

# 2008 Stormwater Needs Assessment Program

## Vancouver Lake/Lake River Subwatershed Needs Assessment Report

Clark County Public Works Clean Water Program

March 2009





**For other formats**

Clark County ADA Office, Voice (360) 397-2000

Relay (800) 833-6384, E-mail [ADA@clark.wa.gov](mailto:ADA@clark.wa.gov)

# 2008 Stormwater Needs Assessment Program Table of Contents

---

	<b>PAGE</b>
Responsible County Officials.....	1
Acronyms and Abbreviations .....	5
Executive Summary.....	9
Study Area .....	9
Intent .....	9
Findings.....	9
Opportunities.....	11
Introduction.....	13
Assessment Approach.....	15
Priorities for Needs Assessment in Vancouver Lake and Lake River ..	15
Assessment Tools Applied in Vancouver Lake/Lake River.....	15
Assessment Actions .....	17
Outreach Activities .....	17
Coordination with Other Programs.....	19
Review of Existing Data .....	21
Broad-Scale GIS Characterization and Metrics .....	23
Water Quality Assessment.....	29
Drainage System Inventory.....	35
Stormwater Facility Inspection .....	37
Illicit Discharge Detection and Elimination Screening.....	39
Stream Reconnaissance and Feature Inventory.....	41
Physical Habitat Assessment.....	43
Physical Habitat Assessment.....	43
Geomorphology Assessment.....	45
Floodplain Assessment.....	53
Wetland Assessment .....	55
Macroinvertebrate Assessment.....	61
Fish Use and Distribution .....	63
Hydrologic and Hydraulic Models.....	69
Analysis of Potential Projects .....	71
Summary of Conditions, Problems, and Opportunities .....	71

# 2008 Stormwater Needs Assessment Program

## Table of Contents

---

Recently Completed or Current Projects .....	73
Analysis Approach.....	74
Emergency or Immediate Actions.....	75
Potential Stormwater Capital Projects .....	77
Public Works and Clean Water Program Referrals .....	79
Projects for Referral to other County Departments, Agencies, or Groups .....	81
Non-Project Management Recommendations .....	83
References.....	85

### Figures

Figure 1: Subwatershed Map – Vancouver Lake and Lake River .....	25
Figure 2: Vancouver Lake and Lake River LWD Recruitment Potential (adapted from R2, 2004) .....	49
Figure 3: Vancouver Lake and Lake River Shade Values (adapted from R2, 2004) .....	51
Figure 4: Vancouver Lake and Lake River Potential Wetlands .....	57
Figure 5: Priorities for suitability of areas from protection and restoration from the hydrologic process (from Draft Watershed Characterization of Clark County (Ecology, 2007) .....	59
Figure 6: Vancouver Lake and Lake River Coho Distribution and Barriers.....	65
Figure 7: Vancouver Lake and Lake River Winter Steelhead Distribution and Barriers.....	66

### Tables

Table 1: Stormwater Needs Assessment Tools .....	15
Table 2: Watershed Scale Metrics .....	26
Table 3: Applicable Water Quality Criteria .....	29
Table 4: Available Data .....	31
Table 5: Drainage System Inventory Results, Vancouver Lake/ Lake River .....	35
Table 6: Lake River 2 Reach Physical Habitat .....	43

# 2008 Stormwater Needs Assessment Program

---

## Responsible County Officials

Program Name: Stormwater Needs Assessment Program  
Project Code: SNAP  
Department: Clark County Public Works Water Resources  
Funding source: Clark County Clean Water Fee  
Reporting Category: 4420 000 531 534 245 011403

Client: Ron Wierenga, Clean Water Program manager

SNAP managers: Rod Swanson, Senior Planner  
Contact: 360-397-6118 x4581  
[rod.swanson@clark.wa.gov](mailto:rod.swanson@clark.wa.gov)

Jeff Schnabel, Natural Resources Specialist III  
Contact: 360-397-6118 x4583  
[jeff.schnabel@clark.wa.gov](mailto:jeff.schnabel@clark.wa.gov)

Subwatershed Lead: Jeff Schnabel

# 2008 Stormwater Needs Assessment Program

---

# 2008 Stormwater Needs Assessment Program

---

## Acknowledgements

Development of Stormwater Needs Assessment reports is a team effort involving many individuals implementing various tools and tasks as described in Stormwater Needs Assessment Program, Volume I.

Thank you to staff who contributed chapters or support for this report, including: Chad Hoxeng, Bob Hutton, Trista Kobluskie, Fereidoon Safdari, Henry Schattenkerk, Cindy Stienbarger, and Rod Swanson.

Special thanks to local agency staff and interested parties who provided discussion, coordination, and project suggestions, including:

Patrick Lee, Clark County Office of Conservation Lands Management  
Joel Rupley, Clark County Endangered Species Act  
Jeroen Kok, Vancouver-Clark Parks and Recreation  
Vancouver Lake Watershed Partnership  
Bill Dygert, Consultant

The following firms were instrumental in completing various field tasks and assisting with compilation of the final report:

Ecological Land Services, Inc. (Karey Bock, Key McMurray)  
Otak, Inc. (Jeannine Johnson, Tim Kraft)



# 2008 Stormwater Needs Assessment Program

---

## Acronyms and Abbreviations

B-IBI	Benthic Macroinvertebrate Index of Biological Integrity
BOCC	Board of County Commissioners
BMP	Best Management Practices
CCD	Clark Conservation District
CIP	Capital Improvement Program
CPU	Clark Public Utilities
CRFPO	Columbia River Fisheries Program Office
CWA	Clean Water Act
CWC	Clean Water Commission
CWP	Clean Water Program
DNR	Department of Natural Resources
EDT	Ecosystem Diagnostic and Treatment model
EIA	Effective Impervious Area
EIM	Environmental Information Management
EMAP	Environmental Mapping and Assessment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FPIA	Focused Public Investment Area
FWS	Fall, Winter, Spring
GCEC	Gee Creek Watershed Enhancement Committee
GIS	Geographic Information System
GMA	Growth Management Act
GPS	Geographic Positioning System

## 2008 Stormwater Needs Assessment Program

---

HPA	Hydraulic Project Approval
IDDE	Illicit Discharge Detection and Elimination
LCFEG	Lower Columbia Fish Enhancement Group
LCFRB	Lower Columbia Fish Recovery Board
LID	Low-Impact Development
LiDAR	Light Detection and Ranging
LISP	Long-term Index Site Project
LWD	Large Woody Debris
MS4	Municipal Separate Storm Sewer System
MOP	Mitigation Opportunities Project
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
NWIFC	Northwest Indian Fisheries Commission
ODEQ	Oregon Department of Environmental Quality
OWQI	Oregon Water Quality Index
PFC	Properly Functioning Condition
RM	River Mile
SCIP	Stormwater Capital Improvement Program
SCIPIT	Stormwater Capital Improvement Program Involvement Team
SCMP	Salmon Creek Monitoring Project
SCWC	Salmon Creek Watershed Council
SNAP	Stormwater Needs Assessment Program

# 2008 Stormwater Needs Assessment Program

---

SWMP	Stormwater Management Program
SWMMWW	Stormwater Management Manual for Western Washington
TIA	Total Impervious Area
TIP	Transportation Improvement Program
TIR	Technical Information Report
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
UGA	Urban Growth Area
UIC	Underground Injection Control
USFS	U.S. Forest Service
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VBLM	Vacant Buildable Lands Model
VLWP	Vancouver Lake Watershed Partnership
WAC	Washington Administrative Code
WCC	Washington Conservation Commission
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSDOT	Washington Department of Transportation
WSU	Washington State University



# 2008 Stormwater Needs Assessment Program

---

## Executive Summary

### Study Area

This Stormwater Needs Assessment report includes the Vancouver Lake and Lake River subwatersheds, on the Columbia River floodplain in western Clark County.

### Intent

Stormwater Needs Assessment reports compile summary information relevant to stormwater management, propose stormwater-related projects and activities to improve stream health, and assist with adaptive management of the county's Stormwater Management Program. The assessments are conducted at a subwatershed scale, providing a greater level of detail than regional WRIA or ESA plans. Stormwater Needs Assessments are not comprehensive watershed plans or stormwater basin plans.

### Findings

#### Watershed Conditions

The table on the following page summarizes conditions in the Vancouver Lake and Lake River subwatersheds, including water quality, biological health, habitat, hydrology, and the stormwater system.

#### Ongoing projects and involvement

The Vancouver Lake Watershed Partnership (VLWP) is actively involved in improving and protecting Vancouver Lake and Lake River through support and study of long-term lake management options. Ecology is coordinating TMDL efforts in Burnt Bridge Creek and Salmon Creek, two primary tributaries to the Vancouver Lake/Lake River system. The Clark County Clean Water Program (CWP) participates in the VLWP and its technical advisory group, and supports the TMDL process through implementation of the NPDES permit and the support of various local organizations working within the Columbia River floodplain. The US Fish and Wildlife Service owns and operates extensive wildlife refuge lands within these two subwatersheds.

There are no significant Clark County capital improvement projects planned in these subwatersheds under the 2008-2013 Transportation Improvement Program or the 2009-2014 Stormwater Capital Improvement Program.

## 2008 Stormwater Needs Assessment Program

Category	Status
<b>Water Quality</b> Overall  Nutrients Turbidity Temperature	<ul style="list-style-type: none"> <li>• Poor to Fair</li> <li>• Included on state 303(d) list of impaired water bodies for fecal coliform (both), and temperature (Lake River only)</li> <li>• Extremely high levels of phosphorus and nitrogen</li> <li>• Very poor water clarity</li> <li>• Elevated summer temperatures</li> </ul>
<b>Biological</b> Algae  Fish	<ul style="list-style-type: none"> <li>• Intense blue-green algal blooms</li> <li>• Routine summer lake closures (swimming) due to potential toxins in blooms</li> <li>• Included on state 303(d) list of impaired water bodies for multiple chemical toxins in fish tissue</li> <li>• Presumed use by fall Chinook, Coho, and winter steelhead</li> <li>• Low regional recovery priority (LCFRB Group D, Tier 4)</li> <li>• Fish community dominated by warm-water species</li> </ul>
<b>Habitat</b> NOAA Fisheries and Washington Conservation Commission criteria  Riparian  Wetland	<ul style="list-style-type: none"> <li>• Forest cover and impervious area percentage fall into the Non-Functioning category</li> <li>• Road density and crossings fall into the Functioning category.</li> <li>• Lake River has good streambank stability, but overall habitat is not properly functioning</li> <li>• Large Woody Debris recruitment potential low (Lake River).</li> <li>• Overall shade below state targets (Lake River)</li> <li>• Extensive wetland and potential wetland areas</li> <li>• Wetland restoration likely to have a high benefit for regional watershed processes</li> </ul>
<b>Hydrology and Geomorphology</b> Overall hydrology  Future condition	<ul style="list-style-type: none"> <li>• Highly influenced by Columbia River flows and tides</li> <li>• Large contributing area, including Burnt Bridge Creek, Salmon Creek, Whipple Creek, Flume Creek</li> <li>• Impervious area not projected to increase in Lake River subwatershed</li> <li>• Impervious area projected to increase in Vancouver Lake subwatershed</li> </ul>
<b>Stormwater (Unincorporated areas)</b> System description  Inventory status System adequacy  Condition	<ul style="list-style-type: none"> <li>• Very limited stormwater infrastructure; primarily road-side ditches</li> <li>• No public stormwater facilities, one private facility</li> <li>• 40 stormwater outfalls</li> <li>• Complete</li> <li>• Adequate control and unknown treatment</li> <li>• Most urbanized areas drain directly to the Columbia River</li> <li>• Assumed adequate; illicit discharge screening not conducted</li> </ul>

## 2008 Stormwater Needs Assessment Program

---

### Opportunities

No specific stormwater management project opportunities were discovered through this assessment.

