DEPARTMENT OF
ECOLOGY
State of Washington

Quality Assurance Project Plan

Asotin Creek Temperature Straight-to-Implementation Vegetation Study

November 2011

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Publication Information

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

The plan for this study is available on Ecology's website at www.ecy.wa.gov/biblio/1103116.html.

Ecology's Activity Tracker Code for this study is 12-047.

Waterbody Numbers: WA-35-1030, WA-35-1038, WA-35-1039, WA-35-1040, WA-35-1050, WA-35-1060, WA-35-1070.

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Quality Assurance Project Plan

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November 2011

Approved by:

Signature: Date: October 2011

Chad Atkins, Client, Water Quality Program, Eastern Regional Office

Signature: Date: October 2011

James Bellatty, Client's Section Manager, Water Quality Program, Eastern Regional Office

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Tighe Stuart, Author / Project Manager / Principal Investigator, EAP

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Signatures are not available on the Internet version.
EAP: Environmental Assessment Program
EIM: Environmental Information Management database

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Abstract

Asotin Creek and its tributaries are included on the 2008 303(d) list for excessive stream temperatures. The Washington State Department of Ecology intends to address these temperature listings through Straight-to-Implementation (STI).

To assist with this STI, an analysis of site potential vegetation in the Asotin watershed will be conducted. Also, effective shade will be assessed at sites where riparian restoration has already occurred. Data collection will include hemispherical photography and brief vegetation surveys at selected reference sites, as well as hemispherical photography at selected sites where restoration has already occurred.

Background

Straight-to-Implementation

The Washington State Department of Ecology (Ecology) intends to address water quality impairments on the 303(d) list in the Asotin Creek watershed through Straight-to-Implementation (STI) in lieu of a TMDL. The STI approach minimizes the need for extensive technical study where the causes of water quality problems are well-documented and the solutions already known. STI is typically used in watersheds where either the vast majority or all of the pollution is nonpoint, with few or no point source contributions.

Study Area Description

Asotin Creek and its tributaries drain the northeastern slope of the Blue Mountains in southeastern Washington, emptying into the Snake River at the town of Asotin (Figure 1). The watershed is within WRIA 35 (Middle Snake). It encompasses 326 square miles (approximately 209,000 acres). Major streams in the watershed include Asotin Creek, N.F. Asotin Creek, S.F. Asotin Creek, George Creek, Pintler Creek, Charley Creek, and Lick Creek. The watershed spans two major ecoregions, the Blue Mountains and the Columbia Plateau.

The main land uses in the watershed are forest (35%), agriculture (29%), and canyon/rangeland (36%). Urban areas cover less than 0.1% of the watershed. Land ownership within the watershed is a mix of public (55%) and private (45%). Public lands in the watershed are managed primarily by the U.S. Forest service (30% of watershed), Washington Department of Natural Resources (8% of watershed), and Washington Department of Fish and Wildlife (6% of watershed). The U.S. Bureau of Land Management and Asotin County each manage less than one square mile.

Asotin Creek and its tributaries support runs of endangered steelhead (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*). Resident populations of rainbow trout (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*) also are present. The Asotin Creek drainage has also traditionally supported a large run of Pacific lamprey (*Lampetra tridentata*), which has greatly declined in recent decades.

There are no major impoundments or NPDES point sources with direct discharges to Asotin Creek or its tributaries. The Asotin Wastewater Treatment Plant is located near the mouth of Asotin Creek but discharges to the Snake River. Asotin County is covered by a Municipal Phase 2 Eastern Washington Stormwater Permit.

