2009 Stormwater Needs Assessment

Woodin Creek
Salmon Creek (r.m. 08.96)

Clark County Clean Water Program

Protecting water through stormwater management

2009 Stormwater Needs Assessment Program

Woodin Creek/Salmon Creek (RM 08.96)
Subwatershed Needs Assessment Report

Clark County Public Works Clean Water Program

March 2010

Table of Contents

PAGE

Figures

Tables

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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
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
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

Executive Summary

Study Area

This Stormwater Needs Assessment report includes the Woodin Creek and Salmon Creek (RM 08.96) subwatersheds in the Salmon Creek watershed.

Intent

Stormwater Needs Assessment reports compile and provide 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. Assessments are conducted at a subwatershed scale, providing a greater level of detail related to stormwater management than regional Water Resource Inventory Area (WRIA) or Endangered Species Act (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 two study area subwatersheds including water quality, biological health, habitat, hydrology, and the stormwater system.

Ongoing Projects and Involvement

The Salmon Creek Watershed Council, Clark Public Utilities, and Ecology are actively involved in improving and protecting Salmon Creek and Woodin Creek through local grass-roots organizing, riparian enhancement work, and ongoing TMDL adaptive management.

Clark County Clean Water Program (CWP) participates in the TMDL process through implementation of the Stormwater Management Program, provides water quality monitoring, and supports various local organizations working within this assessment area.

As of December 2009, this assessment area has no stormwater projects listed in the CWP Capital Planning database, and one Public Works transportation project in the 2010- 2015 Transportation Improvement Program (Chelatchie Prairie Rail Trail).

Category	Status
Water Quality	
Overall	• Poor (Woodin); Poor to Fair (Salmon Creek (RM 08.96)
Fecal coliform bacteria	• TMDL implementation ongoing; concentrations have declined from 1995 levels, targets not met
Turbidity	• TMDL implementation ongoing; targets met
Temperature	• TMDL in development; both subwatersheds exceed standards; Woodin warmest tributary measured
Ammonia, dissolved oxygen	• Historical problems addressed through TMDL (Woodin)
Biological	
Benthic macroinvertebrates	• Low to moderate biological integrity; can likely be improved through habitat rehabilitation
Anadromous fish	• Coho and winter steelhead use; presumed fall Chinook in limited reaches. Moderate regional recovery priority
Habitat	
NOAA Fisheries criteria	• Forest cover, percent total and effective impervious areas, and road density fall into the Non-Functioning category • Stream crossing density in the Properly Functioning category
Riparian	• Overall conditions impaired; shade below state targets at 10-30% • Large woody debris recruitment potential primarily fair; lower along Salmon Creek mainstem
Wetland	• Limited to riparian areas, isolated slope and depressional areas especially near Battle Ground
Hydrology and Geomorphology	
Overall hydrology	• No hydrologic data is available but likely typical for a partly forested rural watershed
Future condition	• Projected impervious area suggests Woodin Non-Functioning and SC 08.96 on the margin of Non-Functioning • Channels expected to be unstable
Stormwater (unincorporated areas)	
System description	• Primarily piped system and road-side ditches
Inventory status	• Complete; 4700 stormwater infrastructure features mapped
System adequacy	• Adequate treatment is probably provided by vegetation in ditches
System condition	• 15 facilities inspected; 40 of 63 (65%) of facility objects in compliance with maintenance standard
Off-site assessment	• 13 high priority outfalls assessed; all in compliance
Retrofit opportunity	• 7 public stormwater facilities referred for potential retrofits
Source control	• Of 17 businesses visited, 8 had source control problems; all resolved successfully • Needs regular inspection; small number of businesses, but of types that rate highly for potential stormwater contamination

Opportunities

Projects listed in the SNAP report represent only a small part of those needed to protect and restore streams within the assessment area. Field work and review of existing information identified numerous potential projects and actions that can improve stream conditions, including the following:

- Focused stormwater outreach and education to streamside landowners based on assessment results
- Potential retrofits (7 identified) or new facility construction (1 identified) to provide enhanced flow control and/or treatment
- Evaluation of 4 potential opportunities for habitat rehabilitation and/or property acquisition for habitat preservation
- Maintenance and enhancement of one public stormwater facility overtaken by invasive plants
- Inspection and technical assistance to bring two private stormwater facilities into maintenance compliance
- Cleanup of 4 sites with trash accumulation or dumping
- Livestock exclusion fencing at three properties with direct livestock access to streams
- Investigation of 2 potential illicit discharges
- Evaluation of several potential opportunities for off-channel rearing enhancement projects
- Installation of energy dissipators at several public outfalls causing erosion
- Eradication of invasive ivy at three locations
- Evaluation of several potential channel rehabilitation opportunities

Non-project stormwater management recommendations address areas where CWP 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 assessment area include:

- Encourage coordination between Clark County and the City of Battle Ground for NPDES permit compliance and leveraged stormwater capital project opportunities
- Clark County should encourage off-site wetland mitigation to restore or enhance wetland functions, particularly west of Brush Prairie
- City of Battle Ground should consider emphasizing protection and restoration of wetlands in the middle and upper reaches of Woodin Creek as the city expands to the east and north
- Consider adding signage to unfenced biofiltration swales to minimize conversion of swales to other uses by adjoining landowners

- Consider increasing the frequency of off-site assessments for stormwater outfalls in critical areas
- Encourage appropriate agricultural practices that emphasize soil and water conservation, livestock exclusion fencing, and reduction in nutrient load to streams
- Educate private landowners on importance of native riparian vegetation and intact riparian forests for shading streams and preserving hydrology
- Replace missing or deteriorated stream name signs

Introduction

This Stormwater Needs Assessment includes the Salmon Creek (RM 08.96) and Woodin Creek subwatersheds. 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 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.

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: Department of Environmental Services Clean Water, Stormwater Capital Planning, Legacy Lands, and ESA; Public Works Operations, Development Engineering and CIP; Community Planning and; Public Health. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities as appropriate.

Assessment Approach

Priorities for Needs Assessment in Salmon Creek (RM 08.96) and Woodin Creek

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, Salmon Creek (RM 08.96) and Woodin Creek subwatersheds are categorized as "Unincorporated Urban Growth Area" and "Rural Residential Including City-Serviced Fringes of Urban Growth Area", respectively.

Subwatersheds in this "Unincorporated Urban Growth Area" category typically include significant areas of development and potential re-development inside the Vancouver UGA of unincorporated Clark County where the county controls development permitting. These are high priority subwatersheds for stormwater needs assessment considering development pressure, subwatershed characteristics and NPDES permit requirements. A wide range of SNAP tools may be used in assessing subwatersheds in this category.

Subwatersheds in the "Rural Residential Including City Service Fringes of Urban Growth Area" category typically include rural areas bordering cities. These subwatersheds often score a high priority for stormwater management in general, but are a lower priority for Clark County due to the rural nature of unincorporated portions. Stormwater management needs tend to be limited in these areas. Urban development in this assessment area is controlled by the city of Battle Ground.

Assessment Tools Applied in Salmon Creek (RM 08.96) and Woodin Creek

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 procedures. 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 (*) are those for which new data was gathered or new analyses were conducted during this needs assessment. The remaining tools or chapters were completed based on pre-existing information.

Table 1: Stormwater Needs Assessment Tools

Outreach And Involvement *	Riparian Assessment
Coordination with Other Programs *	Floodplain Assessment
Drainage System Inventory and Condition *	Wetland Assessment
Review Of Existing Data	Macroinvertebrate Assessment *
Illicit Discharge Screening	Fish Use And Distribution
Broad Scale GIS Characterization *	Water Quality Assessment
Rapid Stream Reconnaissance *	Hydrologic Modeling
Physical Habitat Assessment	Hydraulic Modeling
Geomorphology And Hydrology Assessment *	Source Control *

Assessment Actions

Outreach Activities

SNAP outreach activities in 2009 focused primarily on raising awareness about the SNAP effort and following up on issues discovered in 2008. Letters were sent to landowners regarding trash accumulations and various agriculture management issues observed on their property during the 2008 SNAP effort.

The following activities were completed:

- July 2009 -- Press release to local media.
- The Clean Water Program E-Newsletter is distributed to 265 subscribers. SNAP articles and updates were included in three E-Newsletter editions in 2009:
    - April 2009 – 2008 SNAP reports available
    - August 2009 – 2009 SNAP update
    - December 2009 – Article highlighting SNAP landowner litter pick-up success.
- April 2009 -- SNAP information distributed with Clean Water Program information at Small Farm Expo: 69 participants.
- August 2009 – Letters were sent to sixty-two landowners with accumulations of trash in or near the stream on their property. Twenty-two landowners responded with phone calls to the SNAP coordinator for more information or to inform the CWP that cleanup activities had been completed. One landowner reported removing 1200 pounds of trash and another picked up three garbage bags and four five-gallon buckets of litter, six tires, three washing machines, drain pipe, and aluminum siding.
- August 2009 – Information on the SNAP was distributed at the 10-day Clark County Fair.
- November 2009 – Letters were sent to twenty-one landowners with identified agriculture-related issues on their property. The letters described the problem found (improper manure storage, livestock access to the stream, etc.) and identified a suggested management practice to lessen negative impacts on water quality (cover manure piles, fence livestock from the stream). A list of local resources and a brochure highlighting small acreage best management practices were included in the mailing. No follow-up calls or questions from landowners were received by the SNAP coordinator resulting from these letters and it is unknown whether other agencies listed as resources were contacted by property owners for technical advice.
- Clean Water Program SNAP web pages were updated as needed on an on-going basis; (note, no web visitor/download statistics are available as Clark County had (has) no tracking software during this timeframe).
- A description of the SNAP was included in Clark County's annual stormwater management program plan submitted to Ecology.

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

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

- Site visits by CWP technical assistance staff
- Letters detailing specific problems and solutions 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

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 inform and enhance their programs.

Methods

The CWP maintains a list of potential coordinating programs for each subwatershed area. Coordination takes the form of phone conversations, meetings, or electronic correspondence, and is 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 to include 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 identified 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 Salmon Creek (RM 08.96) and Woodin Creek needs assessment area:

- 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
- Clark County Endangered Species Act program
- Salmon Creek Watershed Council
- Clark Public Utilities

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:

- LCFRB Habitat Assessment (2004)
- LCFRB 6-Year Habitat Workplan
- Clark County Volunteer project data
- Ecology Watershed Characterization and Analysis of Clark County (2009)
- Ecology 303(d) list
- Ecology EIM data
- Clark County 2004 Subwatershed summary
- Clark County 2004 Stream Health Report
- Clark County LISP/SCMP/ Project data (2002-2008)
- Salmon Creek Limiting Factor Analysis Report 2002
- Clark County 6-Year TIP

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, and conclusions about general subwatershed condition and potential future changes

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 comprises two subwatersheds in rural to urbanizing middle Salmon Creek: Woodin Creek and Salmon Creek (RM 08.96). Salmon Creek (RM 08.96) subwatershed groups a number of smaller unnamed streams draining to Salmon Creek. The area is on the relatively level Willamette Valley floor, rising into the low foothills of the Cascade Mountains to the east (Figure 1). Land use is predominantly rural with development in the Battle Ground urban area and along SR 503. Areas of open space remain chiefly as forested canyons, steep hills and public lands.

Topography

The study area is generally very level below about 300 feet in elevation, with more complex hilly terrain formed by Tukes Mountain and the volcanic deposits NE of Battle Ground. The flat plain below 300 feet is cut by shallow stream canyons having headwaters in historical wetland areas. The Salmon Creek floodplain is approximately 120 feet above sea level at the lower end of Salmon Creek (RM 08.96) and about 200 feet at the confluence with Woodin Creek. Tributary streams generally lack floodplains. Lower Woodin Creek and the creek draining from Meadow Glade have small floodplains.

Geology and Soils

The oldest rocks in the study are Western Cascades lava flows that form Tukes Mountain. Sedimentary rocks deposited by the ancestral Columbia and local streams underlie much of the area at depth but these gravel and sandstone deposits are rarely exposed. Cataclysmic Flood Deposits of sand and silt blanket the area below about 350 feet elevation, forming the flat topography in the Meadow Glade-Battle Ground area. Late Ice Age lava flows underlie the headwaters of Woodin Creek and hold Battle Ground Lake in a small eruption crater.

Fine-grained Ice Age Cataclysmic Flood deposits are easily eroded and are prone to landslides in steep canyons.

Recent sand and gravel deposits underlie the Salmon Creek floodplain, and were deposited within the last few thousand years.

Hydrology

Geology and topography play the main role in determining study area hydrologic framework. The relatively flat lying sedimentary deposits are capable of retaining relatively large amounts of

rainfall as recharge. This groundwater recharge returns to the streams in summer months from seeps and springs.

Woodin Creek originates from a pond near the lower boundary of Battle Ground volcanic deposits. Much of the drainage in lower Woodin Creek basin is roadside ditches intended to both drain away rainfall and dry out wetlands. Consequently, stream hydrology is altered considerably from a natural forested condition. The chapter describing geomorphology and hydrology includes a description of hydrology and stream channel forms resulting from current land use conditions.

Hydrologic modeling for Salmon Creek watershed (MGS, March 2003) included analysis of Woodin Creek. Based on a comparison of current hydrology to a forested condition, modeling suggested that the Creek should have generally stable channels above Battle Ground and generally unstable channels downstream of Battle Ground.

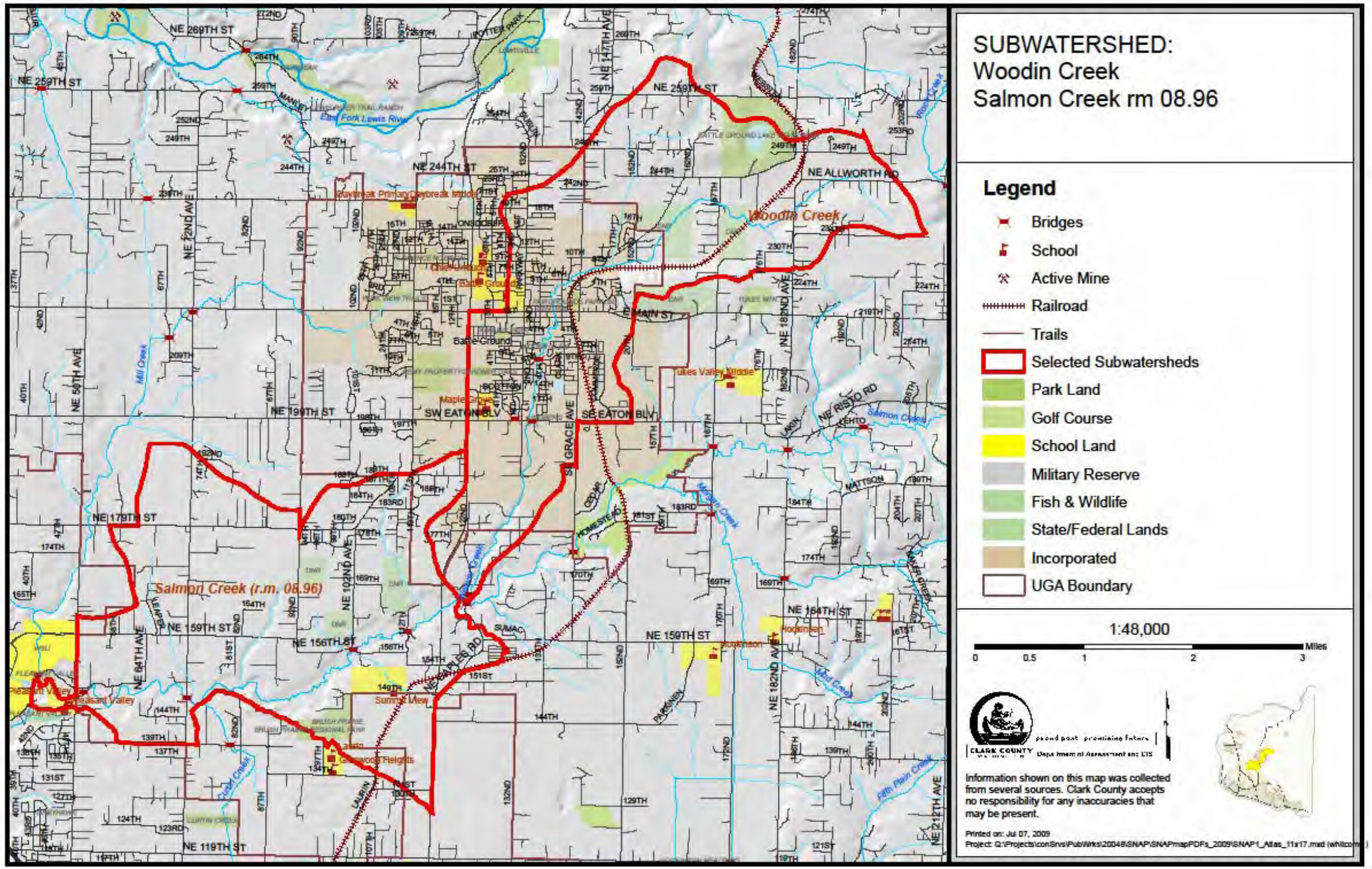


Figure 1: Subwatershed Map: Woodin Creek and Salmon Creek (RM 8.96) Subwatersheds

Subwatershed Metrics
Subwatershed scale metrics provide a simple way to summarize overall conditions. 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).

Overall, these metrics suggest that the study area has non-functioning stream habitat (Table 2).

Table 2: Watershed Scale Metrics

Metric	Woodin Creek	Salmon Creek RM 8.96	Functioning	Non-functioning
Percent Forested (2000 Landsat)	32	15	> 65 %	< 50 %
Percent TIA (2000 Landsat)	24	24	< 5 %	> 15 %
Road Density 2007 data (miles/sq. mile)	11	6.6	< 2	> 3
Stream Crossing Density (crossings per stream mile)	3	2.1	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	28	11	< 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.

The study area is a mix of rural and urban development with little forest remaining outside of wooded ravines, steep hills and areas of public land in upper Woodin Creek subwatershed. Consequently, its low remaining percent forested area suggests non-functioning habitat.

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 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. Values for both subwatersheds qualify as non-functioning habitat.

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, study area road densities qualify as non-functioning (>3 road miles/mi^2).

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 study area subwatersheds both have stream crossing densities within the functioning category (<3.2 crossings/stream mile NOAA Fisheries criteria).

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. Expected EIA places Woodin Creek subwatershed in the non-functioning and less urban Salmon Creek 8.96 at the margin of non-functioning.

Estimated Channel Stability Based on Forest and EIA

In a recent publication by Booth, Hartley, and Jackson (June 2002), a relationship between forest and percent EIA was presented as a graphic (Figure 2). According to this figure, streams in both subwatersheds would be expected to have unstable channels.

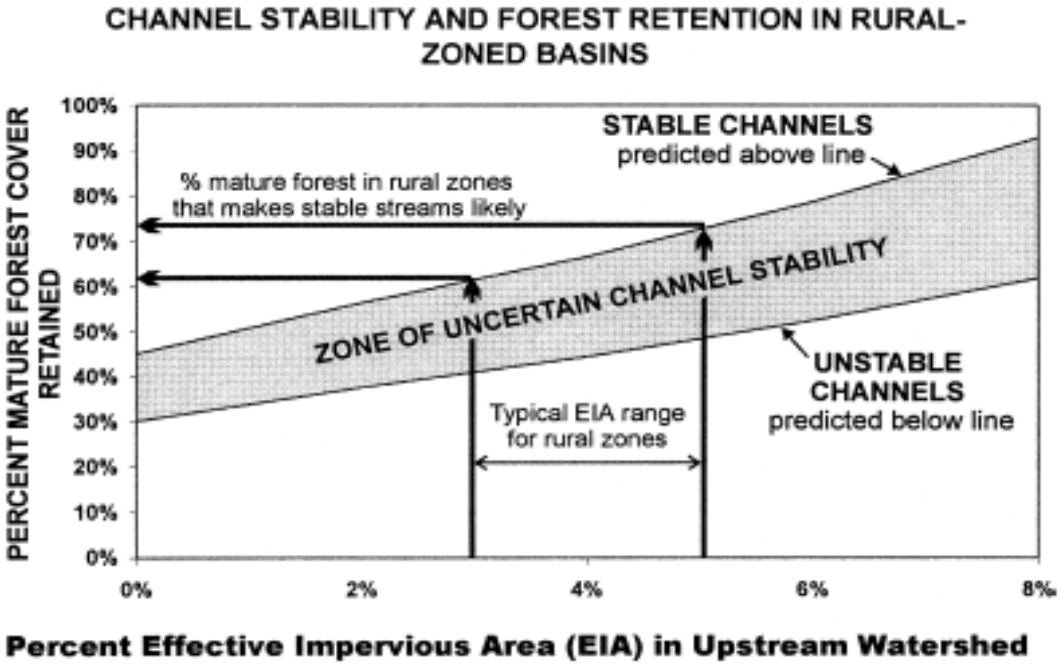


Figure 2: Channel stability in rural areas (Booth, Hartley, and Jackson, June 2002).

Water Quality Assessment

This section briefly summarizes and references available water quality data from the Woodin Creek and Salmon Creek (RM 08.96) subwatersheds. A description of applicable water quality criteria is included, along with discussions of beneficial use impacts, likely pollution sources, 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 Washington state water quality standards, Salmon Creek from below the Cougar Creek confluence to the headwaters, including tributaries, is to be protected for the designated uses of: "Core Summer Salmonid Habitat; 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 602).

Table 3 summarizes currently applicable water quality criteria for the assessment area.

Table 3: Applicable Water Quality Criteria for Woodin Creek and Salmon Creek (RM 08.96) Subwatersheds

Characteristic	Ecology criteria
Temperature	≤ 16 °C (60.8 °F)
Dissolved Oxygen	≥ 9.5 mg/L
Turbidity	shall not exceed 5 NTU over background when background is 50 NTU or less
pH	6.5 – 8.5 units
Fecal coliform bacteria	Geometric mean fecal coliform concentration not to exceed 100 colonies/100mL, and not more than 10% of samples exceeding 200 colonies/100mL.
Aesthetics	Aesthetic values must not be impaired by the presence of materials or their effects… which offend the senses of sight, smell, touch, or taste
Toxics	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 303(d) list of impaired waters is on the Ecology website at: http://www.ecy.wa.gov/programs/wq/303d/index.html

Woodin Creek is Category 4a listed (polluted waters with an approved TMDL) for fecal coliform bacteria, ammonia, and dissolved oxygen, Category 5 listed (polluted waters that require a TMDL) for pH, and Category 2 listed (Waters of Concern) for temperature and chlorine.

The Salmon Creek mainstem has multiple reaches listed within or upstream of the Salmon Creek (RM 08.96) subwatershed, including Category 4a listings for fecal coliform, Category 5 listings (polluted waters that require a TMDL) for pH; and additional Category 2 listings for temperature, dissolved oxygen, and pH.

Both subwatersheds are included in ongoing Salmon Creek TMDL implementation for fecal coliform and turbidity, and in TMDL development for water temperature.

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 the available dataset including fecal coliform bacteria, general water chemistry (temperature, pH, and dissolved oxygen), and benthic macroinvertebrate scores, overall stream health in the Woodin Creek and Salmon Creek (RM 08.96) subwatersheds scored in the poor range.

