2007 Stormwater Needs Assessment Program

Lockwood Creek
Subwatershed Needs Assessment Report

Clark County Public Works Department

Clean Water Program

June 2008

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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
EIA	Effective Impervious Area
EDT	Ecosystem Diagnostic and Treatment model
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
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 Scores
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 Areas
UIC	Underground Injection Control
USFWS	U.S. Department Fish and Wildlife Services
VBLM	Vacant Buildable Lands Model
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area
WSDOT	Washington Department of Transportation

Executive Summary

Study Area

This Stormwater Needs Assessment report focuses on Lockwood Creek, tributary to the East Fork Lewis River. The entire subwatershed is in unincorporated Clark County.

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 than regional Water Resource Inventory Area (WRIA) or Endangered Species Act (ESA) plans. Stormwater Needs Assessments are not intended to take the place of comprehensive watershed plans or stormwater basin plans, but can provide a good foundation for developing them at the subwatershed scale.

Findings

Watershed Conditions

The table on the following page summarizes conditions in the Lockwood Creek subwatershed, including water quality, biological health, habitat, hydrology, and the stormwater system.

Ongoing projects and involvement

Lockwood Creek is well known as part of ongoing work to protect and restore fish habitat within the East Fork Lewis River watershed. Currently, there is a group of habitat restoration projects underway in lower Lockwood Creek.

The Washington Department of Ecology is developing Total Maximum Daily Load (TMDL) for bacteria and temperature in the East Fork Lewis River watershed.

Category	Status
Water Quality	
Overall	• Fair
Fecal coliform bacteria	• TMDL required
Temperature	• TMDL not required but included in EF Lewis River temperature TMDL
Sediment	• No data
Biological	
Benthic macroinvertebrates	• Moderate to poor biological integrity
Anadramous fish	• Coho and winter steelhead use. Moderate regional recovery priority
Habitat	
NOAA Fisheries criteria	• Forest cover and road density fall into the Non-Functioning category. • Stream crossing density and estimated effective impervious area fall into the Properly Functioning category
Riparian	• Forest cover is about 40 percent and is found in stream valleys and some upland areas. • Large woody debris recruitment potential is good in the upper basin and poor in the lower stream reaches.
Wetland	• Primarily limited to riparian areas
Hydrology and Geomorphology	
Overall hydrology	• No hydrologic data is available but likely typical for a partly forested rural watershed
Future condition	• Projected impervious area should remain at levels that do not alter hydrology if forest cover is retained or expanded.
Stormwater (Unincorporated areas)	
System description	• Primarily field drains and road-side ditches. • No public stormwater facilities exist
Inventory status	• Largely incomplete
System adequacy	• Adequate treatment is probably provided by vegetation in ditches. • No flow control other than infiltration in ditches
System condition	• No outfall screening was performed. • Largely undocumented but presumed functional

Opportunities

Few projects were identified by the assessment due to the absence of public land to site them. The main project needs appeared to be for riparian and wetland habitat restoration, undersized culvert replacement, and fish passage barrier removal.

Examples of opportunities for stormwater-related watershed improvement include:

- Focused stormwater outreach and education to streamside landowners in the headwaters areas
- Focused monitoring to determine if fecal coliform sources are present
- Repair of any erosion problems in county road ditches
- Promotion of riparian enhancement projects, particularly in the upper watershed

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 Lockwood Creek subwatershed include:

- The Lower Columbia Fish Recovery Board is planning an effort to identify restoration projects in the East Fork Lewis River below Lewisville Park. The Lockwood Creek subwatershed SNAP report will be forwarded to the LCFRB for review.
- Washington Department of Ecology TMDL development for bacteria and temperature coordination will include Clark County.
- For new construction, emphasize stormwater management practices that focus on reduction of runoff and diffuse infiltration.
- Erosion control BMPs are an important measure to protect streams from land disturbing activities.
- Examine the use of small projects to improve stormwater retention and treatment in roadside ditches.
- While no specific wetland or habitat restoration projects are proposed by the SNAP due to the absence of public land to place projects, restoring headwater wetlands should be a priority to improve hydrologic functions.
- Preserving and restoring riparian functions to improve fish habitat is a priority in Lockwood Creek.
- Fish barrier removal projects in the upper watershed should be considered as existing roads and culverts are upgraded or replaced.
- Develop a system to provide education about appropriate ditch maintenance practices to rural landowners.

Introduction

This report is a Stormwater Needs Assessment for Lockwood Creek subwatershed in the East Fork Lewis River watershed. 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 systematic approach 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 objectives and goals identified by the state Growth Management Act (GMA), ESA recovery plan implementation, TMDLs, WRIA planning, floodplain management, and other local or regional planning efforts.
- Inform county efforts to address the following issues related to hydrology, hydraulics, habitat, and water quality:
    - Impacts from current or past development projects subject to lesser or non-existent stormwater treatment and flow control standards
    - Subwatershed-specific needs due to inherent sensitivities or the present condition of water quality or habitat
    - Potential impacts from future development

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

Results and products of needs assessments promote more effective implementation of various programs and mandates. These include initiating wetland banking systems, identifying mitigation opportunities, and providing a better understanding of stream and watershed conditions for use in planning county road projects. Similar information is also needed by county programs implementing critical areas protections 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 the Public Works CWP and Stormwater Capital Improvement Program (SCIP), several programs within the Department of Community Development, and the county's ESA Program. Potential project or leveraging opportunities are also referred to local agencies, groups, and municipalities as appropriate.

Assessment Approach

Priorities for Needs Assessment in Lockwood 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, the Lockwood Creek subwatershed falls into the "Rural Residential with No UGA" category. Subwatersheds in this category are generally not heavily forested and not a high a priority for basin planning due to the lack of urbanization. However, these areas may take on a higher priority for watershed management activities to protect better quality stream habitat and promote habitat restoration to meet salmon recovery priorities. Accordingly, this effort is largely limited to summarizing existing information to identify potential restoration projects.

Assessment Tools Applied in Lockwood Creek

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

Table 1 lists the set of tools available for use in the SNAP. Tools with an asterisk had new data or analyses for this need assessment. Report sections on the remaining tools were completed using pre-existing information or were not included in the assessment.

Table 1: Stormwater Needs Assessment Tools

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

Assessment Actions

Outreach Activities

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

- July 2007 -- press release to local media
- August 2007 – article in "Planning Stormwater Projects" flyer distributed at Clark County fair and other public events.
- September 2007 – article in Clean Water Program E-Newsletter
- Clean Water Program web pages updated to include the SNAP and SCIP.
- March 31 of each year, a description of the SNAP is included in Clark County's stormwater management program plan submitted to Ecology

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

Coordination with Other Programs

Purpose

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

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

Methods

The CWP maintains a list of potential coordinating programs for each subwatershed area. The list was reviewed in early 2007 and general communications were planned. Coordination took the form of phone conversations, meetings, or electronic correspondence, and was intended to solicit potential project opportunities, encourage data and information sharing, and promote program leveraging.

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

Results

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

The following list includes departments, agencies, and groups contacted for potential coordination during the course of the Lockwood Creek needs assessment:

- Clark County Endangered Species Act program
- Lower Columbia Fish Recovery Board
- Lower Columbia Fish Enhancement Program
- Fish First

One of the earlier restoration projects in Clark County is located on Lockwood Creek between the confluence with the East Fork and Lockwood Creek Road. The project improved habitat conditions and included approximately 2000 stream side plantings The second phase of this project may be built in summer 2008. A third phase of restoration is funded for construction along the creek north of Lockwood Creek Road. It is designed to address degraded floodplain, riparian and instream habitat conditions.

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 Assessments
- LCFRB Workplan
- CC LISP/SCMP/Project Data
- CC Volunteer Project Data
- Ecology 303D
- WRIA Limiting Factors Analysis
- CC Consproj GIS Layer (conservation projects)
- CC 6-year and 20-year TIP
- Ecology EIM Data
- CC Mitigation Opportunities Project
- CC 2007 Stormwater Needs Assessment Program
- CC 2005 Subwatershed Characterization and Classification
- CC 2004 Subwatershed Summary
- CC 2003 Stream Health Report

Broad-Scale GIS Characterization and Metrics

The broad-scale characterization is a GIS-based exercise providing an overview of the geographic and likely habitat 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 is 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.

Many of these characteristics are described in greater detail in later sections. For example geology and soils form the cornerstone of the Geomorphology and Hydrology section.

The characterization includes three components:

- A set of three standard map products as large paper maps
- A summary table of selected subwatershed-scale metrics
- A brief narrative including comparison of metrics to literature values, conclusions about general subwatershed condition and potential future changes

Map Products

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

General Conditions and Subwatershed Metrics

General Geography

Lockwood Creek is a tributary to the East Fork of the Lewis River located in northwest Clark County (Figure 1). It has moderately steep terrain. It is part of the Troutdale Bench formation. Lockwood Creek subwatershed covers 7.9 square miles and receives on average 64.9 inches of rain a year. This subwatershed does not border any cities, towns or rural centers. The closest cities are Battleground to the southeast and La Center to the west. Average parcel size is 9.3 acres. Zoning is entirely rural, with 52 rural residential uses, 22 percent agriculture and 26 percent zoned open space and forestry. Development patterns in this area are not anticipated to change rapidly as defined in the County's recently revised 20 Year Growth Management Plan.

