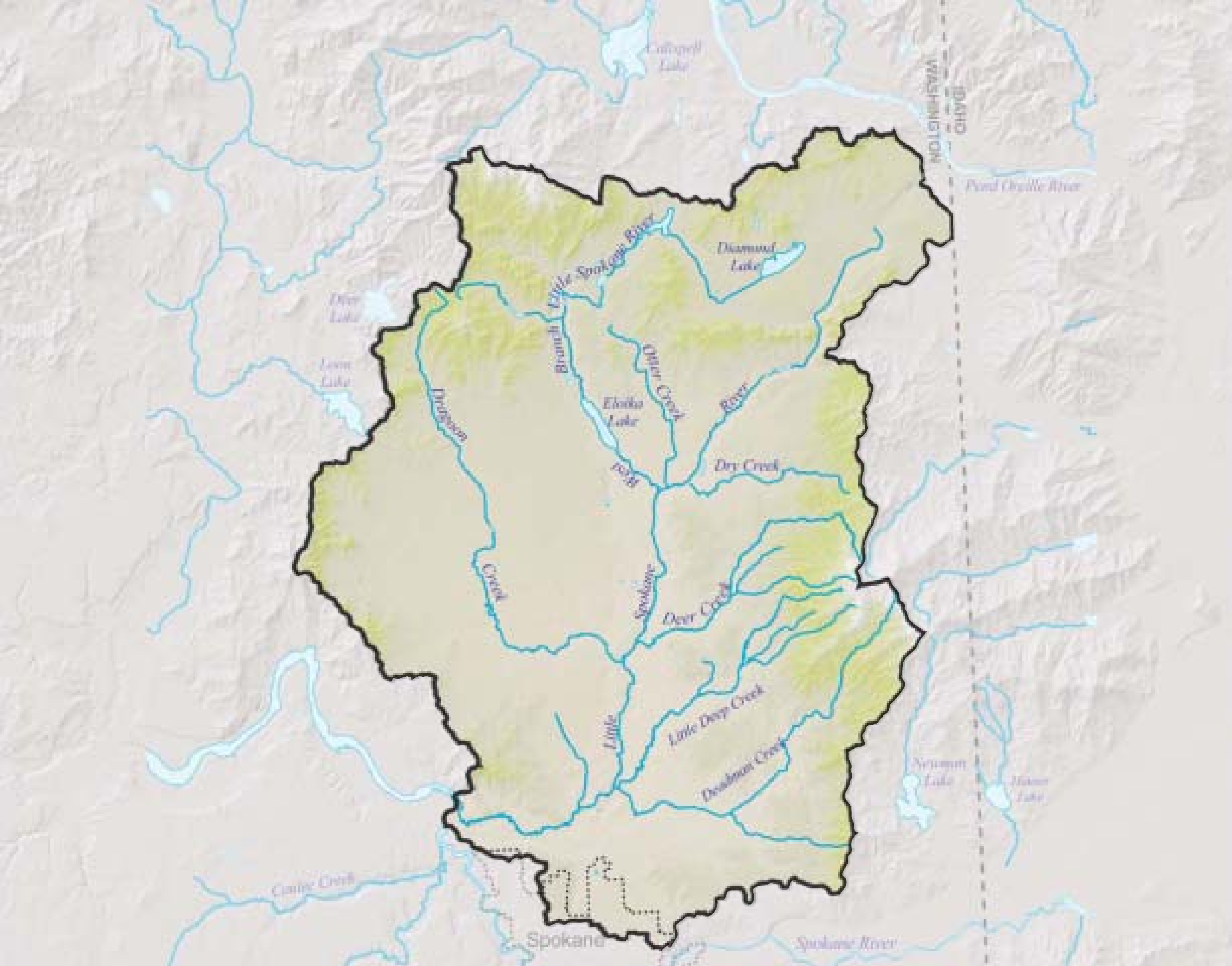
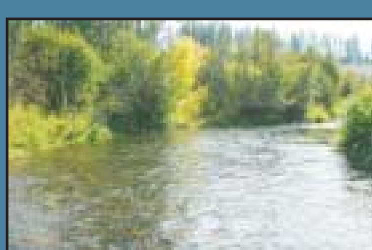
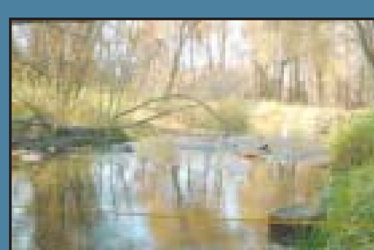
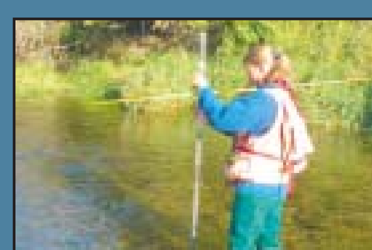


Little Spokane River Basin (WRIA 55) Instream Flow Needs Assessment

December 2003

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December 29, 2003

Spokane County ref: P2960
Golder ref: 013-1372

Spokane County Utilities Division
Mail Stop PWB-4
1116 W Broadway
Spokane, WA 99260

ATTENTION: Stan Miller, Program Manager, WQMP

RE: LITTLE SPOKANE WATERSHED - INSTREAM FLOW NEEDS ASSESSMENT REPORT

Dear Stan:

Enclosed are twelve copies of the Instream Flow Needs Assessment report for the Little Spokane Watershed (Water Resource Inventory Area 55). Golder worked in close cooperation with the multiple stakeholders in the Little Spokane Watershed to develop the approach used in this work. This work was completed with the gracious assistance of private land owners who provided access to their stream-side properties for data collection, and field work assistance from Spokane County and volunteers from the Spokane County Community College.

The methods and approaches used in the site selection, data collection and analysis were screened and accepted by the Washington Department of Fish and Wildlife and the Washington Department of Ecology, and have resulted in a technically defensible product that has met with the acceptance of state agencies.

We very much appreciate the opportunity to have conducted this work with you.

Sincerely,

GOLDER ASSOCIATES INC.

Chris V. Pitre, P.G.
Associate, Water Resources

cc: Bryony Stasney

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LITTLE SPOKANE RIVER WATERSHED PLANNING INSTREAM FLOW NEEDS ASSESSMENT

Prepared under grant # 0200315
from the Washington Department of Ecology

Submitted to:

Little & Middle Spokane Watershed Planning Unit
(WRIAs 55 & 57)
Spokane, Washington

Submitted by:

Golder Associates Inc.
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Chris V. Pitre, P.G.
Senior Project Manager, Water Resources

December 2003

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EXECUTIVE SUMMARY

An instream flow needs assessment of the Little Spokane River Basin (Water Resources Inventory Area [WRIA] 55) was initiated in 2002 by the WRIA 55 and 57 Planning Unit as a component of overall watershed planning efforts for the basin. Instream flow-related assessments and planning have been ongoing for many years in the Little Spokane River Basin. An early basin-wide assessment was completed by Ecology in 1975 resulting in a minimum instream flow rule for the Little Spokane River and a seasonal closure to further appropriation of the tributaries to the river. The basis of the regulatory instream flow levels were statistical flow data: details of the minimum instream flows for the Little Spokane River Basin are found in Chapter 173-555 of the Washington Administrative Code (WAC).

The key purpose of this Little Spokane River instream flow needs assessment is to re-evaluate the existing minimum instream flows in the context of habitat needs for selected fish species (i.e., redband/rainbow trout and mountain whitefish). This assessment focuses on established Minimum Instream Flow Control Points on the Little Spokane River, and locations on tributary streams (Otter, Dragoon, and Deadman creeks). The assessment of the existing minimum instream flows was based on the results of a Wetted Perimeter evaluation as well as a fish habitat evaluation using a single-transect Physical Habitat Simulation (PHABSIM) analysis.

Both the Wetted Perimeter and the PHABSIM methods require the selection of study sites to collect the necessary field data. Study site selection occurred under the guidance of the WRIA 55 Planning Unit Instream Flow Workgroup and included input from representatives from the Washington Department of Fish and Wildlife (WDFW), Ecology and Golder Associates. The decision-making process also included a field visit to a number of potential study sites. Homogeneous reaches were determined from a longitudinal profile of the stream and a site visit. Study sites were selected on the basis of existing minimum instream flow control points, fish habitat, cost-per-site relative to the chosen instream flow methodology, fish distribution and use, hydrology, existing data and site accessibility.

Three study sites were located on the Little Spokane River at Pine River Park, at Chattaroy and at Elk, while sites were also established on Otter, Dragoon and Deadman creeks. The selected sites were visited to identify appropriate cross-section locations for wetted perimeter monitoring. One cross section was selected in a representative riffle area of each study site. The precise location was chosen to take advantage of the best locally available conditions for stage and discharge measurements. Additional considerations for site selection included: flow confinement to one channel; location relative to a confluence so that backwater effects were avoided; accessibility for monitoring; and, bank stability. Transects were located in riffle habitat to better validate the wetted perimeter approach.

<u>Wetted Perimeter Analysis</u>

As the discharge in a river increases, the amount of the streambed that is covered by water (i.e., the wetted perimeter) also increases. The rationale behind the Wetted Perimeter method is that there is a point where the rate of increase of wetted perimeter decreases as the discharge rate increases, resulting in a distinct inflection point in the wetted perimeter versus discharge relationship. If such an inflection point can be easily identified, the corresponding discharge is identified as a potential minimum instream flow recommendation using this methodology.

To develop this relationship, field data were collected to measure the bed profile and water surface elevations at each transect for six different discharges to calculate the wetted perimeter. A stage-discharge regression model was used to determine the wetted perimeter at unmeasured discharges. The wetted perimeter versus discharge results were plotted and analysed to determine if an obvious inflection point could be identified to define a potential minimum instream flow value. The Wetted Perimeter method results, in cfs, are: Little Spokane River at Pine River Park – 160; Little Spokane River at Chattaroy – 50; Little Spokane River at Elk – 32; Dragoon Creek – 40; Deadman Creek – 13; and, Otter Creek – 13.

The application of the Wetted Perimeter method typically includes a degree of subjectivity in selecting the inflection point in the plot of wetted perimeter versus discharge. The Little Spokane River at Elk and Deadman Creek exhibited fairly noticeable inflection points (and several in some cases) while the sites at Pine River Park, Chattaroy, and Dragoon Creek were much more subtle, exhibiting steady changes in the slope rather than a distinct breakpoint. The Otter Creek site showed a break in the slope; however, the pattern of changing slope then reversed itself. This artifact of the transect location highlights the limitations of using a single transect per site. The clear breakpoint on Otter Creek occurs over a range of flows associated with a small terrace on one bank that appears to be higher than the typical base flows in the creek.

The Wetted Perimeter method provides a single instream flow number for application throughout the year, and does not take into account the variability of natural stream hydrograph or the unique biological needs of individual target species and life stages. The Wetted Perimeter flow values are therefore evaluated using the results of the fish habitat analysis to determine if the Wetted Perimeter recommendation provided suitable habitat protection and to determine whether there is justification for use of the wetted perimeter method in less intensive future instream flow studies.

PHABSIM Habitat Flow Relationships

Habitat versus flow relationships were developed to evaluate the biological relevance of the existing minimum instream flows as well as an independent check of recommendations based on the Wetted Perimeter method. To develop a habitat versus flow relationship for the six transects selected for the Wetted Perimeter analysis, the depth and velocity distributions across each transect as well as habitat suitability criteria for depth, velocity, and substrate for the key management species are used.

A PHABSIM approach was used to develop the habitat versus discharge relationship. Within PHABSIM modeling, habitat is typically defined in terms of depth, velocity, substrate and cover. During each of the six field visits, a depth and velocity profile was measured across each transect. These field data were then entered into the PHABSIM model. The measured data were used to calibrate the model. The model then produces simulated distributions of depths and velocities at unmeasured discharges across each transect.

Each simulated discharge is evaluated to determine the amount of suitable habitat available across the transect based on habitat suitability criteria. Habitat suitability criteria identify ranges of suitable depths, velocities and substrate/cover for each species and life stage of interest. The Washington State-wide suitability criteria were used for rainbow trout while suitability criteria developed at expert workshops in Alberta were used for mountain whitefish. Because only a single transect was evaluated at each site for this study, the result of the habitat modeling is a weighted useable width curve, which defines the habitat versus discharge relationship across each transect at each site. The habitat at any discharge can be compared to the maximum available habitat and can be defined as a proportion of the maximum available habitat. The weighted useable width curves were used to define the amount of habitat available for each life stage of interest at the existing minimum flows, as well as the flows recommended by the wetted perimeter analysis.

It is commonly, though erroneously, perceived that more flow is always better. There are specific flow ranges that are more suitable for various life stages of individual species, and no single flow can achieve a perfect balance amongst species and life stages. From the WUW results for the Little Spokane River, low flows are beneficial for rainbow spawning, and mountain whitefish and rainbow trout fry life stages. Higher flows are better for juvenile and adult life stages. Very high flows can have negative effects on the fish community by destroying redds and flushing small/young fish out of refuge habitat.

Evaluation of Existing Minimum Instream Flows

The existing minimum instream flows on the Little Spokane River provide a variable flow regime that reflects the seasonal availability of water in the region. This is a desired feature of an instream flow rule and it is recommended that any adjustments to the current minimum instream flow values should retain this seasonal variability. In general, based on the evaluation of the weighted useable width curves for each life stage of rainbow trout and mountain whitefish, the current minimum instream flows for the three sites on the Little Spokane River provide relatively good habitat protection for most of the year.

Mainstem Instream Flow Compliance Points

The PHABSIM analysis indicates increasing the regulatory minimum instream flow at the Pine River Park site on the Little Spokane River from the existing 115 cfs to the 160 cfs recommended by the Wetted Perimeter Method during July-September would provide a habitat gain for adult and juvenile life stages of rainbow and mountain whitefish, but a decrease in habitat for fry. Spawning does not occur during the summer period. A summary of analysis for rainbow trout at the Pine River Park site is presented below, extracted primarily from Figure 5.7b:

Comparison of Habitat Conditions and Flows at Pine Park @ Dartford

Fish Species and Life Stage	% Optimal Habitat Condition (per PHABSIM)				PHABSIM Flows (cfs)	
	WAC 173-555			Wetted Perimeter Flow	≥ 80 % Optimal Habitat Condition	≥ 95 % Optimal Habitat Condition
	July-Sept. (115 cfs)	Dec.-Jan. (150 cfs)	Mar.-Apr. (190-250 cfs)	(160 cfs)		
Rainbow Trout						
Adult/juvenile	82	95	98-100	98	112-347	150-289
Spawning [1]	n/a	n/a	26-36	43	47-108	62-94
Fry	37	32	21- 27	33	<56	<52
Mountain Whitefish						
Adult	60	76	92-100	80	160-381	199-303
Juvenile	80	93	98-99	95	115-535	164-418
Spawning [1]	n/a	87	n/a	90	134-525	181-417
Fry	89	79	62-72	77	<145	56-96

[1] Rainbow Trout spawn only during March-April, while Mountain Whitefish spawn only during December-January.

At the Chattaroy site on the Little Spokane River, adjustment to the existing minimum flow of 57 cfs is also possible during June and July. However, the Wetted Perimeter-based flow recommendation of 50 cfs provides relatively poor habitat conditions for most life stages during this time period. It is not recommended to use the Wetted Perimeter Method as justification to adjust the existing minimum instream flows at Chattaroy.

At the Elk site on the Little Spokane River, the existing minimum flows (e.g., 38 cfs during the summer) provide good habitat conditions throughout the year for most life stages and do not require adjustment to improve fish habitat. The Wetted Perimeter-based flow recommendation of 32 cfs also provides good habitat conditions for most life stages. Establishing a single regulatory minimum instream value for the full year, as suggested by the Wetted Perimeter Method, does not reflect the seasonal variability of flow and is not recommended for application throughout the year. However, during August through October, the Wetted Perimeter flows are seasonally appropriate, and the minimum flows could be lowered to 32 cfs during this period if desired. This would result in a slight habitat gain for rainbow trout juvenile/adult, but a habitat loss for mountain whitefish juveniles and adults. Adjusting the existing minimum flows at Elk based solely on the fish habitat evaluation does not appear to be warranted.

Tributary Instream Flows

A detailed evaluation to determine the biological relevance of the existing minimum instream flow for Dragoon, Deadman, and Otter creeks is not possible at this time due to the lack of suitable long-term hydrological information. Additionally, the current minimum instream flow rules for these creeks consist of a partial seasonal stream closure from June through October, and therefore no minimum flow values are identified that could be evaluated. Without long-term hydrological data, an evaluation of the habitat corresponding to different flow exceedances is not possible. The only habitat evaluations conducted at this time are for the identified Wetted Perimeter flows.

The Dragoon Creek site has a Wetted Perimeter based flow recommendation of 40 cfs, which the PHABSIM analysis shows provides marginal to very good habitat conditions for the different life stages of fish evaluated. A flow of 40 cfs could be defined as a new minimum flow during the closure period. However, depending on the seasonal flow availability during June through October, adopting the 40 cfs as a new minimum flow may still result in an effective closure of Dragoon Creek at this time of year.

The Deadman Creek site did not have a single obvious flow defined using the Wetted Perimeter approach, but resulted in the identification of two possible recommendations - 13 cfs and 6 cfs. PHABSIM analysis shows that the two flow recommendations resulting from the Wetted Perimeter approach both provided marginal habitat conditions for most fish life stages. The Wetted Perimeter flows do not provide suitable habitat conditions and defining a biologically relevant minimum flow is not possible based on the available data.

The Otter Creek site has a Wetted Perimeter-based flow recommendation of 13 cfs. PHABSIM analysis shows that the Wetted Perimeter-based flow recommendation provides good habitat conditions for most life stages and could be defined as the new minimum instream flow if desired. However, depending on the seasonal flow availability during June through October, adopting the 13 cfs as a new minimum flow may still result in an effective closure of Otter Creek at this time of year.

<u>Other Instream Flow Components</u>

Providing suitable fish habitat is an essential, but not the only consideration in defining instream flow needs. Maintaining flows for water quality, flushing flows to remove sediment, channel maintenance flows to create and maintain fish habitat, and riparian vegetation flows are all critical in protecting the aquatic ecosystem.

Flushing flows, channel maintenance flows, and riparian flows all tend to be relatively large flows that may not occur every year, and the duration of these larger flows when they do occur is relatively short. The current minimum flows are generally well below the requirements for these ecosystem components. While maintaining these components is crucial to protecting the aquatic ecosystem, this range of flows is more typically addressed in systems with large capacity storage facilities and/or large diversions during peak flow periods. Because neither of these conditions are present in the Little Spokane River system, they are not addressed here. At any time when large capacity storage or diversion is considered, studies should be conducted to address flushing flows, channel maintenance flows and riparian flows.

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1.0 INTRODUCTION

The Little Spokane Watershed is located on the eastern border of Washington with Idaho (Figure 1.1). Watershed planning under RCW 90.82 is being jointly conducted in the Little and Middle Spokane River Basins (Water Resources Inventory Areas [WRIAs] 55 and 57, respectively). Current watershed planning work in WRIAs 55 and 57 began in 1998, under the state-sponsored authority of Chapter 90.82 of the Revised Code of Washington (RCW; the Watershed Planning Act). Spokane County is one of the initiating governments for this effort, and is the lead agency for grant and contract administration purposes. Golder Associates Inc. (Golder) completed a draft Phase II – Level 1 Technical Assessment as part of the watershed planning process (Golder, 2001). Since that time, the Planning Unit decided to proceed to Level 2 of Phase II of the watershed planning process with an assessment of instream flow needs of WRIA 55, and the development of a computer simulation model of the hydrologic watershed processes for both WRIAs 55 and 57. This report presents the findings of the instream flow assessment of WRIA 55.