The 2004 habitat report for Lake River (R2 Resource Consultants) and 2008 Technical Foundation for Future Management of Vancouver Lake (VLWP) include priority project areas that local jurisdictions should consider in these subwatersheds. These include riparian forest restoration adjacent to Lake River, particularly on the western shore, protection of hillslope processes, and invasive species removal in both the Vancouver Lake and Lake River subwatersheds.

Non-project stormwater management recommendations address areas where county programs or activities could be modified to better address NPDES permit components or promote more effective mitigation of stormwater problems.

Management recommendations relevant to the Vancouver Lake and Lake River subwatersheds include:

- Vancouver Lake and Lake River restoration and protection has active support and involvement through the Vancouver Lake Watershed Partnership and ongoing TMDL work by Ecology. Support for and coordination with these efforts should be continued and enhanced whenever feasible.
- Collaboration between Clark County, City of Vancouver, and Vancouver-Clark County Parks and Recreation should be pursued for stormwater activities in parklands, and for connected stormwater systems or shared water bodies.



# 2008 Stormwater Needs Assessment Program

---

## Introduction

This Stormwater Needs Assessment includes the Vancouver Lake and Lake River subwatersheds, on the Columbia River floodplain in western Clark County. The Clean Water Program (CWP) is gathering and assembling information to support capital improvement project (CIP) planning and other management actions related to protecting water bodies from stormwater runoff.

## Purpose

The Stormwater Needs Assessment Program (SNAP), initiated in 2007, creates a system for the CWP to focus activities, coordinate efforts, pool resources, and ensure the use of consistent methodologies. SNAP activities assess watershed resources, identify problems and opportunities, and recommend specific actions to help meet the CWP mission of protecting water quality through stormwater management.

The overall goals of the SNAP are to:

- Analyze and recommend the best, most cost effective mix of actions to protect, restore, or improve beneficial uses consistent with NPDES permit objectives and the goals identified by the state Growth Management Act (GMA), ESA recovery plan implementation, Total Maximum Daily Load (TMDLs), WRIA planning, floodplain management, and other local or regional planning efforts.
- Inform county efforts to address the following issues related to hydrology, hydraulics, habitat, and water quality:
  - Impacts from current or past development projects subject to lesser or non-existent stormwater treatment and flow control standards.
  - Subwatershed-specific needs due to inherent sensitivities or the present condition of water quality or habitat.
  - Potential impacts from future development.

The CWP recognizes the need to translate assessment information into on-the-ground actions to improve water quality and habitat. Facilitating this process is a key requirement for the program's long-term success.

Results and products of needs assessments promote more effective implementation of various programs and mandates. These include initiating wetland banking systems, identifying mitigation opportunities, and providing a better understanding of stream and watershed conditions for use in planning county road projects. Similar information is also needed by county programs implementing critical areas protection and salmon recovery planning under the state GMA and the federal ESA.

# 2008 Stormwater Needs Assessment Program

---

## Scope

This report summarizes and incorporates new information collected for the SNAP, as well as pre-existing information. In many cases it includes basic summary information, or incorporates by reference longer reports which may be consulted for more detailed information.

SNAP reports produce information related to three general categories:

- Potential stormwater capital projects for county implementation or referral to other organizations.
- Management and policy recommendations.
- Natural resource information.

Descriptions of potential projects and recommended program management actions are provided to county programs, including the Public Works CWP and Stormwater Capital Improvement Program (SCIP), the Department of Community Development, the Department of Community Planning, and the county's ESA Program. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities as appropriate.

# 2008 Stormwater Needs Assessment Program

## Assessment Approach

Priorities for Needs Assessment in Vancouver Lake and Lake River Clark County subwatersheds were placed into a five year schedule for assessment using the procedures described in *Prioritizing Areas for Stormwater Basin Planning* (Swanson, July 2006).

For SNAP purposes, the Vancouver Lake and Lake River subwatersheds are categorized as “Special Management Areas”. Subwatersheds in this category are located almost entirely within wildlife refuges, or other managed open spaces where urban development and stormwater infrastructure is very limited. Accordingly, this effort is largely limited to summarizing existing information to identify potential habitat restoration projects.

## Assessment Tools Applied in Vancouver Lake/Lake River

The SNAP utilizes a standardized set of tools for subwatershed assessment; including desktop mapping analyses, modeling, outreach activities, and a variety of field data collection. Tools follow standard protocols to provide a range of information for stormwater management. Though not every tool is applied in every subwatershed, the use of a standard toolbox ensures the consistent application of assessment activities county-wide.

Table 1 lists the set of tools available for use in the SNAP. Tools with an asterisk (\*) had new data or analyses for this needs assessment. The remainder of the tools or chapters were completed based on pre-existing information.

<b>Table 1: Stormwater Needs Assessment Tools</b>	
Stakeholders *	Geomorphology And Hydrology Assessment
Outreach And Involvement *	Riparian Assessment
Coordination with Other Programs *	Floodplain Assessment
Drainage System Inventory *	Wetland Assessment
Stormwater Facility Inspection *	Macroinvertebrate Assessment
Review Of Existing Data *	Fish Use And Distribution
Illicit Discharge Screening	Water Quality Assessment
Broad Scale GIS Characterization *	Hydrologic Modeling
Rapid Stream Reconnaissance	Hydraulic Modeling
Physical Habitat Assessment	



# 2008 Stormwater Needs Assessment Program

---

## Assessment Actions

### Outreach Activities

Outreach activities were limited and focused primarily on raising awareness about the SNAP effort. The following activities were completed:

- August 2008 -- press release to local media.
- March 2008 & December 2008-- articles in Clean Water Program E-Newsletter.
- April 2008 -- SNAP information distributed with Clean Water Program information at Small Farm Expo: 69 participants.
- August 2008 – information on the SNAP distributed at 10-day Clark County Fair.
- Clean Water Program web pages updated as needed on an on-going basis; 138 visitors to the SNAP Web page and 95 unique downloads of SNAP documents (note, these figures are under-reported as tracking software only records top 20 pages and documents monthly).
- A description of the SNAP is included in Clark County's annual stormwater management program plan submitted to Ecology.

Clark County Clean Water Commission members were also updated periodically on SNAP progress.

Tools available to educate in response to identified problem areas include the following:

- Site visits by clean water technical assistance staff.
- Letters detailing specific issues to individual landowners.
- General educational mailings to selected groups of property owners.
- Workshops on best management practices, including septic maintenance and mud, manure and streamside property management.
- Referral to other agencies, such as Clark Conservation District or WSU Extension, for educational follow-up.



# 2008 Stormwater Needs Assessment Program

---

## Coordination with Other Programs

### Purpose

Coordination with other county departments and with local agencies or organizations helps to explore potential cooperative projects and ensure that the best available information is used to complete the assessment.

Coordination is a two-way relationship; in addition to bringing information into the needs assessment process, coordinating agencies may use needs assessment results to improve their programs.

### Methods

The CWP maintains a list of potential coordinating programs for each subwatershed area. The list was reviewed in early 2008 and general communications were planned. Coordination took the form of phone conversations, meetings, or electronic correspondence, and was intended to solicit potential project opportunities, encourage data and information sharing, and promote program leveraging.

Potential opportunities for coordination exceeded the scope of CWP and SNAP resources; therefore, not all potentially relevant coordination opportunities were pursued. Coordination was prioritized with departments and groups most likely to contribute materially to identifying potential projects and compiling information to complete the needs assessment.

### Results

See Analysis of Potential Projects for an overall list and locations of potential projects gathered during the needs assessment process. Projects suggested or identified through coordination with other agencies are included.

The following list includes departments, agencies, and groups contacted for potential coordination in the assessment area:

- Vancouver Lake Watershed Partnership
- Lower Columbia Fish Recovery Board
- Clark County Transportation Improvement Program
- Clark County Legacy Lands Program
- Vancouver/Clark County Parks and Recreation
- Washington Department of Ecology
- Washington Department of Fish and Wildlife



# 2008 Stormwater Needs Assessment Program

---

## Review of Existing Data

Data and information review is incorporated throughout this report in pertinent sections. A standardized list of typical data sources created for the overall SNAP effort is supplemented by subwatershed-specific sources as they are discovered. Data sources consulted for this report include, but are not limited to those listed below:

- Technical Foundation for Future Management of Vancouver Lake
- LCFRB Habitat Characterization (2004)
- LCFRB 6-Year Habitat Workplan
- Clark County Volunteer project data
- Ecology 303(d) list
- WRIA 27/28 Plan
- Ecology EIM data
- Clark County 2004 Subwatershed summary
- Clark County 2004 Stream Health Report
- USACE Review of Biological Research on Salmonid Use of Vancouver Lake
- WSU Biological Assessment of the Plankton in Vancouver Lake



# 2008 Stormwater Needs Assessment Program

---

## Broad-Scale GIS Characterization and Metrics

The broad-scale characterization is a GIS-based exercise providing an overview of the biophysical setting for each subwatershed, background information for use in implementing other SNAP tools, and identification of potential acquisition or project sites. GIS data describes many subwatershed characteristics such as topography, geology, soils, hydrology, land cover, land use, and GMA critical areas. A standard GIS workspace including shape files for over 65 characteristics forms the basis for the characterization.

GIS data are generally used as a tool to complete the report and not presented in the report itself. Summary metrics are taken from existing reports and data; for example, Wierenga (2005) summarized many GIS characteristics for Clark County subwatersheds. Some of these characteristics are described in greater detail in later sections.

The characterization includes three components:

- A set of four standard map products, as paper maps for SNAP use.
- A summary table of selected subwatershed-scale metrics.
- A brief narrative including comparison of metrics to literature values, conclusions about general subwatershed condition and potential future changes, and potential mitigation or improvement site identification.

## Map Products

The four standard SNAP map products are: 1) Stormwater Infrastructure and Hydrologic Soil Groups, 2) Critical Areas information, 3) Vacant Buildable Lands within UGAs, and 4) Orthophoto. These maps are printed out for tabletop evaluations.

## General Conditions and Subwatershed Metrics

### *General Geography*

The study area is entirely within the Columbia River flood plain, making it completely unlike the other areas assessed for the SNAP, which are largely stream basins (Figure 1). Most of the area outside of Vancouver is pasture, parks, and wildlife cropland. Industrial and commercial development is concentrated within the City of Vancouver on the south and east fringes of Vancouver Lake subwatershed.

County-owned roads and associated stormwater drainage systems are limited to short access roads on the east side of Vancouver Lake and roads in county parks. State Route 501 runs from the south side of Vancouver Lake north along the west edge of the study area for about five miles.

## 2008 Stormwater Needs Assessment Program

---

### *Topography*

The study area is entirely within the Columbia River flood plain, at elevations between near sea level and up to about 20 feet above sea level. Levies surround much of the flood plain to an elevation of up to 30 feet, separating it from the Columbia River.

### *Geology and Soils*

The study area is underlain by recent alluvium deposited by the Columbia River during floods. Soils are generally sandy and well drained where not saturated by shallow groundwater.

### *Hydrology*

The study area hydrologic framework is controlled by the Columbia River and rivers draining into Vancouver Lake and Lake River. The lake rises and falls seasonally between winter and summer as the Columbia River level rises and falls. Ocean tides also influence the level of the lower Columbia River and Vancouver Lake. During the early 1980s, a project was undertaken to improve Vancouver Lake's habitat by dredging to deepen the lake. The project also created a channel to allow water from the Columbia to flow into Vancouver Lake during times of high flow on the Columbia. The main tributary to Vancouver Lake is Burnt Bridge Creek, which flows directly through the City of Vancouver.

Lake River originates in Vancouver Lake and flows northward along the east margin of the study area, eventually discharging into the Columbia River near Ridgefield. Numerous streams, including Salmon Creek, Whipple Creek, and Flume Creek drain from western Clark County into Lake River. Tidal effects cause Lake River to reverse flow back toward Vancouver Lake.