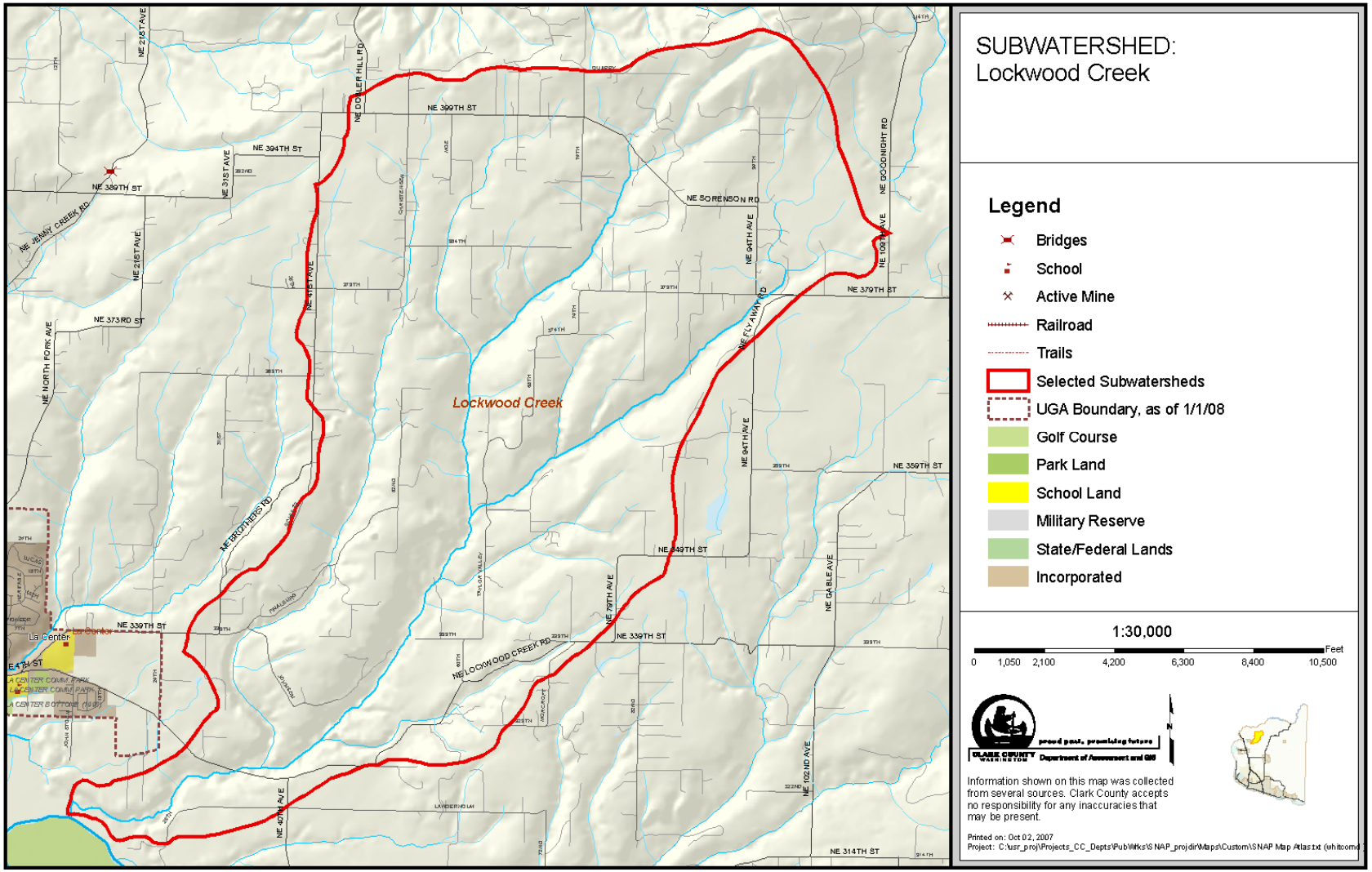

Figure 1: Lockwood Creek Subwatershed Area Map.

Topography

The Lockwood Creek study area is characterized as moderately steep terrain ranging between 5 to 30 percent with an average slope of 14 percent. The average elevation of the subwatershed is 488 feet above sea level. The elevation is approximately 20 feet above sea level at Lockwood Creek's confluence with the East Fork of the Lewis River and approximately 800 feet above sea level at the highest point of the watershed. Forty-five percent of the subwatershed is forested. A large proportion of the tree cover is located along the stream corridors. Only one percent of the subwatershed is classified as floodplain, and two percent is wetlands.

Geology and Soils

Lockwood Creek watershed is underlain mainly by older semi-consolidated sandy gravel commonly referred to as the Troutdale Formation or Troutdale gravels. The uppermost part of the basin is underlain by older volcanic rocks. Terraces up to an elevation of about 250 feet are underlain by material deposited by the East Fork Lewis River and a thin mantle of fine grained Cataclysmic Ice Age flood deposits. Alluvium along Lockwood Creek is reworked sand and gravel eroded from the Troutdale Formation. Lowermost Lockwood Creek crosses the sandy deposits of the East Fork Lewis River flood plain.

The Troutdale Formation is sandy ancestral Columbia River deposits that at depth underlie the entire watershed. It is exposed as weather reddish deposits on hills above about 400 feet altitude. Where streams have eroded into the Troutdale Formation, it forms steep valley walls and hard gravely substrate under stream channels.

Ice Age cataclysmic flood deposits of fine-grained sandy silt layers mantle surfaces below about 350 feet elevation. These deposits are about 14,000 to 12,000 years old and were deposited by a succession of giant floods of the Columbia River caused by ice dam failures in the Missoula, Montana area.

Soils formed on the Troutdale Formation and fine-grained catastrophic flood deposits tend to be fairly clayey. Much of the basin is underlain by Hydrologic Soil Group C soils, which have relatively high runoff rates.

Hydrology

Lockwood Creek's drainage system is cutting into an upland area underlain by the Troutdale Formation. Headwater streams form in rolling, often cleared hilltop fields. Small streams soon descend into shallow valleys and deeper canyons downstream. After exiting its canyon, Lockwood Creek passes a short distance across the East Fork Lewis River flood plain to its mouth.

Channel gradients are generally quite steep in Lockwood Creek subwatershed. Stream headwaters are at elevations above 700 feet and drain a distance of five to seven miles down to the East Fork Lewis flood plain.

No significant stream flow data is available for Lockwood Creek. Hydrologic modeling conducted by Pacific Water Resources (2004) for the Lower Columbia Fish Recovery Board suggested that Lockwood Creek hydrology is compatible with stable steam channel conditions.

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).

These metrics suggest that watershed processes in Lockwood Creek subwatershed are partially impaired. The metrics indicate that some conditions are functioning; others are not, resulting in an assessment of partially impaired. Overall, this subwatershed has good potential for improvement. It has encouragingly low levels of EIA, relatively few stream crossings per mile of stream, sparse population and relatively low levels of development pressure. See Table 2.

Table 2: Lockwood Creek Metrics

Metric	Value	Functioning	Non-functioning
Percent Forested (2000 Landsat)	45	> 65 %	< 50 %
Percent TIA (2000 Landsat)	10	< 5 %	> 15 %
Road Density 2007 data (miles/mile2)	5.6	< 2	> 3
Stream Crossing Density (crossings per stream mile)	2.2	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	3	< 10 %	> 10 %

Forest Cover
The proportion of a watershed in forest 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.

Lockwood Creek subwatershed has 45 percent intact forest cover, below the 50 percent NOAA fisheries threshold for a non-functioning watershed processes. The forested areas area dispersed throughout the entire subwatershed, but much of the canopy cover remains along the riparian corridors. Presumably, the level or mildly sloping areas in the Lockwood Creek subwatershed were cleared for agricultural activities in the late 1800's and early 1900's. A review of 1955 aerial photos showed that present forest distribution patterns are very similar to the 1955 photos.

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 area is 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 of less than five percent as fully functional and greater than 15 percent as non-functional habitat is a reasonable indicator of habitat quality. The TIA measures for Lockwood Creek subwatershed are 10 percent. This falls almost directly in-between the standards for fully functional at 5 percent and non-functioning at 15 percent. For comparison, Lockwood Creek has moderate to low biological integrity based on macroinvertebrate assemblages.

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, almost all of Clark County is non-functioning. Urban streams have road densities approaching 15 to 20 miles per square mile. Lockwood Creek subwatershed has 5.6 miles of road per square mile of land, above the criteria for non-functioning watershed processes, but typical for rural areas.

Stream Crossing Density
Stream crossing density is easily measured using available road and stream channel data. While the metric in Table 6 includes all road crossings, the salmon protection standard considers only larger fills over 60 feet wide, which would be approximately five to ten foot high road fill. According to the NOAA fisheries criteria, Lockwood Creek is functional for salmon habitat.

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 estimated EIA from the Comprehensive Plan for Lockwood Creek is three percent. This is well below the lower standard as defined by NOAA Fisheries of 10 percent for functioning salmon habitat.

The 2008 Comprehensive Plan guides development for the next few years and when used to estimate effective impervious area provides a metric for expected hydrologic impacts due to development. Virtually no changes should be expected in the Lockwood Creek subwatershed.

