

## 1.0 INTRODUCTION

This report describes the data processing and model calibration performed for a hydrodynamic and water quality model of the Green River, located in King County, Washington. Figure 1 shows the location of the river, and the limits of the section of river that was modeled.

The Green River flows from its headwaters in the Cascade Mountain foothills through the King County, Washington communities of Auburn, Kent, and Tukwila before discharging into the Duwamish River. Two sections of the river were modeled in this project. The Middle Green River begins in the Cascade Mountain foothills east of Tacoma, and continues downstream to the city of Auburn, WA. The Lower Green River continues from Auburn to the confluence with the Duwamish River, in the town of Tukwila.



Figure 1: Vicinity Map

The Green/Duwamish River system is unique in that it flows through a heavily urbanized and industrialized environment yet supports a large salmon population (Green/Duwamish Ecosystem Restoration Study, 2003). To protect the river and its prime salmon habitat, King County and the US Army Corps of Engineers have joined together on a study to identify and implement strategies for restoring and protecting the Green/Duwamish River System and its tributaries (Green/Duwamish Ecosystem Restoration Study, 2003).

As part of the Green-Duwamish Watershed Water Quality Assessment Program, King County

contracted with Portland State University to develop a hydrodynamic and water quality model for the Lower and Middle Green River. This model will be used in Total Maximum Daily Load (TMDL) development, in assessing current water quality conditions in the river, and as a planning tool for evaluating the impacts of future development in the basin.

A hydrodynamic and water quality model, CE-QUAL-W2 Version 3.1 (Wells, 1997), has been applied to the river between Flaming Geyser State Park (River Mile 45.0) and the confluence with the Duwamish River, near Tukwila (RM 11.20). CE-QUAL-W2 is a two dimensional (longitudinal-vertical), laterally averaged, hydrodynamic and water quality model that has been under development by the Corps of Engineers Waterways Experiment Station (Cole and Wells, 2000).

This report is divided into the following sections:

- The Introduction Section describes the watershed and discusses the modeling effort.
- The Data Analysis and Model Preparation Section reviews the available data, provides an analysis of the data to determine model simulation periods, and documents procedures used in assembling model boundary conditions and tributary data.
- The Model Calibration section describes the process for calibrating model predictions of hydrodynamics (flow and water level), temperature, bacteria (fecal coliform), and eutrophication model parameters (such as nutrients, algae, dissolved oxygen, and organic matter). The model calibration periods were from May 25, 1995 to November 30, 1996 and April 1, 2001 to July 31, 2002.
- A Sensitivity Analysis section examines the affects on the model of a new channel connecting two sections of the river, which was opened up during a flood event in the winter of 1996. Survey information for this channel is not available. A sensitivity analysis was performed to determine the effects of this channel on hydrodynamics and water quality. A spillway was used in the model to control flow releases to this channel. Model runs were compared with and without the new channel.
- A sensitivity analysis was performed to evaluate changes in pH in the Middle Green River.

## **1.1 The Green-Duwamish Watershed**

The headwaters of the Green River are located in the Cascade Mountains east of Tacoma, WA. There are two reservoirs on the Upper Green River: Howard Hanson Reservoir, which was constructed by the Army Corps of Engineers in the early 1960's as flood control protection for communities on the lower flood plain, and a diversion dam, located five km below Howard Hanson Reservoir, which diverts water for the city of Tacoma. The watershed above this dam is protected, and entry is prohibited (U.S. Army Corps of Engineers, 2003).

The Middle Green River begins below the diversion dam and continues downstream to the city of Auburn, WA. The upstream boundary of the model is 26 km below the diversion dam.

Major tributaries to the Middle Green River include Newaukum Creek, Crisp Creek, and Big Soos Creek, which is the largest tributary to the Green River. The surrounding landscape is primarily farming, production forestry and state parks, but residential development is growing in the region. The tributary creeks to the Middle Green River continue to support prime salmon habitat (Middle Green River Sub-Watershed, 2003). See Figure 2 for the location of these tributaries.

The Lower Green River continues from Auburn to the confluence with the Duwamish River, in the

town of Tukwila. The Lower Green River watershed is heavily urbanized with commercial and industrial development. There is an extensive dike and levee system on the Lower Green protecting the surrounding area from flooding. There are a number of smaller tributaries that contribute flow to the Lower Green, including Auburn, Mill, and Midway Creeks, and Mullen Slough. The Lower Green is tidally influenced up the Duwamish River from Elliot Bay.