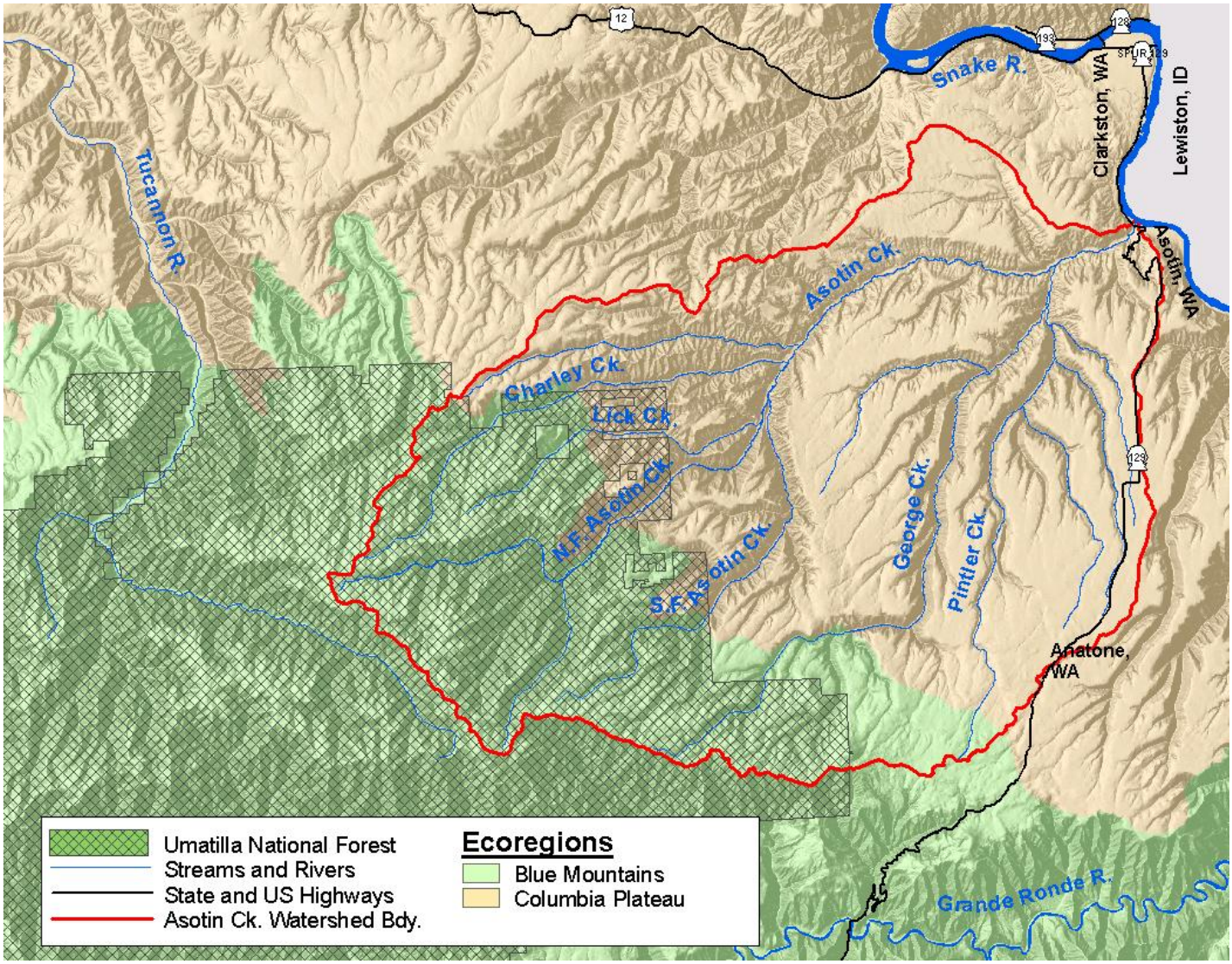

Figure 1. Location of Asotin Creek watershed in southeastern Washington.

Water Quality Impairments

Monitoring conducted by the Washington Department of Fish and Wildlife (WDFW) and the U.S. Forest Service led to the listing of 17 segments of Asotin Creek and its tributaries for Temperature on the 303(d) list during the 2008 Water Quality Assessment. Table 1 presents 303(d) listings for temperature in the Asotin Creek watershed.

Table 1. 303(d) temperature listings in the Asotin Creek watershed.

Water Body	Listing ID	Listing Category	Waterbody ID	Township	Range	Section
Asotin Creek	13851	5	WA-35-1030	10N	46E	16
Asotin Creek	13852	5	WA-35-1030	10N	45E	24
Asotin Creek	13854	5	WA-35-1030	10N	45E	20
Asotin Creek	13860	5	WA-35-1030	9N	44E	3
Asotin Creek	13863	5	WA-35-1030	9N	44E	10
Asotin Creek, N.F.[1]	13985	5	WA-35-1070	9N	43E	25
Asotin Creek, N.F.[1]	13986	5	WA-35-1070	8N	43E	4
Asotin Creek, N.F.	22425	5	WA-35-1060	9N	44E	16
Asotin Creek, S.F.	13858	5	WA-35-1040	9N	44E	10
Asotin Creek, S.F.[1]	22426	5	WA-35-1050	8N	44E	18
Charley Creek	13862	5	WA-35-1038	9N	44E	3
Charley Creek	22427	5	WA-35-1039	9N	42E	13
George Creek	20352	5	[2]	10N	45E	36
George Creek[1]	22429	5	[2]	8N	44E	28
George Creek	29321	5	[2]	10N	45E	25
Lick Creek[1]	22430	5	[2]	9N	43E	15
Pintler Creek	20354	5	[2]	9N	45E	27

[1]These listings are located on U.S. Forest Service Land.
[2]These creeks have not been assigned a Waterbody ID.

