land use / land cover variability. Such a program requires more intensive sampling during storms to examine storm variability and monitoring of smaller catchments where one or several land use / land cover types can be isolated. Discrete samples will be collected during storms at 4-5 sites at regular intervals (e.g., 2-4 hours) for purposes of determining peak storm concentrations and storm loadings for catchments with predominantly single land uses (forest, agricultural, urban, residential). Storm event-mean concentrations can also be calculated for each storm at each site to make comparisons between land uses and land cover.

Information from the 2001 Reconnaissance sampling program and the recommendations from the technical memorandum regarding the watershed water quality modeling strategy would be used to develop the comprehensive water quality monitoring program. This includes information on parameter variability, model input needs and data gaps.

Deliverables/Outcomes: Report summarizing 2001 monitoring results and recommendations for overall sampling program.

Schedule: Sampling – March to August 2001; Report – June 2002

5.3 Comprehensive Monitoring Program Sampling and Analysis Plan

The comprehensive monitoring program is designed to assess the effects of various types of land use and cover on water quality and quantity, and to provide input data for the watershed model. Preliminary information obtained in the reconnaissance sampling effort supported the development of the comprehensive monitoring program. The Sampling and Analysis Plan (SAP) is the guide for the monitoring program and provides information on study objectives, sampling design, site descriptions, sampling and analysis methods, and data management. The SAP also describes the specific activities, standard operating procedures, and quality assurance/quality control procedures that will be used during sample collection, as well as laboratory analytical methods, method detection limits, and quality control methodologies for the comprehensive monitoring program.

The objectives of the Comprehensive Monitoring Program are to:

- Measure in-stream water quality parameter concentrations resulting from different land use/land cover types within the stream drainage area;

- Measure in-stream water quality parameter concentrations as a function of the rise, peak, and fall of the corresponding stream hydrograph to determine peak concentrations and variability within a storm;

- Measure in-stream water quality parameter concentrations in different geographic areas of the watershed throughout the year, including mouths of major tributaries and boundary conditions of the Green River mainstem;

- Measure in-stream water quality parameter concentrations during both storm and baseflow conditions; and

- Collect sufficient data to allow development and calibration of a water quality model for the Green River watershed.

Deliverables/Outcomes: SAP for Comprehensive Water Quality Monitoring Program (to be initiated in October 2001). Reports that present and interpret the water quality, water quantity, and microbiological data collected as part of the monitoring program.

Schedule: Sampling and Analysis Plan – March 2002; Monitoring occurs from October 2001 – May 2004. Data reports from winter 2003 - summer 2004.

5.3.1 Stream Gauging

The GD-WQA will expand on King County's stream gauging network already maintained in the Green River Watershed. This includes recording continuous stream levels (gauge) readings and development of a stage-discharge rating curve for all sites.

5.3.2 Water Chemistry

The GD-WQA will expand the routine water chemistry monitoring that has been conducted by King County and the Muckelshoot Indian Tribe. Water chemistry will be analyzed for a variety of samples representative of different environmental conditions (i.e., storm, baseflow, and routine) at multiple locations. Samples will be analyzed for conventional water quality parameters, metals, and organic chemicals.

5.4 Water Temperature Study

The GD-WQA will expand the site specific water temperature studies that have been conducted in the Green River watershed prior to 1999 to identify stream reaches where water temperature may be detrimental to fish and where cool water inputs help maintain favorable habitat conditions. Water temperature will be analyzed using continuous temperature probes (thermistors). A reconnaissance temperature study will occur from July 2001 to February 2002, with more detailed temperature monitoring from June 2002 to May 2003.

Deliverables/Outcomes: Preliminary Water Temperature Report; SAP for Comprehensive Temperature Study; Final Water Temperature Report.

Schedule: Preliminary Water Temperature Report – June 2002; SAP – June 2002; Final Water Temperature Report – December 2003.

5.5 Water Microbiology

Water microbiology will be analyzed for a variety of samples representative of different environmental conditions. Samples will be analyzed for fecal coliform bacteria, Enterococcus bacteria, and E. coli bacteria. Microbial source tracking may be conducted to identify host species for bacteria in the watershed in limited locations. Site-specific die-off rates may be investigated if deemed necessary for model development.