# 2008 Stormwater Needs Assessment Program

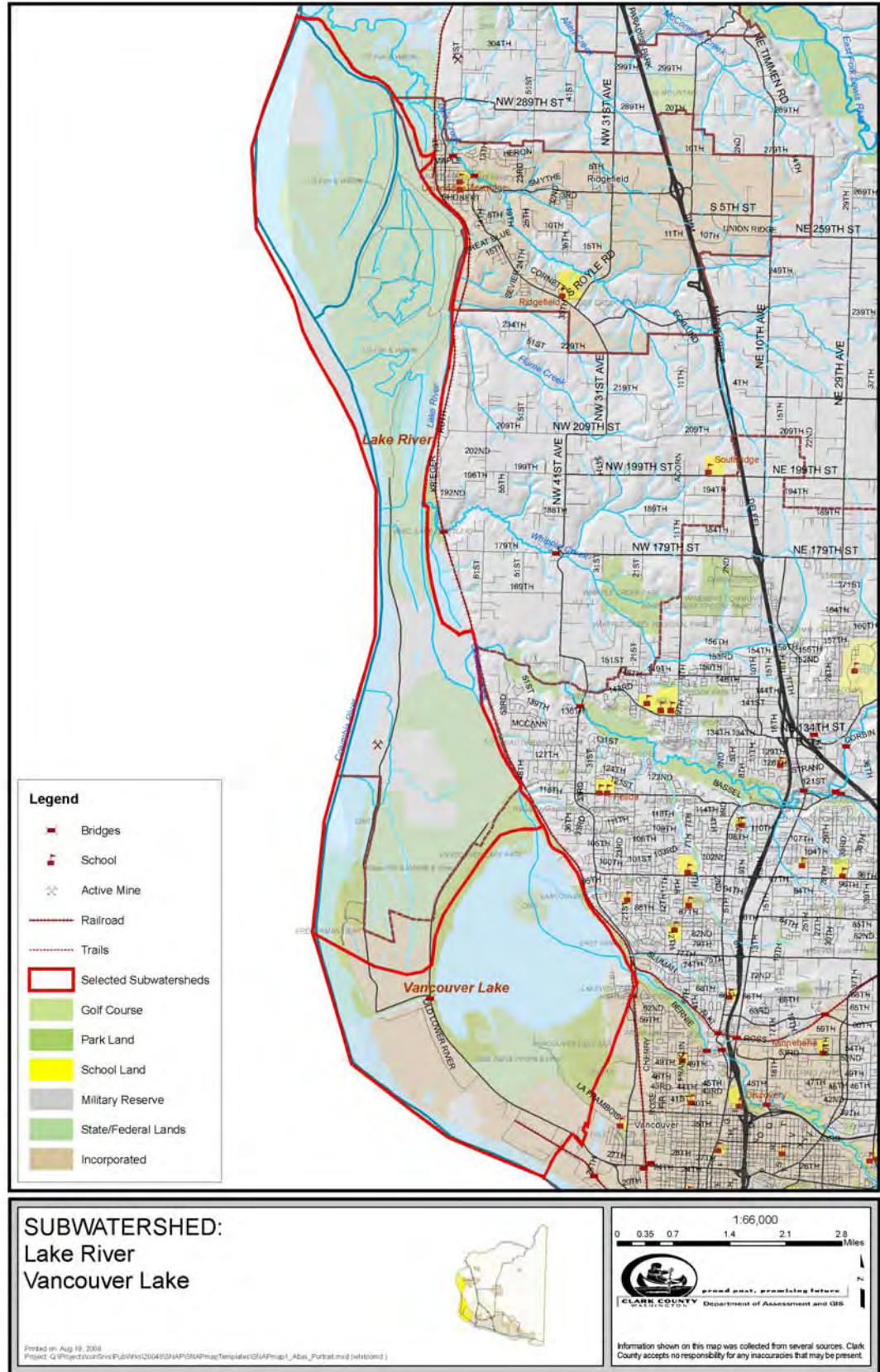


Figure 1: Subwatershed Map – Vancouver Lake and Lake River

# 2008 Stormwater Needs Assessment Program

## *Subwatershed Metrics*

Subwatershed scale metrics provide a simple way to summarize overall conditions. They are designed to apply to subwatersheds drained by alluvial streams where characteristics such as land cover can have a profound influence on stream hydrology and water quality. They are not completely appropriate for use on flood plain systems, but are presented here as a summary of standard metrics. Metrics are calculated from Landsat land cover analysis and current GIS data. Benchmarks for properly functioning and not properly functioning are based on NOAA fisheries standards for salmon protection and restoration (1996 and 2003). Metrics are summarized in Table 2.

<b>Table 2: Watershed Scale Metrics</b>				
<b>Metric</b>	<b>Vancouver Lake</b>	<b>Lake River</b>	<b>Functioning</b>	<b>Non-functioning</b>
Percent Forested (2000 Landsat)	8	8	> 65 %	< 50 %
Percent TIA (2000 Landsat)	18	17	< 5 %	> 15 %
Road Density 2007 data (miles/mile <sup>2</sup> )	2	1.4	< 2	> 3
Stream Crossing Density (crossings per stream mile)	0.1	0.4	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	20	< 1	< 10 %	> 10 %

## *Forest Cover*

The proportion of a watershed in forest cover is known to have a profound influence on watershed processes. Forest cover estimates are taken from a report summarizing land cover for Clark County (Hill and Bidwell, January 2003). Research in the Pacific Northwest has shown that when forest cover declines below approximately 65 percent, watershed forming processes become degraded (Booth and Jackson, 1997). These include reducing riparian shade, less wood debris delivery to streams, increased stormwater runoff, and increased fine sediment delivery due to mass wasting.

Outside of the developed area south and east of Vancouver Lake, the study areas are largely fields, with some pasture and wetlands.

## *TIA (Total Impervious Area)*

Total impervious area is one of the most widely used indicators of urbanization and coincident watershed degradation (Center for Watershed Protection, March 2003). Total impervious areas are estimated from land cover data in Hill and Bidwell (January 2003). While various organizations and publications categorize

## 2008 Stormwater Needs Assessment Program

---

stream condition based on TIA, the NOAA fisheries standard is less than five percent as fully functional and greater than 15 percent as non-functioning. Impervious area estimates from Hill and Bidwell (March 2003) tend to be higher than expected because clear cuts and certain agricultural or rural areas tend to be categorized as forested or grassy urban land cover. The tendency to over estimate urban land cover is reflected in the 17 percent TIA in the Lake River subwatershed and to a lesser extent in the Vancouver Lake subwatershed.

### *Road Density*

Road density, including all public and private roads, is an easily calculated development measure. Based on criteria set by NOAA Fisheries to protect salmon habitat, road densities are at or within the functioning category (< 2 road miles/mi<sup>2</sup>).

### *Stream Crossing Density*

Stream crossing densities are easily measured using available road and stream channel data. The salmon protection standard considers larger fills over 60 feet wide, which would be approximately five to ten foot high road fill. The very low stream crossing densities reflect the few roads found in the flood plain.

### *Future Effective Impervious Area*

Effective impervious area is the amount of impervious area that actually drains to a water body. Depending on factors such as soil types and level of development, effective impervious area is about half (lower intensity development) to almost equal (high intensity development) the TIA value.

The 2008 Comprehensive Plan guides development for the next few years, and when used to estimate effective impervious area it can provide a metric for potential hydrologic impacts due to expected development. Virtually no future EIA changes should be seen in the Lake River subwatershed due to it being a flood plain wildlife refuge. Vancouver Lake has a much higher estimated future EIA due to the potential for development within City of Vancouver.



## 2008 Stormwater Needs Assessment Program

---

### Water Quality Assessment

This section briefly summarizes and references available water quality data from the Vancouver Lake and Lake River subwatersheds. A description of applicable water quality criteria is included, along with a brief summary of conditions and possible implications for stormwater management planning.

### Water Quality Criteria

For a full explanation of current water quality standards see the Ecology website at: <http://www.ecy.wa.gov/programs/wq/swqs/index.html>

Under current Washington state water quality standards, Vancouver Lake and its tributaries, including Lake River, are to be protected for the designated uses of: Core Summer Salmonid Habitat; extraordinary primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (WAC 173-201A-600).

Table 3 summarizes currently applicable water quality criteria for Vancouver Lake and Lake River.

<b>Table 3: Applicable Water Quality Criteria</b>	
<b>Characteristic</b>	<b>2006 Ecology criteria</b>
<b>Temperature</b>	≤ 16 °C (60.8 °F)
<b>Dissolved Oxygen</b>	≥ 9.5 mg/L
<b>Turbidity</b>	shall not exceed 5 NTU over background when background is 50 NTU or less
<b>pH</b>	6.5 – 8.5 units
<b>Fecal coliform bacteria</b>	Geometric mean fecal coliform concentration not to exceed 50 colonies/100mL, and not more than 10% of samples exceeding 100 colonies/100mL.
<b>Aesthetics</b>	Aesthetic values must not be impaired by the presence of materials or their effects... which offend the senses of sight, smell, touch, or taste
<b>Toxics</b>	Toxic substances shall not be introduced... which have the potential...to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent upon those waters, or adversely affect public health

Source: Washington Department of Ecology (<http://www.ecy.wa.gov/programs/wq/swqs/index.html>)

### 303(d) Listed Impairments

The 2008 list of impaired waters may be found on the Ecology website at: <http://www.ecy.wa.gov/programs/wq/303d/index.html>

# 2008 Stormwater Needs Assessment Program

---

There are multiple listings in the study area, as noted below:

## Vancouver Lake:

### Category 5 - Polluted waters that require a TMDL

- Fecal coliform (water)
- PCBs (fish tissue)
- 4, 4'- DDE (fish tissue)
- Toxaphene (fish tissue)
- 2, 3, 7, 8-TCDD (fish tissue)
- Dieldrin (fish tissue)

### Category 1 - Meets tested standards for water quality

- 4, 4'-DDD, Alpha-BHC, Beta-BHC, Gamma-BHC, Endrin, Heptachlor Epoxide, Hexachlorobenzene, Mercury, Chlordane, Heptachlor, Endosulfan I and II, 4'4'-DDT (all in tissue)

## Vancouver Lake Flushing Channel:

### Category 2 - Waters of concern

- pH (water)

## Lake River

### Category 5 - Polluted waters that require a TMDL

- Temperature (water)
- Fecal coliform (water)
- 2, 3, 7, 8-TCDD (fish tissue)
- 4, 4'-DDE (fish tissue)
- Dieldrin (fish tissue)
- PCBs (fish tissue)

## Clark County Stream Health Report

In 2004, the CWP compiled available data and produced the first county-wide assessment of general water quality.

Based on a limited available dataset including fecal coliform bacteria, general water chemistry (temperature, pH, and dissolved oxygen), and benthic macroinvertebrate scores, overall stream health in the Vancouver Lake subwatershed scored in the poor category, while Lake River scored in the fair category.

The 2004 Stream Health Report may be viewed on the county website at:

<http://www.clark.wa.gov/water-resources/stream.html>.

## Available Data

A comprehensive bibliography of reports concerning the Vancouver Lake watershed, including Burnt Bridge Creek, Flushing Channel, Lake River, and Salmon Creek has been compiled by the Vancouver Lake Watershed Partnership and may be found on the web at:

# 2008 Stormwater Needs Assessment Program

[http://www.fishlib.org/library/Bibliographies/VLWP/title\\_page.html](http://www.fishlib.org/library/Bibliographies/VLWP/title_page.html)

A full review of existing datasets and reports is beyond the scope of this summary. Data and information sources reviewed or summarized as part of this water quality characterization are listed in Table 4.

<b>Table 4: Available Data</b>	
<b>Source</b>	<b>Data and/or Report</b>
Clark County Clean Water Program	2004 Stream Health Report and draft reports Vancouver Lake 2007 Volunteer Monitoring Summary
Ecology	303(d) List of impaired water bodies
Vancouver Lake Watershed Partnership	Technical Foundation for Future Management of Vancouver Lake Biological Assessment of the Plankton in Vancouver Lake

### Water Quality Summary

No new water quality data was collected as part of this assessment. The following briefly summarizes information from the above sources. Complete reports may be viewed on the Clean Water Program website at:

<http://www.clark.wa.gov/water-resources/documents-monitoring.html#volmon>

and the Vancouver Lake Watershed Partnership website at:

<http://www.ci.vancouver.wa.us/PublicWorks/vancouverlake/index.htm>

### *Vancouver Lake Conditions*

Studies since the late 1960's indicate that Vancouver Lake has poor water quality.