Estimated Channel Stability Based on Forest and EIA

In a recent publication by Booth, Hartley, and Jackson (June 2003), a relationship between forest and percent EIA was presented as a graphic (Figure 2). According to this figure, Lockwood Creek falls into the 'zone of uncertain channel stability' category. This indicates that through guided protection and restoration activities, it may be possible to increase forest cover, and increase forest functions influencing watershed hydrology. Conversely, loss of forest and increasing EIA adversely influence stream hydrology, making Lockwood Creek more unstable. Based on current subwatershed scale conditions, this subwatershed is a good candidate for protection and restoration of forest functions that could have a measurable impact on channel stability.

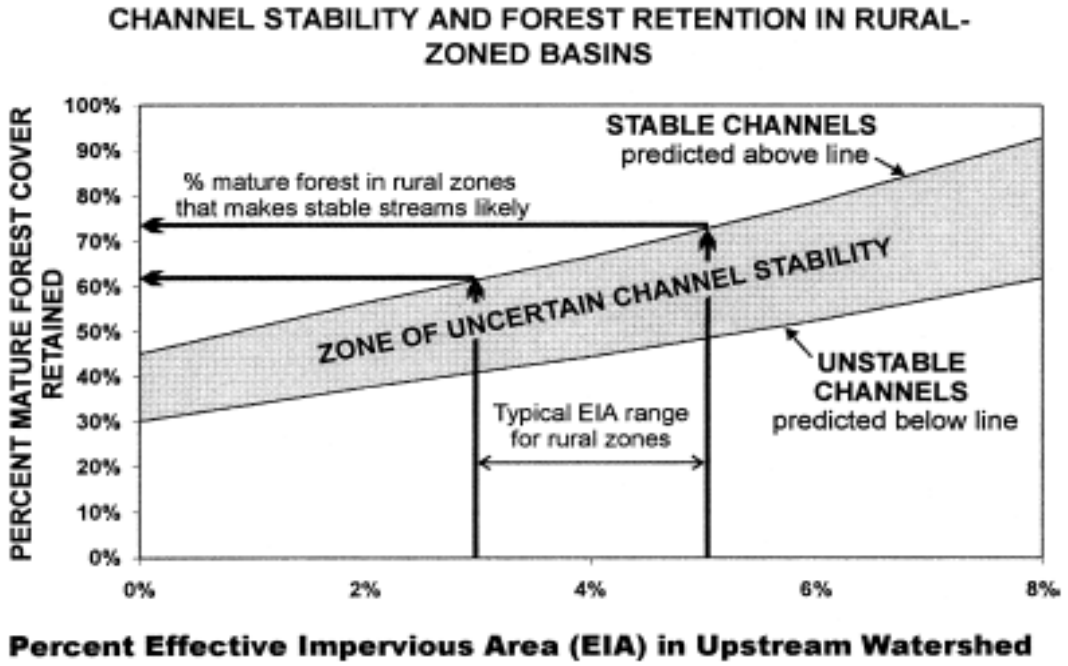

Figure 2: Channel Stability in Rural Areas (Booth, Hartley, and Jackson, June 2002)

Water Quality Assessment

This section briefly summarizes and references available water quality data from the Lockwood Creek subwatershed. 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 the revised standards published in December 2006, Lockwood Creek is to be "protected for the designated uses of: salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values" (WAC 173-201A-600).

Table 3 summarizes currently applicable water quality criteria for Lockwood Creek.

Table 3: Applicable Water Quality Criteria for Lockwood Creek (November 2006)

Characteristic	2006 Ecology Criteria
Temperature	≤ 17.5 °C (63.5 °F)
Dissolved Oxygen	≥ 8.0 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 2002/2004 303(d) list of impacted waters may be found on the Ecology website at:

http://www.ecy.wa.gov/programs/wq/303d/index.html

Lockwood Creek contains segments that are Category 5 listed (polluted waters that require a TMDL) for fecal coliform, and Category 2 listed (waters of concern) for temperature.

A Category 5 listing requires Ecology to develop a TMDL or Water Quality Improvement Project for the waterbody. A TMDL is the amount of pollutant loading that a given waterbody can receive and still meet water quality standards. For non-point pollution sources, TMDLs are typically implemented through Load Allocations and non-regulatory programs.

Lockwood Creek is included in the TMDL Ecology is currently developing to address fecal coliform and temperature issues in the East Fork Lewis River watershed.

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 limited available data including fecal coliform bacteria, general water chemistry (temperature, pH, and dissolved oxygen), and benthic macroinvertebrate scores, overall stream health in lower Lockwood Creek scored in the "fair" range. A simple land-use model predicted fair stream health in the remainder of the watershed.

The 2004 Stream Health Report may be viewed on the county website at http://www.clark.wa.gov/water-resources/stream.html.

Available Data

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

Fecal coliform bacteria and stream temperature have been the focus of most recent monitoring in Lockwood Creek. Clark Public Utilities also collects monthly general water quality data; those data are available from CPU and are not summarized here.

TMDL data analysis and reporting by Ecology is ongoing, and draft reports for the fecal coliform and temperature TMDL monitoring will be available in 2008 or 2009. Data tables and project status may be reviewed at:

http://www.ecy.wa.gov/programs/wq/tmdl/e_fork_lewis

Table 4: Data and Information Sources	
Source	**Data and/or Report**
Clark County Clean Water Program	2004 Stream Health Report and draft reports
Ecology	303(d) List of Impaired Waterbodies Station 27-RIL-0.95 (Riley Cr @ Johnson Rd) Station 27LOC00.0 (Lockwood RM00.0) Station 27-LOC-1.25 Station27-LOC-3.15 (Lockwood Cr @ Lester Ave) TMDL study overviews

Water Quality Summary

Clark County has one active monitoring station (LOC010) in the subwatershed; however, this station has only been utilized for macroinvertebrate sampling (see Macroinvertebrate section). Figure 3 shows the location of station LOC010.

The Ecology TMDL monitoring for fecal coliform included three stations on Lockwood Creek and one station on Riley Creek, a tributary to Lockwood (see Table 4 for location descriptions). Preliminary Ecology data analysis provided in a PowerPoint overview at the web site above indicates the following with regard to Lockwood Creek:

- All four stations met the geometric mean criterion.
- All four stations failed to meet the 90th percentile criterion.
- Dry season fecal coliform values were higher than wet season values for all four stations.

Ecology monitoring for stream temperature included one station at the mouth of Lockwood Creek. Preliminary Ecology data analysis provided in a PowerPoint overview at the web site above indicates the following with regard to Lockwood Creek:

- 7 DAD-Max during 2005 was approximately 22 °C, around 4.5 degrees above the state criterion (17.5 °C).
- Lockwood Creek was generally among the warmest monitoring stations throughout the 2005 monitoring period.

Figure 3: Clark County Lockwood Creek Monitoring Stations

Impacts to Beneficial Uses and Potential Sources

Observed levels of fecal coliform bacteria and stream temperature may have negative impacts on the listed beneficial uses of: salmonid spawning, rearing, and migration, and; primary contact recreation. Table 5 summarizes the primary water quality impacts to beneficial uses in Lockwood Creek, and probable sources of the observed impact.

Fecal Coliform Bacteria

Primary contact recreation is impacted by elevated counts of fecal coliform bacteria which indicate the possible presence of pathogens. Although water contact may take place year-round, elevated bacteria counts are of particular concern during the summer months when the majority of water contact recreation occurs. It is possible that some local residents, particularly children, utilize the creek for recreation. If so, there is some risk of illness associated with bacterial contamination.

Further analysis and reporting by Ecology will likely suggest specific areas and activities that may reduce fecal coliform pollution.

Water Temperature

Water temperature may be an impediment to salmonid use in Lockwood Creek. In particular, elevated temperatures have a detrimental impact on salmonid rearing. Migration and spawning tend to occur during cooler times of the year, but juveniles are exposed to elevated summer temperatures during rearing.

Temperature-related impacts to salmonids begin to occur at stream temperatures greater than approximately 64 degrees F (18 degrees C). Impacts include: decreased or lack of metabolic energy for feeding, growth or reproductive behavior; increased exposure to pathogens; decreased food supply; and increased competition from warm-water tolerant species (ODEQ, 2004 draft).

Solar radiation is the primary driver of water temperature. The susceptibility of a stream to solar radiation is influenced by several factors; including stream flow, channel form, canopy cover (shade), ponds, and the extent of groundwater influence.

Implications for Stormwater Management

Table 5 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 5: Known Water Quality Concerns, Sources, and Solutions for Lockwood Creek				
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** **Storm water facility designs/retrofits to optimize bacteria reduction (see Schueler, 1999)** 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	Salmonid rearing (anadromous) Salmonid spawning and rearing (resident)	vegetation removal	direct solar radiation	**Stormwater infiltration to increase baseflow** **Streamside planting/vegetation enhancement/riparian preservation through acquisition** Education programs Pond removal or limitation
		ponds	direct solar radiation stagnation	
		low summer flows	decreased resistance to thermal inputs	

Drainage System Inventory

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

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

Drainage system inventory and mapping is an ongoing CWP programmatic element focused on populating and updating the StormwaterClk database to include all existing stormwater drainage infrastructure.