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 considerable dataset is available for both subwatersheds in this assessment area.

A full review and summary of available data and studies is beyond the scope of this document. This summary focuses on recent water quality data collected by the CWP including monthly water quality data from Woodin Creek and Salmon Creek (2002 through 2008), and temperature data from both subwatersheds collected during the summer of 2003. Associated reports may be viewed on the CWP website at:
http://www.clark.wa.gov/water-resources/documents-monitoring.html#strmac

In 2009, Ecology (Collyard, 2009) completed a report titled Salmon Creek Nonpoint Source Pollution Total Maximum Daily Load: Water Quality Effectiveness Monitoring (Publication No. 09-03-042). The report incorporates much of the County's available water quality data and is available on the Salmon Creek TMDL website at:
http://www.ecy.wa.gov/programs/wq/tmdl/SalmonCr/SalmonCr.html.
Some information from the Ecology report is summarized in this assessment.

Data and information sources reviewed or summarized as part of this water quality characterization are listed in Table 4.

Table 4: Data Sources

Source	Data and/or Report
Clark County Clean Water Program	2002-2008 Salmon Creek Monitoring Project 2004 Stream Health Report Salmon Creek Watershed Summer 2003 Stream Temperature
Ecology	Salmon Creek Nonpoint Source Pollution Total Maximum Daily Load: Water Quality Effectiveness Monitoring Report

Water Quality Summary
Figure 3 shows the location of monitoring stations referenced in this assessment. Long-term monthly data was collected from 2002-2008 at Station SMN030 (Salmon Cr at NE 50th Avenue) in the Salmon Creek (08.96) subwatershed, and at Station WDN010 (Woodin Cr at Caples Road) in the Woodin Creek subwatershed.

Three stations in this assessment area were included in the Salmon Creek Watershed Summer 2003 Stream Temperature study:

- SMN030
- SMN045 (Salmon Cr at NE 156th Avenue)
- WDN020 (Woodin Cr at NE 181st Street)

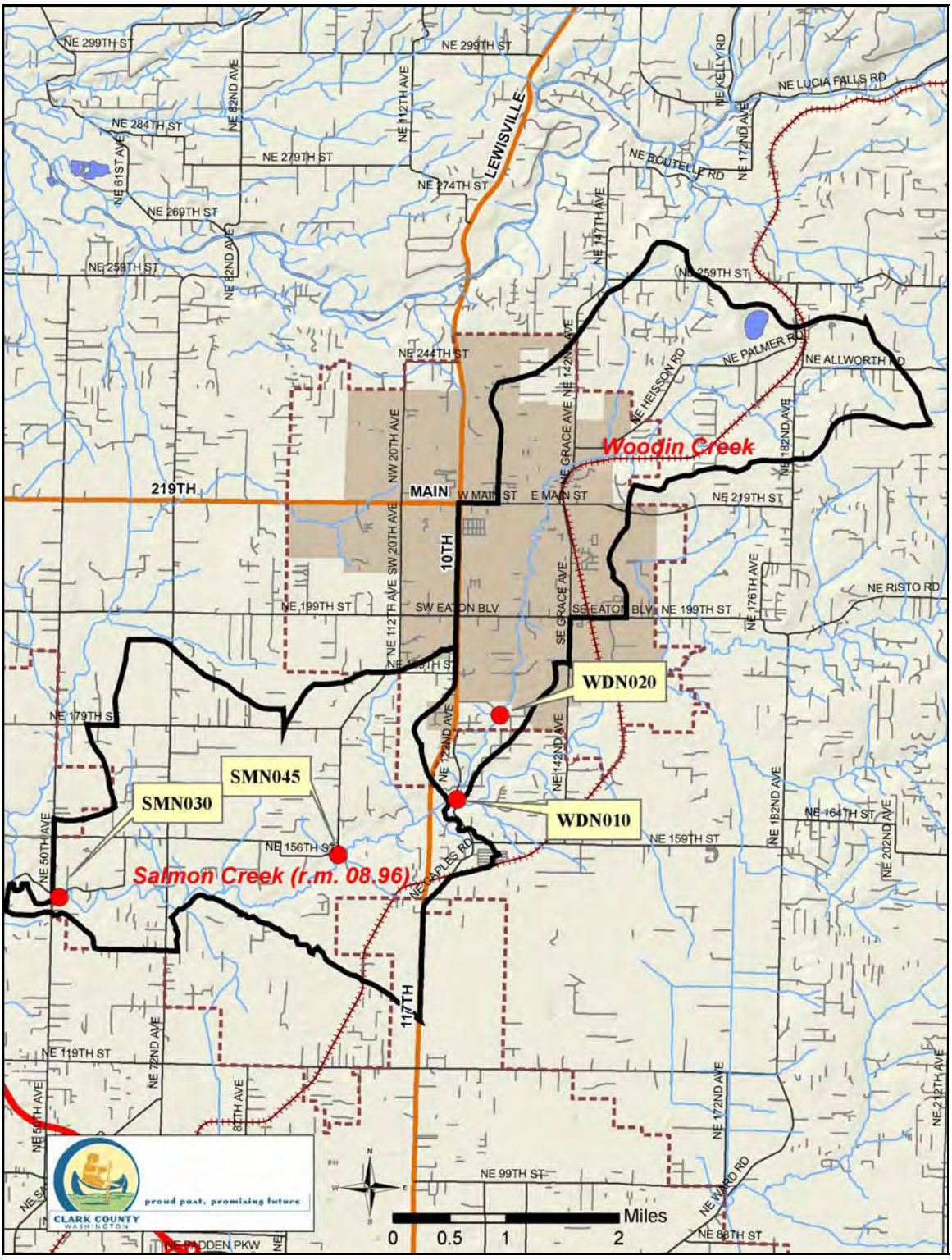


Figure 3: Location of monitoring stations

Oregon Water Quality Index (OWQI) Scores

The OWQI was developed by the Oregon Department of Environmental Quality (ODEQ) as a way to improve understanding of water quality issues by integrating multiple characteristics, and generating a score that describes water quality status (Cude, 2001). It is intended to provide a simple and concise method for expressing ambient water quality.

The OWQI integrates eight water quality variables: temperature; dissolved oxygen; biochemical oxygen demand; pH; ammonia + nitrate nitrogen; total phosphorus; total solids; and fecal coliform. For each sampling event, individual sub-index scores and an overall index score are calculated. Overall index scores are aggregated into low flow (June through September) and high flow (October through May) seasons and a seasonal mean value is then calculated.

Index scores are categorized as follows:
very poor = 0 to 59; poor = 60 to 79; fair = 80 to 84; good = 85 to 89, and; excellent = 90 to 100.

Figure 4 and Figure 5 show seasonal mean OWQI scores for Stations SMN030 and WDN010, respectively, from 2002 through 2008. Among 15 long-term monitoring stations county-wide from 2002-2006, Station SMN030 ranked tied for 10th in overall water quality and Station WDN010 ranked tied for 7th (Hutton and Hoxeng, 2007).

Monthly OWQI values and subindex values for each station since 2002 are summarized below:

- SMN030: monthly OWQI values ranged from Very Poor to Good and tended toward the middle of this range, as 53 of 74 months had OWQI values in the poor or fair category. Monthly sub-index scores for total solids and inorganic nitrogen were consistently poor to very poor, while scores for total phosphorus were typically in the fair to good range. Fecal coliform scores ranged widely, from very poor to excellent, but the majority were excellent. Scores for water temperature, dissolved oxygen, and pH were consistently excellent.
- WDN010: monthly OWQI values ranged from Very Poor to Good, and tended toward the middle of this range, as 58 of 74 months had OWQI values in the poor or fair category. Monthly sub-index scores for total solids were typically poor, and inorganic nitrogen ranged widely. Scores for total phosphorus and fecal coliform also ranged widely, with many scores in the poor to fair range. Scores for water temperature, dissolved oxygen, and pH were excellent with occasional lower scores.

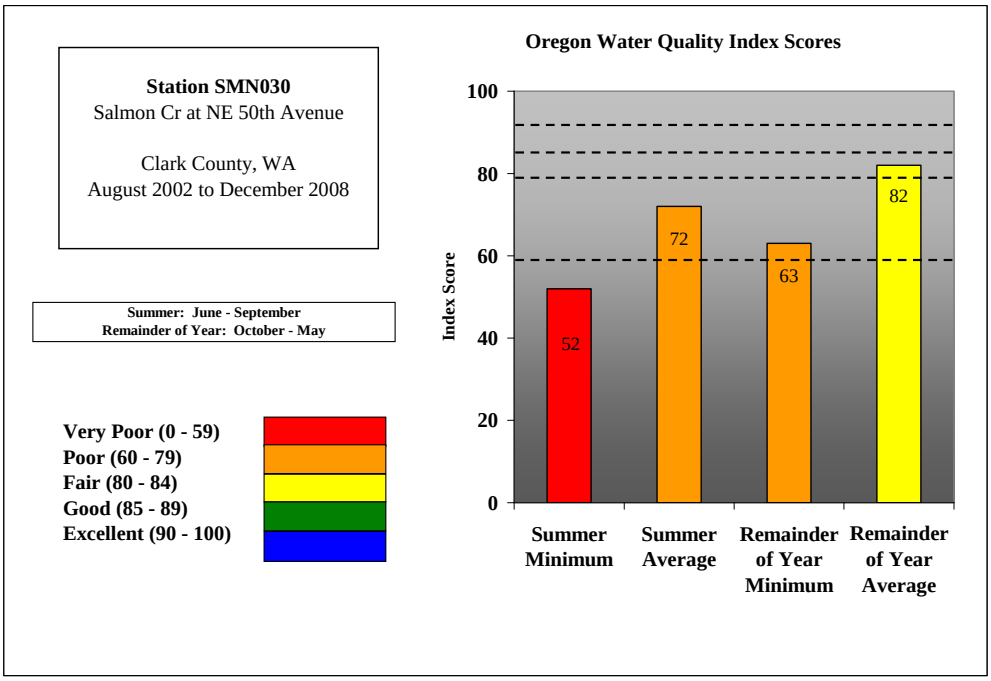


Figure 4: Average Water Quality, Salmon Creek station SMN030, 2002-2008, Oregon Water Quality Index

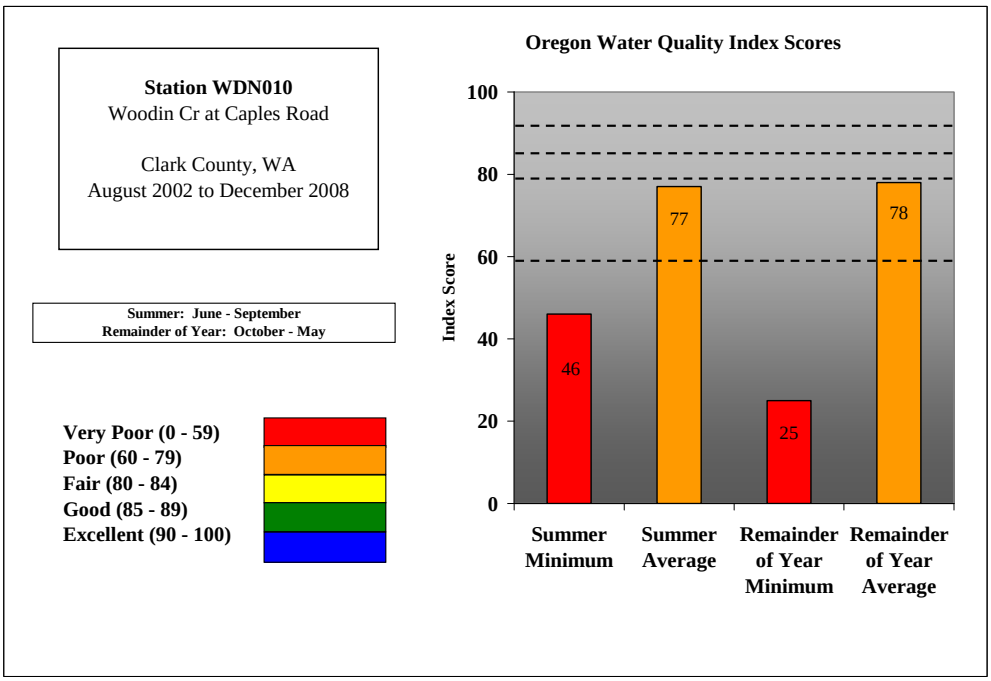


Figure 5: Average Water Quality, Woodin Creek station WDN010, 2002-2008, Oregon Water Quality Index

Trends Over Time
An analysis of statistical trends in OWQI scores based on the 2002 through 2006 dataset found a significant decreasing trend in turbidity subindex scores (indicating increasing turbidity) at Station SMN030 (Hutton and Hoxeng, 2007).

Ecology (Collyard, 2009) used a step-trend analysis to evaluate data collected at SMN030 and WDN010 between 1988 and 2007. Statistically significant decreasing trends were found in fecal coliform, nitrate-nitrite, and total phosphorus concentration at both locations.

Nutrients
Nutrient criteria are not established for Washington streams. EPA suggests a total phosphorus criterion of 0.100 mg/L for most streams, and 0.050 mg/L for streams which enter lakes (EPA, 1986). EPA nitrate criteria are focused on drinking water standards and are not generally applicable to aquatic life issues.

Phosphorus and nitrogen in excess may contribute to elevated levels of algal or plant growth, especially in slower moving, low gradient streams, or in downstream water bodies.

Total phosphorus samples from station SMN030 between August 2002 and December 2008 ranged from <0.020 mg/L to 0.190 mg/L; less than four percent of samples exceeded the EPA criterion during this time period. Station WDN010 ranged more widely, from <0.020 mg/L to nearly 0.400 mg/L, and 27% of samples exceeded the EPA criterion. Seasonal median values (summer vs. remainder of year) were similar at SMN030; at WDN010, summer median value was more than double the remainder of the year.

Turbidity
Ecology (Collyard, 2009) found that all stations on Salmon Creek and tributaries met the 2001 TMDL target levels based on a comparison between 1988-1994 and 2005-2007 data. This includes stations SMN030 and WDN010 within this assessment area. Their 90th percentile values decreased by 69% and 90%, respectively.

Since 2002, the median of 79 turbidity samples at each station (SMN030 and WDN010) was between 4 and 5 NTU, with summer samples having slightly lower turbidity.

Fecal Coliform Bacteria
For a full analysis based on the fecal coliform TMDL, see Collyard, 2009. General results from that report are summarized below.

Based on monthly data from 2005 - 2007, geometric mean fecal coliform concentrations at Station SMN030 and WDN010 declined sharply during both the wet and dry seasons when compared to values from the 1995 TMDL (Table 5). Both stations meet the geometric mean criteria during the wet season; despite the improvements, however, both still fail this criterion during the dry season.

The 90th percentile values also decreased substantially at both stations. Despite improvements, neither station is in full compliance with the state criteria nor the TMDL targets (Table 6).

Station WDN010 still fails the criterion during both wet and dry seasons, while station SMN030 meets the criterion during the wet season and fails in the dry season.

Table 5: 1995 TMDL study fecal coliform criterion compared to 2005-7 Clark County data (from Collyard, 2009)

Geometric mean values for wet and dry seasons.

Station	Wet season					Dry season				
	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]
SMN010	313	59	-82	Yes	none	129	90	-30	Yes	none
CGR020	722	143	-80	No	30	899	696	-23	No	86
SMN030	182	42	-77	Yes	none	281	151	-46	No	34
MIL010	839	50	-94	Yes	none	282	106	-62	No	6
CUR020	1155	23	-98	Yes	none	743	116	-84	No	14
SMN050	234	21	-91	Yes	none	751	106	-86	No	6
WDN	534	71	-87	Yes	none	857	184	-79	No	46
SMN080	28	6	-79	Yes	none	54	34	-35	Yes	none

[1] Percent change required to meet TMDL target limits.
[2] Additional change required to meet TMDL target limits.

Table 6: 2001 TMDL report fecal coliform criterion compared to 2005-7 Clark County data (from Collyard, 2009)

90^{th} percentile values for wet and dry seasons.

Station	Wet season					Dry season				
	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]	TMDL	05-07	% change[1]	Meets criterion?	% Required change[2]
SMN010	1917	321	-83	No	-38	301	347	-15	No	-42
CGR020	9243	601	-93	No	-67	1803	1577	-13	No	-87
SMN030	1261	194	-85	Yes	none	806	342	-58	No	-36
MIL010	8763	381	-96	No	-48	1121	483	-57	No	-59
CUR020	4409	93	-98	Yes	none	2608	472	-82	No	-58
SMN050	1125	138	-88	Yes	none	1404	346	-75	No	-42
WDN	9204	468	-95	No	-57	6509	628	-90	No	-68
SMN080	200	22	-89	Yes	none	318	98	-69	Yes	none

[1] Percent change required to meet TMDL target limits.
[2] Additional change required to meet TMDL target limits.

Stream Temperature

One summer of continuous temperature monitoring (2003) at stations SMN030, SMN045, and WDN020 was conducted as part of the Salmon Creek Watershed Summer 2003 Stream Temperature project.

Figure 6 shows 7-DADMax temperatures during the summer of 2003 for 15 stations throughout the Salmon Creek watershed. The 7-DADMax is the maximum of the 7-day moving average of daily maximum temperatures. Ecology standards utilize this metric to determine temperature compliance (currently the criterion for this assessment area is 60.8 degrees F). At the time of the study, the criterion was 64 degrees F).

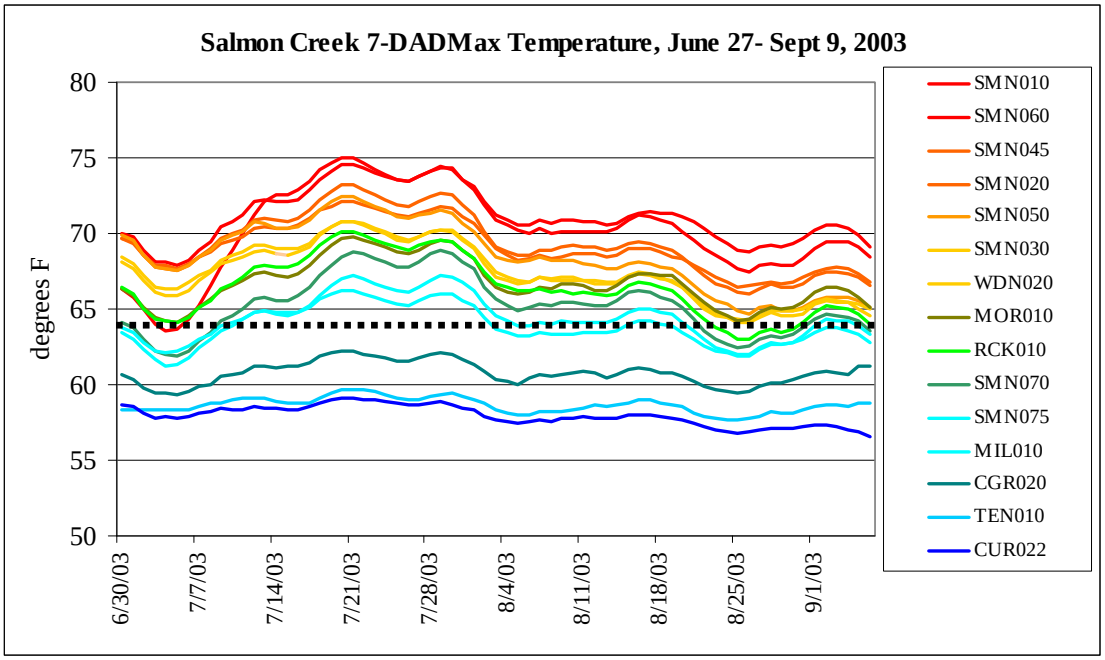


Figure 6: Time series plot of 7-DADMax temperatures, Salmon Creek, summer 2003 (from Schnabel, 2004). Dotted line at 64 F represents the pre-2006 Washington state stream temperature criterion. The current criterion is 60.8 F.

All of the stations within this assessment area had 7-DADMax temperatures exceeding the current state criterion for the entire monitoring period, and spent significant amounts of time each day with elevated temperatures. Among Salmon Creek tributary stations, the WDN020 station was the warmest studied.

Impacts to Beneficial Uses and Potential Sources

General water quality in this assessment area is quite variable, with generally better conditions in the Salmon Creek mainstem, and generally poorer conditions in Woodin Creek. Significant improvements have been observed throughout Salmon Creek, particularly in fecal coliform, turbidity, and nutrients. Despite improvements, impacts to listed beneficial uses include potential core summer salmonid habitat from elevated temperatures, and primary contact recreation as indicated by fecal coliform bacteria. Table 7 at the conclusion of this section summarizes the

primary water quality impacts to beneficial uses in Woodin Creek and Salmon Creek (RM 08.96), and probable sources of the observed impact.

Implications for Stormwater Management

Table 7 lists the primary known water quality concerns and potential solutions for each. Solutions listed in bold indicate areas where CWP activities can have a positive impact. It should be noted that CWP activities, though important, are not likely to achieve water quality improvement goals on their own. Other county departments, local agencies, and not least of all, the public must all contribute to water quality improvement.

Table 7: Known Water Quality Concerns, Sources, and Solutions for Woodin Creek and Salmon Creek (RM 08.96)

Characteristic	Beneficial Use Affected	Potential Sources	Mechanism	Solutions (bold indicates direct Clean Water Program involvement)
Fecal coliform bacteria	Primary contact recreation	failing septic systems	groundwater seeps storm sewers	**Storm sewer screening for source identification and removal** **Education programs** Agricultural Best Management Practices Septic and sanitary sewer system inspection and maintenance
		sanitary sewer leaks	groundwater seeps storm sewers	
		livestock, pets, wildlife	overland runoff storm sewers direct access	
Water temperature	Core summer salmonid habitat	vegetation removal	direct solar radiation	**Stormwater infiltration to increase baseflow** **Streamside planting/vegetation enhancement** **Riparian preservation through acquisition** **Education programs** Pond removal or limitation
		low summer flows	decreased resistance to thermal inputs	

Drainage System Inventory and Condition

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=mapsonline

Drainage system inventory is an ongoing CWP work effort focused on updating the StormwaterClk database to include all existing stormwater drainage infrastructure. During 2008 and 2009, the inventory was a significant priority for the CWP, with a major work effort focused on identifying and mapping previously unmapped infrastructure and reviewing existing records for completeness and accuracy.

Table 8 indicates the number of features currently inventoried in StormwaterClk. Of the total 70 stormwater facilities, twenty are identified as publicly owned and operated.

Table 8: Drainage System Inventory Results, Woodin Creek/Salmon Creek RM 08.96

Database Feature Category	Inventoried prior to 2007	Added during 2007-2009	Total Features
Inlet	175	43	218
Discharge Point (outfall)	27	288	315
Flow Control	35	4	39
Storage/Treatment	221	64	285
Manhole	105	4	109
Filter System	3	1	4
Channel	441	1729	2170
Gravity Main	663	1041	1704
Facilities	29	41	70

Condition

Stormwater system condition is assessed based on three components:

- An evaluation of retrofit opportunities at public stormwater facilities
- An inspection and maintenance evaluation at public stormwater facilities
- An off-site assessment to check for outfall-related problems in downstream receiving waters

Component 1: Retrofit Evaluation

Purpose

The purpose of this component is to identify existing public stormwater facilities that may be retrofitted to provide additional storage or treatment, beyond the level intended during original construction.