Ongoing issues of concern include intense algal blooms that routinely cause closure of the lake to water-contact recreation, extremely high levels of phosphorus and nitrogen, elevated water temperatures, and very high turbidity (low water clarity). Toxic contaminants, excessive sedimentation, and a nearly complete lack of emergent and submergent vegetation are also recognized problems.

Typical indicators of lake condition collected by Clark County show the lake remains eutrophic or hypereutrophic, meaning it is highly enriched with nutrients and algae.

The lake has very poor water clarity, typically ranging from 0.1 to 1.1 meters on a scale where clarity over three meters is desirable. Summer turbidity ranges from about 10 to 175 NTU, much higher than other surface water bodies in Clark County.

## 2008 Stormwater Needs Assessment Program

---

Phosphorus levels commonly exceed the EPA criterion for preventing nuisance algal blooms (<25 ug/L) by ten-fold, while nitrogen levels are high and seasonally variable. Total nitrogen: Total phosphorus ratios suggest that both nitrogen and phosphorus may be the limiting nutrient for algal growth at any given time.

Oxygen levels are typically maintained in an acceptable range due to the lack of thermal stratification and frequent wind mixing. Water temperatures are variable but considered very warm, sometimes reaching 25 degrees C (77 degrees F). Water of this temperature favors particular types of algae, particularly the blue-green varieties responsible for the most problematic blooms.

Chlorophyll-a and algal counts both indicate very high levels of algae. Most eutrophic lakes show maximum chlorophyll-a values ranging from 20 to 200 ug/L. Vancouver Lake fell into this range during 2006 and 2007, but also has far exceeded this range in some years (2004 average 138 ug/L and maximum 409 ug/L). Levels of algae in the lake are of great concern for water-contact recreation. In recent years, Public Health has issued swimming beach closures due to potentially toxic algal blooms with cell concentrations far in excess of World Health Organization guidelines.

Year one of an ongoing biological assessment by WSU scientists indicated that there is little spatial variability in water quality and plankton abundance, but significant seasonal variability.

Ecology and Clark County Public Health beach monitoring programs indicate that e.coli bacteria concentrations are usually suitable for swimming.

Fish tissue analysis performed by Ecology in recent years has resulted in multiple 303(d) listings for toxins in Vancouver Lake.

### *Lake River*

Limited data exists for Lake River. However, available data suggest very similar impairments to Vancouver Lake. Lake River is a direct receiving water for drainage from several Clark County watersheds, including Salmon Creek, Whipple Creek, and Flume Creek. Tidal influence causes daily reversal of Lake River flows into and out of Vancouver Lake.

### Impacts to Beneficial Uses and Potential Sources

General water quality in Vancouver Lake and Lake River is poor to fair. Listed beneficial uses are directly impacted by several water quality characteristics, including: total phosphorus, nitrogen, temperature, turbidity, and toxics.

Observed levels of these characteristics have negative impacts on the listed beneficial uses of: core summer salmonid habitat; extraordinary primary contact recreation; wildlife habitat; and aesthetic values.

## 2008 Stormwater Needs Assessment Program

---

For an excellent overview of water quality concerns and the extent of their impact on the Vancouver Lake and Lake River system, see Chapter 3 of the Technical Foundation for Future Management of Vancouver lake (VLWP, 2008).

### Implications for Stormwater Management

In the case of Vancouver Lake and Lake River, most stormwater impacts to these waterbodies would actually occur in adjacent tributary subwatersheds covered in separate stormwater needs assessments. These include the Lakeshore, Whipple Creek, Burnt Bridge Creek, and multiple Salmon Creek subwatersheds.

It should be noted that stormwater management activities, though important, are not likely to achieve water quality improvement goals on their own. The CWP is an active participant in local efforts aimed at improving Vancouver Lake and Lake River, including the Vancouver Lake Watershed Partnership and existing TMDL working groups in Burnt Bridge Creek and Salmon Creek.



## 2008 Stormwater Needs Assessment Program

---

### Drainage System Inventory

Clark County's drainage system inventory resides in the StormwaterClk GIS database and is available to users through the county's Department of Assessment and GIS, or viewable on the internet through the Digital Atlas located at:

<http://gis.clark.wa.gov/imf/imf.jsp?site=digitalatlas&CFID=56651&CFTOKEN=98300052>

Drainage system inventory is an ongoing CWP work effort focused on updating the StormwaterClk database to include all existing stormwater drainage infrastructure.

The work effort during 2008 in the Vancouver Lake and Lake River subwatersheds focused on identifying and mapping previously unmapped discharge points and conveyance. Table 5 indicates the number of features previously inventoried in StormwaterClk prior to 2008 SNAP work, and the number of features added to the database as a result of 2008 SNAP and mapping project implementation.

The drainage system inventory for both subwatersheds is generally completed. Inventory is ongoing in 2009 as part of a county-wide inventory update.

<b>Table 5: Drainage System Inventory Results, Vancouver Lake/Lake River</b>		
<b>Database Feature Category</b>	<b>Previously Inventoried</b>	<b>Added to Database during 2008</b>
Inlet	0	0
Discharge Point (outfall)	0	40
Flow Control	0	0
Storage/Treatment	0	0
Manhole	0	0
Filter System	0	0
Channel	0	130
Gravity Main	0	52
Facilities	1	0



## 2008 Stormwater Needs Assessment Program

---

### Stormwater Facility Inspection

The stormwater facility inspection process includes two components:

- A public stormwater facility inspection using state and county standards.
- An off-site inspection to check for problems such as downstream bank erosion.

#### *Component 1: Public Stormwater Facility Inspection*

Based on the county's StormwaterCLK database, as of October 2008, there were no mapped public stormwater facilities in the Vancouver Lake and Lake River subwatersheds.

#### *Component 2: Offsite Assessment*

Based on the County's StormwaterCLK database, as of June 2008, there were no mapped outfalls in either the Vancouver Lake or Lake River subwatersheds that discharged into critical areas.



## 2008 Stormwater Needs Assessment Program

---

### Illicit Discharge Detection and Elimination Screening

Illicit discharge screening was not conducted.



## 2008 Stormwater Needs Assessment Program

---

### Stream Reconnaissance and Feature Inventory

A rapid stream reconnaissance and feature inventory was not conducted.



# 2008 Stormwater Needs Assessment Program

---

## Physical Habitat Assessment

### Purpose

Physical habitat assessments provide direct measurements of stream channel morphology, habitat conditions, and riparian conditions for specific stream reaches. This information can be used for planning projects and interpreting hydrologic, macroinvertebrate, and geomorphologic information at reach and subwatershed scale.

### Methods

Physical habitat measurements were made for the Lake River 2 reach (RM 4.7 through RM 7.0) by R2 Resource Consultants (December 2004) for the Lower Columbia Fish Recovery Board. The project followed modified USFS Level II protocols.

### Results

The full watershed assessment report (Kalama, Washougal, and Lewis River Habitat Assessments, Chapter 5: The Salmon Creek Basin) may be found on the LCFRB web page at: [http://www.lcfrb.gen.wa.us/document\\_library.htm](http://www.lcfrb.gen.wa.us/document_library.htm)

A brief summary is presented here.

The Lake River 2 reach had a gradient <0.5 percent, a Montgomery/Buffington dune-ripple bedform, and was categorized as a floodplain backwater slough.

Table 6 includes a comparison to habitat standards for Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition. Information in the R2 report noted that the bed is almost entirely fines. Embeddedness was not recorded due to the absence of gravel substrate.

<b>Table 6: Lake River 2 Reach Physical Habitat</b>		
<b>Parameter</b>	<b>WCC<sup>1</sup></b>	<b>PFC<sup>2</sup></b>
% Pool by Surface Area	Poor	na
Pool Frequency	na	Not Properly Functioning
Pool Quality	na	Not Properly Functioning
LWD	na	Not Properly Functioning
Substrate	na	Not Properly Functioning
Streambank Stability	Good	Properly Functioning
Barriers	na	Properly Functioning

<sup>1</sup> Available Rating: Good; Fair; Poor

<sup>2</sup> Available Ratings: Properly Functioning; At Risk; Not Properly Functioning



## 2008 Stormwater Needs Assessment Program

---

### Geomorphology Assessment

A geomorphology assessment was not conducted.



# 2008 Stormwater Needs Assessment Program

---

## Riparian Assessment

### Purpose

The riparian assessment characterizes existing conditions based on available data, to identify general riparian needs and potential areas for rehabilitation projects. Riparian enhancement projects, such as installation or protection of native plantings within riparian areas, can provide for increased future shading and woody debris recruitment, which can further provide an opportunity for stormwater-related watershed improvement.

The need for riparian rehabilitation tends to be widespread and exceeds the scope and resources of the CWP mission of stormwater management. Therefore, potential riparian projects are usually referred to agencies such as the LCFRB, Lower Columbia Fish Enhancement Group (LCFEG), Clark Public Utilities, Fish First, the Washington State University (WSU) Watershed Stewards Program, or the Clark Conservation District for possible implementation.

This section focuses on opportunities likely to be considered by the CWP SCIP which are primarily on publicly owned lands within high priority salmon-bearing stream reaches as defined by LCFRB salmon recovery priorities.

### Method

Where possible, the assessment is based on GIS data from existing reports, primarily the Habitat Assessment reports prepared for the Lower Columbia Fish Recovery Board (R2 Resource Consultants, Inc., 2004). The Technical Foundation for Future Management of Vancouver Lake (Vancouver Lake Watershed Partnership's Technical Group, 2008) was also reviewed. Results are based on aerial photo interpretation using Washington Forest Practices Board methods for LWD delivery and channel shade estimates.

In streams where no data exists from the LCFRB characterization, an examination of current orthophotographs is used to make a general assessment of riparian condition and identify areas where restoration or preservation projects may be appropriate.

Many riparian project opportunities are discovered through other SNAP activities, including Rapid Stream Reconnaissance feature inventories and geomorphological assessments. Potential projects discovered through these activities are discussed in the respective sections, and most are included on a final list for referral to outside agencies.

The 2008 Technical Foundation for Future Management of Vancouver Lake, the 2004 LCFRB Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, and the 2004 LCFRB Habitat Assessment report were also reviewed for specific project opportunities within each subwatershed.

### Results

## 2008 Stormwater Needs Assessment Program

---

Results are based primarily on the 2004 LCFRB Habitat Assessment for the Lake River subwatershed. The full characterization report is available on the Clark County website at:

<http://www.clark.wa.gov/water-resources/documents.html#mon>

Vancouver Lake subwatershed was not surveyed under the LCFRB project.

At the subwatershed scale, the LCFRB rated the riparian conditions within the Lake River subwatershed as impaired.

### *Riparian (Large Woody Debris (LWD) Delivery)*

Figure 2 shows the Lake River subwatershed's LWD delivery potential. The main stem of Lake River is shown as having primarily low LWD recruitment along the approximate seven-mile distance surveyed. This is due in part to the riparian vegetation consisting entirely of deciduous species and also that the disconnection of overflow channels and sloughs has prevented potential LWD recruitment to stream channels. (R2 Resource Consulting, Inc., 2004 and LCFRB, 2004). The unsurveyed portion of Lake River is estimated to have LWD recruitment levels of none to low based on orthophotography review.

