White Salmon River Watershed Fecal Coliform Bacteria Attainment Monitoring Study

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Cover photo: White Salmon River near BZ corner.

White Salmon River Watershed Fecal Coliform Bacteria Attainment Monitoring Study

by

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Waterbody Number: WA-29-3010

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Abstract

Three segments of the White Salmon River and four of its tributaries, Rattlesnake Creek, Gilmer Creek, Trout Lake Ditch, and Trout Lake Creek, were listed in 1998 under Section 303(d) of the federal Clean Water Act as not meeting Washington State water quality standards for fecal coliform bacteria (FC).

FC data collected by the Washington State Department of Ecology's (Ecology's) Ambient Monitoring Program from 2007 through 2008 suggest FC levels within the White Salmon River watershed have improved. In 2009, Ecology initiated a study to determine if these waters are currently complying with FC standards.

FC results from this study indicate the White Salmon River at river mile (RM) 22.55, Rattlesnake Creek, and Gilmer Creek are still exceeding (not meeting) FC standards. The White Salmon River at RMs 1.43 and 12, Trout Lake Ditch, and Trout Lake Creek are currently meeting FC standards.

Possible sources of FC above the White Salmon River at RM 22.55 were identified as local irrigation ditches, manure management activities, and livestock access to surface waters.

Sources of FC on Rattlesnake Creek are believed to be from upstream residences, possibly faulty onsite sewage systems. Other possible sources, however, cannot be ruled out. At the time of this publication, Ecology continues to work with local stakeholders to identify and voluntarily remediate FC sources at these sites.

Data collected for the purposes of tracking sources of FC pollution during this study identified several sources in Gilmer Creek. During the course of this study, landowners on Gilmer Creek have worked cooperatively with the Underwood Conservation District and Ecology to voluntarily implement best management practices.

When sufficient water cleanup activities have occurred to remove sources of FC in the watershed, an effectiveness monitoring evaluation will be conducted. Effectiveness monitoring evaluations are conducted to determine if cleanup activities have been successful.

Acknowledgements

The author of this report thanks the following people for their contribution to this study:

- Landowners within the White Salmon River watershed who worked cooperatively with the Department of Ecology during this 2009-10 study to implement best management practices to improve water quality.
- Tova Cochran and the staff of the Underwood Conservation District who assisted with the project and provided support to landowners.
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    - Jim Ross and George Onwumere for reviewing the final report.
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    - Nancy Rosenbower and Nancy Jensen at Manchester Environmental Laboratory for providing analytical support.

Introduction

Data collected by the Underwood Conservation District and the Washington Department of Ecology (Ecology) from 1992-2001 suggest elevated levels of fecal coliform bacteria (FC) in the White Salmon River watershed (Ecology, 2008). Three river segments of the White Salmon River and four of its tributaries, Rattlesnake Creek, Gilmer Creek, Trout Lake Ditch, and Trout Lake Creek, are currently listed in under Section 303(d) of the federal Clean Water Act as not meeting Washington State water quality standards for FC.

Listed segments, water quality categories, and a link to listing descriptions are presented in Table 1. See Appendix A for a description of Section 303(d) and applicable water quality standards.

Table 1. White Salmon River watershed FC 2009-10 monitoring stations, 2008 303(d) FC listing categories, and listing IDs.

Waterbody	River mile	Study Station ID	Category[1]	Listing ID Link
White Salmon River	1.43	WS-1.43	2	21580
White Salmon River	12	WS-12	5	5889
White Salmon River	22.5	WS-22.5	5	21587
Rattlesnake Creek	0.1	RSC-0.1	5	5886
Gilmer Creek	0.2	GC-0.2	5	16775
Trout Lake Ditch	2.6	TLD-2.6	5	21588
Trout Lake Creek	0.30	TLC-0.30	2	21590

[1]See Appendix B for description of 303(d) listing categories.

Since the time of the 1998 listing, landowners within the watershed have been implementing water quality improvement projects within the White Salmon mainstem and several tributaries (UCD, 2008 personal communication). Also, land-use changes have likely decreased potential agricultural sources of FC in the watershed.

In 2007-2008, Ecology's Ambient Monitoring Program collected monthly FC samples from stations on the White Salmon River and Rattlesnake Creek. Only one of the 24 samples exceeded (did not meet) the FC water quality standard suggesting water quality conditions may have improved.

In 2009, Ecology's Environmental Assessment Program developed a water quality study to reassess FC levels in the White Salmon River. The primary goals of this 2009-10 study were to:

1. Evaluate whether the current Section 303(d) FC listings of the White Salmon River and selected tributaries are still warranted.
2. Make recommendations for future monitoring efforts.

Study Area

The White Salmon River watershed originates in the Gifford Pinchot National Forest in south central Washington along the south slope of Mt. Adams. It is located in Water Resource Inventory Area (WRIA) 29 and drains approximately 386 mi^2 of Skamania, Yakima, and Klickitat Counties. Its largest watercourse, White Salmon River, flows south for 45 miles before entering the Bonneville Reservoir at Underwood, Washington. The major tributaries to the White Salmon River include Trout Lake and Buck, Mill, Dry, Gilmer, and Rattlesnake Creeks.

Peak flows in the White Salmon River mainstem reflect snowmelt runoff, increasing from an average daily flow of 644 cfs during fall months to flows of 1,538 cfs in the spring (Haring, 2003).

Marine and continental-influenced air masses control the climatic patterns of the White Salmon watershed. The average precipitation ranges from 40-96 inches a year with 75% of it delivered in the form of rain or snow between October and March (NRCS, 2006). The wet, mild winters and the warm, dry summers make the White Salmon watershed agriculturally productive.

The major land uses within the watershed include forest (93%), agriculture (4%), and residential (3%) (Figure 1). The Gifford Pinchot National Forest makes up 78% of the forestlands within the watershed. Public and private timberlands make up the remainder (Ecology, 2010).

The majority of agricultural activity is located in the middle watershed. Agricultural enterprises include diaries, cow-calf operations, hay and pasture, herbs, fruit production, and irrigated agriculture (Haring, 2003). Agricultural practices within the watershed are supported by a complex network of irrigation ditches. The ditches use water from the White Salmon and its tributaries to supply water.

The majority of the rural residents in the White Salmon watershed live in the vicinity of Husum/BZ Corner, and Trout Lake. Other significant population centers are in the lower extent of the watershed and include the rural western outskirts of White Salmon and the east side of Underwood.

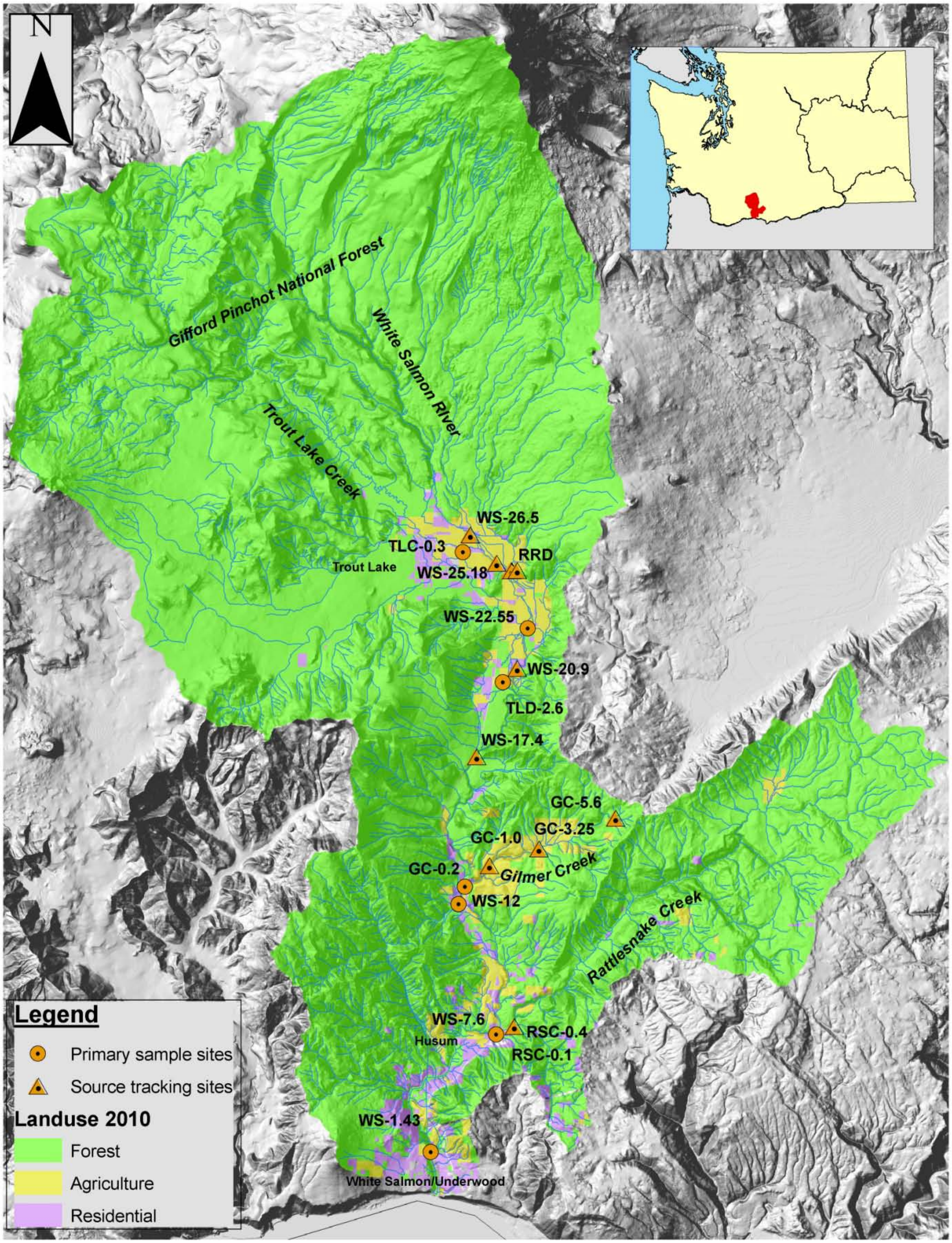

Figure 1. White Salmon River watershed, land uses, and sampling stations.

Past Studies

Because of the scheduled removal of Condit Dam in 2011, numerous environmental studies and recovery plans have been published about the White Salmon River watershed. The removal of the dam will open a significant amount of habitat to anadromous salmon and steelhead. This habitat has been inaccessible since 1913 when Condit Dam was erected.

Table 2 provides a list of publications applicable to this study. Most studies provide detailed physical descriptions of the watershed including land uses affecting water and habitat quality. Major findings from these publications were used to describe current land-use activities and create final conclusions in this report.

Table 2. Past studies and assessments of the White Salmon River watershed.

Year	Title	Purpose	Reference
2009	Recovery Plan White Salmon River	Endangered Species Act Recovery Plan / restore endangered species within watershed.	NOAA, 2009
2006	Middle Columbia-Hood Watershed-Rapid Watershed Assessment	Determine where conservation investments might best address local resource concerns.	NRCS, 2006
2006	Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts	Monitoring of baseline chemical and habitat conditions to guide habitat and fish restoration work.	Allen et al., 2006
2005	Condit Dam Removal: SEPA Supplemental Environmental Impact Statement	Environmental Impact Statement outlining effects to watershed from removal of Condit Dam.	Ecology, 2005
2003	Addendum to Wind/White Salmon Water Resource Inventory Area 29, Salmonid Habitat Limiting Factors Analysis	Identify factors limiting salmon recovery.	Haring, 2003
2000	White Salmon River Sub-basin Summary	Fish and Wildlife Resource Evaluation of the White Salmon River.	Rawding, 2000

SEPA: State Environmental Policy Act.

Conservation Practices

Underwood Conservation District has been the primary group responsible for assisting landowners with implementing best management practices (BMPs) in Skamania and western Klickitat Counties. They have been particularly active in the White Salmon River watershed in working with local citizens to implement practices which enhance and protect water quality.

Some of these projects include, but are not limited to: streambank restoration and protection projects, habitat enhancement for fisheries, development of nutrient management plans for agricultural practices, and education and outreach.

Some specific projects that relate to mitigating FC pollution on 303(d) listed segments are listed in Table 3 and presented in Figure 2.

Table 3. Best management practices implemented by Underwood Conservation District and landowners in the White Salmon River watershed, 1998-2009.

Stream	Medium	Action
White Salmon River	Nutrient and pathogens	Nutrient Management Plan for Mountain Meadows Dairy
		Nutrient Management Plan for Whitewater Holsteins Dairy
	Habitat	Streambank restoration to protect manure lagoon
Trout Lake Creek	Nutrients and pathogens	Nutrient Management Plan for Mountain Laurel Jerseys Dairy
	Habitat	Streambank restoration

Detailed descriptions of specific projects and available services can be found on the Underwood Conservation District's website: http://w3.gorge.net/ucd/home.htm

Other groups within the White Salmon River watershed that provide assistance to rural landowners include the Washington State Conservation Commission (www.scc.wa.gov/), Washington State Department of Ecology, Natural Resource Conservation Service (www.wa.nrcs.usda.gov/), and Friends of the White Salmon River (http://friendsofthewhitesalmon.org/).