1.1 Background

Instream flow-related assessments and planning have been ongoing for many years in the Little Spokane River Basin. An Instream Resources Protection Program (IRPP) study of WRIA 55 was completed by Ecology in 1975 to assess the availability of water for further appropriation (Chung, 1975). As a result of this study a minimum instream flow rule was adopted for the Little Spokane River and selected tributaries to the Little Spokane River were partially and seasonally closed to further appropriation (Chapter 173-555 of the Washington Administrative Code [WAC]).

In 1995, a draft Initial Watershed Assessment of the Little Spokane River Basin was completed for Ecology (Dames and Moore and Cosmopolitan Engineering Group, 1995). The primary purpose of the Initial Watershed Assessment was to evaluate the status of surface and groundwater resources within WRIA 55. The conclusions of the 1995 study included:

1. Flows in the Little Spokane River do not meet instream flow requirements for up to 42% of the summer months during average years;
2. Non-point pollution is increasingly affecting water quality; and,
3. Development and population growth in the lower part of the watershed are steadily increasing the demand for water.

In 2001, a draft assessment of watershed planning (Phase II Level 1 report) in the Little Spokane River Basin (WRIA 55) and Middle Spokane River basin (WRIA 57) was completed (Golder, 2001). The Level 1 report focused on data compilation and watershed characterization for the Middle and Little Spokane River basins, specifically related to watershed planning in the State of Washington under RCW 90.82. A review of instream flow issues in the Little Spokane River Basin was provided in the water quantity chapter of the Level 1 report. A brief summary of instream flow issues presented in the Level 1 report is reiterated in the next section of this report.

Other watershed studies pertinent to instream flow that have been completed within the Little Spokane River Basin include a hydrogeologic characterization of the Deer Park Basin (EMCON, 1992), and an aquifer delineation and groundwater quality investigation of a portion of north Spokane County (Boese and Buchanan, 1996). A Draft Spokane River Subbasin Summary completed in 2000 summarizes fish and habitat information (Northwest Power Planning Commission [NWPPC], 2000). The Pend Oreille Conservation District (POCD) completed a water quality assessment of the Little Spokane River Basin in 2000. The POCD assessment indicated that water temperatures are higher than anticipated for a system so highly dependent upon baseflow. The POCD assessment is continuing through on-going water quality monitoring and stream gaging within the Little Spokane River Basin by the Spokane County Conservation District (SCCD).

1.2 Current Instream Flow Regulation

Minimum instream flows were set for the mainstem of the Little Spokane River from the headwaters to the confluence with the Spokane River in 1976 (WAC 173-555; Appendix A). The background for development of WAC 173-555 is contained in the Ecology document, Washington’s Instream Resources Protection Program (IRPP) Series No. 1 “Instream Resources Protection Program: Little Spokane River Basin WRIA 55”.

Regulatory minimum instream flows have been established for four points on the Little Spokane River (Figure 1.1). These regulatory flows were established based on the 80% exceedance curve of historical data for the three downstream compliance points, and the 90% exceedance curve of historical data for the upstream-most point (Ecology, 1975). Previous to this regulation, seasonal closures were established on tributaries under the Fisheries Code (RCW 75.20), and were incorporated into WAC 173-555. Groundwater is not addressed in WAC 173-555.

Minimum instream flows for the Little Spokane River are specified for two-week time steps at the four compliance points including the abandoned Elk gaging station, Chattaroy, Dartford (at Dartford), and at the confluence with the Spokane River (near Dartford; Table 1-1).

Three control stations on the Little Spokane River currently have continuous flow gaging stations nearby; Little Spokane River at Dartford (Station 12431000) managed by the USGS, Little Spokane River at Chattaroy Road, managed by Spokane Community College, and the Little Spokane River near Dartford (Station 124315000) managed by the USGS. The Elk control station had a USGS gage that collected continuous records from 1949 to 1971. Although the gage is not currently maintained by the USGS, there are more recent bi-monthly measurements taken at the Elk gage between 1987 and 1990. The control station near Dartford (USGS gage 12431500) had monthly flow measurements collected by Ecology and SCCD throughout the 1990’s and has been gaged continuously since 1997 by the USGS in cooperation with Spokane County.

Each control station on the Little Spokane River was analyzed in the WRIA 55/57 Phase II Level 1 report for minimum instream flow excursion statistics based on the entire period of record as well as only the summer months (Table 1-2 and Figures 1.2a through 1.2d; Golder, 2001). The analysis provided the following information:

- The average excursion length at all control stations, ranges from 12 to 22 days.
- The control station at Chattaroy has the highest percent of record below minimum instream flow levels with more than 42% of dry season flows below these levels.
- Chattaroy also recorded the longest excursion length, which infringed on more than just the generally accepted “dry season”, lasting for 262 days.
- An extremely long excursion occurs for Elk, Chattaroy, and at Dartford for the “dry” year. Dartford can be well below the minimum instream flow levels although estimated average base flows are higher than minimum instream flow requirements flows in a dry year.
- The discrete measurements taken near the Elk Control station (Station 9408K) were collected between 1987 and 1990 during the summer months (May - September). During

this period there were 39 daily measurements, 30 of which did not meet minimum instream flow levels. Minimum instream flows were not met during each year data were collected.

- Discrete measurements collected near Dartford control station (Little Spokane River near mouth @ Hwy 291, Station 6205E) show that of the 47 days when data were collected between 1993 and 1997, 10 excursions were recorded. Most of these excursions occurred in the summer or fall of each year.

1.3 Study Purpose

The WRIA 55/57 Planning Unit decided to assess instream flows as an optional component of watershed planning. The instream flow assessment is designed to fulfill the instream flow component of the State of Washington Watershed Planning process under RCW 90.82 for WRIA 55. In the context of the Watershed Planning Act, the instream flow component is comprised of three parts: Step A, Step B, and Step C. Step A includes compilation of existing data and scoping of instream flow needs work. Step B consists of an instream flow analysis. Step C consists of developing recommendations on establishing or modifying existing minimum instream flow regulations.

The key purpose of the Little Spokane River instream flow assessment is to evaluate the biological relevance of existing minimum instream flow regulations. This assessment focuses on both established Minimum Instream Flow Control Points in the Little Spokane River, and tributary streams (Otter, Dragoon, and Deadman creeks) that have been identified as biologically relevant and of interest due to fish habitat issues.

Following this assessment, the Planning Unit can make recommendations to Ecology regarding minimum instream flow targets for the Little Spokane River. The range of recommendations the Planning Unit may provide to Ecology for minimum instream flow targets include:

- Recommend that the minimum flow be maintained as is;
- Recommend a new minimum flow be considered based on the results of this study; and/or,
- Recommend target flows in addition to the existing regulatory minimum instream flow.

1.4 Report Objectives and Structure

This instream flow assessment provides a foundation for the Planning Unit to evaluate instream flow issues in the Little Spokane River and its tributaries from an aquatic habitat perspective. The assessment also provides the science upon which the Planning Unit can make instream flow recommendations.

The following topics are included in this report:

- A regional overview and general description of the Little Spokane River Basin (Section 2.0);
- A description of study approach and design, including: fish species selected for evaluation; habitat suitability criteria; and, field methods used in data collection (Section 3.0);
- A summary of the data analysis techniques employed (Section 4.0);

- Results of the Wetted Perimeter analysis and PHABSIM flow-habitat relationships (Section 5.0); and,
- Conclusions and an evaluation of existing minimum instream flows (Section 6.0).

1.5 Authorization, Acknowledgements and Limitations

This report was commissioned by Spokane County on behalf of the Little and Middle Spokane Watershed (WRIAs 55 and 57) Planning Unit by amendment to Spokane County contract #P2960.

Several individuals contributed significantly to the preparation of this report. Stan Miller, Water Quality Section Manager for the Utilities Division of Spokane County Public Works, is the project manager on behalf of Spokane County. Reanette Boese of Spokane County assisted with the field work. Hal Beecher and Kevin Robinette of the Washington Department of Fish and Wildlife provided substantive technical review and guidance. Doug Allen of the Washington Department of Ecology is the lead representative on behalf of the state.

Property access was graciously provided by Mrs. Ogden, Linda Bates, Will Payne, C. Gordon Cudny family, Tom Hargreaves, the Gorder family, and Elk Park managers Mr. And Mrs. Frank Hager. Stream flow data were provided by Rick Noll of the Spokane County Conservation District and Erin Cunningham of the Spokane County Community College. The contribution of volunteer field work by Blake Mee of Spokane County Community College provided is gratefully acknowledged.

Chris Pitre, senior project manager, water resources, is the project manager on behalf of Golder Associates Inc. Dave Fernet provided senior technical direction. Kasey Clipperton was the primary technical author. Donna DeFrancesco provided coordination of field work and data collection with the assistance of Lisa Vaughn, Bryony Stasney, and Chris Bjornson.

This work has been completed in accordance with generally accepted professional practices at the time of preparation within the limitations of available data and budget.

2.0 STUDY AREA DESCRIPTION

The Little Spokane River Basin (WRIA 55) is located in eastern Washington, on the Washington-Idaho Border (Figure 1.1). The basin is located on the eastern edge of the Columbia River Basalt Plateau, in the foothills of the Rocky Mountain Range. It encompasses just under 700 square miles along the eastern border of Washington, including areas in Spokane, Pend Oreille and Stevens counties. The basin is bounded by WRIA 57 (the Middle Spokane Basin) to the south, WRIA 54 (the Lower Spokane Basin) to the west, WRIA 59 (the Colville River Basin) to the northwest and WRIA 62 (the Pend Oreille River Basin) to the north. Streamflow within the basin is affected by many factors including climate, physical characteristics of the watershed, land use/cover in the watershed, and water use.

2.1 Climate and Precipitation

Climate is often considered the driving factor for streamflow. The climate is spatially and seasonally variable in the Little Spokane River Basin. Precipitation falling as rain usually has a direct and relatively immediate affect on streamflow, depending on basin characteristics. Precipitation falling as snow can be held in snow pack for long periods of time and can be released in a relatively short period (freshet) magnifying seasonal variations in streamflow.

Climate in the basin is characterized by generally warm, dry summers and cool, moist winters. Large variations in climate occur across the basin from a sub-humid mountain climate in the north to semiarid in the south (Dames & Moore and Cosmopolitan Engineering Group, 1995).

Annual precipitation ranges from less than 20 inches to over 40 inches across the basin. Between 12 and 15 feet of snow accumulates on Boyer Mountain in the northwest corner of the basin and on Mount Spokane on the eastern border of the basin with WRIA 57. Snow accumulation is less than three feet in the area of the City of Spokane and the Spokane Valley.

Precipitation variability across the basin is primarily a function of elevation and proximity to upland areas. Based on average annual PRISM precipitation data, annual precipitation within the basin ranges from (Table 2-1):

- 15 to 20 inches in southern, low-lying area of the basin;
- 20 to 25 inches across the moderate elevations of the Deer Park Basin (west-central portion of basin);
- 25 to 30 inches across the moderate elevations of the Diamond Lake area (northeastern portion of basin); and,
- 30 to over 40 inches in the uplands along northern and eastern boundaries of the basin.

The Level 1 Assessment presents average monthly PRISM precipitation for the basin, and illustrates that the majority of the precipitation occurs between November and March (Golder, 2001). Significant snow pack accumulates mostly in the eastern and northern portions of the basin at relatively high elevations. Up to 60% of the total precipitation falls as snow during the winter months over the higher elevations (Golder, 2001). Figures presented in the Level 1 Assessment indicate that spring snowmelt originating from the higher elevation areas in the north and east of WRIA 55 represent an important component of run-off to streams. However, the spring snowmelt contribution to streamflow in the lower-lying central and southern portions of WRIA 55 is often reduced as a result of frequent mid-winter thaws (Golder, 2001).

2.2 Physical Characteristics

Physical characteristics of the watershed include such things as soils and geology, topography, shape and size, among other things. Soils and geology determine whether water flows on the surface of the ground or infiltrates and how this water then moves towards the river. Areas with highly permeable geologic material may show little response to storm events because much of the water is infiltrated and released slowly over time, whereas runoff from areas underlain by bedrock is usually quick. Topography and size of the watershed also influences how much and how quickly water reaches the river. Steep sloped basins often have quick response to precipitation events in terms of a flashy runoff, while a flat basin would not. Basins that are large with many varying length tributaries may have several peak flow periods in response to a storm event or snow melt, while a smaller watershed would only show one peak response to an event.

The subsurface geology of the Little Spokane River Basin is comprised of crystalline basement rocks of granite and gneiss, which outcrop on the uplands surrounding the basins. Columbia River Basalt rocks cover parts of the lower elevations of the basin. Rivers eroded valleys in these deposits, and filled them with unconsolidated sediments. Unconsolidated sediments form the primary aquifers in the basin, but the basalts are also locally tapped as productive aquifers.

Elevations in the watershed range from more than 5,300 feet amsl (NGVD 1929) in the north and east sides of the basin to approximately 1,540 feet amsl (NGVD 1929) at the junction of the Little Spokane River and Spokane River. The basin can be broadly split into two regions: the Columbia Plateau Province and the Northern Rocky Mountain Province. Broad and relatively flat topographic features with deeply incised river drainages characterize the Columbia Plateau Province of the southern portion of the watershed. Steep-sided canyons and relatively straight river courses characterize the Rocky Mountain Province to the north.

In the Little Spokane River Basin, there are areas of subdued topography that represent areas of basement and basalt rocks that were scoured and infilled by periglacial processes, including the Missoula Floods. The Spokane Valley represents the main Missoula Flood channel. The primary aquifers comprise these glacial unconsolidated sediments (e.g., the highly productive SVRP Aquifer). Less productive aquifers occur within the basalts (e.g., the Green Bluff Aquifer).

2.3 Land Use/Land Cover

Land use and land cover also affect run-off from snow and precipitation. The majority of the land in the basin (67.5%) is forested, which occurs predominantly across the northern and eastern portions of the basin. The second largest land use category, covering 25.5% of the basin, is agricultural. Urban or built-up land makes up about 4.4% of the basin. Soil types and vegetative cover in conjunction with topography are the primary components that affect how rainfall runs off the surface of watersheds. In addition, land cover/land use information is used to assess water use and water discharge spatially across the watersheds.

Natural land cover ranges from scrub brush in the lower portions of the basin to mixed coniferous and deciduous forests in the uplands. Evergreen forests are the primary land cover in the mountainous areas to the north and east. Agricultural lands are interspersed throughout the watershed but mostly found on the south and east sides of WRIA 55. The remaining portions of the basin are composed of urban areas, rangeland, wetlands and barren land. Table 2-2 presents a breakdown of land-use types in the basin based on Land Use and Land Cover (LULC) mapping results presented in the WRIA 55/57 Phase II Level 1 Assessment (Golder, 2001).

In forested areas, water is intercepted, and used by trees and shrubs (evapotranspiration) causing the total amount of water that reaches the stream to be much smaller than the actual rainfall and the time it takes to reach the stream much longer. Developed areas have greater percentages of impervious terrain, thereby reducing groundwater recharge and increasing the rate of runoff to streams. However, the use of dry wells, which is common in the Spokane Valley urban area, can increase groundwater recharge.

Land use in the Spokane Valley and around the City of Deer Park is primarily urban and residential development. Substantial suburban development is occurring in the lower reaches of the Little Spokane River north of the City of Spokane. Agricultural land use is concentrated in the Dragoon Creek sub-basin of the Little Spokane Basin, and in the Deadman Creek sub-basin, and scattered in lower density throughout the rest of the lower elevations of the basin. Minor amounts of land are used for rangeland.

2.4 Population

The 2000 Census data indicates that the Little Spokane River Basin population is 95,201. Approximately 89% of the population of WRIA 55 is within Spokane County, with lesser amounts in Stevens (9%) and Pend Oreille (2%) counties (Table 2-3). Population growth over the period 1990-2000 was approximately 17%.

The major population centers in the basin are the City of Deer Park (within the Dragoon Creek sub-basin) and the City of Spokane, although only a small portion of the Spokane City limits are contained within the Little Spokane River Basin boundary. The 1990 Census reports a population of 2,278 in the City of Deer Park and a population of 177,196 in the City of Spokane (Golder, 2001). The 2000 Census reports a population of 195,629 in the City of Spokane, reflecting a 9.5% growth rate between 1990 and 2000 (Golder, 2001).

2.5 Available Streamflow Data

Streamflow data has been collected at more than 80 points within the basin. There are three continuous USGS gaging stations in the study area. Most of the remaining records are bimonthly or random measurements (i.e., “snap-shots” in time) that have been collected by local, state, and federal agencies for various water quality or groundwater studies. The locations of USGS and significant stream gaging stations within the study area are shown in Figure 2.1.

The reliability and accuracy of USGS data are considered high, based on the internal quality control used by the USGS in recording and maintaining the gages. The Spokane Community College (SCC) surface water program currently monitors streamflow at the Chattaroy gage (Figure 2.1). These data have been merged with USGS data and are assumed to be of similar quality. Several of the gaging stations, while having a period of record that is useful, do not have a recent period of record or are missing large periods of time, which limits their value.

The Spokane County Conservation District (SCCD) operates five streamflow monitoring stations in WRIA 55 (Figure 2.1). All stations were installed in September 1999 and record stream depth and water temperature at one-hour intervals. SCCD maintains streamflow data for water years 2000-2003. The stations monitored include:

- LS-1 Little Spokane River, Scotia Rd. near Newport WA.
- LS-3 Otter Cr., Elk to Hwy Rd. near Elk WA.

- LS-4 Little Spokane River, Deer Park-Milan Rd. near Riverside, WA.
- LS-5 Dragoon Cr., Crescent Rd., Chattaroy
- LS-6 Deadman Cr., 15628 N. Little Spokane Dr. Spokane, WA.

2.6 Surface Water Hydrology

The Little Spokane River flows 48.6-miles from just south of Newport, Washington to the confluence with the Spokane River, approximately five miles northwest of the City of Spokane. The headwaters of the Little Spokane River are split approximately evenly between the West Branch of the Little Spokane River and the mainstem. Mean annual flow in the Little Spokane River at Dartford (Station 1231000) is 301 cfs, and ranges from 626 cfs to 128 cfs. Peak flows have been recorded at 3,710 cfs, and minimum flows as low as 63 cfs.

Surface water flow within WRIA 55 is complicated due to aquifer interactions, highly variable climate, snowpack influence and watershed characteristics. An examination of existing data indicates that base flows are very important along almost every stretch of the river, especially during the summer months. Instream flows frequently fail to meet the regulatory levels and the duration of excursions is long indicating that an inconsistency between regulatory targets and current streamflow conditions.

Hydraulic continuity between surface water and groundwater is highest with the alluvial and glacial sand and gravel aquifers along Dragoon Creek, near the outlet of Deadman Creek, and lower reach of the Little Spokane River below Dartford. The SVRP Aquifer is interpreted to be in hydraulic continuity with the Little Spokane River along the reach immediately downstream of Dartford and many springs can be seen along the southern edge of the Little Spokane River (Jenson and Eckhart, 1987). Inter-basin groundwater flow from the Pend Oreille drainage into the Little Spokane River Basin is believed to occur in the northeast corner of WRIA 55.