Methods

The evaluation is conducted at all public stormwater facilities that contain the following facility components: detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters, or bioswales; and discharge to surface waters or to the stormwater drainage infrastructure that eventually discharges to surface waters.

The retrofit evaluation includes a review of the drainage area, stormwater infrastructure condition, facility lot size, ownership of adjacent parcels, and the functionality of the facility objects listed above. Facilities or parcels with the potential to provide additional storage and/or treatment of stormwater are referred as "potential retrofit" opportunities for further evaluation as Capital Improvement Projects.

Results

Based on the county's StormwaterClk database, as of July 2009, there were 2 mapped public stormwater facilities in the Woodin Creek subwatershed and 18 mapped public stormwater facilities in the Salmon Creek (RM 08.96) subwatershed.

Both of the mapped public stormwater facilities in the Woodin Creek subwatershed were within the City of Battleground and were not evaluated for retrofit opportunities. In the Salmon Creek (RM 08.96) subwatershed, eighty-three percent (15) of the mapped public stormwater facilities were evaluated for retrofit opportunities.
Figure 7 summarizes notable retrofit evaluation activities in the Salmon Creek (RM 08.96) subwatershed, including general facility location, evaluated facilities, and referrals for retrofit opportunities.

As listed in Table 9, seven public stormwater facilities were referred for further evaluation as Capital Improvement Projects in the Salmon Creek (RM 08.96) subwatershed; three of which included an increase for potential storage as part of the project description. The average age of the facility referred was 12.3 years. All but two of the facilities referred contained a bioswale that was either landscaped or filled in with cobbles and offered little to no stormwater treatment abilities.

No major defects or hazardous conditions were discovered in the Salmon Creek (RM 08.96) subwatershed.

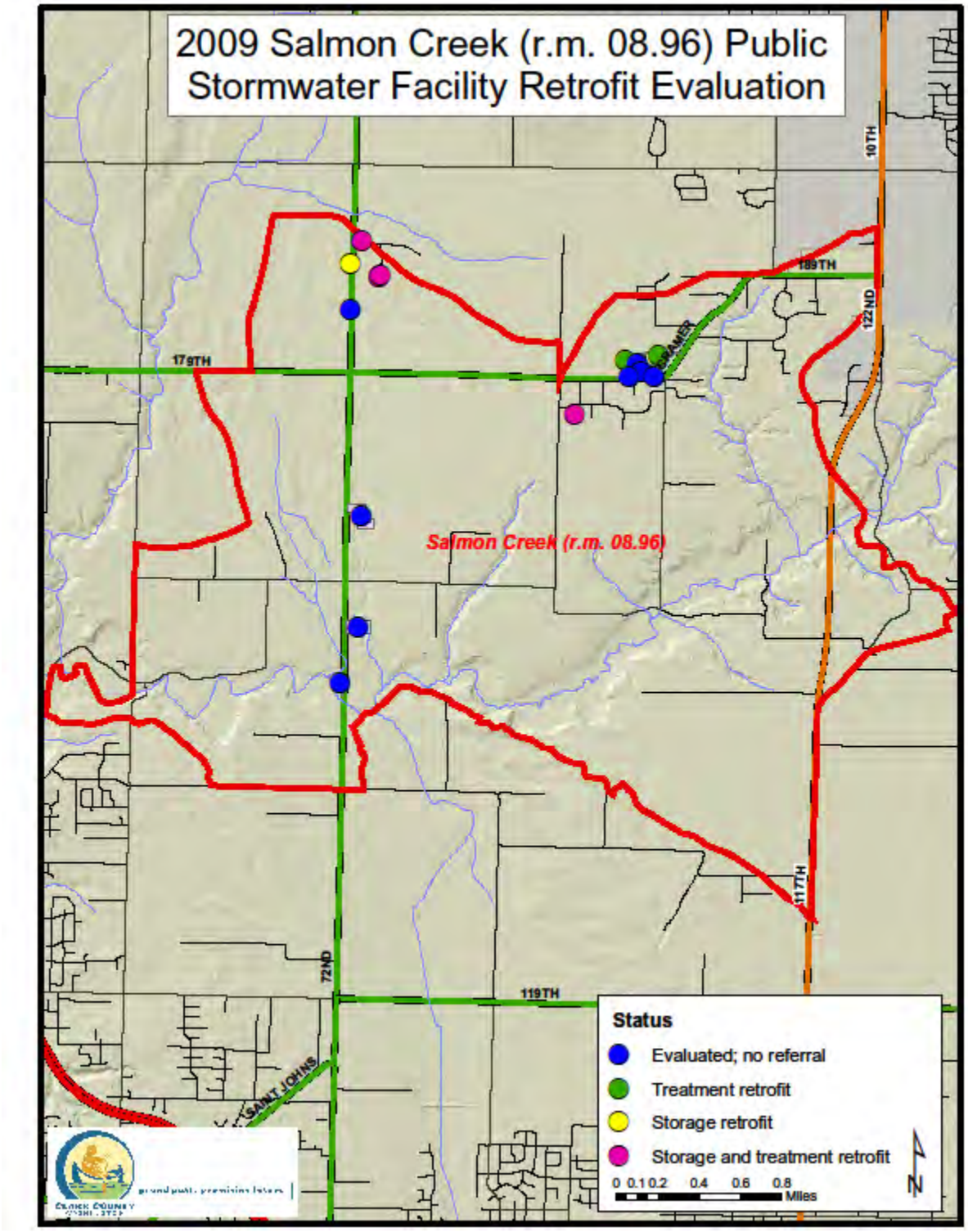


Figure 7: Summary of 2009 Retrofit Evaluation Activities in the Salmon Creek (RM 08.96)

Table 9: Description of Potential Retrofit Opportunities in Salmon Creek (RM 08.96) subwatersheds

Identifier	Facility Name	ID	Install Date	Basis for Project	Project Description	Subwatershed
OS-134	West Glade 2	112	30-Dec-97	Large lot with little infrastructure	Potential storage treatment retrofit.	Salmon Creek (RM 08.96)
OS-135	Sequoia Meadows	872	20-Oct-93	Bioswale landscaped or filled in with cobble; no treatment. Large swale may offer detention.	Potential storage and treatment retrofit	Salmon Creek (RM 08.96)
OS-136	72nd Ave & NE 192nd St	961	unknown	Site may not be functioning as designed. Appears that the outfall may flow back into drainage system.	Potential storage and treatment retrofit	Salmon Creek (RM 08.96)
OS-137	Tiger Lily	1986	16-Sep-99	Bioswale landscaped or filled in with cobble; no treatment	Potential treatment retrofit	Salmon Creek (RM 08.96)
OS-138	Tiger Lily	1987	16-Sep-99	Bioswale landscaped or filled in with cobble; no treatment	Potential treatment retrofit	Salmon Creek (RM 08.96)
OS-139	Tiger Lily	1988	16-Sep-99	Bioswale landscaped or filled in with cobble; no treatment	Potential treatment retrofit	Salmon Creek (RM 08.96)
OS-140	Sequoia Meadows	1999	20-Oct-93	Bioswale landscaped or filled in with cobble; no treatment	Potential treatment retrofit	Salmon Creek (RM 08.96)

Component 2: Inspection and Maintenance Evaluation

Purpose

The inspection and maintenance evaluation verifies that maintenance activities are implemented and facilities are properly functioning.

Methods

The inspection and maintenance evaluation is conducted at public stormwater facilities in conjunction with retrofit evaluations. Public stormwater facilities that contain the following facility components are evaluated: detention ponds, treatment wetlands, wet ponds, pre-settling cells, open filters, or bioswales; and discharge to surface waters or to the stormwater drainage infrastructure that eventually discharges to surface waters.

Public stormwater facilities that contain filter systems, buried detention or retention vaults, and facilities that infiltrate stormwater are typically not included in this evaluation, but may be inspected on a case-by-case basis as resources allow.

The evaluation is conducted using county and state standards equivalent to maintenance standards specified in Chapter 4 of Volume V of the 2005 Stormwater Management Manual for Western Washington. The standards list the part or component of the facility, the condition when repair or maintenance is needed, and the results expected when maintenance is performed. Individual components of a facility are referred to as "facility objects."

The inspection and maintenance evaluation process involves inspecting all facility objects to determine if maintenance complies with the standards. If any facility object fails to meet the maintenance standards, the entire facility is not in compliance. Noncompliant stormwater facilities are referred to the appropriate department for repairs or maintenance.

Results

Maintenance evaluation activities were conducted at 15 public stormwater facilities within the Salmon Creek (RM 08.96) subwatershed. No maintenance evaluation activities were conducted in Woodin Creek subwatershed.

Figure 8 summarizes notable inspection and maintenance evaluation activities in the Salmon Creek (RM 08.96) subwatershed, including general facility location, compliant facilities, and referrals of noncompliant facilities.

Eleven facilities were found to be out of compliance and four facilities were found to be in compliance. As listed in Table 10, these facilities included a total of 63 facility objects, of which 40 (65 percent) were in compliance.

No major defects or hazardous conditions were discovered in the Salmon Creek (RM 08.96) subwatershed.

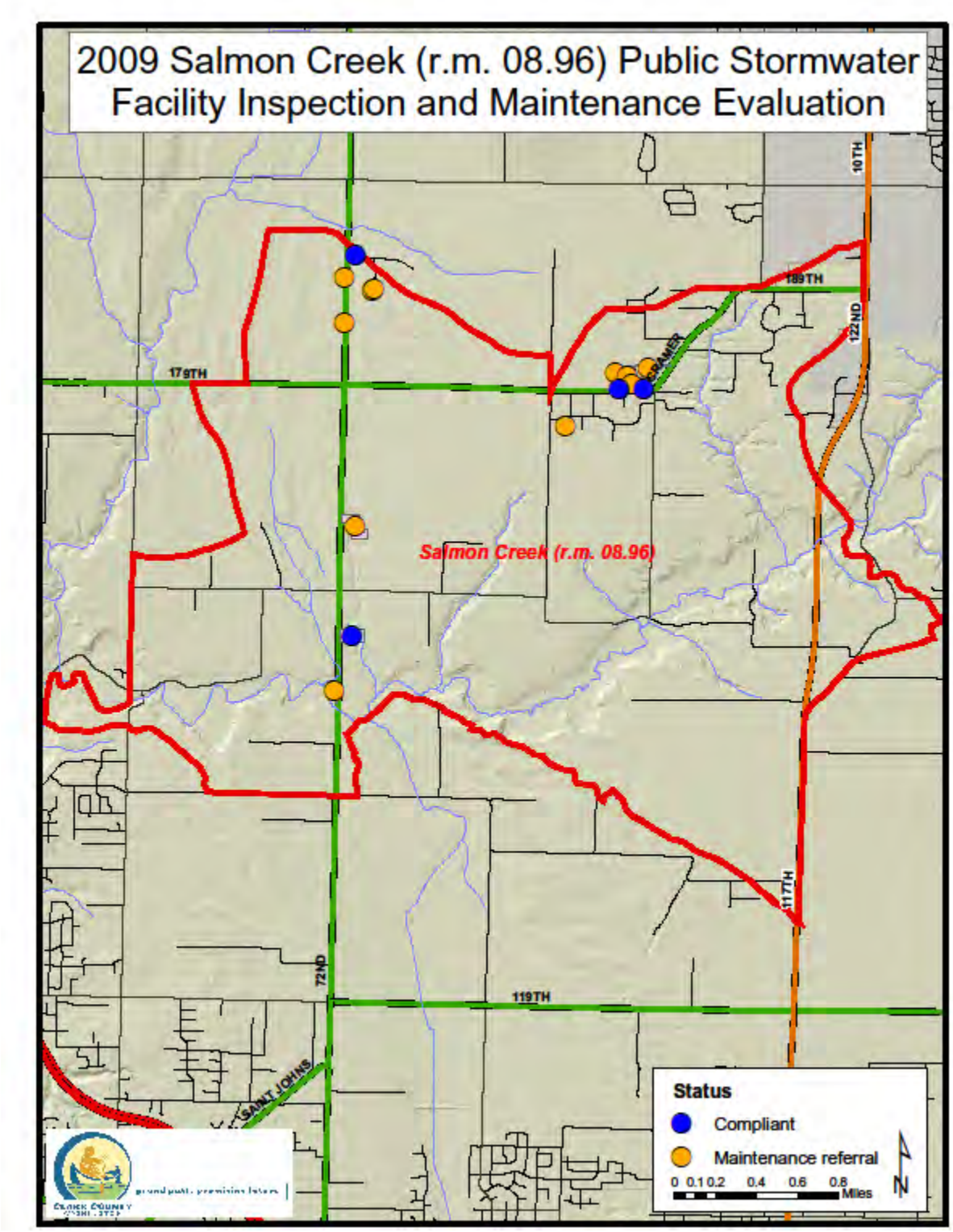
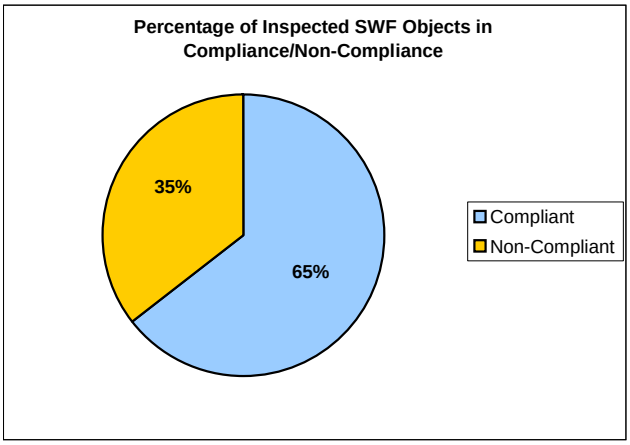


Figure 8: Summary of 2009 Public Stormwater Facility Inspection and Maintenance Evaluation Activities in the Salmon Creek (RM 08.96) subwatershed

Table 10: 2009 Public Stormwater Facility Inspection and Maintenance Evaluation Activity in the Salmon Creek (RM 08.96) subwatershed

SNAP Public Stormwater Facility Maintenance and Inspection Evaluation	
Subwatershed: Salmon Creek (r.m. 08.96)	
Public SWF Inspected	15
Stormwater Facility Objects Inspected	63
% Compliant SWF Objects	65
% Non-Compliant SWF Objects	35



Facility Objects Inspected	Initial Inspections: Compliant	Initial Inspections: Non-Compliant	Most Common Defect	Maintenance Trigger
Access Road or Easement	13	2	n/a	n/a
Catch Basin	3	0	n/a	n/a
Control Structure / Flow Restrictor	2	0	n/a	n/a
Conveyance Stormwater Pipe	9	1	sediment & debris	sediment depth is greater than 20% of pipe diameter.
Detention Pond	4	3	vegetation, poisonous and noxious	any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public.
Facility Discharge Point	1	0	n/a	n/a
Fence, Gate or Water Quality Sign	0	3	sign unreadable	water quality sign is missing or 20% of the surface is unreadable.
Field Inlet	1	1	Sediment	sediment (in the basin) that exceeds 60 percent of the sump depth
Open Channel	1	0	n/a	n/a
Treatment Wetland	1	0	n/a	n/a
Typical Biofiltration Swale	4	12	vegetation	grass is taller than 10 inches; nuisance weeds and other vegetation start to take over.
Wetpond	1	0	n/a	n/a
Total	**40**	**22**		

Component 3: Offsite Assessment

Purpose

Discharges from stormwater outfalls can cause moderate to severe erosion as stormwater moves through the riparian zone and to the receiving water. Erosion creates a source of sediment to the stream due to incision and slope failures. It can also increase slope instability problems.

The Offsite Assessment looks for offsite or downstream problems associated with the county's storm sewer system, particularly from facility outfalls that discharge to critical areas.

Methods

County-owned and operated stormwater outfalls meeting one or more of the following criteria are included in the offsite assessment:

- Within 200 feet of a critical area (e.g. riparian, wellhead protection, landslide hazard, etc)
- Within 300 feet of a headwater stream
- Located on public land
- Originates from a public-dedicated facility currently under the two-year maintenance warranty bond

Stormwater outfalls are prioritized into three categories:

- Priority 1 outfalls are stormwater outfalls that discharge to landslide hazard areas outside of county road rights-of-way.
- Priority 2 outfalls are stormwater outfalls that discharge to all other critical areas outside of county road rights-of-way
- Priority 3 outfalls are stormwater outfalls that discharge to critical areas within county road rights-of-way

At a minimum, all Priority 1 outfalls are inspected. As resources allow, Priority 2 and Priority 3 outfalls may be inspected. If an outfall fails to meet the general outfall design criteria or is contributing to a downstream erosion problem, the outfall is not in compliance. Non-compliant outfalls are referred to the appropriate Public Works program for maintenance or repair, or in some cases referred as potential Capital Projects.

Results

Based on the county's StormwaterClk database, as of June 2009 there were 89 mapped outfalls in the Woodin Creek subwatershed; 0 Priority 1 outfalls, 4 Priority 2 outfalls, and 85 Priority 3 outfalls.

In the Salmon Creek (RM 08.96) subwatershed there were 193 mapped outfalls; 13 Priority 1 outfalls, 30 Priority 2 outfalls, and 150 Priority 3 outfalls.

Figure 9 summarizes notable outfall assessment activities including general outfall locations in the Salmon Creek (RM 08.96) subwatershed.

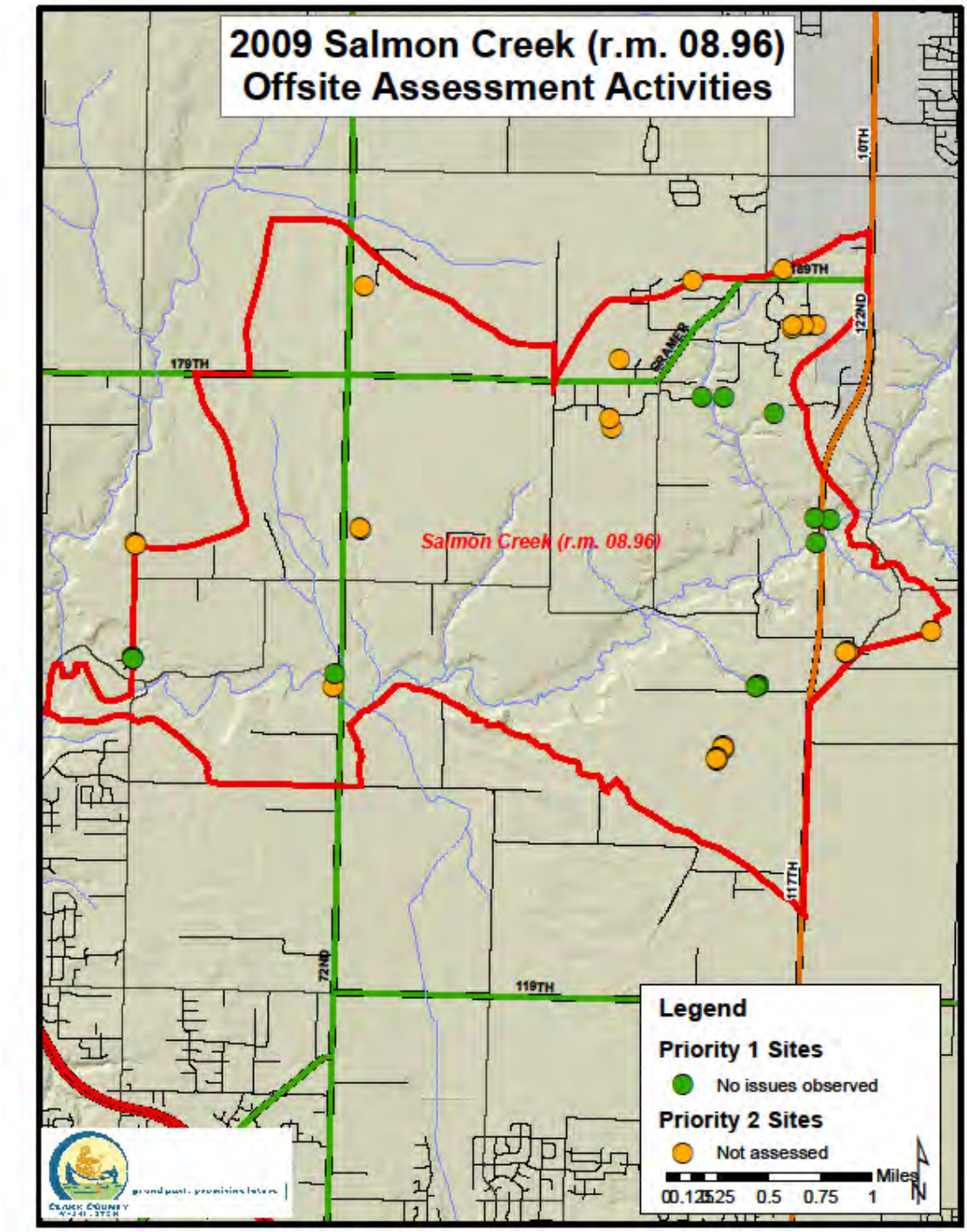


Figure 9: Summary of 2009 Off-site Assessment Activities in the Salmon Creek (RM 08.96) subwatershed

Table 11 summarizes offsite assessment results from the Woodin Creek subwatershed. There were 89 mapped outfalls discharging to critical areas. There were no Priority 1 outfalls to assess. No Priority 2 or Priority 3 outfalls were assessed.

Table 11: 2009 Off-site Assessment Project Activity Summary for Woodin Creek subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	0	4	85
# of outfalls assessed	n/a	0	0
# of outfalls compliant	n/a	n/a	n/a
# of noncompliant outfalls	n/a	n/a	n/a
# of referrals initiated	n/a	n/a	n/a
# of referrals ongoing	n/a	n/a	n/a
# of outfalls fixed	n/a	n/a	n/a

Table 12 summarizes offsite assessment results from the Salmon Creek (RM 08.96) subwatershed. There were 193 mapped outfalls discharging to critical areas. Thirteen Priority 1 outfalls were assessed, of which all were found to be in compliance. No Priority 2 or Priority 3 outfalls were assessed.

Table 12: 2009 Off-site Assessment Project Activity Summary for Salmon Creek (RM 08.96) subwatershed

Metric	Number of Outfalls		
	Priority 1	Priority 2	Priority 3
Total number of mapped outfalls	13	30	150
# of outfalls assessed	13	0	0
# of outfalls compliant	13	n/a	n/a
# of noncompliant outfalls	n/a	n/a	n/a
# of referrals initiated	n/a	n/a	n/a
# of referrals ongoing	n/a	n/a	n/a
# of outfalls fixed	n/a	n/a	n/a

Potential Projects

The offsite assessment project yielded no potential project opportunities.

Management Recommendations

Retrofit evaluations conducted at 15 public stormwater facilities generated 7 referrals for further evaluation as Capital Improvement Projects. The most common treatment BMP across facilities referred was a typical biofiltration swale. All but two of the facilities referred contained a bioswale that was either landscaped or filled in with cobbles reducing treatment abilities and included an increase for potential treatment as part of the project description. The average age of the facility referred in the Salmon Creek (RM 08.96) subwatershed was 12.3 years old. Further evaluations of other stormwater facilities with similar age and stormwater infrastructure may identify additional referrals for further evaluation as Capital Improvement Projects.

