2007 Stormwater Needs Assessment Program

Upper Gee Creek / Lower Gee Creek / Cathlapotle Subwatershed Needs Assessment Report

Clark County Public Works Clean Water Program

May 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 includes the upper Gee Creek, Gee lower Creek, and Cathlapotle subwatersheds in northwestern Clark County. Assessment effort focused on the unincorporated areas, primarily located in the upper watershed.

Intent

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

Findings

Watershed Conditions

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

Ongoing Projects and Involvement

The Gee Creek Watershed Enhancement Committee, US Fish and Wildlife, Friends of Ridgefield Wildlife Refuge, local school children and landowners have adopted the cause of improving and protecting Gee Creek. The watershed continues to benefit from the efforts of these groups.

Major highway construction projects are underway at the 219th Street interchange and planned for SR502 between I-5 and Battle Ground.

There are currently no major projects sponsored by other regional entities such as Lower Columbia Fish Recovery Board, Clark County Legacy Lands Program, Clark Public Utilities, Clark County Transportation Improvement Program, and the Department of Ecology.

There are no Clark County Clean Water Program stormwater projects in Gee Creek under the 2007-2012 Stormwater Capital Improvement Program.

Category	Status
Water Quality	
Overall	• Poor to Very Poor
Fecal coliform bacteria	• TMDL required
Temperature	• Does not meet state criteria
Sediment	• High turbidity and higher than desirable sediment load
Biological	
Benthic macroinvertebrates	• Low biological integrity
Anadramous fish	• Very limited use; low regional recovery priority
Resident fish	• Low cutthroat trout population
Habitat	
Reference condition	• Overall habitat similar to a Category C (degraded) Willamette Valley reference stream
NOAA Fisheries criteria	• Forest cover, road density, and impervious area percentage fall into the Non-Functioning category
Riparian	• Forest cover limited to narrow bands along streams • Invasive vegetation predominant as understory • Large woody debris is limited with low recruitment potential
Wetland	• Primarily limited to near-stream floodplains • Potential headwater wetlands east of I-5
Hydrology and Geomorphology	
Overall hydrology	• Impacted: typical of a flashy urban or unforested rural watershed
Channel stability	• Most stream reaches are incised but relatively stable at present; many are susceptible to future erosion
Future condition	• Projected impervious area will cause increased rate of channel incision, bank failures, and accelerated channel migration in various areas unless adequate runoff controls are in place
Stormwater (Unincorporated areas)	
System description	• Primarily field drains and road-side ditches, with limited piped infrastructure in headwaters and near I-5 corridor • 21 public and private stormwater facilities currently mapped
Inventory status	• Incomplete (estimated 75 percent)
System adequacy	• Inadequate control and treatment • Projected impervious area indicates need for updated control standards with considerable investment in new and retrofit infrastructure
Condition	• 61 percent of public stormwater facility components in compliance with state standards at time of inspection • 86 public outfalls discharging to critical areas; one causing significant erosion • 115 stormwater outfalls inspected for illicit discharges; one significant bacteria source discovered and removed

Opportunities

Projects listed in the SNAP report represent only a small part of those required to protect and restore Gee Creek. Immediate priorities based on current conditions and local program capabilities are listed. Numerous opportunities exist for stormwater-related watershed improvement, including the following:

- Focused stormwater outreach and education to streamside landowners in the headwaters within Vancouver UGA.
- Consider use of WSDOT Clean Water fees to address a number of failing outfalls within the I-5 corridor.
- Focused source control outreach to address fecal coliform pollution in targeted stream reaches.
- Potential retrofits to existing public stormwater facilities, including roadside ditches, for enhanced control or treatment.
- Repair and maintenance of existing stormwater infrastructure.
- Evaluation of potential wetland enhancement or advanced mitigation projects within tax-exempt parcels and areas identified as potential mitigation banks.
- Evaluation of potential fish barriers in the lower watershed.
- Elimination of one significant illicit connection in the upper watershed.
- Inspection of several potentially at risk earthen dams.
- Evaluation of several small stormwater capital improvements for submittal to SCIP.
- Inspection of one potentially failing private stormwater facility.
- Technical assistance visits to landowners with potential source control and water quality ordinance issues.
- Updates to stormwater infrastructure database.
- Promotion of riparian enhancement projects, particularly in the upper watershed.

Non-project stormwater management recommendations address areas where county programs or activities could be modified to better address NPDES permit components or promote more effective mitigation of stormwater problems. Management recommendations relevant to the Gee Creek watershed include:

- Complete the stormwater infrastructure inventory.
- Coordinate and leverage opportunities with groups and agencies active in Gee Creek improvement.
- Encourage the use of Low Impact Development techniques for new development, and runoff reduction techniques for existing development.
- Increase maintenance of stormwater swales to ensure adequate vegetation coverage.

- Confirm that county ditch maintenance practices minimize vegetation removal; provide education for private landowners on appropriate ditch maintenance.
- Replace missing or deteriorated stream name signs at road crossings.
- Encourage removal of invasive plants and riparian restoration through education, technical assistance and/or financial assistance.

Introduction

This report is a Stormwater Needs Assessment for the upper Gee Creek, lower Gee Creek, and Cathlapotle 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 and most cost effective mix of improvement actions to protect existing beneficial uses, and to improve or allow for the improvement of lost or impaired beneficial uses consistent with NPDES objectives and improvement goals identified by the state GMA, ESA recovery plan implementation, TMDLs, WRIA planning, flood plain 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 protections and salmon recovery planning under the state Growth Management Act (GMA) and the federal Endangered Species Act (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 Gee 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).

The upper Gee Creek and lower Gee Creek subwatersheds fall into the "Rural Residential with UGA fringe" category established in the above document. Subwatersheds in this category typically include both city and county jurisdictions. The level of SNAP implementation depends to some extent on coordination between municipalities. Priority for stormwater basin planning is often high in this category, leading to the use of a fairly wide range of SNAP tools.

The Cathlapotle subwatershed falls into the "Wildlife Refuge and Open Space" category. Subwatersheds in this category typically have very limited urban development and stormwater infrastructure. SNAP implementation focuses on drainage inventory, stakeholder coordination, and broad-scale GIS characterization.

Assessment Tools Applied in Gee Creek

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

Table 1 lists the set of tools available for use in the SNAP. Tools marked with an asterisk (*) are those for which new data or analyses were conducted during the course of this needs assessment. The remainder of the tools was assessed based on pre-existing information.

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
- CWP staff provided two SNAP updates at Gee Creek Enhancement Committee meetings

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

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

- Clark County Endangered Species Act program
- Lower Columbia Fish Recovery Board
- Clark County Transportation Improvement Program
- Clark County Legacy Lands Program
- Vancouver/Clark Parks and Recreation
- Gee Creek Watershed Enhancement Committee
- Fish First
- Washington Department of Ecology
- Clark County Weed Management
- Large Private Landholders
- Washington State Department of Transportation

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
- Salmon Recovery Plan
- CC LISP/SCMP/Project Data
- CC Volunteer Project Data
- Ecology 303D (list)
- WRIA Limiting Factors Analysis
- Gee Creek Background Report
- Gee Creek Watershed Restoration Project 2007 annual report
- Gee Creek Restoration Projects
- CC Consproj GIS Layer (conservation projects)
- CC 6-year and 20-year TIP
- Ecology EIM Data
- CC Mitigation Opportunities Project
- CC 2004 Subwatershed Summary
- CC 2004 Stream Health Report

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.

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

Map Products

Three standard SNAP map products are: 1) Stormwater Infrastructure and Hydrologic Soil Groups, 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

Gee Creek is along the western edge of Clark County, lying between the East Fork Lewis River and other smaller streams draining to Lake River (Figure 1). The Gee Creek watershed is composed of three subwatersheds; Upper Gee and Lower Gee are the rural and urban areas above the Columbia River flood plain. Cathlapotle subwatershed occupies the Columbia flood plain, and is largely a wildlife refuge and privately held forestland. The rapidly growing City of Ridgefield is expanding eastward to the I-5 corridor, which bisects Upper Gee Creek subwatershed.

Topography

The Gee Creek study area is rolling hills, giving way to relatively steep canyons cut into sedimentary rock deposits of the Columbia River. The highest hills are about 450 feet above sea level in the south part of the study area, but most of the area is between 250 and 300 feet altitude. Gee Creek develops a flood plain

below I-5 at about 150 feet altitude, which then extends down to near sea level at the Columbia River flood plain.

Geology and Soils

The Gee Creek watershed is underlain by thee principal geologic units, older semi-consolidated sandy gravel commonly referred to as the Troutdale Formation or Troutdale gravels, fine grained catastrophic Ice Age flood deposits, and alluvium along the Gee Creek and Columbia River flood plains. Recent mapping by Evarts (2004) provides a good level of detail for most of the area.

The Troutdale Formation is sandy ancestral Columbia River deposits that at depth underlie the entire watershed. It is exposed as weathered 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.

Fine-grained late Ice Age catastrophic flood deposits mantle much of the watershed above the Columbia River flood plain, and below about 350 feet altitude. 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.

The youngest deposits are modern alluvium on the Columbia River flood plain and Gee Creek. These materials tend to be sandy silt derived from eroded and redeposited catastrophic flood deposits.

Soils formed on the Troutdale Formation and fine-grained catastrophic flood deposits tend to be fairly clayey. Fine-grained catastrophic flood deposits are easily eroded. Soils on modern alluvium tend to be sandier, more permeable and easily eroded as stream banks.

Hydrology

The Gee Creek hydrologic framework is determined by geology and topography. Generally, flatter upland areas underlain by Troutdale Formation and catastrophic flood deposits are incised by channels eroding headward from the Columbia River flood plain. Other than the mainstem of Gee Creek, below I-5 valleys generally have little or no flood plain. Once Gee Creek crosses the Burlington Northern rail line, it empties into the Columbia River flood plain and passes through a series of lakes and sloughs to the Columbia River.

Clark County has maintained a stream gauge on Gee Creek at Abrams Park and a rain gauge at Ridgefield treatment plant since 2003. Data from the stream gauge suggests that Gee Creek is a relatively flashy stream. Examination of a simple hydrology metric, the TQmean, showed that only 25 percent of the daily flows were greater than the mean daily flow. This is indicative of a flashy urban or unforested rural watershed.

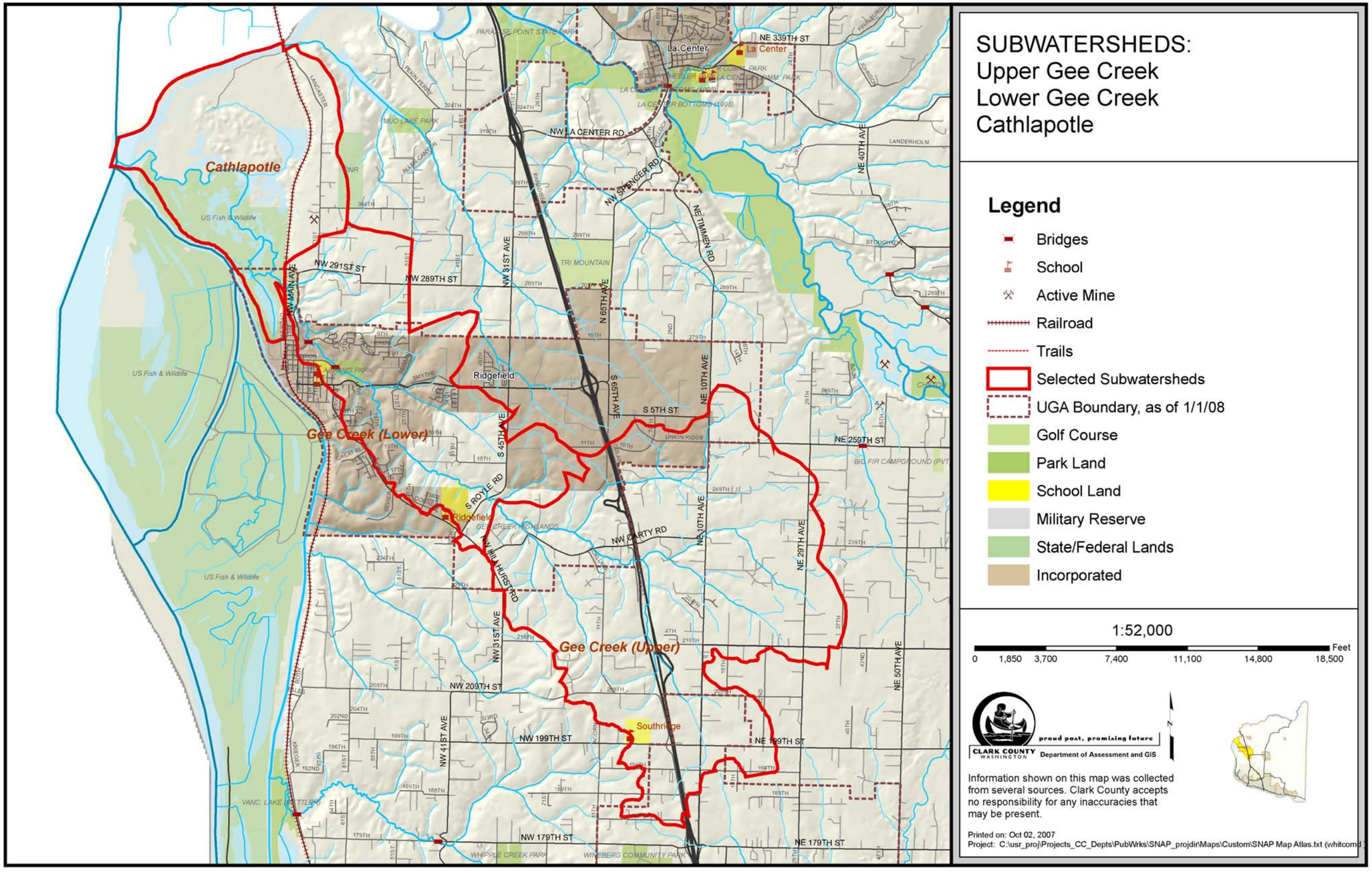


Figure 1: Subwatershed Map: Upper Gee Creek, Lower Gee Creek and Cathlapotle

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 Gee Creek, above the Columbia River flood plain, is a significantly degraded stream habitat (Table 2).

Table 2: Watershed Scale Metrics

Metric	Upper Gee	Lower Gee	Cathlapotle	Functioning	Non-functioning
Percent Forested (2000 Landsat)	18	29	38	> 65 %	< 50 %
Percent TIA (2000 Landsat)	16	19	11	< 5 %	> 15 %
Road Density 2007 data (miles/mile2)	7.4	7.9	1.6	< 2	> 3
Stream Crossing Density (crossings per stream mile)	2.5	2.2	0.3	< 3.2/mile	> 6.4/mile
Percent EIA estimated from the Comprehensive Plan	22	25	2	< 10 %	> 10 %

Forest Cover
The Gee Creek watershed has relatively little intact forest. Forest is mainly in steep valleys and open space on the Columbia River flood plain. Much of the level, or mildly sloping areas, were probably cleared for agriculture in late 1800s and early 1900s.

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.

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 of less than five percent as fully functional and greater than 15 percent as non-functional habitat is a reasonable indicator of habitat quality. For comparison, Gee Creek has 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 (>3 road miles/mi^2), including upper and lower Gee Creek subwatersheds. Urban streams have road densities approaching 15 to 20 miles per square mile. Gee Creek road density outside of the Columbia River flood plain is seven to eight miles per square mile, which is typical of a mixed urban and rural area.

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. Gee Creek stream crossing density outside of the Columbia River flood plain is 2.2 to 2.5 crossings per stream mile, placing it in the functioning category (<3.2 crossings/stream mile) under the 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. Virtually no changes should be expected in Cathlapotle, where it is nearly all wildlife refuge and open space. However, EIA is expected to increase significantly, to around 20 percent in both upper and lower Gee Creek due to urbanization. At these levels, adverse changes to stream hydrology and stability will occur unless development standards effectively control the duration of erosive flows.

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, Gee Creek should have predominantly unstable channels under current and future conditions mitigated to development standards in place before the county adopts Ecology's 2005 Stormwater Management Manual for Western Washington.

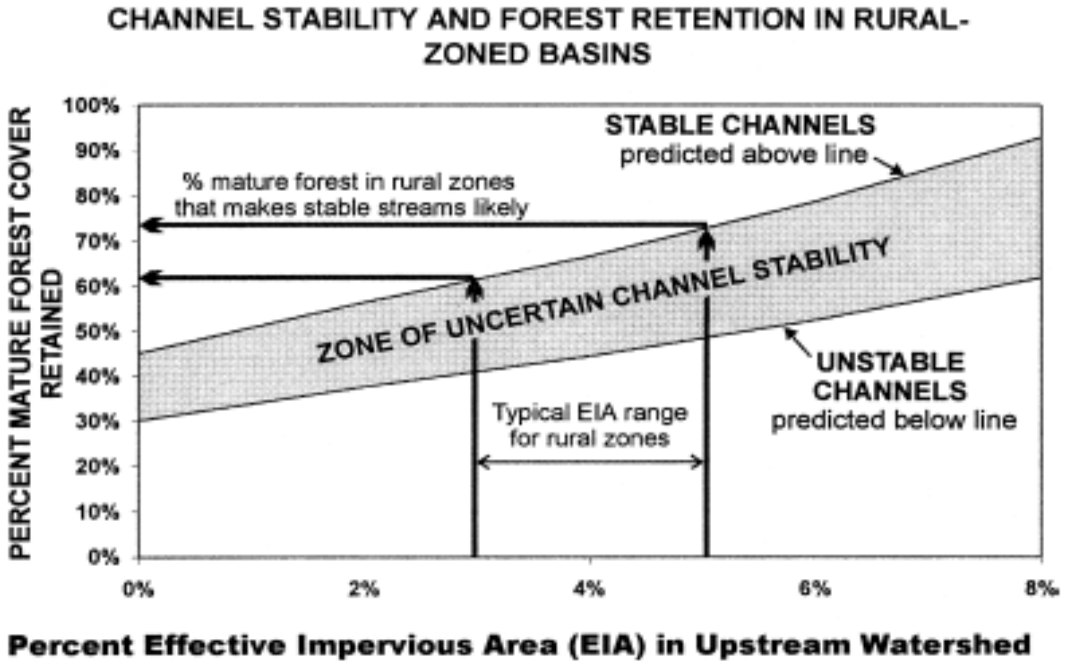


Figure 2: Channel stability in rural areas (Booth, Hartley, and Jackson, June 2002).

Water Quality Assessment

This section briefly summarizes and references available water quality data from the Gee Creek watershed. 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 current Washington State water quality standards, Gee 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 Gee Creek. With the exception of toxics, these characteristics are included in or addressed by the Gee Creek dataset.

Table 3: Applicable Water Quality Criteria for Gee 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

Gee 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 dissolved oxygen and temperature. Segments of Gee Creek are also Category 1 listed (meets tested standards for clean waters) for dissolved oxygen, pH, and ammonia-N.

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

TMDLs are prioritized for development by Ecology each year. Gee Creek is not included on the list of TMDLs to be developed in 2008.

Clark County Stream Health Report

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

Gee Creek was assessed collectively with Whipple, Flume, and Allen Canyon creeks as the West Slope area. Based on available data, including fecal coliform bacteria, general water chemistry (temperature, pH, and dissolved oxygen), and benthic macroinvertebrate scores, overall stream health in the West Slope Watershed scored in the poor to very poor range. Though data were available for only 10 percent of the stream miles in the watershed, a simple land-use model predicted poor stream health in the remainder of the watershed. The rating specifically for Gee Creek was poor based on available data.

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 listed below.

Table 4: Data and Information Sources	
Source	**Data and/or Report**
Clark County Clean Water Program	2002-2006 Long-term Index Site Project Volunteer Monitoring Program 2004 Stream Health Report and draft reports Gee Creek synoptic bacteria study (2003) Gee Creek fecal coliform/turbidity study (2007)
Ecology	303(d) List of Impaired Waterbodies Station 27F070 data (Gee Cr @ Ridgefield)

Water Quality Summary

The following water quality summary is based primarily on monthly data collected between May 2002 and December 2006 at Gee Creek station GEE050 located near Royle Road. Additional results are included from volunteer station GEE030 at Abrams Park, a continuous stage and temperature gage at station GEE028 at Abrams Park, and from a one year multi-station fecal coliform and turbidity survey conducted by the CWP in 2007.