Priority effort in the 2007 SNAP was directed toward identifying and mapping previously unmapped discharge points and stormwater facility polygons to support the Illicit Discharge Detection and Elimination Screening project (IDDE). Lockwood Creek was a lower priority for mapping due to the limited amount of stormwater infrastructure and the fact that IDDE screening activities were not scheduled for this subwatershed. Table 6 indicates the number of features previously inventoried in StormwaterClk prior to 2007 SNAP work, and the number of features added to the database as a result of 2007 SNAP implementation.

The drainage system inventory for Lockwood Creek subwatershed remained incomplete at the conclusion of 2007 SNAP implementation. CWP resources were insufficient to complete mapping in all 2007 SNAP subwatersheds. Inventory completion is ongoing in 2008 and 2009 as part of a county-wide inventory update.

Table 6: Drainage System inventory Results, Lockwood Creek

Database Feature Category	Previously Inventoried	Added to Database during 2007 SNAP
Inlet	0	0
Discharge Point (Outfall)	1	6
Flow Control	3	0
Storage/Treatment	10	0
Manhole	0	0
Filter System	0	0
Channel	85	14
Gravity Main	32	13
Facilities	3	1

Stormwater Facility Inspection

There were no known county stormwater treatment or flow control facilities in Lockwood Creek at the time inspections were completed.

Illicit Discharge Detection and Elimination Screening

No illicit discharge screening was conducted in Lockwood Creek during the current investigation. This work will likely be conducted as part of future bacteria TMDL monitoring.

Stream Reconnaissance and Feature Inventory

A rapid stream reconnaissance and feature inventory was not conducted in Lockwood Creek during this assessment.

Physical Habitat Assessment

Purpose

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

Methods

Physical habitat measurements were made for lower Lockwood Creek (RM 0.8 to RM 1.3) by SP Cramer (January 2005) for the Lower Columbia Fish Recovery Board. The project followed modified USFS Level II protocols.

Results

The SP Cramer report includes a good narrative summary of the results and several figures and tables. A brief summary is presented here.

The Lockwood reach was about half pool, one quarter riffle and one quarter beaver pond. The upper part of the reach was pool riffle habitat and the lower part beaver pond.

Table 7 includes a comparison to habitat standards for Washington Conservation Commission and NOAA Fisheries Properly Functioning Condition standards. Information in the SP Cramer report noted that the bed is primarily gravel (60 to 80 percent) and sand (38 percent in pools and 18 percent in riffles). Embeddedness was significantly high with 46 percent in the 50 to 75 percent embedded category, and an additional 41 percent in the 25 to 50 percent embedded category.

Table 7: Lockwood Reach Physical Habitat

Parameter	WCC[1]	PFC[2]
% Pool by Surface Area	Fair	
Pool Frequency	Poor	Not Properly Functioning
Pool Quality		At Risk
LWD		Not Properly Functioning
Substrate		Not Properly Functioning
Streambank Stability	Poor	Not Properly Functioning
Barriers	Good	Properly Functioning

[1] Available Rating: Good; Fair; Poor

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

Geomorphology and Hydrology Assessment

The geomorphology and hydrology assessment was completed as a stand-alone report after the Lockwood Creek assessment report was completed. The report is attached as Appendix A.

Riparian Assessment

Purpose

The riparian assessment characterizes existing conditions based on available data, to identify general riparian needs and potential areas for rehabilitation projects.

The need for riparian rehabilitation tends to be widespread and exceeds the scope and resources of the CWP mission of stormwater management. Therefore, many potential riparian projects are referred to agencies such as LCFRB, Lower Columbia Fish Enhancement Group (LCFEG), Clark Public Utilities, 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 2004 Watershed Characterization and Habitat Assessment reports prepared for the Lower Columbia Fish Recovery Board (R2, 2004 and SP Cramer, 2004). 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 2004 LCFRB characterization, an examination of current orthophotographs is used to make a general assessment of riparian condition.

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

The 2004 LCFRB Habitat Assessment reports were are also reviewed for site specific or general project recommendations within each subwatershed.

Results

The Lockwood Creek assessment uses results of the 2004 LCFRB Habitat Assessment. The full characterization reports are available on the Clark County website at:

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

Large Woody Debris Delivery

Figure 4 summarizes the LWD delivery potential for Lockwood Creek from the 2004 LCFRB assessment. The LWD recruitment potential for the entire subwatershed is estimated as 'moderate' to 'high. The lower section of Lockwood Creek, from the mouth to the confluence with Riley Creek, is rated as having 'low' or 'none' LWD recruitment potential. However, recent planting projects have covered much of the riparian area south of Lockwood Creek Road.

Shade

Figure 5 illustrates shade conditions for Lockwood Creek from the 2004 LCFRB Habitat Assessment. Almost the entire length of the mainstem of Lockwood Creek is rated as >90 percent, shaded, except for the lowest section closest to the confluence with the East Fork of the Lewis River. For approximately one-half mile upstream from the mouth of Lockwood Creek, the shade rating is 0 to 20 percent.

Potential Projects

No specific projects for the Lockwood Creek subwatershed are listed in the SP Cramer (2004) report. If riparian areas downstream of Lockwood Creek Road remain unplanted, projects should be considered there.

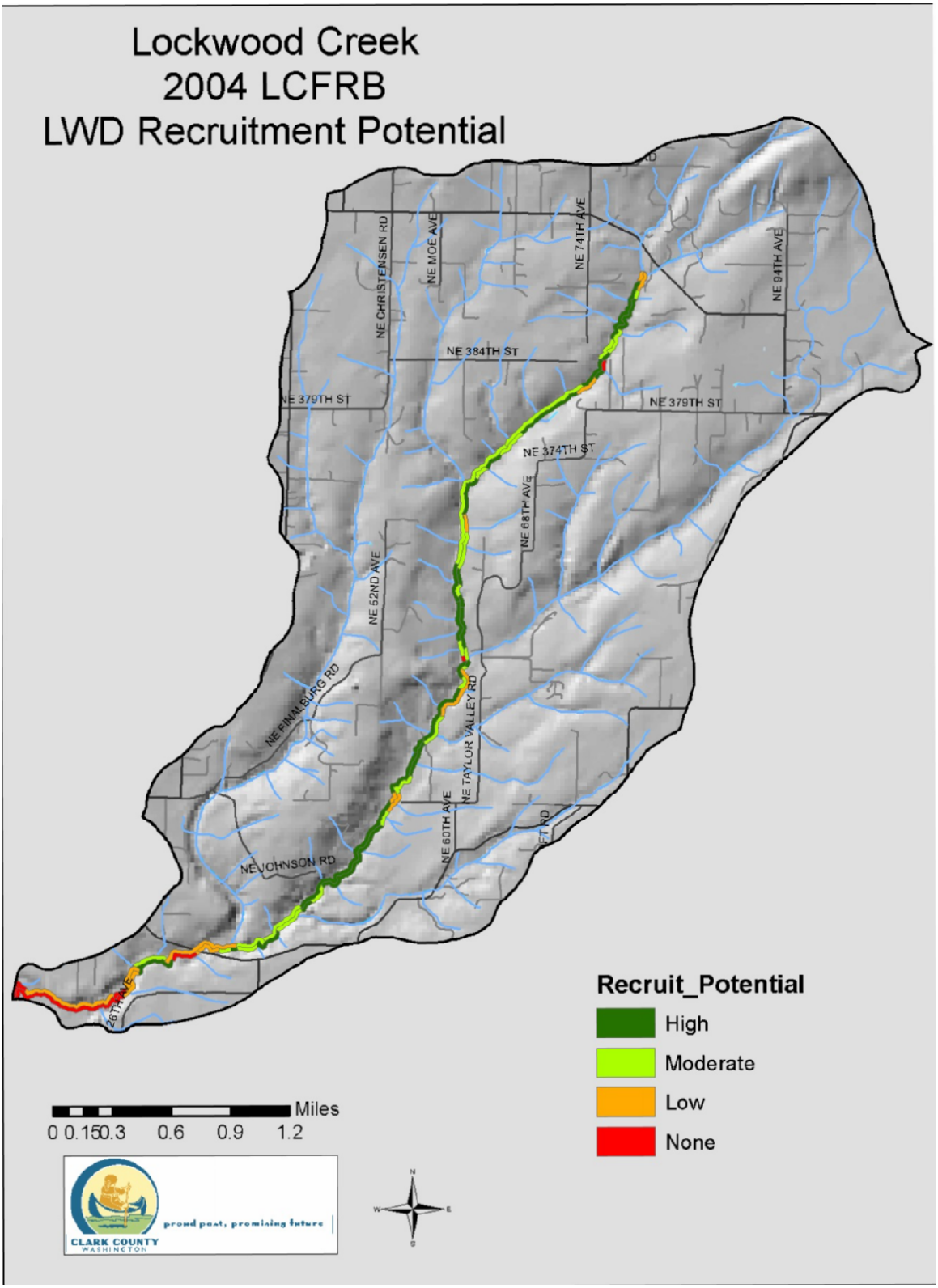

Figure 4: Lockwood Creek East Fork LWD Recruitment Potential (adapted from SP Cramer, 2004)