The inspection and maintenance evaluation is conducted at public stormwater facilities in conjunction with retrofit evaluations. The most common facility objects found out of compliance during the public stormwater facility inspection process were detention ponds, biofiltration swales, and lack of stormwater facility signage. Vegetation issues were the most common noncompliant defect, specifically the conversion of biofiltration swales from their designed state to a landscaped or filled in area. Targeted education and public outreach efforts regarding Clark County's Stormwater Facility Maintenance Manual focused on private homeowners who own property near stormwater facilities may help maintain county stormwater facility maintenance standards. Additionally, adding appropriate signage to facilities with unfenced biofiltration swales may also prevent alteration of biofiltration swales from their original design.

No potential project opportunities were generated from outfall assessments activities. However, an increase in the frequency of offsite assessment activities may prevent erosion problems by discovering potential issues before they become a more serious erosion problem.

Illicit Discharge Detection and Elimination Screening

Illicit Discharge Detection and Elimination Screening assessment was not conducted.

Stream Reconnaissance and Feature Inventory

Purpose

The Feature Inventory records the type and location of significant stream impairments, potential environmental and safety hazards, and project opportunities in selected stream reaches.

Feature Inventory results are used primarily to document conditions and identify potential improvement projects or management actions for implementation by the CWP or other agencies. They also provide an extensive GIS database of sites that can be evaluated for project mitigation needs and as a county-wide planning tool for riparian and habitat enhancement projects.

Methods/Limitations

Geographic scope of the Feature Inventory was established by the CWP taking into consideration projected TIA, DNR water types, stream gradient, zoning, Clark County development permitting authority, and land ownership.

The in-stream assessment approach allowed investigators to observe stream corridor features that are not always identifiable through desk methods, such as analysis of existing aerial photographs and GIS data.

A GPS position, one or more digital photos, and relevant attribute information were collected for each logged feature. All data and linked photos are stored in the Feature Inventory Geodatabase located on the Clark County server at: W:\PROJECT\011403, Needs Assessment Planning and Reports\GIS\Data\CWP Project Planning Database. Feature data includes field observations, estimated measurements, and notes describing important feature characteristics or potential projects.

The Feature Inventory project is not intended to be an exhaustive inventory of all human alterations to the stream corridor. Rather, the project seeks to identify the most significant features pertaining to stormwater management and potential stormwater mitigation projects.

Feature dimensions and other attribute data are estimates, and should not be utilized for quantitative calculations.

Study Area

The extent of the completed Feature Inventory in the Salmon Creek (RM 08.96) subwatershed is shown in Figure 10. Approximately 1.8 miles of the stream corridor was assessed in the subwatershed, entirely within two tributary streams. Mainstem Salmon Creek was not assessed. Most of the Woodin Creek subwatershed lies within the City of Battle Ground and was not assessed. Of the proposed survey extents, two properties were not accessible due to private property concerns.

Additional features of interest were recorded at road crossings, including those crossing creek mainstems, during a Road Reconnaissance survey in selected areas of Salmon Creek (RM 08.96) and the downstream end of the Woodin Creek subwatershed.

Results/Findings

A total of 69 features were logged. Forty-nine in-stream features were identified in the assessed reaches of Salmon Creek (RM 08.96). Twenty road crossings were visited during the Road Reconnaissance (17 in Salmon Creek (RM 08.96) and three in Woodin Creek). A breakdown of recorded features by type is presented in The Feature Inventory recorded significant conditions in the stream corridor relevant to SNAP components. Feature types are listed in Table 13.

Stream crossings (primarily culverts) were the most prevalent in-stream feature type identified, followed by impacted stream buffers, trash, and miscellaneous points of interest.

Table 13: Summary of Features Recorded in Salmon Creek (RM 08.96) and Woodin Creek Subwatersheds

Feature Type	Number Recorded
AGR - Aggradation	0
AP – Access point	0
CM – Channel modification	0
ER – Severe bank erosion	1
IB – Impacted stream buffer	7
IW – Impacted wetland	0
MB – Miscellaneous barrier	2
MI – Miscellaneous point	8
OT – Stormwater outfall	2
SCB – Stream crossing, bridge	1
SCC – Stream crossing, culvert	19
SCF – Stream crossing, ford	0
TR – Trash and debris	6
UT – Utility impact	0
WQ – Water quality impact	3
RR – Road Reconnaissance point	20
Total	69

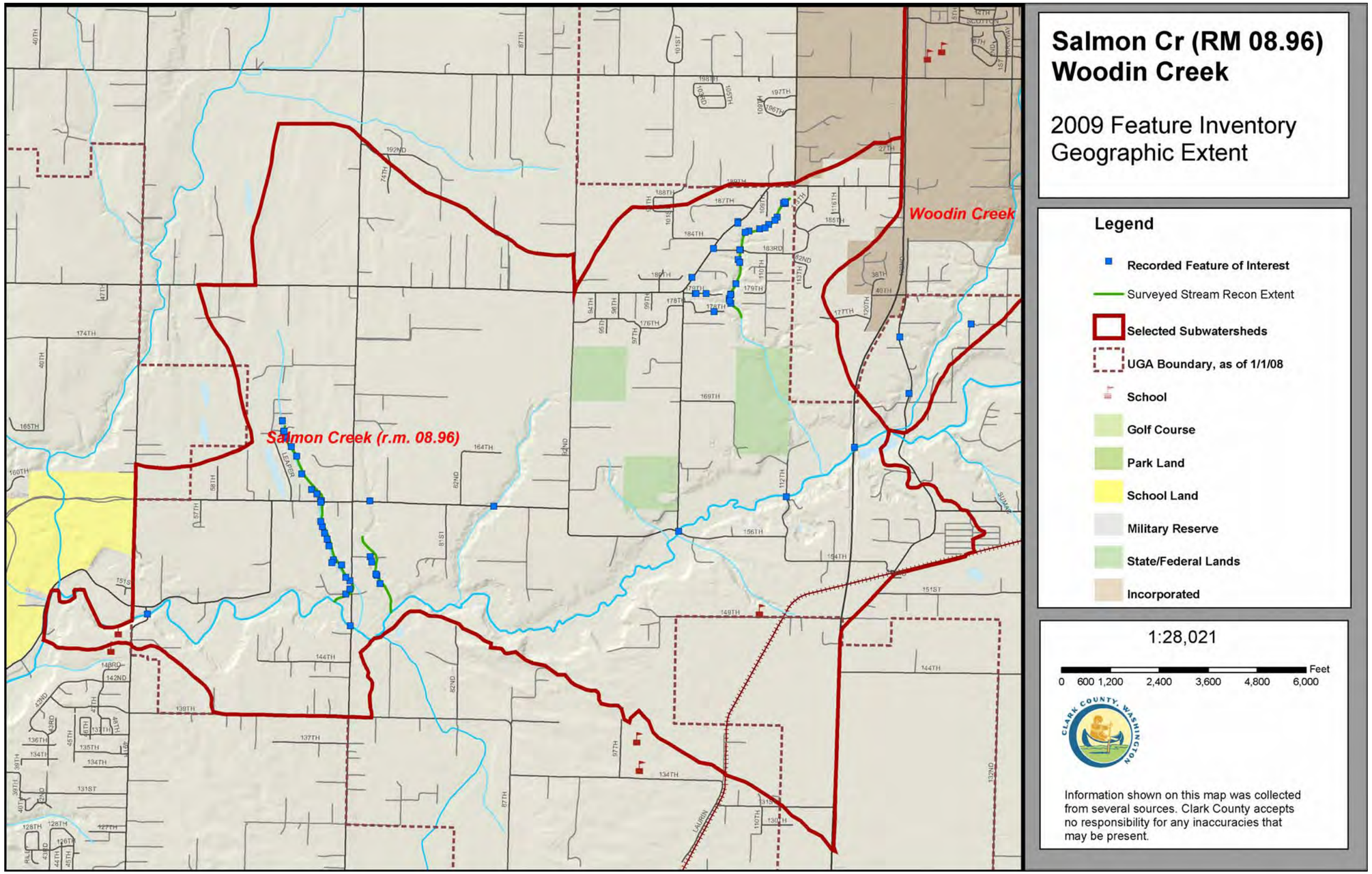


Figure 10: Salmon Creek (RM 08.96) and Woodin Creek: Geographic Extent of 2009 Feature Inventory

General Observations

The geographic scope of the Feature Inventory assessment was limited to a few small tributary reaches where development patterns indicated a higher likelihood of stormwater impacts in this largely agricultural and rural residential subwatershed (Salmon Creek (RM 08.96)).

Field observations suggest that stormwater conveyance in the surveyed tributaries is mainly via road ditches and agricultural field drains. The predominant source of stormwater appears to be runoff from agricultural land and rural residential developments draining to streams via small open channels such as field drain ditches, grassy swales, and roadside ditches. Very few facilities that treat consolidated stormwater flow were observed in surveyed areas.

Culverts were by far the most commonly noted feature in the surveyed reaches, indicating numerous road crossings, primarily private drives and farm roads. The presence of multiple culverts may pose fish passage issues, but most have not been assessed for fish passage potential. Undersized culverts may be providing some passive storage as water backs up behind the constriction.

Riparian conditions were degraded in most of the surveyed areas, particularly in the headwater areas. Though widespread, invasive plant species are less prevalent than in many subwatersheds surveyed in the past, apparently due to landowner efforts to keep pasture and streamside areas cleared. In some areas, riparian areas are nearly devoid of vegetation and livestock were observed with direct access to creek channels.

The discovery of numerous features of interest on small tributary channels indicates that significant stream impairments, potential environmental and safety hazards, and potential project opportunities may exist outside of the geographic scope of this Feature Inventory.

Potential Project Opportunities

Listed opportunities represent potential projects or project areas. They are not fully developed projects, and therefore require additional evaluation and development by Clark County or consultant staff. Identifying them as potential projects in this document is the first step in the process of developing capital projects.

Potential project opportunities were identified based on the results of the Feature Inventory conducted in the Salmon Creek (RM 08.96) and Woodin Creek subwatersheds. The CWP will evaluate the potential projects for further development or referral to the appropriate organization. Each potential project is listed in tables, including the basis for the project and a description of the potential project. The location of each potential project is shown in the figure(s) below. Potential project opportunities were categorized into six groups based on the nature of the potential work. A total of 24 potential projects were identified. A summary of identified project opportunities by potential project category is shown in Table 14. Figure 11 and Figure 12 show the general location of potential projects.

Table 14: Breakdown of Potential Project Opportunities by Category

Potential Project Category	Potential Projects Identified
Emergency/Immediate Actions	1
Stormwater Facility Capital Improvement Projects	1
Stormwater Infrastructure Maintenance Projects	1
Habitat Restoration/Enhancement Projects	1
Property Acquisition for Habitat Preservation	0
Referral Projects for other Agencies	20

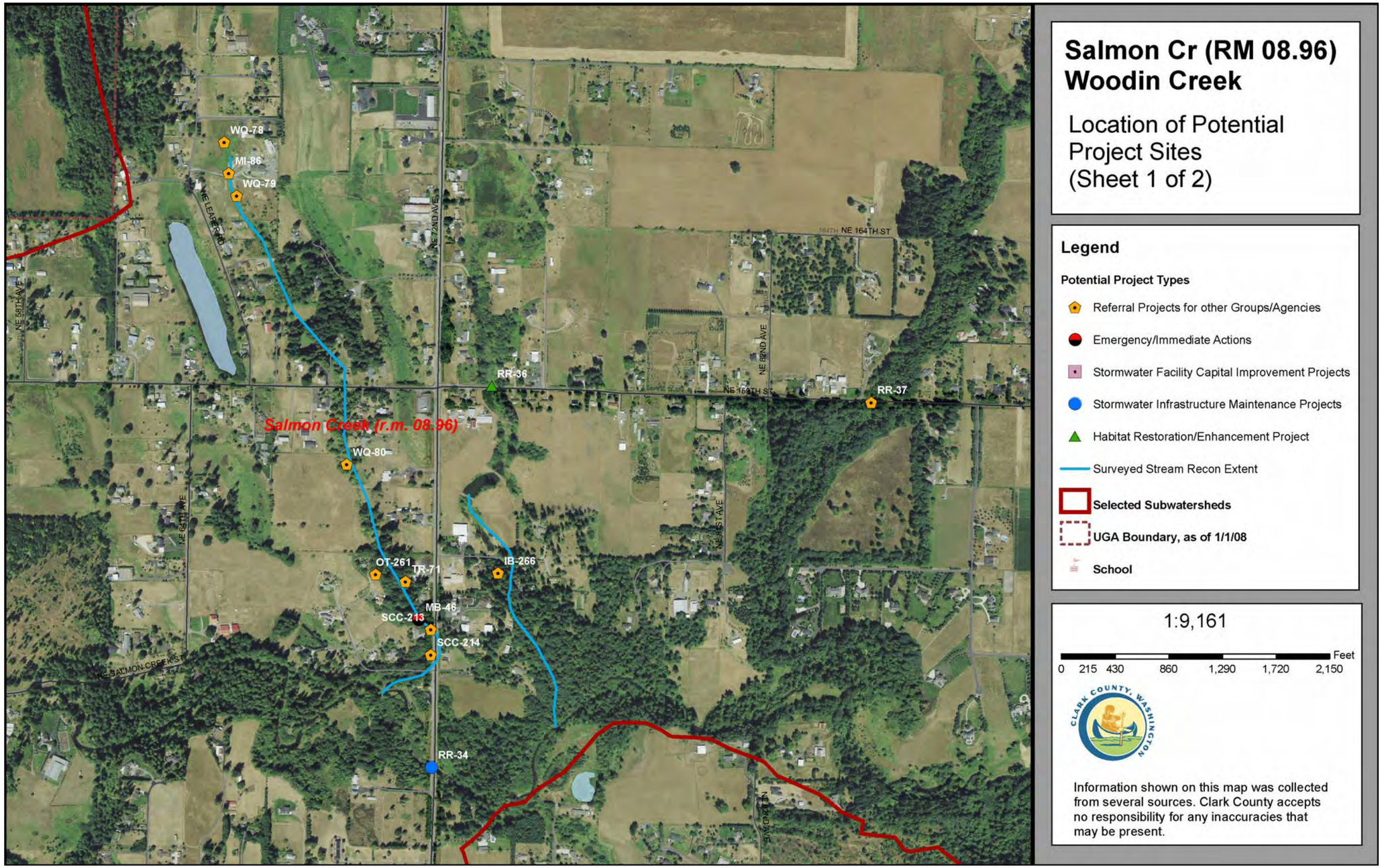


Figure 11: Salmon Creek (RM 08.96) Location of Potential Project Sites

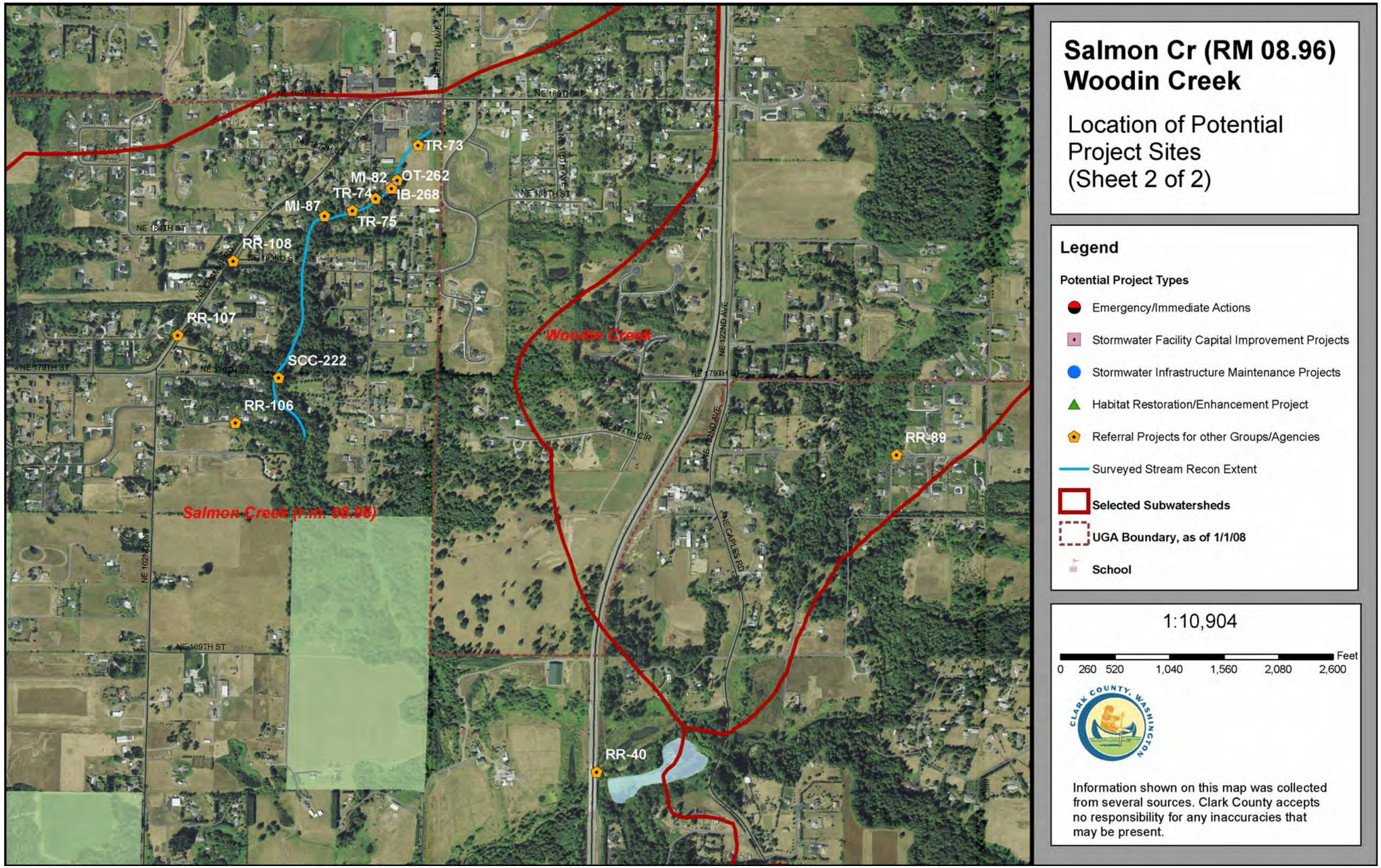


Figure 12: Salmon Creek (RM 08.96) and Woodin Creek Location of Potential Project Sites

Emergency/Immediate Actions
Emergency/Immediate Actions require an immediate site response project to address a potential or imminent threat to public heath, safety, or the environment.

Table 15: Description of Emergency/Immediate Actions

ID	Basis for Project	Project Description
MB-46 (includes SCC-213 and SCC-214)	Man-made dam with failed berm; still holding significant water but remaining berm is eroding; 130 feet upstream of public road, NE 72nd Ave. Combine with inspection of SCC-213 and 214: possible clogged culvert and drainage issues	Engineer inspection

Stormwater Facility Capital Improvement Projects
Stormwater Facility Capital Improvement Projects are projects that create new or retrofit existing stormwater flow control or treatment facilities. Facility retrofits include projects that will increase an existing facility's ability to control or treat stormwater in excess of the original facility's design goals.

Table 16: Description of Potential Stormwater Facility Capital Improvement Project Opportunities

ID	Basis for Project	Project Description
MI-82	Headwater stream is piped through property with existing private facilities and open space; receives significant flow from roadside ditches in City of Battleground UGA	Acquire property and existing facilities. Retrofit/expand for improved flow control. Potential cooperative project with City of Battleground.

Stormwater Infrastructure Maintenance Projects
Stormwater Infrastructure Maintenance Projects include potential projects which address and repair maintenance defects affecting existing stormwater infrastructure. Infrastructure maintenance projects are required by the County NPDES municipal stormwater permit. Projects in this category with estimated costs exceeding $10,000 are considered under the SCIP process. Projects addressing simpler maintenance defects are referred directly to the County Public Works Operations and Maintenance staff.

Table 17: Description of Potential Stormwater Infrastructure Maintenance Project Opportunities

ID	Basis for Project	Project Description
RR-34	Public facility on private parcel (ID 121, 72nd Ave & Salmon Creek facility). Appears to be overtaken with invasive plants.	Review facility for maintenance and evaluate for enhancements

Habitat Restoration/Enhancement Projects
Habitat Restoration/Enhancement Projects include potential projects which result in the restoration or enhancement of wetlands, upland forest, or riparian habitat. In-stream channel

habitat and bank protection projects do not fall within the scope of Clark County's CWP, and are placed under the category of Referral Projects for other Groups/Agencies.

Table 18: Description of Potential Habitat Restoration/Enhancement Project Opportunities

ID	Basis for Project	Project Description
RR-36	Up to 2 acres intact and degraded wetland; headwater; within mapped high quality wetland boundary (1993 CC)	Potential purchase for mitigation and/or wetland enhancement

Property Acquisition for Habitat Preservation
Property Acquisition for Stormwater Mitigation Projects includes potential acquisitions of properties for any purpose that meets permit requirements to mitigate for stormwater impacts. This includes preservation or restoration of upland forest and riparian habitat zones.

No opportunities of this type were identified in the surveyed reaches.

Referral Projects for Other Groups/Agencies
Referral Projects for other Groups/Agencies includes potential projects that do not fall within the defined scope of Clark County's CWP. This includes, but is not limited to, in-channel restoration, agricultural BMPs, fish-passage barrier removals, and invasive plant management. It also includes referrals for projects such as trash removal, stream culvert repairs/maintenance, and drainage projects.

Table 19: Description of Potential Referrals to Other Groups/Agencies

ID	Basis for Project	Project Description
IB-266	Ivy covering native plants for ~200' downstream of road crossing at 154th Street	Eradicate ivy. Reestablish native undergrowth and canopy vegetation
IB-268	Ivy has overtaken the area	Eradicate ivy. Reestablish native undergrowth
MI-86	Man-made channel draining to stream; riparian cover nonexistent	Establish native vegetation and provide erosion control
OT-262	Private facility is completely overgrown; outfall may be causing erosion in stream channel	Refer to Public Works for private facility inspection
RR-106	Erosion at public outfall	Refer to Public Works for maintenance and energy dissipator
RR-107	Erosion at public outfall	Refer to Public Works for maintenance and energy dissipator
RR-108	Ivy has taken over the area	Eradicate ivy. Reestablish native undergrowth
RR-37	Potentially intact stream habitat with healthy riparian canopy	Refer to ESA/Fish recovery program for evaluation
RR-40	Pond and wetland area on WSU parcel	Refer to ESA/Fish recovery program for evaluation: potential for off-channel rearing project
RR-89	Private facility overgrown with blackberries (ID 2026, ViewCrest Acres 2)	Refer to Public Works for private facility inspection

ID	Basis for Project	Project Description
SCC-222	Abandoned culverts under undeveloped 179th Street ROW have high potential for clogging; roadbed above may be failing	Refer to Public Works for inspection
TR-71	Significant amount of wood, plastic, and concrete debris on left bank	Refer to DES outreach
TR-73	Large amount of grass clippings pushed into creek channel; likely from commercial landscaper	Refer to DES Source Control program
TR-74	Significant amount of old trash in creek channel; tires, bottles	Refer to DES outreach
TR-75	Trash, dumping, and burn barrel near creek channel	Refer to DES outreach
WQ-78	Livestock access to creek channel	Refer to DES outreach and CCD
WQ-79	Livestock access to creek channel	Refer to DES outreach and CCD
WQ-80	Livestock access to creek channel	Refer to DES outreach and CCD
MI-87	Potential illicit discharge from residence to right bank of creek.	Refer to IDDE.
OT-261	Potential illicit discharge. May be a covered pipe, unknown source, causing gully erosion on bank	Refer to IDDE.