Flow in the upper reaches of the Little Spokane River increases primarily through the contribution of tributaries such as Deadman and Dragoon creeks. In the lower reaches, flow in the Little Spokane River increases significantly as a result of groundwater discharge from WRIA 57. The river is dominantly gaining water throughout its length. Studies in the mid-1990s documented decreasing annual flows over the years; however, more recent data indicate increasing annual flows. Although annual variations and long-term streamflow trends are affected by water diversions and withdrawals, the dominant influence affecting streamflows is believed to be large-scale weather patterns (e.g., decadal patterns affected by the Pacific Decadal Oscillation [PDO]).

2.7 Flow Regulation

There are approximately 22 dams within WRIA 55 the majority of which are small private dams located on tributaries of the Little Spokane River. All of these dams are classified for one of the following purposes: irrigation, recreation and water quality. There are no dams on the mainstem Little Spokane River (Golder, 2001).

Regulation of flows, including dams, withdrawals and discharges, can change a flow regime through changes in timing, size and location of flows. Dam storage and release practices can influence streamflows upriver and downriver of the impoundment as well as increase the pressure head, which can affect ground water flows. The same effects apply for any structure on the river (e.g., weirs, bridges and natural obstructions). Withdrawals can change in timing and/or location of flows. For example, waters withdrawn and used for irrigation may infiltrate back to the river but it may take weeks and it may return to the river at a different location from where it was withdrawn.

2.8 Water Quality

Waterbodies that do not meet standards of the federal Clean Water Act are listed under Section 303(d) of that act. Several stream reaches in the Little Spokane River basin do not meet federal water quality standards for dissolved oxygen, fecal coliform, pH, temperature and polychlorinated biphenyls (PCBs). The probable source of most exceedance problems on the Little Spokane River is non-point source discharges. There are currently no permitted point source dischargers on the Little Spokane River that are known to contribute to water quality standard violations. Likely non-point source discharges that affect water quality in the Little Spokane River include agricultural activities (e.g., fertilizers and animal feedlots), septic systems, stormwater and highway run-off, forest practices, land development, landfills, and mining.

The Little Spokane River did not meet federal standards of 8 mg/L for dissolved oxygen (DO) concentrations in 1996, but had improved in 1998 and were removed from the 303(d) list. The Little Spokane River also has 303(d) listings for PCBs near the mouth of the river.

Dragoon Creek is listed under 303(d) for DO and fecal coliform. Remarks on the Dragoon Creek 303(d) listing state that it is expected that Dragoon Creek currently meets standards due to the removal of direct discharge from the Deer Park Wastewater Facility, but that no recent monitoring has been completed to verify this (Ecology, 2000).

Data for Dragoon Creek from February 1995 through June 1995 indicate that DO standards were met during this period. Fecal coliform levels, however, are above state standards for sites upstream and near Deer Park. Fecal coliform quantities vary seasonally with higher levels occurring during the summer during low streamflow conditions. Water quality tends to decrease near Deer Park. This suggests that DO and coliform problems may be a result of anthropogenic activities.

2.9 Fish Species and Status

The Washington Department of Fish and Wildlife recently compiled a baseline fisheries assessment of the Little Spokane River watershed (Table 2-4). Throughout the greater Spokane River Basin, three species of native salmonids are known to occur: kokanee (*Oncorhynchus nerka*), redband trout (rainbow; *O. mykiss*) and westslope cutthroat trout (*O. clarkia*; NWPPC, 2000). Little detailed information is available regarding salmonid species distribution and stock composition in the Little Spokane River (NWPPC, 2000). Of these three species, the presence of rainbow trout has been confirmed in the Little Spokane River Basin. It is likely that introgression has occurred between hatchery strain rainbow trout, and native rainbow trout and redband trout (NWPPC, 2000). Dragoon Creek is known to support a resident migratory population of rainbow trout during the spring, however little information is available regarding genetics and other life history information (NWPPC, 2000).

3.0 METHODS

The purpose of this instream flow assessment is to evaluate existing minimum instream flows with respect to how they benefit aquatic biota, and to provide a technical foundation to support instream flow recommendations for selected stream reaches. The selection of methods to support these purposes was based on maximizing the number of sites assessed within the available budget, while maintaining the validity and relevance of data collection to project goals. A number of available methods for the evaluation of instream flow needs were reviewed for applicability to Little Spokane River instream flow assessment goals, the most significant of which are discussed below.

3.1 Methods for Evaluation of Instream Flow Needs

Analysis of habitat conditions within a watershed focuses on the assessment of channel conditions and associated streamflows as they relate to aquatic and riparian habitat. The terms instream flow analysis and instream flow needs assessment are generic terms applied to various methods or approaches that can be used to quantify flow-habitat relationships and make recommendations on flow management. The different methods that can be used for the analysis each have particular strengths, weaknesses, and associated costs. Some methods overlap with techniques used to answer geomorphologic or hydrologic questions.

Methods developed for assessing instream flow needs have been focused primarily on protecting aquatic habitats. Approaches for determining instream flows that provide suitable habitat for fish species have received the most attention. The various methods available for assessing instream flow requirements have been reviewed several times by academia, agency scientists, and the private sector over the last 20 years (e.g., Stalnaker and Arnette, 1976; Wesche and Rechard, 1980; Morhardt, 1986; Courtney, 1995; Jowett, 1997). The most recent of those documents providing useful review information include the proceedings of a recent conference on ecohydraulics (Utah State University, 1999) and two reports on assessing effects of hydroelectric power generation (Morrison, 2000; Natural Resource Solutions, 2000). Annear and others, 2002, recommend that five components should be addressed in an IFN study: hydrology, biology, geomorphology, water quality, and connectivity.

Most instream flow methods fall into one of three categories, although there are modifications to many methods that cross between these categories:

- Statistical desktop methods (e.g., the Tennant Method);
- Hydraulic rating curves (e.g., the Wetted Perimeter and Toe-width Methods); and,
- Habitat assessments (e.g., PHABSIM and IFIM-type methods).

The statistical methods provide estimates of minimum instream flow requirements that are empirically derived from historical flow data and generally do not have a direct relationship with the biological flow needs of aquatic life. Statistical methods can be the least expensive if sufficient streamflow data are available. Hydraulic rating curve methods can be tailored to address specific flow characteristics that are related to flow needs of specific life stages of specific species (e.g., salmon spawning habitat). Hydraulic rating methods are intermediate in terms of complexity and costs. Habitat assessment methods integrate the multiple variables important to fish habitat and are the most complex, rigorous, and time-consuming. They are also the most expensive.

Of the available methods, a Wetted Perimeter, hydraulic rating curve method, with the addition of measurements of habitat cover and substrate was selected for the Little Spokane River instream flow needs assessment. In discussions and a reconnaissance of the river with Hal Beecher (WDFW instream flow specialist), it was determined that sites consisting of one transect within a homogenous reach would be suitable for an instream flow analysis on the Little Spokane River and tributaries. Based on review of initial data collected, and approval form Hal Beecher, a more detailed one-transect PHABSIM analysis was applied (see Appendix B for meeting minutes summarizing conversations regarding methodology selection).

3.1.1 Description of Wetted Perimeter Method

The Wetted Perimeter Method is a hydraulic rating curve method based on the relationship between streamflow and the wetted perimeter of the stream channel (i.e., the distance along the wetted portion of the bottom and sides of a stream). It requires data describing the cross-sectional geometry at a stream transect and knowledge of water levels at various discharges. The underlying biological assumption is that reductions in the wetted perimeter are correlated with losses in habitat quality. The method uses transect data from critical or important habitat areas, typically riffles because of their sensitivity to changes in flow and stage, to establish the relationship between flow and wetted perimeter. Hydraulic modeling can be used to generate synthetic data for unmeasured flows. The discharge versus wetted perimeter plot is then interpreted to help identify appropriate minimum instream flows. The identification of instream flow values is based largely on the location of inflection points on the wetted perimeter-discharge curve (i.e., where the slope of the curve changes sharply). Usable results will identify a range of low flows over which increasing the flow will result in a relatively high rate of increase in habitat as represented by the wetted perimeter, and a range of high flows over which an increase in flows returns a lower rate of increase of habitat. The point at which the shift from higher gains in habitat to lower gains in habitat occurs is termed the inflection point, and is typically identified as the minimum instream flow requirement for that stream reach.

Additional information such as substrate type and presence of cover may be added to the basic method to improve interpretation, as was carried out in the present study. Information such as depth, velocity, substrate, and cover distributions may be incorporated into the analysis, and compared to habitat preference criteria of target management species, to augment the wetted perimeter analysis.

A limitation of all rating curve methods is that habitat is measured only at specific locations; areal extent of habitat types is not determined or quantified. These methods are therefore often applied at biologically critical locations such as known spawning sites or potential barriers to movement where determination of passage flow requirements is desired. A further limitation is that the habitat assessments are only strictly valid within the range of discharges for which stage/discharge measurements are made. Extrapolations of habitat quality or availability beyond the range of observed discharges may not be valid. Wetted perimeter may therefore be less useful in situations where a proposed flow regime involves discharges outside the range of flows used in the wetted perimeter analysis. This situation, however, is not likely, because most of the likely flow modifications are typically targeted toward critical low-flow periods. The usefulness of results and the ease with which inflection points can be identified are subject to the channel morphology at the selected transect locations. The wetted perimeter method produces a single flow number for all species and life stages and does not account for the unique biological needs of individual target species and life stages.

3.1.2 Description of PHABSIM

Generally accepted as the best available tool for determining quantitative relationships between flows and fish habitat, the Physical Habitat Simulation System (PHABSIM) is a collection of computer programs that can be used to represent habitat suitability according to characteristics of microhabitat availability (typically depth, velocity, substrate, cover; Milhous and others, 1989). PHABSIM is an integral part of the Instream Flow Incremental Methodology (IFIM), which provides a problem-solving framework for water resource issues relating to streams and rivers (Bovee and others, 1998), and is perhaps the most commonly used element of IFIM in assessment of physical habitat. PHABSIM includes an assortment of simulation tools, which aide in the classification of physical habitat structure within a stream and the assessment of flow-dependent characteristics of physical habitat with regards to the biological needs of selected target species and life stages.

PHABSIM and the resultant Weighted Usable Area (WUA) versus discharge relationships (which represent habitat availability at different discharges) is currently the most comprehensive and widely accepted instream flow analysis method used in North America. PHABSIM has been applied in numerous areas to develop instream flow regulations, and has withstood challenges in legal proceedings. PHABSIM is, however, time-consuming and costly to apply. Typically, a major portion of the cost of such a study is expended in the determination of the microhabitat preferences of fish species and life stages. These “fish preference curves” are commonly a source of uncertainty in PHABSIM results, and may be subject to criticism. When there is no way to develop site-specific preference curves, it is necessary to use more generic, or regionally applicable preference curves.

The major goal of physical habitat simulation is to achieve a representation of physical properties of a particular stream that may be connected, through biological (or other) considerations, to social, political, and economic frameworks. This relationship is a continuous function between physical habitat and stream flow that can be used to consider trade-offs between the values of water used instream with water used out-of-stream. PHABSIM can be used for a variety of applications including quantification of instream flow requirements, negotiation of water delivery schedules, and impact analysis (Hardy, 2002).

3.2 Selection of Evaluation Species

Based upon fish species assessment work completed by WDFW, the WRIA 55 Instream Flow Workgroup selected mountain whitefish and rainbow trout upon which to focus the instream flow assessment. Unique instream flow need characteristics of these species are that mountain whitefish need high flows, and rainbow trout need cold water. These species were selected as being sensitive indicator species. It was rationalized that if instream flow-based requirements for mountain whitefish and rainbow trout are met, then it is likely that they are also met for other aquatic biota. The WDFW assessment provides strong evidence that both of these species occur at the six selected monitoring sites (Table 2-4, Figure 3.1 and Appendix B).

The Instream Flow Workgroup/WRIA 55 Planning Unit concluded that the use of these target species provided an assessment of two sensitive species that spawn in both the spring and late fall (Appendix B). The use of these two species for the Little Spokane Instream Flow Needs Assessment was approved by Hal Beecher of WDFW (Appendix B).

The following species descriptions for mountain whitefish and rainbow trout are summarized from a book entitled “Inland Fishes of Washington” (Wydoski and Whitney, 1979), unless otherwise noted.

3.2.1 Mountain whitefish (*Prosopium williamsoni*)

Mountain whitefish is the most common whitefish found in Washington State. Mountain whitefish typically reside in both lakes and streams. In stream environments, they are most often found in riffles during the summer and prefer large pools during the winter. Preferred water temperatures range between 9 and 11 °C (48 and 52 °F) and life expectancy can reach 11 years. Mountain whitefish diet typically consists of aquatic insect larvae, crayfish, fish eggs, leaches, and some smaller fish.

Mountain whitefish reach maturity at approximately 3 to 4 years of age. Spawning typically occurs in the fall, between October and December and takes place in gravely stream riffles or on gravel shoals along lakeshores. Mountain Whitefish in the Little Spokane River Basin typically spawn during December and January (Chris Donely personal communication, April 18, 2003). Females have been known to produce between 2,900 and 9,400 eggs. Eggs hatch within approximately one month. At low temperatures, egg incubation is often prolonged.

3.2.2 Rainbow trout (*Oncorhynchus mykiss*)

Rainbow trout prefer cool water temperatures (typically less than 21 °C [70 °F]) with high dissolved oxygen content. Growth rates of rainbow trout in eastern Washington are high relative to growth rates of western Washington due to less precipitation and higher nutrient accumulations, contributing to increased food supplies and higher water temperatures. Rainbow trout typically feed on aquatic insects, worms, fish eggs and occasionally smaller fish. Their diet is subject to change based on the season and fluctuations in availability of various food types. Rainbow trout fisheries in Washington State are highly dependent upon hatchery stocking of lakes and less often, stocking of streams.

Rainbow trout spawning typically occurs in the spring between February and June and is dependent upon water temperature and geographic location. Chris Donley of WDFW (personal communication) confirmed that the Little Spokane River rainbow trout typically spawn in March and April, and that there are also a fall spawning rainbow trout that has been stocked in the Little Spokane River. Most rainbow trout reach maturity in three years, but depending upon growth rates, age of maturity can range between one and five years. Successful spawning is highly dependent upon the presence of running water, and lake populations rely upon tributaries for suitable spawning habitat. Females dig redds and deposit between 200-9000 eggs, covering them with gravel for incubation. Up to 95% of eggs are fertilized; however only 65-85% survive the incubation period, often as a result of high levels of silt. Eggs hatch after approximately 50 days of incubation, when water temperatures reach around 10 °C (50 °F). Following emergence, rainbow fry rear in pools and areas of low streamflow velocity until they are large enough to withstand higher velocities typically associated with riffle habitats.

Spokane Basin rainbow trout stock originated in the McCloud River near Mr. Shasta, California (NWPPC, 2000). Redband trout (*O. mykiss gairdneri*) is a subspecies of rainbow trout (*O. mykiss*). Resident populations of Columbia River redband trout are found throughout the Columbia River basin east of the Cascades, including the Little Spokane River system. Karen Divens with WDFW confirmed that redband trout spawn and rear at approximately the same time as rainbow trout, therefore the instream flow needs assessment would also indirectly assess habitat needs for redband trout (Appendix B, February 25, 2003 Minutes).

3.3 Habitat Suitability Criteria

Rainbow trout habitat suitability criteria were obtained from the Washington Department of Fish and Wildlife and Washington Department of Ecology publication entitled, "Instream Flow Study Guidelines" (2003; Appendix C). The curves presented in this document are fallback curves for the state of Washington, meaning that they are generalized habitat preference curves used when site-specific habitat preference data is not available. Site-specific curves do not exist for rainbow trout in the Little Spokane River, and these state fallback curves are the most recent and are considered the best available science (Hal Beecher personal communication, November 6, 2002). These are

Category III curves, implying that they are transferable to streams and conditions that may differ from the streams where the curves were originally developed (Hal Beecher, personal communication, November 6, 2002).

The state instream flow document discussed above does not include habitat preference criteria for mountain whitefish and criteria of this type have not yet been developed for the State of Washington (Hal Beecher personal communication, November 6, 2002). Therefore, regional depth and velocity habitat suitability criteria developed at an expert workshop for use in Alberta were used for mountain whitefish (Addley and others, unpublished report; Appendix C). Habitat suitability criteria developed in an expert workshop for the Highwood River, Alberta (Clipperton and others, 2002) were used for evaluation of mountain whitefish substrate suitability. The substrate suitability criteria were weighted according to the protocols outlined in the document "Instream Flow Study Guidelines" produced by WDFW and Ecology (1996). Approval of the use of the Alberta curves for the Little Spokane instream flow assessment was provided by Hal Beecher (personal communication).

3.4 Study Site Selection

Study site selection occurred under the guidance of the WRIA 55 Planning Unit Instream Flow Workgroup, and included input from representatives from WDFW, Ecology and Golder. The decision making process included a field visit to a number of potential study sites as well as suggestions from John Whalen with WDFW, who provided insight on the biota of the Little Spokane River. Homogeneous reaches were determined from an elevation profile of the stream (Figure 3.2) and the site visit. Study sites were selected on the basis of existing minimum instream flow control points, fish habitat, cost per site relative to the chosen instream flow methodology, fish distribution and use, hydrology, existing data, and site accessibility. A number of Planning Unit meetings and Instream Flow Workgroup meetings were devoted to discussion of these criteria as they relate to the selection of instream flow study sites. Ultimately, six sites were chosen for evaluation based upon the criteria listed (Figure 3.3). Each of these sites and the associated decision making process is discussed in greater detail below. Appendix B presents Planning Unit Meeting minutes and memos documenting the selection of study sites.

Three of the study sites were selected as they are in close proximity to established minimum instream flow compliance points, and were chosen primarily due to the fact that these compliance points were initially established without regard to biological criteria. These sites include:

1. **Little Spokane River at Pine River Park** – flows below the USGS at Dartford gage are anticipated to be relatively high. This reach is considered a critical reach and warrants focus due to:
   a. Its importance relative to fish habitat (e.g., this reach has the highest flow in the basin and may provide the best fish habitat); and,
   b. The use of the nearby gaging station in water rights enforcement.
2. **Little Spokane River at Chattaroy** – this site is considered relatively pristine and warrants focus for purposes of maintaining the apparently high quality habitat. This site was selected for assessment of the established minimum flow at Chattaroy.
3. **Little Spokane River at Elk Park** – this site is considered relatively pristine and warrants focus for purposes of maintaining the apparently high quality habitat. This site was selected for its use in assessing the validity of the existing

minimum flow at Elk, as well as the viability of managing new water rights based on flow at this site.