Deliverables/Outcomes: to be determined

Schedule: to be determined

5.6 Benthic Macroinvertebrate and Habitat Monitoring and Assessment

King County uses a method called the Benthic Index of Biotic Integrity (B-IBI) as a "report card" for measuring the health of the benthic aquatic invertebrate community and for the stream ecosystem as a whole (Fore et al. 1997). However, since B-IBI scores may vary across a watershed and region based on physical conditions in addition to water quality, habitat (e.g., substrate, flow, riparian vegetation) must be evaluated as well.

Biological monitoring of aquatic insect communities, an indicator of general water quality conditions, will be conducted in the Green River watershed in late summer (August/September) 2002 and 2003. This monitoring program will expand on the current benthic macroinvertebrate monitoring program already conducted by King County.

Deliverables/Outcomes: Benthic Macroinvertebrate SAP; Final Report on Benthic Macroinvertebrate

Schedule: SAP – July 2002; Final Report – July 2004.

5.7 Data Management

The GD-WQA team recognizes that data management is an integral part of the overall program. Proper data management systems and techniques are required to maintain and evaluate existing monitoring data, newly collected monitoring data, and model output data. Towards this end, the GD-WQA, SWAMP, and Marine Outfall Siting Study (MOSS) projects are coordinating on the development of a data management system to store, organize and retrieve data. The data management task includes a contract with Pacific Northwest National Laboraties (PNNL, also known as Battelle Northwest), to review our current data management systems, recommend

improvements in the data management systems, and assist with the implementation of these improvements.

Deliverables/Outcomes: Data management recommendations on alternative Information Management Systems. Data management system design and initiate development.

Schedule: June 2002

5.8 Land Use Modeling

Current land use/cover will be determined from the most recent Landsat (Thematic Mapper) classification, integrated with other watershed GIS coverages and databases. Future land use patterns will be modeled as part of the assessment of possible future conditions in the watershed. Future land use will be based on an extrapolation of current land use, taking into account the provisions of the Growth Management Act and local zoning codes. Depending on the methods used to predict possible future land use, the future scenarios may also account for transportation, economic, and other societal influences and constraints.

The Puget Sound Regional Council is evaluating the option of modeling future land use in the four county area (King, Pierce, Snohomish and Kitsap) using the UrbanSim model developed by the University of Washington. A decision on the use of UrbanSim by the PSRC is expected in June 2002. If UrbanSim is developed for King County as a tool for estimating future land use and it is available by 2004, then the Green WQA expects to use it for modeling future land use.

Deliverables/Outcomes: Predictions of future land use/land cover.

Schedule: GMA and local zoning – 2004; If UrbanSim – June 2005

5.9 Watershed Modeling

The GD-WQA team is coordinating with the SWAMP project on the development of watershed models to predict runoff quantity and quality in tributaries to major rivers. The watershed models will be developed and calibrated by AquaTerra Consultants. The modeling tasks include a watershed modeling needs assessment, an evaluation of available watershed models and model recommendation. The recommendation includes both selection of a model and development of a modeling strategy based on level of data requirements.

Following the selection of a watershed model, a simulation plan will be developed that describes the modeling framework, data, schedule, and procedures to be applied in each study area (e.g., sub-basin). The simulation plan will include the data available, watershed segmentation, land uses and constituents to be modeled, sites for calibration, model performance targets, and alternative watershed scenarios to be evaluated. Modeling will be carried out for a variety of different current and future scenarios of land use and best management practices.

Deliverables/Outcomes: Technical memorandum on watershed modeling needs assessment, modeling strategy, and model recommendations. Watershed modeling simulation plan. Existing conditions modeling. Future conditions modeling.

Schedule: Technical memorandum – March 2002; Watershed modeling simulation plan – October 2002; Existing condition model – Fall 2003; Future conditions model – Fall 2004

5.10 Mainstem Green River Modeling

A two-dimensional chemical fate/transport model (CE-QUAL-W2) will be developed that is specific to the Green River mainstem. This model will be developed to the level of detail necessary to meet the project objectives. The GD-WQA team will coordinate with the King County Flood Hazard Reduction section and the U.S. Army Corp of Engineers on Green River mainstem modeling activities, including information on cross sections and hydraulic conditions. In Phase 1, the model will be developed using existing information on channel cross sections, flows, water quality, and boundary conditions. In Phase 2, updated information will be available from the watershed model (flows and water quality) for current and future conditions, boundary conditions, and channel cross sections.

Deliverables/Outcomes: Phase 1 and 2 mainstem models.