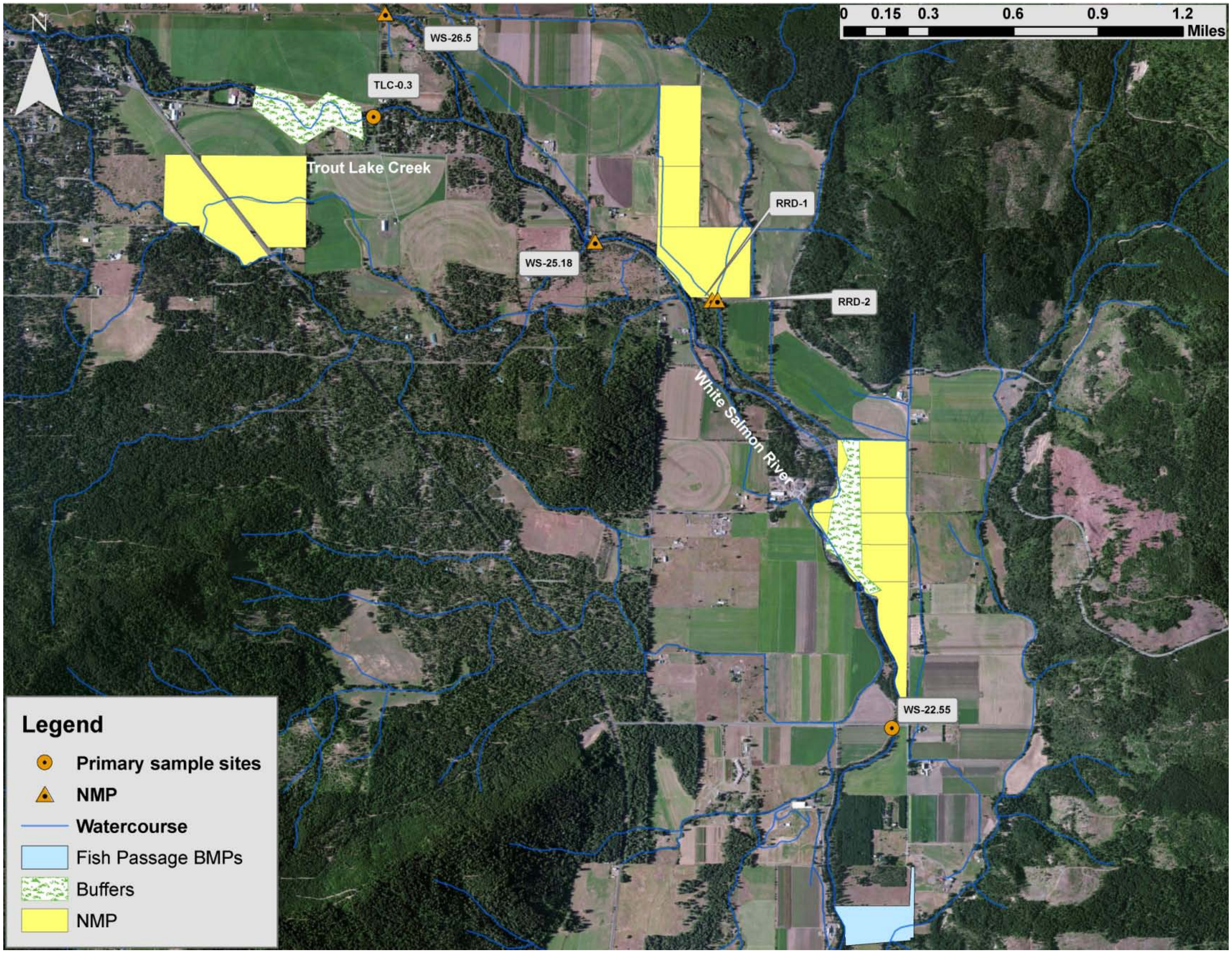

Figure 2. Approximate locations and type of best management practices implemented in the White Salmon River watershed. *NMP: Nutrient Management Plan.*

Goals and Objectives

The primary goals of this 2009-10 study are to:

1. Evaluate whether the current Section 303(d) FC listings for the White Salmon River and selected tributaries are still warranted.
2. Recommend if a Total Maximum Daily Load (TMDL) improvement report should be developed.

The secondary goal of this attainment monitoring study was to collect additional data which will be used to recommend corrective actions, if needed, within the watershed that promote attainment of the water quality standards.

The project goals were met through completing the following objectives:

- Collect, analyze, and interpret data to determine if Washington State water quality standards for FC are being met.
- Where necessary, collect credible water quality data that will be used to identify sources of FC.
- Provide support to Ecology's nonpoint source pollution staff in identifying and remediating sources of FC.

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Methods

The Quality Assurance Project Plan for this study describes procedures used to collect and analyze FC samples (Collyard and Von Prause, 2009). Sampling locations are shown in Figure 1 and described in Table 4.

Ecology sampled seven locations in the White Salmon River watershed for FC twice monthly from October 2009 through September 2010 (Table 1). Sampling locations were selected based on historic sampling stations and segments currently listed as impaired for FC (Ecology, 2008).

Ecology added more monitoring stations during the study when necessary to investigate possible sources of FC or to determine the extent of pollution (Table 4). These additional source tracking stations were chosen by bracketing samples around land uses upstream of initial sampling locations when elevated FC concentrations were consistently observed.

Bacteria grab samples were collected from the stream thalweg when possible. Samples collected from bridges were collected from the upstream side using a rope and weighted containers. Samples were put directly into sterile, pre-cleaned containers and transferred to a cooler with ice.

Ecology's Manchester Environmental Laboratory analyzed all samples using the membrane filtration (MF) method (MEL, 2008). Laboratory analyses for FC were performed in accordance with Manchester Laboratory protocols (MEL, 2008). Results of the quality assurance evaluation are present in Appendix D.

Table 4. Location descriptions of White Salmon River watershed primary and source tracking FC monitoring stations, 2009-10.

Station ID[1]	Type[2]	Description	Latitude	Longitude
29-WS-1.43	P	White Salmon River at RM 1.43 below dam	45.7488	-121.5222
29-WS-7.6	ST	White Salmon River at RM 7.6 (Main Street Bridge)	45.4856	-121.4856
29-WS-12	P	White Salmon River at RM 12 near boat launch	45.8506	-121.5044
29-WA-17.4	ST	White Salmon River at RM 17.4 downstream of Winegartner Rd	45.9091	-121.5022
29-WS-20.9	ST	White Salmon River at RM 20.9 (Strong Rd Bridge)	45.9455	-121.4791
29-WS-22.55	P	White Salmon River at RM 22.5 (Sunnyside Rd Bridge)	45.9641	-121.4693
29-WS-25.18	ST	White Salmon River at River Rd Bridge	45.9886	-121.4216
29-RRD-1	ST	White Salmon River irrigation ditch 1 at River Rd	45.9834	-121.4834
29-RRD-2	ST	White Salmon River irrigation ditch 2 at River Rd	45.9858	-121.4830
29-WS-26.5	ST	White Salmon River at N. Sunnyside Rd Bridge	46.0001	-121.507
29-RSC-0.1	P	Rattlesnake Creek at RM 0.1 near mouth (Hwy Bridge)	45.7971	-121.4850
29-RSC-0.4	ST	Rattlesnake Creek at RM 0.4 near Indian Creek Rd	45.79864	-121.4781
29-GC-0.2	P	Gilmer Creek at RM 0.2 near mouth	45.8577	-121.5044
29-GC-1.0	ST	Gilmer Creek at RM 1.0 off BZ Hwy	45.8644	-121.4940
29-GC-3.25	ST	Gilmer Creek at RM 3.25 off Oak Ridge Rd culvert	45.8716	-121.4649
29-GC-5.6	ST	Gilmer Creek at RM 5.6 off BZ Hwy	45.8845	-121.4201
29-TLD-2.6	P	Trout Lake Ditch at Sunnyside Rd culvert	45.9379	-121.4844
29-TLC-030	P	Trout Lake Creek Station at RM 0.30 (Old Creamery Bridge)	45.9951	-121.5080

[1] WRIA-waterbody initials-river mile.
[2] P: Primary sample station; ST: Source tracking sample station.

Data Analysis

Studies

All data used in this review were obtained from Ecology's Environmental Information Management (EIM) system (www.ecy.wa.gov/eim/). A list of studies and data used for the analysis are presented in Table 5.

Table 5. White Salmon River watershed studies in EIM used in the 2009-10 data analysis.

Study Name	User Study ID
Statewide River and Stream Ambient Monitoring - Pre-1980	AMS001B
Statewide River and Stream Ambient Monitoring -1980-1988	AMS001C
Statewide River and Stream Ambient Monitoring - WY 1989-WY 1999	AMS001D
Statewide River and Stream Ambient Monitoring - WY 2000-WY 2009	AMS001E
White Salmon River Watershed Enhancement Project - 1994-1997	C9500131
White Salmon River FC Attainment Monitoring - 2009-2010	SCOL0002

WY: Water year.

Attainment of Water Quality Standards

Ecology used data collected in 2009-10 to determine if 303(d) listed waters within the White Salmon watershed are attaining water quality standards for FC. Only the most recent 12 months of FC data were used. FC geometric means were calculated by back-transforming the mean of log-transformed concentration values. FC 90th percentiles were calculated as the 90th percentile of a log-normal distribution, where the mean and standard deviation are estimated from the log-transformed data. All calculations were performed in excel 2007.

Ecology determined attainment of water quality standards using the following Washington State water quality standard for FC:

> "Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200/colonies mL" [WAC 173-201A-200(2)(b)].

Trend Monitoring

Ecology used the Seasonal Kendall Trend test (Helsel and Hirsch, 2002) for detecting long-term trends in FC data. The test accounts for seasonal variations in data over time and for outliers in data sets. Both of these conditions are common in water quality data sets and can significantly influence regression results. Furthermore, data are not required to be normally distributed.

The Seasonal Kendall test identifies whether or not a statistically significant trend exists in a time-series dataset. The absolute values of Z statistics are compared to a table of critical values to determine if there is a trend at the selected level of significance (α=0.1). A positive value of Z indicates an upward trend, while a negative Z value indicates a downward trend. With α=0.1, Z scores greater than 1.64 indicate a significant increasing trend, while Z scores less than -1.64 indicate a significant decreasing trend. All statistical tests were performed using Systat® version 13.0.

Fecal Coliform Target Reductions

The Statistical Rollback Method (Ott, 1995) was used to establish FC reduction targets for stream segments not meeting water quality standards. Ecology has applied this method in other FC studies (Ahmed and Hempleman, 2006, Swanson, 2006). The FC targets are only in place to assist water quality managers in assessing the progress toward compliance with the FC water quality criteria. Compliance is measured as meeting water quality criteria.

Results and Discussion

During the 2009-10 monitoring study, all primary sampling stations meet the yearly geometric mean water quality standard for FC (Figure 3). The yearly 90th percentile water quality standards were met at all stations with the exception of GC-0.2 and WS-22.55. Although Figure 3 suggests most stations are meeting yearly standards for FC, exceedances may be masked by averaging data over time. Because of this, water quality standards require, if sufficient data exist, the data to be averaged by season (Ecology, 2008).

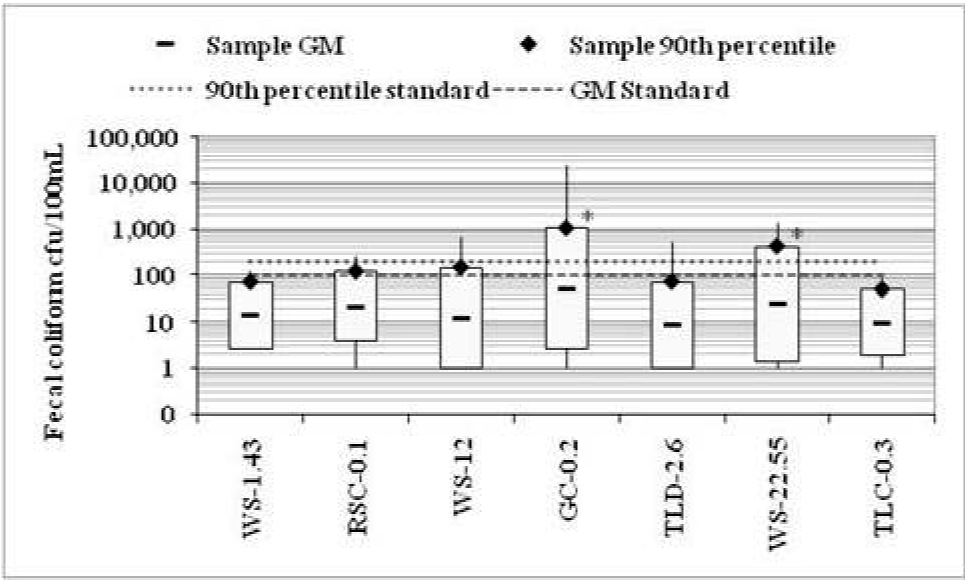


Figure 3. Yearly FC geometric means and 90th percentiles, 2009-10.
Red indicates value is above water quality criteria.

Critical Season

When sufficient data exist, Washington State water quality standards require FC data be divided into seasons so that high FC values are not masked over time (Ecology, 2008). Seasonality is typically determined by reviewing plots of FC concentrations at all sites over time or is based on local flow or precipitation (Ahmed and Hempleman, 2006; Swanson, 2006).

Table 6 presents results of all FC sampling events that were above the water quality standard of 100 cfu/100 mL. All stations, with the exception of Trout Lake Creek (TLC-0.3), had one or more sample that was above the water quality standard. Although patterns of FC are present, they are not consistent across time or sampling stations, and they most likely represent station-specific, land-use activities.

Table 6. FC results above 100 cfu/100 mL from individual sampling events, 2009-10.