The three other sites were chosen primarily on the basis of fish habitat related issues and the need to address the role of tributaries in the provision of fish habitat. Spawning habitat is nearly absent on the mainstem and is known to occur primarily in tributary streams (Appendix B, June 19, 2002 Minutes). Jason McClellan (WDFW) described the Little Spokane River tributaries as thermal refugia for fish during summer months, but there is little actual data on the numbers of fish entering tributaries (Appendix B, June 19, 2002 Minutes). The three other tributary streams selected for analysis based on fish habitat issues are:

4. **Deadman Creek near mouth**– this site is considered by WDFW to provide valuable spawning and rearing habitat for key species.
5. **Dragoon Creek near mouth** – this site warrants focus due to the high degree of land use, the anticipated high level of future land use, and associated 303(d) listings. This creek has high nitrate concentrations (e.g., 6 mg/l) even during low flow periods.
6. **Otter Creek near mouth** – this site is considered by WDFW to provide valuable spawning and rearing habitat for key species. Additionally, there was an observable decrease in flow when irrigation pumps were activated during a WDFW survey.

3.5 Transect Site Selection

The six selected reaches were visited to identify appropriate cross-section locations for wetted perimeter monitoring. One cross section was selected in a representative riffle area of each study site. The precise location was chosen to take advantage of the best locally available conditions for stage and discharge measurements. Additional considerations for site selection included: flow confinement to a single channel; location relative to a confluence so that backwater effects were avoided; accessibility for monitoring; and, streambank stability. Transects were chosen in riffle habitat based on suitability for the wetted perimeter approach (not habitat approach) and on the basis of site access.

3.6 Field Data Collection Procedures

A total of six field visits were made to each of the six selected study sites. During the initial field visit in September 2002, transects and stations were established, and a low-flow measurement was taken. Substrate and cover assessments were also completed during the initial site visit. Five additional flow measurements were made in late fall 2002/winter 2003. The timing of these measurements was based upon real-time streamflow conditions at the USGS Dartford Gage. Table 3-1 provides a summary of the measured flows at each site, as well as the flows at the USGS Dartford Gage during each of the six monitoring periods. Memos summarizing each of the six field visits are provided in Appendix D. Photographs of each site during each of the six field visits are provided in Appendix E

3.6.1 Criteria for Dispatching Field Crews

Flow monitoring was scheduled on the basis of real-time streamflow conditions at the USGS Dartford Gage as well as weather forecasts for the region. Each field visit was scheduled to assess a different range of low to high flows. Reanette Boese of Spokane County arranged access to streamside locations prior to each visit. Health and safety plans were distributed and signed by all participating field crewmembers prior to commencement of field activities. Each field crew consisted of a minimum of one Spokane County person and one Golder person, and often included more field personnel depending upon scheduled activities.

3.6.2 Substrate and Vegetation Surveys

A minimum of twenty stations were established across each transect. During the initial survey, substrate composition, the vertical velocity profile, and physical cover for each fish life stage were recorded at each station across each transect. Vegetation (both aquatic and terrestrial) was also assessed across each transect, as was a description of terrestrial vegetation at the high water mark. A description of transect information from the vegetation line was recorded. Vegetation species, type, condition, and cover was recorded for 10 feet upstream and downstream of each transect.

3.6.3 Velocity, Depth and Discharge Measurements

A minimum of 20 depth and velocity measurements were taken across each transect. Mean water column velocity was determined at each vertical measurement point, using a Swoffer water velocity meter. Discharge was determined following standard USGS methods. Additional vertical stations were established such that no more than 10% of river flow occurred between any two points.

In high flow conditions, a high-flow sampling protocol was employed to obtain flows where discharges exceeding 300 cfs, that involved a three-person crew and an inflatable raft with an outboard motor.

3.6.4 Channel Morphology Measurements

When locating cross sections during the initial site visit, cross-sectional profiles of the transects were surveyed at each the six study sites. Cross sections were surveyed using protocols similar to Harrelson and others (1994), Kondolf and Micheli (1995), and Rosgen (1996). Two end points were established at each cross-section location. Cross sections were oriented perpendicular to flow, from the left terrace across the river to the right terrace. Each end of the cross section was permanently marked for future measurements with a 2.5-foot long by ½ inch diameter rebar pin. The rebar was driven flush into the ground with a sledgehammer, capped and marked. Each pin was documented for location with GPS tools.

Cross sections were surveyed using a laser level and graduated rod with laser detector. A tagline marked in one-foot increments was stretched across the channel between the two pins. The tagline was zeroed on the left downstream bank headpin. Horizontal and vertical coordinates were then obtained across the channel. Major topographic breaks were surveyed and a minimum of 20 measurements across the channel were made. In addition, the following features were noted for each cross-section: left pin; left terrace; left edge of water; right edge of water; right terrace; and, right pin. These features were also surveyed during the five subsequent flow monitoring periods to provide a relationship between flow and water surface elevation.

Relative streambed elevations were surveyed across each transect at each slope break across each transect. Vertical stations across each transect were established at each slope break, and each change in substrate type. Spokane County surveyed the locations of the head pins to a horizontal accuracy of +/- 1.0 foot, and a vertical accuracy of +/- 0.1 foot.

3.7 Data processing procedures

Field data compiled during the initial visit at each transect included channel elevation data, substrate composition, velocity breaks and other physical cover, vegetation data, horizontal station coordinates, vertical or depth coordinates and mean water velocity data. All data were entered into individual spreadsheets and channel elevations were plotted to create cross-sectional profiles for each of the six transects. Discharge was calculated through input of horizontal and vertical coordinates and velocity measurements.

During each subsequent flow monitoring visit, station, depth, velocity and elevation data were collected entered into appropriate spreadsheets. Water surface elevation and associated flow were plotted for each visit (Figures 3.4 through 3.9; Appendix D).

4.0 ANALYSIS

The instream flow needs analysis was conducted using two different approaches: a Wetted Perimeter evaluation; and, a limited habitat evaluation method using PHABSIM (Physical Habitat Simulation) modeling. The Wetted Perimeter method is a hydraulic rating approach and is considered a standard setting method, while the habitat evaluation using PHABSIM is considered an incremental approach capable of evaluating different flow management alternatives (Annear and others, 2002).

4.1 Wetted Perimeter Analysis

The wetted perimeter for each transect was calculated using the surveyed bed profile and modeled water surface elevations. A stage-discharge approach was used to model water surface elevations at unmeasured discharges. PHABWin-2002, developed by Utah State University, is a Windows©-based version of PHABSIM (Physical Habitat Simulation). The water surface modeling module within PHABWin-2002 (identical to IFG4 in PHABSIM) was used to conduct the stage-discharge regression modeling. The basic premise of stage-discharge modeling is to define a relationship between the water surface elevation (stage) and discharge, based on a log-linear regression of measured water surface elevations at several different discharges (Hardy, 2002).

Water surface elevations were measured at six different discharges for each site; however, the PHABWin-2002 software can only accommodate five sets of calibration data. A preliminary evaluation of the stage-discharge data was conducted to identify any potential outliers and select the five data points measured in the field that provided the best stage-discharge relationship. The field data were entered into a spreadsheet and imported into PHABWin-2002. A visual assessment of the bed profile and measured water surface elevations was conducted using the plotting options within the PHASWin-2002 software to ensure the data were entered correctly. Any irregularities, such as sharp jumps in the bed profile, were checked against the field notes to confirm data accuracy.

PHABWin-2002 is not designed specifically for calculating the wetted perimeter at single transect. In order to run the PHABWin-2002 model, at least two transects are required so that an area can be defined between transects. For the purpose of the Wetted Perimeter analysis (and the PHABSIM analysis described later), a second transect was created that mirrored the measured transect. The field data defining the bed profile, water surface elevation, velocities, and substrate were simply copied and inserted in the model at a location 1ft upstream of the first transect. This essentially created a simulated stream segment with a length of 1ft.

The fact that both transects are identical and have the same water surface elevations is not a concern for the hydraulic modeling because the stage-discharge model treats each transect independently. The PHABWin-2002 model has an option to model the weighted useable bed area (as opposed to the weighted useable area of the water surface typically used for PHABSIM studies) that was used to define the wetted perimeter. This is an option within the habitat model, and therefore the velocity model and habitat models had to be run. To define the wetted perimeter, a habitat suitability curve was created that had a suitability of 1.0 (i.e., optimal) for all depths, all velocities, and all substrate types. When the habitat model is run to calculate the weighted useable bed area, the entire bed area that is under water is defined as potentially useable habitat. With a distance of 1ft defined between transects, the weighted useable bed area is also a measure of the wetted perimeter of each transect. Because the result is displayed as an area per 1000 ft of stream, the result was simply divided by 1000 to give the final wetted perimeter value. The results were checked back against the data output files produced during PHABWin-2002 modeling for confirmation.

The Wetted Perimeter approach uses a graphical representation of the wetted perimeter plotted against discharge to identify a breakpoint or change in slope in the plot to define the instream flow recommendation. The method assumes that a breakpoint will be detectable and that the breakpoint has biological relevance. In some instances, a statistical approach has been attempted to define the change in slope on the wetted perimeter versus discharge curve to define the recommended instream flow (Annear and Conder, 1983). A statistical approach to define the breakpoint requires multiple transects across similar habitat types within each reach to be measured in order to perform even basic statistics. This level of effort was not carried out for the Little Spokane River study and as a result, defining the breakpoint was a subjective evaluation. The primary purpose for inclusion of the wetted perimeter analysis in this study is to evaluate the correlation between results of the wetted perimeter method and the PHABSIM analysis. Based on the resulting correlation, judgment may be made on whether application of the less costly wetted perimeter approach in future instream flow studies is appropriate.

4.2 PHABSIM Analysis

The PHABSIM group of models is one component of the Instream Flow Incremental Methodology (IFIM) (Bovee 1982, Bovee and others, 1998). A PHABSIM analysis involves hydraulic modeling (water surface modeling and velocity modeling) and habitat modeling to develop a relationship between habitat availability and discharge for the selected species and life stages of interest. The water surface modeling for the Little Spokane River followed the same protocols as defined in the Wetted Perimeter approach outlined above.

The velocity modeling module within PHABWin-2002 (identical to the IFG4 program in PHABSIM) was used to simulate velocity distributions across each transect. The measured velocity distribution across each transect at the known discharge is used to calibrate the velocity model by solving Manning's equation. The IFG4 program then uses Manning's equation to predict the velocity distribution at unmeasured discharges [see Hardy (2002) for a detailed discussion of this procedure]. All model option defaults were used in running the velocity models. Once again, although an identical transect was created to run the model as described above, the velocity model treats each transect independently, so the mirrored transect 1ft upstream has no influence on the results of the measured transect.

Separate velocity models were defined for low, medium and high discharges based on the range of flows measured at each site. Within each velocity model, a single-velocity modeling approach was used whereby the velocity profile from a single calibration discharge was used to model the velocities for all discharges within that model. The range of flows to be simulated followed the "rule-of-thumb" criteria of no less than 0.4 times the calibration discharge and no more than 2.5 times greater than the calibration discharge. Using this range of flows for each of the low, medium and high discharge models provided an overlap of simulated discharges between each velocity model to aid in merging the results together for final analysis. The velocity modeling results were evaluated by reviewing the velocity adjustment factor (VAF) at each simulated discharges. Milhous and others (1989) evaluate VAF value ranges as:

- 0.9 to 1.1 is considered good;
- 0.85 to 0.9, and 1.1 to 1.15 is considered fair;

- 0.8 to 0.85, and 1.15 to 1.20 is considered marginal; and,
- Less than 0.8 and more than 1.2 is poor.

The hydraulic modeling results define the distribution of depths and velocities across each transect at each simulated discharge. A substrate profile is defined directly from the field data and remains constant at all simulated discharges. The next step in the PHABSIM analysis is to conduct the habitat modeling using the results of the hydraulic modeling.

The habitat modeling module within PHABWin-2002 (identical to HABTAT from PHABSIM) evaluates the suitability of habitat for each species and life stage of interest at each simulated discharge for every point across each transect based on habitat suitability criteria. Habitat suitability criteria (HSC) define ranges of depths, velocities and substrate types as either suitable, unsuitable, or somewhere in between. With each different discharge that is simulated, the depths and velocities will change and as a result, the potential suitability of the available habitat will also change. The Washington state-wide HSC curves were used for rainbow trout (WDFW and Ecology, 1996) and regional HSC curves developed at an expert workshop for use in Alberta were used for mountain whitefish (Addley and others, unpublished report). The curve coordinates are provided in Appendix C.

The typical product of PHABSIM modeling is a weighted useable area (WUA) curve that provides a relationship between useable habitat and discharge for each species and life stage under investigation. Each transect is divided into verticals based on the location of the depth and velocity measurements taken in the field. Each vertical has a calculated area depending on the distance between measurements along the transect and the distance to the next adjacent transect. The area defined at each vertical along the transect is referred to as a cell. For the Little Spokane River, the distance to the next adjacent transect was always set as 1ft while the distance between measurement locations along each transect varied according to a variety of factors such as stream width. Each cell has an average depth, average velocity and a channel index (substrate or cover suitability) value for each simulated discharge. The WUA of each individual cell is defined as the total area of the cell multiplied by the combined habitat suitability factor for that cell at each simulated discharge. As an example, if a cell has an area of 10 square feet and the simulated depth, velocity and channel index had corresponding HSC values of 1.0, 0.9, and 0.8, respectively, the combined suitability for that cell at that simulated discharge would be 0.72 (1.0*0.9*0.8 = 0.72). The WUA for that cell would therefore be 7.2 square feet. As depths and velocities for each cell change with discharge, the habitat suitability can also change. It is quite common to have depth as a limiting factor in a cell at low discharges while velocities become limiting at high discharges. The final WUA for each simulated discharge is the sum of the weighted useable areas for each cell with a standardized output reported as square feet of habitat per 1000 feet of stream.

The approach used for the Little Spokane River Project was designed to evaluate the change in habitat across a single transect with changes in discharge for six different reaches. The original study design was focused on the selection of transects for a Wetted Perimeter approach. Extending the analysis to conduct a PHABSIM evaluation was decided after all of the transects had been selected. The WUA values are only representative of a single habitat type, typically a riffle habitat, chosen for its suitability in a Wetted Perimeter approach and it may not be the most representative habitat type for the reach. Riffle transects are, however, typically the most sensitive to changes in flow because of their shallow nature, and also tend to be the most productive habitat types (where stream oxygenation occurs, benthic invertebrate [bug] production is highest, and where many fish species spawn and egg incubation occurs). It is for this reason that riffle habitat types are most often used in the Wetted Perimeter approach.

The WUA curves produced from the habitat modeling for the Little Spokane River Project are effectively the weighted useable width (WUW) of each transect. The WUA curves were divided by 1,000 to transform the WUA result (reported as ft^2/1,000 ft) to a measure of the WUW across the transect on which the analysis was based. Each WUW curve was also normalized by dividing each value in the WUW curve by the maximum value in the curve to provide a result with a value range between zero and one. This allows for easier comparison between life stages without losing any information on how habitat changes with discharge for each life stage.

As is typical in PHABSIM modeling using a single velocity approach, the transition between the low, medium and high velocity models is not always smooth, and may result in jumps in the WUA/WUW curve between these transition discharges. A sliding weighted average was calculated using overlapping discharges from the low to medium flow model and from the medium to high flow model to smooth the transition of results between flow models. Weighting the lowest overlapping discharge in favor of the lower flow model and adjusting the weighting at each successive point until the final discharge is weighted in favor of the higher flow model accomplish this. The weighting factors used varied depending on the number of overlapping discharges. At a minimum, the calculation included three overlapping discharges with a weighting factor of 0.75/0.25, 0.5/0.5, and 0.25/0.75.

5.0 RESULTS

The results from each of the approaches were compared to the existing minimum instream flows defined in Chapter 173-555 WAC. The existing minimum instream flows were originally defined using a standard office approach based on a flow duration curve analysis. To conduct the evaluation of existing instream flow criteria on the Little Spokane River, these criteria were initially compared to the results of the Wetted Perimeter analysis. As the results of the Wetted Perimeter analysis were generally inconclusive, the WUW curves were used to define the habitat available at the existing minimum instream flow, the habitat corresponding to the Wetted Perimeter results, and the habitat corresponding to the local hydrology using the weekly 10%, 50%, and 90% flow duration statistics. For Dragoon Creek, Deadman Creek, and Otter Creek, an existing minimum instream flow value and long-term hydrology were not available. The evaluation of instream flows for these sites was based on a general assessment of the WUW curves, and a comparison to any existing hydrological information.

5.1 Wetted Perimeter Analysis

Wetted perimeters were defined for each site from field measurements of the bed profile and simulated water surface elevations using a stage-discharge regression (Figures 5.1 through 5.6). The slope of the wetted perimeter versus discharge relationship between adjacent discharge measurement points was also plotted to assist in defining the breakpoints on the plot. The definition of the breakpoint remained subjective as many of the sites exhibited a gradually changing slope rather than an obvious break in the slope. Table 5-1 summarizes the breakpoints defined for each site. In some cases, several breakpoints could be identified, but for the reasons provided in Section 6, a single Wetted Perimeter value is identified for evaluation with the habitat results.

A common criticism of the Wetted Perimeter method is the subjectivity in selecting a breakpoint in the plot of wetted perimeter versus discharge. The Little Spokane River at Elk and Deadman Creek exhibited fairly noticeable breakpoints while the sites at Pine River Park, Chattaroy, and Dragoon Creek were much more subtle, exhibiting relatively steady changes in the slope rather than a distinct breakpoint. The Otter Creek site showed a break in the slope; however, the pattern of changing slope then reversed itself. The clear breakpoint on Otter Creek occurs over a range of flows associated with a small terrace on one bank that appears to be higher than the typical base flows in the creek. No clear breakpoint is apparent at lower flows on Otter Creek.

5.2 PHABSIM Habitat Flow Relationships

The habitat-discharge relationship for each site was initially output from the PHABWin-2002 model as a weighted useable area (WUA) curve. The Little Spokane River study was designed to evaluate the weighted useable width (WUW) of a single transect. To properly represent the WUW of the transect, the final WUA, reported as ft^2/1,000 ft of stream was divided by 1,000 to show the representative amount of habitat available across the transect.

5.2.1 Little Spokane River at Pine River Park

The measured discharges and water surface elevations for the Pine River Park site are shown in Table 5-2. This table also shows the calibration flow for the low, medium, and high flow models, the range of simulated discharges used for each model, and a comparison of the measured and predicted water surface elevations. The final range of flows modeled was from 50 cfs to 875 cfs. The measured water surface elevation provided in Table 5-2 is the average value from the measured water surface elevations at the left and right bank. The water surface elevation at 106.1 was selected as the left bank value rather than the average due to the large difference in measured values and the better fit in the stage-discharge rating curve of the 96.34 ft value. Two separate linear stage-discharge regressions were used to model water surface elevations at the Pine River Park site. All modeled flows less than or equal to 325 cfs used the 106.1 cfs, 119.5 cfs, and 300.9 cfs discharges to develop the stage-discharge regression. At modeled flows greater than 325 cfs, the 300.9 cfs, 549.4 cfs, and 868.1 cfs discharges were used to develop the stage-discharge regression.

The calibration details for the velocity model along with a graphical representation of the velocity model performance at simulated discharges are provided in Appendix F. No extreme velocities were observed at the simulated discharges and the velocity adjustment factors were all within the expected range of 0.8-1.2 as defined by Milhous and others (1989). The velocity adjustment factors for each simulated discharge are provided in Appendix F.

A sliding weighted average was calculated using overlapping discharges from the low- to medium-flow model and from the medium- to high-flow model to smooth the transition of results between flow models. The overlapping discharge ranges at the Pine River Park site were 160 cfs to 240 cfs with nine overlapping discharges for the low-flow to medium-flow transition, and 400 cfs to 600 cfs with nine overlapping discharges for the medium-flow to high-flow transition. The final WUW curves for the Pine River Park site are shown in Figures 5.7a and 5.7b.