The data are presented in terms of a multi-characteristic water quality index, followed by summaries of several individual characteristics. Summarized water temperature data collected from approximately May through September between 2002 and 2006 are also included. Figure 3 shows the approximate locations of the above-referenced 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 – September) and high flow (October – 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 shows seasonal mean OWQI scores for station GEE050 from 2002 through 2006. Among 15 long-term monitoring stations county-wide, Gee Creek

station GEE050 ranked 4th worst in overall water quality during this time period (Hutton and Hoxeng, 2007).

Individual monthly OWQI values since 2002 were in the Very Poor or Poor category every month with the exception of April 2003 and May 2003. Monthly sub-index scores for total solids and total phosphorus were consistently poor or very poor, while scores for fecal coliform, stream temperature, and inorganic nitrogen ranged from very poor to excellent and showed wide seasonal variations. Sub-index scores for dissolved oxygen and pH were consistently good to excellent.

Trends over Time

An analysis of potential statistical trends in OWQI scores based on the 2002 - 2006 dataset found no significant water quality trends at station GEE050 (Hutton and Hoxeng, 2007).

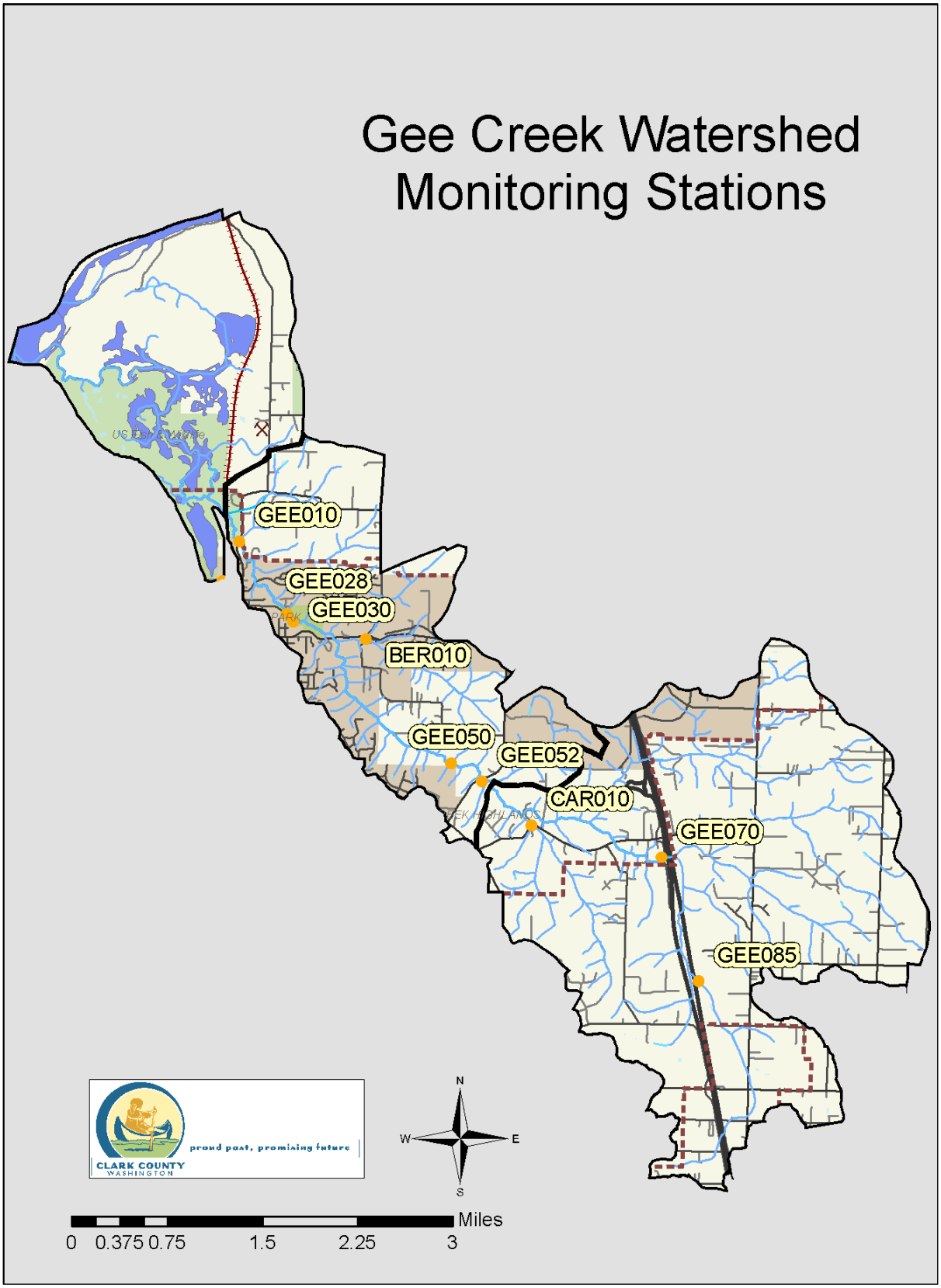


Figure 3: Gee Creek Watershed Monitoring Stations

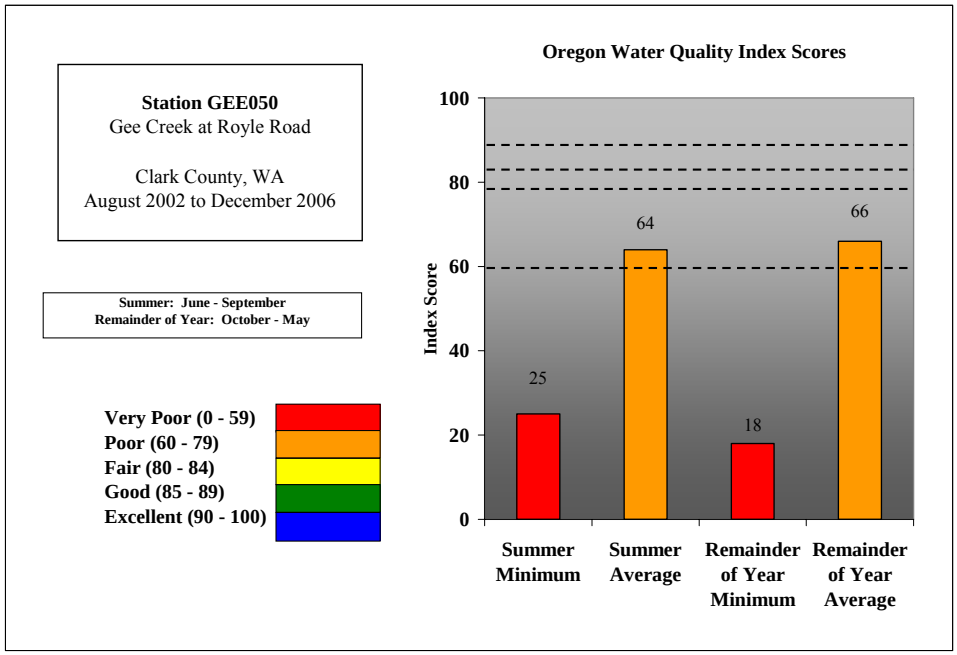


Figure 4: Average water quality, Gee Creek station GEE050, 2002-2006. Oregon Water Quality Index.

Fecal Coliform Bacteria

The overall range of sample values at station GEE050 was 15 cfu/100mL to 3300 cfu/100mL. Figure 5 shows seasonal geometric mean fecal coliform values from August 2002 through December 2006. Geometric mean values for both seasons exceeded the state criterion of 100 cfu/100mL by one to two times. Based on 17 sampling events, the summer (June – September) geometric mean was 209 cfu/100mL. Based on 35 sampling events, the Fall-Winter-Spring (October – May) geometric mean was 162 cfu/100mL.

Station GEE050 also failed to meet the 10 percent criterion for both seasons, with 41 percent of summer samples and 46 percent of FWS samples exceeding 200 cfu/100mL.

The 10 percent criterion may also be evaluated by examining the 90th percentile values. The criterion is met if the 90th percentile value is 200 or lower. For the GEE050 dataset, the summer and FWS 90th percentile values were 612 and 836 cfu/100mL, respectively, approximately three to four times higher than the criterion.

The volunteer dataset from station GEE030 at Abrams Park is not extensive; however, quarterly fecal coliform values from 2003 through 2006 indicate 36 percent of FWS samples and 100 percent of summer samples exceeded 200 cfu/100mL. Ninetieth percentile values for FWS and summer seasons were 500 and 1380 cfu/100mL, respectively, 2.5 to 7 times the criterion.

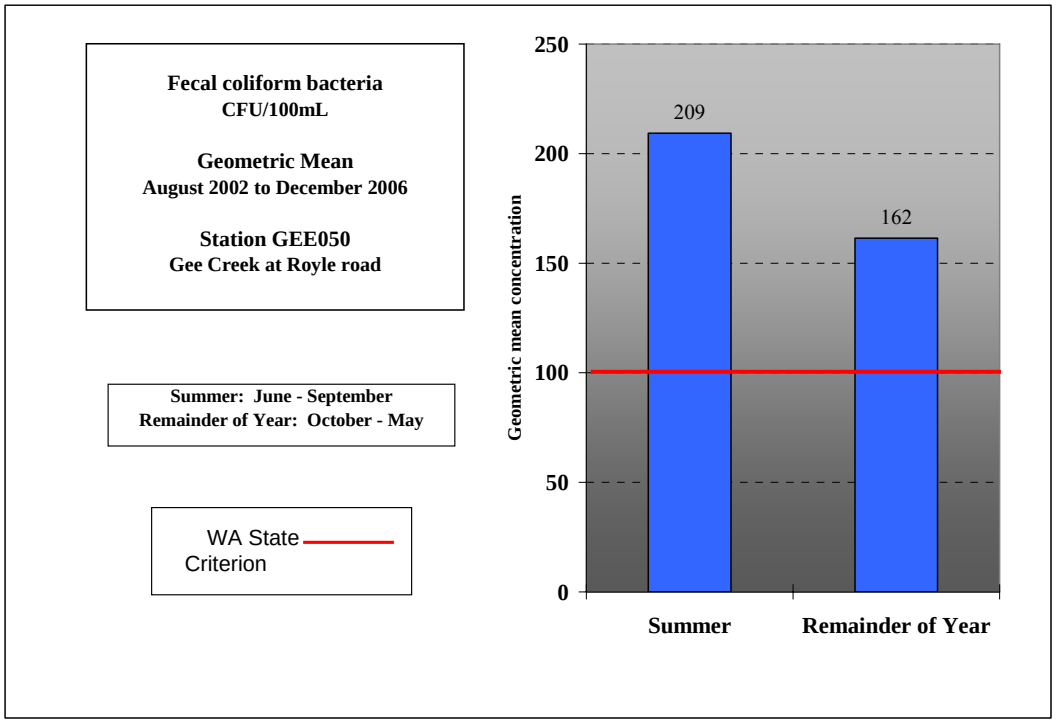


Figure 5: Seasonal geometric mean fecal coliform, Gee Creek station GEE050, August 2002 through December 2006.

Preliminary results from the CWP 2007 Gee Creek fecal coliform study include the following:

- The Bertsinger Road tributary had high fecal coliform concentrations from June through September (geometric mean 616 cfu/100mL, range 320-945)
- Gee Creek at Abrams Park, Gee Creek at Royle Road, and the Carty Road tributary had periodic high fecal coliform concentrations during much of the fall, winter, and spring (geometric mean 277-348 cfu/100mL, overall range 28 – 6000)
- Different source types are likely contributing to high concentrations in different stream reaches.

Nutrients

Nutrient criteria are not established for Washington streams. US 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 GEE050 between August 2002 and December 2006 ranged from 0.052 mg/L to 0.264 mg/L, and 85 percent of samples

exceeded the EPA criterion of 0.100 mg/L. Total phosphorus concentrations typically vary seasonally in many locations; however, seasonal median values in Gee Creek are relatively similar:

- Summer median = 0.163 mg/L
- FWS median = 0.121 mg/L

Turbidity

It is difficult to establish an exact background turbidity level for Gee Creek because no data exists from a time when Gee Creek was not impacted by human activities. However, based on data from the least-impacted streams monitored by the CWP, we estimate that natural background turbidity in most Clark County streams would have been in the range of 0.5 to 2 NTU. Based on this estimate, the turbidity criterion for Gee Creek is likely between 5.5 and 7 NTU.

Since August 2002, the median of 53 turbidity samples at GEE050 is 6.1 NTU, with individual samples ranging from 2.2 NTU to 82 NTU. Turbidity varies somewhat seasonally, with the FWS median nearly twice the summer median:

- Summer median = 4.5 NTU
- FWS median = 8.5 NTU

Higher turbidity readings in the 20-40 NTU range are common during storm events. Extremely high turbidity values often indicate a specific sediment source during rainfall events. The highest recorded value in Gee Creek since 2002 was 4660 NTU, collected by volunteers at the GEE030 station at Abrams Park in August 2004. The source of this event was insufficient erosion controls at a subdivision construction project. Although the developer was subsequently fined by Ecology, the event caused lasting damage to the creek. Sediment from this event remains visible at Abrams Park in 2007, over one mile downstream from the source.

Among 15 CWP-operated long-term monitoring stations countywide, Gee Creek station GEE050 ranked 2nd worst in average turbidity from 2002 - 2006.

Stream Temperature

In addition to monthly temperature readings incorporated into OWQI calculations, continuous temperature loggers recorded hourly temperature values between May and October during 2002 to 2006. Continuous readings provide a more complete picture of temperature dynamics than monthly grab samples.

Table 5 summarizes the continuous temperature data. The 7-Day average maximum value is the maximum of the 7-day moving average of daily maximum temperatures. The 2006 Ecology standards utilize this metric to determine temperature compliance for protecting salmonid habitat as a beneficial use (Gee Creek criterion is 63.5° F). Maximum daily ΔT is the maximum daily temperature fluctuation, and gives some indication of the susceptibility of the stream to heat input.

Summer stream temperature at GEE050 (Royle Road) was relatively consistent and exceeded the 63.5° F state criterion by 5° to 7° F in each year monitored, while temperatures at the Abrams Park stations (GEE030 and GEE028) were somewhat more variable and exceeded the criterion by 3° to 8° F over the same period.

Due to the negative effects of chronic high temperatures on salmonids and other cold-water biota, the amount of time spent with elevated temperatures is also of interest. Figure 6 indicates the number of days on which the *daily* maximum temperature exceeded 64° F at stations GEE050, GEE030, and GEE028. Sixty-four degrees is the Class A criterion prior to November 2006 rule changes and is a threshold above which salmonids are known to suffer deleterious effects.

The number of days with temperatures exceeding 64° F has ranged from 43 to 68 at GEE050 and from 39 to 81 at the two Abrams Park stations. Annual variations at individual stations are likely attributable to differences in ambient air temperatures and stream flow. Regardless of variations between years and stations, all available data from Gee Creek indicates stream temperatures remain elevated over a substantial time period each summer.

Table 5: Seasonal Maximum, 7-Day Moving Average and Maximum Daily Temperature Change at Gee Creek Stations Gee050, GEE030, and GEE028, 2002 - 2006

7-Day average		Maximum daily ΔT	
Date	**Maximum**	**Date**	**Value**
GEE050:			
07/23/02	70.1	07/10/02	8.9
07/21/03	68.6	07/29/03	5.8
07/22/04	70.6	07/12/04	7.2
07/29/05	68.9	07/28/05	5.3
07/24/06	70.7	06/29/06	5.1
GEE030:			
07/23/06	71.2	06/27/06	9.6
GEE028:			
07/12/03	66.5	07/03/03	5.4
07/21/04	70.2	06/17/04	7.0
07/29/05	66.4	06/19/05	3.8
06/28/06	68.0	05/14/06	6.3

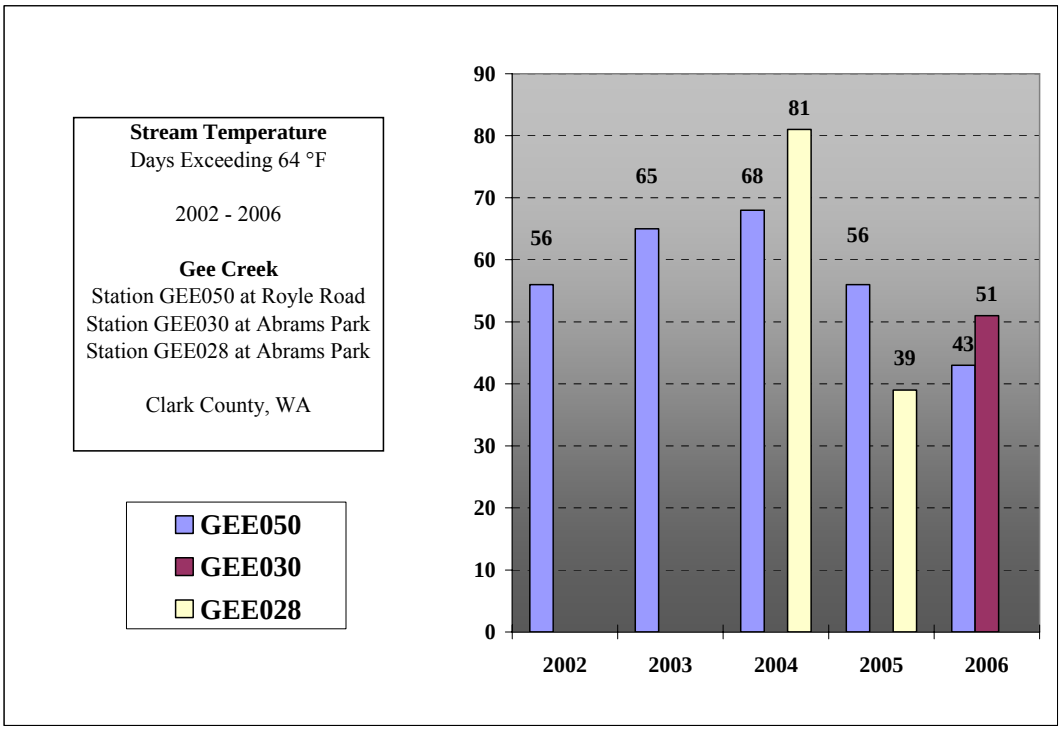


Figure 6: Days exceeding 64° F, 2002 – 2006, Gee Creek stations GEE050 and GEE028.

Impacts to Beneficial Uses and Potential Sources

General water quality in Gee Creek is poor according to the OWQI and other measures discussed above. Listed beneficial uses are degraded according to several water quality characteristics, including: fecal coliform bacteria, stream temperature, turbidity, total phosphorus, and total solids.

Observed levels of these characteristics may have negative impacts on the listed beneficial uses of: salmonid spawning, rearing, and migration; primary contact recreation; wildlife habitat; and aesthetic values. Table 6 at the conclusion of this section summarizes the primary water quality impacts to beneficial uses in Gee 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. Although Gee Creek has no developed swimming or wading areas, it is likely that some local residents, particularly children, utilize the creek for recreation in the Abrams Park area and other areas of the watershed. If so, there is some risk of illness associated with bacterial contamination.

The extent of elevated fecal coliform results during 2007 and 2008 suggest the presence of fairly widespread and consistent sources that will likely require considerable effort to control.

Turbidity and Solids
Gee Creek exhibits among the highest routine turbidity levels based on county-wide monitoring data, and is susceptible to very high short-term turbidity during rain events. The available data suggests Gee Creek carries a higher than desirable load of fine silt and sediment.

The primary sources of excessive turbidity and silt load in Gee Creek are probably related to soil and bank erosion. Off-site erosion (development, agriculture, recreational vehicle use), in-stream erosion (bank scour, slumping, re-suspension of sediments during high flows) likely contribute significantly to the elevated turbidity during rain events.

Turbid water may limit foraging ability and indicate the presence of fine silt that clogs gills and spawning beds. Fine sediment deposits compromise gravel spawning areas, smother eggs, and impact food availability by suppressing benthic macroinvertebrate populations.

Total Phosphorus (TP)
Groundwater in Gee Creek is high in phosphorus, tending to increase in the deeper aquifers (Turney, 1990). As shallow sources deplete during the summer, deeper aquifers with longer flow paths and subsequently higher phosphorus levels tend to contribute a greater share of surface flows. Naturally elevated concentrations stemming from the underlying geology may be augmented by nutrients from fertilizers, leaking septic tanks and sewer infrastructure, wildlife, and direct livestock access.