Stormwater Management Recommendations

A number of general stormwater management measures should be implemented throughout the Woodin Creek and Salmon Creek (RM 08.96) subwatersheds:

- Educate private landowners concerning importance of invasive plant removal, and suggest removal techniques.
- Educate private landowners on importance of native riparian vegetation for shading streams.
- Encourage appropriate agricultural practices that emphasize soil and water conservation, livestock exclusion fencing, and reduction in nutrient load to streams.
- Post stream identification signs where roads cross streams. Repair or replace deteriorated signs if necessary.
- Do not overlook stormwater and agricultural runoff inputs to small tributary streams that were not surveyed as a part of this Feature Inventory. These inputs may be more numerous than originally anticipated and likely represent the most significant source of water quality impairment in the subwatershed.

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 scales.

Methods

Physical habitat measurements were made for a single reach of Woodin Creek (Weaver 1, RM 0.0 to RM 2.0) and no reaches within Salmon Creek RM 8.96 by R2 Resource Consultants, Inc. (December 2004) for the Lower Columbia Fish Recovery Board. The project followed modified USFS Level II protocols.

Results

The R2 Resource Consultants, Inc. (R2) report includes a good narrative summary of the habitat survey results, including figures and tables, some of which are presented here. The full report may be found on the CWP website at:
http://www.clark.wa.gov/water-resources/documents-monitoring.html#strmac

The Weaver 1 survey reach is classified as a moderate gradient mixed control to moderate gradient contained channel type. The reach has a map gradient of 1.0 percent. The channel is strongly controlled by bedrock; however, because of the small stream size, confinement is moderate to high, depending on valley width. Habitat consists primarily of pools, which represents 42 percent of the survey reach habitat by length. Riffles and glides comprise the remainder of the habitat. The maximum depth of pools averages greater than 0.5 meters.

R2 noted that the dominant and subdominant substrate classes of streambed riffles are comprised of gravel (49 percent) and sand (33 percent). Embeddedness is rated in each habitat unit according to four categories (0-25%, 25-50%, 50-75%, and 75-100%). The overall mean embeddedness level is 51 percent. Table 20 summarizes habitat evaluations based on Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition standards.

Table 20: Summary of Habitat Evaluations of Woodin Creek (Weaver 1 Survey Reach) based on Washington Conservation Commission and NOAA Fisheries Properly-Functioning Condition Standards

Parameter	WCC[1]	PFC[2]
% Pool by Surface Area	Fair	
Pool Frequency		Not properly functioning
Pool Quality	Poor	Not properly functioning
LWD	Poor	Not properly functioning
Substrate	Poor	Not properly functioning
Streambank Stability	Good	Properly functioning
Water temperature	Poor	Not properly functioning

[1] Available Ratings: Good; Fair; Poor

[2] Available Ratings: Properly Functioning; At Risk; Not Properly Functioning

Geomorphology Assessment

Purpose

This report is an assessment of physical conditions in three unnamed Salmon Creek tributaries in the Salmon Creek (RM 08.96) subwatershed, based on field reconnaissance and review of remote sensing data. The field reconnaissance included characterizations of the channel, bank, and floodplain conditions at seven points. No reach delineations were made.

The objectives of this geomorphic assessment were to:

- Detail the geomorphic factors and processes influencing hydrology, sediment delivery, channel form, water quality, and habitat.
- Describe the apparent influence of past land use on geomorphic processes.
- Identify reaches that are unstable or moving toward unstable conditions under current channel morphologic and hydrologic conditions.
- Identify reaches that are stable or moving toward stable conditions under current channel morphologic and hydrologic conditions.
- Identify reaches that are most and least sensitive to future changes in hydrologic conditions.

Geomorphic field reconnaissance and remote sensing analysis results are used to make management recommendations and identify project types that might be implemented by Clark County to protect reaches that are currently unstable or sensitive to future disturbance, and to enhance the reaches that are currently stable or are less sensitive to future disturbance.

Methods

The geomorphic assessment is based on a reconnaissance of several points in unnamed tributaries to Salmon Creek (RM 8.96). The geomorphic reconnaissance was conducted in parallel with the stream reconnaissance and feature inventory. Channel, bank, and floodplain conditions were documented during the reconnaissance in December 2009. A detailed description of the methods used to document each channel, bank, and floodplain characteristic is provided in the see Stream Reconnaissance and Feature Inventory chapter.

Documented channel conditions included:

- Bankfull channel width and depth (or bank height where bankfull depth was not discernible).
- Channel gradient.
- Substrate material conditions.
- Sinuosity.
- Amount of functioning large woody debris (LWD).
- Channel type.
- Channel stability.

Channel types were based on the Montgomery and Buffington (1997) process-based classification system, which includes the cascade, step pool, plane bed, pool/riffle, dune/ripple, bedrock, and

colluvial channel types. Additional channel types identified included glide-cohesive/rectangular, excavated/constructed, wetland, impounded, and other. Channel stability of the surveyed reach was a field determination based on the channel's relative equilibrium within the context of its hydrologic regime, sediment supply, and riparian vegetation. Each reach's channel stability was based on visual determination of whether the channel appeared to be stable (dynamic equilibrium), actively incising, actively widening, actively incising and widening, or actively aggrading. It was also noted when a channel was forced into stability by unnatural processes (e.g., mechanical armoring).

Documented bank conditions included the location and relative percentage of active bank erosion, bank material conditions, and a classification of bank stability. Bank stability classification was based on a protocol that uses bank vegetation, undercutting, erosion and scalloping, exposed tree roots, and downed trees to classify a stream channel as stable, slightly unstable, moderately unstable, or completely unstable (Scholz and Booth 2001). This classification, combined with other bank assessment methods, provides a way to describe current and potential future bank stability conditions.

Documented floodplain conditions included the floodplain width and a classification describing the relative degree of floodplain connectivity between the active channel and the floodplain. This floodplain connectivity metric was used to describe how frequently the stream channel currently accesses the adjacent floodplain. Floodplain connectivity was assessed using the following qualitative categories:

- **Low connectivity**: The stream rarely exceeds the horizontal and vertical limits of the active/bankfull channel.
- **Medium connectivity**: The stream shows signs of occasionally overflowing the active/bankfull channel.
- **High connectivity**: The stream appears to exceed the limits of the active, bankfull channel, and inundates significant portions of the adjacent floodplain or overbank areas at regular (approximately annual) intervals.

Geomorphic field reconnaissance data were collected and entered in a geodatabase then reviewed using a geographic information system (GIS) and pertinent and available remote sensing data. For this geomorphic assessment, the reviewed GIS layers were Clark County's stormwater and sewer utility alignments, parcel boundaries, and two foot contours based on light detection and ranging (LiDAR) data (Clark County 2009).

The response potential is a qualitative classification that describes the likelihood that a reach will experience future channel degradation resulting from hydrologic changes. Each geomorphic survey point was classified as having low, moderate, or high response potential. This response potential is a preliminary estimate and should be field verified as part of project planning. Response potential is a function of the channel, bank, and floodplain conditions including existing channel and bank stability, channel and bank material conditions, channel gradient and level of functional LWD, underlying geologic conditions, and the existing level of development within the drainage areas contributing to the reach. Response potential classifications are as follows:

- **Low response potential**: May have geologic conditions that are resistant to channel change or may be artificially confined, armored, or lined to limit channel response.

- **Moderate response potential**: Has geologic or geomorphic conditions susceptible to alluvial changes caused by historic, ongoing, or future land use and hydrologic change in the watershed.
- **High response potential**: Exhibits alluvial characteristics, and is susceptible to extreme channel or geomorphic change if land use or the watershed's hydrologic patterns change.

Also, response potential generally increases as functional LWD and floodplain connectivity decrease.

Geologic Setting
The geology of the Salmon Creek (RM 08.96) subwatershed includes widespread cataclysmic flood deposits and recent alluvium in the Salmon Creek flood plain.

Cataclysmic flood deposits are silt to sand-sized sediments that are interpreted as slack-water deposits of large floods initiated by the failure of ice dams at Glacial Lake Missoula in western Montana during the late Pleistocene, regionally dated between 17,000 and 13,000 years ago (Everts 2004). Flood deposits are unconsolidated and are susceptible to erosion.

Recent flood plain alluvium along Salmon Creek is sand and grave deposited by Salmon Creek after the end of the Pleistocene Ice Age. The cataclysmic flood deposits are overlain by various silt loam soils. These soils are characterized by moderate to poor permeability that may locally inhibit infiltration.

Results
The findings of the geomorphic field reconnaissance indicate that the observed streams in the Salmon Creek (RM 08.96) subwatershed have been, and continue to be, influenced by both natural geologic characteristics and human development within the subwatershed. The geomorphic characteristics of the channel were also found to be influenced by localized features such as bank hardening, channel crossings, channel modifications, and riparian vegetation loss.

A total of 7 geomorphic points were collected on three small streams.
Figure 13, Figure 14, and Figure 15 illustrate the locations of each tributary, and the geomorphic data points. The geomorphic data collected for each reach are grouped by tributary and summarized in Table 21.

Data points GG-166 through 168 are on one tributary referred to as upper tributary. Data points GG-162 through 164 are on a single tributary referred to as lower tributary and data point GG-165 is the sole point on a third tributary referred to as middle tributary.

The following discussion focuses on the response potential of surveyed geomorphic reaches, and the specific physical characteristics and factors that determine the response potential in the Salmon Creek (RM 08.96) subwatershed. Refer to Table 21, Figure 13, Figure 14, and Figure 15 for the response potential and geographic location of individual reaches.

Table 21: Geomorphic data, Salmon Creek (RM 08.96) tributaries

Inventory Site ID #	Channel Conditions									Bank Conditions					Floodplain Conditions		Underlying Geologic Material	Response Potential
	Bankfull Channel Width (ft)	Bankfull Channel Depth (ft)	Channel Gradient (%)	Substrate Material		Sinuosity	Functional LWD	Channel Type	Channel Stability	Active Bank Erosion	Eroding Banks (%)	Bank Stability	Bank Material		Floodplain Width (ft)	Floodplain Connectivity		
				Primary	Secondary								Primary	Secondary				
GG-166	3	2	< 1%	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Incising	No data	< 5%	Moderately Unstable	Fines	Sand	35	Medium	Flood Deposits	Moderate
GG-167	3	1	< 1%	Fines	Sand	Low (1.0-1.2)	Prop functioning	Not reported	Widening	No data	< 5%	Slightly Unstable	Fines	Sand	30	Medium	Flood Deposits	Moderate
GG-168	3	2	< 1%	Fines	Fines	Medium (1.2 - 1.5)	At risk	Plane bed	Stable	No data	< 5%	Slightly Unstable	Fines	Sand	40	Medium	Flood Deposits	Moderate
GG-165	3	2	< 1%	Fines	Sand	Low (1.0-1.2)	At risk	Plane bed	Stable	No data	5 - 30%	Moderately Unstable	Fines	Sand	40	Medium	Flood Deposits	Moderate
GG-162	5	2	< 1%	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Stable	No data	< 5%	Forced stable	Fines	Sand	50	Medium	Flood Deposits	Low
GG-163	5	3	< 1%	Fines	Sand	Low (1.0-1.2)	Prop functioning	Wetland	Stable	No data	No data	Stable	Fines	Sand	20	Medium	Flood Deposits	Low
GG-164	7	3	< 1%	Fines	Sand	Straight (1.0)	Not prop functioning	Plane bed	Incising	No data	< 5%	Forced stable	Fines	Sand	60	Low	Flood Deposits	Moderate

LWD = Large woody debris

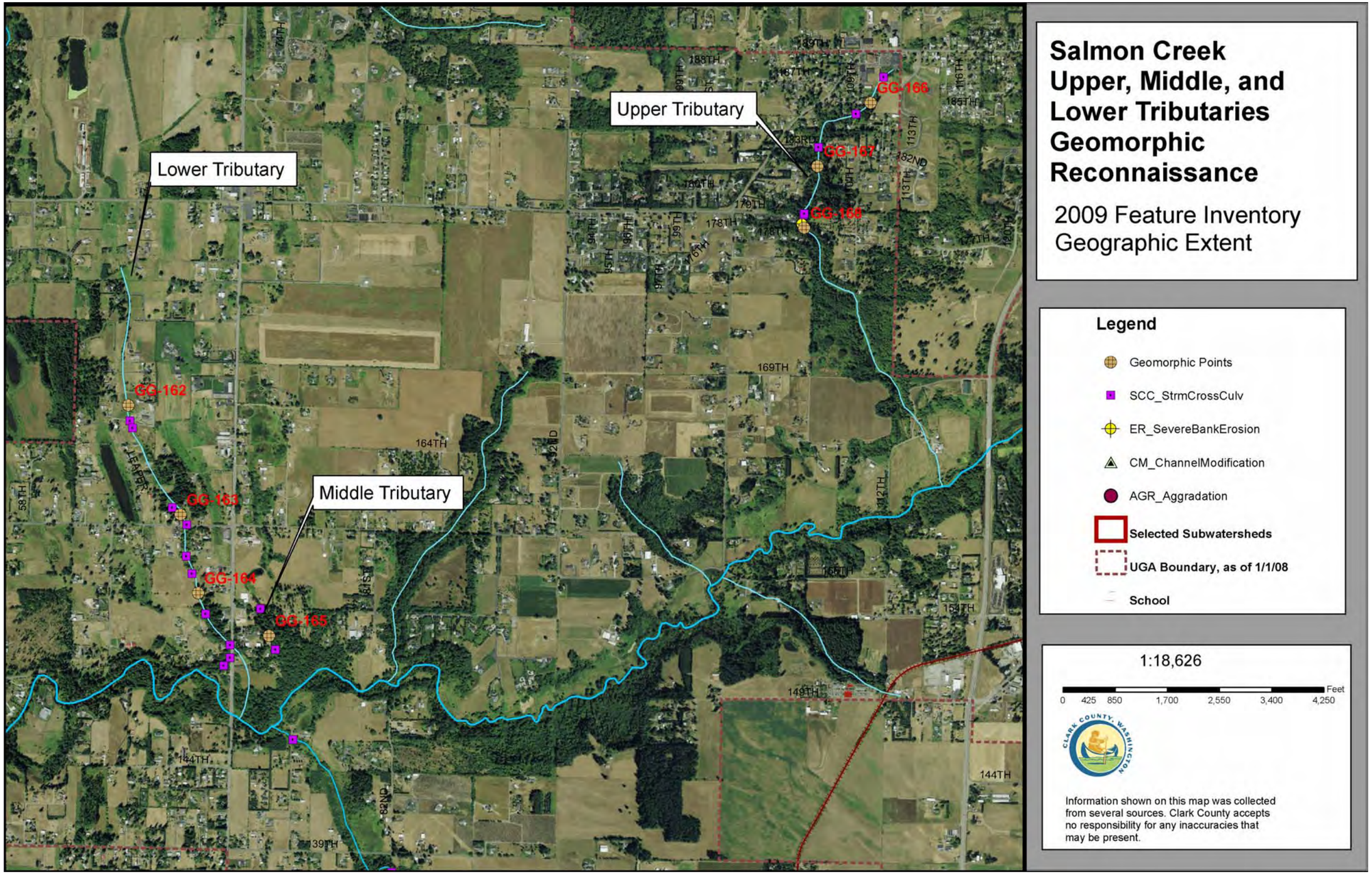


Figure 13: Geomorphic data points, Salmon Creek (RM 08.96) lower tributary

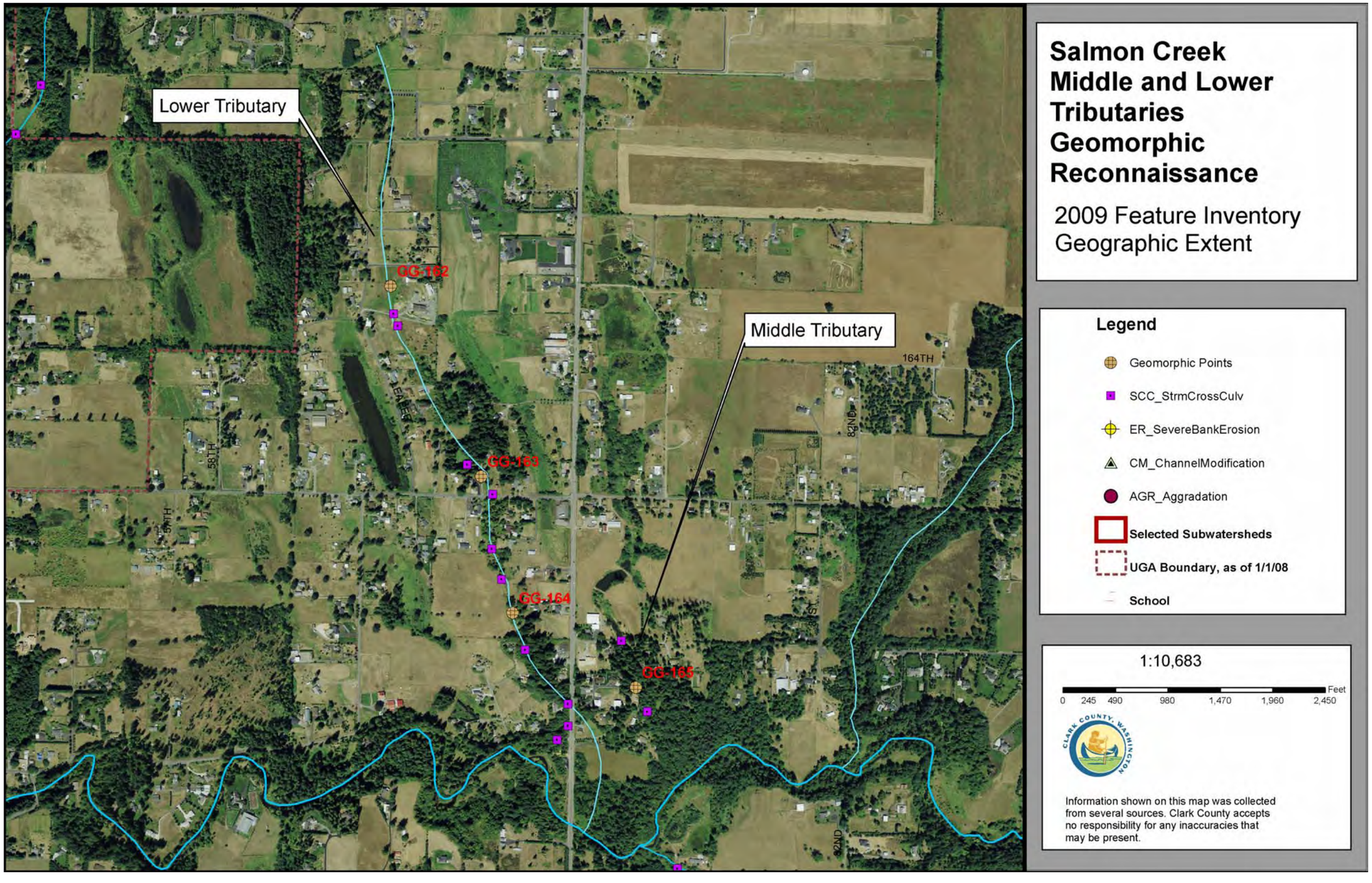


Figure 14: Geomorphic data points, Salmon Creek (RM 08.96) middle tributary

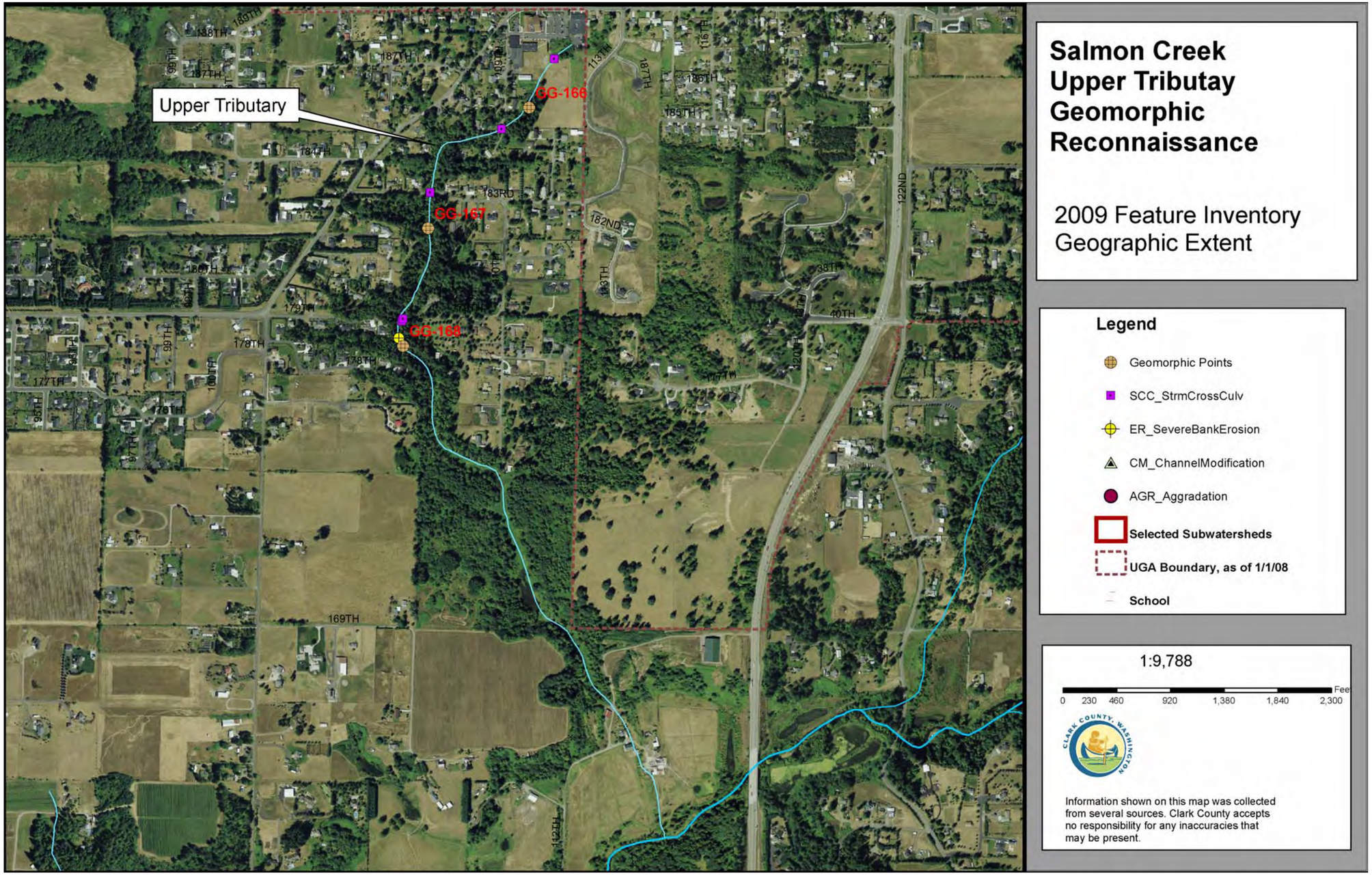


Figure 15: Geomorphic data points, Salmon Creek (RM 08.96) upper tributary

Response Potential by Tributary

Upper Tributary
Sites GG-166 through GG-168 are in an area draining relatively new suburban residential development and appear to be slightly to moderately unstable under current conditions. Overall this group of sites probably have a moderate response potential and are responding to the land cover change from agriculture to low density residential. The channel at these points is in fine-grained Catastrophic Flood deposits, which are easily eroded. The gradient is very low, with a narrow and relatively deep channel with moderate floodplain connection.