Existing and Ongoing Studies

The Asotin Creek watershed has been heavily studied during recent decades. The Snake River Salmon Recovery Board (SRSRB) has selected the Asotin Creek basin for study as an Intensively Monitored Watershed (Bennett and Bouwes, 2009). This effort is focused on Charley Creek, Lick Creek, and the upper Asotin Creek branches, with an emphasis on salmon habitat restoration. The Intensively Monitored Watershed work includes riparian vegetation surveys and water temperature monitoring. In 2001, the SRSRB performed an Ecosystem Diagnosis and Treatment Model habitat assessment of the Asotin Creek watershed. Asotin Creek has been the subject of recent ongoing work by Washington State University's Department of Natural Resource Sciences (e.g., Hardesty et al., ongoing). The Asotin Creek basin was included in the Washington State Conservation Commission's analysis of limiting factors for salmonid habitat in southeast Washington (Kuttel, 2002). The U.S. Forest Service (USFS) has conducted stream vegetation surveys and water temperature monitoring (Delbert Groat, personal communication). The Washington Department of Fish and Wildlife (WDFW) has conducted additional water temperature monitoring (Steve Martin, personal communication).

Water Quality Standards and Beneficial Uses

Designated Beneficial Uses

The 2006 Water Quality Standards for Surface Waters of the State of Washington Chapter 173-201A WAC (Ecology, 2006) designates the following uses within the Asotin watershed: *Char spawning and rearing*; *Core summer salmonid habitat*; and *Salmonid spawning, rearing, and migration*. Table 2 lists the use designations by waterbody.

The key identifying characteristics for each applicable use are as follows (WAC 173-201A-200):

- **Char spawning and rearing:** This use protects spawning or early juvenile rearing by native char, or use by other species similarly dependent on such cold water. This use also protects summer foraging and migration of native char; and spawning, rearing, and migration by other salmonid species.
- **Core summer salmonid habitat:** This use protects summer season, defined as June 15 through September 15, salmonid spawning or emergence, or adult holding; summer rearing habitat by one or more salmonids; or foraging by adult and sub-adult native char. Other protected uses include spawning outside of the summer season, rearing, and migration by salmonids.
- **Salmonid spawning, rearing, and migration:** This use protects salmon or trout spawning and emergence that only occur outside of the summer season (September 16 – June 14). Other uses include rearing and migration by salmonids.

In some waters, special considerations are necessary to protect spawning and incubation of char and salmonid species. Supplemental spawning/incubation criteria have been established for specified time periods to protect these special uses. Figure 3 illustrates where the beneficial and supplemental spawning/incubation uses apply within the Asotin Creek watershed.

Each beneficial use designation has associated water quality criteria. The following section describes the applicable temperature criteria for the designated uses within the basin.

Table 2. Use designations for waterbodies in the Asotin Creek watershed within WRIA 35.

Water Body	Aquatic Life Uses		
	Char spawning and rearing	Core summer salmonid habitat	Salmonid spawning, rearing, and migration
Asotin River from and including Charley Creek to headwaters (including tributaries) not otherwise designated Char		X	
Asotin River, North Fork, and all tributaries above Lick Creek, except those waters in or above the Umatilla National Forest	X		
Asotin River, North Fork, and all tributaries above Lick Creek that are in or above the Umatilla National Forest	X		
Charley Creek and the unnamed tributary at latitude 46.2851 longitude -117.3216: All waters (including tributaries) above the junction, except those waters in or above the Umatilla National Forest	X		
Charley Creek and the unnamed tributary at latitude 46.2851 longitude -117.3216: All waters (including tributaries) above the junction that are in or above the Umatilla National Forest	X		
George Creek, above and including Coombs Canyon (including tributaries)	X		
George Creek and the unnamed tributary at latitude 46.2292 longitude -117.1874 (Section 29 T9N R45E), all waters above junction not otherwise designated Char		X	
All other waters[1]			X

[1]Information not included in Table 602 of the water quality standards.