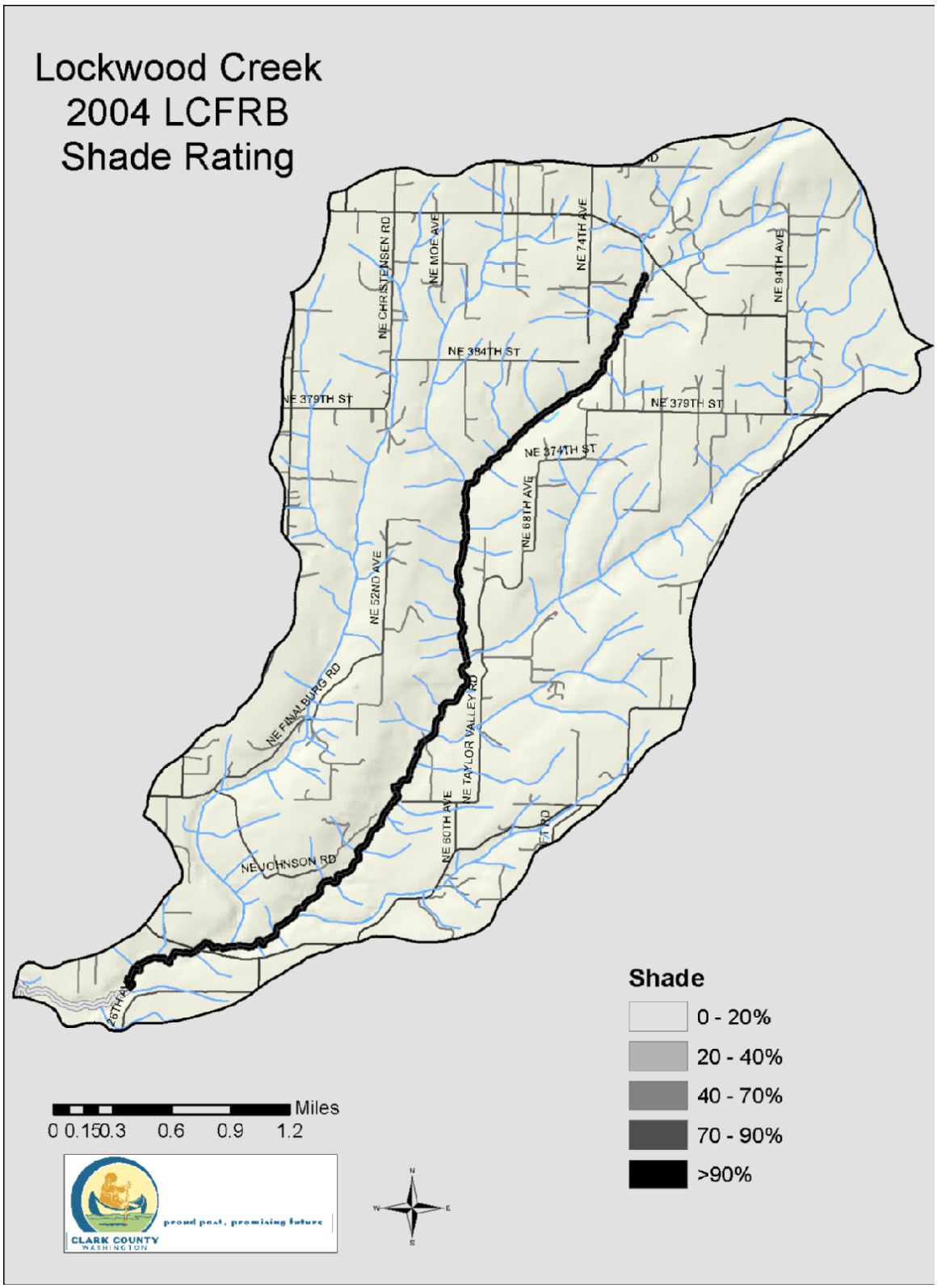

Figure 5: Lockwood Creek Shade Values (adapted from R2, 2004)

Floodplain Assessment

No floodplain assessment was conducted for the Allen Canyon Creek subwatershed.

Wetland Assessment

Purpose

Wetlands perform important hydrologic, water quality, and habitat functions. The primary reason for the wetland assessment is to:

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

The 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.

Methods

The assessment includes review of existing GIS data for wetlands. Primary information sources are the Clark County Wetlands Atlas, Draft Watershed Characterization of Clark County Version 3 (Ecology, 2007), and personal communication with other county programs. Detailed field evaluations and extensive review of existing data were not applied in the Lockwood Creek subwatershed.

Geomorphology/Hydrology assessments may also discover potential wetland-related project opportunities.

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 6 shows potential wetland areas within the Lockwood Creek subwatershed based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory, and the county high-quality wetlands layer.

Potential wetlands and related stormwater project opportunities are very limited within the Lockwood Creek subwatershed. A well-drained geologic setting combined with stream morphometry consisting of steep, narrow channels descending from upland benches limit wetland areas to narrow near-stream floodplains.

The Clark County Regional Wetland Inventory and Strategy Study did not recommend any mitigation opportunities within Lockwood Creek, and there is only one tax-exempt parcel in the subwatershed that overlaps with potential wetlands from the Clark County wetlands model.

Draft Watershed Characterization

The Draft Watershed Characterization may be found on the Clark County website at http://www.clark.wa.gov/mitigation/watershed.html. Results pertaining to the Lockwood Creek subwatershed are summarized below.

Lockwood Creek is part of the Rain-dominated Mountainous hydrogeologic unit, characterized by rain-dominated precipitation, both shallow and deep patterns of groundwater flow, and moderate to steep topography (Ecology, 2007).

Figure 7 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.

In general, green areas have higher levels of importance for watershed 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, 2007)

The Lockwood Creek subwatershed is shown as suitable for protection and restoration (light green) due to its relatively high level of importance for watershed processes and relatively lower level of alteration. Suggested measures include maintaining watershed processes primarily through preservation of existing forest cover (Ecology, 2007).

Potential Projects

The only potential project location for further exploration based on the scope of this wetland assessment is on property owned by Highland Lutheran Church in the upper watershed. Parcel #256706-000 consists primarily of open space (1.2 acres) along a sparsely vegetated headwater tributary with potential wetlands.

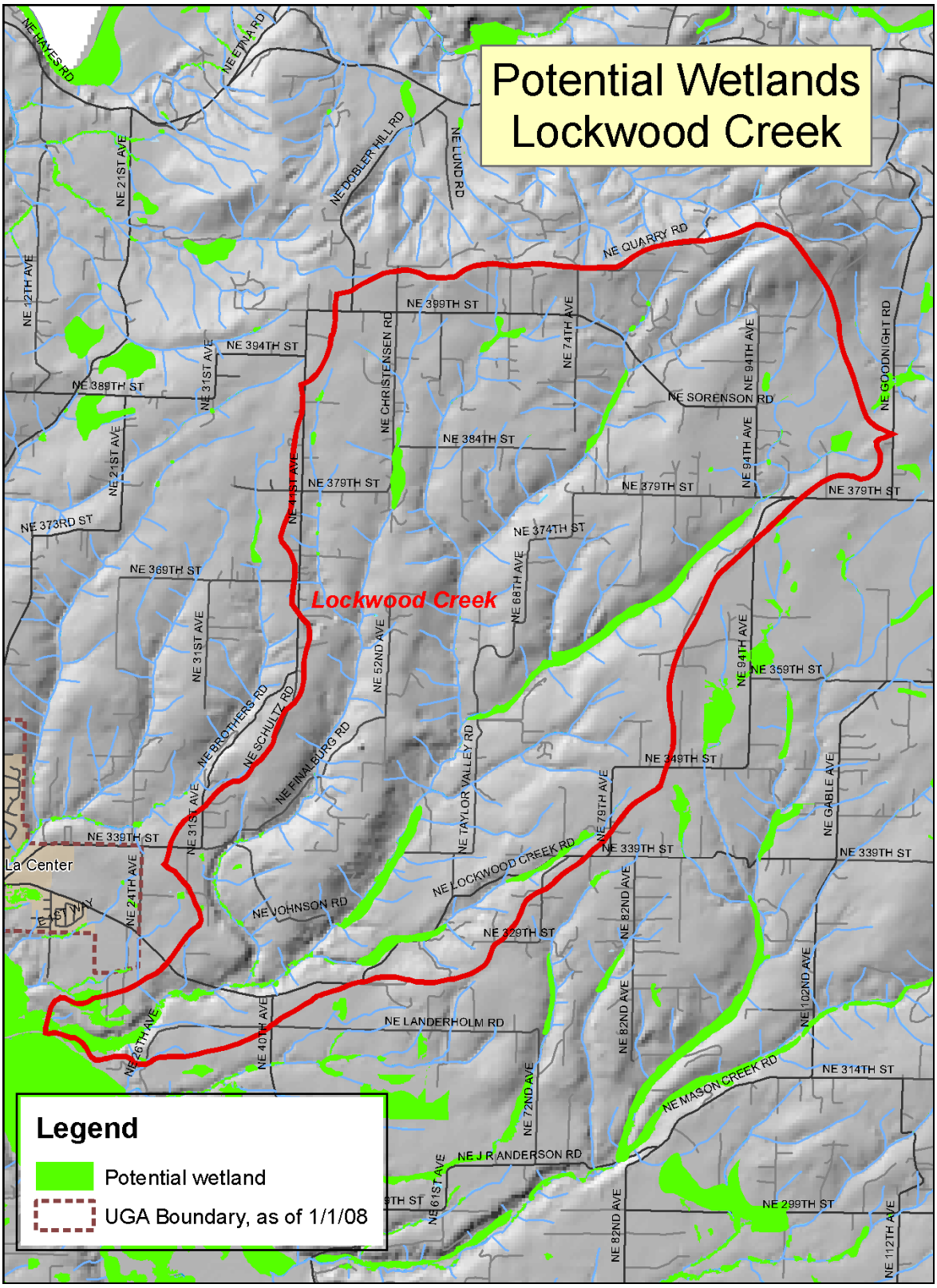

Figure 6: Potential Wetlands in Lockwood Creek Subwatershed.