Station ID	Sample Date																						
	10/13/09	10/26/09	11/4/09	11/18/09	12/7/09	12/21/09	1/5/10	1/19/10	2/2/10	2/18/10	3/1/10	3/29/10	4/12/10	4/26/10	5/10/10	5/24/10	6/7/10	7/6/10	7/20/10	8/2/10	8/31/10	9/14/10	9/27/10
WS-1.43				░		░																	
RSC-0.1	░	░																					░
WS-12				░		░	░					░											
GC-0.2						█	█				█	█		░			░						
TLD-2.6																					█		
WS-22.5		░		░		░	░					░							█	█	█		
TLC-0.3																							

░ **: FC 100-500 cfu/100 mL**

█ **: FC >500 cfu/100 mL**

Monthly geometric mean (GM) and 90th percentiles were examined to determine seasonality on stations where enough data were available (>5 samples in a month). No seasonal patterns were easily observed at sampling stations WS-1.43, RSC-0.1, and GC-0.2 (data not presented).

Since seasonality of FC data could not be easily established, local precipitation patterns were used to set critical season boundaries. The critical conditions for nonpoint sources generally occur during high-rainfall periods, particularly during the start of a rainfall event when bacteria are “flushed” from surface soils into the streams (Ahmed and Rountry, 2004).

Average monthly precipitation data (1948-2005) from the Mt. Adams Ranger Station near the town of Trout Lake were used to establish the critical season for this study (Appendix E). Months having 10% or greater of the average annual precipitation (November - March) were used to establish the wet season, while the dry season made up the remaining months (April - October).

Water Quality Standards

Wet-season and dry-season GM and 90th percentiles for sampling stations are presented in Figure 4. Partitioning FC data into wet and dry seasons resulted in the exceedance (not meeting) of the 90th percentile standard at RSC-0.1 during the dry season. Also, the GM and 90th percentile were not met during the wet season at GC-0.2 while no exceedances of either standard occurred during the dry season. Both wet and dry season FC 90th percentiles did not meet standards at WS-22.5 and suggest several sources or activities may be contributing to the yearly FC levels. No other exceedances of the water quality standard were observed (Figure 4). Differences between wet and dry season were mixed among stations and likely reflect differences in FC sources or source delivery to surface waters.

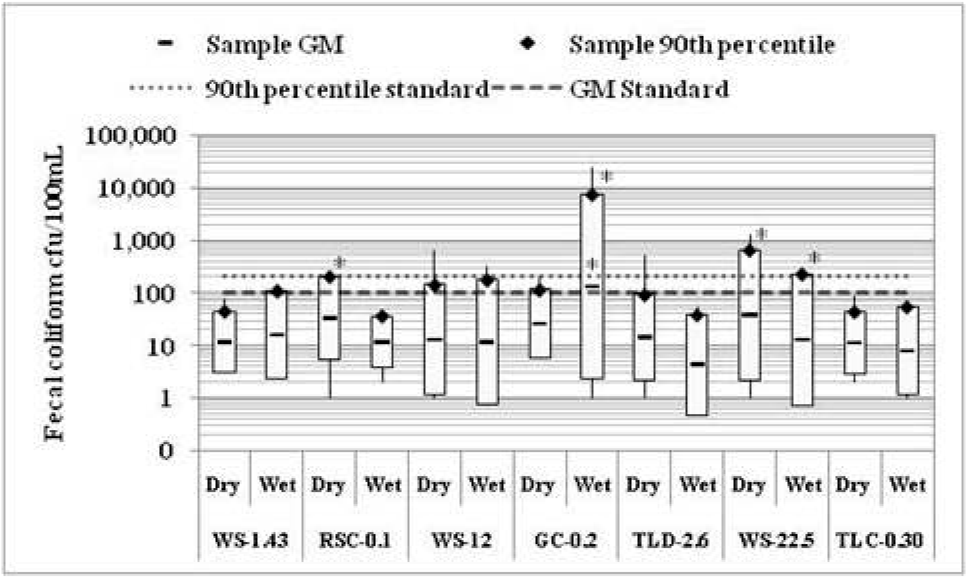


Figure 4. Critical season FC geometric means and 90th percentiles, 2009-10.
Red indicates value is not meeting water quality criteria.

Supplementary Results

Precipitation

To help relate sources of FC pollution to FC results, average daily precipitation for the days FC sampling occurred was compared with FC results (Figure 5). Average daily precipitation was calculated by averaging the daily precipitation on the day of, and two days prior to, the sampling events. This comparison was made with stations that had not met one or more of the critical season water quality standards.

Overall, FC concentrations increased with increasing precipitation (Figure 5). There were, however, several high FC events occurring during the dry season that were not related to precipitation. Increases in FC levels in Rattlesnake Creek at station RSC-0.1, Gilmer Creek at GC-0.2, and the White Salmon at WS-22.5 from June to September 2010 were not related to precipitation events.

Based on the information provided above, it is likely there are several land-use activities which are contributing to FC concentrations. Wet-season FC sources are likely related to runoff events occurring where manure collects or is stored. Dry-season FC sources are likely related to direct FC discharges into surface waters. These could include wildlife or livestock access to surface water, illicit discharges, breaches in manure storage ponds, and irrigation returns.

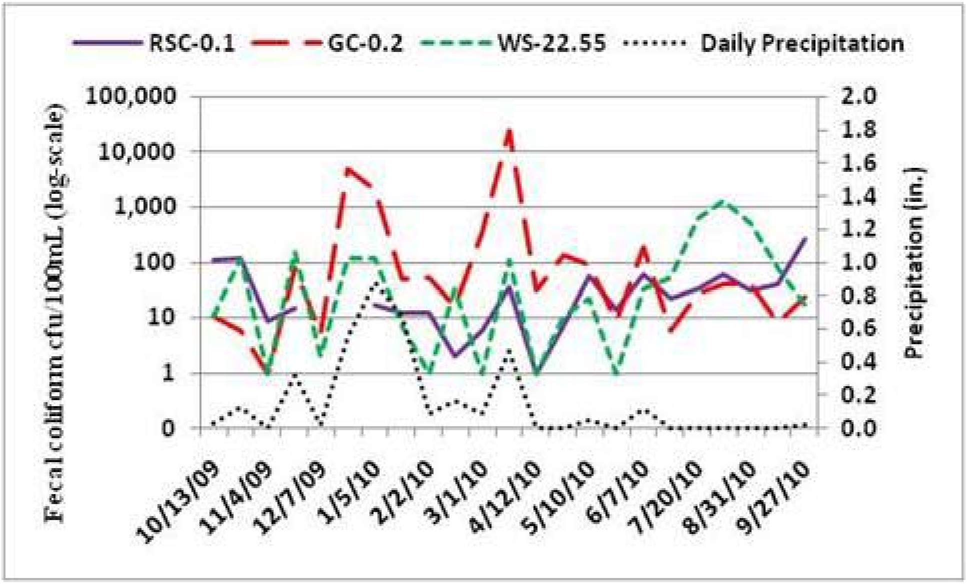


Figure 5. FC concentrations at selected sampling stations plotted against daily precipitation collected near the town of Trout Lake.

Trends

Trends analyses were conducted on FC data collected from WS-1.43, RSC-0.1, and GC-0.2. The remaining stations did not have sufficient data sets to perform the analyses.

Results from the Seasonal Kendall Trend analysis indicate a significant increase in FC levels at WS-1.42 (Table 7). The magnitude of the increase was small, as indicated by the slope of the increase (0.006). Although RSC-0.1 and GC-0.2 indicate FC levels are decreasing based on slope and negative Z-score, the trends were not significant. Supplemental results for the analysis are presented in Appendix F.

Table 7. Results from Seasonal Kendall Trend analysis of FC data.

Station	Slope	Z-score[1]	Trend	Significant?	n	Starting Year
WS-1.42	0.006	2.54	Up	Yes	111	1972
RSC-0.1	-0.43	-1.153	Down	No	92	1992
GC-0.2	-2.97	-1.032	Down	No	74	1992

[1]Z scores greater than 1.64 indicate a significant increasing trend, while Z scores less than -1.64 indicate a significant decreasing trend.

Land Use and Potential Sources of Bacteria

Three areas of concern were identified during this study: Rattlesnake Creek at RSC-0.1, Gilmer Creek at GC-0.2, and the White Salmon River at WS-22.55. Each stream segment exhibited unique patterns of FC over time which are likely related to contributing land-use activities.

Figure 1 provides an overview of land uses within the White Salmon River watershed. Several types of land uses and human activities that have the potential to contribute FC to surface waters were identified during this study:

Agriculture

Potential agricultural sources of FC include:

- Three dairies are located in the middle White Salmon River watershed. Dairies can produce and store large amounts of liquid and solid manure that must be managed appropriately
- There are several livestock operations within the watershed. Unrestricted access of animals to streams and ditches leads to manure runoff and direct discharges of manure to streams. Animals can also impact streambanks by trampling and grazing streamside vegetation, thus reducing the filtering and infiltration capacity of the riparian area.
- Pastures used for grazing or hay production within the watershed apply manure to the fields for fertilizer. Impacts to surface waters can occur when manure is applied above agronomic rates, during inappropriate times (e.g., weather, prior to irrigation), too close to streams and ditches, and on fields lacking vegetative BMPs or adequate manure setbacks.

Onsite Sewage systems

All homes and businesses in the surrounding areas of concern use onsite septic systems to treat human waste. The largest concentration of onsite systems occurs in the communities of Husum/BZ corner, Trout Lake, and near the mouth of Rattlesnake Creek at the town of Husum.

Wildlife

Migratory birds, small mammals, deer, and elk are potential sources of waste in the White Salmon River watershed. Specifically, a large number of elk inhabit the Gilmer Creek sub-watershed and often congregate in pasture lands used by cattle. While Ecology acknowledges wildlife as a potential source of FC, it is, in most cases, considered a natural contribution that cannot be controlled

Recreation

Much of the recreational activity within the White Salmon River watershed is concentrated in the National Forest and the mainstem of the White Salmon River. Any of these activities may be a source of FC pollution if the waste of recreating humans and their pets is not disposed of properly and thus reaches surface waters.

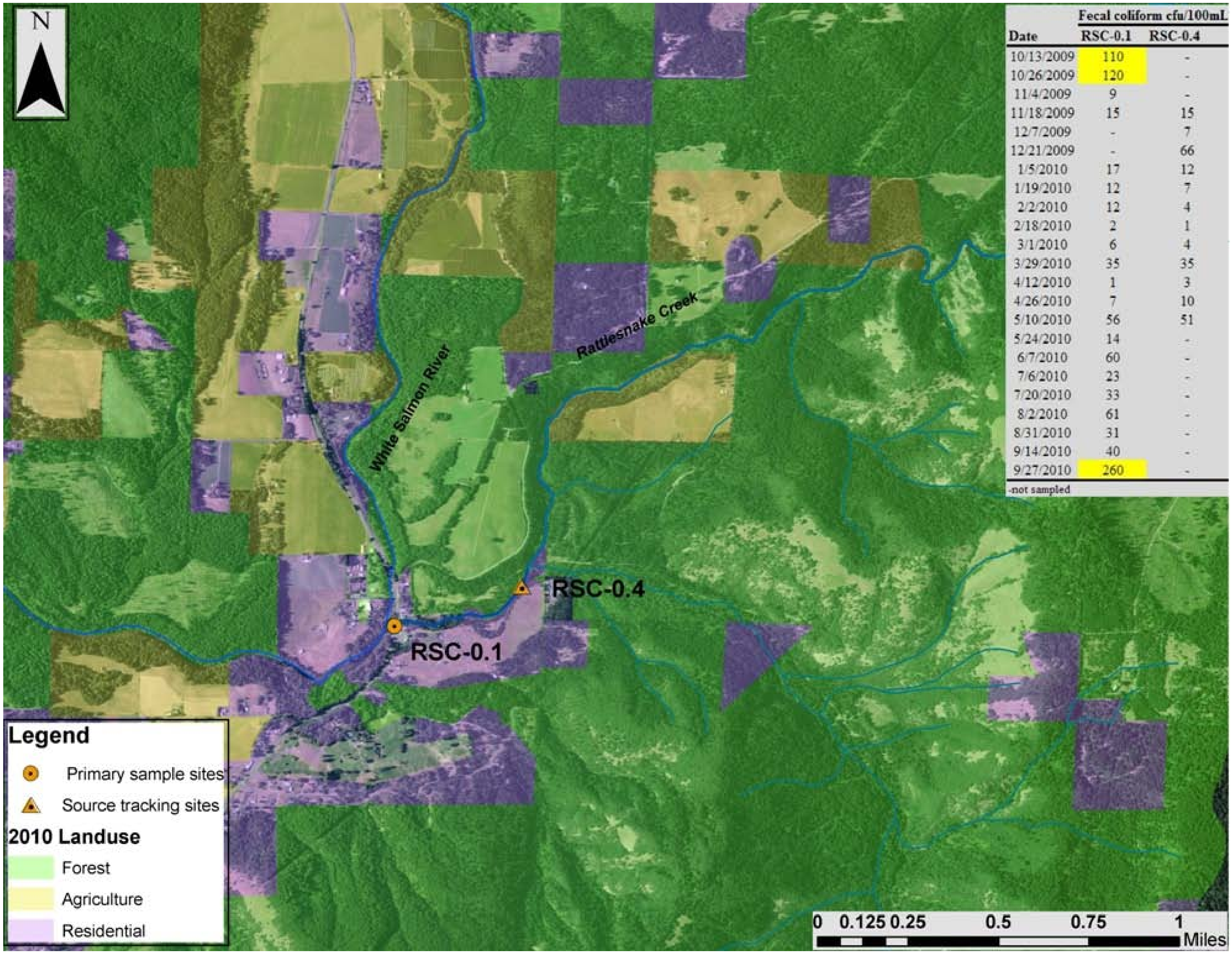
Source Tracking Results

During this 2009-10 study, FC samples were taken upstream of the primary sampling stations when frequent or consecutive water quality exceedances were observed. Land use, tributary location, and stream accesses were taken into consideration when bracketing source tracking sample locations. When an area or land use was identified as potentially contributing to FC pollution, a data report was generated and passed to Ecology nonpoint pollution staff for remediation. During this study, three source tracking events occurred upstream of the primary sampling stations: RSC-0.1, GC-0.2, and WS-22.55.