Temperature Criteria

Temperature affects the physiology and behavior of fish and other aquatic life. Temperature may be the most influential factor limiting the distribution and health of aquatic life and can be greatly influenced by human activities.

Temperature levels fluctuate over the day and night in response to changes in climatic conditions and river flows. Since the health of aquatic species is tied predominantly to the pattern of maximum temperatures, the criteria are expressed as the highest 7-day average of the daily maximum temperatures (7-DADMax) occurring in a water body.

In the Washington State water quality standards, aquatic life use categories are described using key species (salmon versus warm-water species) and life-stage conditions (spawning versus rearing) [WAC 173-201A-200; 2006 edition].

The beneficial uses designated within the upper Yakima River basin include *Char spawning and rearing, Core summer salmonid habitat,* and *Salmonid spawning, rearing and migration*. The applicable temperature criteria for the designated uses are contained in 173-201A-200(c) as:

(1) To protect the designated aquatic life uses of "Char Spawning and Rearing," the highest 7-DADMax temperature must not exceed 12°C (53.6°F) more than once every ten years on average.

(2) To protect the designated aquatic life uses of "Core Summer Salmonid Habitat," the highest 7-DADMax temperature must not exceed 16°C (60.8°F) more than once every ten years on average.

(3) To protect the designated aquatic life uses of "Salmonid Spawning, Rearing, and Migration," the highest 7-DADMax temperature must not exceed 17.5°C (63.5°F) more than once every ten years on average.

The state uses the criteria described above to ensure that where a waterbody is naturally capable of providing full support for its designated aquatic life uses, that condition will be maintained. The standards recognize, however, that not all waters are naturally capable of staying below the fully protective temperature criteria. When a waterbody is naturally warmer than the above-described criteria, the state provides an additional allowance for additional warming due to human activities. In this case, the combined effects of all human activities must also not cause more than a 0.3°C (0.54°F) increase above the naturally higher (inferior) temperature condition.

In addition to the maximum criteria noted above, compliance must also be assessed against criteria that limit the incremental amount of warming of otherwise cool waters due to human activities. When water is cooler than the criteria noted above, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted to: (1) incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/T+7 as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge), and (2) incremental temperature increases resulting from the combined effect of all nonpoint source activities in the waterbody must not at any time exceed 2.8°C (5.04°F).

Special consideration is also required to protect spawning and incubation of salmonid species. Where Ecology determines the temperature criteria established for a waterbody would likely not result in protective spawning and incubation temperatures, the following criteria apply:
(1) Maximum 7-DADMax temperatures of 9°C (48.2°F) at the initiation of spawning and at fry emergence for char; and (2) Maximum 7-DADMax temperatures of 13°C (55.4°F) at the initiation of spawning for salmon and at fry emergence for salmon and trout.

Figure 2 illustrates the applicable beneficial uses, supplemental spawning/incubation criteria, and associated temperature criteria for all waterbodies within the Asotin Creek watershed.