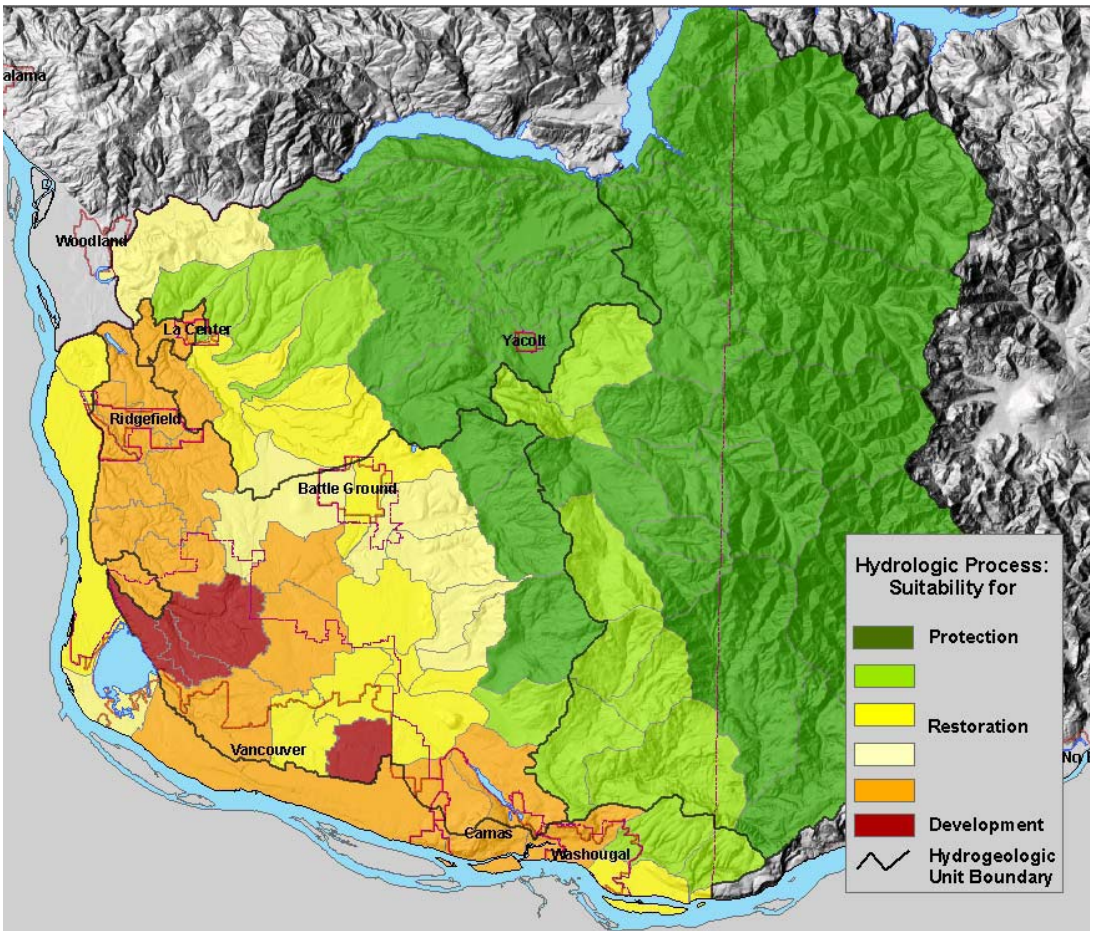

Figure 7: Priorities for suitability of areas for protection and restoration for the hydrologic process (from Draft Watershed Characterization of Clark County (Ecology, 2007)).

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). For example, to maximize the comparability of samples, macroinvertebrate collection is from multiple riffles within a single reach. Samples are collected during late summer, preserved, and delivered to a contracted lab for organism identification, enumeration, and calculation of BIBI 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.

The Lockwood Creek macroinvertebrate samples were collected by the CWP in 2004 (Clark County, 2005) and Clark Public Utilities in 2005. Both samples were from station LOC020 located downstream from Lockwood Creek Road and approximately one mile east of La Center.

Results

LOC020's average B-IBI score was 26, which is near the bottom of the moderate biological integrity category. There was a four point difference between the two scores, 24 in 2004 and 28 in 2005. This is within typical year to year variation of less than five points observed for Puget Sound streams (Karr 1998 and Law 1994).

Table 8: LOC020 Average Annual Macroinvertebrate Community Metrics and Total Score from Within the Period 2004 through 2005

B-IBI Metrics	LOC020 2-Year Averages		
	Value	Score	Category
Total number of taxa	33.0	3	moderate
Number of Mayfly taxa	6.5	3	moderate
Number of Stonefly taxa	5.0	3	moderate
Number of Caddisfly taxa	4.5	1	low
Number of long-lived taxa	5.5	5	high
Number of intolerant taxa	0.5	1	low
Percent tolerant taxa	42.5	3	moderate
Percent predator taxa	7.4	1	low
Number of clinger taxa	20.0	3	moderate
Percent dominance (3 taxa)	62.7	3	moderate
Total B-IBI score		26	**moderate**

Table 8 shows the ten individual average annual metric results are classified as three low, six moderate, and one high. In particular, the low scoring metric for intolerant taxa suggest signs of degraded water and habitat quality since they are among the first organisms to disappear as human disturbances increase (Fore, 1999). Also, the sites' low scores for Caddisfly and percent predators could reflect, respectively, less varied stream habitat and decreasing diversity in prey items.

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). Figure 8 shows that LOC020 station's 2004 and 2005 B-IBI scores fall in the lower portion of the range of expected scores (estimated 2000 Total Impervious Area from Wierenga, 2005). By comparing Lockwood Creek 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.

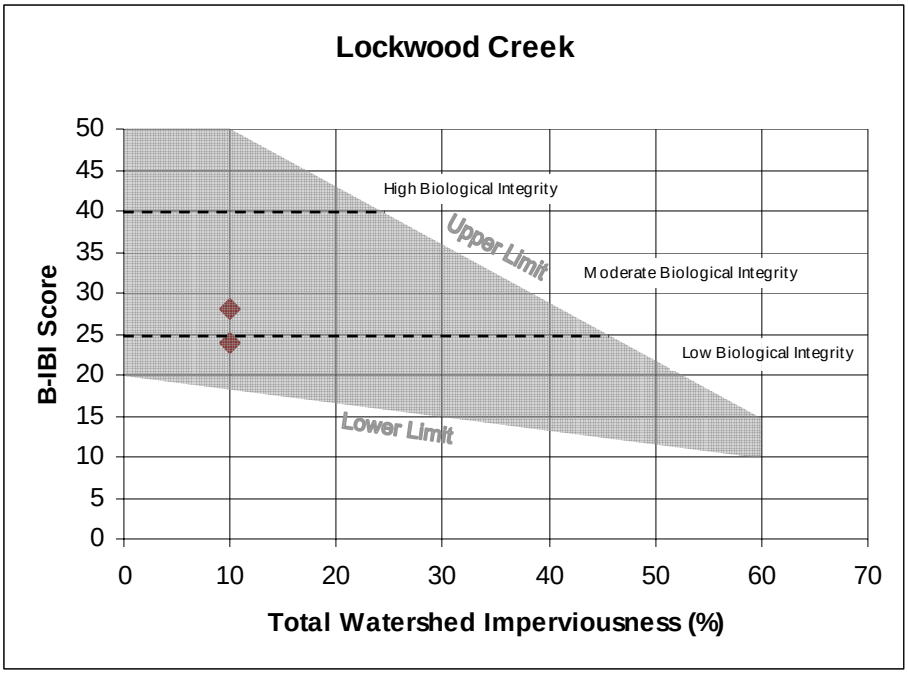

Figure 8: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et al., 2004. Markers indicate Total BIBI scores at LOC020 for particular years, vs. estimated 2000 subwatershed TIA.

Given Lockwood Creek's B-IBI scores are lower than typical for the relatively low amount of subwatershed impervious area; it is likely that factors other than total watershed impervious area are contributing to degraded biological integrity. This implies an opportunity to improve biological integrity by improving watershed conditions, for example, restoring forest cover and riparian habitat.