Despite high nutrient levels, algae growth does not appear to contribute greatly to observed turbidity. However, the downstream impacts of high phosphorus concentrations may be more significant than local effects. High nutrients may contribute to blue-green algal blooms in the lower end of the watershed in the Columbia River floodplain, where high-nutrient water enters slower-moving areas.

Water Temperature
Water temperature may be an impediment to salmonid use in Gee Creek. In particular, elevated temperatures have a detrimental impact on salmonid rearing. Migration and spawning tend to occur during cooler times of year, but juveniles are exposed to elevated summer temperatures during rearing. Resident cutthroat trout are exposed at all age classes.

Temperature-related impacts to salmonids begin to occur at stream temperatures greater than 64°F. 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).

Gee Creek is consistently among the warmer streams monitored by the Clean Water Program, with summer temperatures regularly exceeding 64°F. This suggests temperature moderation will be a necessary component in any plan to recover fish populations.

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.

Gee Creek has relatively good riparian canopy cover throughout much of the watershed, though many areas do receive direct solar radiation and would benefit from riparian enhancement. A substantial number of man-made headwater ponds are also present, some of which likely contribute significantly to elevated temperatures. Below average summer stream flows over the past several years have made the stream more susceptible to temperature impacts.

Given the relatively dry summers in the Pacific Northwest, stormwater systems generally should not be a major factor in elevating summer temperatures. The majority of storms occur during cooler weather patterns. In some cases storm sewers may even contribute cool water in the form of piped baseflow. However, urban runoff from summer storms may cause stream temperatures to spike well above the criterion for a short period of time.

Implications for Stormwater Management

Table 3 lists the primary known water quality concerns and potential solutions for each. Solutions listed in bold indicate areas where Clean Water Program activities can have a positive impact. It should be noted that Clean Water Program 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.

Among the CWP activities most likely to have a positive impact on water quality are:

- effective stormwater system designs, retrofitting, and maintenance
- source detection and removal projects; and
- public education programs

Table 6: Known Water Quality Concerns, Sources, and Solutions for Gee 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	
Turbidity	Salmonid spawning, rearing, and migration; Aesthetic enjoyment	erosion *(development projects; land clearing; cropland; impervious surfaces; channel erosion)*	overland runoff storm sewers channel dynamics	Erosion control regulations **Storm sewer system cleaning and maintenance** **Storm water facility designs/retrofits to optimize settling and removal of suspended silt/clay** Agricultural Best Management Practices Stream bank stabilization/rehabilitation **Storm water outfall/facility retrofits to reduce flow-induced channel erosion**
		algae	in-stream growth due to excess nutrients	
Total phosphorus	Aesthetic enjoyment	natural groundwater	groundwater seeps	Erosion control regulations Septic system inspections and maintenance Sanitary sewer leak identification and removal **Storm sewer system cleaning and maintenance** **Storm water facility designs/retrofits to optimize settling and removal of suspended silt/clay** Agricultural Best Management Practices **Education programs (reduced fertilizer use)**
		fertilizers	overland runoff storm sewers	
		erosion	(see turbidity)	
		livestock, pets, wildlife	(see bacteria)	
		failing septic systems	(see bacteria)	
		sanitary sewer leaks	(see bacteria)	

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

The drainage system inventory 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 Gee Creek report area during 2007 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), and to a lesser extent the Public Facility Inspection project. Table 7 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 the upper Gee, lower Gee, and Cathlapotle subwatersheds remained incomplete at the conclusion of 2007 SNAP implementation. Staff availability was insufficient to complete this task as scheduled. Inventory completion is ongoing in 2008 and 2009 as part of a county-wide inventory update.

Table 7: Drainage System Inventory Results, Gee Creek Watershed

Database Feature Category	Previously Inventoried	Added to Database during 2007 SNAP
Inlet	105	4
Discharge Point (Outfall)	5	137
Flow Control	10	0
Storage/Treatment	108	3
Manhole	37	1
Filter System	0	0
Channel	206	198
Gravity Main	364	229
Facilities	20	1

Stormwater Facility Inspection

The Public Stormwater Facility Inspection project is designed to meet requirements of Clark County's 2007 NPDES permit which requires an ongoing inspection program for county stormwater treatment and flow control facilities.

The stormwater facility inspection process includes two components:

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

Component 1: Public Stormwater Facility Inspection

Purpose

The purpose of Public Stormwater Facility Inspection project is to verify that maintenance activities are implemented, verify that facilities are properly functioning, and identify possible retrofit projects and major repairs.

Methods

The Public Stormwater Facility Inspection project is derived from 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 that may need repairs, the condition when repair or maintenance is needed, and the expected results. Individual components of a facility are referred to as "facility objects" and are listed in Table 9.

The public stormwater facility inspection process involves inspecting all facility objects to determine if all maintenance is in compliance with the standards. If any facility object does not meet the maintenance standards, the entire facility is not in compliance. Noncompliant stormwater facilities are referred to the appropriate public works departments for repairs or maintenance.

Results

Based on the county's StormwaterClk database, as of December 2007, there were eight mapped public stormwater facilities in the Gee Creek subwatersheds.

Figure 7 summarizes notable inspection activities including general facility location, compliant facilities and referrals of noncompliant facilities.

As listed in Table 7, eight public stormwater facilities in the Gee Creek watershed were inspected, including a total of 49 facility objects. Thirty

(61 percent) of the facility objects were in compliance. The remaining nineteen (39 percent) of the facility objects were not in compliance. The inspection process generated eight referrals: three referrals were to the Public Works Clean Water Program to revisit public facilities that were either under construction or not accessible due to construction activities; and five referrals were to Public Works Maintenance and Operations for needed maintenance activities.

Maintenance Referrals

Public stormwater facilities that were referred to the CWP will be revisited when construction activities are completed or as part of the 2008 inspection process.

Referrals made to public works maintenance and operations department will be scheduled for repair or maintenance in early 2008. Once referrals are addressed, the CWP revisits facilities to conduct a second inspection to ensure compliance.

No major defects or hazardous conditions were discovered; non-compliant issues included excess sediment depth, trash or debris, vegetation maintenance, and lack of signage.

Retrofit Opportunities

The public facility inspection process in the Gee Creek subwatersheds yielded no retrofit opportunities.

Management Recommendations

The most common facility objects found out of compliance during the public stormwater facility inspection process overall were bioswales and facility fencing. Bioswale defects included either sparse vegetation or vegetation exceeding 10 inches in height. Sparse vegetation coverage in particular, may lead to excessive erosion and decrease stormwater runoff treatment within facilities. The most common defect found for facility fencing was missing or unreadable water quality signs; both defects were consistent with inspection results for public stormwater facilities from other subwatersheds.

Maintaining vegetation of bioswales and providing water quality signs informing the public that the bioswale is a stormwater facility will bring facilities into compliance.

Component 2: Offsite Assessment

Purpose

Stormwater outfalls can cause moderate to severe erosion as stormwater moves from the outfall, through the riparian zone, and to the receiving water. The erosion creates a source of sediment to the stream due to incision and slope failures.

The purpose of the Offsite Assessment project is to detect possible offsite or downstream problems associated with the county's municipal separate storm sewer system (MS4), particularly from facility outfalls that discharge to critical areas.

Methods

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

- within 200 feet of a critical area such as stream channel
- within 300 feet of a headwater stream
- Located on public land
- Discharges stormwater from a public-dedicated facility that is currently under the two year private maintenance warranty bond

The Offsite Assessment project is based on county and state standards equivalent to the maintenance standards specified in Chapter 4 of Volume V, of the *2005 Stormwater Management Manual for Western Washington*. The standards list general design criteria and outfall features critical to reducing the chance of adverse impacts due to concentrated discharges from pipe systems and culverts, both onsite and downstream.

The offsite assessment process involves inspecting all outfalls that discharge into critical areas as well as a 300 foot survey downstream of the outfall to look for any adverse impacts that may be caused by stormwater discharges.

If any outfall fails to meet the general outfall design criteria or is contributing to aggravation or creation of 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.

Results

Based on the county's StormwaterCLK database, as of August 2007, there were 86 mapped outfalls in upper Gee Creek and lower Gee Creek subwatersheds that discharged into critical areas (Figure 8).

Table 9 summarizes notable outfall assessment activities including critical areas, general outfall location and referrals of noncompliant outfalls.

As summarized in Table 8, 86 outfalls that discharged into critical areas were assessed. One outfall (Outfall 1499) was determined to be out of compliance. A referral for this outfall was initiated to the CWP Engineering Support section.

Potential Projects

One referral was initiated for the outfall assessment project. It was discovered that moderate erosion was occurring at Outfall 1499. The repair of this outfall may be a potential project for 2008, and is included in the list for potential projects.

Table 8: 2007 Outfall Assessment Project Activity Summary of Gee Creek Watershed

Metric	Number
# of outfalls assessed	86
# of outfalls compliant	85
# of noncompliant outfalls	1
# of referrals initiated	1
# of referrals ongoing	1
# of outfalls fixed	0

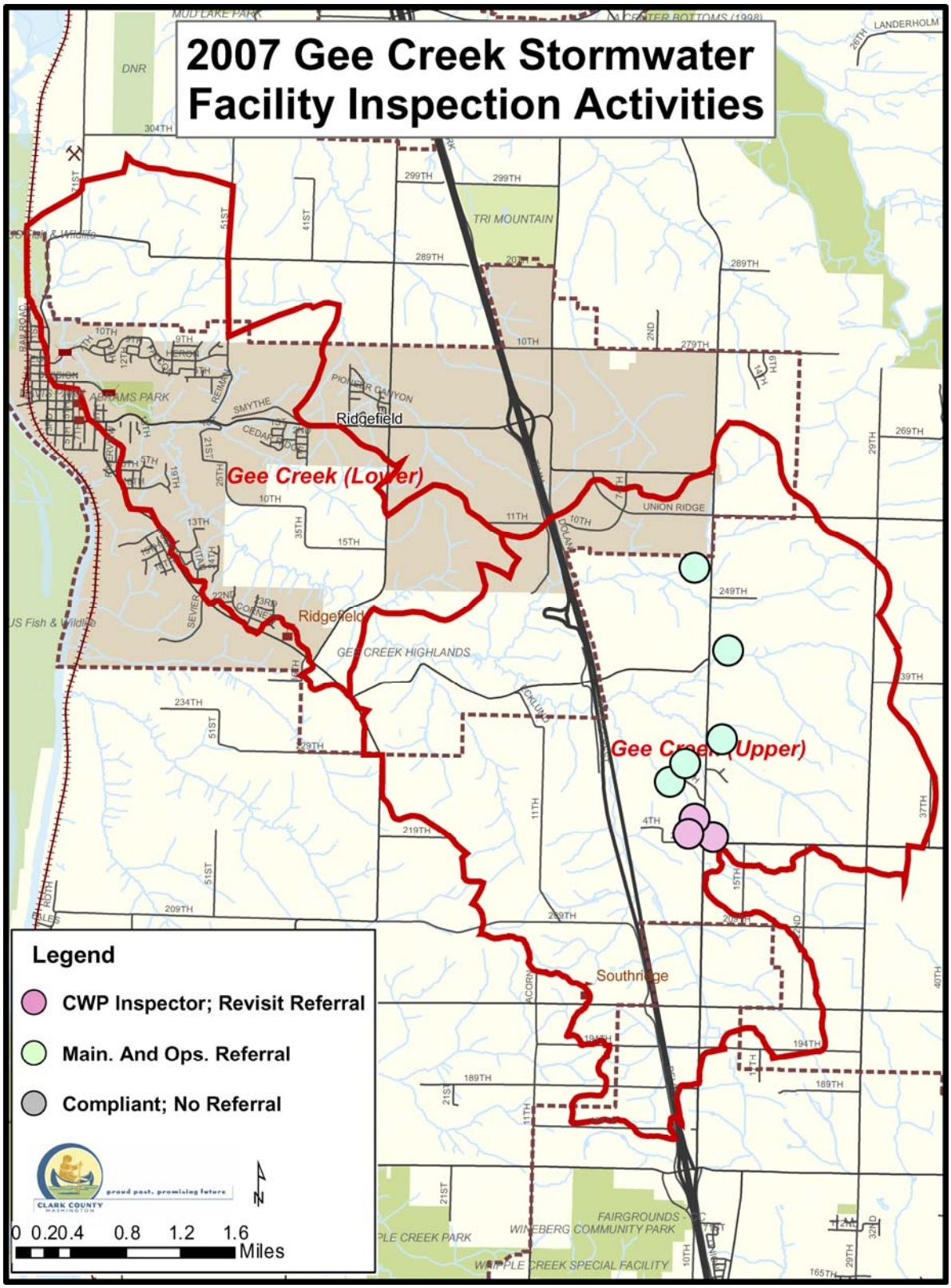


Figure 7: Summary of 2007 Public Stormwater Facility Inspection Activities in Gee Creek Watershed

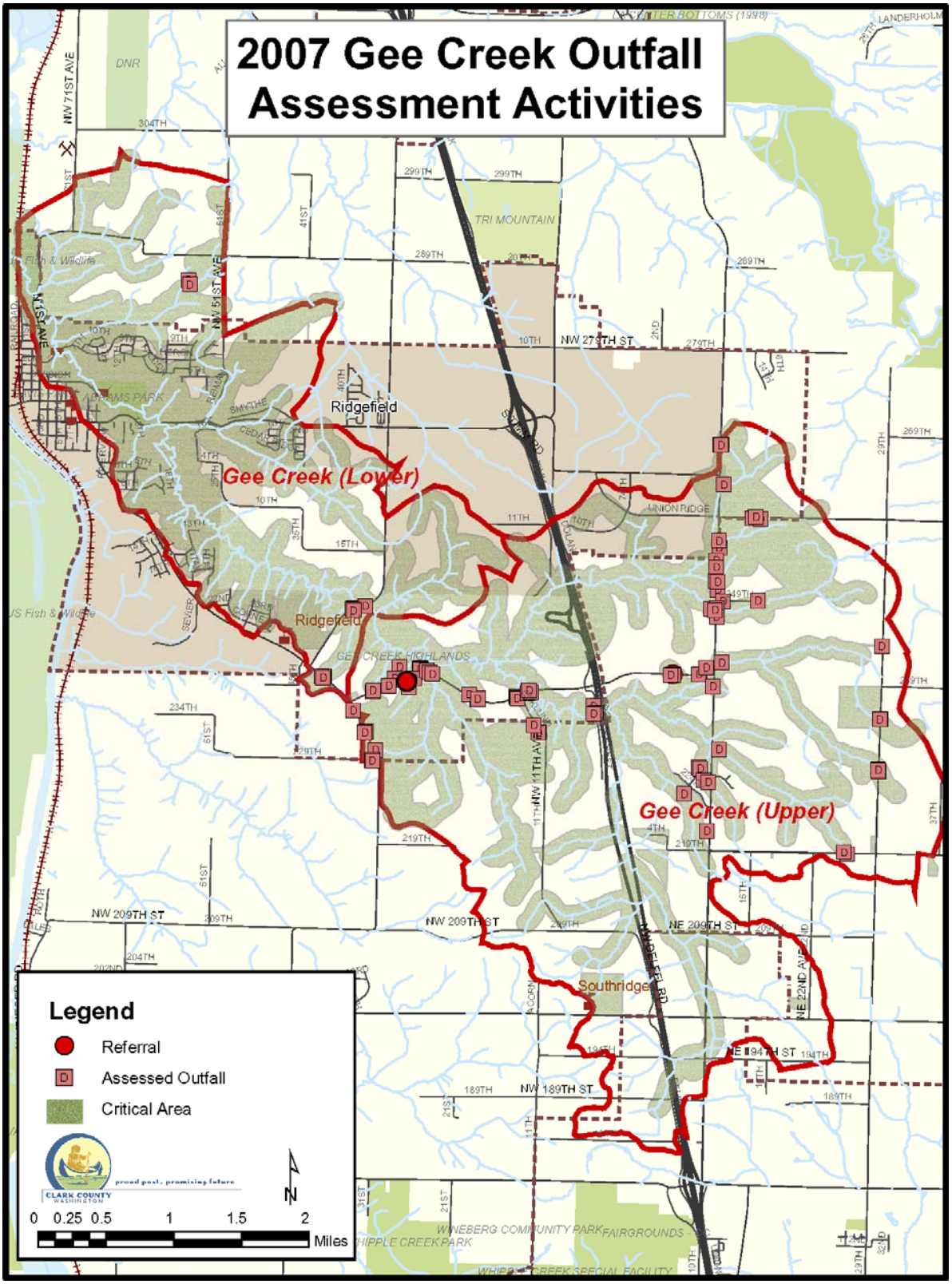


Figure 8: Summary of 2007 Outfall Assessment Activities in Gee Creek Watershed

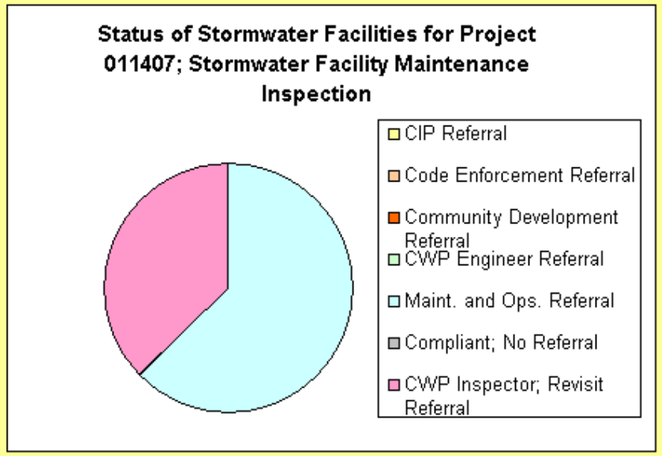
Table 9: 2007 Public Stormwater Facility Inspection Project Activity of the Gee Creek Watershed

SNAP Public Stormwater Facility Inspections (maintained by Public Works)

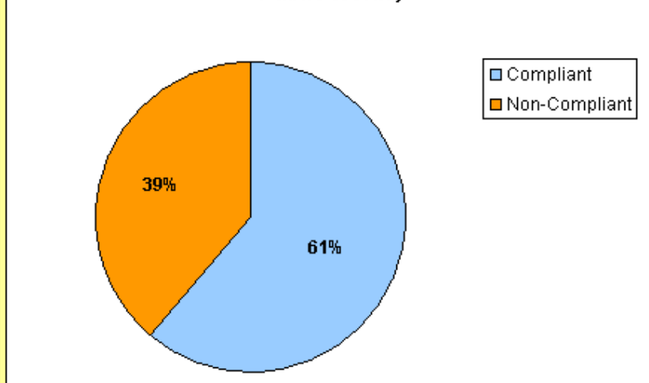
Subject: Gee Creek Subwatershed; Project 011407 Stormwater Facility Maintenance Inspection Initial Results

Total SNAP SWF Inspections	
Maintained by Public Works	**8**
Compliant	**0**
Non-Compliant	**5**
Not Visited (Under Construction)	**3**

Referrals of Non-Compliant SWF's as December 2007		**Referral Addressed and Facility Compliant as of December 2007**
CIP Referral	0	n/a
Code Enforcement Referral	0	n/a
Community Development Referral	0	n/a
CWP Engineer Referral	0	n/a
Maint. and Ops. Referral	5	0
Compliant; No Referral	0	n/a
CWP Inspector; Revisit Referral	3	0



Facility Objects Inspected	**Initial Inspections**		**Defect**	**Maintence Trigger**	**Facility Objects Repaired as of December 2007**
	Compliant	**Non-Compliant**			
Access Road or Easement	5	0	N/A	N/A	N/A
Catch Basin	1	2	sediment & debris	Sediment exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the	N/A
Closed Detention System	0	0	N/A	N/A	N/A
CONTECH StormFilter	0	0	N/A	N/A	N/A
Control Structure / Flow Restrictor	0	0	N/A	N/A	N/A
Debris Barrier	0	1	trash & debris / litter	Trash or debris that is plugging more than 20% of the openings	N/A
Detention Pond	5	0	N/A	N/A	N/A
Drainage Trench	0	0	N/A	N/A	N/A
Drywell	0	0	N/A	N/A	N/A
Energy Dissipater	6	0	N/A	N/A	N/A
Fence, Gate or Water Quality Sign	0	5	sign unreadable	Water quality sign is missing or 20% of the surface is unreadable.	N/A
Field Inlet	0	1	unable to locate	field inlet overgrown or submerged	N/A
Infiltration Basin	0	0	N/A	N/A	N/A
Infiltration Trench	0	0	N/A	N/A	N/A
Inlet / outlet storm pipe	13	2	sediment & debris	sediment depth is greater than 20% of pipe diameter.	N/A
Sediment Trap	0	1	vegetation	vegetation growing across and blocking more than 10% of the basin opening.	N/A
Typical Biofiltration Swale	0	6	vegetation, poor coverage	grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom or filter strip surface area.	N/A
Wet Biofiltration Swale	0	1	water depth	N/A	N/A
Wetland	0	0	N/A	N/A	N/A
Wetpond	0	0	N/A	N/A	N/A
Wetvaullt	0	0	N/A	N/A	N/A
Total SWF Objects	**30**	**19**			
Total Percentage	**61**	**39**			



Illicit Discharge Detection and Elimination (IDDE) Screening

Purpose

The purpose of the IDDE Screening project is to detect, isolate, and eliminate illicit connections and illicit discharges to Clark County's municipal separate storm sewer system (MS4).