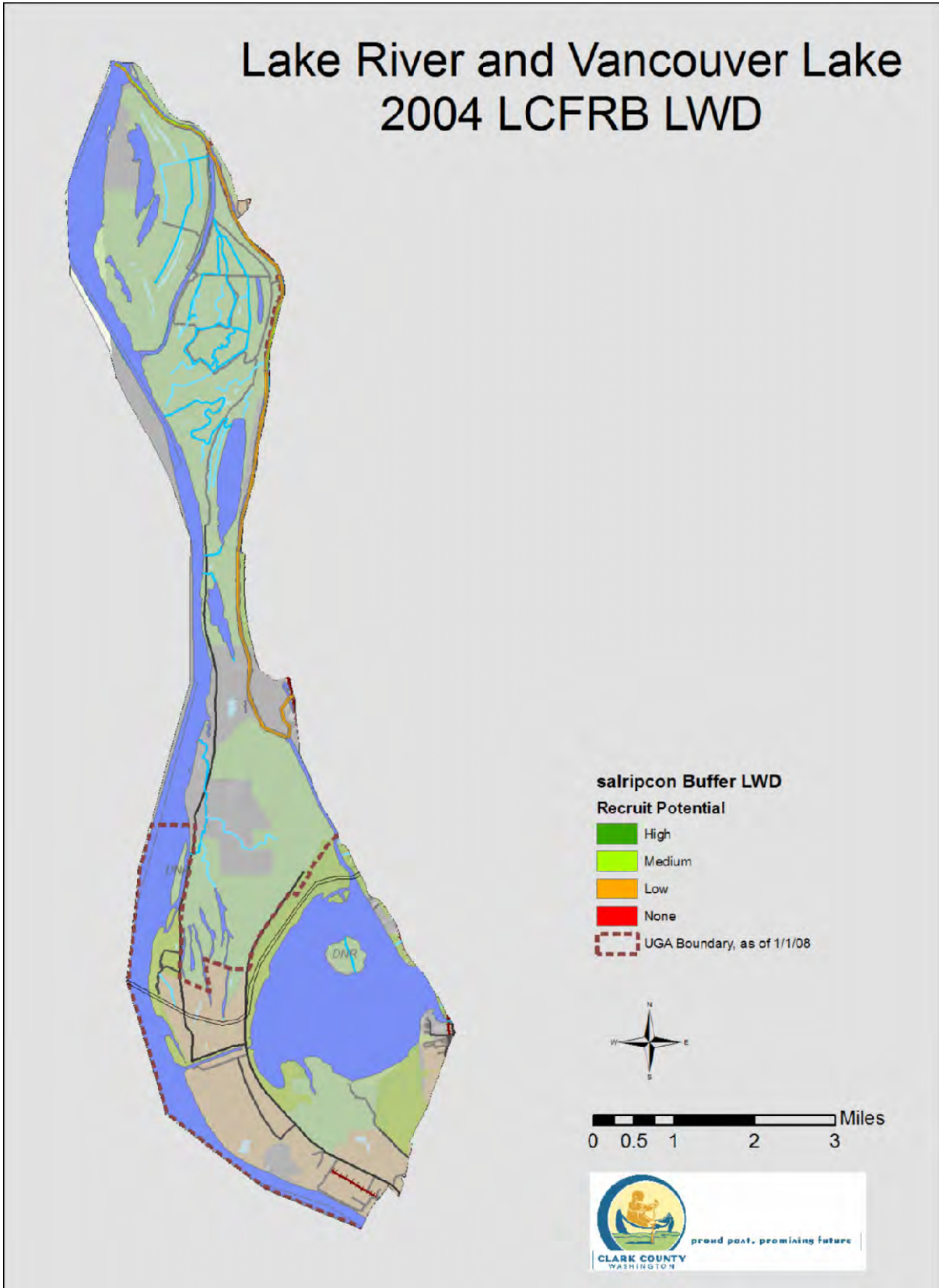


Figure 2: Vancouver Lake and Lake River LWD Recruitment Potential (adapted from R2 Resource Consultants, Inc., 2004)

## 2008 Stormwater Needs Assessment Program

---

### *Shade*

The Lake River subwatershed's shade rating from the 2004 LCFRB Habitat Assessment is illustrated on Figure 3. Lake River subwatershed shade levels range from 0 to 20 percent, based on survey results and orthophotography review.

The LCFRB habitat assessment for Lake River indicated that the majority of Lake River is currently off-target with respect to the State Forest Practices' shade/elevation screen standards.

### Management Recommendations

Overall recommended management activities for the Lake River subwatershed include riparian forest restoration adjacent to Lake River in areas degraded by grazing or areas with limited riparian cover, protection and restoration of hillslope processes, and removal of invasive species.

Within the Vancouver Lake subwatershed, riparian reforestation for increased LWD recruitment and invasive species removal would be beneficial in the areas immediately surrounding Vancouver Lake (Vancouver Lake Watershed Partnership Technical Group, 2008).

### Potential Projects

Although there were several priority project areas within the Vancouver Lake and Lake River subwatersheds listed for restoration within the 2004 R2 Resource Consulting, Inc. report and the 2008 Technical Foundation for Future Management of Vancouver Lake report (VLWP), this assessment did not discover specific potential projects likely to be suitable for consideration by the CWP Stormwater Capital Improvement Program.

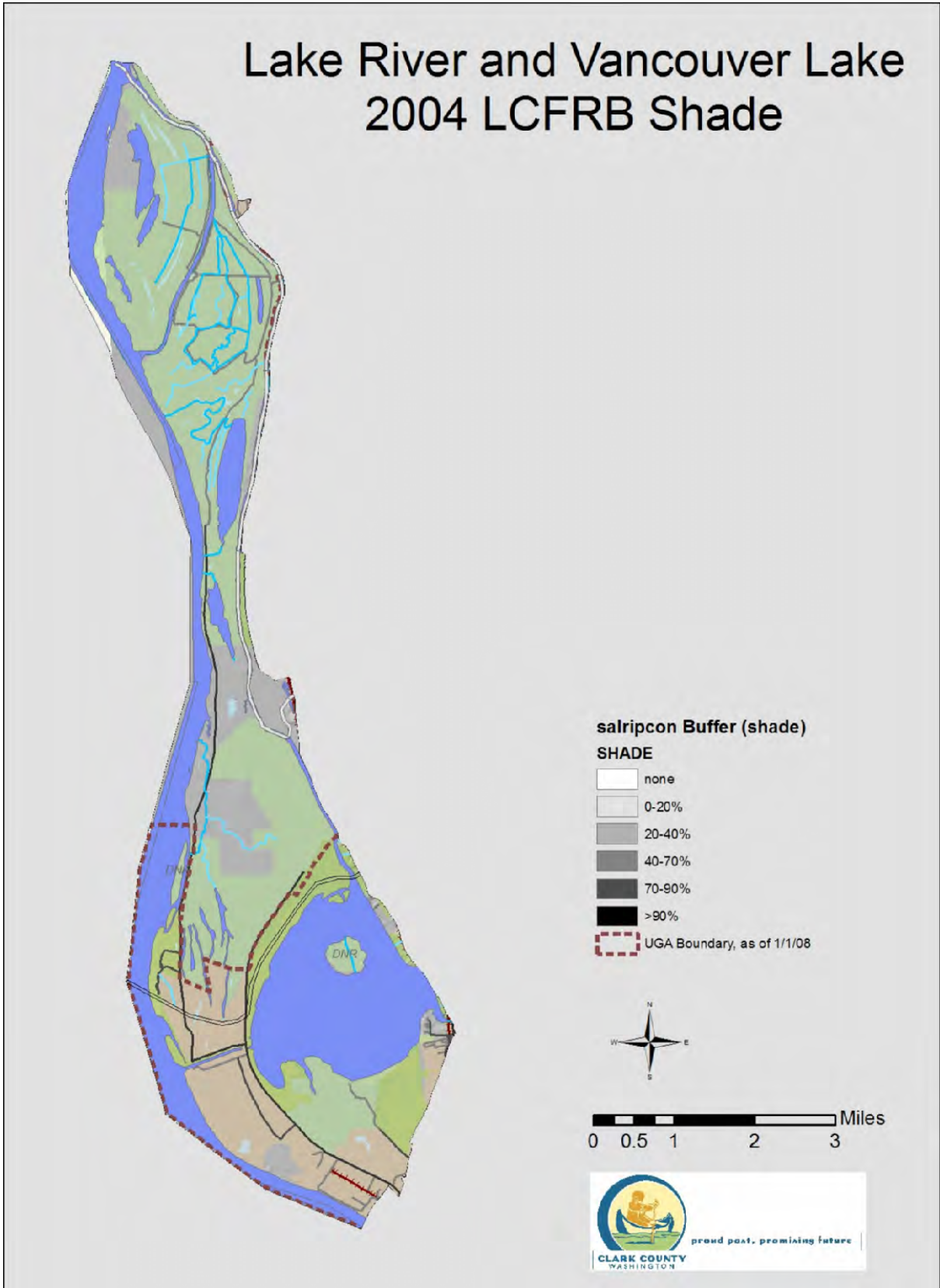


Figure 3: Vancouver Lake and Lake River Shade Values (adapted from R2 Resource Consultants, Inc., 2004)



## 2008 Stormwater Needs Assessment Program

---

### Floodplain Assessment

A floodplain assessment was not conducted.



# 2008 Stormwater Needs Assessment Program

---

## Wetland Assessment

### Purpose

Wetlands perform important hydrologic, water quality, and habitat functions. The primary reasons for the wetland assessments are to:

- Describe wetland conditions related to how they influence hydrology, water quality, and habitat;
- Identify priority potential wetland projects to mitigate for stormwater impacts; and
- Make management recommendations for wetlands related to stormwater management.

A primary objective of the wetland assessment is to identify sites containing modestly sized, degraded, or ditched wetlands where minor construction projects can be used to improve wetland hydrology. Improved wetland function can reduce peak storm discharges, increase groundwater recharge, and improve habitat through increasing biodiversity, species population health and organic input.

### Methods

The assessment includes review of existing GIS data for wetlands. Primary information sources are the county wetlands atlas, Draft Watershed Characterization of Clark County Version 3 (Ecology, 2007), and personal communication with other county programs.

Stream Reconnaissance and Geomorphology/Hydrology assessments may also discover potential wetland-related project opportunities. Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results section.

Tax-exempt parcels often indicate the presence of publicly owned land, schools, or churches where large parcel sizes and opportunities for leveraging may exist. Potential wetlands were overlaid with tax-exempt parcels and with county vacant buildable lands model (VBLM) information to identify possible wetland enhancement opportunities.

### Results

Figure 4 shows potential wetland areas within the Vancouver Lake and Lake River subwatersheds based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory, and high-quality wetlands layer.

The Lake River subwatershed has large expanses of wetland associated with the Lake River riparian corridor, and the flood plain area and associated sloughs located between Lake River and the Columbia River.

## 2008 Stormwater Needs Assessment Program

---

In the Vancouver Lake subwatershed, wetlands are primarily associated with Vancouver Lake and the Columbia River floodplain. Many of these wetlands are degraded by past agricultural activity.

Washington Department of Fish and Wildlife, Ducks Unlimited, Clark County, and others have coordinated on the restoration of wetland and marsh habitat in these subwatersheds. However, opportunities for wetland-related *stormwater management* projects are limited. Although there were many areas of potential wetlands within the subwatersheds reviewed, the review of the wetland inventories and studies did not identify any potential projects related to stormwater management within publicly held or tax-exempt lands.



Figure 4: Vancouver Lake and Lake River Potential Wetlands

## 2008 Stormwater Needs Assessment Program

---

### *Draft Watershed Characterization*

The Washington Department of Ecology completed a prototype watershed assessment to assist in planning wetland and riparian habitat restoration and preservation projects. The Draft Watershed Characterization (Washington Department of Ecology, 2007) may be found on the Clark County website at: <http://www.clark.wa.gov/mitigation/watershed.html>

Results pertaining to the Vancouver Lake and Lake River subwatersheds are summarized below.

The Vancouver Lake and Lake River subwatersheds are part of the Columbia River hydrogeologic unit. This unit is influenced by the Columbia River. Sub-surface water flow patterns influenced by groundwater discharge from the adjacent upland units and recharge from the rivers. Geologic deposits consist primarily of relatively recent river alluvium (sand and silt) (Ecology, 2007).