Schedule: Phase 1 – October 2002; Phase 2 - 2004-2005

5.11 Duwamish River/Elliott Bay Estuary Modeling

In 1999, King County developed a three-dimensional hydrodynamic and chemical fate and transport model for the Duwamish River and Elliott Bay (King County 1999). The County selected the Environmental Fluids Dynamic Computer Code (EFDC), which consists of two components. The first is a hydrodynamic component that describes water and particle flow. The second is a chemical fate and transport component that describes the addition, removal, movement and behavior of chemicals in the estuary.

For selected model simulations conducted with the watershed and Green River mainstem model, the output will be entered into the EFDC model to simulate selected constituents in the estuary.

Deliverables/Outcomes: Estuary Modeling of future conditions.

Schedule: 2004-2005

5.12 Model Integration

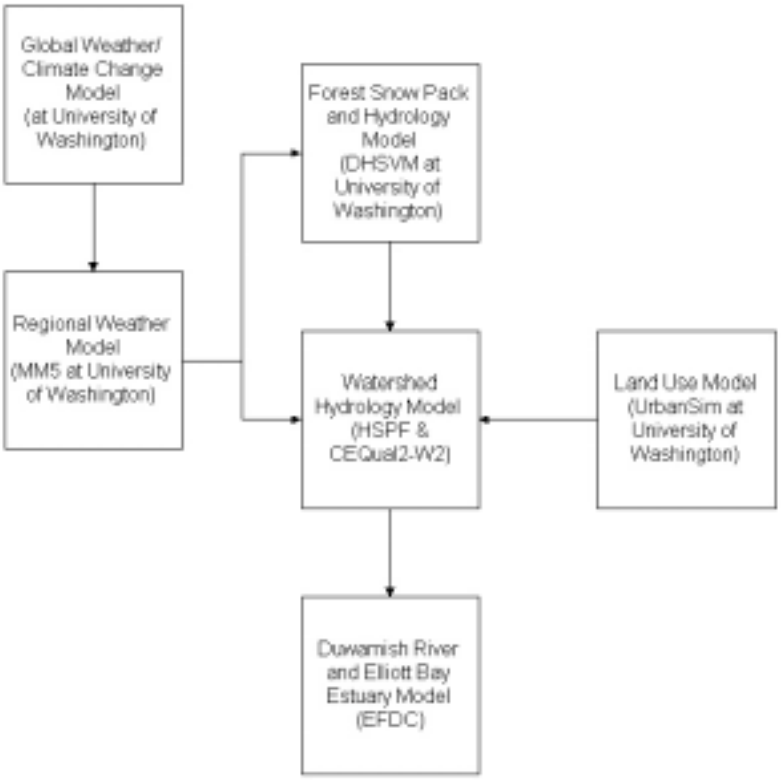
King County has contracted with PNNL (Battelle) to evaluate model integration options for the GD-WQA and SWAMP projects. The purpose is to integrate the various models within the GD-WQA and SWAMP programs into systems that optimize interaction between the multiple models that comprise each of these efforts. This work will evaluate, design, and offer alternative options for efficiently streaming data between models and visualization of results to simplify the operation of project models in sequence or in isolation. A decision on the level of model integration and visualization options will be made after evaluation of alternative options.

GD-WQA models include a land use/cover model, and watershed, mainstem river, and estuary hydrodynamic and water quality models (Figure 4). The model integration task will be coordinated with the UW PRISM suite of models. The integrated system will allow King County decision-makers to understand regional environmental impacts of management decisions and to facilitate the visualization of modeling results

Deliverables/Outcomes: Needs assessment. Model integration planning options (Phase 1). Integrated models (Phase 2).

Schedule: Phase 1: 2002. Phase 2: 2003-2006 (as necessary)

Figure 4. Proposed Model Relationships



5.13 Best Management Practice Evaluation

Development of hydrodynamic and water quality models that account for changes in land use / land cover will provide tools to support evaluation of best management practices (BMPs) and other pollutant abatement measures that improve water quality or aquatic conditions. Once the models are developed, the GD-WQA Team will be able to compare the impact on water quantity and quality from changes in BMPs and application of specific pollution control strategies. Potential comparisons include state-of-the-practice vs. state-of-the-art BMPs, including emerging concepts. The specific scenarios evaluated will be developed as the project progresses. This will be a key component of King County's efforts to evaluate BMP and water quality abatement options that might be considered as part of TMDLs in the Green-Duwamish watershed.