Physical Habitat Factors

Overall habitat quality is generally poor and some significant macroinvertebrate habitat features are degraded. In 2004, a stream habitat survey was performed at LOC020 (Lower Columbia Fish Recovery Board, 2005), using a modified version of USFS Region 6 Level II Stream Survey Protocol. The riffle substrate was 78 percent gravel and 18 percent sand. Sand embeddedness for the entire reach averaged 50 percent. The reach was considered as generally having open canopy. Entrenchment, possibly related to anthropogenic influences, impacted roughly 50 percent of the surveyed area contributing to the erosion of unstable streambanks. Utilizing the PFC criteria, the surveyed area was rated poor overall and not properly functioning for substrate, bank stability, and large woody debris. These results suggest degradation of important macroinvertebrate habitat features, including measures of low percentage of riffle habitat, high substrate embeddedness, elevated levels of sand and fine particles, and poorly shaded riparian vegetation.

Hydrology
No stream gauge data exists for Lockwood Creek. However, based on watershed characteristics and stream channel conditions such as entrenchment, benthic macroinvertebrate populations are impacted by some alteration of stream hydrology due to forest clearing.

Water Quality
Limited water quality data exists for Lockwood Creek. Conditions that may influence aquatic habitat include elevated temperatures due to lack of adequate riparian shade, and general water quality degradation due to a variety of non-point sources. Specific findings include:

- The Ecology 303(d) list includes portions of Lockwood Creek as 'Polluted waters that require a TMDL for fecal coliform and as 'Waters of Concern" for temperature.
- In 2004, Clark County reported fair water quality for Lockwood Creek as part of a broad County-wide assessment (Clark County, 2004).

Management Recommendations for Lockwood Creek
Improvements to habitat complexity and decreasing water temperatures, both in this reach and upstream, should help increase the biological diversity in Lockwood Creek. Sand embeddedness was high and likely impairs macroinvertebrate diversity, therefore, controlling sediment input and bank erosion is central to increasing biological ratings. Increasing forest cover in the subwatershed could also improve habitat conditions.

Fish Use and Distribution

Purpose

Fish distribution refers to the geographic extent of salmon and steelhead use. This information helps to: identify stream segments where land-use changes may impact fish populations, inform management decisions, and aid in identifying and prioritizing potential improvement projects.

Methods

Fish distribution is mapped from existing Clark County GIS information, which reflect data collected and analyzed by the Northwest Indian Fisheries Commission (NWIFC). Fish distribution data for Clark County is available on the County's website.

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

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

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

Results/Summary

Distribution

All available evidence suggests that anadromous fish use of Lockwood Creek includes Coho (Figure 9) and winter steelhead (Figure 10). The Salmon Recovery Plan (LCFRB, 2004) has classified Lockwood Creek as a Group B subwatershed, the second highest level for protection and/or restoration activities.

Barriers

The WDFW barrier database and the 2007 LCFRB Regional Culvert Survey provide the most complete assessment of barriers in Lockwood Creek subwatershed. Two other barriers in this subwatershed should be mentioned because they fully or partly block potential habitat. One is a total barrier on where Finalburg Road crosses Riley Creek near NE Adams Road. The other is a partial barrier on a Lockwood Creek tributary near the intersection of Lockwood Creek Road and Fuller Road.