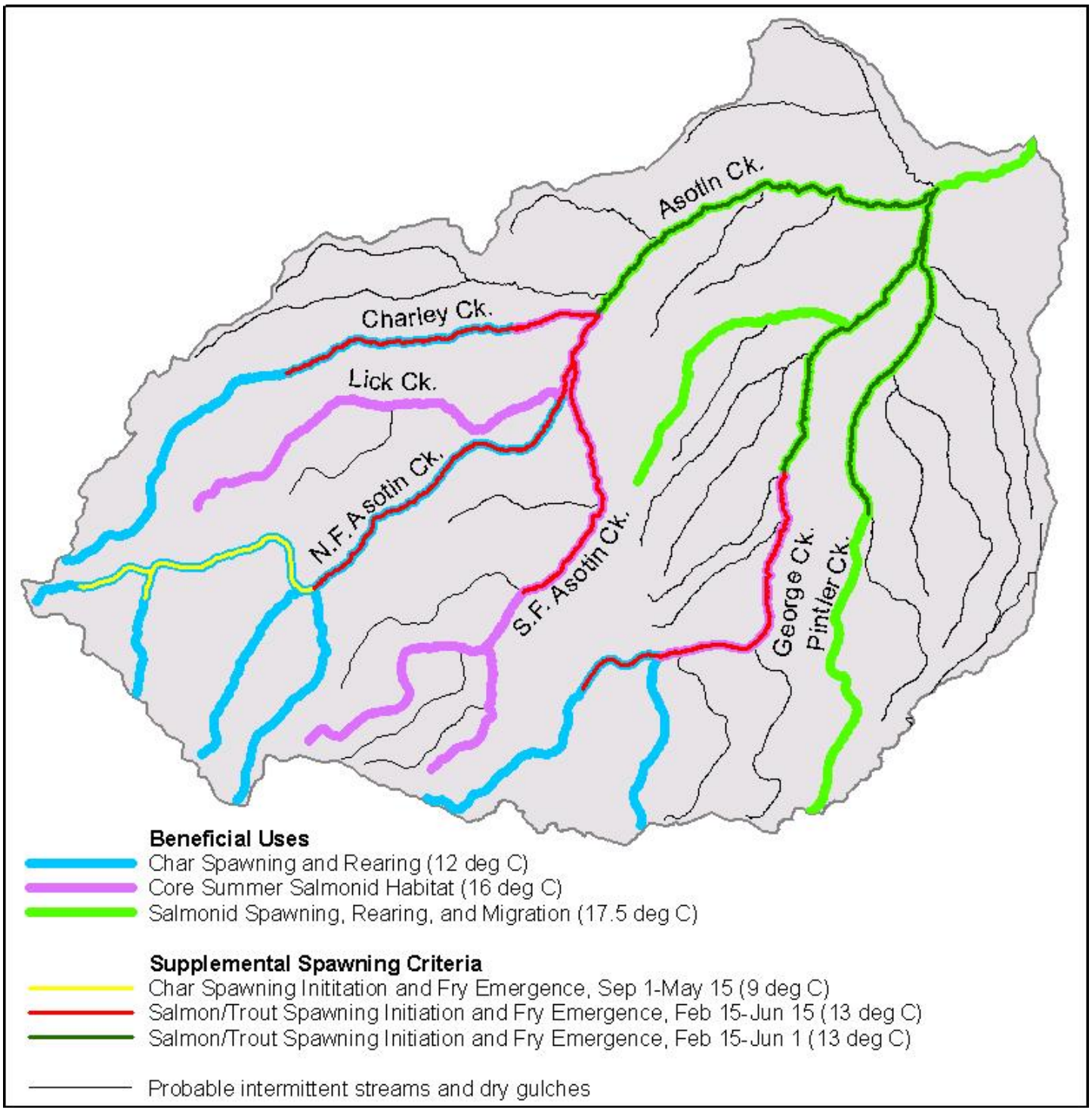

Figure 2. Applicable beneficial uses and supplemental spawning criteria in the Asotin Creek watershed.

Quality Objectives

Bias

Bias is defined as the difference between the population mean and the true value of the parameter being measured (Lombard and Kirchmer, 2004). Bias attributed to sampling and field measurement techniques will be minimized by following appropriate protocol and standard operating procedures (SOPs) discussed and referenced in this QA Project Plan. The primary attribute being measured in this study is effective shade, which is highly variable and heterogeneous. Therefore, avoiding measurement bias is largely a matter of choosing representative locations for measurements. Procedures provided in this QA Project Plan are used to collect representative field measurements of the highest quality possible.

Precision

Precision is the measure of variability in the results of replicate measurements due to random error (Lombard and Kirchmer, 2004). This random error is inherently associated with field sampling and laboratory analysis. Field errors are minimized by adhering to strict measurement protocols.

Measurement Quality Objectives

EPA defines measurement quality objectives (MQOs) as " 'acceptance criteria' for the quality attributes measured by project data quality indicators. [They are] quantitative measures of performance…" (EPA, 2002).

No MQOs are established for effective shade or vegetation height measurements as these measurement types are not typically duplicated. These attributes are typically heterogeneous and variable across space. Therefore it is more important for the purposes of this project to account for the spatial variability of these measurements than the precision at a single location.

Project Goals and Experimental Design

To assist with the implementation of measures designed to reduce stream temperatures in Asotin Creek and its tributaries, this project has two goals:

1. Characterize system potential riparian vegetation throughout the Asotin Creek watershed.
2. Assess progress of implementation activities at achieving site potential shade.