Figure 5 depicts priority areas for protection and restoration of hydrologic processes county-wide based on an analysis of the relative importance and level of alteration in each subwatershed.

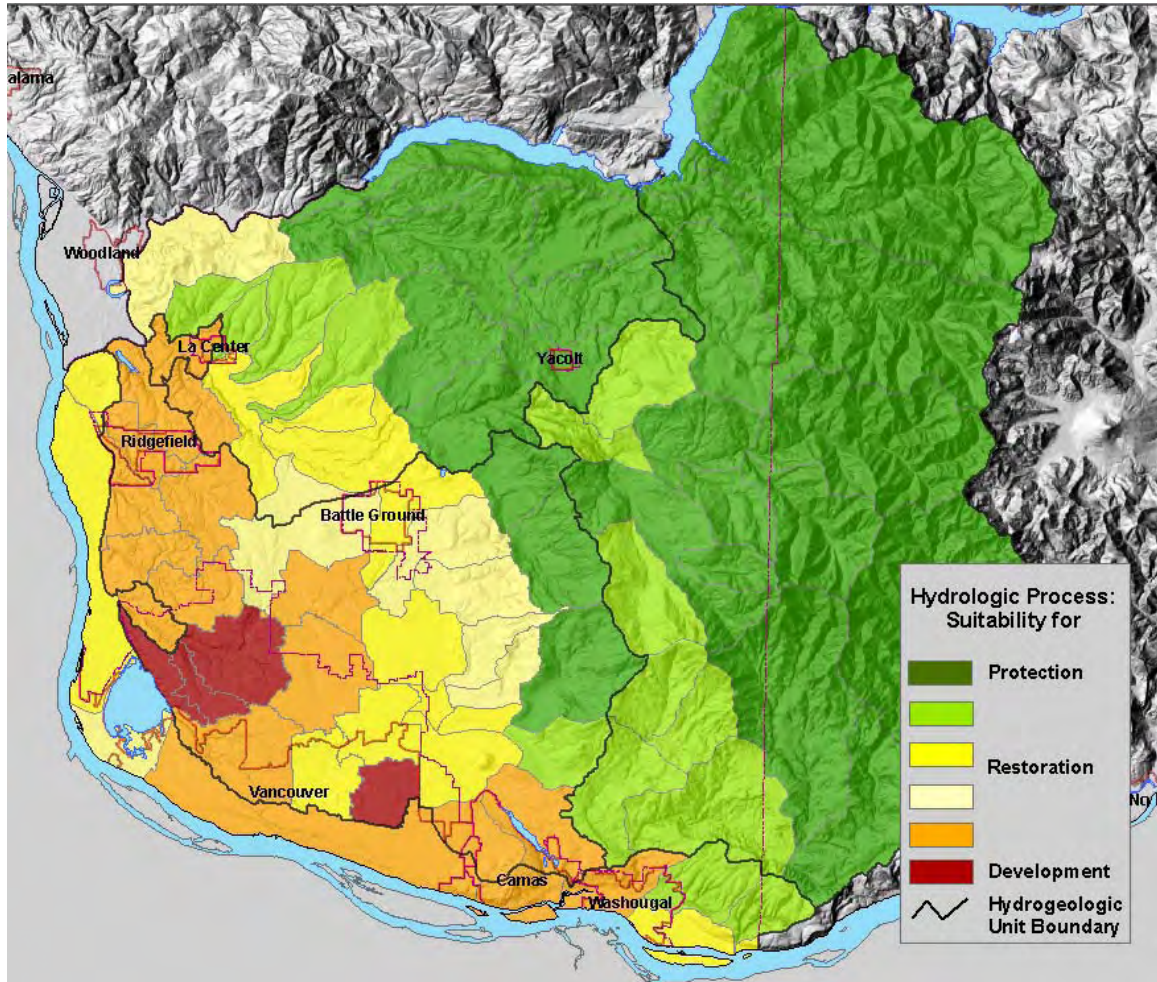


Figure 5: Priorities for suitability of areas for protection and restoration for the hydrologic process (from Draft Watershed Characterization of Clark County (Ecology, 2007)).

In general, green areas have higher levels of importance for watershed hydrologic processes and limited alteration and should be considered for protection. Yellow areas have a higher level of importance for watershed processes and a higher level of alteration and should be considered for restoration unless watershed processes are permanently altered by urban development. Orange to red areas have lower levels of importance for watershed processes and higher levels of alteration and should be considered as more suitable for development (Ecology, 2007).

Restoration (“dark yellow”) is the focus for the Vancouver Lake and Lake River subwatersheds. According to the Draft Watershed Characterization, restoration in “dark yellow” areas will have the most significant benefit, relative to other rated subbasins, in restoring watershed hydrologic processes and assisting in maintaining down-gradient aquatic resources. Restoration measures could include increasing floodplain connectivity through removal of ditches, dikes and berms (Ecology, 2007).

## 2008 Stormwater Needs Assessment Program

---

### Potential Projects

This assessment did not discover specific potential stormwater mitigation projects to improve wetland hydrology within the Vancouver Lake and Lake River subwatersheds.

## 2008 Stormwater Needs Assessment Program

---

### Macroinvertebrate Assessment

No benthic macroinvertebrate survey information is available for the Vancouver Lake or Lake River subwatersheds.

Standard metrics such as the Benthic Macroinvertebrate Index of Biological Integrity (B-IBI) would not apply in this area due to the absence of typical pool-riffle channel types.



# 2008 Stormwater Needs Assessment Program

---

## Fish Use and Distribution

### Purpose

Fish distribution refers to salmon and steelhead use. This information helps to identify stream segments where land-use changes may impact fish populations, informs management decisions, and aids in identifying and prioritizing potential habitat improvement and protection projects.

### Methods

Fish distribution for the Vancouver Lake and Lake River subwatersheds is mapped from existing Clark County GIS information, which reflects data collected and analyzed by the Northwest Indian Fisheries Commission (NWIFC). Fish distribution data for Clark County is available on the County's website. The US Army Corps of Engineers also prepared a review of available research on salmonid use in Vancouver Lake during 2007 (USACE, 2007).

Several sources of barrier assessment data are available and are briefly summarized here, including:

- WDFW passage barrier database
- SalmonScape (<http://wdfw.wa.gov/mapping/salmonscape/>)
- Clark County 1997 passage barrier data
- Clark Conservation District/LCFRB passage barrier dataset

Many stream crossings have not been assessed for passage barrier potential, and the extent of public and private road crossings is a good indicator of the potential for additional barriers. Road crossings were mapped by overlaying the county road layer with LiDAR-derived stream data.

The barrier assessment data was also reviewed for specific project opportunities within each subwatershed. Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results section.

### Results/Summary

#### *Distribution*

The fish distribution map from Clark County GIS information (Figure 6) varied slightly from fish distribution data originating from the SalmonScape database. These differences are identified within the Lake River subwatershed discussion below. For the purposes of this report, when the fish distribution mapping figures differ from SalmonScape fish distribution data, it is assumed that the SalmonScape distribution is a more accurate representation of the fish populations within the listed watersheds.

The available evidence suggests that anadromous fish use within the Lake River subwatershed includes Coho salmon and winter steelhead (Figures 6 and 7). SalmonScape also identified the known presence of fall Chinook, and the presumed presence of fall chum and summer steelhead within Lake River.

## 2008 Stormwater Needs Assessment Program

---

The Vancouver Lake subwatershed has a known presence of Coho salmon and presumed presence of winter steelhead.

Research, particularly recent research, regarding salmonid use of Vancouver Lake and Lake River is very limited. USACE (2007) reviewed research by US Fish and Wildlife in 1977, Envirosphere, Inc. in 1983 and 1984, and Fishman Environmental Services Inc. in 2002. The most recent net and trap counts were conducted by Envirosphere in 1983 and 1984 and indicated the presence of juvenile Chinook, Coho, and Steelhead.

The most recent research by Fishman focused on the function of the flushing channel as it relates to fish passage and habitat. Fishman concluded that flushing channel habitat is suitable for salmonids at least seasonally (see barriers section). Available evidence was insufficient to characterize relationships between salmonids and predator species in the channel, and to assess stranding or impacts from the tide gates. The report also concluded that the current extent of salmonid use in the lake and channel is unknown.