The rainbow trout spawning habitat suitability criteria have a very narrow range of depths that are identified as suitable for spawning use. As a result, the WUW curves for rainbow trout spawning also tend to be very narrow, and for the Pine River Park site, also peaks at a relatively low discharge of 70 cfs. It is important to note that the habitat suitability criteria for rainbow trout spawning were developed using data from streams in which depths rarely reached 2 feet. WDFW is currently in the process of developing a scale-independent spawning habitat suitability model to account for mesohabitat rather than just depth alone as a habitat determinant (Hal Beecher personal communication, June 9, 2003).

As is common with PHABSIM analysis, the fry life stages also tend to indicate that the most available habitat occurs at relatively low discharges. This is a result of the fry habitat suitability criteria defining a preference for shallow, slow habitat, which is often maximized when there is very little water in the stream. Conditional criteria can be used to correct this issue by only accounting for suitable habitat at a specified distance from the bank of a river; however, these data were not available from the statewide habitat suitability criteria curves and is also not a modeling option within PHABWin-2002.

In contrast, the rainbow trout and mountain whitefish juvenile and adult WUW curves have a broader range of discharges that provide useable habitat, although the amount of habitat available is much greater for mountain whitefish than it is for rainbow trout (Figures 5.7a-b). This is a result of a broader range of suitable depths and velocities defined for mountain whitefish.

As an additional piece of information, the effect of substrate on modeled mountain whitefish habitat availability was also evaluated (Figures 5.8a and 5.8b). The habitat for mountain whitefish was modeled with and without substrate suitability criteria at every site. Figure 5.8b show the normalized results of this comparison for the Little Spokane River at Pine River Park site. Although the total amount of habitat is different, the general shape of the WUW curves are very similar up to the peak of the curve and differ slightly at higher flows when the curves are normalized. This indicates that mountain whitefish are not very sensitive to the type of substrate available and select habitat based primarily on the depth and velocity conditions. Similar results were observed for all sites and are presented in Appendix G. All modeling results presented in Section 5 of this report are computed by including substrate preference criteria for all mountain whitefish life stages.

5.2.2 Little Spokane River at Chattaroy

The measured discharges and water surface elevations for the Chattaroy site are shown in Table 5-3. This table also shows the calibration flow for the low, medium, high and very high flow models, the range of simulated discharges used for each model, and a comparison of the measured and predicted water surface elevations. The final range of flows modeled was from 30 cfs to 525 cfs. The measured water surface elevations provided in Table 5-3 are the average values from the measured water surface elevations at the left and right bank. Two separate linear stage-discharge regressions were used to model water surface elevations at the Chattaroy site. All flows less than or equal to 300 cfs used the 68.7 cfs, 188.9 cfs, and 312 cfs discharges to develop the stage-discharge regression. At flows greater than 300 cfs, the 312 cfs and 509.2 cfs discharges were used to develop the stage-discharge regression.

The calibration details for the velocity model along with a graphical representation of the velocity model performance at simulated discharges are provided in Appendix F. No extreme velocities were observed at the simulated discharges and the velocity adjustment factors were all within the expected range of 0.8-1.2, as defined by Milhous and others (1989). The velocity adjustment factors for each simulated discharge are provided in Appendix F.

A sliding weighted average was calculated using overlapping discharges from the low- to medium-flow model, from the medium- to high-flow model, and from the high- to very high flow-model to smooth the transition of results between flow models. The overlapping discharge ranges at the Chattaroy site were 100 cfs to 120 cfs with three overlapping discharges from the low- to medium-flow model, 200 cfs to 250 cfs with three overlapping discharges from the medium- to high-flow model, and 300 cfs to 350 cfs with three overlapping discharges from the high-flow to very high-flow model. The final WUW curves for the Chattaroy site are shown in Figures 5.9a and 5.9b.

Similar to the Pine River Park site, the results indicate that in general there is much more useable habitat for mountain whitefish than rainbow trout at the Chattaroy site. Due to the placement of the transect across a riffle, the resulting available habitat will favor life stages that can use faster water such as mountain whitefish. Velocities are suitable for rainbow trout spawning up to about 150 cfs, at which point the velocity becomes the main limiting factor. The depth criteria for rainbow trout spawning are very narrow and indicate a preference for relatively shallow water, however WDFW is in the process of developing a model to account for mesohabitat rather than just depth alone as a habitat determinant (Hal Beecher personal communication, June 9, 2003). The depth across the transect becomes deeper than the optimum spawning depth at flows greater than 120 cfs.

The rainbow trout juvenile/adult habitat preference criteria indicate a very narrow range of suitable velocities. The velocities across the transect exceed the optimum velocities even at the lowest simulated discharge. The depth is also limiting at this low discharge. As the discharge increases, the depths gradually become more suitable for rainbow trout while the velocities become less suitable. At flows greater than about 200 cfs, high velocities become the primary limiting habitat factor for rainbow trout juvenile/adult life stages.

A similar WUW pattern for both species of fry is observed at the Chattaroy site, indicating the most suitable habitat for these life stages is available during low flow conditions. The mountain whitefish juvenile, adult and spawning WUW curves are all very similar with peaks in the range of 150 to 175 cfs. The WUW curves are broader than the rainbow trout curves, and the higher levels of useable habitat are sustained as flows increase up to the highest simulated discharge.

The water surface modeling indicates that flows greater than about 375 cfs begin to spill out of the main channel and onto the floodplain. This is evident from the field results taken at 509.2 cfs that show water level above bankfull. This can also be seen in the WUW curves that show an increase in habitat for some life stages beginning at about 375 cfs (Figures 5.9a and 5.9b).

5.2.3 Little Spokane River at Elk

The measured discharges and water surface elevations for the Elk site are shown in Table 5-4. This table also shows the calibration flow for the low- and medium-flow models, the range of simulated discharges used for each model, and a comparison of the measured and predicted water surface elevations. A high flow calibration discharge was not available during the field data collection program. The final range of flows modeled was from 22 cfs to 90 cfs. The measured water surface elevations provided in Table 5-4 are the average values from the measured water surface elevations at the left and right bank. A single linear stage-discharge regression using all five measured discharges was used to model water surface elevations at the Elk site.

The calibration details for the velocity model along with a graphical representation of the velocity model performance at simulated discharges are provided in Appendix F. No extreme velocities were observed at the simulated discharges and the velocity adjustment factors were within the expected range of 0.8-1.2 as defined by Milhous and others (1989). The velocity adjustment factors for each simulated discharge are provided in Appendix F.

A sliding weighted average was calculated using overlapping discharges from the low- to medium-flow model to smooth the transition between models in the WUW curve. The overlapping discharge range at the Elk site was 30 cfs to 46 cfs with nine overlapping discharges from the low-flow to medium-flow model. The final WUW curves for the Elk site are shown in Figures 5.10a and 5.10b.

The substrate at the Elk site was predominantly large cobble, small boulder and sand. The habitat preference criteria for rainbow trout spawning and mountain whitefish spawning/incubation indicate zero suitability for these categories of substrate. Because rainbow trout build redds for spawning, these results may be reasonable for the transect selected. This result should not be interpreted that rainbow trout spawning does not occur at all within this stream segment; however, suitable rainbow trout spawning habitat was not predicted to occur on the selected transect.

The result for mountain whitefish spawning also initially indicated no available habitat for this life stage at this transect. The substrate coding system used for the Little Spokane River study follows that of WDFW and Ecology (1996). In the coding system, a dominant and subdominant substrate category is identified and coded. At the Elk site, this resulted in either a code indicating sand as dominant with large cobble or boulder as subdominant, or the reverse situation. In some cells, however, there can be upwards of 30% to 40% of the cell covered with all sizes of gravel and small cobble. Although none of the individual substrate categories was dominant or even sub-dominant, in combination, these substrate types can provide some suitable habitat for mountain whitefish spawning and egg incubation because mountain whitefish are broadcast spawners. As a result, a new transect profile was created for mountain whitefish spawning to capture the fact that suitable spawning substrate was available and to allow for an evaluation of this life stage.

The results for the Little Spokane River at the Elk site are similar to the other sites on the Little Spokane River. Rainbow trout juvenile/adult habitat is limited by high velocities across most of the transect at discharges as low as 30 cfs while shallow depths are limiting across all simulated discharges. This is a result of transect placement across riffle habitat. The mountain whitefish WUW curves tend to be much broader across the entire range of simulated discharges relative to the site further downstream. One primary difference between the Elk site and the downstream site is that the relative habitat for each life stage remains reasonably high, rarely dropping below 50% of the optimum WUW at all simulated discharges. This may be due, in part, to the narrower range of simulated discharges at the Elk site compared to the downstream sites, but also indicates that the habitat remains relatively constant over all simulated discharges.

5.2.4 Dragoon Creek

The measured discharges and water surface elevations for the Dragoon Creek site are shown in Table 5-5. This table also shows the calibration flow for the low, medium, high and very high flow models, the range of simulated discharges used for each model, and a comparison of the measured and predicted water surface elevations. The range of flows modeled was from 10 cfs to 175 cfs. The measured water surface elevations provided in Table 5-5 are the average values from the measured water surface elevations at the left and right bank. A single linear stage-discharge regression using all five measured discharges was used to model water surface elevations at the Dragoon Creek site.

The calibration details for the velocity model along with a graphical representation of the velocity model performance at simulated discharges are provided in Appendix F. No extreme velocities were observed at the simulated discharges and the velocity adjustment factors were within the expected range of 0.8-1.2, as defined by Milhous and others (1989). There were some velocity adjustment factors that were outside of the guidelines in the transition flow ranges between the low- and medium-flow models and the medium- to high-flow models. The velocity adjustment factors were also below the guideline at several of the lowest simulated discharges; however, the simulated depths and velocities are reasonable in all of these cases. The velocity adjustment factors for each simulated discharge are provided in Appendix F.

A sliding weighted average was calculated using overlapping discharges from the low- to medium-flow model, from the medium- to high-flow model, and from the high- to very high-flow model to smooth the transition of results between flow models. The overlapping discharge ranges at the Dragoon Creek site were 26 cfs to 35 cfs with five overlapping discharges from the low- to medium-flow model and 85 cfs to 95 cfs with three overlapping discharges from medium- to high-flow model.

The rainbow trout spawning habitat availability relationship was also adjusted at the Dragoon Creek site due to a bimodal pattern in the WUW curve in the lower flow ranges that did not appear to be associated with any change in channel form. The rainbow trout spawning WUW curve was adjusted by applying a linear interpolation between 18 cfs and 35 cfs (Figures 5.11a and 5.11b).

Similar to the study sites on the Little Spokane River, the results for Dragoon Creek indicate that there is relatively little rainbow trout habitat relative to the amount of mountain whitefish habitat. This is once again likely due to the placement of the transect in riffle habitat that will show a preference for species that can tolerate higher velocities, as well as the narrow suitability ranges of the rainbow trout habitat suitability criteria. As noted above, the depth criteria for rainbow trout spawning were developed in shallow streams and therefore indicate a preference for relatively shallow water, however WDFW is in the process of developing a model to account for mesohabitat rather than just depth alone as a habitat determinant (Hal Beecher personal communication, June 9, 2003).

The mountain whitefish curves for the juvenile, adult and spawning life stages are broad, with steady increases in habitat occurring to approximately 50 cfs, at which point the habitat gains begin to level off and the useable habitat remains high up to the highest simulated discharge. The fry life stages of both species show the typical pattern with the peak amount of habitat indicated at a relatively low discharge, although the mountain whitefish fry curve indicates habitat remains relatively high over the higher range of simulated discharge as well.

5.2.5 Deadman Creek

The measured discharges and water surface elevations for the Deadman Creek site are shown in Table 5-6. This table also shows the calibration flow for the very low-, low-, medium-, high- and very high-flow models, the range of simulated discharges used for each model, and a comparison of the measured and predicted water surface elevations. The final range of flows modeled was from 3 cfs to 200 cfs. The measured water surface elevations provided in Table 5-6 are the average values from the measured water surface elevations at the left and right bank. The left bank water surface elevation of 95.81 at a discharge of 8.2 cfs was selected as it provided a better fit in the stage-discharge regression. Two separate linear stage-discharge regressions were used to model water surface elevations at the Deadman Creek site. All models except the very high-flow model used the 5.5 cfs, 8.2 cfs, 24.4 cfs, and 98.6 cfs discharges to develop the stage-discharge regression. The very high-flow model used the 24.4 cfs, 98.6 cfs and 152.0 cfs discharges to develop the stage-discharge regression at the Deadman Creek site.

The calibration details for the velocity model and a graphical representation of the velocity model performance at simulated discharges are provided in Appendix F. No extreme velocities were observed at the simulated discharges and the velocity adjustment factors were all within the expected range of 0.8-1.2, as defined by Milhous and others (1989). There were some velocity adjustment factors that were outside of the guideline ranges in the transition flow ranges between the low- and medium-flow models and the medium- and high-flow models; however, the simulated depths and velocities are reasonable in all of these cases. The velocity adjustment factors for each simulated discharge are provided in Appendix F.

A sliding weighted average was calculated using overlapping discharges to smooth the transition of results between flow models. The overlapping discharge ranges at the Deadman Creek site were 5 cfs – 8 cfs with four overlapping discharges from the very low- to low-flow model, 12 cfs to 15 cfs with four overlapping discharges from the low- to medium-flow models, 50 cfs to 60 cfs with three overlapping discharges from the medium- to high-flow models, and 100 cfs to 120 cfs with four overlapping discharges from the high- to very high-flow models. The final WUW curves for the Deadman Creek site are shown in Figures 5.12a and 5.12b.

The pattern in the difference in the amount of available habitat between species is again apparent at the Deadman Creek site. The juvenile, adult and spawning life stages of both species do exhibit a similar pattern of sharp habitat gains up to about 25 cfs. The habitat for these three life stages of mountain whitefish remains relatively high with increased discharge over the simulated range of flows, while the rainbow trout habitat availability curves begin to decline at flows of approximately 75 cfs. The fry life stages of both species show the same pattern as other sites, with peak habitat indicated at relatively low flows compared to the other life stages. The rainbow trout fry curve drops off dramatically by 25 cfs, while the mountain whitefish fry have a broader range of flows that has a steady decline in habitat until about 100 cfs.

The photographs from the field visit at 152 cfs (Appendix E) clearly show that the water level was near the bankfull stage. The modeled water surface elevations and the elevation of the permanent vegetation show a change in the channel form at around 100 cfs to 120 cfs, although the bankfull stage is higher at approximately 320 cfs. Several of the WUW curves show a distinct change in slope at flows where the change in the channel profile occurs above 100 cfs. Even at these higher discharges, the velocities across the transect are not limiting to mountain whitefish juveniles and adults for the Deadman Creek site.

5.2.6 Otter Creek

The measured discharges and water surface elevations for the Otter Creek site are shown in Table 5-7. This table also shows the calibration flow for the low- and medium-flow models, the range of simulated discharges used for each model, and a comparison of the measured and predicted water surface elevations. A high flow calibration discharge was not available during the field data collection program. The final range of flows modeled was from 2.0 cfs to 25 cfs. The measured water surface elevations provided in Table 5-7 are the average values from the measured water surface elevations at the left and right bank. A single linear stage-discharge regression using all four measured discharges was used to model water surface elevations at the Otter Creek site.

The calibration details for the velocity model and a graphical representation of the velocity model performance at simulated discharges are provided in Appendix F. No extreme velocities were observed at the simulated discharges and the velocity adjustment factors were within the expected range of 0.8-1.2, as defined by Milhous and others (1989). The velocity adjustment factors for each simulated discharge are provided in Appendix F.

A sliding weighted average was calculated to smooth the transition between models in the WUW curve. The overlapping discharge ranges at the Otter Creek site were 7 cfs to 9 cfs with three overlapping discharges from the low-flow to medium-flow model. The final WUW curves for the Otter Creek site are shown in Figures 5.13a and 5.13b.

The WUW curves differ from the other sites in the Little Spokane River study. The curves for rainbow trout and mountain whitefish fry are relatively flat across all of the simulated discharges. The total amount of available habitat for mountain whitefish fry is actually the highest among all of the life stages, indicating that the velocities were relatively slow and little deep-water habitat was available over the range of simulated discharges. Rainbow trout and mountain whitefish juvenile and adult life stages show a steady increase in the amount of available habitat up to the highest simulated discharge. This is also an indication that velocities remain low across all discharges and the habitat becomes more suitable as depth increases. However, the absolute amount of either rainbow trout or mountain whitefish habitat at the Otter Creek site (WUA less than 2 ft) was substantially less than all the other sites investigated in the Little Spokane River study.

Similar to the Little Spokane River at Elk, there was no suitable habitat represented across the selected transect for rainbow trout and mountain whitefish spawning. The limiting habitat factor for spawning was substrate. However, unlike the Elk site that had large cobbles and boulders as a dominant substrate category, the substrate at the Otter Creek transect was mostly silt and sand. The placement of the transect for the current study may or may not be representative of the entire Otter

Creek reach and the results from this analysis do not imply that other suitable spawning locations in Otter Creek are not available.

6.0 DISCUSSION

6.1 Evaluation of Existing Minimum Instream Flows

The focus of the Little Spokane River Instream Flow Needs Study was to evaluate the biological relevance of existing minimum instream flows. The existing minimum instream flows are compared against the flow values derived using the Wetted Perimeter method. The available habitat, based on the weighted useable width curves presented in Section 5, is calculated for the current minimum instream flows, the Wetted Perimeter flow, and for the 90%, 50%, and 10% weekly exceedance flows for the sites with available hydrology. Comparing the WUW results against the available hydrology ensures that the recommended instream flows are appropriate in terms of the range of flows seasonally available for each reach. In conjunction with ensuring that appropriate seasonal flows are evaluated, the habitat evaluation should also account for any seasonal changes in fish presence or life cycle activities. A species periodicity table was developed in consultation with WDFW to determine the timing of rainbow trout and mountain whitefish spawning to be used for habitat evaluations (Table 6-1).

The spawning life stage is also representative of egg incubation because the habitat suitability curves for spawning are developed by measuring redd locations for rainbow trout or by the presence of eggs for mountain whitefish. During the spawning period, the adult life stage is typically not evaluated in conjunction with the spawning life stage due to behavioral changes in the adult fish. Although adult rainbow trout would not usually be evaluated during the spawning period, rainbow trout juveniles and adults have a joint habitat suitability curve and as juveniles are present year-round, the analysis is completed for the entire year. The fry life stage is considered to be present year-round because this life stage covers the time from emergence through to the end of the first year.

Although fry, juvenile and adult life stages are assumed to be present year round, the habitat suitability curves for these life stages are not based on winter observations. Behavioral changes have been documented during winter periods associated with reduced water temperatures and ice cover (Golder, 1997). In general, it would appear that fish select winter habitats with low velocity, greater depth, and good daytime cover (Cunjak, 1996). Because winter habitat suitability curves are not currently available, the winter period was evaluated using the available habitat suitability curves. However, the potential limitations of this approach should be recognized when considering the results of the WUW analysis. This limitation would not apply to the existing minimum instream flows that are based on flow statistics, or the Wetted Perimeter analysis that is based on channel morphology.