System Potential Vegetation Study

The Asotin Creek Straight-to-Implementation temperature project is proceeding under the assumption, which is well supported by available data and by past TMDLs, that all streams in the basin need the effective shade that would occur from system potential riparian vegetation. *System potential mature riparian vegetation* is defined as: *that vegetation which can grow and reproduce on a site, given: climate, elevation, soil properties, plant biology, and hydrologic processes.*

Asotin Creek and its tributaries contain numerous reaches that currently appear to possess system potential riparian vegetation. Several (8 to 10) reference sites will be selected in such reaches. Reference sites will be as widely distributed throughout the basin as possible considering site access. Table 3 lists possible reference sites. At each site, the following activities will be performed:

- Hemispherical canopy photographs will be taken from the stream center to measure effective shade on the stream.
- Hemispherical canopy photographs will be taken from underneath the riparian canopy on the stream banks to measure canopy density.
- A brief vegetation survey will record overstory species present, understory species present, and vegetation height.
- Bankfull width will be measured at the point where the hemispherical photograph is taken.

Table 3. Possible reference sites in the Asotin Creek basin.

Site Location	Latitude	Longitude	Elevation (m)
Asotin Ck. above Kearney Gulch	46.3284	-117.1633	354
Asotin Ck. above Palmer Gulch	46.3120	-117.2489	467
Asotin Ck. at WDFW access	46.3016	-117.2636	488
Charley Ck. near mouth	46.2893	-117.2933	555
Charley Ck. on FS land	46.2745	-117.4284	938
Lick Ck. near mouth	46.2590	-117.3124	640
Lick Ck. below Moonshine Spring	46.2597	-117.3910	898
Lick Ck. above water gap	46.2550	-117.4240	1030
George Ck. above Pintler Ck.	46.3005	-117.1205	349
George Ck. near Little Butte	46.1601	-117.2916	1071
N.F. Asotin Ck. near Headwaters	46.2020	-117.5317	1483
N.F. Asotin Ck. above Lick Ck.	46.2544	-117.3039	610
N.F. Asotin Ck. at FS Boundary	46.2361	-117.3593	735
S.F. Asotin Ck. above Warner Gulch	46.2150	-117.2858	757
S.F. Asotin Ck. near mouth	46.2650	-117.2927	583

A soils-based potential vegetation analysis will result in a map of distinct potential vegetation zones. It is expected that two to three vegetation zones will be needed for the Asotin Creek watershed. This analysis will be based on weight of evidence from the following sources, depending on availability and usefulness:

- **USDA Ecological Site/Plant Association data** – For each soil type in the USDA/NRCS soil survey, a site association has been defined, along with characteristic forest and/or rangeland plant coverage.
- **DNR Soils Site Index** – For forestland, the Washington Department of Natural Resources (DNR) has assigned a site index for each soil type, which is defined as the height of mature trees on that soil type. For lands east of the Cascade mountain crest, the site index value is a height at age 100 years.
- **General Land Office (GLO) surveys** – The General Land Office surveyed all township and section lines during the last 1800s. Surveyors often made notes of vegetation present along streams.
- **Reference Site Data** – Ecology will collect data, as described above.
- **Intensively Monitored Watershed Data** – Eco Logical Research, under contract from the Snake River Salmon Recovery Board, is collecting riparian vegetation data on Charley Creek and the North and South Forks of Asotin Creek. A Lidar flight may also take place.
- **Historical Photographs** – Historical photographs of the Blue Mountains region are available through the Umatilla National Forest website, at www.fs.fed.us/r6/uma/publications/history/.

- **U.S. Forest Service** – The USFS has conducted extensive vegetation surveys on Charley Creek, Lick Creek, and N.F. and S.F. Asotin Creek. These vegetation studies included solar pathfinder readings, a method of determining effective shade similar to hemispherical photography (Delbert Groat, personal communication).
- **Northwest Habitat Institute's IBIS database** – The Interactive Biodiversity Information System (IBIS, 2008) database provides GIS coverages of current and historic wildlife habitat types.
- **LANDFIRE** – The Landscape Fire and Resource Management Planning Tools Project, provided through the USGS, provides 30-meter resolution coverages of current and potential vegetation conditions nationwide.

Vegetation height, density, and overhang values will be defined for each potential vegetation zone, based primarily on data collected at reference sites, resulting in a shade curve for each zone. Shade curves will be verified to stream-center hemiviews taken at reference sites, while accounting for topographic shade present at each site.