Middle Tributary
The tributary draining to site GG-165 has land cover that is a mix of small pastures, fields and residential development along main roads. The stream segment represented by GG-165 is in the lowermost part of the tributary where it has made a transition from a series of drained wetlands and manmade ponds to a stream channel. Field observations suggest that the channel is generally stable with some bank instability under current conditions. Riparian conditions are generally poor. The channel is in Catastrophic Flood deposits which are easily eroded. At GG-165, the stream has the potential to respond to development by widening due to erosion into fine-grained banks. There is also the potential to improve stability by improving riparian conditions. A notable feature of this tributary is the significant amount of wetlands associated with the main north south channel. Several of these are older stormwater facilities.

Lower Tributary
The tributary including sites GG-162, GG-163, and GG-164 has land cover that is mainly agricultural and drained wetlands in the upper part, transitioning to a mix of pasture and rural residential development downstream.

The stream location represented by GG-162 is the uppermost site on the tributary where the stream is actually a straight ditch draining wetland for agriculture. At this point the stream probably has a fairly low response potential due to its low gradient and ability to leave its banks and flood wetland fields.

At GG-163 the stream is a low gradient, stable wetland channel with good riparian conditions. While the channel is in fine-grained Catastrophic Flood deposits, the gradient and connected wetlands suggest that it has a relatively low response potential. The presence of a grade-controlling culvert immediately downstream of GG-163 also supports a relatively low response potential and potential for aggrading sediment at this site if land cover changes increase stream flows.

Site GG-164 is an incising channel in fine-grained Catastrophic Flood deposits, with poor flood plain connection. Riparian conditions are non-functioning as a mix of trees and pasture. Poor flood plain connection, poor riparian conditions, low gradient and fine-grained bank material suggest that this site has moderate response potential.

Management Recommendations

Based on geomorphic assessment results and information from other relevant inventories (e.g., stream features inventory), management recommendations have been developed that emphasize the following objectives:

- Protecting reaches that are currently marginally unstable or sensitive to future disturbance.
- Enhancing reaches that are currently stable or are less sensitive to future disturbance.

Recommendations to protect reaches include the implementation of projects that will prevent further channel degradation from changes in the watershed land use and hydrology. Enhancement recommendations include projects that will improve and help rehabilitate the geomorphic functions of existing reaches. For example, enhancement is recommended in reaches that exhibit self-forming alluvial channel characteristics.

In general, the management recommendations have been grouped according to broadly defined watershed management strategies for each geomorphic reach group, and specific rehabilitation project categories: channel, bank, and floodplain. The watershed management strategies and channel, bank, and floodplain rehabilitation projects are described in the following subsections.

Watershed Management Strategies

The geomorphic processes of the Salmon Creek (RM 08.96) subwatershed tributaries are inextricably linked with hydrologic processes and land use management in its watershed. Therefore, geomorphic-based management recommendations cannot succeed without addressing development trends and processes in the watershed. Practically speaking, the existing hydrologic regime is unlikely to significantly change, assuming the use of stormwater best management practices (BMPs) to address additional runoff from future development. Stormwater management should direct protection and restoration efforts where they have the greatest opportunity for success.

The tributaries within the Salmon Creek (RM 08.96) subwatershed present unique management opportunities. The following management strategies and recommendations may be effective at restoring geomorphic process and reducing the effects of altered hydrology when applied in the appropriate areas.

- **Manage runoff**: The area has relatively low levels of urbanization, and is largely rural residential with some agriculture. The presence of headwater wetlands presents an opportunity to manage runoff by restoring wetland hydrology to reduce frequency of erosive flow and manage runoff from future development.
- **Support channel function and encourage natural features**: Management strategies should continue to preserve riparian areas, while limiting or controlling access points to the creek. In addition, promoting the establishment of native vegetation, particularly conifers, would promote the success of channel rehabilitation projects as well as the natural ability of the channel to sustain physical channel complexity. Where channels are drained wetlands, examine the potential to restore wetland hydrology.

- **Conserve and protect areas with established LWD**: Few areas in the subwatershed have properly functioning levels of LWD in the channel, as well as mature or nearly mature riparian vegetation as a source of LWD recruitment. Canyons and ravines tend to be wooded and are protected by county habitat and wetland regulations.
- **Restore and preserve wetlands and established hydrologic processes**: Historically, the upper reaches of many of the tributaries within the Salmon Creek (RM 08.96) subwatershed included natural wetlands, probably as closed depressions. Most of them are now converted to fields and pastures through ditch networks. Land acquisition and preservation, in turn, can help prevent future hydrologic changes downstream and improve summer low flows by increasing recharge. County and federal laws regulate the filling of wetlands and can provide protection for existing wetlands. Projects to restore wetland hydrology, where feasible should be considered, especially in basins where urban development is anticipated.

Channel, Bank, and Floodplain Rehabilitation Projects

This section describes and categorizes potential projects that could be implemented to improve or maintain channel, bank, and/or floodplain conditions in Salmon Creek (RM 08.96) subwatershed tributaries. Table 22 summarizes (by reach) where project categories are most appropriate.

Channel Rehabilitation

Potential actions that could promote in-channel stabilization throughout the Salmon Creek (RM 03.83) subwatershed tributaries include the following.

Grade Control. Grade control features are intended to limit channel incision, increase the base channel elevation, and improve overbank and floodplain connectivity. Placement of grade control structures is recommended in reaches where reducing channel incision would improve stream stability and function.

Grade control would be most appropriate in reaches where incision is common and ongoing, and where the channel exhibits self-forming alluvial characteristics and the potential for rehabilitating floodplain connectivity. Also, grade control structures could be especially beneficial if added in strategic locations where nickpoint migration threatens to cause increasing channel incision and channel degradation, or where further incision or associated bank erosion could threaten infrastructure, such as road crossings and utility alignments.

Table 22: Potential channel rehabilitation projects by category.

Tributary	Site	Channel Rehabilitation Project Categories												
		Channels						Banks						Floodplain
		Grade Control		LWD Placement		Channel Realignment		Stabilization		Revege-tation		Structure Removal		Revegetation
Upper Tributary r	GG-166	X								X				
Upper Tributary	GG-167			X						X				
Upper Tributary	GG-168			X						X				
Middle Tributary	GG-165			X						X				
Lower Tributary	GG-162					X				X				X
Lower Tributary	GG-163									X				X
Lower Tributary	GG-164	X		X						X				X

Large Wood Debris Placement. In-channel LWD creates hydraulic and habitat complexity. Placement of LWD is recommended where it can improve stream function by increasing channel complexity and stability and enhance floodplain connectivity. LWD can also be placed to function as grade control. Due to the elevated risk of failure in the urban environment, LWD placement should be carefully engineered.

Channel Realignment. Channel realignment is recommended when erosion threatens infrastructure or to enhance habitat. In Salmon Creek (RM 08.96) subwatershed tributaries, habitat could be improved by realigning ditches to create or improve wetland or channel habitat, as well as improve geomorphic and hydrologic processes.

Bank Rehabilitation

Bank Stabilization. Bank stabilization structures are intended to stabilize a failing or eroding bank. Bank stabilization structures could incorporate LWD placement as well as revegetation with native species. Placement of bank stabilization features is recommended where these structures would improve overall bank conditions, prevent further degradation at locations of severe erosion, and/or protect infrastructure.

Due to the relatively stable conditions in these streams, no bank stabilization project areas are recommended.

Bank Revegetation. Bank revegetation is intended to restore vegetation quality and quantity. Revegetation with native species can help control the spread of invasive species. Bank revegetation can improve bank stability, stream cover, and eventually supply large wood debris for restoring and preserving channel habitat. These goals are applicable in almost any stream reach. They can be leveraged on county open space improvements such as trail construction. Revegetation efforts would need to be coupled with the removal of invasive species and regular maintenance to ensure the survival of native plant species.

Bank re-vegetation is recommended for much of Salmon Creek (RM 8.96) due to the extensive loss of natural vegetation and replacement by cover such as blackberries and reed canary grass. Most of this work would be on private land.

Bank Structure (Hydromodification) Removal (e.g. Riprap Removal). Previous treatments may no longer function as originally intended, or may be failing altogether. Removal of these structures is recommended where removal can improve stream function and habitat. None were observed in the geomorphic field work.

Floodplain Revegetation

Floodplain revegetation is intended to restore vegetation quality and quantity that influence flood plain habitat, woody debris delivery, shade, and flood control functions. Reestablishment of native species can help control invasive weeds throughout the creek's floodplain areas. Floodplain revegetation should be considered in conjunction with other riparian planting strategies such as bank revegetation. Revegetation of flood plain wetlands is recommended for headwater streams where aerial photography shows ditches or channels through fields.

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, and 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), but also with analysis of the Salmon Creek Limiting Factors Analysis Report (HDR Engineering, Inc., 2002). These reports apply primarily to salmon-bearing stream reaches and therefore do not provide information for many smaller streams. 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 their respective sections, and most are included on a final list for referral to outside agencies.

The 2002 Salmon Creek Limiting Factors Analysis and the 2004 LCFRB Habitat Assessment report were 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.

Data sources are primarily the 2004 LCFRB Habitat Assessment for the Salmon Creek (RM 08.96) and Woodin Creek subwatersheds. The full characterization report is available on the Clark County website at: http://www.clark.wa.gov/water-resources/documents.html#mon.

For areas within the subwatersheds not included in the habitat assessment (tributaries to Salmon Creek and Woodin Creek), LWD recruitment potential and shade rating analyses were based on a qualitative review of 2007 orthophotographs.

Results

Riparian (Large Woody Debris (LWD) Delivery)

LWD recruitment potential is primarily fair for Salmon Creek (RM 08.96) and especially so for Woodin Creek. Table 23 summarizes estimated percentages of total mainstem stream lengths by LWD recruitment potential condition for each subwatershed. Figure 16 shows the Salmon Creek (RM 08.96) and Woodin Creek subwatersheds assessed LWD delivery potential. Within the Salmon Creek (RM 08.96) subwatershed, the assessment includes the mainstem of Salmon Creek and one tributary entering Salmon Creek from the north. The assessment reaches of Salmon Creek are mapped as having primarily low and medium LWD recruitment along approximately nine of the eleven miles of left and right streambanks assessed. The mainstem of Salmon Creek is shown as having lower levels of LWD recruitment, especially on the right bank, in areas upstream of approximately NE 88th Ave. The assessed tributary from the north is shown as having low LWD recruitment.

Non-assessed reaches within the Salmon Creek (RM 08.96) subwatershed appear to have various degrees of LWD recruitment potential. Some reaches, including a tributary entering Salmon Creek from the north at about NE 81st Ave, as well as tributaries entering Salmon Creek from the northwest and from the southeast at about NE 156th St, flow through forested areas and likely have high LWD recruitment potential. Others, including tributaries entering Salmon Creek from the north at about NE 72nd Ave, flow through non-forested areas and likely have low to medium LWD recruitment potential.

Within the Woodin Creek subwatershed, the assessment includes the mainstem of Woodin Creek and one tributary entering Woodin Creek from the north. The assessed reaches of Woodin Creek are mapped as having primarily medium LWD recruitment along approximately seven of the twelve miles assessed. The assessed tributary from the north is shown as having high to medium LWD recruitment.

Non-assessed reaches of and tributaries to Woodin Creek pass through a variety of vegetative cover classes and would be expected to exhibit various LWD recruitment levels accordingly.

Table 23 Salmon Creek (RM 08.96) and Woodin Creek LWD Recruitment Potential (R2 Resource Consultants Inc. 2004)

	Frequency	
Condition	**Salmon Creek Mainstem**	**Woodin Creek Mainstem**
Good	20%	23%
Fair	47%	61%
Poor	34%	16%

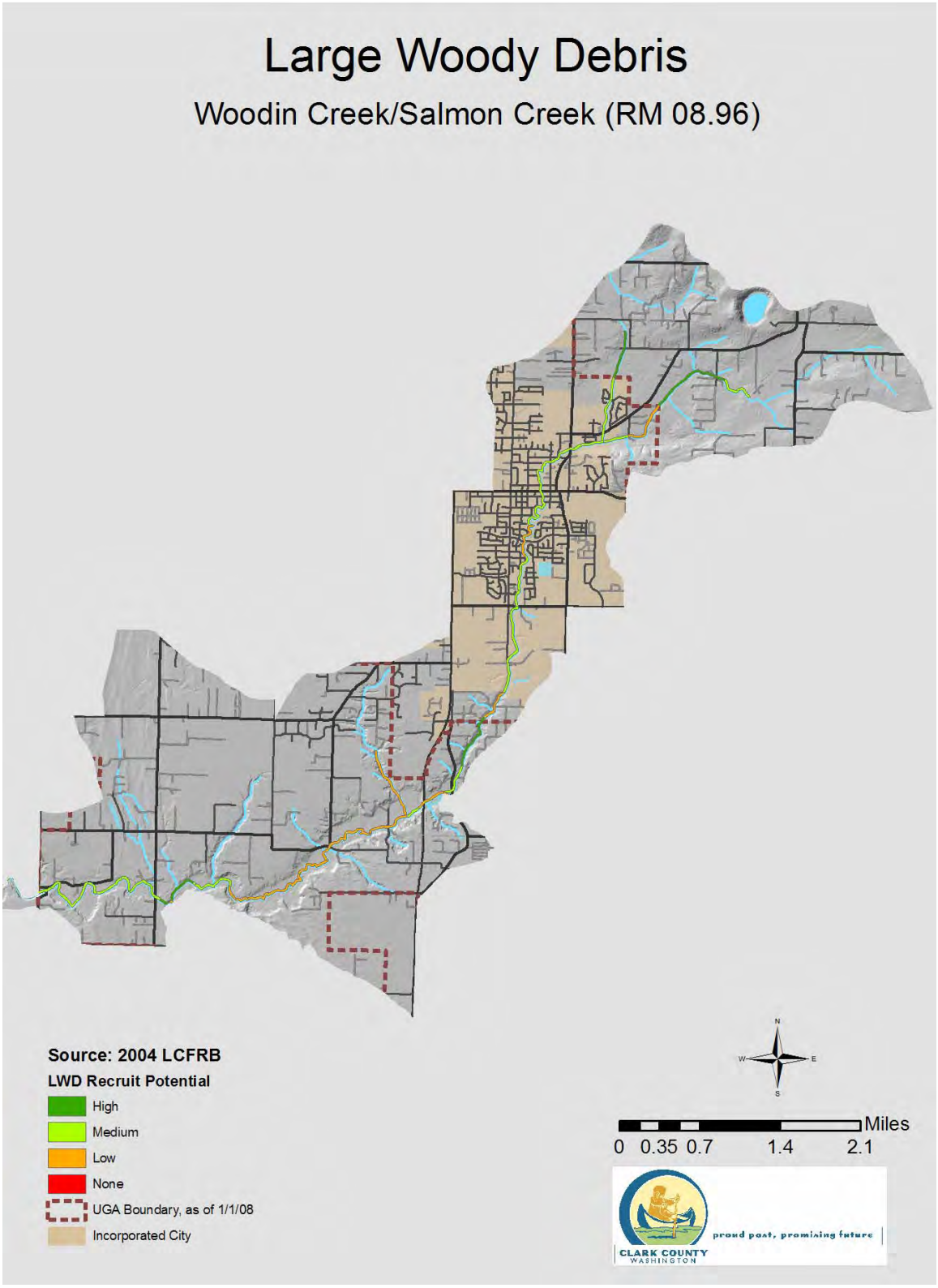


Figure 16: Woodin Creek and Salmon Creek (RM 08.96) LWD Recruitment Potential (adapted from R2 Resource Consultants, Inc., 2004)

Shade

The Salmon Creek (RM 08.96) and Woodin Creek subwatersheds shade ratings from the 2004 LCFRB Habitat Assessment are illustrated on Figure 17. Within the Salmon Creek (RM 08.96) subwatershed, the assessment covered the mainstem of Salmon Creek and an unnamed tributary entering Salmon Creek from the north. The mainstem of Salmon Creek within the Salmon Creek (RM 08.96) subwatershed has shade levels ranging from 10 to 30 percent. The tributary from the north has a shade level of 10 percent.

Non-assessed reaches within the Salmon Creek (RM 08.96) subwatershed appear to have various levels of shade. Some reaches, including a tributary entering Salmon Creek from the north at about NE 81st Ave, as well as tributaries entering Salmon Creek from the northwest and from the southeast at about NE 156th St, flow through forested areas and likely have relatively high shade values. Others, including tributaries entering Salmon Creek from the north at about NE 72nd Ave, flow through non-forested areas and likely have low values for shade.

Within the Woodin Creek subwatershed, shade ratings were in the range of 10 to 30 percent in the assessed reaches of Woodin Creek. The assessed tributary from the north is also shown as having shade values ranging from 10 to 30 percent.

Non-assessed reaches of and tributaries to Woodin Creek pass through a variety of vegetative cover classes and would be expected to exhibit various shade values accordingly.

The LCFRB habitat assessment for the Salmon Creek (RM 08.96) and Woodin Creek subwatersheds indicated that all of the reaches are currently off-target with respect to the State Forest Practices shade/elevation screen standards.

Management Recommendations

Overall recommended management activities for the Woodin Creek subwatershed from RM 0.0 to RM 2.0 include improving riparian condition and large wood potential by hardwood conversion, conifer release, or riparian plantings. For all tributaries of Salmon Creek, recommended management activities include placing wood in low gradient portions of tributaries.

Potential Projects

Potential projects in the Woodin Creek subwatershed may be limited by the urban setting of Woodin Creek and the general lack of publicly owned land on its banks. Within the city limits of Battle Ground, Woodin Creek passes through Hidden Glen Park and other properties that contain existing Clark County Public Works mitigation projects. Portions of these areas are currently forested, and portions have been more recently planted with native trees and shrubs. These areas will over time contribute more shade and LWD to Woodin Creek.

Within the Salmon Creek (RM 08.96) subwatershed, the mainstem of Salmon Creek flows through one parcel that is owned by Clark County: Pleasant Valley Park (parcel # 186013-000). This park is the location of several Clark County Public works mitigation projects, as well as a Clark Public Utilities enhancement project. Still, some opportunity does exist to establish forested vegetation on the north bank of Salmon Creek at this parcel. The mainstem of Salmon Creek within this subwatershed is the location of numerous other Clark County and Clark Public

Utilities enhancement sites distributed along its length. A "cluster" of enhancement opportunities s exists immediately downstream (west) of NE 72nd Ave, for example. One of the southern tributaries crosses the Chelatchie Prairie Railroad, a county-owned property that may present limited enhancement opportunity.

Below (Table 24) is a summary of public owned lands within these watersheds.

Table 24: Tax Exempt Parcels Overlapping Potential Riparian Restoration Areas

ASSR_SN	ASSR_AC	OWNER	PT1DESC	Description
186013-000	8.65 acres	Clark County, c/o Parks Department	Unused or vacant land	Parcel contains many existing mitigation and enhancement projects for Clark County Public Works and Clark Public Utilities, but may have opportunity for further enhancement
300004-000 300007-000	34.72 acres 102.76 acres	Clark County, c/o Public Works	Railroad Right-of-way	Contains Chelatchie Prairie Railroad, may present limited opportunity for enhancement where streams cross

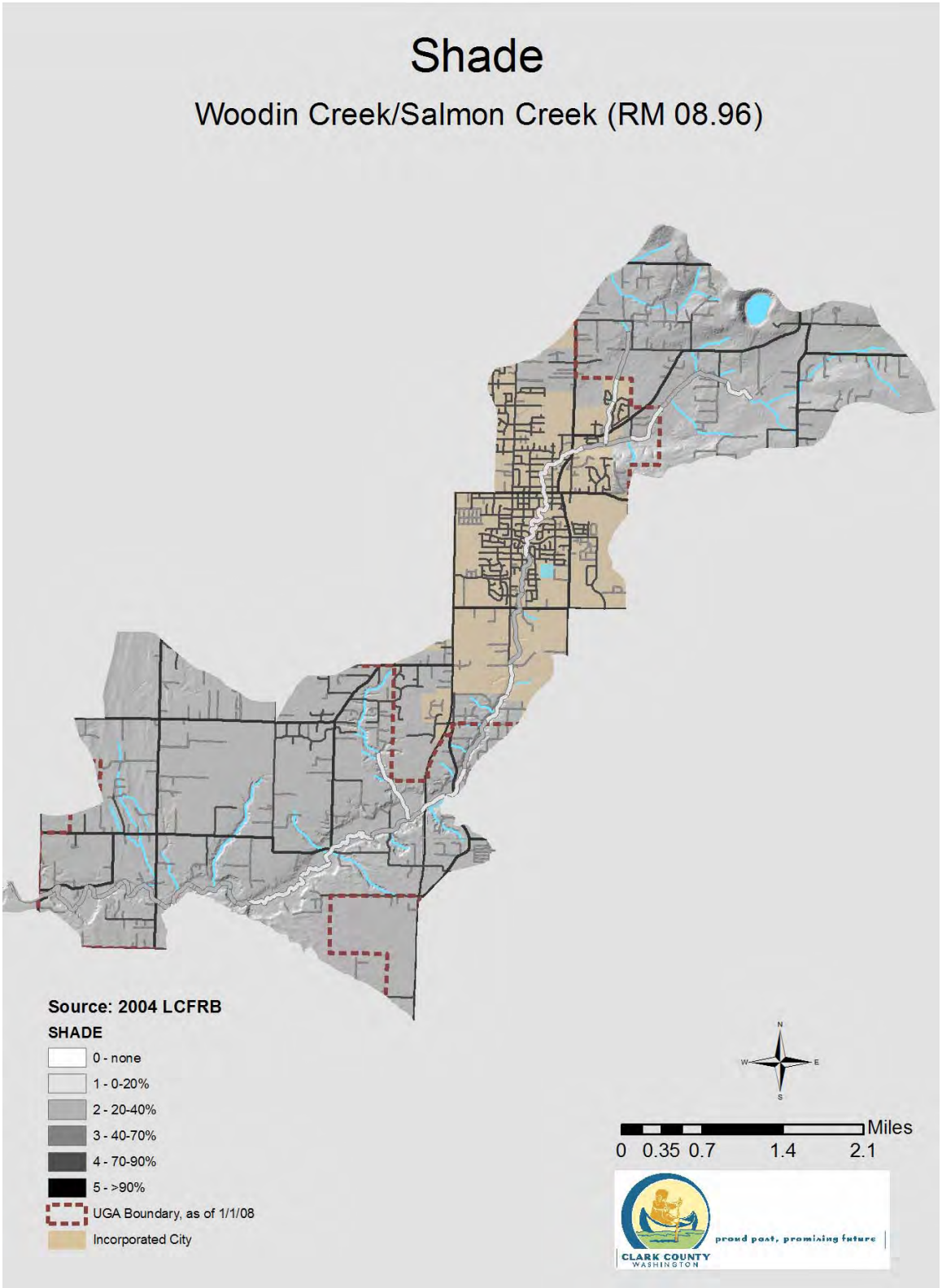


Figure 17: Woodin Creek and Salmon Creek (RM 08.96) Shade Values (adapted from R2 Resource Consultants, Inc, 2004)

Floodplain Assessment

A floodplain assessment was not conducted.