Rattlesnake Creek (RSC-0.1)

The first two FC samples collected on Rattlesnake Creek (RSC-0.1) were above (did not meet) the water quality standard of 100 cfu/100 mL (Figure 6). For purposes of identifying sources, an additional station was added on 11/18/09, 0.4 miles upstream of RSC-0.1. When no additional exceedances were observed after several weeks at either station, sampling was discontinued at RSC-0.4 (Figure 6). A third FC sample collected on 9/27/10 was above the FC water quality standard; however, this was the final sampling event for the study.

Land uses within the Rattlesnake Creek sub-watershed include forest (about 96% of area), residential (3%), and agriculture (1%) (Figure 2). The majority of residential activity is located in the lower river segment just above RSC-0.1 (Figure 6). Agricultural activities in this sub-watershed appear to be limited to hay and pasture lands that have little connectivity to surface water. Onsite sewage systems just above RSC-0.1 are one of the suspected sources of FC pollution, although other possible sources cannot be ruled out completely



Date	Fecal coliform cfu/100mL RSC-0.1	Fecal coliform cfu/100mL RSC-0.4
10/13/2009	110	-
10/26/2009	120	-
11/4/2009	9	-
11/18/2009	15	15
12/7/2009	-	7
12/21/2009	-	66
1/5/2010	17	12
1/19/2010	12	7
2/2/2010	12	4
2/18/2010	2	1
3/1/2010	6	4
3/29/2010	35	35
4/12/2010	1	3
4/26/2010	7	10
5/10/2010	56	51
5/24/2010	14	-
6/7/2010	60	-
7/6/2010	23	-
7/20/2010	33	-
8/2/2010	61	-
8/31/2010	31	-
9/14/2010	40	-
9/27/2010	260	-

-not sampled

Figure 6. Rattlesnake Creek sub-watershed sampling stations and land use.

Gilmer Creek (GC-0.2)

FC concentrations above water quality standards in Gilmer Creek GC-0.2 were first observed on 12/27/09. High FC levels continued periodically through the wet season and appeared to be correlated with precipitation events (see Figure 5).

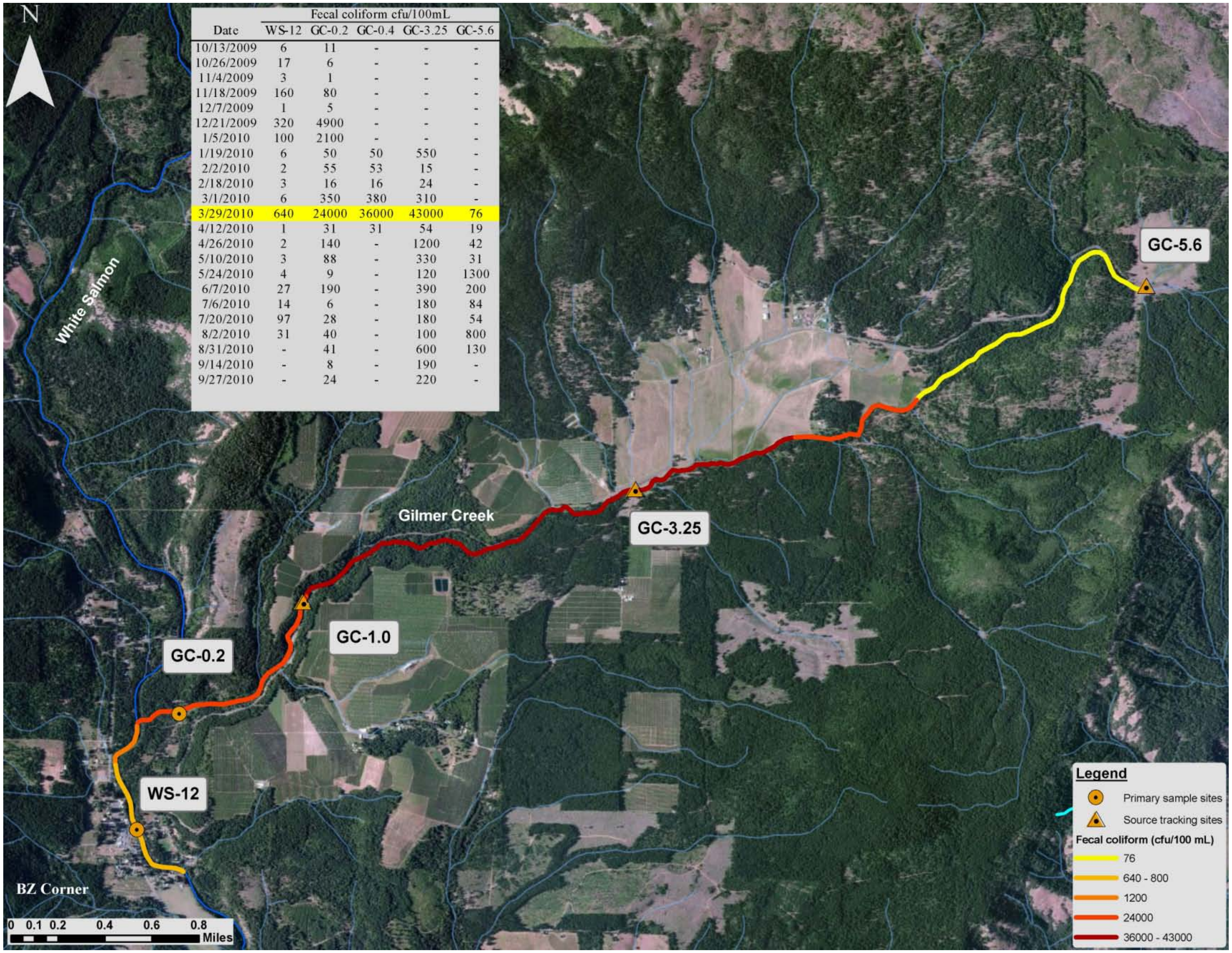
Land-use activities within the Gilmer Creek sub-watershed include orchards in the lower watershed and a livestock operation in the upper watershed. Seasonal grazing of livestock also occurs in the forested areas of Gilmer Creek during the dry season. Animals have unrestricted access to Gilmer Creek at multiple locations during these times.

In addition to the anthropogenic sources of fecal bacteria mentioned above, the Gilmer Creek sub-watershed is home to approximately 100 resident elk. Although elk are unlikely responsible for the high levels of FC observed on Gilmer Creek, they should be considered a potential source.

Three additional sampling stations above GC-0.2 aided in identifying potential sources of high FC levels on Gilmer Creek. Where possible, station locations bracketed differing land uses when assess to Gilmer Creek was possible.

Figure 7 presents a sampling event that occurred on 3/29/10 on Gilmer Creek in which high FC levels were observed between RM 0.1 and 3.25. FC concentrations from Gilmer Creek appeared to be high enough to increase FC levels on the White Salmon River (WS-12), approximately 0.65 miles below the confluence with Gilmer Creek. The source of FC was determined to be originating from a livestock operation between RM 3.25 and 5.6.

Following this event, Ecology nonpoint pollution staff worked with the Underwood Conservation District and the landowner of the livestock operation to identify sources. Recognizing the need to address surface water impacts from livestock operations, the landowner began implementing BMPs to remediate FC sources in the spring of 2010. This was done with the assistance from the Conservation District as well as Ecology grants. Details of this effort are presented in Appendix I.



Date	Fecal coliform cfu/100mL				
	WS-12	GC-0.2	GC-0.4	GC-3.25	GC-5.6
10/13/2009	6	11	-	-	-
10/26/2009	17	6	-	-	-
11/4/2009	3	1	-	-	-
11/18/2009	160	80	-	-	-
12/7/2009	1	5	-	-	-
12/21/2009	320	4900	-	-	-
1/5/2010	100	2100	-	-	-
1/19/2010	6	50	50	550	-
2/2/2010	2	55	53	15	-
2/18/2010	3	16	16	24	-
3/1/2010	6	350	380	310	-
3/29/2010	640	24000	36000	43000	76
4/12/2010	1	31	31	54	19
4/26/2010	2	140	-	1200	42
5/10/2010	3	88	-	330	31
5/24/2010	4	9	-	120	1300
6/7/2010	27	190	-	390	200
7/6/2010	14	6	-	180	84
7/20/2010	97	28	-	180	54
8/2/2010	31	40	-	100	800
8/31/2010	-	41	-	600	130
9/14/2010	-	8	-	190	-
9/27/2010	-	24	-	220	-

Figure 7. 2009 orthophoto of Gilmer Creek, FC sampling stations, and results from the 3/19/10 sampling event.
FC results between sampling stations are an estimate based on results of upstream and downstream sampling stations.

White Salmon River (WS-22.55)

FC concentrations on the White Salmon River at RM 22.55 (station WS-22.55) were above the water quality standard of 100 cfu/100 mL eight times during this study. FC followed precipitation patterns closely between 10/13/09 and 4/12/10 (Figure 8). During this period, FC samples above the water quality standard ranged between 120 and 160 cfu/100 mL. Overall, FC levels ranged from 1 - 160 cfu/100 mL during this period.

Beginning on 7/20/10, FC levels at WS-22.55 began increasing steadily before peaking at 1300 cfu/100 mL on 8/2/10. After the peak, FC levels at this station gradually decreased to below water quality standards after four weeks (Figure 8).

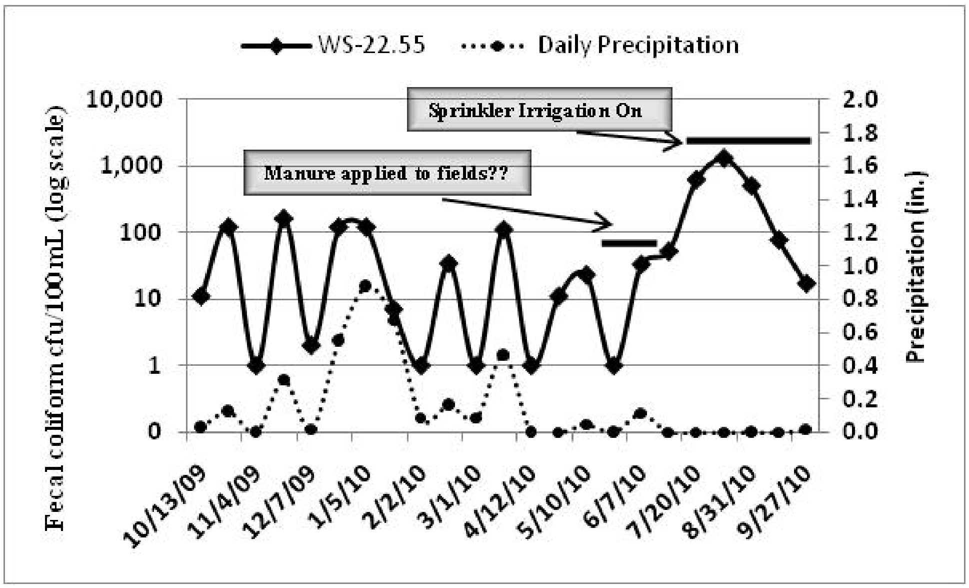


Figure 8. Instantaneous FC results from the White Salmon River at river mile 22.55 (WS-22.55) and total daily precipitation.

On 8/31/10, four additional sampling stations were added upstream of WS-22.55 (Figure 9). Two of these stations were located on the White Salmon mainstem at RMs 25.18 and 26.5. The other stations were located on two irrigation return ditches (RR-1, RR-2) which cross River Road, approximately three miles upstream from WS-22.55. FC samples were collected from these source tracking stations through the remainder of the study.

Samples collected from upstream sampling stations on the same date indicate a 25% decline in FC from upstream to downstream. This indicates sources of FC are between WS-22.5 and WS-25.18 on the date of this sampling event.