Implementation Site Effectiveness

A significant amount of riparian restoration work has already been accomplished in the Asotin Creek watershed (ACCD, 2004). To assess the effectiveness of these projects, several sites where riparian restoration has been implemented will be selected. These sites should span a range of vegetation development, including sites where plantings have only recently been established, as well as sites where plants have had a chance to grow for a number of years. Table 4 lists possible implementation sites.

Table 4. Possible implementation effectiveness sites.
These mostly represent older restoration projects which occurred between 1996 and 2001.

Site Location	Latitude	Longitude	Elevation (m)
Asotin Ck. at gulch above Asotin	46.3331	-117.0702	250
George Ck. above Pintler Ck.	46.3063	-117.1150	329
Asotin Ck. above George Ck.	46.2846	-117.2827	529
Asotin Ck. at Dry Gulch	46.2944	-117.2717	506
Asotin Ck. at Headgate County Park	46.3268	-117.2069	414
Asotin Ck. just above Lick Ck.	46.2595	-117.2987	596
Charley Ck. blw wildlife area bdy	46.2820	-117.3638	742
Lick Ck. on wildlife area	46.2596	-117.3613	821
S.F. Asotin Ck. abv confluence	46.2701	-117.2913	566
Asotin Ck. blw Palmer Gulch	46.3142	-117.2439	456

At each site, a hemispherical canopy photograph will be taken from the stream center. The camera location will be carefully marked with a GPS and with detailed descriptions, to insure that it can be found again in future years if desired. Effective shade measurements resulting from these photographs will be compared to the shade expected from potential vegetation to determine how quickly restoration sites are progressing toward site potential shade. If desired, this can be repeated in the future as riparian vegetation continues to grow taller and thicker at these sites, providing an ongoing measure of progress. Bankfull width will be measured at the point where the hemispherical photograph is taken.

It should be emphasized that this activity only measures the effectiveness of reestablished vegetation at direct stream shading. Reestablishing riparian vegetation also has other benefits, such as bank stabilization, channel narrowing (which indirectly increases effective shade), runoff filtration, and wildlife habitat.

Organization and Schedule

Table 5 lists the people involved in this project. All are employees of the Washington State Department of Ecology. Table 6 presents the proposed schedule for this project.

Table 5. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Chad Atkins Water Quality Program Eastern Regional Office Phone: 509-329-3499	EAP Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Tighe Stuart Directed Studies Unit Eastern Operations Section Phone: 509-329-3476	Project Manager/ Principal Investigator	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data. Analyzes and interprets data. Writes the draft report and final report.
James Ross Directed Studies Unit Eastern Operations Section Phone: 509-329-3425	Field Assistant	Helps collect samples and records field information.
Gary Arnold Eastern Operations Section Phone: 509-454-4244	Section Manager for the Project Manager and Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP: Environmental Assessment Program.
QAPP: Quality Assurance Project Plan.

Table 6. Proposed schedule for completing field work, and reports.

Field and laboratory work	Due date	Lead staff
Field work completed	October 2011	Tighe Stuart
Environmental Information System (EIM) database		
No data will be produced that needs entry into EIM.		
Final report		
Author lead / Support staff	Tighe Stuart	
Schedule		
Draft due to supervisor	January 2012	
Draft due to client/peer reviewer	February 2012	
Draft due to external reviewer(s)	March 2012	
Final (all reviews done) due to publications coordinator	May 2012	
Final report due on web	June 2012	

Measurement Procedures

Field procedures will follow approved Environmental Assessment Program SOPs (Ecology, 2011):

- EAP013 - Determining Coordinates via hand-held Global Positioning System (GPS) Receivers
- EAP045 - Hemispherical Digital Photography Field Surveys Collected as part of a Temperature Total Maximum Daily Load (TMDL) or Forests and Fish Unit Technical Study
- EAP046 - Computer Analysis of Hemispherical Digital Images Collected as part of a Temperature Total Maximum Daily Load (TMDL) or Forests and Fish Unit Technical Study

Reference and implementation effectiveness sites will be located on maps, and deviations will be recorded in field notes. If the site location does not have easily recognizable landmarks, a GPS reading will be taken to obtain accurate latitude and longitude. At implementation effectiveness sites, extremely detailed notes will be taken as to the exact hemiview camera location. These notes will be precise enough to allow field crews to return in future years to take photos from the same location.

Hemispherical photos will be taken as follows:

- At implementation effectiveness sites, one photo will be taken from the stream center.
- At reference sites, one photo will be taken from the stream center, one from the left bank underneath representative vegetation, and one from the right bank underneath representative vegetation.