Wetland Assessment

Purpose

Wetlands perform important hydrologic, water quality, and habitat functions. The primary reasons for the wetlands 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
- 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.

Potential project sites have been reviewed and verified through field reconnaissance and are detailed in the results section below.

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 18 shows potential wetland areas within the Woodin Creek/Salmon Creek (RM 08.96) subwatersheds based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory, and high-quality wetlands layer.

The Woodin Creek and Salmon Creek (RM 08.96) subwatersheds have potential riverine wetland areas associated with the riparian corridor and floodplain areas of the main creeks. There are sloped wetlands in the eastern and northern parts of Battle Ground and isolated sloped and depressional wetlands in the Salmon Creek (RM 08.96) subwatershed. Table 25 shows the total area and proportion of wetland classes estimated to be present in the subwatershed.

Table 25 Distribution of Wetlands by Hydrogeomorphic Class

HGM Class	Area (ac.)	% of Sub-basin*	% of total wetland
Lacustrine Wetlands	29	0.3%	2%
Slope Wetlands	618	6%	44%
Depressional Wetlands	537	5%	38%
Riverine Wetlands	236	2%	17%
All Wetlands	1418	14%	

*Subwatershed area 9,953 Ac.

A significant portion of the wetlands outside the stream floodplains have been cleared and partially drained for agricultural use. There is restoration potential; however there is very little publicly held or tax-exempt land containing wetlands in the subwatershed. There is potential for the County to encourage off-site wetland mitigation to restore or enhance wetland functions, particularly west of Brush Prairie. The City of Battle Ground might consider emphasizing protection and restoration of wetlands in the middle and upper reaches of Woodin Creek as the city expands to the east and north. Without a land acquisition program, there are limited opportunities for further public wetland restoration projects in this subwatershed.

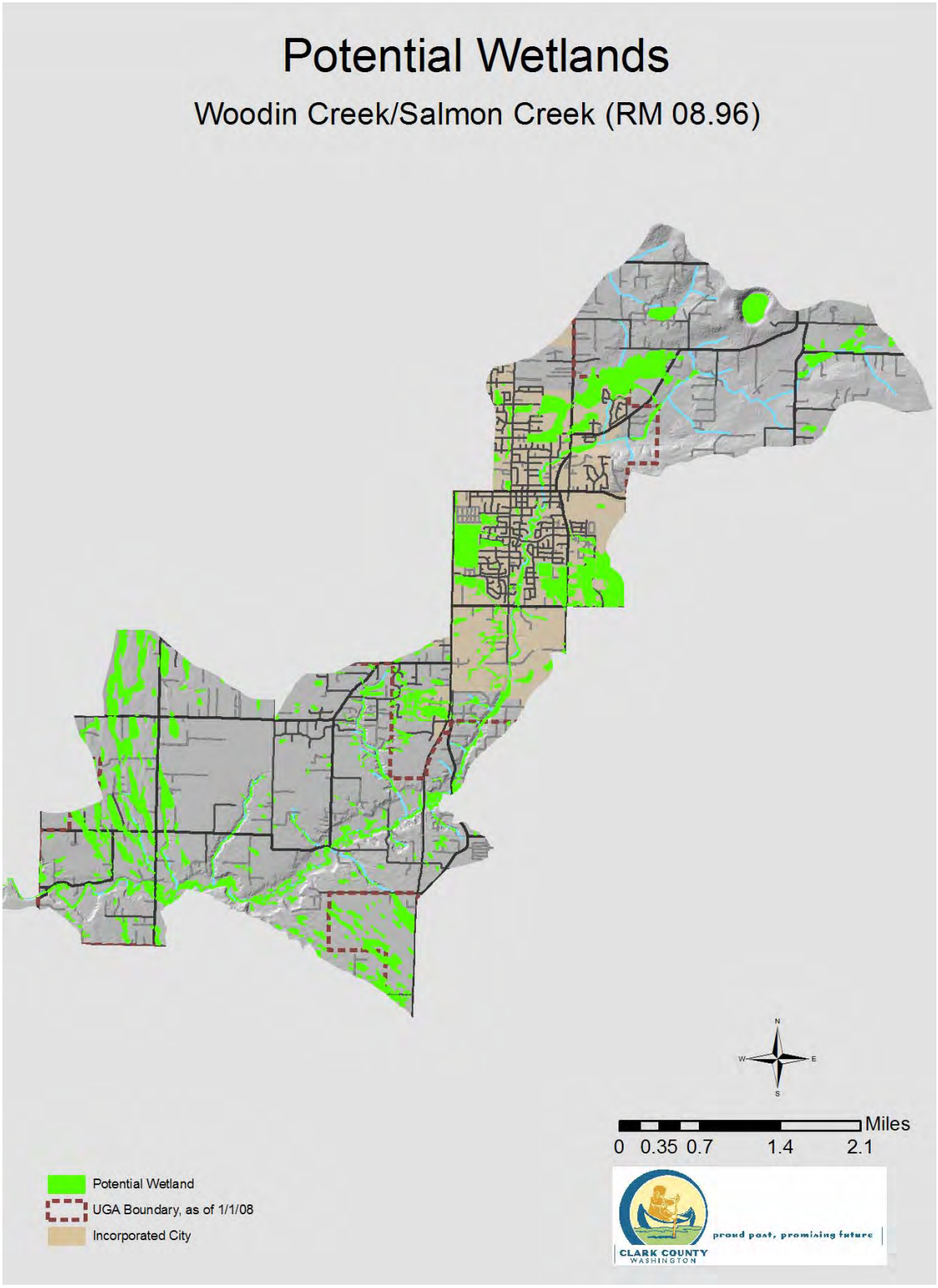


Figure 18: Woodin Creek and Salmon Creek (08.96) Potential Wetlands

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 Watershed Characterization and Analysis of Clark County (Washington Department of Ecology, 2009) may be found on the Ecology website at:
http://www.ecy.wa.gov/mitigation/docs/09-06-019_small.pdf

Results pertaining to the Woodin Creek/Salmon Creek (RM 08.96) subwatersheds are summarized below.

The Woodin Creek/Salmon Creek (RM 08.96) subwatersheds are part of the Terrace hydrogeologic unit. This unit is dominated by rain; has a westward to southwestern trending groundwater flow pattern; a large delta (now a terrace) formed by glacial floods consisting of gravels, sand, silts and clay; and a relatively level to moderately steep topography in the foothills and slopes above the Columbia River (Ecology, 2009).

Figure 19 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.

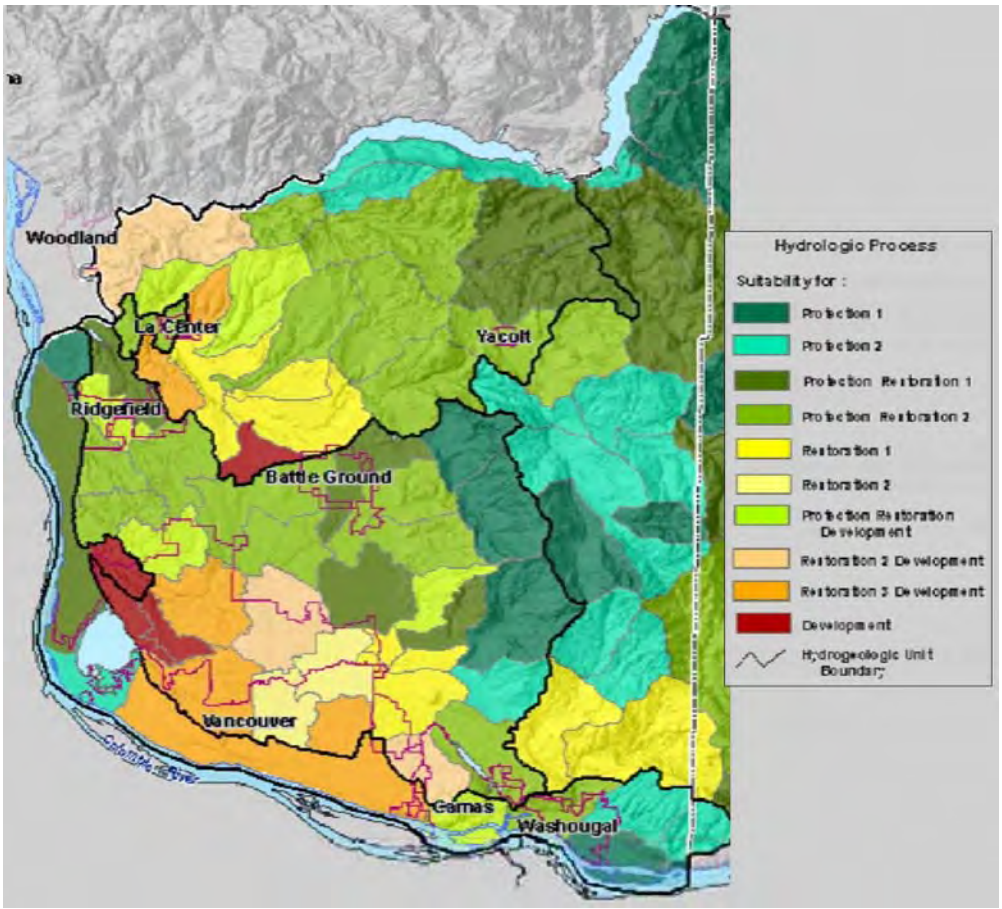


Figure 19: Priority areas for protection and restoration of hydrologic processes (from Watershed Characterization and Analysis of Clark County (Ecology, 2009))

In general, blue and 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. Because orange areas represent a transition from restoration areas, planning measures employing both restoration and appropriately sited development should be considered (Ecology, 2009).

Protection Restoration 1 (dark green) is the hydrologic process priority for the Woodin Creek subwatershed and Protection Restoration 2 (green) is the hydrologic process priority for the Salmon Creek (RM 08.96) subwatershed.

Macroinvertebrate Assessment

Purpose

The Benthic Macroinvertebrate Index of Biological Integrity or B-IBI (Karr, 1998) is a widely used measurement of stream biological integrity or health based on macroinvertebrate populations. Macroinvertebrates spend most of their lives in the stream substrate before emerging as adults. While in the stream, they are subject to impacts from continuous and intermittent pollutant sources, hydrology and habitat changes, and high summer water temperatures.

The B-IBI score is an index of ten metrics describing characteristics of stream biology, including: tolerance and intolerance to pollution, taxonomic richness, feeding ecology, reproductive strategy, and population structure. Each metric was selected because it has a predictable response to stream degradation. For example, stonefly species are often the most sensitive and the first to disappear as human-caused disturbances increase, resulting in lower values for the metric "Number of Stonefly taxa".

In addition to the overall B-IBI scores, examining individual metric scores gives insight into stream conditions and better explains differences in the overall score.

Methods

All field and laboratory work followed CWP protocols for macroinvertebrate sampling and analyses (June 2003). Samples are collected during late summer, preserved, and delivered to a contracted lab for organism identification, enumeration, and calculation of B-IBI metrics.

Raw data values for each metric are converted to a score of one, three, or five, and the ten individual metrics are added to produce an overall B-IBI score ranging from 10 to 50. Scores from 10 to 24 indicate low biological integrity, from 25 to 39 indicate moderate integrity, and greater than 39 indicate high biological integrity.

Results are influenced by both cumulative impacts of upstream land use and reach-specific conditions at or upstream of sampling sites. Thus, samples from a reach integrate local and upstream influences. Many of the B-IBI metrics are also influenced by naturally occurring factors in a watershed; for example, the absence of gravel substrate can lower scores.

Macroinvertebrate monitoring in the assessment area has occurred at multiple locations and varying frequencies. Woodin (Weaver) Creek macroinvertebrate samples were collected in the lower portion of the watershed near NE 169th Street for Clark Public Utilities in 2001 (Clark Public Utilities, 2002), just south of 132nd Avenue at station WDN030 by the CWP in 2004 (Clark County Public Works, 2005) , and downstream from NE 181st Circle at Station WDN018 by the CWP in 2008. Salmon Creek (RM 8.96) macroinvertebrate samples were collected along the main stem above Mill Creek for Clark Public Utilities (Clark Public Utilities, 2002) during 1996 and 2001.

Results

Woodin Creek total B-IBI scores of 24 in 2001, 22 for both WDN030 in 2004 and WDN018 in 2008 place them in the upper portions of the low biological integrity category.

Table 26 shows that both WDN030 and WDN018 have five low, four moderate, and one high score among their average yearly individual metrics but their pattern differs for four of the metrics. Consistently low scoring for Mayfly, Stonefly, intolerant taxa, and percent predator taxa metrics for both stations over both years suggest the presence of pollutants such as heavy metals or pesticides, degraded water and habitat quality, and decreasing diversity in prey items (Fore, 1999).

B-IBI scores of 22 (1996) and 32 (2001) in the mainstem within the Salmon Creek (RM 08.96) subwatershed vary from the upper low to moderate range of biological integrity.

Table 26: Station WDN018 and Station WDN030 Annual Macroinvertebrate Community Metrics and Total Scores from 2004 and 2008

B-IBI Metrics	WDN030 2004			WDN018 2008		
	Value	Score	Category	Value	Score	Category
Total number of taxa	29	3	moderate	37	3	moderate
Number of Mayfly taxa	3	1	low	3	1	low
Number of Stonefly taxa	0	1	low	3	1	low
Number of Caddisfly taxa	4	1	low	7	3	moderate
Number of long-lived taxa	5	5	high	3	3	moderate
Number of intolerant taxa	0	1	low	1	1	low
Percent tolerant taxa	23.5	3	moderate	67.6	1	low
Percent predator taxa	3.9	1	low	2.4	1	low

B-IBI Metrics	WDN030 2004			WDN018 2008		
	Value	Score	Category	Value	Score	Category
Number of clinger taxa	12	3	moderate	25	5	high
Percent dominance (3 taxa)	74.6	3	moderate	57.1	3	moderate
Summary of avg. metric scores		22	low		22	low

Booth et al. (2004) found that there is a wide but well defined range of B-IBI scores for most levels of development, but observed overall that B-IBI scores decline consistently with increasing watershed total impervious area (TIA).

By comparing Woodin Creek and Salmon Creek RM 8.96 to the likely range of conditions for watersheds with similar amounts of development, measured as total impervious area, it is possible to make some general statements about the potential benefits from improving stream habitat.

Figure 20 shows that both of Woodin Creek's B-IBI scores are in the lower third of the range of expected scores (estimated 2000 Total Impervious Area from Wierenga, 2005). With B-IBI scores falling toward the lower end of the typical range for subwatersheds with about 24 percent impervious area, Woodin Creek significantly underperforms given its moderate levels of TIA. It is likely that factors other than impervious area are contributing to the low scores, and biological integrity could probably be increased by improving habitat and stream conditions.

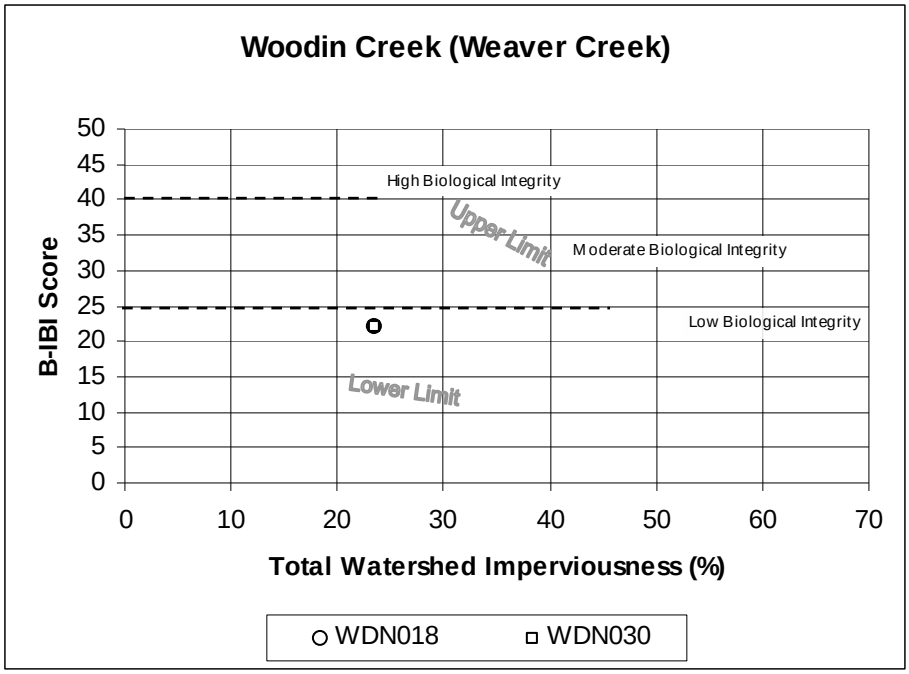


Figure 20: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et. al., 2004. Markers indicate Total B-IBI scores at Station WDN018 for 2008 and Station WDN030 for 2004, versus estimated 2000 subwatersheds TIA.

Figure 21 shows that Salmon Creek RM 8.96 B-IBI scores are mostly in the middle third of the expected range for watersheds with about 24 percent impervious area (estimated 2000 Total Impervious Area from Wierenga, 2005). Since these BIBI scores fall close to the middle of the typical range, there is some room for improvement of biological integrity. An opportunity exists to increase the level of biological integrity by improving habitat and stream conditions.

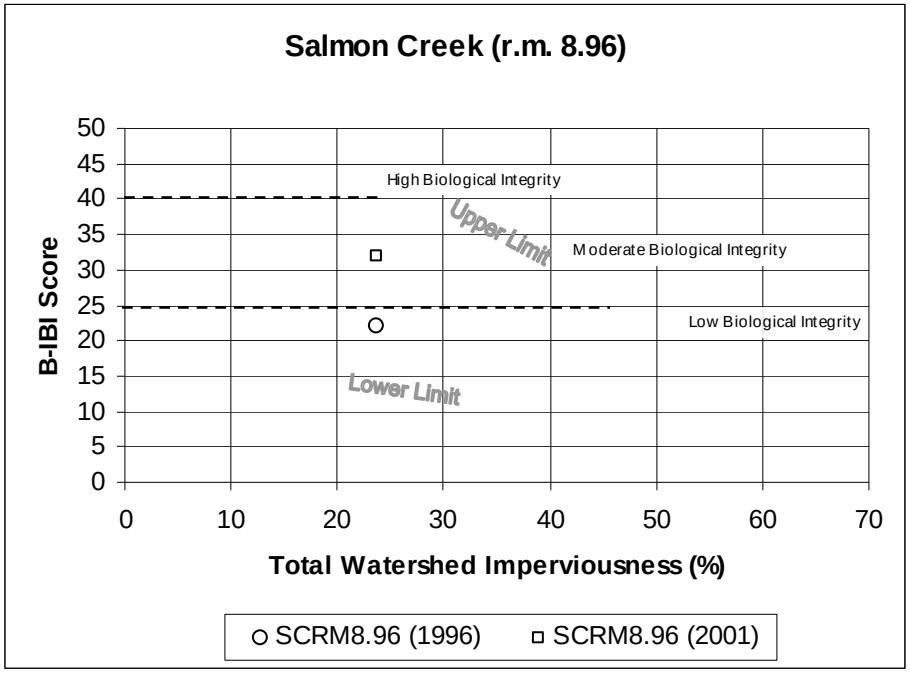


Figure 21: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et. al., 2004. Markers indicate Total B-IBI scores at station within the SCRM8.96 subwatershed for 1996 and 2001 versus estimated 2000 subwatersheds impervious TIA.

Management Recommendations

Woodin Creek's low biological integrity significantly underperforms with respect to its moderate levels of TIA and suggests the need for management strategies that rehabilitate impaired habitat and minimize water quality impacts. Salmon Creek RM 8.96's similar TIA but low to moderate biological integrity suggests the need to minimize or prevent further degradation while rehabilitating already impaired habitat. Strategies might include protecting forested riparian areas and rehabilitating those that are impaired, promoting forestry best management practices, increasing overall forest cover, improving stormwater treatment and control, and minimizing sediment loading to streams.

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 Salmon Creek (RM 08.96) and Woodin Creek subwatersheds is mapped from existing GIS information in the WDFW SalmonScape database, and is available at http://wdfw.wa.gov/mapping/salmonscape/

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

- WDFW passage barrier database.
- 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 below.

Results/Summary

Distribution

The available evidence suggests that anadromous fish use within the Salmon Creek (RM 08.96) subwatershed includes Coho salmon and winter steelhead, with fall Chinook also presumed present in the mainstem (Figure 22 and Figure 23).

The Woodin Creek subwatershed also contains Coho salmon and winter steelhead. Known anadromous fish usage stops approximately south of East Main Street in Battle Ground, where the creek enters a long piped section underneath a parking lot and several roadways. The SalmonScape data shows presumed presence continuing further upstream through the Battle Ground urban center.