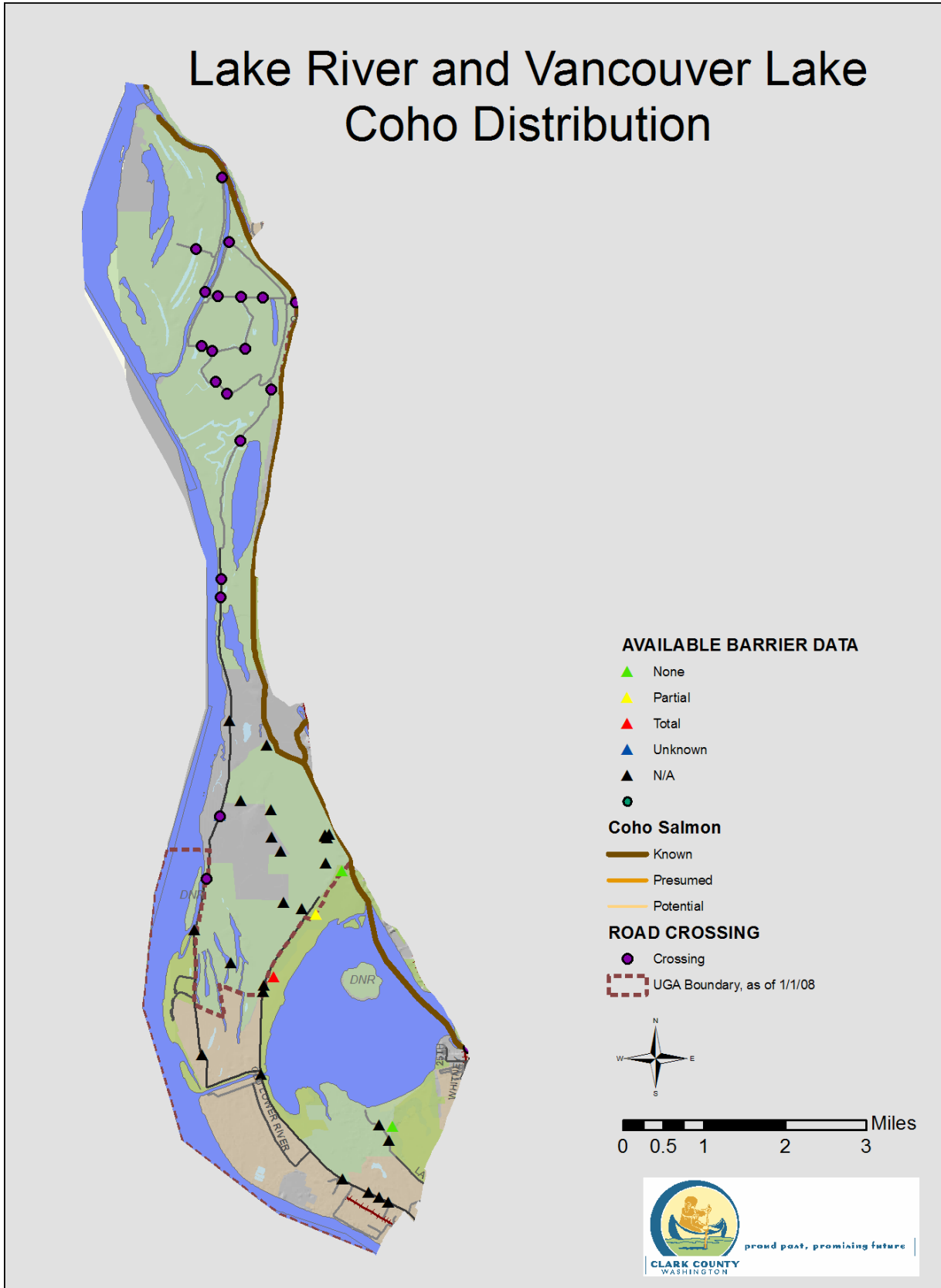


Figure 6: Vancouver Lake and Lake River Fish Distribution and Barriers

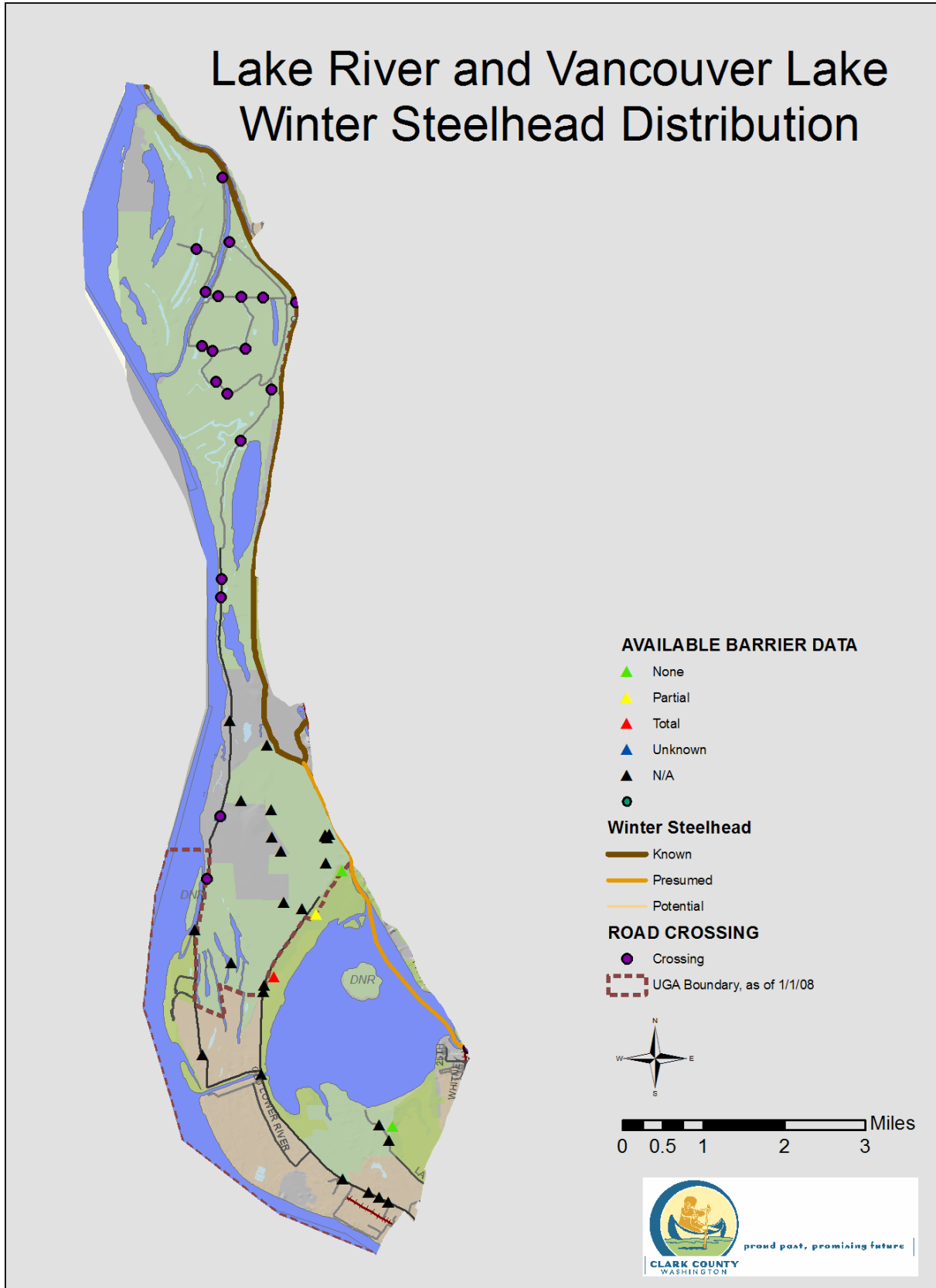


Figure 7: Vancouver Lake and Lake River Fish Distribution and Barriers

## 2008 Stormwater Needs Assessment Program

---

### Barriers

The WDFW barrier database provides the most complete barrier assessment (Figures 6 and 7).

There are no mapped barriers within the main stem of Lake River within the Lake River subwatershed, although there are full and partial barriers on Buckmire Slough (located directly north of Vancouver Lake and connected to lowermost Lake River) (Figures 6 and 7).

Vancouver Lake and the associated flushing channel to the Columbia River at the southwest end of the lake are not mapped as having any full or partial barriers. The flushing channel is a 4,400 foot long channel that allows water from the Columbia River to flow into Vancouver Lake. It has a system of culverts and tide gates at the lake end to prevent flow out of the lake. The flushing channel analysis completed by Fishman (2002) documented habitat conditions and juvenile salmonid use within the channel. Fishman concluded that: “current habitat conditions do not preclude the use of the flushing channel by ESA-listed salmonids. Suitability of habitat is likely seasonal, depending on water quality conditions and Columbia River levels”.

### Recommendations

Vancouver Lake and Lake River do not contain mapped barriers which could be improved or removed for improved fish passage. Other barriers discovered in the area should be evaluated on a case by case basis as part of management plans for refuge areas and Vancouver Lake.



## 2008 Stormwater Needs Assessment Program

---

### Hydrologic and Hydraulic Models

No new modeling was performed for this assessment.

In 2008, the US Army Corps of Engineers performed basic hydraulic modeling for the Vancouver Lake Watershed Partnership. The central question was whether modifications to the Vancouver Lake flushing channel could increase flow and circulation to benefit habitat within Vancouver Lake.

Of the scenarios considered, enlarging the flushing channel culverts resulted in the greatest decrease in hydraulic retention time. However, flow velocities in the lake remained slow in all the modeled scenarios, with tidal impacts still dominating lake dynamics. Further information from the USACE briefing on model results can be viewed on the VLWP website at:

[http://www.cityofvancouver.us/PublicWorks/vancouverlake/MapsMaterials/vlwp\\_mapsandmaterials.htm](http://www.cityofvancouver.us/PublicWorks/vancouverlake/MapsMaterials/vlwp_mapsandmaterials.htm)



# 2008 Stormwater Needs Assessment Program

---

## Analysis of Potential Projects

This section provides a brief summary of stormwater problems and opportunities, notes recently completed or current projects within the study area that may be relevant to SNAP project selection, describes the analytical approach, and lists recommended projects and activities for further evaluation. Projects or activities are placed in one of six categories.

## Summary of Conditions, Problems, and Opportunities

### Conditions and Problems

This section briefly summarizes important results from the assessment and identifies overall stormwater-related problems.

### *Coordination with Other Programs*

Vancouver Lake and Lake River lie within an area of primarily open space, parks, and wildlife lands, where stormwater-related implementation and infrastructure is minimal. The Vancouver Lake Watershed Partnership has taken an active role in coordinating local interest and supporting the development of long-term management and improvement plans for Vancouver Lake. Both of these subwatersheds should also benefit from ongoing TMDL implementation by Ecology in upstream watersheds, particularly Salmon Creek and Burnt Bridge Creek. Clark County CWP actively participates in the VLWP and TMDL implementation.

### *Broad-Scale Characterization*

Vancouver Lake and Lake River have a large, multi-jurisdictional drainage area stretching from the City of Battle Ground, through central Clark County and the City of Vancouver. Soils in the immediate area tend to be sandy and well-drained, though saturated by shallow groundwater in many areas. Much of the subwatershed is classified as Hydrologic Soil Group D, which is often associated with wetland conditions.

Hydrologic conditions are heavily influenced by the Columbia River and ocean tides, along with tributary flows from Salmon Creek, Burnt Bridge Creek, Whipple Creek, and Flume Creek.

Standard metrics for forest cover and total impervious area, based on NOAA fisheries standards, while not completely applicable to large flood-plain systems, indicate significant human alteration and suggest habitat is somewhat degraded.

Estimate effective impervious area of 20 percent in the Vancouver Lake subwatershed, based on the 2008 Comprehensive Plan, suggests that a significant amount of new stormwater infrastructure may be needed to control impacts from future growth within the City of Vancouver UGA, though much of this runoff may be piped directly to the Columbia River.

# 2008 Stormwater Needs Assessment Program

---

## *Water Quality Assessment*

There are multiple 303(d) listings in the study area, including Category 5 listings (water) for fecal coliform and temperature, and Category 5 listings (fish tissue) for PCBs, 4,4'-DDE, Toxaphene, 2,3,7,8-TCDD, and Dieldrin.

TMDLs for fecal coliform, turbidity, and temperature are in place or being developed for the Salmon Creek and Burnt Bridge Creek watersheds which are tributaries to the study area.

Intermittent datasets exist for Vancouver Lake and Lake River since the 1960s. Despite significant restoration efforts in the late 1970s and early 1980s, Vancouver Lake remains impaired with consistently poor water quality. Ongoing issues of concern include intense algal blooms that routinely cause closure of the lake to water-contact recreation, extremely high levels of phosphorus and nitrogen, elevated water temperatures, and very high turbidity (low water clarity).

## *Drainage System Inventory*

Drainage mapping is generally complete. If necessary, additional inventory will be completed during 2009. County stormwater infrastructure is very limited, with no publicly owned stormwater facilities and a single private facility. There are approximately 40 stormwater outfalls in the study area, primarily from roadside ditches and field drains.

## *Public Stormwater Facility Inspection*

As of October 2008, there are no public stormwater facilities in the study area.

## *Illicit Discharge Screening*

Illicit discharge screening was not conducted in the Vancouver Lake or Lake River subwatersheds.

## *Stream Reconnaissance Feature Inventory*

Stream reconnaissance was not conducted in the Vancouver Lake or Lake River subwatersheds.

## *Physical Habitat*

Physical habitat data is limited. A section of Lake River (site Lake River 2, RM 4.7 through 7.0) was assessed in 2004 as part of a countywide assessment sponsored by the Lower Columbia Fish Recovery Board. Although the assessment reach had good streambank stability and no passage barriers, measures of pool frequency, large woody debris, and substrate indicated habitat conditions that are not properly functioning.

## *Geomorphology and Hydrology*

Geomorphology and hydrology assessments were not conducted.

## 2008 Stormwater Needs Assessment Program

---

### *Riparian Assessment*

In the 2004 LCFRB Habitat Assessment, LWD delivery potential was estimated as low in much of the Lake River subwatershed, with impaired riparian conditions throughout. Shade levels were off-target with respect to state standards, ranging from zero to 20 percent.

Vancouver Lake subwatershed was not included in the 2004 LCFRB study.

### *Wetland Assessment*

Both subwatersheds have large expanses of wetland and potential wetland within riparian areas and Columbia River floodplains.

Ecology's draft wetland characterization of Clark County places the study area in a category suitable for restoration due to a higher relative level of importance for watershed processes and a higher level of current alteration from historical conditions.

Washington Department of Fish and Wildlife, Ducks Unlimited, Clark County, and others have coordinated on the restoration of wetland and marsh habitat in these subwatersheds. However, opportunities for wetland-related stormwater management projects are limited.

### *Macroinvertebrate Assessment*

No benthic macroinvertebrate survey information is available for the Vancouver Lake or Lake River subwatersheds.

### *Fish Use and Distribution*

The available evidence suggests that anadromous fish use includes Fall Chinook, Coho salmon and winter steelhead. The LCFRB identified Lake River as Tier 4 in its 2004 Salmon and Steelhead Recovery Plan. It is a Group D subwatershed because it includes only Tier 4 reaches. Recovery priority is low.

Available research on fish use in these subwatersheds is very limited and the extent of anadromous fish use is unknown. Fish populations in Vancouver Lake and Lake River are dominated by warm-water species.