The data analysis presented in the report focused on several key life stages, although the results and data analysis for each life stage are presented in Appendix H. The mountain whitefish adult life stage was used to represent the life stages that had WUW curve peaks at a higher range of flows, while the rainbow trout juvenile/adult life stage represents life stages with a low to moderate flow peak. Both spawning life stages are presented, with mountain whitefish spawning representing the higher flow range of WUW curves and rainbow trout spawning representing the lower flow range of WUW curves. The flow needs for the fry life stage for both species require much lower flows than the other life stages, which were evaluated and presented in Appendix H, but are not presented in the main report to reduce the complexity of the data analysis.

6.1.1 Little Spokane River at Pine River Park

The existing minimum instream flows for the Little Spokane River at Dartford, and the hydrology from the USGS gage at Dartford were used to evaluate the results of the downstream Pine River Park site. The WUW curves for the Pine River Park site peaked at a flow as low as 50 cfs to 70 cfs for rainbow trout and mountain whitefish fry and rainbow trout spawning life stages, and as high as 190 cfs to 290 cfs for juvenile and adult life stages for both species and for mountain whitefish spawning.

Table 6-2 presents flows and habitat values for the Little Spokane River at Pine River Park for rainbow trout juvenile and adult life stages associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WU curve. The results for rainbow trout juvenile/adult (Table 6-2) show that the current minimum instream flows provide very good habitat conditions throughout the year ranging from 82% to 100% of the optimum habitat conditions. The existing minimum instream flow provides seasonally appropriate habitat conditions (i.e., mimic the natural hydrograph) that are very similar to the habitat available at the 50% exceedance flow during the lower flow months and similar to the 90% exceedance flow during the wetter months. The flow derived from the Wetted Perimeter method provides a very high habitat condition throughout the year for rainbow trout juvenile/adult; however, it is a single minimum flow and therefore does not provide any seasonal variability. The Wetted Perimeter flow is close to the 10% exceedance flow from August through October, which means that in general, this flow would only be present under conditions about 10% of the time (i.e., about one year in ten). The existing minimum flows provides similar average habitat conditions as the Wetted Perimeter on an annual basis, but provides seasonal flow variability, and specifies a minimum flow that is always less than average flow conditions (i.e., 50% exceedance flow) throughout the year.

Table 6-3 presents flows and habitat values for the Little Spokane River at Pine River Park for the rainbow trout spawning life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WUW curve. The rainbow trout spawning habitat results shown in Table 6-3 reveal this life stage exhibits the lowest habitat availability of the life stages evaluated at the Pine River Park site. The small amount of habitat availability is a result of the peak of the WUW spawning curve for rainbow trout at 70 cfs. Because rainbow trout spawning occurs in two of the wettest months of the year, it would appear that either the selected transect is not representative of spawning habitat in the Pine River Park Reach, or that there is no available spawning habitat for rainbow trout in this reach, or that the habitat suitability criteria used in the analysis are not suitable for this location. The best result for rainbow trout spawning is provided by the Wetted Perimeter flow, although even that flow provides relatively poor habitat conditions. As discussed earlier, the Wetted Perimeter result does not account for the seasonal variability in the flow regime and recommends flows below the 90% exceedance flow.

Table 6-4 presents flows and habitat values for the Little Spokane River at Pine River Park for mountain whitefish adult life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WU curve. Mountain whitefish adult appear to be the most sensitive species in terms of seasonal changes in habitat, with the existing minimum instream flows providing habitat in the range of 60% of optimum during July and August and up to near optimum conditions in March and April (Table 6-4). For the most part, the habitat available at the existing minimum instream flows is comparable to the habitat available at the 50% exceedance flow, which can be considered to be average or typical habitat conditions. The only exception would be for the months of June and July, where the existing minimum instream flow habitat values are substantially lower than the 50% flow exceedance habitat for mountain whitefish adult.

Table 6-5 presents flows and habitat values for the Little Spokane River at Pine River Park for the mountain whitefish spawning life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WUW curve. The mountain whitefish spawning results indicate very good habitat conditions for the current minimum instream flows as well as the Wetted Perimeter flows (Table 6-5). The 50% exceedance flow provides near optimal habitat conditions for mountain whitefish spawning, however, the gain in habitat is marginal compared to the current minimum flows or the Wetted Perimeter flows.

Overall, the current minimum instream flows provide good habitat protection for most life stages throughout the year and also produces a desirable seasonally variable flow regime. The Wetted Perimeter flows often provide very good habitat conditions; however the Wetted Perimeter flow is derived from a fairly subtle breakpoint in the wetted perimeter versus discharge plot (Figure 5.1), which is considered the best available choice using the Wetted Perimeter method. Switching to the Wetted Perimeter flow during June and July would result in good habitat improvements for rainbow trout and mountain whitefish adults. Similarly, using the Wetted Perimeter during December and January would result in marginal habitat improvements for mountain whitefish spawning.

6.1.2 Little Spokane River at Chattaroy

The existing minimum instream flows for the Little Spokane River at Chattaroy, and the hydrology from the USGS gage at Chattaroy were used to evaluate the results of the Chattaroy site. The WUW curves for the Chattaroy site peaked at a flow as low as 30 to 60 cfs for rainbow trout and mountain whitefish fry and rainbow trout spawning life stages, and as high as 130 to 175 cfs for the juvenile and adult life stages of both species and for mountain whitefish spawning.

Table 6-6 presents flows and habitat values for the Little Spokane River at Chattaroy for rainbow trout juvenile and adult life stages associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WU curve. The results for rainbow trout juvenile/adult (Table 6-6) indicate the existing minimum instream flows provide very good habitat conditions for March through May, reasonably good habitat conditions for October though February and June, and marginal habitat conditions from July through September. At all times of the year, the current minimum flows provide better habitat conditions than the Wetted Perimeter flow. Although the habitat conditions are lower overall at the Chattaroy site compared to the Pine River Park site, the existing minimum flows appear seasonally appropriate in most cases. The exception to this pattern occurs during June, July, and into August when the available habitat at the existing minimum flows is much lower than the habitat available at the 50% exceedance flow, which is considered the typical condition for that time of year. The available habitat between December and mid-February is also well below the habitat available at the 50% exceedance flow value. However it should be noted that there is some uncertainty associated with the winter habitat evaluation due to a lack of winter habitat suitability data. Increasing the existing minimum flow may be warranted for during June through early August. The Wetted Perimeter flow is not a good alternative at the Chattaroy site.

Table 6-7 presents flows and habitat values for the Little Spokane River at Chattaroy for the rainbow trout spawning life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WUW curve. The habitat for rainbow trout spawning is poorly matched with the hydrology of the

Chattaroy site during the spawning period, as indicated by zero or very minimal habitat availability at the existing minimum instream flows and for each of the hydrological statistics (Table 6-7). The Wetted Perimeter flow indicates excellent rainbow trout spawning conditions; however, the flow is not seasonally appropriate because it is less than half of the 90% exceedance flows. It would once again appear that either the selected transect is not representative of spawning habitat in this reach or that the spawning habitat criteria are not suitable for this location, or both.

Table 6-8 presents flows and habitat values for the Little Spokane River at Chattaroy for the mountain whitefish adult life stages associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WU curve. The results for mountain whitefish adult habitat availability at the Chattaroy site indicate the existing minimum instream flows provide very good habitat conditions for March through May, reasonably good habitat conditions from October though February and June, and marginal habitat conditions from July through September (Table 6-8). At all times of the year, the current minimum flows provide better habitat conditions than the Wetted Perimeter flow. The seasonal pattern of habitat availability for mountain whitefish adult is very similar to that discussed previously for rainbow trout juvenile/adult. As with rainbow trout, the available habitat for mountain whitefish adult during June and July under the existing minimum flows is much lower than the 50% exceedance flow habitat condition. The limitation with the winter habitat evaluation previously identified for rainbow trout is also a concern for mountain whitefish. Increasing the existing minimum flow may be warranted for June and July. The Wetted Perimeter flow is not a good alternative at the Chattaroy site.

Table 6-9 presents flows and habitat values for the Little Spokane River at Chattaroy for the mountain whitefish spawning life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WUW curve. The mountain whitefish spawning habitat provided by the existing minimum instream flows is reasonably good and is similar to the habitat available at the 90% exceedance flow (Table 6-9). The Wetted Perimeter flow produces the worst habitat conditions for mountain whitefish spawning and should not be used to adjust the minimum flow at this site. Improvement to the minimum flow is possible for this time period to bring the habitat conditions closer to those available at the 50% exceedance flow.

The existing minimum instream flows at the Chattaroy site on the Little Spokane River appear to be reasonable during most of the year for most life stages. Increases to the minimum flows during June and July could, however, result in substantial habitat gains for rainbow trout and mountain whitefish juvenile and adult life stages during these months. Increases in the minimum flow during December and January can improve mountain whitefish spawning, but the potential for habitat improvement is less relative to the potential gains during June and July.

The flow recommendation based on the Wetted Perimeter method generally provides poor habitat conditions for most life stages except for the fry of both species, and rainbow trout spawning. The wetted perimeter versus discharge plot did not produce an obvious breakpoint and although the resulting flow recommendation is believed to be the best choice possible, it may not reflect the local hydrology at the Chattaroy site. The Wetted Perimeter flow of 50 cfs is well below the 90% exceedance flow for the entire year except for August and September.

6.1.3 Little Spokane River at Elk

The existing minimum instream flows for the Little Spokane River at Elk, and the hydrology from the USGS gage at Elk were used to evaluate the results of the Elk site. The WUW curves for the Elk site peaked at a flow as low as 22 to 24 cfs for all life stages of rainbow trout and for mountain whitefish fry, and as high as 70 to 75 cfs for juvenile, adult and spawning life stages of mountain whitefish. The hydrology is naturally much less variable at the Elk site compared to the downstream sites on the Little Spokane River.

Table 6-10 presents flows and habitat values for the Little Spokane River at Elk for rainbow trout juvenile and adult life stages associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WU curve. The existing minimum instream flows for the Little Spokane River at Elk provide very good habitat conditions for rainbow trout juvenile and adult life stages that are seasonally appropriate when compared to the habitat available at the 50% exceedance flow (Table 6-10). The 10% exceedance flows during April and May were beyond the highest modeled flow and therefore the habitat availability could not be evaluated. The Wetted Perimeter flows provide the best habitat conditions for rainbow trout juveniles and adults, but as has been discussed previously, the single minimum flow recommendation is not always seasonally appropriate.

Table 6-11 presents flows and habitat values for the Little Spokane River at Elk for the mountain whitefish adult life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WUW curve. The mountain whitefish adult results are similar in that the current minimum instream flows provide good habitat conditions throughout the year (Table 6-11). The Wetted Perimeter flows provide the lowest habitat conditions throughout the year compared to the other flows evaluated.

Table 6-12 presents flows and habitat values for the Little Spokane River at Pine River Park for the mountain whitefish spawning life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedance flows), and the Wetted Perimeter flow (WP). The habitat values are normalized relative to the maximum useable habitat across the transect based on the peak of the WUW curve. The mountain whitefish spawning habitat evaluation also indicates very good habitat conditions under the existing minimum instream flows (Table 6-12). The Wetted Perimeter flows provide the lowest habitat values, although the habitat availability is still relatively good.

The relatively consistent habitat conditions throughout the year for all of the life stages at the Elk site are in part due to the flat shape of the WUW curves, indicating that habitat is relatively insensitive to flow changes over the range of naturally occurring flows. In addition, the Elk site has a relatively stable flow regime, which also results in a relatively flat WUW curve.

Overall, the current minimum instream flows as well as the Wetted Perimeter flows for the Little Spokane River at Elk provide good habitat conditions for both species throughout the year. There was a fairly distinct breakpoint in the wetted perimeter versus discharge plot and the Wetted Perimeter recommended flow is considered to be a good instream flow determination within the limits of the Wetted Perimeter method. As discussed previously, the current instream flows are more seasonally appropriate compared to the Wetted Perimeter flow. Adjusting the current minimum flows during the dry months of August through October to the Wetted Perimeter flow would result in a minor habitat gain for rainbow trout juvenile and adults while resulting in a slightly greater habitat loss for the mountain whitefish adult life stage, and is therefore not recommended. The existing minimum instream flows appear to be suitable for protecting fish habitat.

6.1.4 Dragoon Creek

The existing minimum instream flows for Dragoon Creek specify that the creek is closed to further diversions from June 1 through October 31. In order to effectively evaluate the biological relevance of the current instream flow recommendation (creek closure), long-term gaging data are required. Local discharge information is available for a period of less than five years, which is too short to properly evaluate the trends in habitat conditions during average, wet and dry periods.

The WUW curves for the Dragoon Creek site peaked at a flow as low as 10 to 18 cfs for rainbow trout and for mountain whitefish fry, 40 cfs for rainbow trout juvenile/adult, 80 cfs for both spawning life stages, and from 115 cfs to 160 cfs for adult and juvenile mountain whitefish. All life stages except for the fry had steady habitat increases up to 40 cfs after which further habitat gains began to flatten off.

A habitat-based evaluation is possible with the flow recommendations derived using the Wetted Perimeter method. The results of the evaluation are provided in Table 6-13, which presents available habitat, normalized for each life stage, based on the instream flows defined by the Wetted Perimeter analysis for Dragoon Creek. Dragoon Creek had two potential breakpoints in the wetted perimeter plot and therefore both points were evaluated to determine if either point appeared to be more biologically suitable. The 40 cfs flow provides reasonably good habitat conditions for most life stages, while the 9 cfs recommendation provides very poor habitat conditions for most life stages. Therefore, the 40 cfs Wetted Perimeter flow recommendation is considered the result of this analytical technique for Dragoon Creek. The 40 cfs flow could be defined as a new minimum instream flow during the current closed period, although depending on the local hydrology, this recommendation may still result in an effective closure of the stream if this flow is rarely attained.

6.1.5 Deadman Creek

The existing minimum instream flows for Deadman Creek specify that the creek is closed to further diversions from June 1 through October 31. In order to effectively evaluate the biological relevance of the current instream flow recommendation, long-term gaging data are required. Local discharge information is available for a period of less than five years, which is too short to properly evaluate the trends in habitat conditions during average, wet and dry periods.

The WUW curves for the Deadman Creek site peaked at a flow as low as 3 cfs for rainbow trout fry, from 11 cfs to 35 cfs for mountain whitefish fry and for rainbow trout juvenile/adult and spawning, and as high as 80 cfs to 125 cfs for mountain whitefish adult, spawning and juvenile life stages. Rainbow trout spawning and mountain whitefish juvenile, adult and spawning life stages have sharp habitat declines as flows drop below 30 cfs. The rainbow trout juvenile/adult curve has a very sharp decline in habitat below its peak of 16 cfs while at higher flows, the habitat remains relatively good up to 75 cfs.

A habitat evaluation is possible with the flow recommendations derived using the Wetted Perimeter method. The results of these evaluations are provided in Table 6-14, which presents available habitat, normalized for each life stage, based on the instream flows defined by the Wetted Perimeter analysis for Deadman Creek. Deadman Creek had two distinct breakpoints in the wetted perimeter plot and therefore both points were evaluated to determine if either point appeared to be more biologically suitable. The 13 cfs flow provides marginal habitat conditions for most life stages, while the 6 cfs recommendation provides very poor habitat conditions for all life stages except for mountain whitefish fry. Therefore, the 13 cfs flow recommendation was considered to be the result of the Wetted Perimeter analysis. However, neither of the two flows defined by the Wetted Perimeter method appear to provide suitable habitat conditions for all life stages that would be suitable to define a new minimum instream flow during the current closed period. A more detailed evaluation of the local hydrology is required before a biologically based IFN could be determined.

6.1.6 Otter Creek

The existing minimum instream flows for Otter Creek specify that the creek is closed to further diversions from June 1 through October 31. Long-term gaging data are required in order to effectively evaluate the biological relevance of the current instream flow recommendation. Local discharge information is available for a period of less than five years, which is too short to properly evaluate the trends in habitat conditions during average, wet and dry periods.

The WUW curves for the Otter Creek site peaked at a flow as low as 2 cfs to 7 cfs for rainbow trout and mountain whitefish fry, while rainbow trout and mountain whitefish juvenile and adult life stages all have a peak at 25 cfs, the highest simulated discharge. The habitat increases are fairly gradual for the juvenile and adult life stages of both species, while the habitat for both species of fry remains fairly good at all simulated discharges.

A habitat-based evaluation is possible with the flow recommendations derived using the Wetted Perimeter method. The results of these evaluations are provided in Table 6-15, which presents available habitat, normalized for each life stage, based on the instream flows defined by the Wetted Perimeter analysis for Otter Creek. The Wetted Perimeter-derived flow of 13 cfs provides good habitat conditions for most life stages and could be used to define a new minimum instream flow regime for Otter Creek. During the period of closure, a discharge of 13 cfs may effectively result in no further diversions if a flow of 13 cfs is relatively rare from June through October.

6.2 Other Instream Flow Considerations

An IFN recommendation for the protection of the aquatic ecosystem should account for more than just fish habitat flows. Ecosystems are intricately connected, and attempting to protect just a single component of an ecosystem may not only fail to protect other ecosystem components, but may in the end fail to protect the initial component of interest. The natural flow paradigm (Poff and others, 1997) developed from the understanding that many aquatic ecosystems have evolved around a naturally variable flow regime, and that different components of an ecosystem require variable and seasonally appropriate flows to complete their life cycle.

Annear and others (2002) recommend that five components should be addressed in an IFN study: hydrology, biology, geomorphology, water quality, and connectivity. Many recent IFN studies have incorporated other ecosystem components into the final IFN recommendations:

- Trinity River, California (USFWS and Hoopa Valley Tribe, 1999);
- Colorado River (Muth and others, 2000);
- Nooksack River, Washington (Hardy, 2000);
- Klamath River Basin, California (Hardy and Addley 2001);
- Highwood River, Alberta (Clipperton and others, 2002); and,

- Mokelumme River, California (McGurk and Paulson, 2002).

Water quality, temperature, riparian needs, and channel maintenance flows are commonly evaluated in a detailed IFIM study. The current level of effort defined for the Little Spokane River study did not warrant detailed studies on these other issues. Many of these other parameters are typically evaluated in relation to flow releases from reservoirs in other studies, which is not an issue on the Little Spokane River.

A preliminary evaluation can, however, be conducted for some of these considerations using simple office evaluation techniques. For channel maintenance the effective discharge for forming and maintaining channel shape as flows in the range of 0.8-1.6 times the bankfull flow (Andrews and Nankervis, 1995). Tennant (1976) defined channel maintenance flows as 200% of the mean annual flow. Similarly for riparian ecosystems, Gom and Mahoney (2002) identified a flow with a magnitude of 1.25 times the bankfull flow to be necessary for cottonwood recruitment with the 90% exceedance flow necessary for cottonwood survival. These generic flow ranges are evaluated for the Little Spokane River study sites; however, the site-specific conditions at each site may warrant a different flow value for maintenance of a particular ecosystem feature than developed by these generic assessments.

The bankfull elevation was determined for each site based on the field notes, which provided information on the elevation and the location of permanent vegetation with particular attention to the elevation of shrubs. At some sites, shrubs had either been grazed or removed and the only permanent vegetation present was grass, which is not as good an indicator as shrubs of the bankfull elevation. The bed profile was also used to identify any obvious breaks in channel form that would correspond to the top of bank. The corresponding simulated discharge where the water surface elevation was at the level of these bankfull indicators was determined to be the bankfull discharge. A summary of the bankfull discharges for each site is provided in Table 6-16.