Deliverables/Outcomes: Literature review of BMP effectiveness. Modeling of BMP implementation on water quality.

Schedule: 2004-2005.

5.14 Ecological and human health risk assessment

The ecological and human health risk assessment will be conducted to help prioritize locations, water quality parameters, or biota for possible future actions. The risk assessment evaluates the potential for water quality parameters to affect the health of aquatic organisms, birds, mammals, and people. The risk assessment will be conducted in two phases, a screening-level risk assessment (SLRA) and a detailed-level risk assessment (DLRA).

The purpose of the SLRA is to identify stressors (i.e., chemicals or physical properties) that may potentially impact aquatic life, wildlife, or human health. This will be done using a deterministic approach (Barnthouse et al. 1986, Suter et al. 1992). The stressors identified as potentially impacting aquatic life, wildlife, or human health will be further evaluated using a detailed-level risk assessment, which will try to evaluate the magnitude of the potential impacts. Estimations of potential impact in both the SLRA and the DLRA will be made using both the measured data and the concentrations estimated from the model simulations.

Deliverables/Outcomes: Screening-Level Risk Assessment Report. Detailed Risk Assessment Report.

Schedule: 2004-2006

6 DELIVERABLES AND SCHEDULE

Planning for the GD-WQA was initiated in 1999. It is anticipated that this project will be completed in 2006. The majority of the work is expected to be conducted between 2001 and 2003. By 2004, effort should begin to decrease until the completion of the project in 2006. Table 3 provides a list of deliverables, their description, and estimated completion dates for the project.

Table 3. GD-WQA Deliverables.

Report	Description	Estimated Completion Date
GD-WQA Scope of Work	Presents overview of overall project scope of work.	May 2002
Habitat Limiting Factors and Reconnaissance Assessment Report. Part II, Chapter 1.2 Water Quality.	Provides baseline information for the WRIA and identifies limiting habitat factors for salmonids	December 2000
Addenda to: Habitat Limiting Factors and Reconnaissance Assessment Report. Part II, Chapter 1.2 Water Quality. Bacteria, other data sources.	Provides baseline information for the WRIA for data not covered in original report	June 2002
Centennial Clean Water Fund Report	Fulfills contract obligation to DOE for grant	June 2002
Watershed Model Selection Report	Describes various watershed models available and makes recommendations	March 2002
Watershed Model	Calibrated	August 2003
	Existing Conditions	December 2003
	Future Conditions	December 2004
Watershed Modeling Report	Describes watershed models and calibrations	December 2004
Sampling and Analysis Plan	Describes study area, objectives, and methods for sampling program	March 2002
Addenda to Sampling and Analysis Plan	As needed, may develop additional methods for specialized studies (e.g., temperature)	August 2002
Mainstem modeling	Setup and calibration of the mainstem model	September 2002
Preliminary Temperature Analysis Report	A summary of the temperature data collected from various sources through winter 2002; recommendations for future studies	June 2002
SAP for Temperature Study	Describes study area, objectives, and methods for comprehensive temperature study	June 2002

Report	Description	Estimated Completion Date
Temperature Analysis Report	Describes the overall temperature distribution throughout the watershed and identifies potential areas of concern	December 2003
Reconnaissance Sampling Report	Describes the water quality data collected for the 2001 reconnaissance sampling	August 2002
Water Quality Sampling Report	Describes the locations, dates, parameters, precipitation, and flows associated with each storm and baseflow sampling event	June 2004
Water Quality Data Report	Provides a summary of all data collected through 2003 for the GD-WQA	June 2004
Macroinvertebrate Monitoring Report	Describes the methods and results of the Macroinvertebrate Sampling Program	July 2004
Fish Survey Report	Describes fish surveys conducted in the Duwamish River	December 2002
Human Use Survey Report	Describes methods and results for human use surveys conducted in support of the human health risk assessment	December 2003
Land Use Projection Report (Existing and Future)	Provides land use results for land use / land cover predictions based on Growth Management Act or UrbanSim model results	June 2005
BMP Evaluation Report	Compares impacts to water quality from different BMPs	December 2004
Risk Assessment Report (SLRA & DLRA)	Describes potential exposure and effects to aquatic life, wildlife and human health	December 2005
Summary Report(s)	Summarizes overall project results for non-technical reviewers	June 2006

7 REFERENCES

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