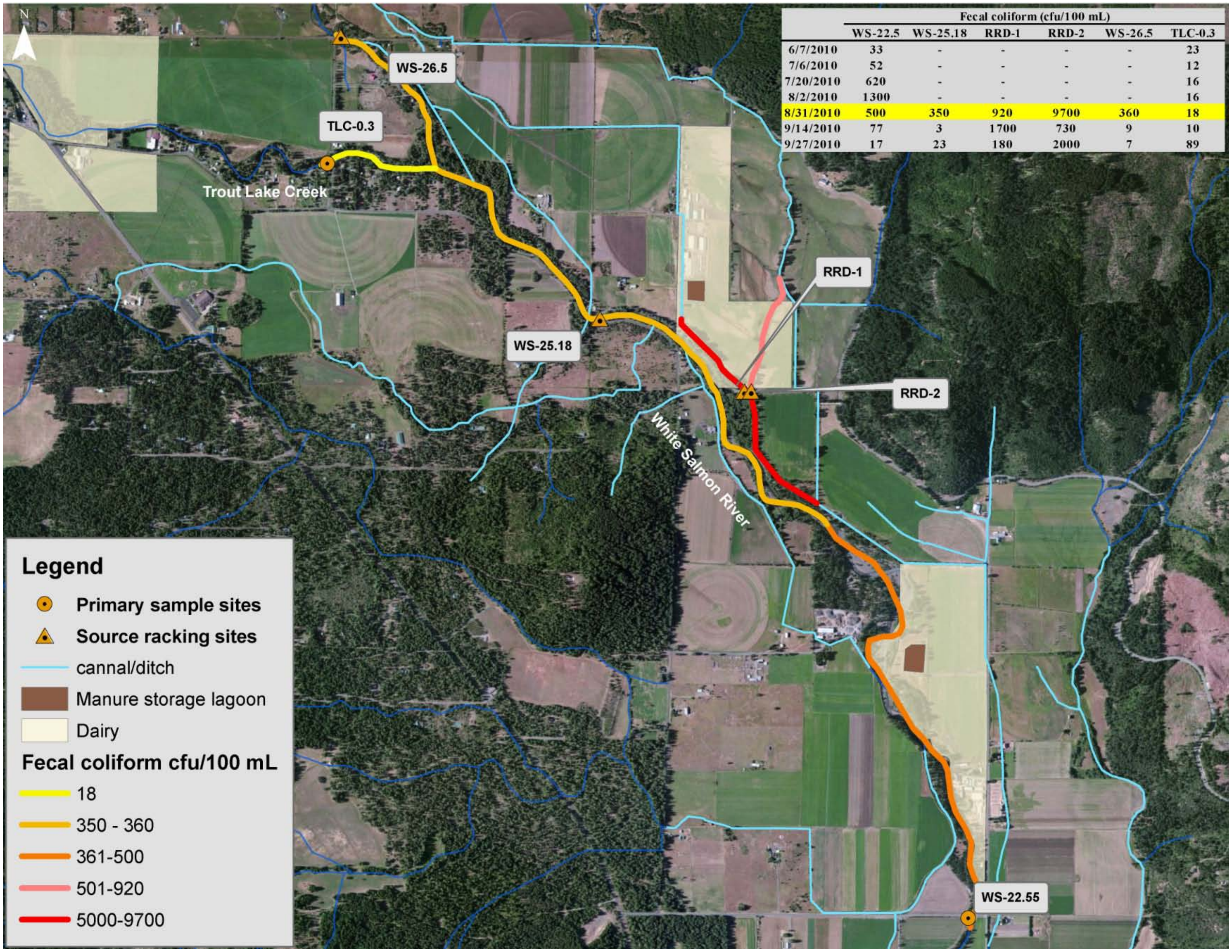
FC samples collected from irrigation ditches crossing River Road (RR-1 and RR-2) show high FC. Initially, water from RR-1 and RR-2 were believed to enter the White Salmon River above WS-22.5; however, the national hydrography dataset (NHD) used in this analysis suggests they do not (Figure 9). Although the NHD includes irrigation pipelines or ditches, the coverages are often incomplete because of changing or unknown irrigation practices. An on-the-ground inspection may be necessary to confirm this. Regardless, results from this sampling event demonstrate that irrigation ditches provide conveyance of FC pollution to surface waters. The likely sources of FC pollution to ditches include activities such as livestock grazing and manure spreading. Manure may enter the ditches either by direct deposit or through runoff from precipitation or irrigation sprinklers.

The increase in FC between these sampling periods appears to correlate with two activities observed by Ecology field staff during this time period (Figure 8):

1. Manure application had occurred just prior to FC increases.
2. Sprinkler systems used to irrigate pasture lands above WS-22.55 had been started.

Although this information is anecdotal, it may provide local landowners a starting point for implementing pollution-prevention actions. Additional investigation is needed.

See Appendix G for an inspection report from the Washington State Conservation Commission of the dairy manure lagoon just above WS-22.55.



	Fecal coliform (cfu/100 mL)					
	WS-22.5	WS-25.18	RRD-1	RRD-2	WS-26.5	TLC-0.3
6/7/2010	33	-	-	-	-	23
7/6/2010	52	-	-	-	-	12
7/20/2010	620	-	-	-	-	16
8/2/2010	1300	-	-	-	-	16
8/31/2010	500	350	920	9700	360	18
9/14/2010	77	3	1700	730	9	10
9/27/2010	17	23	180	2000	7	89

Figure 9. 2009 orthophoto of the White Salmon River, FC sampling stations, and monitoring results from the 8/31/10 sampling event. *FC results between sampling stations are estimates based on FC results from sampling stations.*

Future Monitoring

Effectiveness Monitoring

Ecology routinely performs follow-up monitoring studies after sufficient implementation of BMPs have occurred to support water quality improvement. This effectiveness monitoring evaluation determines if the interim targets and water quality standards have been met. This is an essential component of any restoration or implementation activity since it measures to what extent the work performed or recommended has attained the watershed restoration objectives or goals.

An effectiveness evaluation will address three questions with respect to restoration or implementation activity:

1. Is the restoration or implementation work achieving the desired objectives or goals (significant improvement)?
2. How can restoration or implementation techniques be improved?
3. Is the improvement sustainable?

An effectiveness monitoring study should be conducted in the White Salmon watershed after sufficient restoration or implementation of BMPs has occurred. The decision of when effectiveness monitoring should occur will be made by Ecology with stakeholder input.

FC Compliance Stations and Targets

Although compliance is measured as meeting water quality standards, FC targets are routinely established to assist water quality mangers in assessing the progress toward compliance with water quality criteria. Table 8 provides a list of sampling stations that should be used as part of an effectiveness monitoring evaluation. FC target reductions are recommended and calculated based on critical seasons and the 2009-10 sample results. The limiting basis for the reduction was the higher percent reduction between the GM and the 90th percentile.

Table 8. Recommended compliance stations and FC targets for future effectiveness monitoring studies.

Station	Critical Season	GM	90th Percentile	Limiting Basis for Reduction	Target Reduction (%)
RSC-0.1	Dry	33	204	90th percentile	2.0
GC-0.2	Wet	131	7506	90th percentile	97.3
GC-3.25	Dry	166	944	90th percentile	78.8
GC-3.25	Wet	317	4312	90th percentile	95.3
WS-22.55	Dry	38	649	90th percentile	68.2
WS-22.55	Wet	13	227	90th percentile	12.0

Conclusions

Results of this 2009-2010 White Salmon FC study support the following conclusions:

- Four of the seven 303(d) listed stream segments met both parts of the water quality standards for FC. However, Rattlesnake Creek at river mile (RM) 0.1, Gilmer Creek at RM 0.1, and White Salmon River at RM 22.55 continue to not fully meet water quality standards for FC.
- Trend analysis indicated FC levels have decreased on Rattlesnake and Gilmer Creeks; however, the trends were not significant. A statistically significant increase was detected on the White Salmon River at RM 1.43; however, water quality standards were not violated.
- Sources of FC pollution on Rattlesnake Creek are suspected to be from residential properties just above station RSC-0.1. Additional sampling or onsite investigations may be needed to further determine the sources.
- Sources of FC pollution on Gilmer Creek were isolated to a livestock operation in the upper watershed. Ecology has worked with the Underwood Conservation District and the landowner to correct the problems.
- Sources of FC pollution on the White Salmon River between RM 22.55 and 25.18 are believed to be from several sources or land-use activities. Some of the possible sources include:
    - An operating dairy manure lagoon adjacent to the White Salmon River just above station WS-22.55.
    - Irrigation ditches running through livestock pastures between RM 22.55 and 25.18.
    - Manure and irrigation management practices occurring on pastures with irrigation ditches with direct connectivity to the White Salmon River between RM 22.55 and 25.18.
- Sources of FC between RM 22.55 and 25.18 may best be remediated through a review of existing land-use practices, onsite inspections, and by working with the local conservation district and landowners. At this time, no additional FC sampling is needed to address these issues.
- An effectiveness monitoring evaluation should be conducted at such time when Ecology nonpoint pollution (Water Quality) staff believes sufficient BMPs have been implemented. Preferably, this would occur after implementation has occurred at a watershed scale, rather than a sub-watershed scale, to save costs.
- Provided that local stakeholders continue to work cooperatively with Ecology water quality managers, the development of a TMDL improvement report for FC is not necessary.

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Appendices

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Appendix A: Water Quality Standards and Beneficial Uses for Fecal Coliform Bacteria

The Washington State water quality standards include designated beneficial uses, waterbody classifications, and numeric and narrative water quality criteria for surface waters of the state. This appendix provides Washington State water quality information and those standards applicable to the White Salmon River watershed.

The 303(d) listed segments within the White Salmon watershed have a designated beneficial use of *Primary Contact*. *Primary Contact* criteria are intended for waters where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin-diving, swimming, and waterskiing. *Primary Contact* use is designated to any waters where human exposure is likely to include exposure of the eyes, ears, nose, and throat [WAC 173-201A-200(2)(b)]. (Ecology, 2008) The applicable water quality standard is presented in Table A-1.

Table A-1. Washington State water quality standards for FC in the White Salmon River watershed.

Parameter	2006 Classification	2006 Criteria[1]
Fecal Coliform	Primary Contact Recreation	*"Must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200/colonies mL"*

[1] WAC 173-201A-200(2)(b) (Ecology, 2008).

Designated uses for individual rivers and streams are available in Table 602 of the water quality standards (www.ecy.wa.gov/programs/wq/swqs/desig_uses.html).

Water quality impairments are documented in Washington's Water Quality Assessment (WQA) Mapping Tool. See www.ecy.wa.gov/programs/wq/303d/index.html for the most recent WQA information.

Appendix B: Water Quality Assessment / Categories 1 to 5

The 303(d) list identifies polluted waters in Washington. The Water Quality Assessment is a list that tells a more complete story about the condition of Washington's surface waters. It is a state requirement to satisfy federal Clean Water Act requirements and to prioritize TMDL efforts.

The 303(d) list divides waterbodies into five categories

- Category 1 – Meets tested standards for clean water.
- Category 2 – Waters of concern.
- Category 3 – Lack of sufficient data.
- Category 4 – Polluted waters that do not require a TMDL because the problems are being solved in one of three ways:
  - 4a – Has an approved TMDL and it is being implemented.
  - 4b – Has a pollution control plan in place that should solve the problem.
  - 4c – Is impaired by a non-pollutant such as low water flow, dams, and culverts.
- Category 5 – Polluted waters that require a TMDL – the 303(d) list.

Applicable Ecology web links

Water Quality Assessment Categories
www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html

Ecology's policy on how waterbodies are placed in various categories
http://www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html

Appendix C: 2008 Water Quality Impairments

Table C-1. Water quality impairments within the White Salmon River watershed, 2008.

Waterbody Name	Category	Parameter	Listing Detail Link	Map Link
Bear Creek	4A	Temperature	23063	23063
Buck Creek	2	FC	21582	21582
Cascade Creek	2	Mercury	21649	21649
Cultus Creek	2	Temperature	23051	23051
Gilmer Creek	5	FC	16775	16775
	1	pH	11061	11061
Grand Meadows Creek	2	Temperature	23052	23052
Indian Creek	5	Temperature	5882	5882
Mosquito Creek	2	Temperature	23056	23056
Rattlesnake Creek	5	FC	5886	5886
	1	FC	16776	16776
	1	pH	11052	11052
	2	pH	21617	21617
	5	Temperature	5884	5884
	5	Temperature	5885	5885
Trout Lake Creek	2	FC	21590	21590
	2	pH	21629	21629
	5	Temperature	21610	21610
	2	Temperature	23058	23058
	2	Temperature	23059	23059
	2	Temperature	23060	23060
Trout Lake Ditch	5	FC	21588	21588
White Salmon River	5	FC	5889	5889
	1	FC	16777	16777
	2	FC	21580	21580
	5	FC	21587	21587
	1	FC	21589	21589
	4C	Instream Flow	6222	6222
	1	pH	11065	11065
	2	pH	21625	21625
	2	pH	51055	51055
	1	Temperature	21604	21604

Appendix D: Study Quality Assurance Evaluation

FC samples met the measurement quality objectives (MQOs) outlined in the Quality Assurance Project Plan (Collyard and Von Prause, 2009). Results for laboratory duplicates and field replicates are presented in Tables D-1 and D-2.

Laboratory duplicates

Analytical precision was determined for this study by calculating the relative percent difference (RPD) of duplicate laboratory FC samples. The MQO used by Manchester Environmental Laboratory for membrane-filtered bacteria duplicates is 40% RPD (MEL, 2006). The average RPD of all duplicate samples met the MQOs for laboratory duplicates. Results are presented in Table D-1.

Table D-1. Duplicate laboratory sample statistics.

Parameter	Average percent RPD	MQO precision standard (RPD)	Number of duplicates	Number of samples	Percent of samples duplicated
FC	37	40	21	221	10

Field replicates

Sampling precision was determined for this study by calculating the relative standard deviation (RSD) for replicate FC samples collected in the field. Ecology's MQO for analyzing precision in replicated FC samples requires that at least 50% of the samples be below a 20% RSD and that at least 90% of the samples be below a RSD of 50% (Mathieu, 2006).

Of the 45 replicate FC samples with a concentration above 20 cfu/100 mL, 92% of the replicate pairs were below 20% RSD and 100% were below 50% RSD (Table D-2). FC samples collected for this study met Ecology's MQO quality assurance precision criteria.

Table D-2. Replicate field sample statistics.

Parameter	Average percent RSD	MQO Precision	Meets MQO criteria	Number of replicates	Number of samples	Percent of samples replicated
FC	12.9	50% of replicates must be <20% RSD	Yes	45	221	20

Appendix E. Average Monthly Precipitation

Table E-1. Average monthly precipitation (1948-2005) at Mt. Adams Ranger Station near the town of Trout Lake and the critical season based on the percent of yearly precipitation.

Precipitation (inches)	Month	% of yearly Precipitation	Critical Season
8.16	Jan	18.7	Wet Season
5.13	Feb	11.7	
4.71	Mar	10.8	
2.35	Apr	5.4	Dry Season
1.55	May	3.5	
1.03	Jun	2.4	
0.34	Jul	0.8	
0.67	Aug	1.5	
1.38	Sep	3.2	
3.52	Oct	8.1	
7.04	Nov	16.1	Wet Season
7.82	Dec	17.9	

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Appendix F: Systat® Results of Seasonal Kendall Analysis

The Seasonal Kendall test (Helsel and Hirsch, 2002) accounts for seasonality by computing the Mann-Kendall test on each of the seasons separately, and then combining the results. So for monthly seasons, January data are compared only with January, February only with February, etc. No comparisons are made across season boundaries.