The IDDE screening project is designed to meet the requirements of Clark County's 2007 NPDES permit which requires identifying and removing illicit connections to the county's MS4.

Methods

IDDE screening includes checking every stormwater outfall for potential illicit discharges, conducting follow-up investigations to track down suspected discharges or connections, and referrals to the proper agencies for termination. Field work is primarily conducted during the dry summer season.

IDDE Screening activities were completed in upper Gee Creek and lower Gee Creek subwatersheds during 2007.

Results

Based on the county's StormwaterClk database, as of August 2007, there were 115 mapped stormwater outfalls in the Gee Creek subwatersheds, consisting primarily of pipe outfalls and roadside ditches.

Figure 9 summarizes notable screening activities; including general outfall locations, outfalls where water samples were collected, follow-up investigations performed, referrals made, and sources removed.

As summarized in Table 10, 115 outfalls were screened and water samples were collected at three outfalls. A follow-up investigation was conducted for one location. In this case, an illicit connection was confirmed and a source area adequately pinpointed to trigger a referral for removal. Removal activities are ongoing for this illicit connection as of December 2007 (see Case Summary 1419). Effectiveness monitoring will be conducted once the connection has been removed. All investigated outfalls for the IDDE Screening project will be revisited in 2008.

Table 10: 2007 Project Activity Summary of Upper Gee Creek and Lower Gee Creek Subwatersheds as of December 2007	
Metric	**Number**
# of outfalls screened	115
# of outfalls with sufficient flow to collect water samples	3
# of suspected illicit connections	1
# of investigations initiated	1
# of illicit connections identified	1
# of outfalls to be re-visited in 2008	1
# of referrals	1
# of investigations and referrals ongoing	1
# of illicit connections terminated	0
# of cases closed without resolution	0

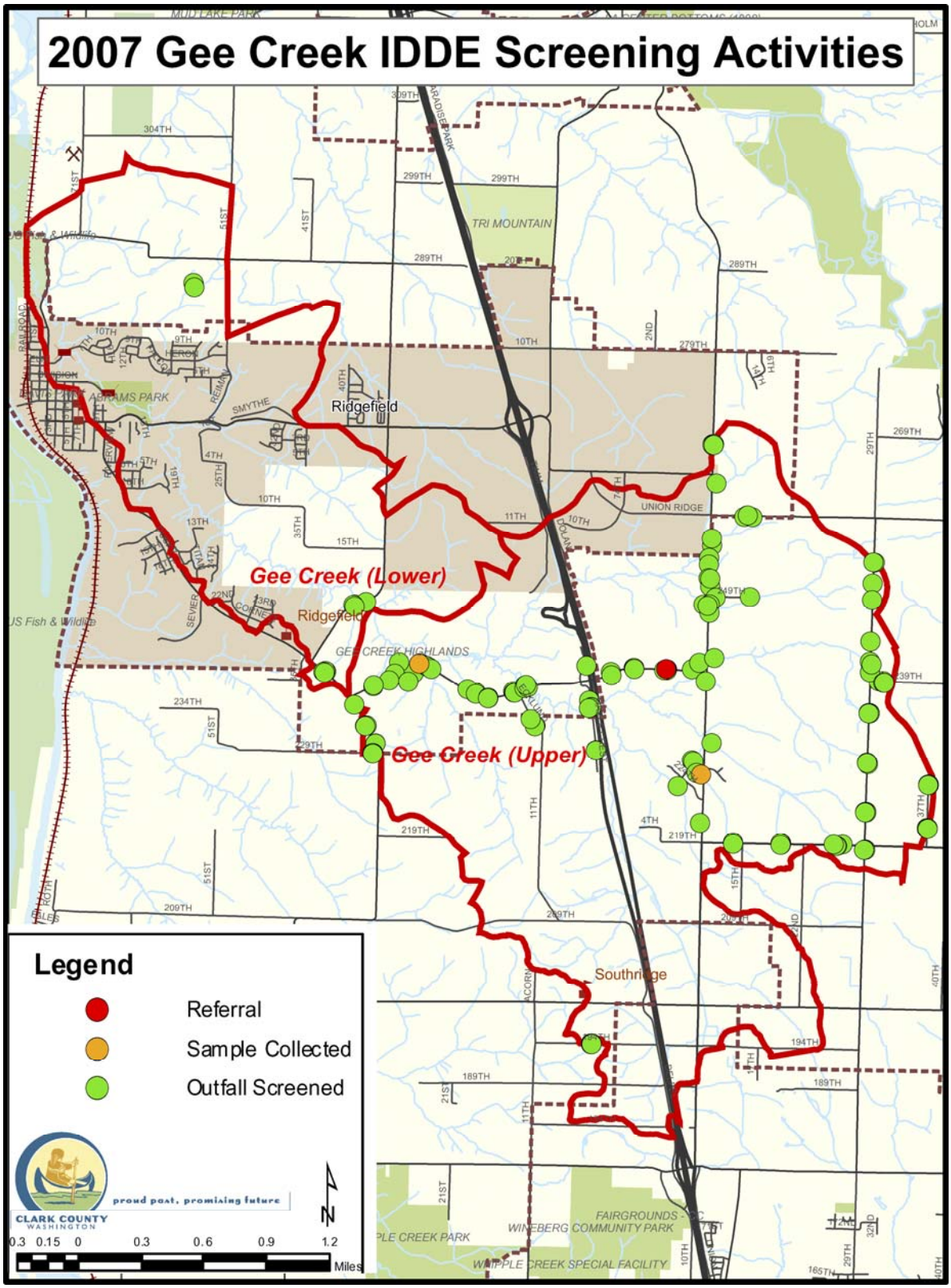


Figure 9: Summary of 2007 IDDE Screening Project Activities in Gee Creek Watershed

IDDE Screening Project
Case Summary: 1419
Date: December 2007

Initial screening location ID: 1419
LocationID_Code: 224
Investigation ID: 74

Outfall description:
Pipe outfall, 6 inch PVC

Drainage area: ~15 ac

Initial screening:

Initial screening was completed on September 6, 2007. Outfall #1419 was dry. However, field observation of the drainage ditch revealed lush vegetation approximately 75 feet upstream of Outfall #1419. Further examination of the area revealed an unknown pipe discharging into the stormwater drainage ditch. Field observations revealed a strong odor and brownish discoloration of flow originating from pipe. A fecal coliform sample was collected.

Flowchart analysis of fecal coliform concentration indicated a strong possibility of a sanitary wastewater source in the unknown pipe upstream of Outfall #1419 (Table 11). Estimated flow at the pipe at the time of sampling was low (~0.02 cfs)

Table 11: September 17, 2007

Flowchart	Result	Trigger
Fecal coliform (cfu/100mL)	30,000	>500

Investigation:

An onsite investigation was initiated by the Clean Water Program on September 17, 2007; the same day results from the laboratory analysis were received.

Due to the extremely high fecal coliform levels at location A (Figure 10), an on-site investigation was coordinated with Clark County Public Works Code Enforcement. Onsite investigation revealed multiple hookups to pipe discharging into stormwater drainage ditch; one positive grey water hookup and one possible drywell overflow hookup. Drywell was impacted by a manure pile and horse wash rack which drained into an open top drywell.

Referral:

The case was immediately referred to the Clean Water Program section Waste Reduction Specialist and to Clark County Health Department for follow-up.

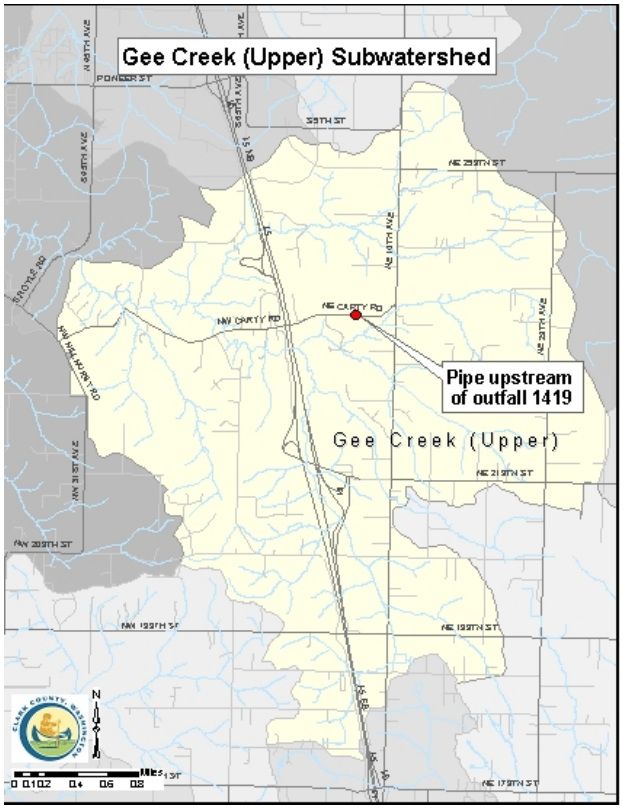


Figure 10: General Location of Pipe Upstream of Outfall #1419

Responsible Party:

The illicit connection originated from a private residence located at 306 NE Carty Road, Ridgefield, WA, 98642, Tax # 215403-000. Located at this residence is a horse boarding facility, Mountain View Stables.

Corrective Action:

Manure pile was removed. Illicit discharge is a candidate for fecal coliform source tracking methods to determine if sewage is a source.

Effectiveness Monitoring:

N/A

Outfall status:

Referral ongoing.

Additional Actions/Discussion:

The Clean Water Program may have fecal source tracking tools in 2008. Fecal source tracking involves using a molecular-based method that utilizes host specific biomarkers to determine if fecal coliform sources are human or non human. Outfall 1419 will be a candidate for fecal source tracking.

Stream Reconnaissance and Feature Inventory

Reach Reconnaissance Survey

No rapid reach assessment was completed for Gee Creek

Feature Inventory Summary – Upper Gee Creek Watershed

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.

Methods/Limitations

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.

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

The Feature Inventory recorded significant conditions in the stream corridor relevant to SNAP components. Feature types are listed in Table 13.

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

A GPS position, 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\011418, Stream Reconnaissance SNAP\GIS\Data\Geodatabase. Feature data includes field observations, estimated measurements, and/or notes describing important feature characteristics or potential projects.

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

For additional information pertaining to the Feature Inventory SNAP tool, see Volume 1 of the SNAP.

Study Area

The extent of the completed Feature Inventory in the upper Gee Creek subwatershed is shown in Figure 11. Approximately 4.1 miles of the stream corridor were assessed in the subwatershed. Difficulties in accessing some areas led to three notable gaps in the Gee Creek survey. Two reaches of the tributary streams in the northern part of the subwatershed were not accessible due to private property concerns. The reach of Gee Creek in the Interstate 5 (I-5) median was excluded from the Feature Inventory due to difficult access, safety concerns, and ongoing road construction.

Results/Findings

A total of 68 features were identified in the upper Gee Creek subwatershed. A breakdown of recorded features by type is presented in Table 12. Stream crossings were the most prevalent feature type identified, followed by stormwater outfalls and impacted stream buffers.

Table 12: Summary of Features Recorded in Upper Gee Creek Subwatershed

Feature Type	Number of Recorded
AP – Access point	0
ER – Severe bank erosion	0
CM – Channel modification	1
IB – Impacted stream buffer	10
IW – Impacted wetland	0
MI – Miscellaneous point	8
MB – Miscellaneous barrier	3
OT – Stormwater outfall	12
SC – Stream crossing	30
TR – Trash and debris	0
UT – Utility impact	0
WQ – Water quality impact	4
Total	**68**

A map showing the location and type of all recorded features is shown in Figure 12. A larger, poster-sized version of the same map is on file at the County. In addition, specific information collected at each feature can be accessed by using the Feature Inventory Geodatabase.

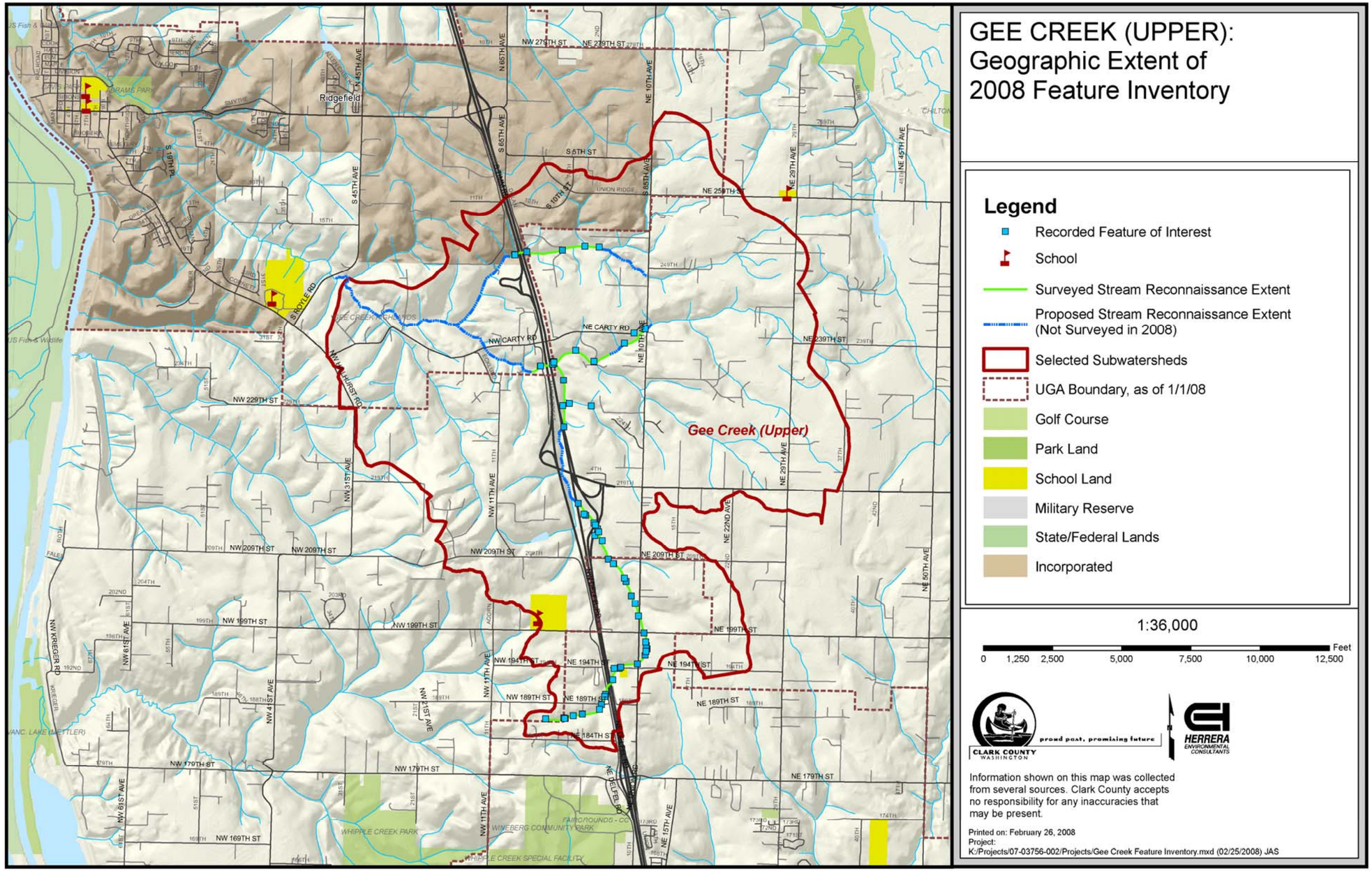


Figure 11: Extent of the Completed Feature Inventory in Upper Gee Creek

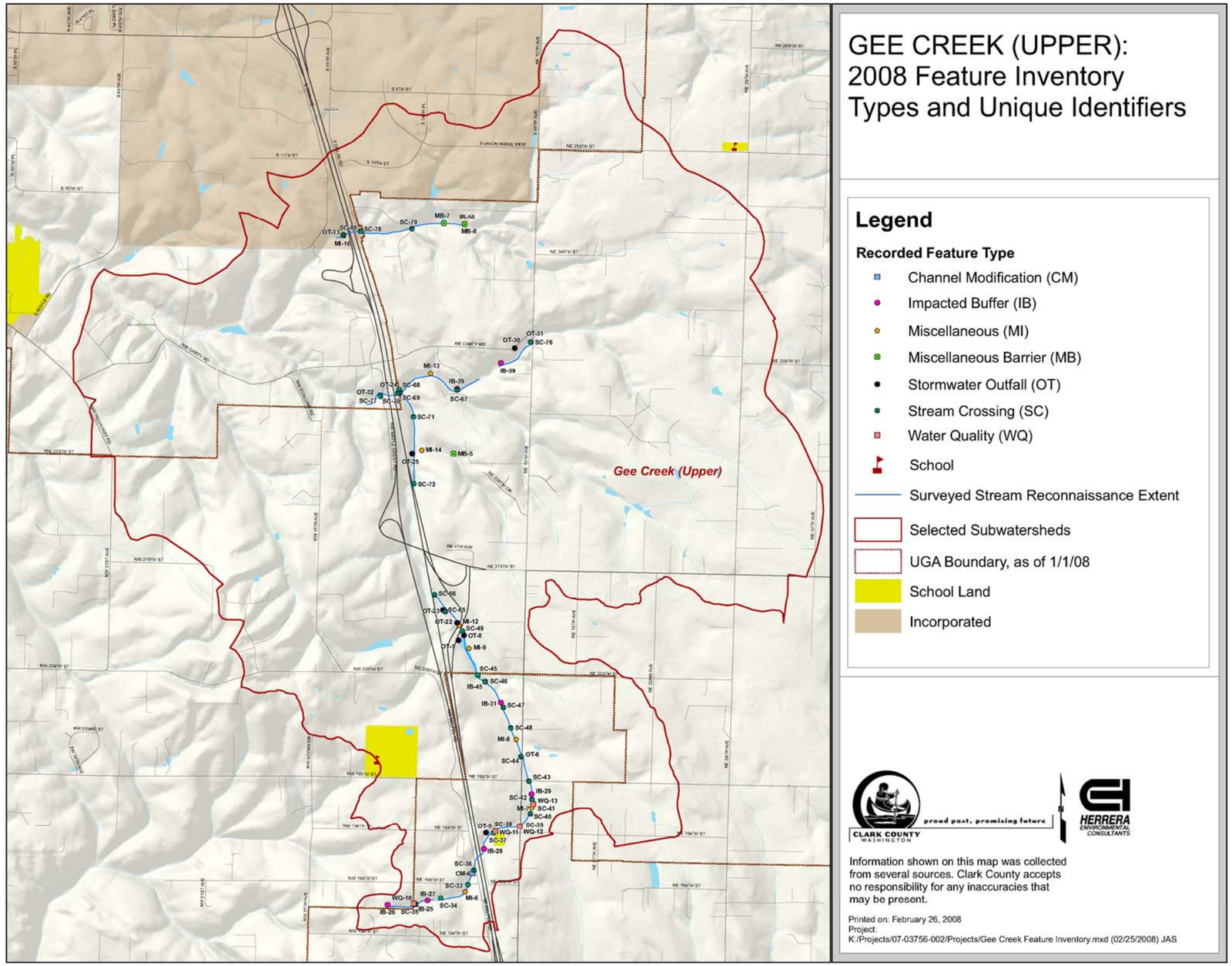


Figure 12: The Location and Type of All Recorded Features in Upper Gee Creek

The following subsections contain general descriptions of the upper Gee Creek subwatershed conditions. The descriptions include observations, trends, and issues that were identified either during the field work or during subsequent review of collected information.