At reference sites, representative vegetation heights will be measured using a hand-held clinometer. For each tree measured, the field technician will measure a convenient horizontal distance from the tree trunk using a long measuring tape. The technician will then use the clinometer to measure the angles from eye level to the top of the tree and to the bottom of the tree. The angle up, angle down, and horizontal distance will be carefully recorded in a field notebook. The location of each tree measured will be mapped on a printed orthophoto.

At reference sites, all overstory and understory tree and shrub species will be noted, along with their relative density. Tree and shrub species will be identified to species level where possible. Forbs and grasses will be noted if they are particularly abundant or are apparently contributing to stream shading or bank stabilization in a significant way.

Quality Control Procedures

Effective shade can be quite variable spatially, even within one vegetation type. To insure that measured effective shade values are representative of potential vegetation zones, the following will be done:

- Multiple (2-3) reference sites will be chosen in each likely vegetation zone.
- At each site, the hemispherical photo will be taken from a location judged to be representative, as explained in SOP EAP045.
- At 1/5 of sites, an additional stream center hemiview photo will be taken about 1/4 mile upstream or downstream from the original site.

Effective shade data are not typically entered into EIM. Therefore, these duplicate measurements are not technically necessary, nor are they typically included in temperature TMDL studies. They are included in this study to help gauge the level of variability within each vegetation zone, particularly because shade curves will be developed from this data.

Vegetation heights can also be quite variable. To ensure that measured vegetation heights are representative, at least two height measurements will be taken of each dominant vegetation type at each reference site. For example, if the riparian vegetation at a site consists of mixed cottonwoods and ponderosa pine with an alder understory, then at least two cottonwoods, two pines, and two alders will be measured.

Data Management Procedures

In the field we will enter field measurement data into a field book with waterproof paper. We will then enter this data into EXCEL® spreadsheets (Microsoft, 2007) as soon as practical after returning from the field. These spreadsheets will be used for data analysis.

The types of data being collected during this study are not typically entered into EIM.

All spreadsheet files, paper field notes, and Geographic Information System (GIS) products created as part of the data analysis will be kept with the project data files.

Audits and Reports

The project manager will prepare and submit a report of the findings of this study to the client at the end of the project. This report will include at a minimum:

- Descriptions of the potential vegetation types occurring in the Asotin Creek watershed
- A map showing where these potential vegetation types occur
- A shade curve for each potential vegetation type
- An analysis of shade measurements at sites where implementation has already occurred

Data Verification and Validation

Field staff will check field notebooks for missing or improbable measurements before leaving each site. The EXCEL® workbook file containing field data will be labeled DRAFT until data verification is complete. Data entry will be checked against the field notebook data for errors and omissions. Missing or unusual data will be brought to the attention of the project manager for consultation. Valid data will be moved to a separate file labeled FINAL.

Data Quality (Usability) Assessment

The project lead will verify that all field measurements have met the appropriate quality objective. For this project, that will mean verifying that enough measurements have been taken to assess field variability of the attributes being measured, and to find a reasonable average value for these attributes at each site and for each vegetation zone. If the results are not adequate, then the project lead will determine how or whether to use that data for analysis.

References

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Appendix. Glossary, Acronyms, and Abbreviations

Glossary

Char: Char (genus *Salvelinus*) are distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background.)

Clean Water Act: A 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.

Hemispherical Photography: A method of assessing effective shade and other attributes of the solar radiation environment below the forest canopy. Software is used to analyze a photo of the forest canopy taken using a hemispherical (fish-eye) lens.

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 NPDES 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.

Parameter: A physical chemical or biological property whose values determine environmental characteristics or behavior.

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 is 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.

Reach: A specific portion or segment of a stream.

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

Streamflow: Discharge of water in a surface stream (river or creek).

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

Total Maximum Daily Load (TMDL): 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.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically 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 estuaries, lakes, and streams that fall short of state surface water quality standard, and are not expected to improve within the next two years.

Acronyms and Abbreviations

BMP	Best management practices
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
GIS	Geographic Information System software
GPS	Global Positioning System
i.e.	In other words
MQO	Measurement quality objective
NPDES	(See Glossary above)
QA	Quality assurance
RM	River mile
SOP	Standard operating procedures
SRSRB	Snake River Salmon Recovery Board
TMDL	(See Glossary above)
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
ft	feet