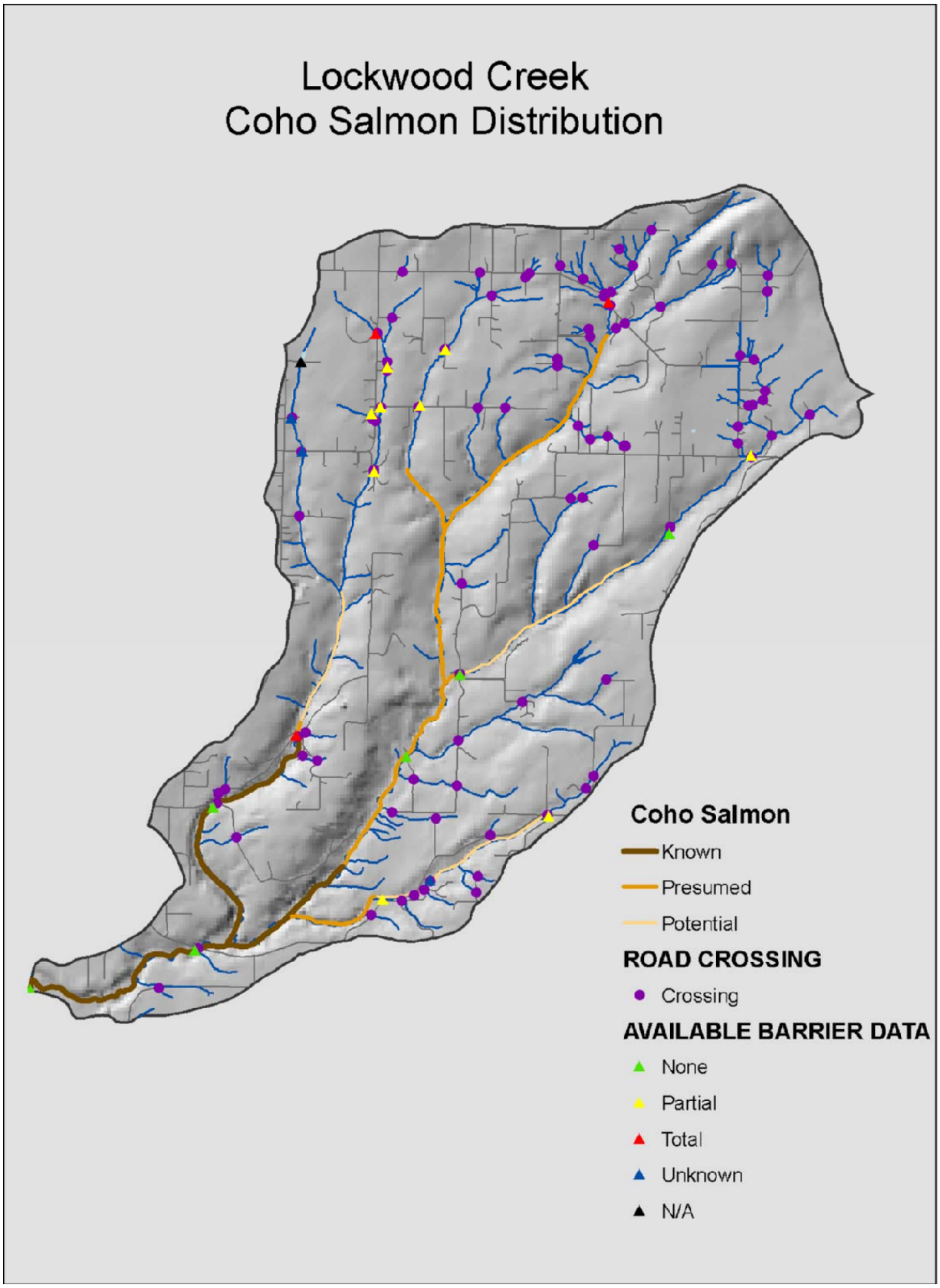

Figure 9: Coho Distribution and Barriers

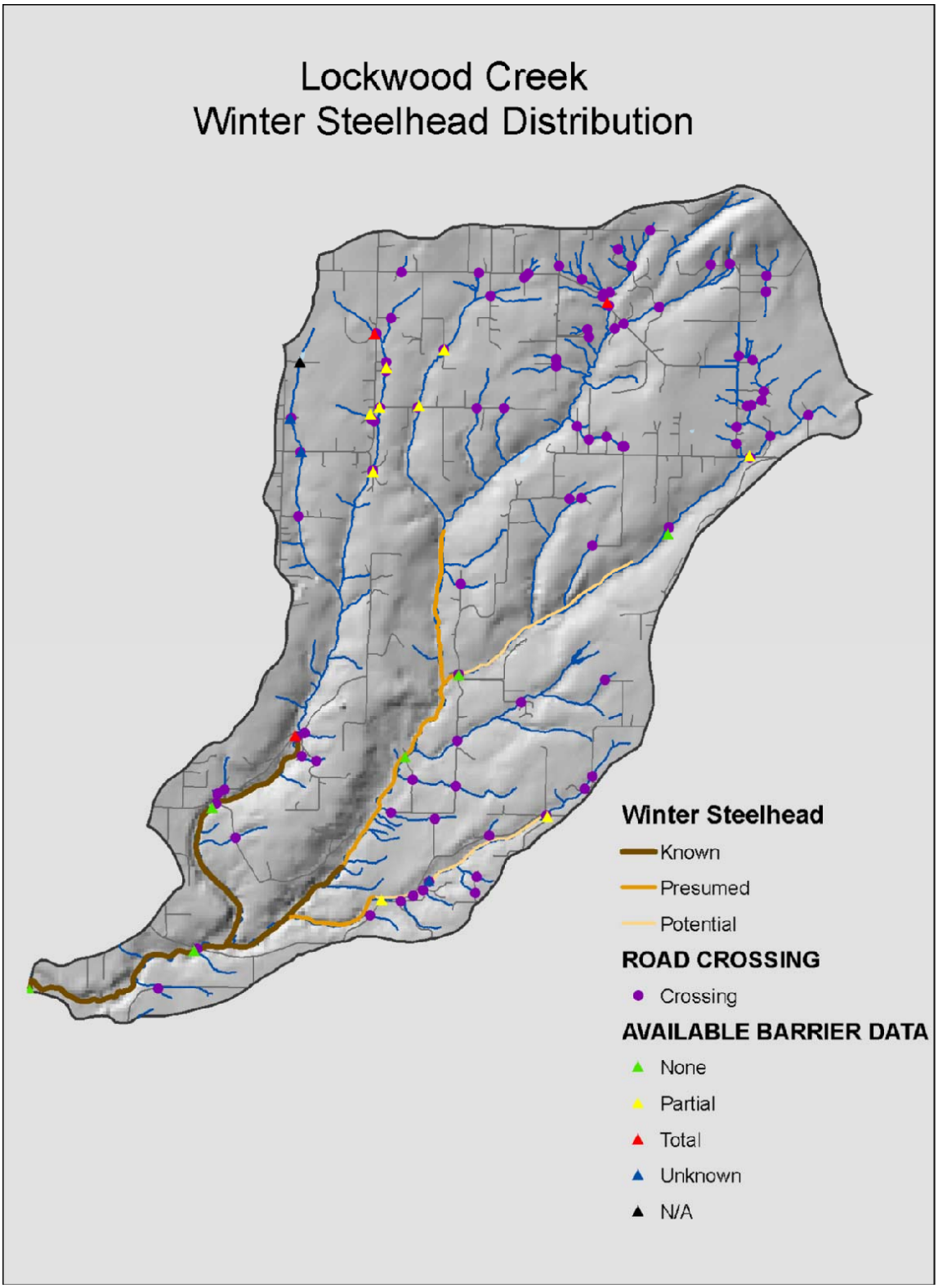

Figure 10: Winter Steelhead Distribution and Barriers

Recommendations

This report does not include additional information to make specific recommendations for Lockwood Creek barrier removals separate from existing inventories and assessments. Generally, barriers should be considered for removal as existing stream crossings are upgraded or replaced.

Hydrologic and Hydraulic Models

No modeling projects were completed for the SNAP report. However, an HSPF model was completed by Pacific Water Resources (August 2004) for the East Fork Lewis River as part of WRIA planning for WRIA 27 and 28. It includes limited information for Lockwood Creek as a modeled subbasin.

Analysis of Potential Projects

The analysis of potential projects includes:

- A brief summary of stormwater problems and opportunities,
- Notes recently completed or current projects within the study area that may be relevant to SNAP project selection,
- Describes the analytical approach, and
- Lists recommended projects and activities for further evaluation.

Projects or activities are placed in one of several categories.

Summary of Conditions, Problems, and Opportunities

Conditions and Problems

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

Coordination with Other Programs:

The Washington Department of Ecology is developing TMDLs for bacteria and temperature in the East Fork Lewis River watershed.

Broad-Scale Characterization:

Lockwood Creek soils tend to be fine-grained and may be easily eroded. The subwatershed is well drained uplands cut by shallow to deep canyons. The entire area is rural with no urban development.

Standard subwatershed scale metrics compared to NOAA fisheries standards suggest Lockwood Creek habitat is degraded, but still meets or is near meeting several standards for properly functioning. Non-functioning criteria include forest cover less than 50 percent and road density. Land cover, zoning, and subwatershed metrics suggest that a protect and restore approach is appropriate.

Water Quality Assessment:

Lockwood Creek has 303(d) listed segments and is part of the East Fork Lewis River fecal coliform and temperature TMDL project.

The limited water quality information indicates Lockwood Creek has concerns for bacteria contamination and water temperature. The Clark County Stream Health Report (2004) summarized Lockwood Creek stream health as fair.

Drainage System Inventory:

Drainage mapping is partially complete due to a lower priority for illicit discharge inspection. Additional mapping will be completed in 2008 and 2009.

Stormwater Facility Inspection:

As of December 2007, there were no known public stormwater facilities in unincorporated areas of Lockwood Creek subwatershed.

Illicit Discharge Screening:
Illicit discharge screening was not conducted in Lockwood Creek subwatershed. Screening is anticipated as part of future bacteria TMDL work.

Geomorphology and Hydrology:
See Appendix A for results of these assessments.

Riparian Assessment:
The most reliable riparian assessment data in Clark County is limited to the areas assessed during the 2004 LCFRB Habitat Assessment. Lockwood Creek was included in this assessment.

Generally, riparian conditions to support large woody debris recruitment are at good levels where characterized along the mainstem. Riparian shade is good for the length of the mainstem; most of the stream appears to have some degree of forest cover above where the creek crosses the East Fork Lewis River flood plain.

Public land is very limited within the subwatershed; therefore riparian projects would typically be on private land and require landowner cooperation.

Wetland Assessment:
Based on available wetlands data, potential wetlands are largely limited to riparian areas and a few upland areas. Ecology's draft wetland characterization of Clark County places Lockwood Creek in a category where the priority should be protection and restoration of wetland hydrology.

No wetland projects are proposed because there is no public land included in potential wetland areas.

Macroinvertebrate Assessment:
Based on two samples from lower Lockwood Creek, the creek displayed moderate to low biological integrity. The range of B-IBI scores for comparable areas is generally higher than observed in Lockwood Creek. Considering this, it is probable that biological integrity could be increased through improvements to upstream water quality conditions.

Fish Use and Distribution:
The LCFRB (2008) has identified Lockwood Creek as a relatively important stream for salmon recovery. There is known use by Coho salmon and winter steelhead in the lower reaches.

This report does not make specific recommendations for Lockwood Creek barrier removals separate from existing inventories and assessments. Generally, barriers should be considered for removal as existing stream crossings are upgraded or replaced.

Recently Completed or Current Projects

There are no stormwater projects planned for Lockwood Creek in the 2007 through 2011 SCIP.

Analysis Approach

Purpose

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

Stormwater capital improvement project opportunities are recommended for further evaluation by engineering staff and potential development into projects for consideration through the SCIP process. Referrals to ongoing programs such as IDDE Screening or Operations and Maintenance are addressed within the program work plans and schedules. There are also referrals to other county departments, such as Public Health, or to outside agencies such as Clark Conservation District and Clark Public Utilities for actions outside the CWP scope.

Methods

The project review is qualitative and based on best professional judgment of CWP staff. 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 on the basis of problem severity, estimated cost and benefits, land availability, access, proximity and potential for grouping with other projects, and potential for leveraging resources.

Based on this review, lower priority opportunities are removed from the list. Higher priority projects are recommended for further consideration.

Emergency or Immediate Actions

Limited field work in Lockwood Creek subwatershed did not discover any situations that required immediate action.

Potential Stormwater Capital Projects

- None are identified at this point.

Stormwater Infrastructure Maintenance CIPs

- None are identified at this point.

Stormwater Class V Underground Injection Control Projects

- No county-owned Class V UIC wells are known in Lockwood Creek subwatershed.

Habitat Rehabilitation/Enhancement Projects

- None are proposed due to the absence of public land.

Property Acquisition for Stormwater Mitigation

- No stormwater facilities or land acquisitions for facilities are proposed.

Public Works and Clean Water Program Referrals

- Several minor culvert problems found by WEST Consultants were referred to Public Works Operations.

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

- Limited field work resulted in no referrals.
- Fish passage barriers are well known to resource management agencies.

Non-Project Management Recommendations

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. Information of this type contributes to adaptive management strategies and more effective stormwater management during the permit term.

Management and programmatic recommendations in Lockwood Creek subwatershed, by permit component, include:

Storm Sewer Mapping and Inventory

- No recommendations, mapping is planned for completion in 2008-2009.

Coordination of Stormwater Activities

- The Lower Columbia Fish Recovery Board is planning an effort to identify restoration projects in the East Fork Lewis River below Lewisville Park. The Lockwood Creek subwatershed SNAP report will be forwarded to the LCFRB for review.
- TMDL development for bacteria and temperature will include Clark County.

Mechanisms for public involvement

- Publish SNAP report on CWP web page.

Development Regulations for Stormwater and Erosion Control

- EIA is not expected to increase to significant levels due to development envisioned by the Comprehensive Plan. For construction projects, emphasize stormwater management that focuses on reduction of runoff and diffuse infiltration close to the source.
- In a hilly subwatershed such as Lockwood Creek, effective erosion control measures for land disturbing activities are critical to protecting and restoring stream habitat.

Stormwater Capital Improvements

- Examine the use of small projects to improve stormwater retention and treatment in roadside ditches.

Operation and Maintenance Actions

- Restoring access to fish habitat is a priority in Lockwood Creek. Fish barrier removal projects in the upper watershed should be considered as existing roads and culverts are upgraded or replaced.
- Review county ditch maintenance practices for vegetation removal.

Education and Outreach to reduce behaviors that contribute pollution

Areas where increased outreach could improve stream conditions include:

- Stream crossings have missing or deteriorated stream name signs that should be replaced.
- Develop a system to provide education about appropriate ditch maintenance practices to rural landowners.

TMDL Compliance

- As Ecology and local stakeholders develop the East Fork bacteria and temperature TMDL, implementation measures will be identified.

Monitoring Stormwater Program Effectiveness

- Problems caused by stormwater are common and most severe on small tributary streams. Future Stormwater Needs Assessments may be most effective by focusing on smaller tributary streams.

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Appendices

Appendix A — Geomorphology and Hydrology Assessment