Stormwater Infrastructure
The stormwater conveyance to Gee Creek and its tributaries is mainly via field and roadside ditches. Flow in the subwatershed is predominately southeast to northwest. The predominant source of stormwater in the subwatershed appears to be rural residential development draining to roadside ditches, and piped flow from impervious surfaces related to I-5.

Riparian Vegetation
Impacted stream buffers are prevalent in the upper Gee Creek subwatershed. Riparian vegetation is composed primarily of invasive reed canary grass and blackberry, with a nearly universal absence of riparian forest canopy cover. The exceptions are relatively small areas on the mainstem and tributaries of Gee Creek upstream of I-5 at the north end of the subwatershed (outside of the UGA boundary), where the existing forest provides some shade to the stream. In some agricultural areas, invasive plant species are being kept in check through grazing. Unfortunately, the heavily grazed areas in the subwatershed are characterized by an overall lack of riparian vegetation.

Channel Condition
Generally, stream channels within the surveyed reaches are stable, but have greatly simplified cross-section and plan view geometry. In impacted reaches, typical channel morphology is planar, and the channel bed is structurally controlled by clay acting as weak bedrock. Inflections in the profile likely occur along jointing weaknesses. The bed is smooth, with low hydraulic roughness, resulting in supply limited conditions (high transport capacity relative to sediment supply). However, an alluvial veneer in the form of sand and gravel deposition is locally present near areas of increased hydraulic roughness such as flow obstructions. Bank erosion is limited due to root cohesion. In the less impacted reach which flows south and parallel to I-5, the channel exhibits forced pool-riffle morphology and limited pool-riffle development, and the planform is slightly sinuous. In this reach, wood recruitment from the adjacent floodplain is moderate and in-channel wood debris facilitates local bedform development and channel migration. Hydraulic complexity of flow patterns around wood debris shifts the balance between transport capacity and sediment supply from supply-limited to episodically transport-limited.

The best channel restoration potential exists in the remaining forested reaches on the mainstem and tributaries of Gee Creek upstream of I-5 at the north end of the subwatershed (outside of the UGA boundary). This area is desirable for restoration because of lack of conflict with existing landowners and land uses. This area also represents a lengthy, contiguous reach where unfragmented habitat

value may be greatly increased for a small investment. Channel conditions would benefit greatly from reforestation of the adjacent floodplain and riparian corridor to increase recruitment of woody debris. Engineered structures to facilitate bedform development and capture/sort gravels could improve conditions in the short-term. However, without reforestation and associated recruitment of woody debris from the riparian corridor, installation of engineered structures is not a self-sustaining solution in the long-term.

Additional Results

Features of interest were often discovered when field crews ventured up small, first order tributary channels outside of the area defined by the geographic scope of work. When located, these features were recorded in the same manner as other features. 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. This result may influence the CWP when determining the geographic scope of future stream reconnaissance efforts.

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 prior to submittal to the SCIP process. Identifying them as potential projects in this document is the first step in the process of developing SCIP projects.

Potential project opportunities were identified based on the results of the Feature Inventory conducted in the upper Gee Creek subwatershed. The CWP will evaluate the potential projects for further development or referral to the appropriate organization. Each potential project is listed in Tables 15 through 19, including the basis for the project and a description of the potential project. The location of each potential project is shown in Figures 13 through 16. Potential project opportunities were categorized into six groups based on the nature of the potential work. A total of 43 potential projects were identified. A summary of identified project opportunities by potential project category is shown in Table 13.

Table 13: Breakdown of Potential Project Opportunities by Category

Potential Project Category	Potential Projects Identified
Emergency/Immediate Actions	3
Stormwater Facility Capital Improvement Projects	9
Stormwater Infrastructure Maintenance Projects	2
Habitat Restoration/Enhancement Projects	6
Property Acquisition for Stormwater Mitigation	0
Referral Projects for other Agencies	23

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. Emergency/Immediate Actions identified based on the results of the Feature Inventory are described in Table 14.

Table 14: Description of Potential Project Opportunities

ID	Basis for Project	Project Description
MB-7	15-foot-high earthen dam is impounding a private pond on a small tributary stream. Outlet works are in disrepair and the dam is failing, presenting a serious hazard to downstream landowners and the environment. Pond may be acting as a source of thermal loading. Dam is an impassable barrier to fish.	Immediate site inspection by engineering staff to determine structural integrity of the dam. May warrant removal of dam and restoration of tributary stream. At minimum, project should mitigate for thermal and fish passage impacts of the dam.
MI-9	There is a breach in the berm separating a large manmade pond from the stream. Area is currently affected by the I-5 construction activities and pond is being used to treat stormwater runoff for the construction site. Large pond is surrounded by invasive plant species, and is likely acting as a source of thermal loading.	Immediate site inspection by engineering staff to determine structural integrity of the berm. Repair berm and/or construct appropriately sized and armored outfalls. Begin management of reed canary grass and blackberry. Reestablish native undergrowth and canopy vegetation to shade out invasive plants and improve shading of water surface to reduce thermal loading.
MB-5	15-foot-high earthen dam on small tributary stream. Two large headcuts progressing through the dam. Severe erosion and scour. Outlet works are in disrepair and the dam is failing, presenting a serious hazard to downstream landowners and the environment. Pond may be acting as a source of thermal loading.	Immediate site inspection by engineering staff to determine structural integrity of the dam. Project will likely include immediate removal or stabilization of the dam and restoration of tributary stream.

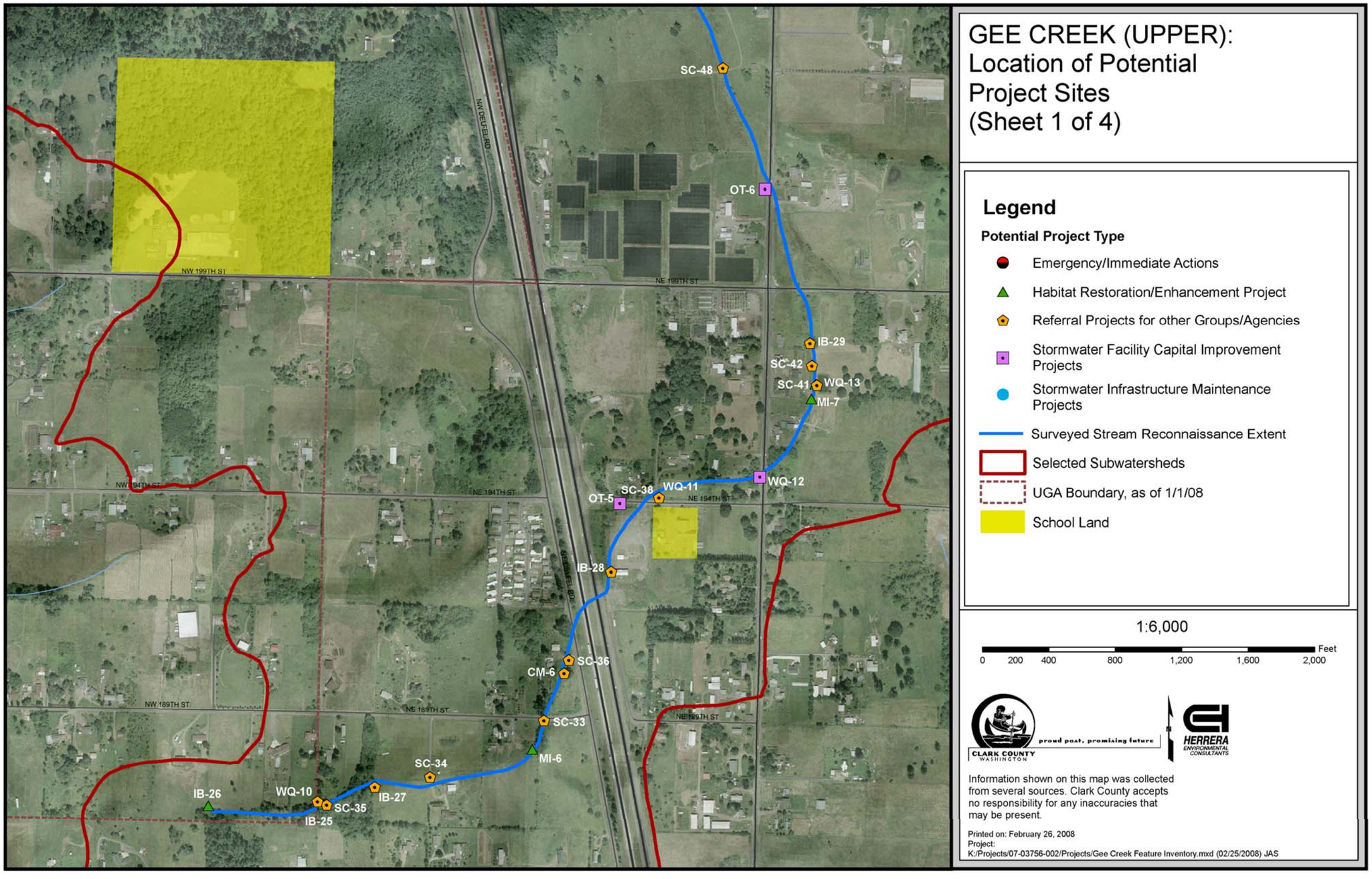


Figure 13: Potential Projects Noted in Feature Inventory

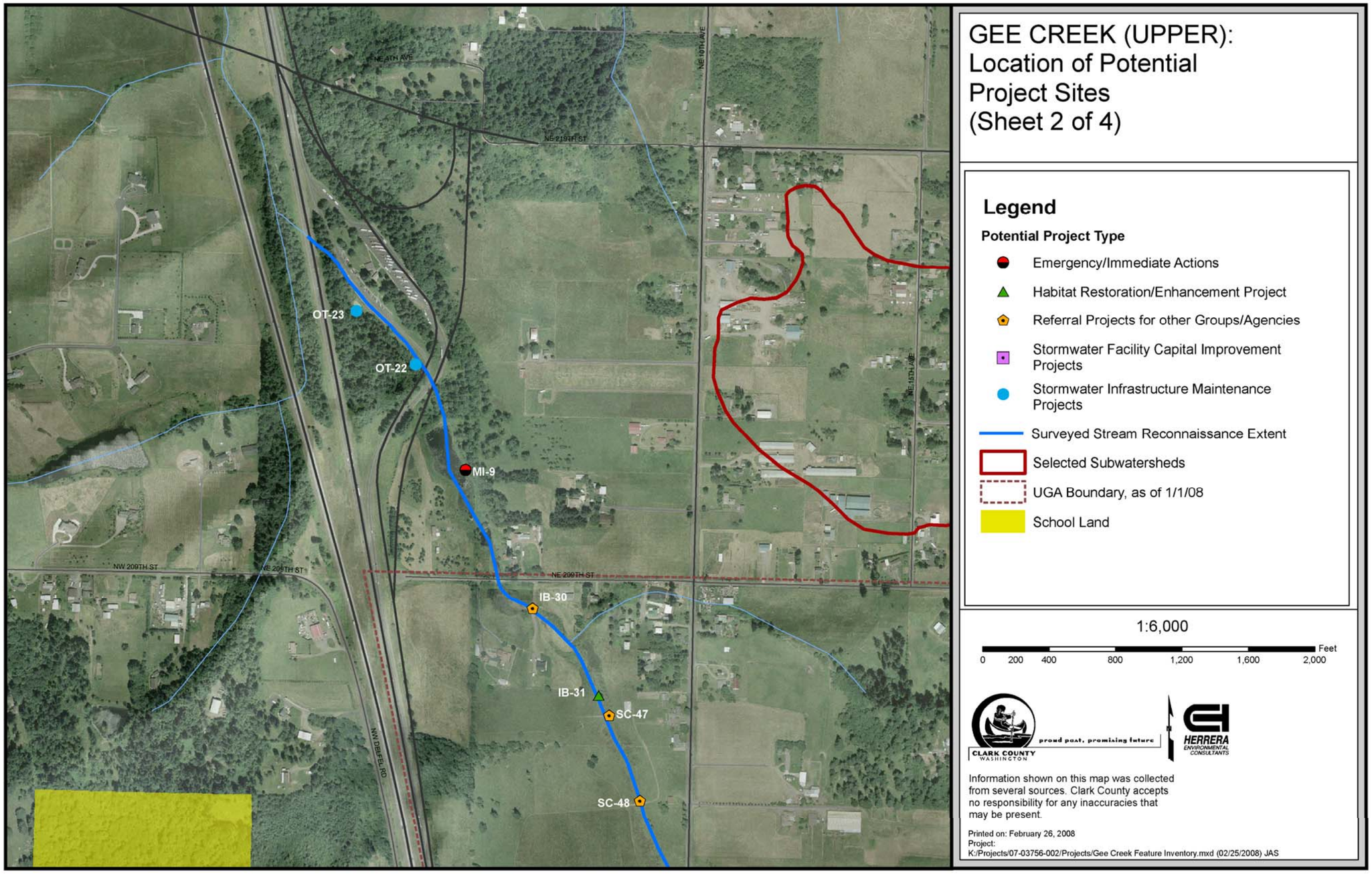


Figure 14: Potential Projects Noted in Feature Inventory

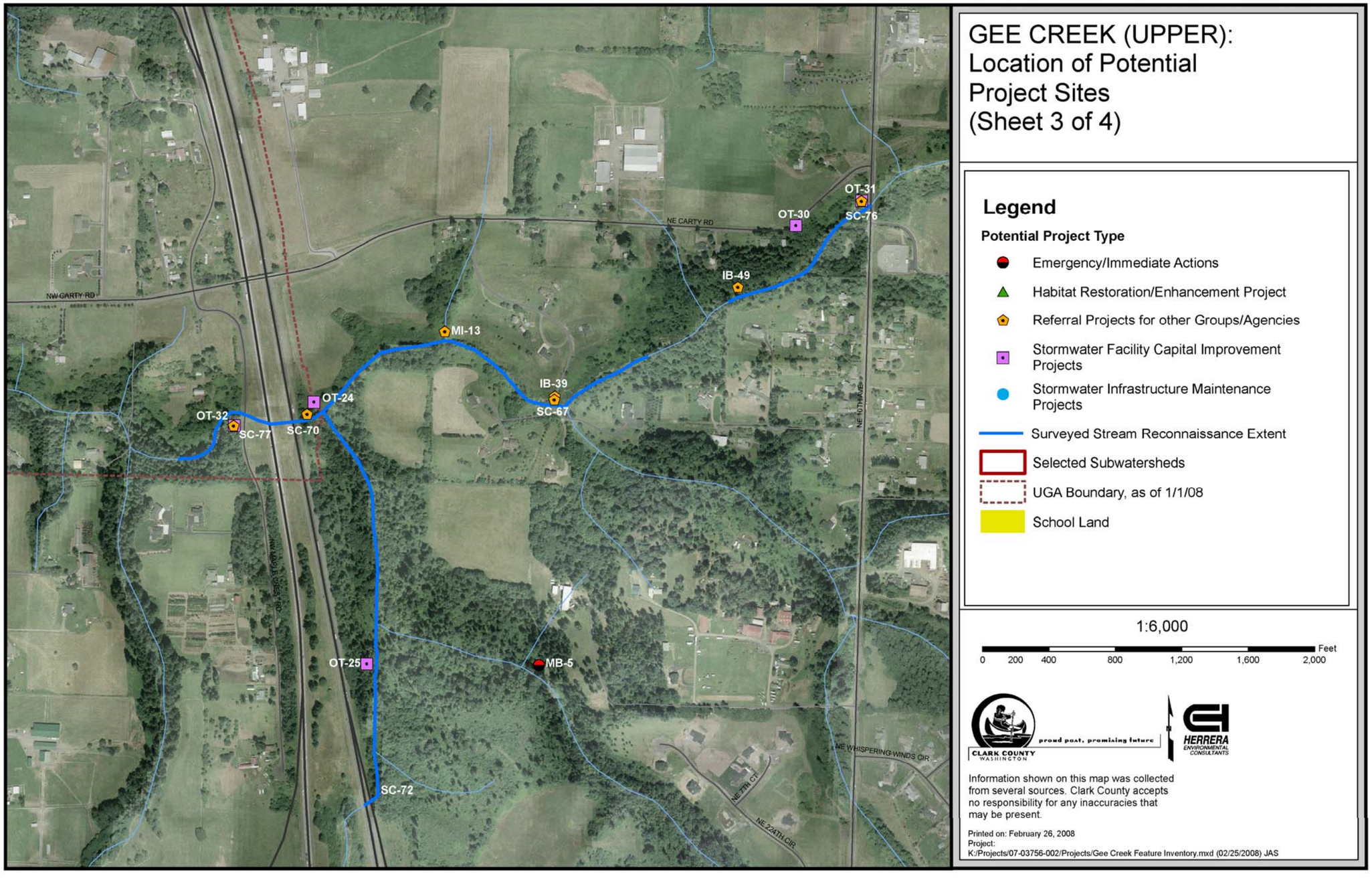


Figure 15: Potential Projects Noted in Feature Inventory

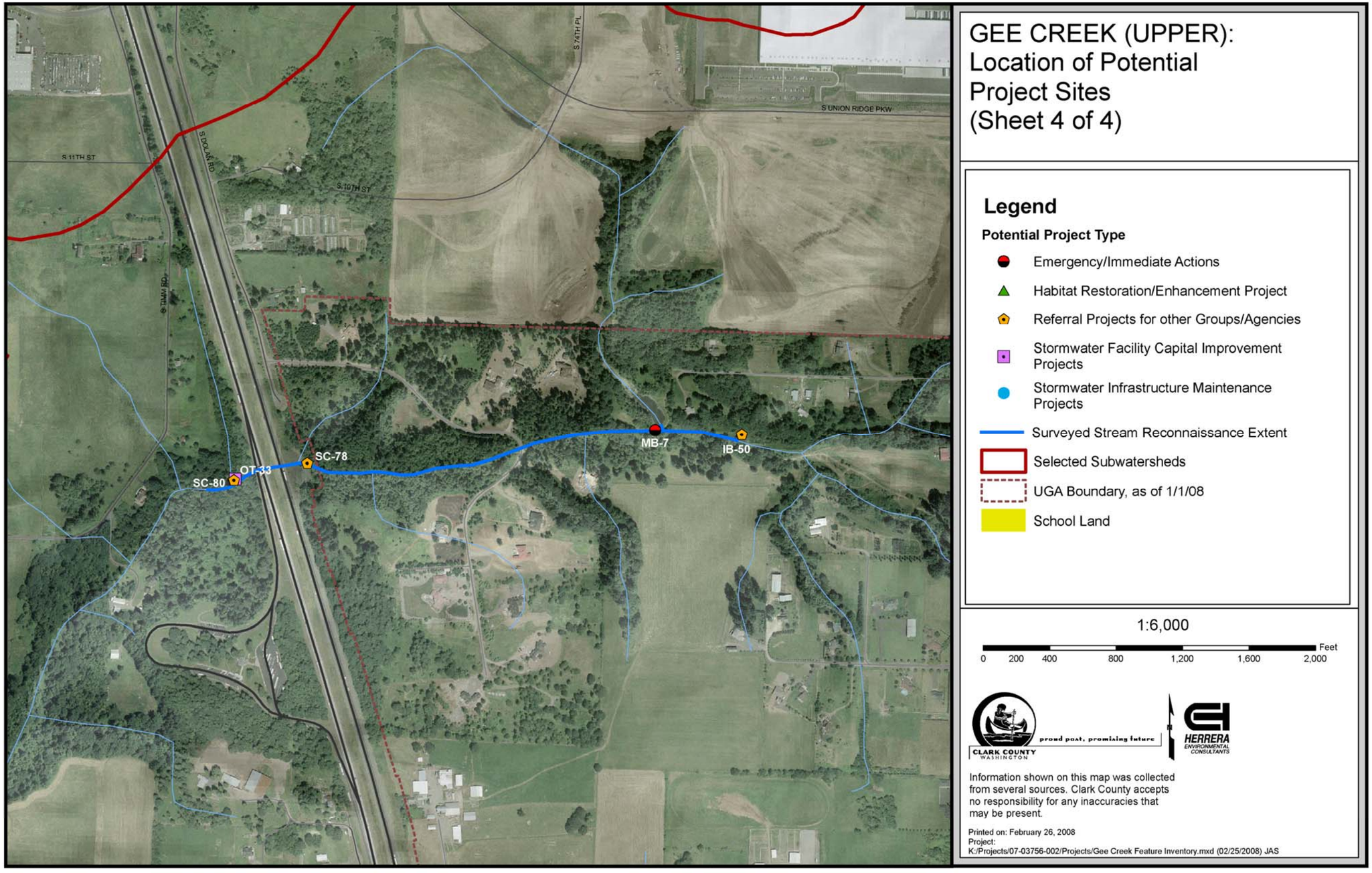


Figure 16: Potential Projects Noted in Feature Inventory

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. Stormwater Facility Capital Improvement Projects identified based on the results of the Feature Inventory are described in Table 15.