The bankfull discharges at the Little Spokane River Pine River Park and Elk sites and Deadman Creek were slightly above the highest simulated discharge used for habitat modeling. The stage-discharge regression was extrapolated further to identify the bankfull elevation for each of these sites; however, the extrapolation is still within acceptable limits of water surface modeling. The Otter Creek site required that the stage-discharge regression to be extrapolated well above the highest measured discharge of 13.7 cfs. For Otter Creek, an additional discharge and water surface elevation measurement would increase the confidence in the estimation of the bankfull discharge. However, for the purpose of the current IFN evaluation, the estimate provided in Table 6-16 should be sufficient.

The mean annual flow (MAF) can also be used as a benchmark for identifying other instream flow components. Tennant (1976) used 200% MAF for a period of 48 hours to identify flushing flow requirements, while 100% MAF was identified as a suitable recreation and aesthetic flow. The MAF was calculated from the gages on the Little Spokane River at Dartford (period of record 1947-2000), at Chattaroy (period of record 1976-1996, 1998-1999) and at Elk (period of record 1949 – 1971). The summary of available mean annual flows is provided in Table 6-16.

Based on the estimation of the bankfull discharge and the calculation of the mean annual flow, the range of flows necessary for channel maintenance and riparian flows are provided in Table 6-17. These values are office-based calculations and would require field verification if a site-specific evaluation is desired. Although these flows appear very large, the duration of the flows is typically very short within any given year. Andrews and Nankervis (1995) found the average duration of channel maintenance flows on the gravel-bed streams they studied to be just over two weeks per year, while the Tennant (1976) recommendation is only for a period of 48 hours. Without large capacity storage or diversion on a system, small-scale withdrawals typically have a minimal impact on flows in the range of the bankfull discharge. Likewise, without upstream storage taking place that typically stores peak flows for release during low flow periods, flow management for issues such as channel and riparian vegetation maintenance is generally not required.

Water quality is another component that should be considered in conjunction with the fish habitat results. Sections of Dragoon Creek, the lower reach of Deadman Creek and several reaches of the Little Spokane River at the Dartford gage and further downstream all have Section 303(d) listings. Temperature is an issue on Deadman Creek and the lower Little Spokane River, fecal coliform is an issue on Dragoon Creek and the lower Little Spokane River, and dissolved oxygen is an issue on Dragoon Creek. Protecting water quality by maintaining minimum flows can alleviate some water quality issues, but minimum flows alone are often not sufficient to manage water quality issues entirely.

Because the Little Spokane River at the Dartford gage currently has a 303(d) listing, this would suggest that applying a minimum flow is not sufficient in and of itself to protect water quality in the Little Spokane River. Increasing the minimum flows to protect water quality may improve water quality conditions but may not be the most efficient solution; other approaches, such as riparian management to improve stream shading or managing point source discharges, may prove to be more effective for water quality management. If further definition of water quality flow requirements is desired, additional detailed water quality instream flow studies would be necessary.

Although the existing minimum flows are well below the flow required for flushing flows, channel maintenance flows, and riparian flows, this is likely not an area of concern at this point in time for the Little Spokane River watershed. Typically, the impacts of small-scale diversions have a very minor influence on these larger flows and should not be an issue unless major on-stream storage or diversions are being considered. As with the water quality issue, management of riparian conditions is only partly met by providing the flows sufficient to regenerate the riparian zone. Sufficient flows in combination with good riparian land management are required to protect riparian ecosystems over the long term. Maintaining a good riparian zone and providing channel maintenance flows are essential components of protecting the aquatic ecosystem and creating and maintaining good fish habitat.

7.0 CONCLUSIONS

In general, the existing minimum instream flows in the Little Spokane River mainstem appear to be reasonable for protecting fish habitat of the target management species. The fact that the higher flows in the system are not heavily influenced by activities in the basin ensures that channel maintenance and riparian flows will also be provided on a regular basis. As discussed in Section 6, there are a few periods in the year where small adjustments to the existing minimum flows could be made to improve fish habitat. The evaluation of the Wetted Perimeter results by PHABSIM showed that the ability of the Wetted Perimeter Method to provide recommendations that resulted in flows of benefit to rainbow and mountain whitefish varied significantly. For example, PHABSIM analysis confirms that the results from the Wetted Perimeter analysis provides very good habitat conditions at the Pine River Park site, while the Wetted Perimeter analysis provides marginal habitat conditions that are worse than the existing minimum flows at other sites such as the Chattaroy site.

The major limitation to adopting the Wetted Perimeter flows is the absence of an obvious inflection point at some of the cross sections, and the lack of seasonal variability in the flow recommendation. Maintaining the seasonal flow pattern should be an important component to any instream flow recommendation. The current minimum instream flows provide a much better seasonal pattern of flow while maintaining good habitat conditions throughout the year.

Some of the limitations to the habitat analysis included the use of the statewide rainbow trout habitat suitability curves without site-specific validation, which was beyond the scope of the current project. In particular, the rainbow trout spawning curves indicate habitat suitability for a very narrow range of depths, which were not well represented at the chosen transects. If development of site-specific habitat suitability curves is desired, a spawning survey may be warranted to determine critical spawning locations throughout the Little Spokane River watershed. Due to the lack of suitable streamflow data for Dragoon, Deadman, and Otter Creeks, potential biologically based instream flow needs recommendations could not be developed.

If changes to the existing minimum flows are desired, the development of the habitat-discharge relationship in the weighted useable width curves will allow for a habitat evaluation of any proposed new flow recommendations. When suitable streamflow data is available for the tributary creeks, a biological evaluation of the flow regime may be conducted. Although the ability to describe the change in the overall ecosystem is not possible, the change in relative habitat availability will provide some guidance in making any future water management decisions.

8.0 REFERENCES

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TABLES

TABLE 1-1

Minimum Instream Flows (MISFs) at Control Points in the Little Spokane River Basin (cfs).

Month	Day	Elk	Chattaroy	Dartford	Confluence
January					
	1	40	86	150	400
	15	40	86	150	400
February					
	1	40	86	150	400
	15	43	104	170	420
March					
	1	46	122	190	435
	15	50	143	218	460
April					
	1	54	165	250	490
	15	52	143	218	460
May					
	1	49	124	192	440
	15	47	104	170	420
June					
	1	45	83	148	395
	15	43	69	130	385
July					
	1	41.5	57	115	375
	15	39.5	57	115	375
August					
	1	38	57	115	375
	15	38	57	115	375
September					
	1	38	57	115	375
	15	38	63	123	380
October					
	1	38	70	130	385
	15	39	77	140	390
November					
	1	40	86	150	400
	15	40	86	150	400
December					
	1	40	86	150	400
	15	40	86	150	400

TABLE 1-2

Minimum Instream Flow Excursion Summary for WRIA 55

	Elk		Chattaroy		At Dartford	
Period Of Record	7/1949 - 10/1971	June – October Only	10/1975 - 09/1996	June – October Only	5/1929 - 9/1932, 1/1947 - 9/1999	June – October Only
Days in Record	8415	3633	7671	3213	20515	8659
Days of Instream Flow Violations	813	416	2521	1352	3135	1909
Number of Continuous Excursions of Instream Flow Levels	71	22	162	62	205	94
Percent of Record below Instream Flow Levels	10%	11%	33%	42%	15%	22%
Max Continuous Days below Instream Flow Levels	153	92	262	153	245	181
Average Continuous Days below Instream Flow Levels	12	19	16	22	15	20

TABLE 2-1

Comparison of PRISM and Little Spokane River Basin Climate Station Data

(Golder Associates, 2001)

Station	**Station Elevation** (ft amsl)	**Avg. Annual Station Precipitation** (inches)	**Avg. Annual PRISM Precipitation Range** (inches)
Spokane International Airport	2,355	16.25	15 – 20
Deer Park 2 E	2,201	21.8	20 – 25
Newport	2,134	26.5	25 – 30
Mt. Spokane Summit	5,280	41.4	>35

TABLE 2-2

USGS Land Use / Land Cover Summary for Little Spokane River Basin

(Golder Associates, 2001).

Land Use/Land Cover	Acres	% WRIA 55
Urban or Built Up Land	19,181	4.4
Agricultural Land	110,293	25.5
Rangeland	6,391	1.5
Forest Land	292,051	67.5
Water	2,498	0.6
Wetland	1,023	0.2
Barren Land	903	0.2

TABLE 2-3

Little Spokane River Basin Population

(Golder Associates, 2001)

County	Population		% Change
	1990	2000	
Spokane	361,364	417,939	16
Stevens	30,948	40,066	29
Pend Oreille	8,915	11,732	32

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Common Name	Species Name	Location	Source
Salmonidae			
Brown Trout *Introduced Species*	*Salmo trutta*	Dry Creek	McLellan (2003)
		Eloika Lake	Divens and others (2001)
		Little Spokane River	Hartung and Meier (1980); EWU, unpubl. data (2001)
		Otter Creek	McLellan (2003)
		Sacheen Lake	WDFW, unpubl. data (2000)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
		Wethey Creek	WDFW, unpubl. data (2002)
Eastern Brook Trout *Introduced Species*	*Salvelinus fontinalis*	Bear Creek	McLellan (2003)
		Beaver Creek[1]	McLellan (2003)
		Buck Creek	EWU, unpubl. data 2000; McLellan (2003)
		Deer Creek	WDFW, unpubl. data 1978; EWU, unpubl. data (1999); McLellan (2003)
		Dragoon Creek	EWU, unpubl. data (2001)
		Dry Creek	McLellan (2003)
		Heel Creek	McLellan (2003)
		Little Deer Creek	EWU, unpubl. data (1999)
		Little Spokane River	EWU, unpubl. data (1999)
		Mud Creek	Lines (1982)
		Otter Creek	WDFW, unpubl. data 1974; McLellan (2003)
		Sacheen Lake	Divens and others (2002b)
		S. Fork Deadman Creek	EWU, unpubl. data (1999)
		Spring Heel Creek	McLellan (2003)
		Trout Lake	WDFW, unpubl. data (1993)
		Wethey Creek	WDFW, unpubl. data (2002)
Lake Trout *Introduced Species*	*Salvelinus namaycush*	Horseshoe Lake	WDFW, unpubl. data (1993, 1995 and 1997)

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Kokanee *Native Species*	*Oncorhynchus nerka*	Buck Creek	EWU, unpubl. data (2000)
		Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Horseshoe Lake	WDFW, unpubl. data (1993, 1995 and 1997)
		Little Spokane River	EWU, unpubl. data (2000)
Rainbow Trout *Introduced/ Native Species*	*Oncorhynchus mykiss*	Bear Creek	McLellan (2003)
		Beaver Creek[1]	McLellan (2003)
		Buck Creek	EWU, unpubl. data 2000; McLellan (2003)
		Chain Lake	Polacek and Baldwin (1999)
		Dartford Creek	WDFW, unpubl. data (1986 and 1992)
		Deadman Creek	EWU, unpubl. data (1999)
		Deer Creek	EWU, unpubl. data 1999; McLellan (2003)
		Diamond Lake	Phillips and Divens (2000)
		Dragoon Creek	EWU, unpubl. data (2001)
		Dry Creek	McLellan (2003)
		Eloika Lake	Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Horseshoe Lake	WDFW, unpubl. Data (1993)
		Little Deep Creek	EWU, unpubl. data (1999)
		Little Deer Creek	EWU, unpubl. data (1999)
		Little Spokane River	Hartung and Meier (1980 and 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data 1999, 2001
		Otter Creek	WDFW, unpubl. data 1974; McLellan (2003)
		Trout Lake	WDFW, unpubl. data (1993)
		WB Little Spokane River	McLellan (2003)
		Wethey Creek	WDFW, unpubl. data (2002)

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Mountain Whitefish *Native Species*	*Prosopium williamsoni*	Bear Creek	McLellan (2003)
		Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Dry Creek	McLellan (2003)
		Horseshoe Lake	WDFW, unpubl. data 1993
		Little Spokane River	Hartung and Meier (1980 and 1995); Pfeiffer (1988); EWU, unpubl. data (2001)
		Otter Creek	McLellan (2003)
		WB Little Spokane River	McLellan (2003)
		Wethey Creek	WDFW, unpubl. data (2002)
Pygmy Whitefish *Native Species*	*Prosopium coulteri*	Horseshoe Lake	Mongillo and Hallock (1995); Hallock and Mongillo (1998)
		Little Spokane River	Hartung and Meier (1980)
Esocidae			
Grass Pickerel *Introduced Species*	*Esox americanus vermiculatus*	Buck Creek	EWU, unpubl. data (2000)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Little Spokane River	Hartung and Meier (1980 and 1995)
		WB Little Spokane River	McLellan (2003)
Cyprinidae			
Carp *Introduced Species*	*Cyprinus carpio*	Little Spokane River	Hartung and Meier (1980)
Chiselmouth *Native Species*	*Acrocheilus alutaceus*	Chain Lake	WDFW, unpubl. data (1993); Polacek and Baldwin (1999)
		Little Spokane River	Hartung and Meier (1980 and 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data (1999 and 2001)
Longnose Dace *Native Species*	*Rhinichthys cataractae*	Bear Creek	McLellan (2003)
		Deadman Creek	EWU, unpubl. data (1999)
		Deer Creek	McLellan (2003)
		Dry Creek	McLellan (2003)
		Little Deep Creek	EWU, unpubl. data (1999)
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987); EWU, unpubl. data (2001)
		WB Little Spokane River	McLellan (2003)

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Northern Pikeminnow *Native Species*	*Ptychocheilus oregonensis*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Dragoon Creek	Lines (1982); EWU, unpubl. data (2001)
		Dry Creek	McLellan (2003)
		Little Spokane River	Hartung and Meier (1980, 1995); Pfeiffer (1988); EWU, unpubl. data (1999 and 2001)
Redside Shiner *Native Species*	*Richardsonius balteatus*	Chain Lake	Polacek and Baldwin (1999)
		Deadman Creek	EWU, unpubl. data (1999)
		Dragoon Creek	Lines (1982)
		Little Deep Creek	EWU, unpubl. data 1999
		Little Spokane River	Hartung and Meier (1980; 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data (1999 and 2001)
Speckled Dace *Native Species*	*Rhinichthys osculus*	Bear Creek	McLellan (2003)
		Deadman Creek	EWU, unpubl. data (1999)
		Dragoon Creek	EWU, unpubl. data (2001)
		Little Deep Creek	EWU, unpubl. data (1999)
		Little Spokane River	EWU, unpubl. data (1999)
		Otter Creek	McLellan (2003)
Tench *Introduced Species*	*Tinca tinca*	Chain Lake	WDFW, unpubl. data (1993); Polacek and Baldwin (1999)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens and others (2002b)
		Trout Lake	WDFW, unpubl. data (1993)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Catostomidae			
Bridgelip Sucker *Native Species*	*Catostomus columbianus*	Bear Creek	McLellan (2003)
		Deadman Creek	EWU, unpubl. data (1999)
		Dragoon Creek	EWU, unpubl. data (2001)
		Little Deep Creek	EWU, unpubl. data (1999)
		Little Spokane River	Hartung and Meier (1980 and 1995); EWU, unpubl. data (2001)

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Largescale Sucker *Native Species*	*Catostomus macrocheilus*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Little Spokane River	Hartung and Meier (1980 and 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data (2001)
Longnose Sucker *Native Species*	*Catostomus catostomus*	Horseshoe Lake	WDFW, unpubl. data (1993)
		Little Spokane River	Hartung and Meier (1980)
		Little Spokane River	Pfeiffer (1988)
		Trout Lake	WDFW, unpubl. data (1993)
Centrarchidae			
Black Crappie *Introduced Species*	*Pomoxis nigromaculatus*	Chain Lakes	WDFW, unpubl. data (1993)
		Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens and others (2002b)
Bluegill *Introduced Species*	*Lepomis macrochirus*	Horseshoe Lake	WDFW, unpubl. data (1995)
		Little Spokane River	Hartung and Meier (1980)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Green Sunfish *Introduced Species*	*Lepomis cyanellus*	Bear Creek	McLellan (2003)
		Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Horseshoe Lake	WDFW, unpubl. data (1995)
		Sacheen Lake	Divens and others (2002b)
		Trout Lake	WDFW, unpubl. data (1993)

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Largemouth Bass *Introduced Species*	*Micropterus salmoides*	Diamond Lake	Phillips and Divens (2000)
		Dry Creek	McLellan (2003)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Little Spokane River	Hartung and Meier (1980); Pfeiffer (1988)
		Sacheen Lake	Divens and others (2002b)
		Spring Heel Creek	McLellan (2003)
		Trout Lake	WDFW, unpubl. data (1993)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Pumpkinseed *Introduced Species*	*Lepomis gibbosus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Horseshoe Lake	WDFW, unpubl. data (1993)
		Little Spokane River	Hartung and Meier (1980 and 1995)
		Sacheen Lake	Divens and others (2002b)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Smallmouth Bass *Introduced Species*	*Micropterus dolomieui*	Eloika Lake	Zook (1978)
Percidae			
Yellow Perch *Introduced Species*	*Perca flavescens*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Horseshoe Lake	WDFW, unpubl. data (1993 and 1995)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens and others (2001)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Ameiurus			
Black Bullhead *Introduced Species*	*Ameiurus melas*	Eloika Lake	Divens and others (2001)

TABLE 2-4

UPDATED LIST OF FISH SPECIES REPORTED TO OCCUR WITHIN THE LITTLE SPOKANE RIVER SYSTEM

(from McLellan and O'Connor, 2003)

Brown Bullhead *Introduced Species*	*Ameiurus nebulosus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Divens and others (2001)
		Little Spokane River	Hartung and Meier (1980); EWU, unpubl. data (1999)
		Sacheen Lake	Divens and others (2002b)
		Trout Lake	WDFW, unpubl. data (1993)
Yellow Bullhead *Introduced Species*	*Ameiurus natalis*	Eloika Lake	Zook (1978); Divens and others (2001)
		Fan Lake	Divens and others (2002a)
		Horseshoe Lake	WDFW, unpubl. data (1995)
		Spring Heel Creek	McLellan (2003)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Cottidae			
Sculpin spp. *Native Species*	*Cottus* spp.	Buck Creek	EWU, unpubl. data (2000)
		Dragoon Creek	Lines (1982); EWU, unpubl. data (2001)
		Little Spokane River	EWU, unpubl. data (1999)
		Wethey Creek	WDFW, unpubl. data (2002)
Mottled Sculpin *Native Species*	*Cottus bairdi*	Deer Creek	McLellan (2003)
		Dry Creek	McLellan (2003)
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987)
		Otter Creek	McLellan (2003)
		WB Little Spokane River	McLellan (2003)
Slimy Sculpin *Native Species*	*Cottus cognatus*	Bear Creek	McLellan (2003)
		Buck Creek	McLellan (2003)
Torrent Sculpin *Native Species*	*Cottus rotheus*	Dry Creek	McLellan (2003)

[1]Beaver Creek; tributary to the West Branch Little Spokane River

TABLE 3-1

Summary of Little Spokane River Flows

Site Visit	Date	Time	Flow at Dartford (cfs)	LSR-1 Pine River Park (cfs)	LSR-2 Elk Park (cfs)	LSR-3 Chattaroy (cfs)	LSR-4 Otter Creek (cfs)	LSR-5 Dragoon Creek (cfs)	LSR-6 Deadman Creek (cfs)
1	9/24/2002	8:00	119			68.7			
		16:00	119		32.3				
		17:00	119				3.7		
	9/25/2002	7:00	119 [1]					17.2	
		11:00	117						5.5
		12:00	117	106.1					
2	10/24/2002	13:00	132			75.9			
	10/25/2002	10:00	132		40.0				
		12:00	132						8.2
		13:00	130	119.5					
	10/31/2002	13:00	123 [2]				3.0		
		15:00	126					27.8	
3	12/16/2002	11:00	305			152.4			
		13:00	305					73.5	
		15:00	318		48.9				
		16:00	318				7.0		
	12/17/2002	9:00	400	340.6					
		11:00	400						34.2
4	1/8/2003	13:00	329					54.6	
		15:00	325		51.5				
		16:00	322				3.7		
	1/9/2003	10:00	308			188.9			
		11:00	308	300.9					
		13:00	308						24.4
5	2/6/2003	10:00	525			312.0			
		12:00	525					123.2	
		14:00	525 [3]	549.4					
		16:00	520						49.8
	2/7/2003	10:00	496		58.0				
		11:00	496				5.3		
6	3/26/2003	10:00	823 [4]			509.2			
		13:00	828	868.1					
		15:00	828						152.0
		16:00	828					172.3	
	3/27/2003	10:00	894		69.3				
		12:00	894				10.1		

1) Flows at Dartford ranged between 117-119 cfs during gaging
2) Flows at Dartford ranged between 123-125 cfs during gaging period
3) Flows at Dartford ranged between 520-525 cfs during gaging period
4) Flows at Dartford ranged between 823-828 cfs during gaging period

TABLE 5-1

Wetted Perimeter Flow Recommendations at Little Spokane River Basin Study Sites

Study Site	Wetted Perimeter Flow Recommendation (cfs)
Little Spokane River at Pine River Park	160
Little Spokane River at Chattaroy	50
Little Spokane River at Elk	32
Dragoon Creek	40 / 9*
Deadman Creek	13 / 6*
Otter Creek	13

* Multiple inflection points result in alternative interpretations of minimum instream flow recommendation based on the Wetted Perimeter Method.