The Seasonal Kendall test calculates the probability of a relationship occurring between the variable (FC) and time (year). With α=0.1, Z scores greater than 1.64 indicate a significant increasing trend, while Z scores less than -1.64 indicate a significant decreasing trend.

A separate test (Sen) calculates the slope of the trend. A negative slope indicates a decreasing trend while a positive slope indicates an increasing trend. The greater or lesser the slope, the larger the rate of change over time.

Table F-1. Mann-Kendall Statistics for Seasons.

Season	WS-1.43				RSC-0.1				GC-0.2			
	n	Statistic	ASE	Tau	n	Statistic	ASE	Tau	n	Statistic	ASE	Tau
Nov	8	4	8.083	0.143	5	-2	4.082	-0.200	4	-2	2.944	-0.333
Dec	6	7	5.323	0.467	4	-4	2.944	-0.667	3	3	1.915	1.000
Jan	9	0	9.592	0.000	7	-7	6.658	-0.333	6	3	5.323	0.200
Mar	10	16	11.136	0.356	6	0	5.228	0.000	5	0	4.082	0.000
May	7	3	6.658	0.143	6	-5	5.323	-0.333	5	-8	4.082	-0.800
Jun	6	3	5.323	0.200	5	-1	3.958	-0.100	4	0	2.944	0.000
Aug	7	3	6.658	0.143	5	6	4.082	0.600	4	0	2.944	0.000
Oct	9	12	9.487	0.333	6	7	5.323	0.467	5	-4	4.082	-0.400
Feb	6	2	5.228	0.133	5	-3	3.606	-0.300	4	2	2.944	0.333
Apr	7	0	6.583	0.000	5	-5	3.958	-0.500	4	4	2.944	0.667
Jul	7	13	6.658	0.619	6	-1	5.323	-0.067	5	-6	4.082	-0.600
Sept	6	1	5.323	0.067	6	-5	5.323	-0.333	5	-6	4.082	-0.600

ASE (Asymptotic Standard Error): Standard deviation of each parameter.
Tau: A statistic used to measure the association between two measured quantities.

Table F-2. Results of Seasonal Kendall trend analysis.

Station	Statistic	ASE	Z	p-Value	Slope
WS-1.43	67.0	25.71	25.69	2.45	0.006
RSC-0.1	-20.0	16.472	-1.15	0.12	-0.426
GC-0.2	-14.0	12.596	-1.03	0.15	-2.967

ASE (Asymptotic Standard Error): Standard deviation of each parameter.

Appendix G: Site Visit by the Washington State Conservation Commission to the White Salmon Dairy Farm Manure Lagoon

STATE OF WASHINGTON
CONSERVATION COMMISSION
PO Box 47721 • Olympia, Washington 98504-7721 • (360) 407-6200 • FAX (360) 407-6215

August 03, 2011

To: Mark Clark, Stu Trefry, Ray Ledgerwood, Debbie Becker, Ron Shultz
From: Butch Ogden and Carol Smith
Re: **Site Visit of White Salmon Dairy Farm Manure Lagoon**

Conclusions

Due to concern about nearby high fecal counts and the belief that a manure lagoon was placed within the CREP buffer on a dairy along the White Salmon River, five of us visited the dairy farm located upstream of RM 22.55 on July 28, 2011. We examined the manure lagoon and CREP riparian buffer. The five people involved in the visit included: Butch Ogden (WSCC), Virginia Klein (FSA), Sergio Paredes (NRCS), Tova Cochrane (Underwood Conservation District), and Carol Smith (WSCC). These are our conclusions:

- The manure lagoon is about 2.5 acres in size and lies 105-188' from the stream edge. It existed prior to 1981 when NRCS began assisting the previous landowner with a storage pond, pumping, and piping equipment at headquarters. The lagoon was already in existence at that time. The current landowner said the previous landowner told him that the lagoon was built out of enforcement action. Enforcement of water quality law implies that Ecology was involved, and we suspect the lagoon construction was funded by Ecology. We don't have evidence of the source of funding nor any specifications regarding the lagoon. NRCS searched their records to ascertain whether they had specs or contributed funds, but could not find any records. They don't think they funded it. In any case, we do not have specs on the lagoon, which would be helpful.
- The manure lagoon appeared to be in good condition. Sergio noted that there was no evidence of breaching or leakage. It was placed in an elevated site, 35-40' rise from stream edge to lagoon (Figure 1). The floodplain in this area is expansive and contains the entire farm and Trout Lake valley bottom.
- There is a possibility of hydrologic connection from the lagoon to the stream, but dye or similar testing is needed to ascertain whether this is a source of the high fecal counts.
- The manure lagoon is not located within the CREP buffer. The CREP buffer ranged from 77-102' in width in this area. Carol examined the initial plan for the CREP buffer (Figure 2). The plan shows that the CREP site plan did not include the lagoon. When existing infrastructure exists, it is common for planners to narrow the buffer in the area of the infrastructure to exclude it. This is acceptable as long as the narrow section meets or exceeds minimum buffer width and 77' (the narrowest buffer width at the site) exceeds the minimum required buffer width. Also, the site visit verified that the buffer stopped prior to the manure lagoon boundary (Figure 3). However, see the comment in the next bullet about the condition of the CREP buffer in this area.

- In general, the CREP buffer is of variable quality. There is a band of mature existing trees, mostly cottonwood, along much of the stream length, but this pre-existing band of trees varies in width from 0-200'. The CREP buffer was planted outside of the existing riparian vegetation with the intention to increase buffer width and increase the conifer component. Downstream of the lagoon, the pre-existing buffer is wide (up to 400') and the buffer condition appeared be to be good. Although we did not walk this section, we could look down and see it, and I can measure the buffer through aerial photos. The CREP plantings just southwest of the manure lagoon had poor survival (Figure 3). This area was also the site of construction for the Ecology-funded stream restoration. Some of the low survival might be due to that activity. Just west of the lagoon and further upstream, the buffer condition ranged from good to fair (Figure 4). In this area, there is a mix of ponderosa pine, elderberry, spirea, snowberry, and hawthorn in addition to the pre-existing mature trees that are mostly cottonwood. Survival of the CREP plants was adequate with good growth in one section and more limited growth in another, likely due to wildlife browse judging from the droppings. There is no evidence of livestock presence in the CREP buffer.
- The CREP buffer should never have been approved. To fund a forested buffer under CREP, it needs to support salmon or steelhead in that particular reach. This reach is located at about RM 22.5. Since 1913, Condit Dam has completely blocked upstream river access to all anadromous salmon at RM 3.3. In addition, a waterfall at RM 16 also blocks passage for most salmonids most of the time (WSCC LFA Report 1999). However even though the buffer should not have been enrolled in CREP, the buffer has other benefits, such as improving water quality and habitat for other fish species.
- The nearby side channel was restored with DOE funds in 2007. Willows were planted along the channel's edge, wood was placed to protect the toe of the bank from erosion, and the vertical eroding river bank was sloped back to a stable angle of repose and planted. Figure 5 shows the site in 2006 prior to the restoration, while Figures 6 and 7 show the site in 2009 and 2011. The project looks like it is successful in that the vegetation is growing well and the banks are vegetated and sloped back, which likely inputs less sediment to the stream. The lagoon is in a much more protected status with this river bank no longer actively eroding away.
- The landowner has been actively involved in maintaining a clean dairy operation. At his own expense, he has maintained and replanted his CREP buffer. He has kept his NMP up-to-date with the help of the Underwood Conservation District, and has had regular passing WSDA inspections of his operation. His dairy is organic, and he has shunned the use of chemicals, which is a benefit to water quality and fish habitat.

Recommendations

- Continue to search for other possible fecal inputs to the White Salmon River in this area starting including neighboring sites. This might include manure application timing and other practices. A review of these practices between the District, NRCS, and the landowners for both farms would be warranted with modifications as appropriate.
- If management practices are improved and fecal counts still do not meet standard, then testing for lagoon inputs to the stream may be needed, particularly during the winter storm season.
- The CREP buffer is not in good shape in one small area southwest of the lagoon. However, this stream does not provide salmon habitat, and this CREP buffer should not have been approved, as it is ineligible if no salmon are in the reach. Given the need to prioritize our limited CREP funds at this time, we cannot recommend spending funds to improve the buffer in this one section. However, the landowner has been voluntarily planting ponderosa pine within the buffer at his own expense, and district staff thought he might be willing to restore this section himself.

Figures

Figure 1. Facing north overlooking the manure lagoon. The stream would be about 100’ or more to the left. The CREP buffer is directly ahead as it juts out after narrowing between the stream and the lagoon. The lagoon is slightly elevated compared to the rest of the farm topography.

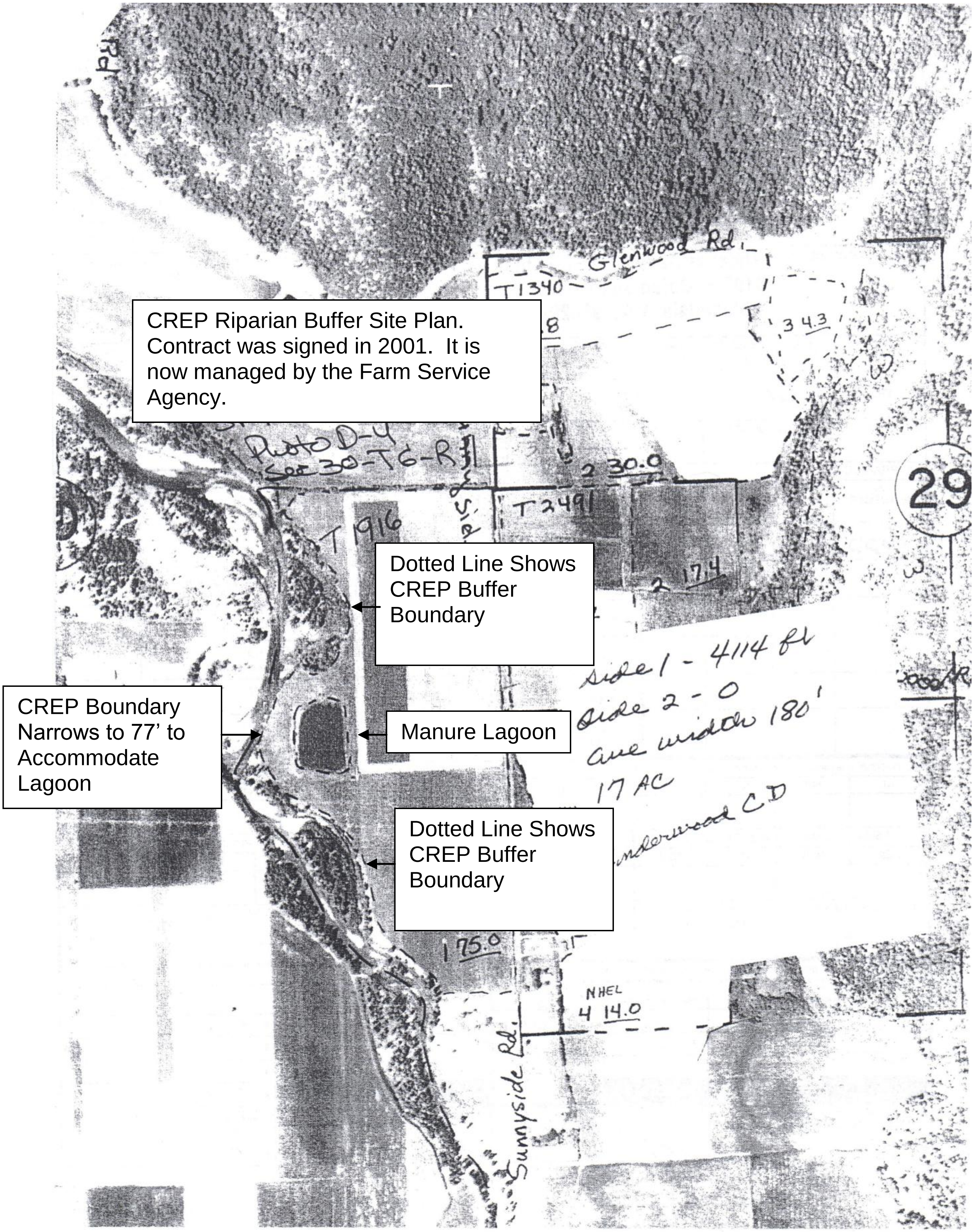

Figure 2. The CREP site plan which shows that the buffer did not include the lagoon.

Figure 3. This shows part of the CREP buffer that has poorer plant survival with barren areas along the outer edge. The buffer extends from the stream to the access road and ranges from 77’-102’ in this area. To increase functionality, conifers and denser plantings are needed. The lagoon lies behind the photographer and is not in the CREP buffer.


Figure 4. The CREP buffer just west of the lagoon and upstream of the lagoon is in better condition with improved plant density, conifer component, and adequate growth.

Figure 5. This is a “before” picture of the DOE project in 2006.

Figure 6. This is the same area shown in Figure 5, but two years after the restoration project (photo taken in 2009).

Figure 7. This is the same area shown in Figures 5 and 6, but reflects current, 2011, conditions. This side channel has successful willow establishment, pulled back vegetated banks, and instream wood components.