Table 15: Description of Potential Project Opportunities

ID	Basis for Project	Project Description
OT-33	1.5-foot-diameter corrugated metal outfall pipe drains stormwater directly to the stream from an unidentified source. Stormwater is likely untreated. No energy dissipater.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-31	Small ditch delivers untreated stormwater to stream from NE 10th Avenue.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-30	Road ditch drainage from north side of Carty Road is conveyed under the road to an open channel which conveys stormwater to the creek.	Construct a new stormwater facility to detain and treat runoff from ditch.
OT-24	Open channel appears to be draining the northbound lane of I-5. Channel is downcut through clay but appears stable at present.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-32	One foot diameter corrugated metal outfall pipe drains stormwater directly to the stream from southwest side of Maple Crest Drive. Stormwater is untreated. No energy dissipater.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-5	Outfall from pond at northeast corner of parcel. A second outfall pipe connects to the stream approximately 200 feet upstream of the feature point. Effectiveness of stormwater treatment facility is unknown.	Investigate effectiveness of existing stormwater facility. Retrofit existing facility to improve function if feasible.
WQ-12	Roadside ditches drain agricultural runoff and stormwater to the stream.	Investigate source of runoff and construct appropriate facilities to enhance water quality (new stormwater facility to detain and treat runoff or agricultural water quality BMP).
OT-6	Roadside ditch drains untreated	Investigate source of

Table 15: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
	stormwater to stream from the south on west side of NE 10th Avenue.	stormwater and construct a new stormwater facility to detain and treat runoff appropriately.
OT-25	Open channel drains stormwater directly to the stream from an unidentified source. Stormwater is likely untreated. No energy dissipater. Channel has cut down approximately two feet.	Investigate source of stormwater and construct a new stormwater facility to detain and treat runoff appropriately.

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. Stormwater Infrastructure Maintenance Projects identified based on the results of the Feature Inventory are described in Table 16.

Table 16: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
OT-22	One foot diameter plastic outfall pipe drains stormwater from a swale within the rest area. Outfall lacks an energy dissipater and erosion is present.	Retrofit outfall with appropriate energy dissipation measures to eliminate erosion.
OT-23	Open channel stormwater outfall drains detention basin in rest area. Channel is partially cobble-armored, but is actively cutting down through exposed clay. Poor outfall design/implementation.	Modify stormwater facility outlet structures to eliminate problem.

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. Instream 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. Habitat Restoration/Enhancement Projects identified based on the results of the Feature Inventory are described in Table17.

Table 17: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
IB-26	Lack of vegetation along the riparian corridor. Intermittent patches of blackberry.	Re-establish native riparian vegetation through plantings.
IB-25	Lack of vegetation along the riparian corridor.	Re-establish native riparian vegetation through plantings. Protect with livestock exclusion fencing.
MI-6	Lack of vegetation along the riparian corridor at confluence of small tributary.	Re-establish native riparian vegetation through plantings. Protect with livestock exclusion fencing.
MI-7	Lack of vegetation and presence of invasive species along the riparian corridor at confluence of small tributary.	Re-establish native riparian vegetation through plantings.
SC-41	Lack of vegetation and presence of invasive species along the riparian corridor.	Re-establish native riparian vegetation through plantings.
IB-31	Heavily grazed reach with lack of riparian vegetation. Rushes in clumps throughout pasture and concentrated along stream	Re-establish native riparian vegetation through plantings. Protect with livestock exclusion fencing and modified grazing practices.

Property Acquisition for Stormwater Mitigation
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 projects of this type were identified in surveyed reaches of the upper Gee Creek subwatershed.

Referral Projects for Other Groups/Agencies
Referral Projects for other Groups/Agencies include 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 within Clark County departments for projects such as trash removal, stream culvert repairs/maintenance, and drainage projects. Referral Projects for other Groups/Agencies identified based on the results of the Feature Inventory are described in Table 18.

Table 18: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
IB-50	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass and blackberry.	Eradicate reed canary grass and blackberry. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.
IB-49	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass and blackberry. Infestation extends from feature point upstream to NE 10th Avenue.	Eradicate reed canary grass and blackberry. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.
IB-39	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass and blackberry.	Eradicate reed canary grass and blackberry. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.
MI-13	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass and blackberry.	Eradicate reed canary grass and blackberry. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.
IB-27	Widespread invasive plant species in riparian buffer extending from feature point downstream approximately 2000 feet to I-5. Reed canary grass is mixed with other grasses (blue grass). Grazed/mowed fields.	Eradicate reed canary grass and other invasives. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.
IB-28	Widespread invasive plant species within and immediately adjacent to the floodplain. Reed canary grass and blackberry infestation extends from feature point downstream along I-5 northbound, and then east along NE 194th Street crossing.	Eradicate reed canary grass and blackberry. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.
IB-29	Impacted buffer along entire stream from NE 10th Avenue to 199th Street. Minimal vegetation or widespread invasive plants present.	Eradicate reed canary grass and blackberry. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.

Table 18: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
IB-30	Widespread invasive plant species in riparian corridor. Primarily reed canary grass.	Eradicate reed canary grass and blackberry. Reestablish native undergrowth and canopy vegetation to shade out invasive plants.
SC-48	Private culvert crossing with failing embankments in middle of heavily grazed pasture. Lack of riparian vegetation throughout reach.	Stabilize culvert headwalls. Replace culvert if necessary to achieve flow capacity requirements. Reestablish native riparian vegetation through plantings. Protect with livestock exclusion fencing and modified grazing practices.
SC-47	Private culvert crossing with failing embankments in middle of heavily grazed pasture. Lack of riparian vegetation throughout reach.	Stabilize culvert headwalls. Replace culvert if necessary to achieve flow capacity requirements. Reestablish native riparian vegetation through plantings. Protect with livestock exclusion fencing and modified grazing practices.
SC-78 & 80	400+ foot long culvert under I-5. Length and hydraulic conditions at both low and high flows may limit fish passage.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required.
SC-70 & 77	400+ foot long culvert under I-5 and Maple Crest Drive. Length and hydraulic conditions at both low and high flows may limit fish passage.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required.
SC-36	500+ foot long culvert under I-5. Length almost certainly limits fish passage.	Conduct additional barrier analysis to determine if culvert retrofit or replacement is required or feasible.
SC-76	Outlet end of culvert under NE 189th Street is severely damaged (crushed closed) limiting hydraulic capacity and potential for fish passage.	Repair or replace culvert.
SC-67	Culvert inlet and outlet completely submerged.	Investigate further. Culvert may require additional maintenance to remove blockages.
SC-35	Undersized culvert with failing embankments on private property.	Replace culvert with an appropriately sized and stabilized crossing. Remove crossing altogether if feasible.

Table 18: Description of Potential Project Opportunities		
ID	**Basis for Project**	**Project Description**
SC-34	Undersized culvert on private property. Sediment deposition present as a result of culvert.	Investigate further. Culvert may require replacement to improve capacity and potential to pass fish or additional maintenance to remove blockages.
SC-33	Outlet end of culvert under NE 10th Avenue is severely damaged (crushed closed) limiting hydraulic capacity and potential for fish passage. Culvert is poorly aligned to flow. Widespread invasive plant species present in riparian buffer.	Repair or replace culvert. Begin management of reed canary grass and other invasive plants. Reestablish native undergrowth and canopy vegetation to shade out invasive plants.
SC-42	Failing embankment on private culvert. Flow capacity of culvert appears to be appropriate.	Stabilize culvert headwalls.
WQ-10	Ditch along property line drains runoff from property north of the creek and/or NE 189th Street.	Investigate source of runoff and construct appropriate facilities to enhance water quality (new stormwater facility to detain and treat runoff or agricultural water quality BMP).
WQ-11	Inflow point for agricultural runoff.	Investigate source of runoff and apply source control and/or construct appropriate agricultural BMP facilities to enhance water quality.
WQ-13	Large manmade pond drains to stream. Pond may be acting as a source of thermal loading and/or contributing to other water quality impairments.	Investigate the effects of the pond on water quality. Modify facility to achieve improved water quality. Look into modifying pond and using it to treat stormwater.
CM-6	Small dam and failing foot bridge blocking channel and impounding water to form a small pond on private property. Widespread invasive plant species present in riparian buffer.	Remove blockages from channel. Eradicate reed canary grass and other invasive plant species. Re-establish native undergrowth and canopy vegetation to shade out invasive plants.

Stormwater Management Recommendations

A number of general stormwater management measures should be implemented throughout the upper Gee Creek subwatershed:

- In developing areas, emphasize stormwater management that focuses on reduction of runoff and diffuse infiltration close to the source rather than in centralized facilities. LID practices should be encouraged.
- Educate private landowners concerning importance of invasive plant removal, and suggest removal techniques.
- Educate private landowners on importance of native riparian vegetation and forest canopy for shading streams.
- Educate landowners to discourage disposal of yard debris in streams or other receiving waters.
- In residential areas, encourage landowners to adopt green solutions such as disconnecting gutter down spouts that encourage infiltration of stormwater close to the source.
- Provide a list of suggested plants for stream revegetation and local nurseries that stock them for distribution to landowners.
- Encourage transmission of stormwater through open channels such as grass-lined conveyance ditches or bioswales rather than using piped systems.
- Confirm that county ditch maintenance practices minimize vegetation removal whenever possible.
- Post stream identification signs where roads cross streams. Repair or replace deteriorated signs if necessary.
- Do not overlook stormwater 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.

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 Gee Creek at station GEE050 (see Figure 3) in fall of 2002 using EPA EMAP protocols (Schnabel, December 2003).

Results

Results for the most widely used EMAP metrics are summarized in Table 19. Overall habitat quality is normalized to the best available reference site within the Willamette Valley, monitored by Oregon DEQ. The reference site is in the "least degraded by human activity" category and is rated marginally acceptable as a reference site due to obvious human disturbance. The GEE050 Habitat Quality Index score of 91, compared to the disturbed reference site, suggests that Gee Creek has relatively good habitat for a typical Willamette Valley stream significantly degraded by human activities.

Overall physical habitat quality is influenced by numerous factors that may vary significantly both spatially and temporally. Thus, results such as these from a single survey and a single location do not necessarily reflect habitat conditions for the entire subwatershed.

Metrics suggested some degree of stream bed instability and hydrologic impacts. Associated channel conditions such as embeddedness, the amount of fine sediment in the channel substrate, and the amount of riffles, indicated less than ideal conditions. Riparian conditions were generally good but large woody debris was less than needed for properly functioning conditions.

Table 19: EMAP Metrics and Interpretation for Gee Creek at Royal Road (Schnabel, December 2003)			
Habitat Category	**Index**	**Result**	**Characterization**
Overall habitat quality	Habitat quality index (HQI)	91	Score is relative to a DEQ grade-C (degraded Willamette Valley) reference condition scoring 100
Overall riparian quality	QR1 index RCOND index	0.64 0.60	Good Good
Hydrologic flashiness	Mean of Flashrt1, Flashrt2, and Flashrt3 indices	3.47	Signs of hydrologic impact
	Individual metric		
Channel morphology	Pool percentage (PCT_POOL) Riffle percentage (as PCT_FAST)	58% 10%	Meets recommended pool area Does not meet recommended riffle area
Residual pools	Residual pool volume (TOTPVOL)	51.2 m^3	n/a
Substrate composition	Dominant substrate Mean embeddedness (XEMBED) Substrate sand and fines (PCT_SAFN) D_{50} (median particle size, mm)	53% 69% 36% 5	Coarse gravel and larger (>16mm) "Not properly functioning" "At risk" (7% fines <0.6mm, 29% sand (0.6-2mm) n/a
Bed substrate stability	Bed stability index (LRBS_BW4)	-0.68	Streambed somewhat unstable
Fish cover	Natural fish cover by area (XFC_NAT)	0.36	Fish cover relatively sparse
Large woody debris	Total LWD density (C1W)	348/mile	"Not properly functioning" (good density and some large pieces, but not enough)
Riparian vegetation cover	Stream shading (XCDENMID)	71%	Moderately shaded
Human disturbance	Riparian human disturbance index (W1_HALL)	0.33	n/a
Invasive plant species	Overall invasive plant proportion (ip_score) (individual species proportion)	1.18	Reed canary grass dominant (English Ivy = 0.09, Him Black = 0.09, Reed Canary = 1.00)

Geomorphology and Hydrology Assessment

The geomorphology and hydrology assessment was completed as a stand-alone report after the bulk of this document was finalized. When available, this report will be 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

Riparian assessments for the SNAP are based primarily on GIS data from existing reports, particularly 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 or lower priority streams. The reports are based on aerial photo interpretation using Washington Forest Practices Board methods for LWD delivery and channel shade estimates.

In subwatersheds where no data exist from the 2004 LCFRB Habitat Assessment, a qualitative examination of current orthophotos 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.

Results

Gee Creek was not included in the 2004 LCFRB Habitat Assessment. This summary is based on a qualitative review of 2007 orthophotos and is limited to the upper Gee Creek subwatershed which includes most of the remaining unincorporated area.

Overall, forest cover in upper Gee Creek is limited to narrow strips along riparian corridors. There are few remaining areas of intact upland forest. The riparian corridor is relatively intact in the reach between Royle Road and I-5; upstream of I-5, substantial gaps in forest cover are evident. Notable areas with very limited

riparian forest include the mainstem upstream of the Gee Creek rest area to the headwaters, and the headwaters of the Carty Road tributary.

Gee Creek is outside the typical scope of CPU riparian enhancement projects. Current aerial photos and available information suggest there are very few recent planting projects within the upper Gee Creek subwatershed.

Public land within the Gee Creek watershed is very limited. Most projects would likely require private landowner cooperation. County or state road projects could also provide riparian enhancement opportunities as an element of mitigation plans.

Potential Projects

Priorities based on this qualitative review include:

- Focus on areas upstream of I-5. There are numerous reaches with limited to non-existent forest cover.
- Evaluate critical vacant or underutilized lands within the Vancouver UGA in the headwaters.
- Opportunities for preservation are limited; however, relatively large blocks of intact forest exist along the mainstem and northern tributaries between Royle Road and I-5.

Floodplain Assessment

No floodplain assessment was conducted for the Gee Creek subwatersheds.

Wetland Assessment

Purpose

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

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

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 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 Gee Creek watershed.

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.

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

Results

Figures 17 and 18 show potential wetland areas within the Gee Creek watershed based on data from the county wetlands atlas, including the Clark County wetland model, National Wetlands Inventory, and high-quality wetlands layer.

In general, potential wetlands tend to be concentrated along fairly narrow floodplain areas, with some larger areas of potential headwater wetlands primarily east of Interstate 5 in upper Gee Creek. A large area of potential wetlands is also indicated in lower Gee Creek in the area west of NW 51st Avenue and north of NW 289th Street. Much of the Cathlapotle subwatershed consists of Columbia River floodplain and associated wetlands.

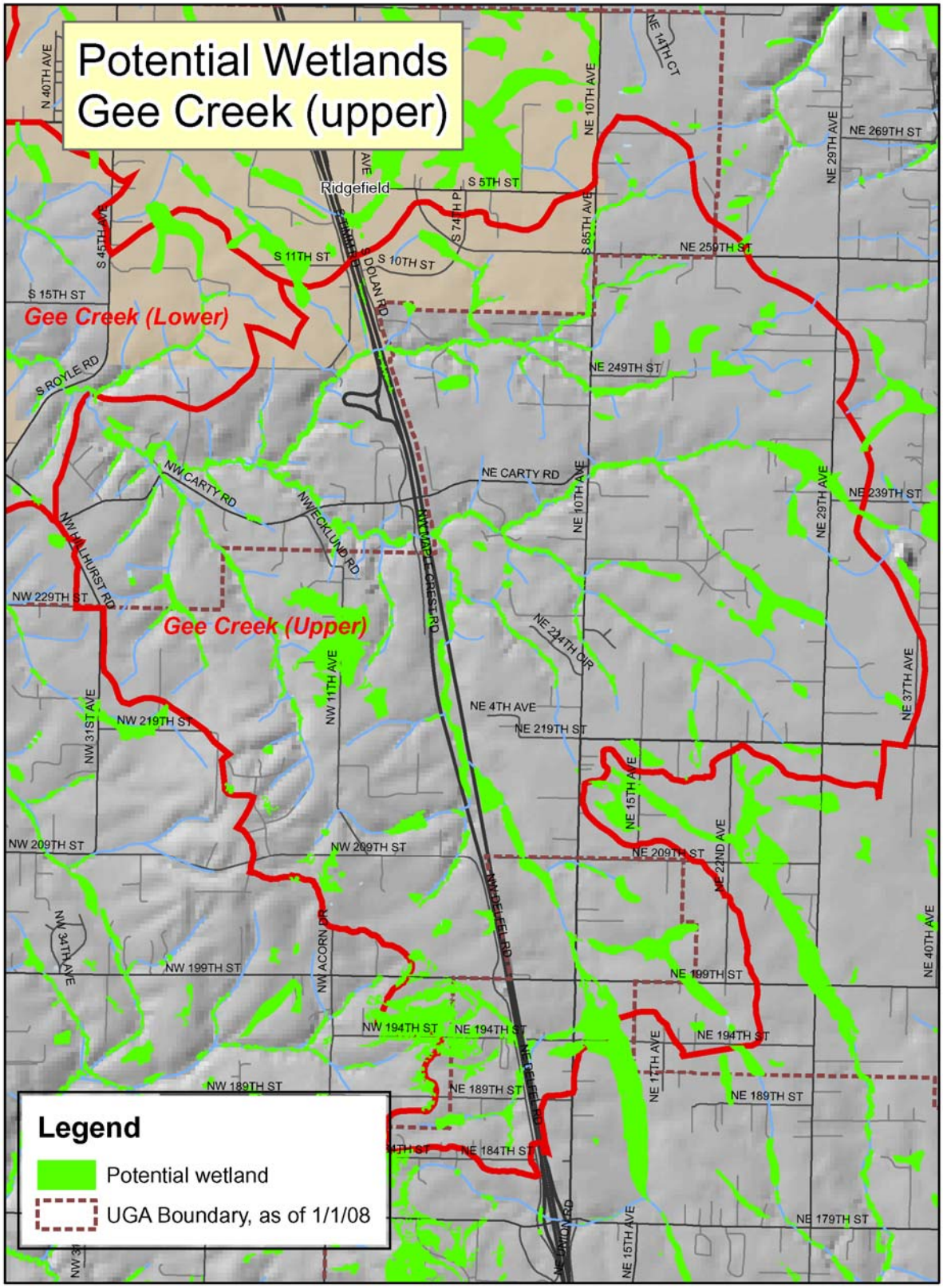


Figure17: Potential Wetlands in the Upper Gee Creek Subwatershed

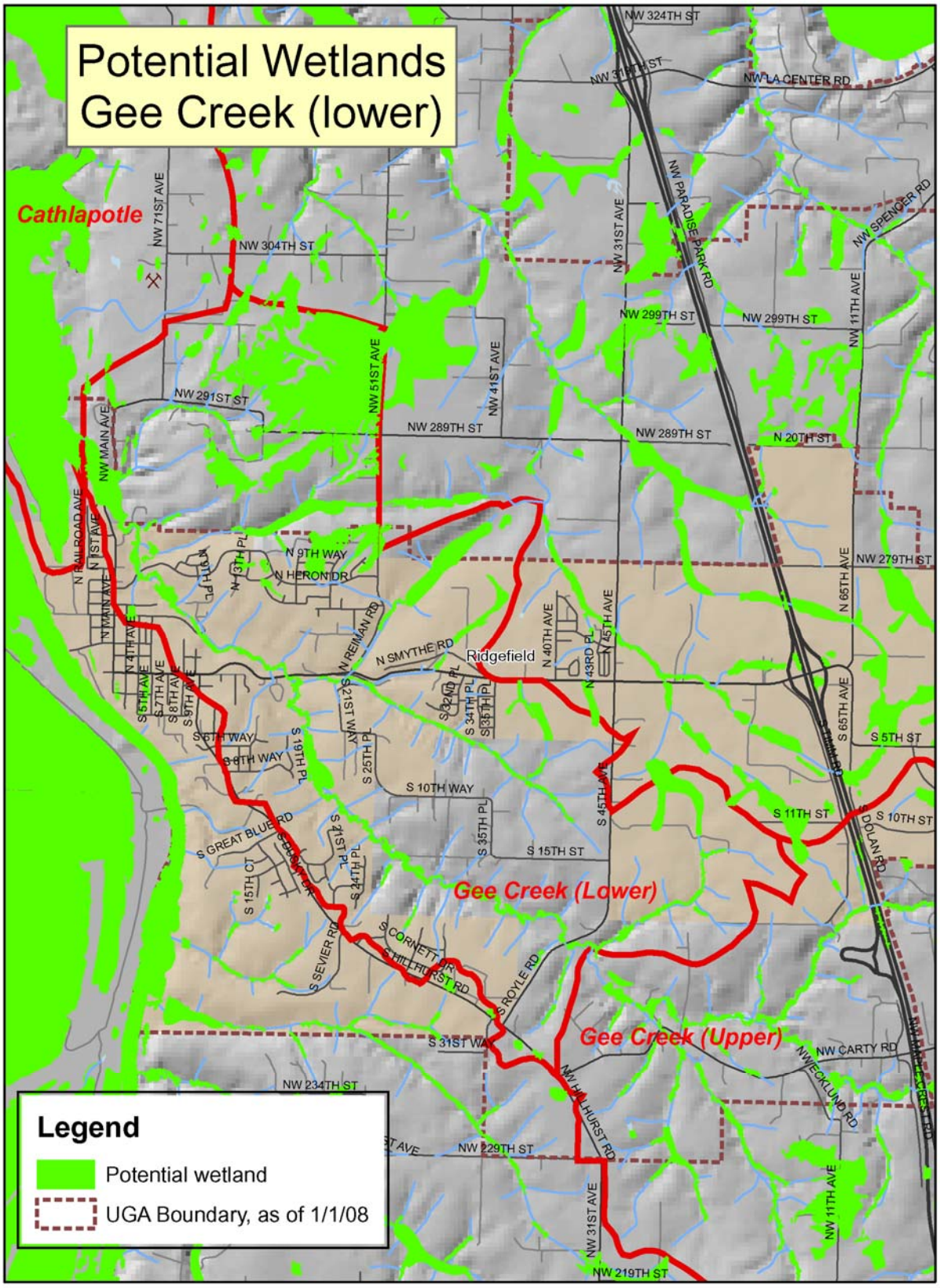


Figure18: Potential Wetlands in the Lower Gee Creek Subwatershed.