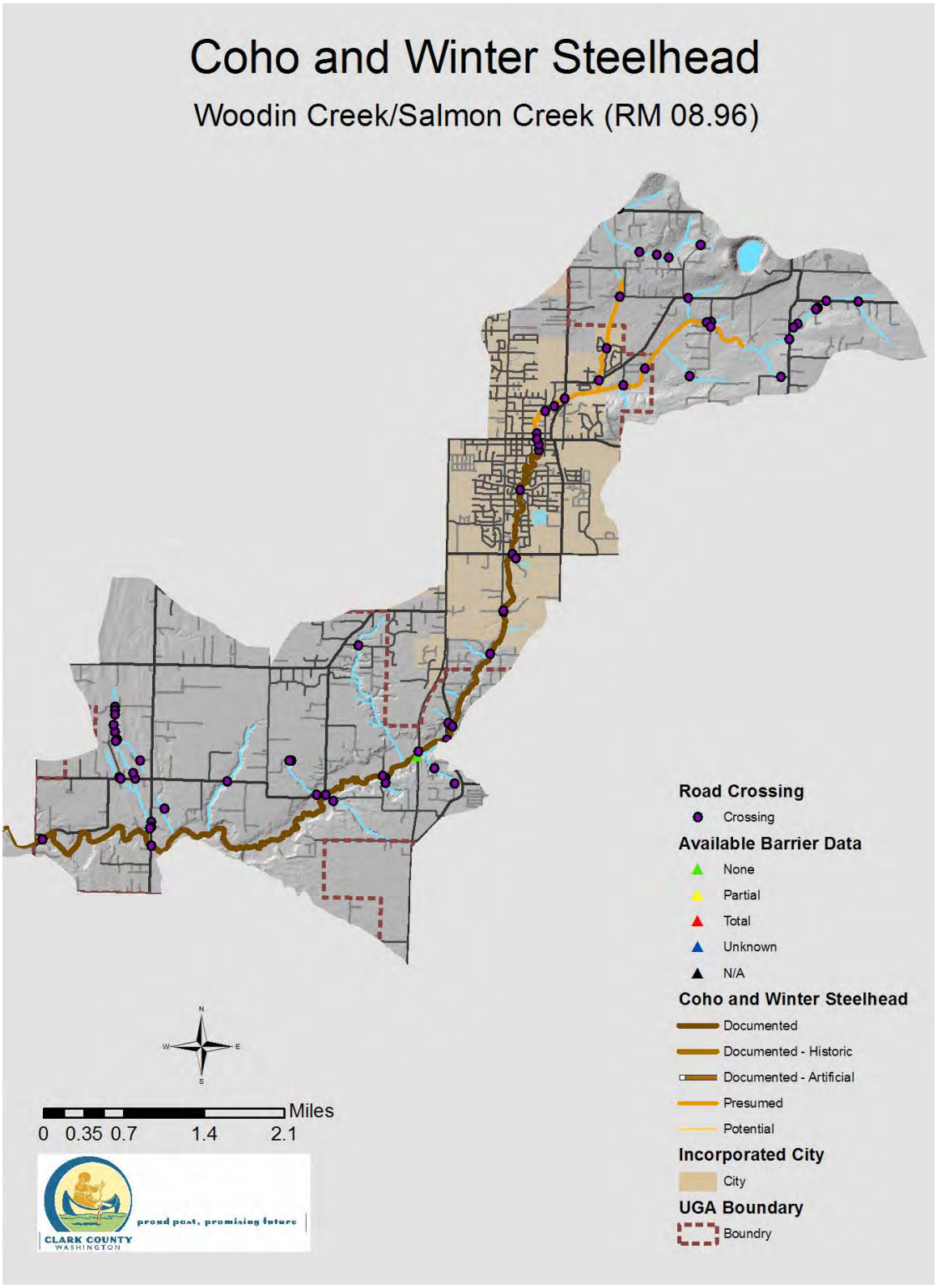


Figure 22: Salmon Creek (RM 08.96) and Woodin Creek Fish Distribution and Barriers

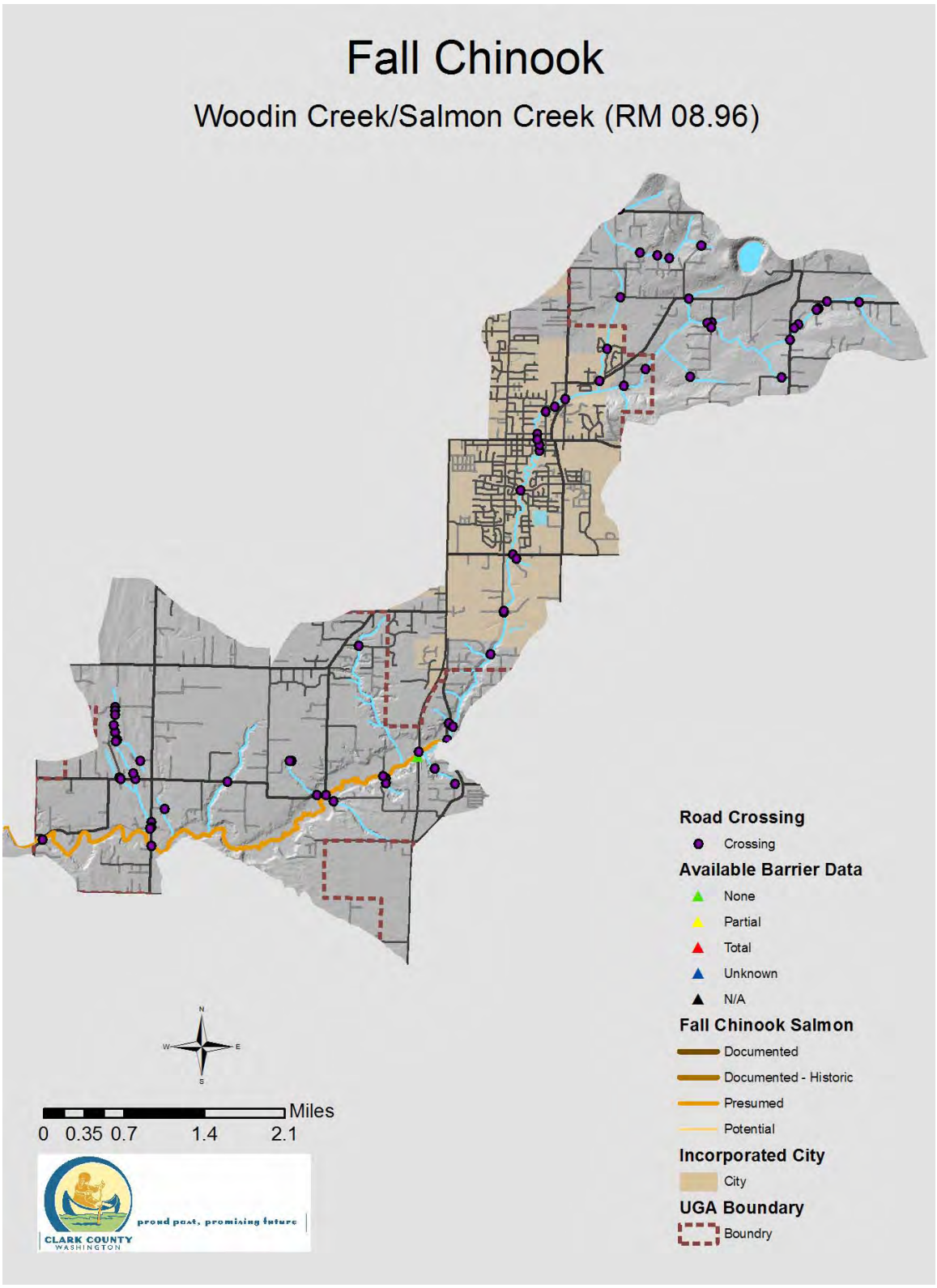


Figure 23: Salmon Creek (RM 08.96) and Woodin Creek Fish Distribution and Barriers

Barriers

The WDFW barrier database provides the most complete assessment of barriers in the Salmon Creek (RM 08.96) and Woodin Creek subwatersheds (Figure 22 and Figure 23).

There are no mapped barriers within these two subwatersheds. However, the section of Woodin Creek where it passes under several major roads and a parking lot near Main Street in downtown Battle Ground could be considered a partial barrier to anadromous fish.

The SalmonScape data indicates the presence of two barriers that were removed on the mainstem of Woodin Creek and an associated tributary, both located at SW 20th Street. These fish passable crossings were installed as part of the NE 199th Street improvement project completed by Clark County Department of Public Works.

Recommendations

The partial barrier on Woodin Creek near Main Street is considered a low priority for replacement, simply because of its proximity to major urban infrastructure. Approximately 230 feet of a 600 foot stream reach in downtown Battle Ground is currently piped under roads and a parking lot, which poses a significant retrofitting challenge. Additionally, given its location in the upper portion of the Woodin Creek subwatershed, the amount of upstream habitat that would be opened up is not significant.

Hydrologic and Hydraulic Models

Hydrologic and Hydraulic Models were not created for this sub-watershed.

Analysis of Potential Projects

The analysis of potential projects:

- Briefly summarizes stormwater conditions, 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.
- Lists recommended projects and activities for further evaluation.

Projects or activities are placed in one of several categories.

Project descriptions summarize more detailed descriptions found in report sections. Project planners are encouraged to reference the longer descriptions and also to utilize the information found for each potential project in the SNAP GIS database available from the Clean Water Program. Reference IDs for the database are included in the tables for each project.

Summary of Conditions, Problems, and Opportunities

Conditions and Problems

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

Coordination with Other Programs

The assessment area lies within or near the urbanized Battle Ground area. The City of Battle Ground is an NPDES Phase II permittee and is in the process of developing stormwater management activities. Ecology coordinates ongoing TMDL implementation and adaptive management in Salmon Creek. Clark Public Utilities is active in riparian habitat rehabilitation. The Salmon Creek Watershed Council provides a forum for citizens and organizations to participate in on the ground restoration, water quality, and advocacy. One transportation improvement project is included in the 2010 through 2015 Clark County Transportation Improvement Program (Chelatchie Prairie Rail Trail, extending from the Battle Ground Fair Grounds to Battle Ground Lake State Park). The Clean Water Program regularly communicates and coordinates with all of these entities.

Broad-Scale Characterization

The study area is rural to urbanizing and is drained by Woodin Creek, the middle Salmon Creek main stem, and several of its small unnamed tributaries. Areas of open space remain in forested canyons, steep hills, and public lands. The topography is generally level except for Tukes Mountain and shallow stream canyons. Geology consists of sedimentary gravel and sandstone deposited by the ancestral Columbia River, overlain with more recent, easily erodible, fine-grained deposits. Late ice age lava flows underlie the headwaters of Woodin Creek and hold Battle Ground Lake. Stream hydrology is altered significantly from a natural forested condition.

Standard subwatershed scale metrics such as percent forest, percent total impervious area, road density, and effective impervious area, when compared to NOAA fisheries standards, suggest stream habitat is not properly functioning.

Water Quality Assessment
Multiple stream segments within this assessment area are included on the 2008 303(d) Ecology list of impaired water bodies. Both subwatersheds are included in ongoing TMDL implementation for fecal coliform and turbidity, and in TMDL development for water temperature.

A relatively large water quality dataset is available for the study area, as Clark County maintains long-term monitoring stations on both lower Woodin Creek and the Salmon Creek main stem.

General water quality in this assessment area is Poor to Fair, with generally lower water quality in Woodin Creek.

Recent trend analyses indicate decreases in fecal coliform and nutrient concentrations, but increasing turbidity in the Salmon Creek mainstem. Despite this increase, turbidity within both subwatersheds currently meets TMDL target levels. Fecal coliform has declined sharply but still fails one or both components of the state criteria at various sampling locations.

One summer of temperature monitoring in 2003 indicated that all three stations monitored in this assessment area substantially exceeded current temperature standards. Woodin Creek was the warmest of seven Salmon Creek tributary streams monitored.

Drainage System Inventory and Condition
Significant updates to the drainage mapping database were completed in 2008 and 2009. Over 3000 stormwater infrastructure features were added during this time period; almost five-thousand features are mapped in this study area, including seventy stormwater facilities of which twenty are publicly owned and operated.

Fifteen public stormwater facilities were evaluated for potential retrofit opportunities, seven of which were referred for further project evaluation. Forty of the 63 facility objects making up those facilities (65%) were in compliance with standards in the *2005 Stormwater Management Manual for Western Washington, Volume V*. No major defects or hazards were discovered. The most common out-of-compliance components were detention ponds, biofiltration swales, and signage. The conversion of biofiltration swales by adjacent landowners from the designed state to a landscaped or filled area was a commonly identified issue.

An off-site evaluation was conducted at 13 priority outfalls discharging to mapped critical areas. All outfalls were in compliance.

Source Control
Source control inspections were conducted at 17 businesses in this assessment area. Eight of those sites had source control problems; all eight were successfully resolved. This assessment area has a relatively low number of businesses compared to other subwatersheds; however, a high percentage engage in activities that rate highly for potential stormwater pollution.

Illicit Discharge Screening
Illicit Discharge Detection and Elimination (IDDE) screening was not conducted.

Stream Reconnaissance Feature Inventory
Focusing on areas of higher likelihood of stormwater impacts within the assessment area, a feature inventory was conducted for approximately 1.8 miles of stream corridor along two Salmon Creek tributaries. Stream conditions at twenty road crossings were also examined. A total of sixty-nine features were recorded, forty–nine from in-stream work, consisting primarily of culverts, impacted stream buffers, trash, and miscellaneous points of interest. A total of 22 potential project opportunities were identified in five categories.

Physical Habitat
In the 2004 LCFRB Habitat Assessment, physical habitat measurements were only made for one reach of Woodin Creek within this assessment area. Based on Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition standards, habitat was rated as mostly poor and not properly functioning. Habitat consisted primarily of pools (42%) in this reach, with riffles and glides making up the remainder. Riffle habitat had gravel (49%) and sand (33%) substrate, with average embededdness of 51%.

Geomorphology and Hydrology
Geomorphic field reconnaissance in December 2009 of conditions at seven points on three small tributaries within Salmon Creek RM 08.96 were used to help classify these stream reaches response potential as low, medium, or high likelihood for future channel degradation resulting from hydrologic changes. The findings indicate that the observed streams have been, and continue to be, influenced by natural geologic characteristics, localized stream and streambank features such as bank hardening, and human development within the subwatersheds. Among the seven surveyed reaches, two were classified as having low and five as having moderate response potentials.

Riparian Assessment
In the 2004 LCFRB Habitat Assessment, overall riparian conditions assessed in the study area were rated impaired. Large woody debris recruitment potential was primarily poor to fair in both subwatersheds. Shade levels for all assessed stream reaches were below state targets.

Wetland Assessment
Both subwatersheds have potential riverine wetland areas along main creeks as well as isolated sloped and depressional wetlands throughout the area, especially in the vicinity of Battle Ground.

Ecology's draft watershed characterization of Clark County places the subwatersheds of Woodin Creek and Salmon Creek (RM 08.96) in the categories of Protection Restoration 1 and 2, respectively. On a subwatershed scale, these categories have higher levels of importance for watershed hydrologic processes and limited alteration suggesting consideration for protection.

Macroinvertebrate Assessment
Based on samples collected from 2004 and 2008 for Woodin Creek and 1996 and 2001 for Salmon Creek (RM 08.96), biological integrity is low for Woodin and low to moderate for Salmon Creeks. B-IBI scores are toward the lower end of the typical range for subwatersheds with similar amounts of impervious area. Woodin Creek, in particular, significantly underperforms given its moderate levels of TIA. In both subwatersheds, biological integrity could likely be improved significantly through habitat rehabilitation.

Fish Use and Distribution
The available information suggests that anadromous fish use in the Salmon Creek (RM 08.96) subwatershed includes Coho salmon and winter steelhead. Fall Chinook are presumed present in the mainstem. Woodin Creek also contains Coho salmon and winter steelhead downstream of East Main Street in Battle Ground.

There are no mapped barriers identified on the Salmon Creek or Woodin Creek subwatersheds.

Recently Completed or Current Projects

As of December 2009, there are no stormwater projects listed for these subwatersheds in the CWP capital planning database. The only Public Works project listed in the 2010-1015 Transportation Improvement Plan is the Chelatchie Prairie Rail Trail that will run from the Battle Ground Fair Grounds almost to Battle Ground Lake State Park.

Analysis Approach

Purpose
The Analysis of Potential Projects narrows the initial list of possible opportunities to a manageable subset of higher priority potential projects. 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 illicit discharge 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 considering 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.

Emergency/Immediate Actions

Emergency/Immediate actions may be pursued by Clark County staff or referred to other appropriate agencies. These cases represent a potential or immediate threat to public health, safety, or the environment, and require timely follow-up.

Identifier	Issue	Project	Action
MB-46 (includes SCC-213 and SCC-214)	Man-made dam with failed berm; still holding significant water but remaining berm is eroding; 130 feet upstream of public road, NE 72nd Ave. Combine with inspection of SCC-213 and 214: possible clogged culvert and drainage issues.	Site visit.	Refer to CWP Capital Planning

Potential Stormwater Capital Projects

Stormwater Facility Capital Improvement Projects

Identifier	Issue	Project	Action
MI-82	Headwater stream is piped through property with existing private facilities and open space; receives significant flow from roadside ditches in City of Battleground.	Acquire property and existing facilities. Retrofit/expand for improved flow control. Potential cooperative project with City of Battleground.	Refer to CWP Capital Planning
OS-134	Facility (West Glade 2) sits on a large parcel with room for potential expansion	Potential storage treatment retrofit.	Refer to CWP Capital Planning
OS-136	(72nd Ave & NE 192nd St) Facility may not be functioning as designed. Appears that the outfall may flow back into drainage system.	Potential storage and treatment retrofit.	Refer to CWP Capital Planning
OS-135	(Sequoia Meadows) Bioswale landscaped or filled in with	Potential storage treatment retrofit.	Refer to CWP Capital

Identifier	Issue	Project	Action
	cobble; no treatment. Large swale may offer detention.		Planning
OS-140	(Sequoia Meadows) Bioswale landscaped or filled in with cobble; no treatment.	Potential treatment retrofit.	Refer to CWP Capital Planning
OS-137	(Tiger Lily) Bioswale landscaped or filled in with cobble; no treatment.	Potential treatment retrofit.	Refer to CWP Capital Planning
OS-138	(Tiger Lily) Bioswale landscaped or filled in with cobble; no treatment.	Potential treatment retrofit.	Refer to CWP Capital Planning
OS-139	(Tiger Lily) Bioswale landscaped or filled in with cobble; no treatment.	Potential treatment retrofit.	Refer to CWP Capital Planning

Stormwater Infrastructure Maintenance CIPs

Identifier	Issue	Project	Action
RR-34	(72nd Ave & Salmon Creek). Public facility on private parcel Appears to be overtaken with invasive plants.	Review facility for maintenance and evaluate for enhancements.	Refer to CWP Capital Planning

Stormwater Class V Underground Injection Control (UIC) Projects

No projects of this type were identified.

Habitat Rehabilitation/Enhancement Projects

Identifier	Issue	Project	Action
RR-36	Up to 2 acres intact and degraded wetland in headwater area; within mapped high quality wetland boundary	Potential purchase for mitigation and/or wetland enhancement.	Refer to CWP Capital Planning
OS-199	Opportunity to establish riparian forest along Salmon Creek. Mix of public/private property. Potential Legacy Lands program acquisition.	Pleasant Valley Park potential riparian enhancement (Parcel #186013-000 9 ac.) and other adjacent Battle Ground Schools public parcel.	Refer to CWP Capital Planning

Identifier	Issue	Project	Action
OS-200	Opportunity to establish riparian forest on tributary of Salmon Creek on County property	Chelatchie Prairie Railroad right-of-way potential riparian enhancement (Parcels #30004-000 35 ac., 300007-000 103 ac.).	Refer to CWP Capital Planning
OS-201	Opportunity to establish riparian forest on Salmon Creek mainstem. Mix of public/private property. Potential Legacy Lands program acquisition.	Salmon Creek / CASEE center riparian enhancement	Refer to CWP Capital Planning

Property Acquisition for Habitat Preservation
No projects of this type were identified.

Follow-up Activities for Referral within CWP

Private Stormwater Facilities Maintenance

Identifier	Issue	Action
OT-262	(Meadow Glade Elementary) Private facility is completely overgrown; outfall may be causing erosion in stream channel.	Refer to Public Works for private facility inspection.
RR-89	(ID 2026, ViewCrest Acres 2). Private facility overgrown with blackberries	Refer to Public Works for private facility inspection.

Public Works Stormwater Infrastructure Maintenance
No projects of this type were identified.

CWP Outreach/Technical Assistance

Identifier	Issue	Action
MI-86	Man-made channel draining to stream; riparian cover nonexistent	Refer to DES Outreach
TR-71	Significant amount of wood, plastic, and concrete debris on left bank	Refer to DES Outreach
TR-73	Large amount of grass clippings pushed into creek channel; likely from commercial landscaper	Refer to DES Outreach.
TR-74	Significant amount of old trash in creek channel; tires, bottles	Refer to DES Outreach
TR-75	Trash, dumping, and burn barrel near creek channel	Refer to DES Outreach
WQ-78	Livestock access to creek channel	Refer to DES Outreach and CCD
WQ-79	Livestock access to creek channel	Refer to DES Outreach and CCD
WQ-80	Livestock access to creek channel	Refer to DES Outreach and CCD

CWP Infrastructure Inventory

No projects of this type were identified.

CWP Illicit Discharge Screening

Identifier	Issue	Action
MI-87	Potential illicit discharge from residence to right bank of creek.	Refer to IDDE.
OT-261	Potential illicit discharge. May be a covered pipe, unknown source, causing gully erosion on bank	Refer to IDDE.

Projects for Referral to Other County Departments, Agencies, or Groups

Identifier	Issue	Action
OS-203	North bank tributary ½ mile east of NE 72nd Avenue may have rearing/spawning potential; intact riparian corridor with few road crossings	Refer to ESA/Fish Rescue program for evaluation
OS-202	North bank tributary ¼ mile west of NE 117th Avenue may have rearing/spawning potential; intact riparian corridor, possible barriers could be removed	Refer to ESA/Fish Rescue program for evaluation

Identifier	Issue	Action
RR-37	Potentially intact stream habitat with healthy riparian canopy	Refer to ESA/Fish Rescue program for evaluation
RR-40	Pond and wetland area on WSU parcel; potential for off-channel rearing project	Refer to ESA/Fish Rescue program for evaluation
RR-106	Erosion at public outfall	Refer to Public Works for maintenance and energy dissipator
RR-107	Erosion at public outfall	Refer to Public Works for maintenance and energy dissipator
SC-222	Abandoned culverts under undeveloped 179th Street ROW have high potential for clogging; roadbed above may be failing	Refer to Public Works for inspection
IB-266	Ivy covering native plants for ~200' downstream of road crossing at 154th Street.	Refer to CPU
IB-268	Ivy has overtaken the area.	Refer to CPU
RR-108	Ivy has overtaken the area.	Refer to CPU

Channel Rehabilitation Projects

Several potential channel rehabilitation opportunities were identified by staff completing the Geomorphology chapter. These opportunities are listed in the Geomorphology Assessment section. From a stormwater perspective, channel rehabilitation projects are typically not a high priority.

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 study area subwatersheds, by NPDES permit component, include:

Storm Sewer Mapping and Inventory

- Focus on timely database updates as development occurs, with the goal of maintaining a complete stormwater infrastructure inventory

Coordination of Stormwater Activities

- Encourage coordination between Clark County and the City of Battle Ground for NPDES permit compliance and leveraged stormwater capital project opportunities

Mechanisms for public involvement

- Publish SNAP reports on CWP web page and email newsletters

Development Regulations for Stormwater and Erosion Control

- Clark County should encourage off-site wetland mitigation to restore or enhance wetland functions, particularly west of Brush Prairie
- City of Battle Ground should consider emphasizing protection and restoration of wetlands in the middle and upper reaches of Woodin Creek as the city expands to the east and north

Stormwater Source Control Program for Existing Development

- The area including Brush Prairie and commercial properties in Meadow Glade and Manor neighborhoods southwest of the city of Battle Ground should be kept on a regular rotation for source control inspection.

Operation and Maintenance Actions to Reduce Pollutants

- Consider adding signage to unfenced biofiltration swales to minimize conversion of swales to other uses by adjoining landowners
- Consider increasing the frequency of off-site assessments for stormwater outfalls in critical areas

Education and Outreach to Reduce Behaviors that Contribute Stormwater Pollution

- Encourage appropriate agricultural practices that emphasize soil and water conservation, livestock exclusion fencing, and reduction in nutrient load to streams
- Perform targeted technical assistance responding to results of field assessments
- Educate private landowners on importance of native riparian vegetation and intact riparian forests for shading streams and preserving hydrology
- Replace missing or deteriorated stream name signs

TMDL Compliance

- Continue collaboration on Salmon Creek TMDL development. Clark County fulfills its TMDL compliance obligations through ongoing implementation of the Stormwater Management Program

Monitoring Stormwater Program Effectiveness

- None

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