There are no known fish passage barriers.

### *Hydrologic and Hydraulic Modeling:*

Limited hydraulic modeling performed by USACE in 2008 indicated that enlarging the culverts on the Vancouver Lake flushing channel could increase flows and decrease hydraulic retention time in the lake. However, overall flow velocities remained slow and tidal influences continued to dominate lake dynamics in all modeled scenarios.

### Recently Completed or Current Projects

# 2008 Stormwater Needs Assessment Program

---

There are no stormwater projects in the Vancouver Lake or Lake River subwatersheds under the 2009-2014 Stormwater Capital Improvement Program.

## Analysis Approach

### Purpose

The Analysis of Potential Projects narrows the initial list of possible projects to a manageable subset of higher priority opportunities. Listed opportunities in sections of the SNAP report include sites requiring immediate follow-up, possible stormwater capital improvement projects, referrals to ongoing programs, and potential projects for referral to other county departments or outside agencies.

Stormwater capital improvement project opportunities are recommended for further evaluation by engineering staff, and potential development into projects for consideration through the SCIP process. Referrals to ongoing programs such as IDDE screening, operations and maintenance, and source control outreach receive follow-up within the context and schedules of the individual program areas. Referrals to other county departments, such as Public Health, or to outside agencies such as Clark Conservation District and Clark Public Utilities, may lead to additional activities outside the CWP scope.

### Methods

An initial review is conducted for all potential projects identified during the stormwater needs assessment. Field notes, descriptions, field photos, and other associated information are reviewed. In some cases, additional field reconnaissance is performed.

In general, potential capital projects are evaluated by CWP staff on the basis of problem severity, estimated cost and benefits, land availability, access, proximity and potential for grouping with other projects, and potential for leveraging resources. Staff considers supporting data and information from throughout the SNAP report to assist in the initial project review.

Based on this review, lower priority opportunities are removed and higher priority projects are recommended for further consideration by the CWP.

## 2008 Stormwater Needs Assessment Program

---

### Emergency or Immediate Actions

There were no emergency or immediate actions identified in the study area.



## 2008 Stormwater Needs Assessment Program

---

### Potential Stormwater Capital Projects

No specific stormwater capital projects were identified in this assessment.



## 2008 Stormwater Needs Assessment Program

---

### Public Works and Clean Water Program Referrals

No specific project referrals were identified in this assessment.



## 2008 Stormwater Needs Assessment Program

---

Projects for Referral to other County Departments, Agencies, or Groups  
No specific project referrals were identified in this assessment.

The 2004 habitat report for Lake River (R2 Resource Consultants) and 2008 Technical Foundation for Future Management of Vancouver Lake include priority project areas that local jurisdictions should consider in these subwatersheds. These include riparian forest restoration adjacent to Lake River, particularly on the western shore, protection of hillslope processes, and invasive species removal in both the Vancouver Lake and Lake River subwatersheds.



### Non-Project Management Recommendations

Non-project stormwater management recommendations address areas where county programs or activities could be modified to better address NPDES permit components or promote more effective mitigation of stormwater problems. Information of this type contributes to adaptive management strategies and more effective stormwater management during the permit term.

Management and programmatic recommendations in the Vancouver Lake and Lake River subwatersheds, by permit component, include:

#### Coordination of Stormwater Activities

- The Vancouver Lake Watershed Partnership provides coordination of restoration and protection activities in Vancouver Lake and Lake River. Support for and coordination with this effort should be continued and enhanced whenever feasible.
- Collaboration between Clark County, City of Vancouver, and Vancouver-Clark County Parks and Recreation should be pursued for stormwater activities in parklands, and at connection points between County and City stormwater systems tributary to Vancouver Lake and Lake River.

#### TMDL Compliance

- There are no specific actions noted to increase TMDL compliance. Continued involvement and implementation of coordinated improvement activities under Ecology's ongoing TMDL adaptive management process is included in the county stormwater management program plan.



# 2008 Stormwater Needs Assessment Program

---

## References

- Booth, D.B. and C.R. Jackson. (1997). Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detention, and the Limits of Mitigation: Journal of the American Water Resources Association, vol. 33, no. 5, p. 1077-1090.
- Booth, D.B., Hartley, D., and Jackson, R. (June 2002). Forest Cover, Impervious-Surface Area, and the Mitigation of Stormwater Impacts: Journal of the American Water Resources Association vol. 38, no. 3. p. 835-845.
- Booth, D. B., et al. (October 2004). Reviving Urban Streams: Land Use, Hydrology, Biology, and Human Behavior: Journal of the American Water Resources Association, pp. 1351-1364.
- Center for Watershed Protection (March 2003). Impacts of Impervious Cover on Aquatic Systems: Watershed Protection Monograph No. 1.
- City of Vancouver – Surface Water Management (May 2007). Burnt Bridge Creek Watershed Program. Vancouver, WA
- Clark County Public Works Water Resources (June 2003). Standard Procedures for Monitoring Activities, pp. 46-48.
- Clark County Public Works Water Resources (December 2003). Long-Term Index Site Monitoring Project: 2002 Physical Habitat Characterization, pp. 35.
- Clark County Public Works Water Resources (2004). Clark County Stream Health, A comprehensive overview of the condition of Clark County's streams, rivers, and lakes, pp 46.
- Clark County (2004). Regional wetland inventory and strategy: 51 pages.
- Cornelius, L. (July 2006). Gee Creek Watershed Restoration Background Report: WSU Clark County Extension.
- Cornelius, L. and J. Finley (January, 2008). Gee Creek Watershed Restoration Project 2007 Annual Report: WSU Clark County Extension.
- Cramer, S.P. & Associates, Inc. (January 2005). Chapter 4: East Fork Lewis River Basin – Habitat Assessment, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.
- Cude, C. (2001). Oregon Water Quality Index: A Tool for Evaluating Water Quality Management Effectiveness. Journal of the American Water Resources Association. Vol. 37, No.1.

# 2008 Stormwater Needs Assessment Program

---

Everts, Russel C. (2004). Geologic map of the Ridgefield 7.5' quadrangle, Washington: U.S. Geological Survey Scientific Investigations Map 2834, scale 1:24,000. (<http://pubs.usgs.gov/sim/2004/2844>).

Fore, L.S., City of Bellevue (March 1999). Measuring the Effects of Urbanization on Bellevue Streams, pp. 24.

Hill, K., and M.C. Bidwell (January 2003). A Rapid Land Cover Classification for Clark County: Washington: Department of Landscape Architecture and Urban

Ecology Lab, College of Architecture and planning, University of Washington, Seattle, Washington.

Hutton, R., and C. Hoxeng (April 2007). Clark County Long-term Index Site and Salmon Creek Monitoring Projects' Status and Trends Based on Oregon Water Quality Indices and Turbidity: Clark County Water Resources Program, Vancouver, Washington.

Karr, J.R. (1998). Rivers as Sentinels: Using the Biology of Rivers to Guide Landscape Management, River Ecology and Management: Lessons from the Pacific Coastal Ecosystems. Springer, NY, pp. 502-528.

Law, A.W. (1994). The effects of watershed urbanization on stream ecosystem integrity. Masters Thesis. University of Washington, Seattle Washington.

Lower Columbia Fish Recovery Board. (Dec. 2004). Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Volume II, Subbasin Plan Chapter G, North Fork and East Fork Lewis.

Lower Columbia Fish Recovery Board. (Dec. 2004). Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Volume II, Subbasin Plan Chapter H, Lower Columbia Tributaries Bonneville and Salmon.

Lower Columbia Fish Recovery Board. (Dec. 2004). Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Volume II, Subbasin Plan Chapter I, Washougal.

Lower Columbia Fish Recovery Board. (2007). Regional Culvert Inventory, Project #02-1658N, Final Report.

Lower Columbia Fish Recovery Board. (2008). East Fork Lewis River Community Habitat Restoration Plan and Project Design – Draft Technical Memorandum 1 and 2.

## 2008 Stormwater Needs Assessment Program

---

Montgomery, David R. and John M Buffington (1997). Channel-reach morphology in mountain drainage basins: GSA Bulletin; May 1997; v. 109; no. 5; p. 596–611.

National Marines Fisheries Service (August 1996). Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale: Environmental and Technical Services Division, Habitat Conservation Branch.

National Marines Fisheries Service (March 2003). ESA Guidance for Analyzing Stormwater Effects: NOAA Fisheries Service, Northwest Region.

Parametrix, Inc. (2002). Burnt Bridge Creek Riparian Habitat Assessment. Prepared for the City of Vancouver, 37 pp.

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 1: Introduction and Methods, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 3: The North Fork Lewis River Basin, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 5: The Salmon Creek Basin, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources

R2 Resource Consultants, Inc. (December 2004). Kalama, Washougal, Salmon, and Lewis River Habitat Assessments Chapter 6: The Washougal River Basin, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

Schnabel, J. (December 2003). Long-Term Index Site Monitoring Project: 2002 Physical Habitat Data Summary: Clark County Public Works Department, Water Resources Program, Vancouver, Washington.

Schnabel, J. (September 2004). Salmon Creek Watershed: Summer 2003 Stream Temperature. Clark County Public Works Department, Water Resources Program, Vancouver, Washington.

Schueler, T. (1999). Microbes and Urban Watersheds: Ways to Kill ‘em. Watershed Protection Techniques. 3(1): 566-574.

## 2008 Stormwater Needs Assessment Program

---

S.P. Cramer & Associates, Inc. (January 2005). Chapter 4: East Fork Lewis River Basin – Habitat Assessment, report prepared for the Lower Columbia Fish Recovery Board under contract to Clark County Water Resources.

State of Oregon Department of Environmental Quality (July 2004). Draft Lower Willamette Subbasin TMDL.

Swanson, R.D. (July 2006). Prioritizing Areas for Stormwater Basin Planning: Clark County Public Works, Water Resources Program.

Vancouver Lake Watershed Partnership Technical Group. Technical Foundation for Future Management of Vancouver Lake (November 2008).

Turney, G.L. (1990). Quality of Groundwater in Clark County, Washington: US Geological Survey Water Resource Investigation Report 90-4149, 97 p.

United States Environmental Protection Agency (1986). Quality Criteria for Water 1986: EPA 440/5-86-011, Office of Water Regulations and standards, Washington, DC.

US Army Corps of Engineers (November 2007). Review of Biological Research on Juvenile and Adult Salmonid use of Vancouver Lake. Portland District.

U.S.G.S. (2002). Hydrologic Trends Associated with Urban Development for Selected Streams in the Puget Sound Basin: Western Washington (Water-Resources Investigations Report 02-4040), Tacoma, WA, pp. 40.

Washington Department of Ecology (November 2006). Water Quality Standards for Surface Waters of the State of Washington: Chapter 173-201A WAC. Publication # 06-10-091.

Washington Department of Ecology (April 2005). O'Brien, Ed. 2005 Stormwater Management Manual for Western Washington: Volume I -- Minimum Technical Requirements and Site Planning, Report 05-10-029, Olympia, WA.

Washington State Department of Ecology. Stormwater Management Manual for Western Washington (February 2005). Publication Numbers 05-10-029 through 05-10-033.

Washington Department of Ecology (April 2007). Draft Watershed Characterization of Clark County, Version 3: Shorelines and Environmental Assistance Program.

Washington Forest Practices Board Manual (March 2000).

Washington State University Vancouver (2009). Bollens, Stephen and Gretchen

## 2008 Stormwater Needs Assessment Program

---

Rollwagen-Bollens. Year One Annual Report: Biological Assessment of the Plankton in Vancouver Lake, WA.

Wierenga, R., Clark County Water Resources, (January 2005). Technical Report: Subwatershed Characterization and Classification: Clark County Washington, pp. 17.

Wierenga, R. (2005.) Benthic Macroinvertebrate and Water Temperature Monitoring for Clark County Watershed Assessments in 2004. Clark County Public Works Department – Water Resources Program. Washington Department of Ecology Grant number G0300020 and Clark County Clean Water Program.