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 Gee Creek subwatersheds are summarized below.

Gee Creek is part of the Terrace hydrogeologic unit, characterized by rain-dominated precipitation, west to southwesterly trending groundwater flow, and a large delta (now a terrace) formed by glacial floods consisting of gravels, sand, silts and clay. Topography is relatively level to moderately steep in the foothills and slopes above the Columbia River (Ecology, 2007).

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.

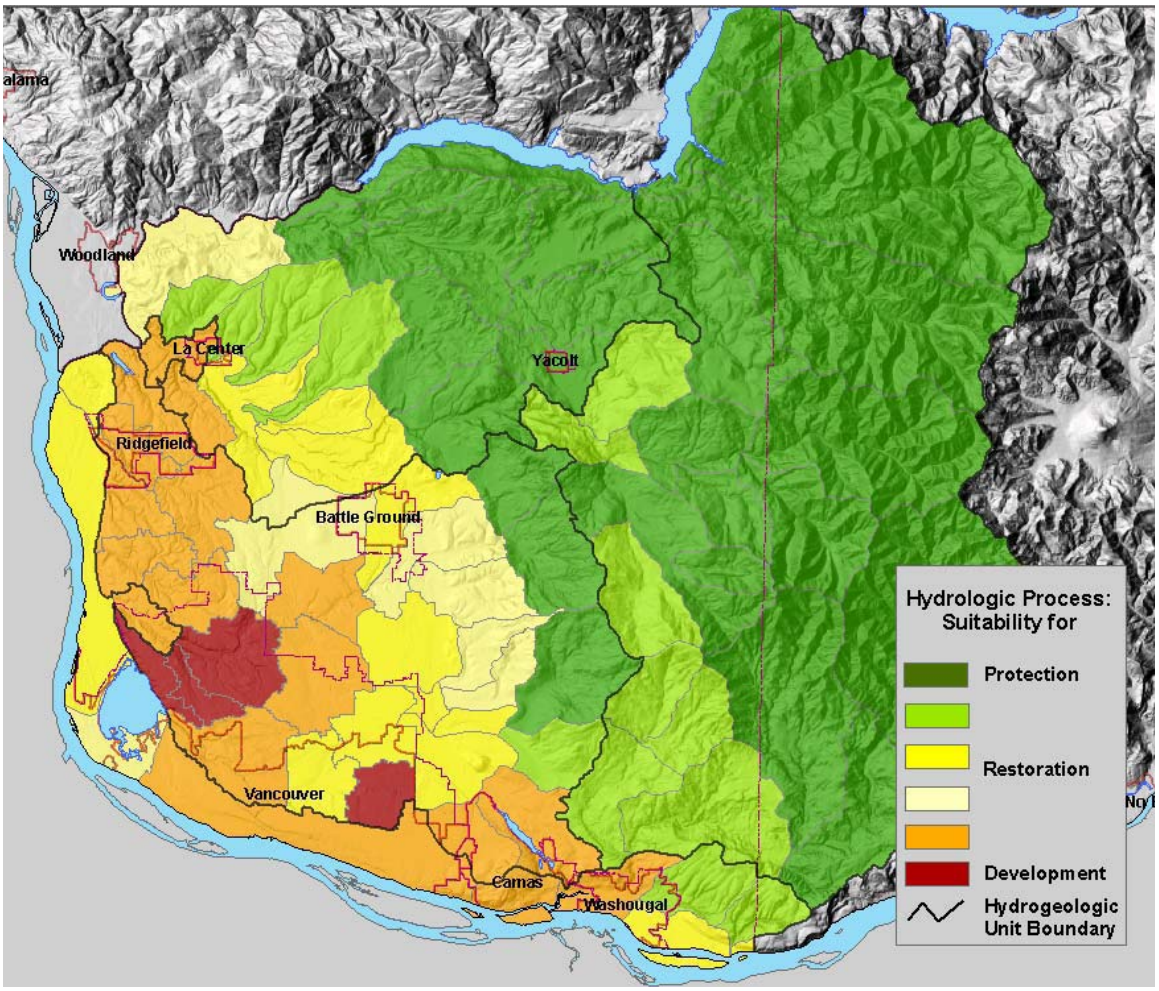


Figure 19: Priorities for suitability of areas for protection and restoration for the hydrologic process (from Draft Watershed Characterization of Clark County (Ecology, 2007)).

In general, green areas have higher levels of importance for watershed 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 has 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 highest ranked areas for protection (dark green) do not typically occur in the Terrace unit. Overall, results for the Terrace unit suggest focusing restoration activities east of Interstate 5, with particular emphasis on "siting and designing development in a manner that protects and maintains processes (i.e., through low impact development measures including clustering, density bonuses, transfer of development rights, and mitigation banking)", and concentrating development on the west side of I-5 in upland areas while protecting aquatic resources and discharge areas, such as slope wetlands. (Ecology 2007).

The watersheds of Whipple, Flume, Gee Creek, Allen and lower Lacamas Creek are indicated as suitable for both development and restoration (orange) due to a higher level of alteration and a lower level of importance. The Clark County Regional Wetland Inventory and Strategy Study recommend two banking opportunity areas (Opportunities #2 and #3) in upper Gee Creek. These could be areas where projects that enhance wetland hydrology to mitigate for stormwater impacts should be considered.

Potential Projects

Potential project locations for further exploration based on this wetland assessment include:

- The Clark County Regional Wetland Inventory and Strategy Study recommend two mitigation opportunities in this area: Opportunity #2 in Gee Creek/Flume Creek and Opportunity #3 in upper Gee Creek.
- Table 20 includes tax exempt parcels that overlap with potential wetlands from the Clark County wetlands model.
- The area north of NW 289th Street and west of NW 51st Avenue is relatively undeveloped, contains relatively large parcels, and is located in the largest contiguous area of modeled potential wetlands within the Gee Creek subwatersheds. Property acquisition and/or landowner leveraged projects could be pursued in this area.
- The WSDOT SR502 widening project will potentially impact significant wetland areas in upper Gee Creek. Possible leveraged mitigation projects should be further explored.

Table 20: Tax Exempt Parcels Overlapping Potential Wetlands				
ASSR_SN	**ASSR_AC**	**OWNER**	**PT1DESC**	**Description**
215428-000	1.75	Clark County	Unidentified Buildings or Use	in Ridgefield UGA but CC owned
215439-000	2.11	Clark County	Unused or Vacant Land - No improvements	existing facility
215109-000	1.20	Clark County	Surfaced streets with curbs and gutters.	roadway partially paved
215175-000	1.65	Clark County	Unused land timbered.	existing facility
216674-000	4.05	Bethel Evan Methodist Church	Churches, synagogues, temples, Sunday school buildings.	vacant church property
216973-000	0.87	Clark County	Unused land timbered.	existing facility
216958-042	0.00	Clark County	Unused platted land.	existing facility
179392-000	40.00	Ridgefield School Dist #122	Public - Secondary schools (junior high and high schools).	existing forest and wetland
117431-000	1.96	Pleasant View Nazarene Church	Unused or Vacant Land - No improvements	church ball field
217154-000	40.00	State Of Washington	Unused or Vacant Land - No improvements	existing pond and forest, possible existing habitat project

Macroinvertebrate Assessment

Purpose

The Benthic Macroinvertebrate Index of Biological Integrity or B-IBI (Karr, 1998) is a widely used measure 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 chronic and acute pollutant sources, hydrology modifications, and habitat changes.

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 Clark County's standardized protocols for macroinvertebrate sampling and analyses (Clark County Public Works Water Resources, June 2003). Samples are collected during late summer, preserved, and delivered to a contracted laboratory 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 10-24 indicate low biological integrity, from 25-39 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 the sampling station. Thus, samples from a given 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.

Gee Creek macroinvertebrate data were collected from station GEE030 at Abrams Park, and from station GEE050 downstream of Royle Road (see Figure 3 in the Water Quality Assessment section).

Results

Results for the two Gee Creek stations of GEE030 and GEE050 are based on a total of ten samples from 2001 through 2007. Over this period, the average Total

B-IBI score was 25 at GEE030 and 22 at GEE050 (Table 21). These scores fall in the category of moderate and low biological integrity, respectively. Annual B-IBI scores were also well within typical inter-annual variability of less than five points observed for Puget Sound streams (Karr 1998 and Law 1994) and in Clark County data.

Averages for each station's ten sub-metrics were also very similar to the extent that their categorical classifications were identical. Examining average results for the ten metrics shows that almost half had low ratings, with the remainder being moderate. In particular, the low average scores for the Stonefly metric and intolerant taxa metric suggest degraded water and habitat quality since sensitive taxa are among the first organisms to disappear as human disturbances increase (Fore, 1999). In addition, low scores for Mayfly taxa and percent predator taxa could also reflect, respectively, the presence of certain pollutants such as heavy metals and decreasing diversity in prey items.

The similarity between both Total B-IBI and sub-metric scores at these two stations tends to suggest that degradation of biological health in Gee Creek may be system-wide rather than a symptom of poor conditions in isolated reaches.

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 20 indicates that B-IBI scores at GEE030 and GEE050 fall in the lower to middle range of expected scores (estimated 2000 Total Impervious Area from Wierenga, 2005). By comparing Gee Creek to the likely range of conditions for watersheds with similar amounts of development, measured as impervious area, it is possible to make some general statements about the potential benefits from improving stream habitat.

Given that available B-IBI scores fall in the lower half of the expected range for watersheds with 16 percent and 19 percent impervious areas, respectively, it is likely that factors other than total watershed impervious area are contributing to the observed degradation of biological integrity at these stations. This implies an opportunity to increase the level of biological integrity by improving habitat and stream conditions. Management strategies that limit further degradation and promote rehabilitation are therefore important for improving the relatively low biological integrity in Gee Creek.

Table 21: GEE030 and GEE050 Average Annual Macroinvertebrate Community Metrics and Total Scores from 2001 through 2007.						
	GEE030 4-Year Averages			GEE050 6-Year Averages		
BIBI Metrics	Value	Score	Category	Value	Score	Category
Total number of taxa	34	3	moderate	33	3	moderate
Number of Mayfly taxa	4	1	low	4	1	low
Number of Stonefly taxa	4	1	low	3	1	low
Number of Caddisfly taxa	6	3	moderate	5	3	moderate
Number of long-lived taxa	4	3	moderate	3	3	moderate
Number of intolerant taxa	0	1	low	0	1	low
Percent tolerant taxa	28	3	moderate	44	3	moderate
Percent predator taxa	4	1	low	4	1	low
Number of clinger taxa	18	3	moderate	18	3	moderate
Percent dominance (3 taxa)	55	3	moderate	54	3	moderate
Summary of avg metric scores		22	low		22	low
6-year average B-IBI Score		**25**	**moderate**		**22**	**low**

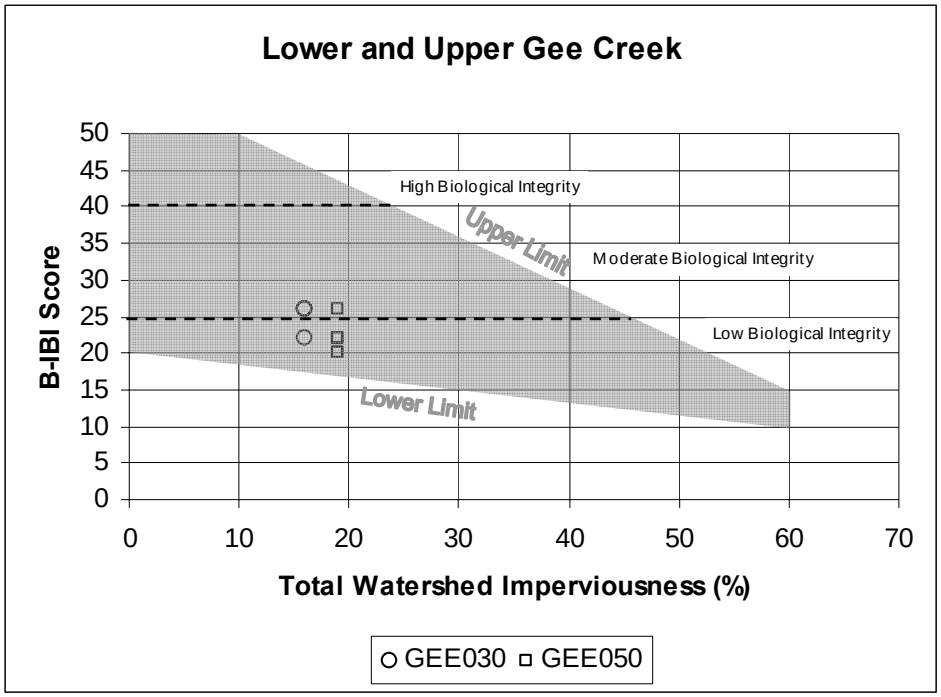


Figure 20: Approximate range of B-IBI in Puget Lowland watersheds, showing progressive decline with increasing imperviousness in the upstream watershed. Adapted from Booth et al., 2004. Markers indicate Total BIBI scores at GEE030 and GEE050 for particular years, vs. estimated 2000 subwatershed TIA.

Physical Habitat Factors

Physical habitat is discussed in more detail in the Physical Habitat Assessment section. Based on a 2002 field assessment at GEE050 (Clark County, December 2003), 'overall riparian quality' was rated 'good', and the 'overall habitat quality' rated 91 out of 100 compared to a Category C Willamette Valley reference stream site. Streams in reference Category C have some remaining habitat value but are significantly degraded.

Other generally accepted criteria suggested degradation of important macroinvertebrate habitat features, including measures of increased hydrologic flashiness, low percentage of riffle habitat, high substrate embeddedness, and elevated levels of sand and fine particles. Bed substrate stability metric indicated a 'somewhat unstable' channel. In general, all of the above are indications that current habitat stability and quality are insufficient to support healthy macroinvertebrate populations.

Hydrology

TQmean is a hydrologic statistic calculated as the average annual fraction of a year that daily mean discharge exceeds annual mean discharge (Booth et al, 2004). Lower fractions indicate a more "flashy" system. Based on continuous monitoring data (2003 – 2006) from a station at Abrams Park, Gee Creek has a

relatively low average TQmean value of 0.25, indicating a hydrologic setting more similar to urban watersheds than to other suburban or rural areas. Watersheds with similar values experience excessive stormwater runoff and streambank erosion that may substantially alter macroinvertebrate populations by increasing streambed disturbances, increasing sedimentation, and diminishing the quality of aquatic habitat.

Water Quality

General water quality is summarized in the Water Quality Assessment section. Conditions or results that may negatively impact macroinvertebrate populations include:

- The Ecology 303(d) list includes portions of Gee Creek as 'Waters of Concern' for dissolved oxygen and temperature.
- In 2004, Clark County reported poor water quality for Gee Creek as part of a broad County-wide assessment (Clark County, 2004).
- In 2004 an extremely high turbidity event and mud deposits in lower Gee Creek were traced to insufficient erosion control at a residential development site. Substantial sediment from this source is still present.
- Continuous summer water temperature monitoring from 2002 through 2006 at GEE030 and GEE050 indicated temperatures exceeded state criteria every year and remained elevated over substantial periods.

A wide range of human activities could be contributing to poor quality water in Gee Creek given the extent and intensity of watershed land uses. Water quality data suggest both stormwater and non-stormwater pollutant sources may be negatively impacting benthic macroinvertebrates. Impacts could result from increases in erosive and polluted runoff from development, agriculture, rural homes, and hobby farms, as well as reduced streamside vegetation leading to excessive streambank erosion, heating of streams, and possibly lower dissolved oxygen levels.

<u>Stormwater Management Recommendations</u>

Based on the relatively low biological integrity indicated by the existing dataset, stormwater management efforts should support limiting further degradation and rehabilitation of degraded areas. Suggested stormwater management activities that may protect and improve aquatic habitats include:

- Reducing peaks and duration of stormwater flows through capital facility improvements
- Fully applying current erosion control standards for development projects
- Promoting LID practices to minimize increases in impervious area
- Riparian habitat improvement projects

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 improvement projects.

Methods

Fish distribution is mapped from the County's existing GIS shape files, which reflect data collected by the Northwest Indian Fisheries Commission (NWIFC). A summary of Gee Creek fish use and past investigations is also available in the *Gee Creek Watershed Restoration Background Report* (Cornelius, July 2006).

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 clarkgis\avdata\shapes\resource\fishpass.shp)
- 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 (roads.shp) with LiDAR derived stream data from StrmCntr.shp.

Results/Summary

Distribution

All available evidence suggests that anadramous fish use of Gee Creek is limited, and resident populations of cutthroat trout are relatively low.

The NWIFC reports "presumed" use by Coho salmon and winter steelhead in the mainstem up to the I-5 crossing (Figure 21). Cornelius (July 2006), and Cornelius and Finley (January 2008) summarize past agency reports and anecdotal fish distribution information. Among the reported findings are:

- In 2007, the presence of Coho salmon and cutthroat trout was confirmed during USFWS Columbia River Fisheries Program Office (CRFPO) juvenile trapping in lower Gee Creek on the Carty Unit.
- The origin of Coho salmon is uncertain due to egg box releases in recent years from Ridgefield High School.
- From 2002-2005, electrofishing conducted in the mainstem between the Carty Unit and Royle Road found only cutthroat trout and juvenile Coho, both in very low numbers. Relatively large numbers of warm-water fish were collected.

- A significant manure spill in 2001 may have adversely impacted resident and/or anadramous fish populations in the middle mainstem.
- From 1993 to 1997, USFWS rotary screw traps in lower Gee Creek detected the presence of cutthroat trout, juvenile Coho, and juvenile Chinook salmon.
- Until the early 1950s, agency reports and anecdotal evidence suggest the presence of fishable numbers of cutthroat trout, as well as the possible presence of chum and Coho salmon.