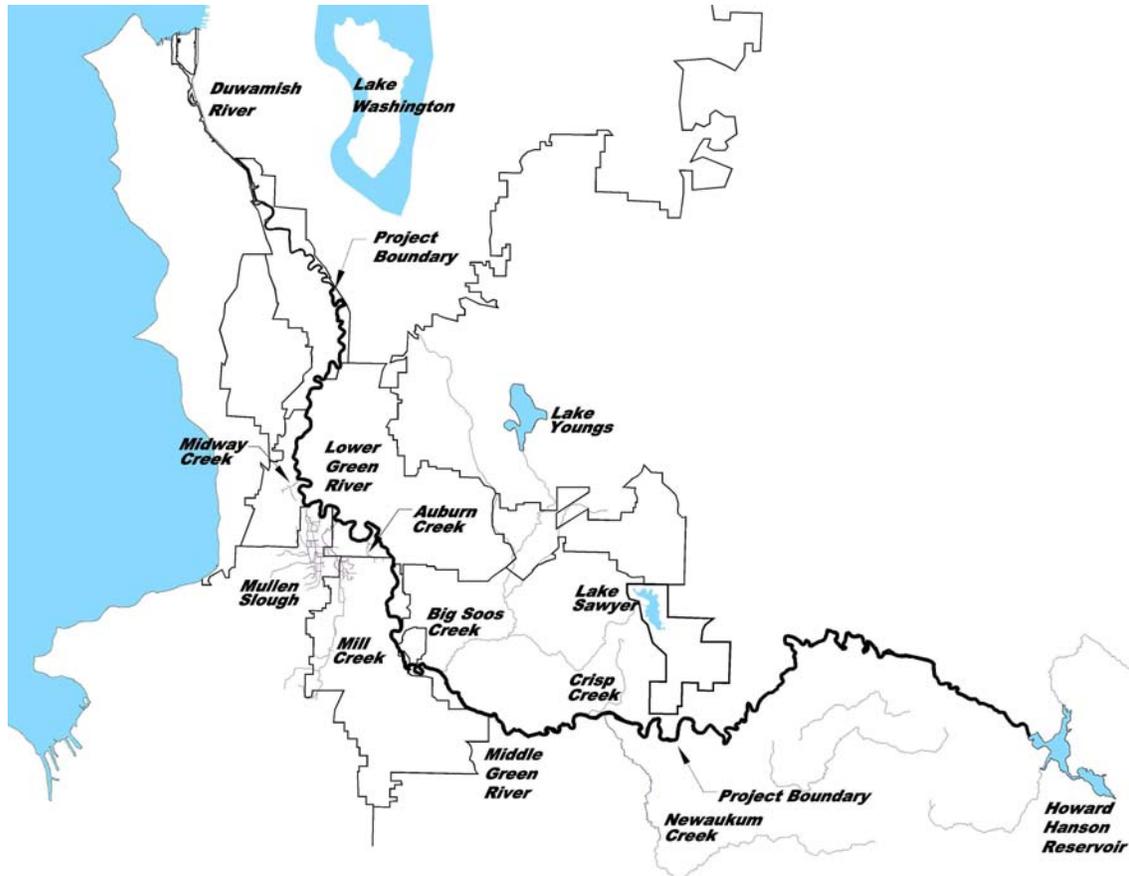


Figure 2: Green River and Major Tributaries

## 1.2 Prior Green River Models

Both the Middle Green River and the Lower Green River have been modeled with the Army Corps of Engineers program HEC2. HEC2 is a steady-state program that models one-dimensional river hydraulics and is commonly used for establishing flood plain elevations. King County modeled the Middle Green River with HEC2 in the middle 1990's, and in the late 1990's the Army Corps of Engineers converted both Lower and Middle Green River HEC2 data to HEC-RAS, which is the Army Corps of Engineer's Windows-based follow-up program to HEC2.

The Duwamish River and Elliot Bay have been modeled using Environmental Fluids Dynamic Computer Code, a three-dimensional hydrodynamic and transport model. This model was developed as part of a program to evaluate and simulate the impacts of combined sewer overflows on the river and bay (King County Combined Sewer Overflow Water Quality Assessment for Duwamish River and Elliot Bay, 1999).