Appendix H: Supporting Fecal Coliform Data Summaries

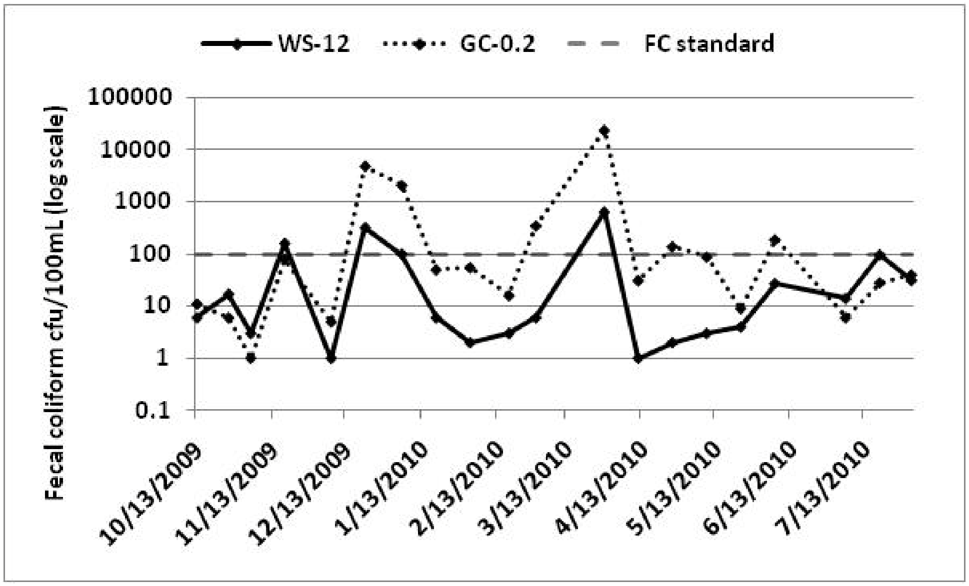

Figure H-1. Instantaneous FC results from the White Salmon River below the confluence with Gilmer Creek (WS-12) and Gilmer Creek at GC-0.2.

Appendix I: Gilmer Creek Water Quality Improvements

In 2009-10, Ecology conducted a fecal coliform monitoring study on the White Salmon River watershed in southwest Washington. During this study, a livestock operation was identified as a contributing source of FC to Gilmer Creek, a tributary to the White Salmon River.

In June and July of 2010, the Underwood Conservation District (UCD) conducted an onsite evaluation of conservation practices for the livestock operation on Gilmer Creek. The UCD, in cooperation with the landowner, prioritized and recommended several water quality improvement projects to reduce FC sources coming from the operation.

In September 2010, the UCD submitted an application to Ecology for grant consideration under the Coastal Protection Fund Program (Terry Husseman Account) to help fund these improvements. The application was reviewed and prioritized, and the UCD was notified in late September that $19,997 was identified for the project. The scope of work details was finalized, and a grant agreement was completed on January 12, 2011. The UCD also pursued implementation support through the Cooperative Conservation Partnership Initiative, National Resource Conservation Service, and the Washington State Conservation Commission.

Following are some of the key findings of a quarterly progress report submitted to Ecology by the UCD in July 2011.

High Priority Areas

Calf Barn Lot

Two watering troughs with an overflow pipe were identified as discharging water directly to the ground, creating mud and mixing with manure before entering a tributary to Gilmer Creek. The landowner has piped the overflow directly to the creek.

KC Barn Lot

Overwintering livestock had direct access to a tributary to Gilmer Creek. The landowner has constructed a berm and installed panel fencing to create approximately 30 feet of buffer between the barn lot and the tributary. The buffer was seeded with native vegetation. An off-channel watering trough was installed for overwintering livestock.

Cow/Calf Lot

Historically, cattle had direct access to the right bank of Kline Creek. The landowner has installed an exclusion fence creating between 30 to 40 feet of buffer between the lot and Kline Creek. Native willow cuttings and bareroot plants were planted in the buffer, and the area was seeded with grass. Livestock watering occurs at an alternative site, well away from the creek.

Field Application of Manure

The landowner plans to improve the timing of manure application on pasture lands to reduce runoff potential. The UCD recommends avoiding manure application when pastures are wet or frozen, and avoiding spreading within 100 feet of a wellhead or waterbody.

Lower Priority Areas

Schoolhouse Lot

At this location, livestock have direct access to Gilmer Creek. The landowner will work to manage livestock to reduce loafing and heavy use impacts. Native willow cuttings and bareroot plants were planted along several areas of the creek. Four temporary fenced enclosures to protect plantings while they establish have been installed. Additional improvements recommended by the UCD include building a hardened livestock crossing and planting additional vegetation.

Fat Lot

Surface water runoff from a livestock holding area was identified as draining into a ditch which flows into Gilmer Creek. Water quality impacts intensify during periods of heavy use coupled with rain and snowmelt events. The landowner has installed panel fencing and created approximately 30 feet of buffer between the holding facility and the ditch. The area was seeded with grass to help stabilize the soil. Additional routing of surface water has been proposed.

Timeline/Resources

Table I-1. Timetable of activities and resources needed to implement Underwood Conservation District (UCD) recommendations for Gilmer Creek.

Year	Area	Activities	Resources Needed
2010	Calf Barn Lot	Overflow water piping to Gilmer Creek	Schedule 40 3” min. pipe, trencher
	KC Barn Lot	Exclusion fencing from Gilmer Creek and off-channel watering	Fence panels, posts, schedule 40 2” min. pipe, tank/trough, grass seed, shrubs/livestakes
	Cow/Calf Barn	Exclusion fencing from Kline Creek	Fence panels, posts, grass seed, shrubs/livestakes
	Fields	Better manure application timing	Manure spreader
2011	Fat Lot	Exclusion fencing/buffer from surface runoff	Fence panels, posts, seed
2012	Schoolhouse Lot	Hardened livestock crossings, stream vegetation establishment	6” minus rock, geotextile fabric, tractor/backhoe, grass seed, shrubs/livestakes, temporary browse protection

A photo summary of BMPs, including before and after photos, are presented in Figures I-2 through I-11. Visual observations of the changes made to the livestock operation reflect considerable landowner commitment to water quality improvements. Simple changes such as those referenced above can make a positive impact to downstream water quality. Future water quality monitoring is expected to show improvement in the quality of Gilmer Creek. Water quality in other locations in the White Salmon River watershed could benefit from the same level of landowner commitment.

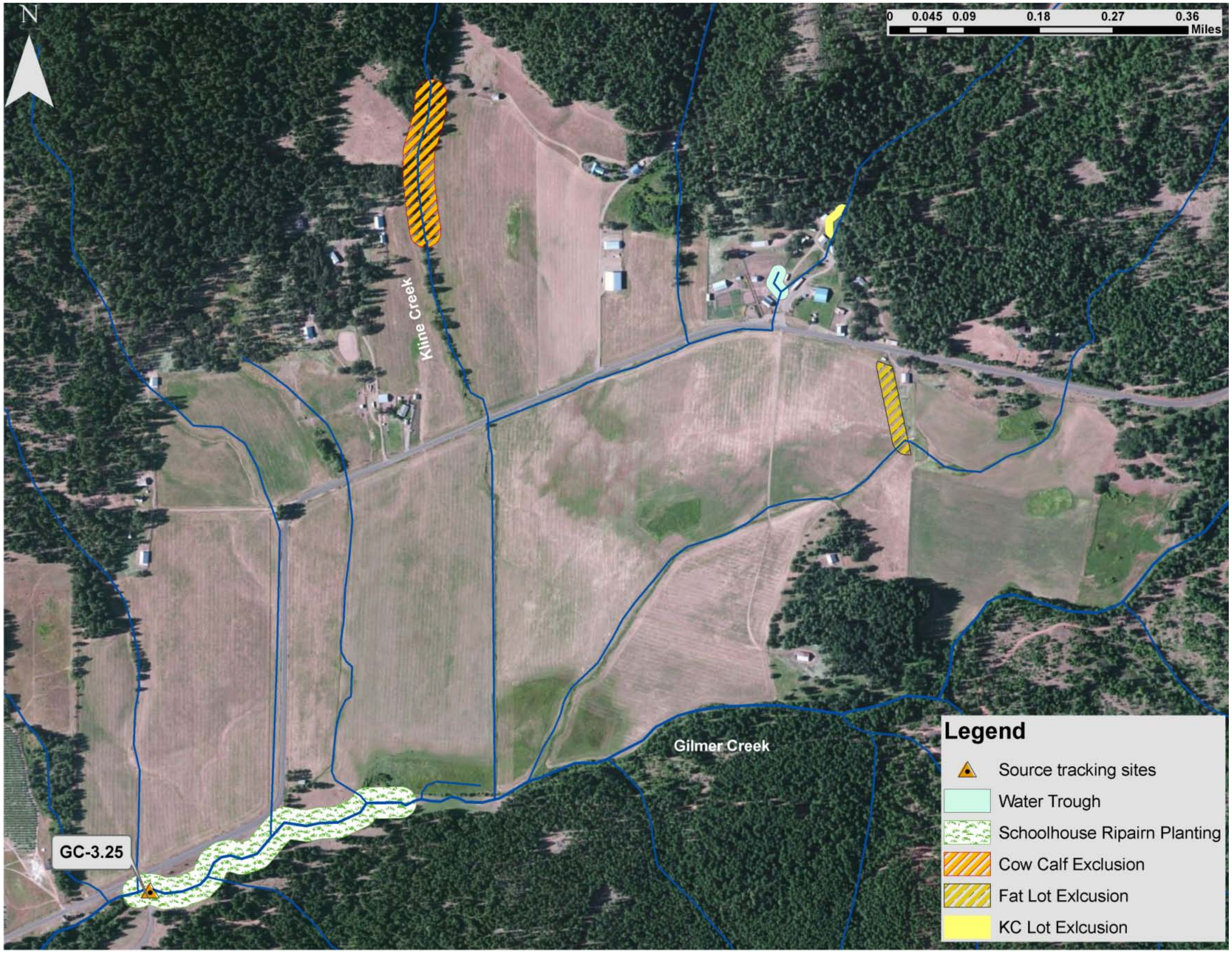

Figure I-1. BMPs installed on livestock operations within the Gilmer Creek sub-watershed in 2010-11.

Figure I-2. KC Barn fence and off-channel water trough photos.

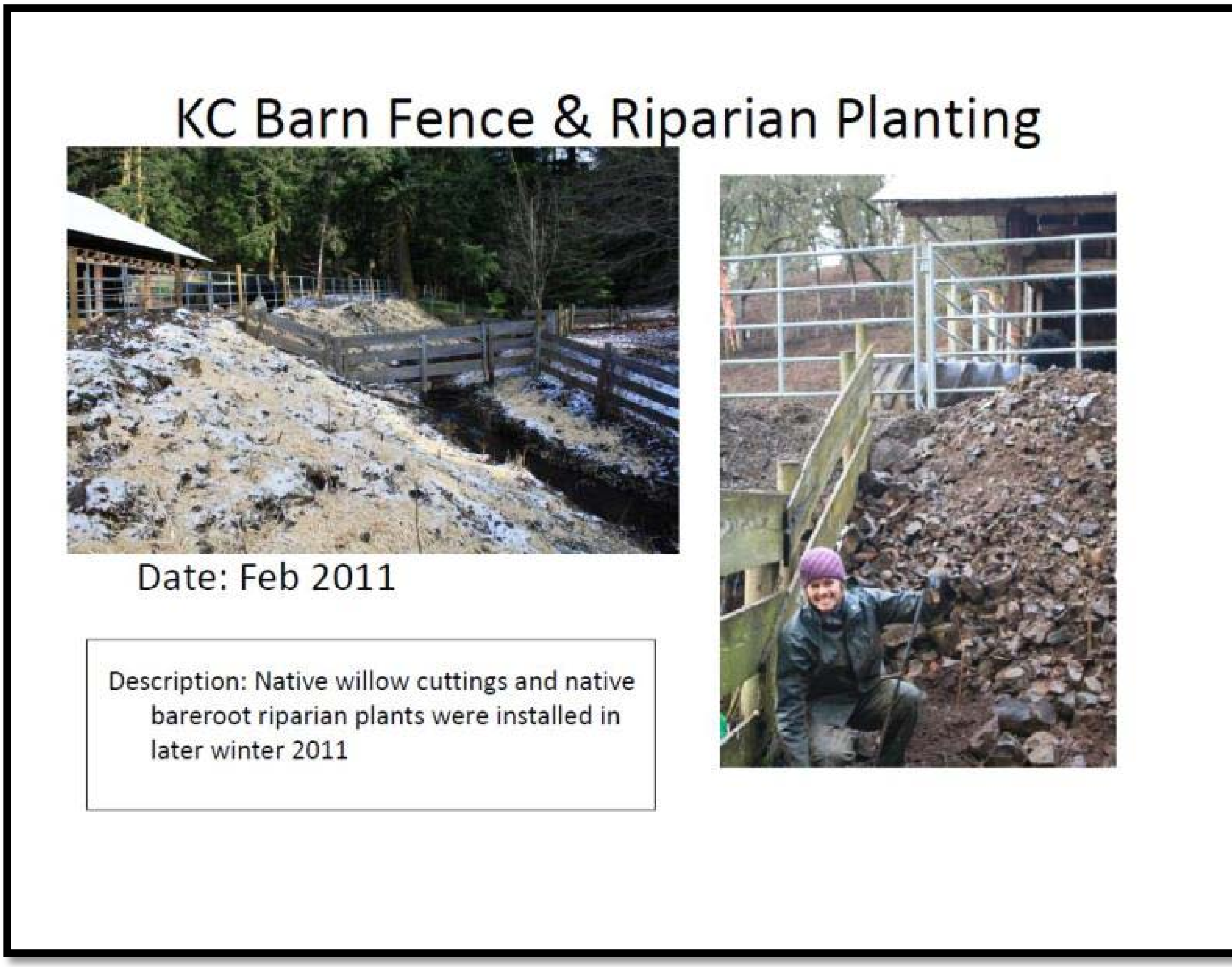

Figure I-3. KC Barn fence and riparian planting, February 2011.