Barriers

Gee Creek was not assessed by the LCFRB 2004 Watershed Characterization and is a low priority for regional salmonid recovery (Gee Creek is not listed in the top four tiers of recovery priority).

Though not a regional priority, Gee Creek is referenced briefly in the 2004 LCFRB Salmon and Steelhead Recovery Plan. Both upper and lower Gee Creek are identified as areas where the first recovery priority should be to "restore access to habitat blocked by artificial barriers".

The WDFW barrier database provides the most complete assessment of barriers in the Gee Creek watershed and includes all barriers listed in the other data sources above. WDFW reports total barriers at Pioneer Street on the north branch of Bertsinger Road tributary, at I-5 on the north mainstem branch, and in the upper headwaters near the northbound I5 Gee Creek rest area. Partial barriers are also reported on the south mainstem branch at I-5, and near the northbound rest area (Figure 21).

Figure 21 also shows the extent of public and private road crossings in the watershed. Due to limited barrier analysis in Gee Creek by local and state agencies, it is likely that some unassessed road crossings present additional passage barriers.

Potential barriers in upper Gee Creek are also noted in the Rapid Stream Reconnaissance section.

<u>Recommendations</u>

While there are barriers to existing habitat in Gee Creek, the relatively limited anadramous fish use compared to other Clark County streams suggests a lower priority for barrier removal projects.

Barrier projects in the upper watershed should be limited to upgrades as existing infrastructure is replaced or improved. Though potential and known barriers are common in the remaining unincorporated areas of the upper watershed, multiple known and potential barriers exist in the lower mainstem and tributaries within the Ridgefield UGA. Priority for barrier assessment and removal should be given to these lower mainstem and tributary areas.

Areas for referral to WDFW, CCD, and/or City of Ridgefield for further assessment include:

- Union Pacific railroad crossing near Gee Creek mouth
- Public and private road crossings in the mainstem reach between Main Street and Royle Road

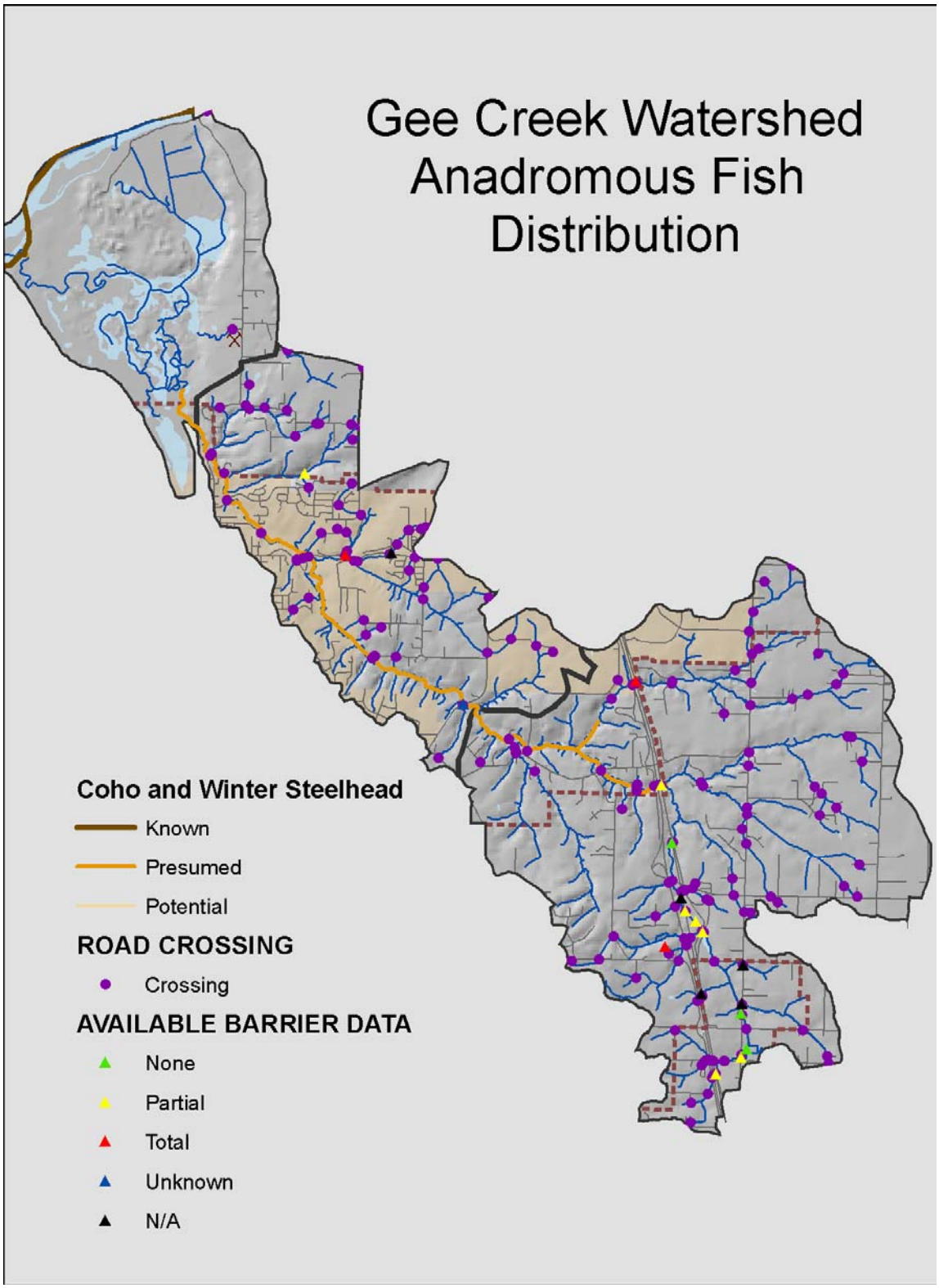


Figure 21: Anadromous Fish Distribution And Barriers in Gee Creek.

Sources: Northwest Indian Fisheries Commission; WDFW barrier database; Clark County road crossings.

Hydrologic and Hydraulic Modeling

Hydrologic and hydraulic modeling was not conducted for the Gee Creek watershed.

Analysis of Potential Projects

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

Summary of Conditions, Problems, and Opportunities

Conditions and Problems

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

Coordination with Other Programs:

Gee Creek benefits from its connection with the Ridgefield National Wildlife Refuge, an area of regional significance and substantial public support. The Gee Creek Enhancement Group, local schools, and interested residents have pursued numerous activities including habitat assessments and restoration, salmon egg-boxes, volunteer monitoring, public education, and community policing of development and mining activities.

Watershed-specific projects by regional entities including LCFRB, Clark County Legacy Lands Program, Clark Public Utilities, Clark County Transportation Improvement Program, and the Department of Ecology are not significant.

Broad-scale Characterization:

Gee Creek soils tend to be fine-grained, have high clay content, and are easily erodible. Most of the watershed has little or no floodplain, and basin hydrology is typical of a "flashy" urban or unforested rural watershed (TQmean = 25%).

Standard metrics based on NOAA fisheries standards indicate significant human alteration and suggest Gee Creek stream habitat is significantly degraded. These metrics include forest cover, TIA and EIA, road density, and stream crossing density.

Based on current and future predicted EIA and forest cover, it is likely that stream channels will remain predominantly unstable.

Water Quality Assessment:

Gee Creek is 303(d) listed for fecal coliform under Category 5 (polluted waters that require a TMDL) and for dissolved oxygen and temperature under Category 2 (waters of concern).

A relatively large water quality dataset is available for Gee Creek as Clark County maintains long-term monitoring and hydrologic stations. Volunteer monitors are also active through Clark County and the Gee Creek Enhancement Group.

Based on 2002-2007 data, water quality index scores are poor, and no significant temporal trends are apparent. Fecal coliform monitoring in 2007 indicates ongoing seasonal sources in many areas of the watershed and significant exceedences of state criteria. Stream temperatures are significantly elevated during summer, exceeding state criteria by 5° to 7° F and remaining elevated for extended periods. Dissolved oxygen concentration is typically good to excellent and may warrant consideration by Ecology for de-listing.

Overall, fecal coliform bacteria, stream temperature, turbidity, and total phosphorus are the primary parameters of concern in this watershed.

Drainage System Inventory:
Drainage mapping is incomplete; however, most ditch outfalls and channels were mapped in 2007. Additional mapping will be completed in 2008 and 2009.

Stormwater Facility Inspection:
As of December 2007, there were only eight mapped public stormwater facilities in unincorporated areas of Gee Creek. Sixty-one percent of facility components within these facilities were in compliance with standards in the *2005 SWMMWW Volume 5*. All eight facilities required referrals either for maintenance work or to re-visit facilities currently under construction.

Off-site assessments conducted for 86 public stormwater outfalls discharging to critical areas identified one case of moderate erosion caused by an outfall.

Illicit Discharge Screening:
Screening conducted at 115 known stormwater outfalls, primarily from roadside ditches, identified one illicit connection. In this case, a direct residential connection was discharging wastewater to the county ditch carrying fecal coliform bacteria at a concentration of 30,000 cfu/100mL.

Stream Reconnaissance Feature Inventory:
Significant stream impairments, potential environmental and safety hazards, and stormwater project opportunities were recorded for approximately four miles of stream corridor in the upper watershed. A total of 68 significant features were identified, primarily stream crossings, stormwater outfalls, and impacted stream buffers. Forty-eight potential projects were identified in six categories, with the majority being projects outside the scope of CWP activities and subsequently recommended for referral to outside groups or agencies.

General observations from the feature inventory in the upper watershed included:
- Predominant sources of stormwater are rural residential development draining to roadside ditches, and piped stormwater flow from I-5.

- Impacted buffers are prevalent in the upper watershed, with a nearly universal lack of intact forest cover.
- Stream channels appeared to be relatively stable but exhibit greatly simplified geometry.
- Features of interest were often discovered along small first-order tributaries, many of which were not included in the survey scope. Thus it is likely that additional features of interest exist in areas not assessed.

Physical Habitat:
Physical habitat data is limited. Based on results from an assessed reach near Royle Road in 2002, habitat quality was similar to a Category C reference stream in the Willamette Valley. Category C is marginally acceptable as a reference stream due to obvious human disturbance.

Geomorphology and Hydrology:
See Appendix A for results of these assessments. Results were not available at the time of report completion.

Riparian Assessment:
The most reliable riparian assessment data in Clark County is limited to the areas assessed during the 2004 LCFRB Habitat Assessment. The Gee Creek watershed was not included in the assessment.

A qualitative review of 2007 aerial photography indicated that riparian forest is relatively intact in the reach between Royle Road and I-5, and in some areas of the lower watershed through the City of Ridgefield. Forest cover in the upper watershed is limited to narrow strips along riparian corridors and is nearly non-existent in the headwaters upstream of the Gee Creek rest area.

Public land is very limited within the watershed; 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 narrow floodplain areas. Notable large areas of potential or current wetland include the area west of NW 51st Avenue and north of NW 289th Street in the lower watershed, and in the headwaters within the Vancouver UGA. Much of the Cathlapotle subwatershed consists of current wetland within the Columbia River floodplain.

The Clark County regional wetland inventory recommended two potential mitigation opportunities within the watershed.

Ecology's draft wetland characterization of Clark County places Gee Creek in a category suitable for both development and wetland restoration due to a higher relative level of alteration and lower relative importance to regional watershed processes.

There are ten tax-exempt parcels which overlap potential wetland areas.

Macroinvertebrate Assessment:
Based on samples collected from 2001 to 2007, Gee Creek exhibits low biological integrity. Scores are low compared to the predicted range of B-IBI scores for areas with similar TIA, suggesting that factors other than TIA are contributing to low scores. Thus it is likely that biological integrity could be increased through improvements to habitat and stream conditions.

Fish use and Distribution:
The available evidence suggests that anadramous fish use of Gee Creek is limited, and resident populations of cutthroat trout are low.

Gee Creek is not a regional priority for salmon recovery; however, the 2004 LCFRB Salmon and Steelhead Recovery Plan identify both upper and lower Gee Creek as areas where the first priority should be to "restore access to habitat blocked by artificial barriers".

Several complete and partial barriers are already known; currently unassessed crossings at the railroad bridge near the mouth of Gee Creek and at public and private road crossings in the lower watershed could represent additional barriers.

Recently Completed or Current Projects

There are no stormwater projects in Gee Creek under the 2007-2011 SCIP. Ongoing construction by WSDOT at the 219th Street interchange includes a number of stormwater control facilities and upgrades. WSDOT is also currently developing plans to widen SR502 from I-5 to Battle Ground. The Gee Creek Enhancement Committee and City of Ridgefield are exploring opportunities for projects within the Ridgefield UGA.

Analysis Approach

Purpose

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

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

agencies such as Clark Conservation District and Clark Public Utilities may lead to additional activities outside the CWP scope.

Methods

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

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

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

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-7	15' high private dam failing	Site visit	Refer to CWP engineering
MI-9	Breach in berm separating pond from stream	Site visit	Refer to CWP engineering
MB-5	15' high private dam with headcuts, erosion, and scour	Site visit	Refer to CWP engineering
wetlands (City of Ridgefield property near 259th St and 10th Ave)	recent enhancement project failing; severe ongoing erosion	Site visit	Refer to CWP Source Control staff/City of Ridgefield

Potential Stormwater Capital Projects

Stormwater Capital Facility Improvement Projects

Identifier	Issue	Project	Action
OT-6	Ditch draining untreated stormwater from 10th Ave and adjacent ag property	Enhance treatment/flow control in ditch	Evaluate project for 2008 SCIP
20-yr CIP	NE 10th Ave/SR502 project	Leverage for stormwater benefit	Refer to project manager

Stormwater Infrastructure Maintenance CIPs

Identifier	Issue	Project	Action
Outfall 1499	Public outfall causing moderate stream bank erosion	Re-design or repair outfall	Evaluate for 2008 SCIP
taxlot 215439-000	public facility berm breached and no storage	repair berm/outlet structure	Evaluate for 2008 SCIP

Stormwater Class V Underground Injection Control projects:
None exist in Gee Creek

Habitat Rehabilitation/Enhancement Projects
No specific projects for Clark County action were discovered in the following areas; however, they merit further general evaluation in search of future projects:

- Upstream of I-5, particularly in critical vacant/underutilized lands inside Vancouver UGA.
- Evaluate Clark County Regional Wetland Inventory Opportunities #2 and #3.
- Area north of NW 289th St and west of NW 51st Ave.

Property Acquisition for Stormwater Mitigation

Identifier	Issue	Project	Action
OT-5 and taxlot	abandoned private facility and vacant headwater parcel	property acquisition /facility repair or retrofit	Evaluate for 2008 SCIP

Other than listed above, no specific potential acquisition sites were discovered. However, relatively large blocks of intact forest cover exist along the mainstem and northern tributaries between Royle Road and I-5. Due to the loss of historical forest cover watershed-wide, future opportunities to protect or acquire forested land in this area should be pursued.

Follow-up Activities for Referral within CWP

Private Stormwater Facilities Maintenance

Identifier	Issue	Project	Action
OT-5	Private facility may be ineffective, and no energy dissipater at outfall	Maintenance	Refer to PW private facility inspector

Public Works stormwater infrastructure maintenance

Identifier	Issue	Project	Action
OT-30	Water ponds along side of roadway	Ditch culvert maintenance and install energy dissipator	Refer to PW Operations
taxlot 215175-000	erosion at outfall, failing silt fence	repair or remove silt fence, repair dissipater	Refer to PW Operations

The Public Facility Inspection section describes additional routine stormwater infrastructure maintenance needs referred to Public Works Operations during ongoing inspections.

CWP Outreach/Technical Assistance

Identifier	Issue	Action
OT-6	Pasture and ag runoff to county ditch with minimal treatment	Refer to CWP Outreach; contact landowners about BMPs, CCD assistance, and Gee Creek Enhancement Committee
IB-26	Headwater stream with livestock access	Same as above
MI-6	Headwater stream with livestock access	Same as above
MI-7/SC-41/WQ-13	Headwater stream with livestock access. Pond and lack of riparian cover.	Same as above
IB-31	Heavily grazed, lack of riparian cover	Same as above
IB-25/SC-35/WQ-10	Eroding drainage ditch, livestock crossing, and livestock access	Refer to CWP Outreach for on-site technical assistance visit

CWP Infrastructure Inventory

Identifier	Issue	Action
OT-33	Unmapped pipe outfall	Refer to CWP inventory project
OT-31	Unmapped ditch outfall	Refer to CWP inventory project
OT-6	Ditch mapping incomplete in this area	Refer to CWP inventory project
OT-25	Unmapped ditch outfall	Refer to CWP inventory project

Projects for Referral to Other Departments/Agencies/Groups

Identifier	Issue	Action
OT-33	18" pipe outfall from I-5 ROW or rest area. No dissipater	Refer to WSDOT; consider as package for annual Clean Water fee project
OT-24	Downcutting channel draining I-5	same as above
OT-22	Swale outfall in northbound rest area with no dissipater. Active erosion.	same as above
OT-23	Detention pond outfall in northbound rest area downcutting.	same as above
OT-25	Ditch outfall draining I-5 northbound with no dissipater. Active erosion.	same as above
SC-76	Downstream end of 189th Street culvert is crushed closed	Refer to PW Operations
SC-33	Downstream end of 10th Avenue culvert is crushed	Refer to PW Operations
OT-32	Outfall from ditch on Maple Crest Road is untreated and no energy dissipater	Refer to City of Ridgefield
Fish use	Multiple crossings not previously assessed for barriers	Refer to Gee Creek Enhancement Committee and WDFW

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 Gee Creek subwatersheds, by permit component, include:

Storm Sewer Mapping and Inventory

- A complete drainage system inventory is critical to effective maintenance and inspection activities. Sufficient resources should be allocated to complete the stormwater inventory both in Gee Creek and countywide.

Coordination of Stormwater Activities

- Gee Creek restoration and protection has active support and involvement groups in the Gee Creek Watershed Enhancement Committee, Friends of Ridgefield Wildlife Refuge, USFWS, and City of Ridgefield. Support for and coordination with these entities should be provided whenever feasible.

Mechanisms for public involvement

- Publish SNAP reports on CWP web page

Development Regulations for Stormwater and Erosion Control

- EIA is expected to increase to approximately 20 percent in the upper and lower Gee Creek subwatersheds under the current Comprehensive Plan. At these levels, adverse changes to stream hydrology and stability will occur unless development standards effectively control the duration of erosive flows. Clark County is currently working to adopt standards equivalent to the 2005 Ecology stormwater manual.
- In developing areas, emphasize stormwater management that focuses on reduction of runoff and diffuse infiltration close to the source rather than in centralized facilities. LID practices should be encouraged.
- Consider stormwater basin planning as a tool to better manage stormwater impacts due to future growth in the entire Gee Creek watershed.

Stormwater Source Control Program for Existing Development

- Encourage landowners to adopt runoff reduction practices such as disconnecting downspouts.

Operation and Maintenance Actions to Reduce Pollutants

- Sparse vegetation coverage in stormwater swales was the most common cause of facility non-compliance in Gee Creek. Increased maintenance attention to this issue is recommended to help control erosion and increase treatment effectiveness.

- Fish barrier removal projects in the upper watershed should be limited to upgrades as existing infrastructure is replaced. Priority for barrier removal should be in the lower mainstem within Ridgefield.
- Confirm that county ditch maintenance practices minimize vegetation removal whenever possible.
- Promote the use of geomorphically-based performance standards when designing new or replacement hydraulic structures at road crossings.

Education and Outreach to reduce behaviors that contribute stormwater pollution
Areas where increased outreach could improve stream conditions include:

- Perform targeted technical assistance responding to results of field assessments.
- Invasive plants are ubiquitous in Gee Creek and Clark County; eradication and/or control of these plants are beyond the resources of public agencies and require actions by private landowners. Increased education and technical support would be beneficial, including removal techniques and lists of suggested plants for re-vegetation.
- Many stream crossings have missing or deteriorated stream name signs that should be replaced.
- Develop a process to provide education about appropriate ditch maintenance practices to rural landowners.

TMDL Compliance
- None noted. The TMDL process has not yet been initiated by Ecology in the Gee Creek watershed.

Monitoring Stormwater Program Effectiveness
- Problems caused by stormwater are common and most severe on small tributary streams. Assessment of all streams is beyond the scope of SNAP work. Future SNAP reports may benefit by focusing more assessment resources on smaller tributary streams rather than mainstem reaches.

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Appendices

Appendix A — Geomorphology and Hydrology Assessment