Figure I-4. *Before and after photos:* KC Barn fence and riparian planting.

Figure I-5. *Before photos:* Fat Lot surface water exclusion fencing and seeding.

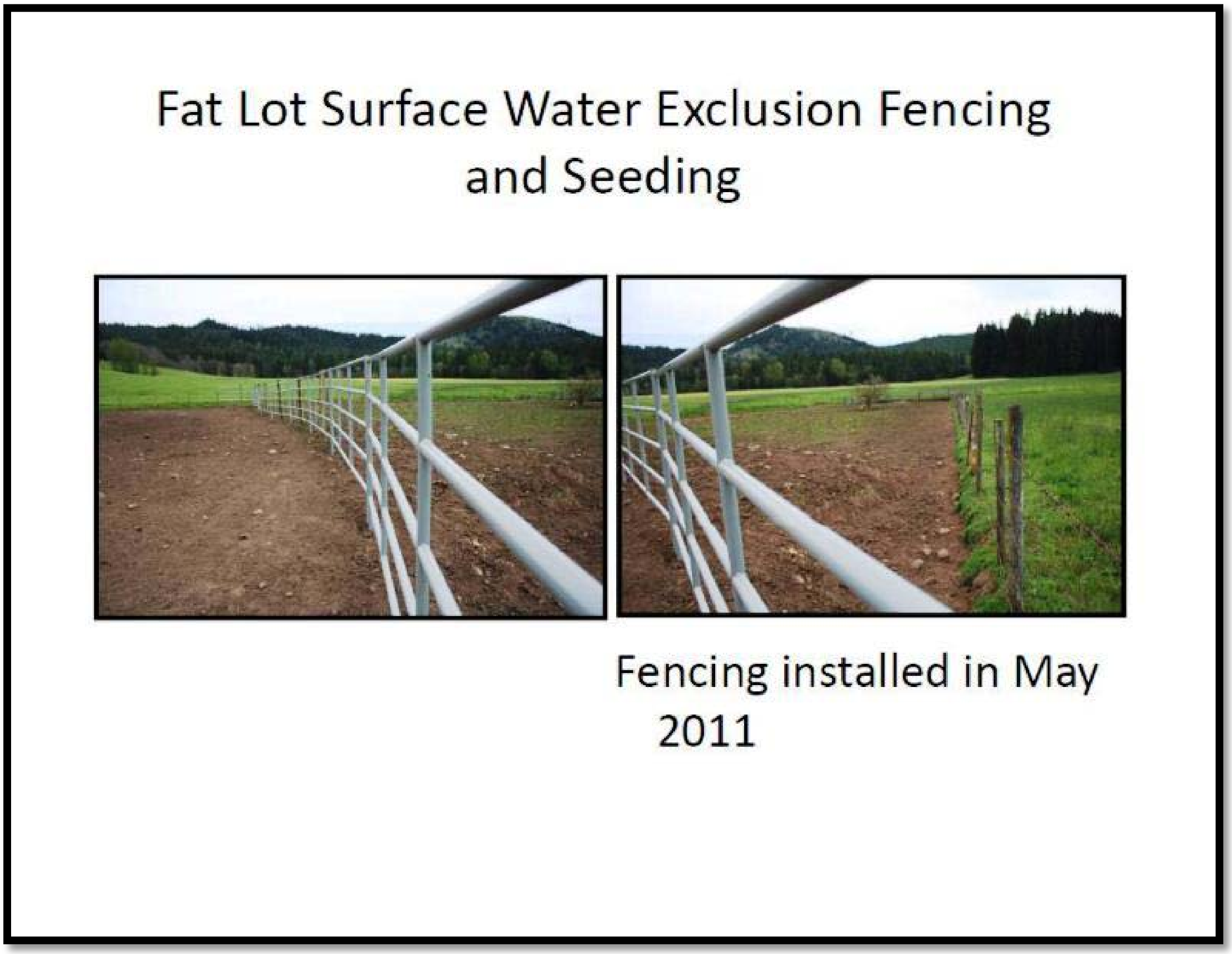

Figure I-6. *After photos:* Fat Lot surface water exclusion fencing and seeding.

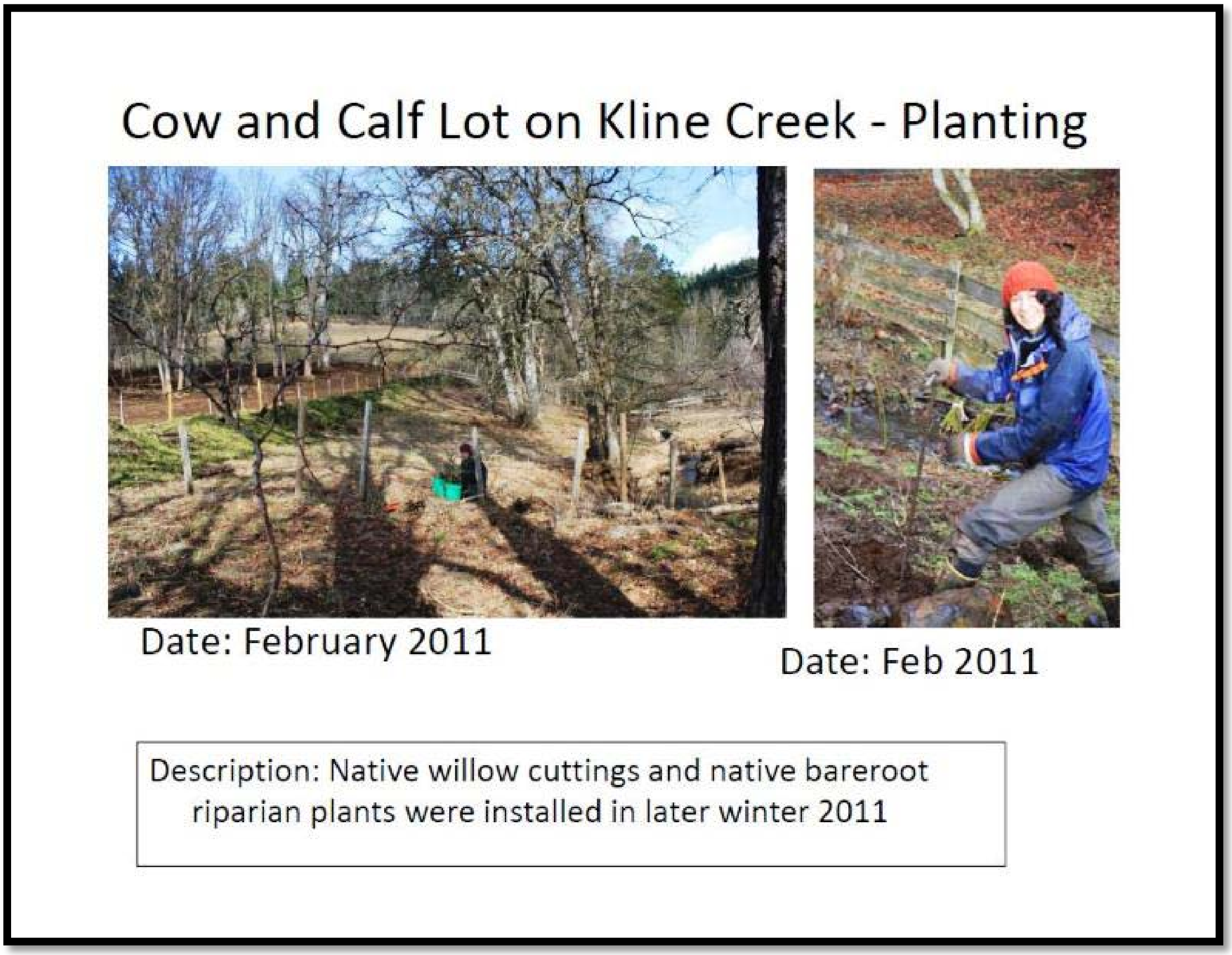

Figure I-7. *Before photos:* Cow/Calf Barn fencing and riparian planting.

Figure I-8. *After photos:* Cow/Calf Barn fencing and riparian planting.

Figure I-9. *Before photos*: Schoolhouse lot riparian planting.

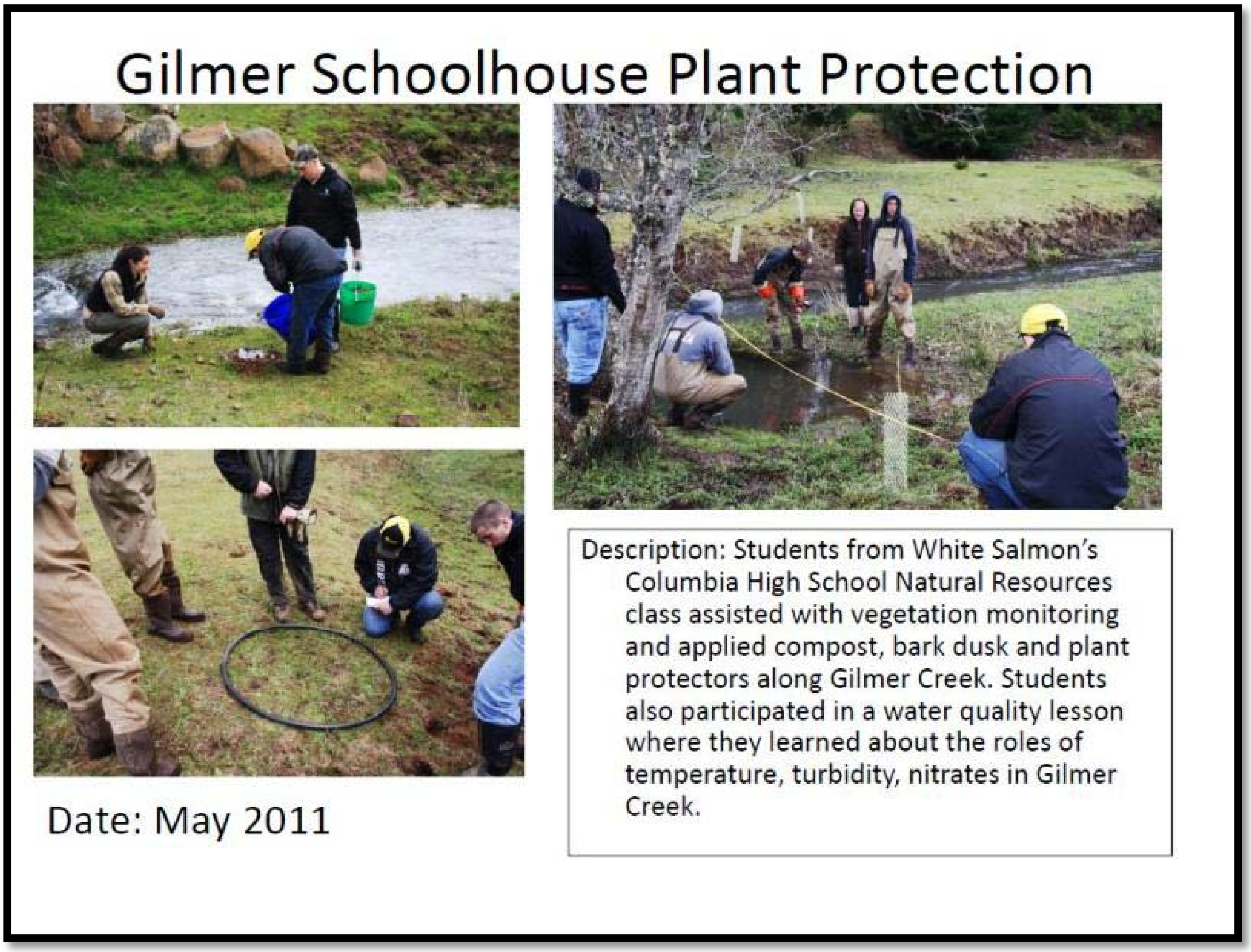

Figure I-10. Schoolhouse lot riparian planting education and outreach.

Figure I-11. *After photos:* Schoolhouse lot riparian planting.

Appendix J: Glossary and Acronyms

Glossary

Attainment monitoring: Monitoring to determine if water quality standards have been met.

Best management practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Clean Water Act: Federal Act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each waterbody or segment, regardless of whether or not the uses are currently attained.

Exceeded criteria: Did not meet criteria; were above criteria.

Effectiveness monitoring: Monitoring to determine whether the recommended *Detailed Implementation Plan*, after a significant portion of the recommendations or prescriptions have been implemented, is adequate in meeting (1) the goals and objectives for the TMDL project or (2) other desired outcomes over long temporal scales.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 + or - 0.2 ° Celsius. FC are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric mean (GM): A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Hydrologic Unit Code: An eight-digit number used to identify a geographic area representing part or all of a surface drainage basin or distinct hydrologic feature.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities. This includes, but is not limited to, atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of *point source* in section 502(14) of the Clean Water Act.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, saltwaters, wetlands and all other surface waters and water courses within the jurisdiction of the state of Washington.

Thalweg: The deepest and fastest moving portion of a stream.

Total Maximum Daily Load (TMDL): Water cleanup plan. A distribution of a substance in a waterbody designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Water year (WY): October 1 through September 30. For example, WY07 is October 1, 2006 through September 30, 2007.

303(d) List: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited waterbodies (ocean waters, estuaries, lakes, and streams) that fall short of state surface water quality standards and are not expected to improve within the next two years.

90th percentile: A statistical number obtained from a distribution of a data set, above which 10% of the data exists and below which 90% of the data exists.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMP	(See Glossary above)
Ecology	Washington State Department of Ecology
FC	(See Glossary above)
GM	(See Glossary above)
n	number
RM	river mile
UCD	Underwood Conservation District
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area

Units of Measurement

cfs	cubic feet per second
cfu	colony forming unit