TABLE 5-2

Stage-Discharge Modeling Results for the Little Spokane River at Pine River Park

Measured Discharge (cfs)	**Modeled Flow Range** (cfs)	**Measured WSL** (ft)	**Predicted WSL** (ft)	**Difference** (ft)
106.1	50 - 240	96.34	96.33	-0.01
119.5		96.43	96.43	0.00
300.9	160 - 600	97.20	97.20	0.00
549.4		97.99	98.04	+0.05
868.1	400 - 875	98.93	98.89	-0.04

TABLE 5-3

Stage-Discharge Modeling Results for the Little Spokane River at Chattaroy

Measured Discharge (cfs)	**Modeled Flow Range** (cfs)	**Measured WSL** (ft)	**Predicted WSL** (ft)	**Difference** (ft)
68.7	30 – 120	88.70	88.70	0.00
188.9	100 - 250	89.46	89.40	-0.06
312.0	200 – 350	89.81	89.81	0.00
509.2	300 – 525	90.76	90.76	0.00

TABLE 5-4

Stage-Discharge Modeling Results for the Little Spokane River at Elk

Measured Discharge (cfs)	**Modeled Flow Range** (cfs)	**Measured WSL** (ft)	**Predicted WSL** (ft)	**Difference** (ft)
32.3	22 – 46	93.23	93.23	0.00
40.0		93.35	93.32	-0.03
51.5		93.41	93.44	+0.03
58.0	30 – 90	93.46	93.49	+0.03
69.2		93.60	93.58	-0.02

TABLE 5-5

Stage-Discharge Modeling Results for Dragoon Creek

Measured Discharge (cfs)	**Modeled Flow Range** (cfs)	**Measured WSL** (ft)	**Predicted WSL** (ft)	**Difference** (ft)
17.2	10 – 35	94.71	94.72	+0.01
54.6	26 – 95	95.19	95.19	0.00
73.5		95.39	95.34	-0.05
172.2	85 – 175	95.78	95.83	+0.05

TABLE 5-6

Stage-Discharge Modeling Results for Deadman Creek

Measured Discharge (cfs)	**Modeled Flow Range** (cfs)	**Measured WSL** (ft)	**Predicted WSL** (ft)	**Difference** (ft)
5.5	3 – 8	95.70	88.70	0.00
8.2	5 – 15	95.81	95.80	-0.01
24.4	12 – 60	96.12	96.14	+0.02
98.6	50 – 125	96.70	96.69	-0.01
152.0	100 – 200	97.08	97.03	-0.05

TABLE 5-7

Stage-Discharge Modeling Results for Otter Creek

Measured Discharge (cfs)	**Modeled Flow Range** (cfs)	**Measured WSL** (ft)	**Predicted WSL** (ft)	**Difference** (ft)
3.0		95.16	95.15	-0.01
3.7	2 – 9	95.24	95.25	+0.01
5.3		95.46	95.45	-0.01
13.7	7 – 25	96.10	96.10	0.00

TABLE 6-1

Timing of Rainbow Trout and Mountain Whitefish Presence/Absence in the Little Spokane River Basin

(*Presence is indicated by the shaded cells and absence is indicated by blank cells.*)

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainbow Trout Fry	■	■	■	■	■	■	■	■	■	■	■	■
Rainbow Trout Juvenile	■	■	■	■	■	■	■	■	■	■	■	■
Rainbow Trout Adult	■	■	■	■	■			■	■	■	■	■
Rainbow Trout Spawners						■	■					
Mountain Whitefish Fry	■	■	■	■	■	■	■	■	■	■	■	■
Mountain Whitefish Juvenile	■	■	■	■	■	■	■	■	■	■	■	■
Mountain Whitefish Adult	■	■			■	■	■	■	■	■	■	■
Mountain Whitefish Spawners			■	■								

TABLE 6-2

Juvenile and Adult Rainbow Trout Flow and Optimum Habitat Values for the Little Spokane River at Pine River Park

	Discharges (cfs)					Rainbow Trout Juvenile/Adult Habitat Relative to Optimum Habitat				
Date	MISF*	Flow Exceedance			WP	MISF*	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	130	170	150	109	160	0.89	0.99	0.95	0.79	0.97
Oct 15	140	193	154	103	160	0.92	1.00	0.96	0.76	0.97
Nov 1	150	214	160	113	160	0.95	0.99	0.97	0.81	0.97
Nov 15	150	233	180	123	160	0.95	0.98	0.99	0.86	0.97
Dec 1	150	287	187	123	160	0.95	0.90	1.00	0.86	0.97
Dec 15	150	324	209	132	160	0.95	0.83	0.99	0.90	0.97
Jan 1	150	336	214	130	160	0.95	0.81	0.99	0.89	0.97
Jan 15	150	437	227	150	160	0.95	0.72	0.98	0.95	0.97
Feb 1	150	514	234	162	160	0.95	0.59	0.98	0.98	0.97
Feb 15	170	750	277	176	160	0.99	0.41	0.92	0.99	0.97
Mar 1	190	839	409	200	160	1.00	0.39	0.74	1.00	0.97
Mar 15	218	898	470	222	160	0.99	0.40	0.67	0.99	0.97
Apr 1	250	1175	563	248	160	0.98	0.40	0.55	0.98	0.97
Apr 15	218	1107	582	230	160	0.99	0.40	0.55	0.98	0.97
May 1	192	1017	523	220	160	1.00	0.40	0.58	0.99	0.97
May 15	170	628	435	194	160	0.99	0.52	0.72	1.00	0.97
Jun 1	148	566	325	152	160	0.95	0.55	0.82	0.96	0.97
Jun 15	130	462	263	141	160	0.89	0.69	0.95	0.93	0.97
Jul 1	115	305	211	120	160	0.82	0.87	0.99	0.85	0.97
Jul 15	115	241	166	105	160	0.82	0.98	0.98	0.77	0.97
Aug 1	115	192	148	99	160	0.82	1.00	0.94	0.74	0.97
Aug 15	115	175	134	94	160	0.82	0.99	0.91	0.69	0.97
Sep 1	115	176	132	99	160	0.82	0.99	0.90	0.74	0.97
Sep 15	123	174	135	102	160	0.86	0.99	0.91	0.75	0.97
Average Habitat						0.93	0.74	0.87	0.88	0.97

*MISF = regulatory minimum instream flow per WAC 173-555.

TABLE 6-3

Spawning Rainbow Trout Flow and Optimum Habitat Values for the Little Spokane River at Pine River Park

	Discharges (cfs)					**Rainbow Trout Spawning Habitat Relative to Optimum Habitat**				
Date	MISF*	**Flow Exceedance**			WP	MISF*	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Mar 1	190	839	409	200	160	0.36	0.05	0.09	0.34	0.43
Mar 15	218	898	470	222	160	0.30	0.05	0.06	0.29	0.43
Apr 1	250	1175	563	248	160	0.26	0.05	0.06	0.26	0.43
Apr 15	218	1107	582	230	160	0.30	0.05	0.06	0.28	0.43
Average Habitat						0.31	0.05	0.07	0.29	0.43

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-4

Adult Mountain Whitefish Flow and Optimum Habitat Values for the Little Spokane River at Pine River Park

	Discharges (cfs)					Mountain Whitefish Adult Habitat Relative to Optimum Habitat				
Date	MISF*	Flow Exceedance			WP	MISF*	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	130	170	150	109	160	0.67	0.84	0.75	0.57	0.80
Oct 15	140	193	154	103	160	0.71	0.93	0.77	0.54	0.80
Nov 1	150	214	160	113	160	0.75	0.98	0.79	0.59	0.80
Nov 15	150	233	180	123	160	0.75	1.00	0.88	0.64	0.80
Dec 1	150	287	187	123	160	N/A	N/A	N/A	N/A	N/A
Dec 15	150	324	209	132	160	N/A	N/A	N/A	N/A	N/A
Jan 1	150	336	214	130	160	N/A	N/A	N/A	N/A	N/A
Jan 15	150	437	227	150	160	N/A	N/A	N/A	N/A	N/A
Feb 1	150	514	234	162	160	0.75	0.56	1.00	0.81	0.80
Feb 15	170	750	277	176	160	0.84	0.37	0.98	0.87	0.80
Mar 1	190	839	409	200	160	0.92	0.33	0.74	0.95	0.80
Mar 15	218	898	470	222	160	0.98	0.31	0.62	0.99	0.80
Apr 1	250	1175	563	248	160	1.00	0.31	0.51	1.00	0.80
Apr 15	218	1107	582	230	160	0.98	0.31	0.49	0.99	0.80
May 1	192	1017	523	220	160	0.93	0.31	0.55	0.99	0.80
May 15	170	628	435	194	160	0.84	0.45	0.69	0.93	0.80
Jun 1	148	566	325	152	160	0.74	0.50	0.91	0.76	0.80
Jun 15	130	462	263	141	160	0.67	0.64	0.99	0.71	0.80
Jul 1	115	305	211	120	160	0.60	0.94	0.97	0.62	0.80
Jul 15	115	241	166	105	160	0.60	1.00	0.83	0.55	0.80
Aug 1	115	192	148	99	160	0.60	0.93	0.74	0.53	0.80
Aug 15	115	175	134	94	160	0.60	0.86	0.69	0.50	0.80
Sep 1	115	176	132	99	160	0.60	0.87	0.68	0.53	0.80
Sep 15	123	174	135	102	160	0.64	0.86	0.69	0.54	0.80
Average Habitat						0.70	0.80	0.72	0.76	0.80

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-5

Spawning Mountain Whitefish Flow and Optimum Habitat Values for the Little Spokane River at Pine River Park

	Discharges (cfs)					**Mountain Whitefish Spawning Habitat Relative to Optimum Habitat**				
Date	MISF*	**Flow Exceedance**			WP	MISF*	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Dec 1	150	287	187	123	160	0.86	0.99	0.96	0.75	0.90
Dec 15	150	324	209	132	160	0.86	1.00	0.97	0.79	0.90
Jan 1	150	336	214	130	160	0.86	1.00	0.98	0.78	0.90
Jan 15	150	437	227	150	160	0.86	0.93	0.98	0.86	0.90
					Average Habitat	0.86	0.98	0.97	0.80	0.90

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-6

Juvenile and Adult Rainbow Trout Flow and Optimum Habitat Values for the Little Spokane River at Chattaroy

	Discharges (cfs)					**Rainbow Trout Juvenile/Adult Habitat Relative to Optimum Habitat**				
Date	MISF*	**Flow Exceedance**			WP	MISF*	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	70	102.7	67.6	47.3	50.0	0.53	0.85	0.50	0.27	0.30
Oct 15	77	107.1	64.4	37.5	50.0	0.60	0.89	0.46	0.16	0.30
Nov 1	86	125.9	70.0	51.9	50.0	0.68	0.98	0.53	0.32	0.30
Nov 15	86	144.8	83.7	67.0	50.0	0.68	0.96	0.66	0.49	0.30
Dec 1	86	184.5	101.5	76.7	50.0	0.68	0.81	0.85	0.59	0.30
Dec 15	86	197.8	118.1	71.9	50.0	0.68	0.76	0.94	0.54	0.30
Jan 1	86	215.9	128.7	88.8	50.0	0.68	0.69	0.99	0.70	0.30
Jan 15	86	202.3	128.6	85.7	50.0	0.68	0.74	0.99	0.67	0.30
Feb 1	86	240.2	114.9	89.3	50.0	0.68	0.59	0.93	0.70	0.30
Feb 15	104	285.4	119.4	82.0	50.0	0.86	0.43	0.95	0.64	0.30
Mar 1	122	435.8	181.9	99.3	50.0	0.96	0.27	0.82	0.83	0.30
Mar 15	143	478.4	222.9	117.8	50.0	0.97	0.29	0.66	0.94	0.30
Apr 1	165	610.4	245.5	139.2	50.0	0.89	0.31	0.56	0.97	0.30
Apr 15	143	460.5	292.2	133.5	50.0	0.97	0.28	0.40	0.99	0.30
May 1	124	422.5	252.5	120.7	50.0	0.97	0.27	0.53	0.96	0.30
May 15	104	347.6	183.0	92.5	50.0	0.86	0.27	0.82	0.74	0.30
Jun 1	83	281.4	152.0	70.8	50.0	0.65	0.45	0.94	0.53	0.30
Jun 15	69	283.0	130.7	61.9	50.0	0.51	0.44	1.00	0.43	0.30
Jul 1	57	209.5	108.8	60.1	50.0	0.38	0.72	0.90	0.42	0.30
Jul 15	57	176.4	94.0	51.4	50.0	0.38	0.84	0.76	0.31	0.30
Aug 1	57	133.8	77.9	41.0	50.0	0.38	0.99	0.60	0.19	0.30
Aug 15	57	103.4	65.4	33.6	50.0	0.38	0.86	0.47	0.12	0.30
Sep 1	57	103.8	64.9	35.7	50.0	0.38	0.86	0.47	0.14	0.30
Sep 15	63	105.6	61.0	40.4	50.0	0.45	0.88	0.43	0.19	0.30
					Average Habitat	0.66	0.64	0.72	0.54	0.30

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-7

Spawning Rainbow Trout Flow and Optimum Habitat Values for the Little Spokane River at Chattaroy

	Discharges (cfs)					**Rainbow Trout Spawning Habitat Relative to Optimum Habitat**				
Date	MISF*	**Flow Exceedance**			WP	MISF*	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Mar 1	122	435.8	181.9	99.3	50.0	0.24	0.00	0.05	0.49	0.94
Mar 15	143	478.4	222.9	117.8	50.0	0.14	0.00	0.01	0.27	0.94
Apr 1	165	610.4	245.5	139.2	50.0	0.09	0.00	0.00	0.15	0.94
Apr 15	143	460.5	292.2	133.5	50.0	0.14	0.00	0.00	0.17	0.94
Average Habitat						0.15	0.00	0.02	0.27	0.94

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-8

Adult Mountain Whitefish Flow and Optimum Habitat Values for the Little Spokane River at Chattaroy

	Discharges (cfs)					Mountain Whitefish Adult Habitat Relative to Optimum Habitat				
Date	MISF*	Flow Exceedance			WP	MISF*	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	70	102.7	67.6	47.3	50.0	0.51	0.74	0.49	0.32	0.35
Oct 15	77	107.1	64.4	37.5	50.0	0.55	0.77	0.46	0.22	0.35
Nov 1	86	125.9	70.0	51.9	50.0	0.61	0.92	0.51	0.36	0.35
Nov 15	86	144.8	83.7	67.0	50.0	0.61	0.99	0.60	0.48	0.35
Dec 1	86	184.5	101.5	76.7	50.0	N/A	N/A	N/A	N/A	N/A
Dec 15	86	197.8	118.1	71.9	50.0	N/A	N/A	N/A	N/A	N/A
Jan 1	86	215.9	128.7	88.8	50.0	N/A	N/A	N/A	N/A	N/A
Jan 15	86	202.3	128.6	85.7	50.0	N/A	N/A	N/A	N/A	N/A
Feb 1	86	240.2	114.9	89.3	50.0	0.61	0.80	0.83	0.63	0.35
Feb 15	104	285.4	119.4	82.0	50.0	0.75	0.66	0.87	0.59	0.35
Mar 1	122	435.8	181.9	99.3	50.0	0.89	0.47	0.98	0.72	0.35
Mar 15	143	478.4	222.9	117.8	50.0	0.98	0.47	0.86	0.86	0.35
Apr 1	165	610.4	245.5	139.2	50.0	1.00	0.49	0.78	0.97	0.35
Apr 15	143	460.5	292.2	133.5	50.0	0.98	0.47	0.63	0.96	0.35
May 1	124	422.5	252.5	120.7	50.0	0.90	0.47	0.76	0.88	0.35
May 15	104	347.6	183.0	92.5	50.0	0.75	0.50	0.98	0.66	0.35
Jun 1	83	281.4	152.0	70.8	50.0	0.59	0.67	1.00	0.51	0.35
Jun 15	69	283.0	130.7	61.9	50.0	0.50	0.67	0.95	0.44	0.35
Jul 1	57	209.5	108.8	60.1	50.0	0.40	0.91	0.79	0.43	0.35
Jul 15	57	176.4	94.0	51.4	50.0	0.40	0.99	0.67	0.36	0.35
Aug 1	57	133.8	77.9	41.0	50.0	0.40	0.96	0.56	0.26	0.35
Aug 15	57	103.4	65.4	33.6	50.0	0.40	0.75	0.47	0.18	0.35
Sep 1	57	103.8	64.9	35.7	50.0	0.40	0.75	0.47	0.21	0.35
Sep 15	63	105.6	61.0	40.4	50.0	0.45	0.76	0.43	0.25	0.35
Average Habitat						0.63	0.75	0.73	0.53	0.35

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-9

Spawning Mountain Whitefish Flow and Optimum Habitat Values for the Little Spokane River at Chattaroy

	Discharges (cfs)					Mountain Whitefish Spawning Habitat Relative to Optimum Habitat				
Date	MISF*	Flow Exceedance			WP	MISF*	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Dec 1	86	184.5	101.5	76.7	50.0	0.70	1.00	0.80	0.63	0.40
Dec 15	86	197.8	118.1	71.9	50.0	0.70	1.00	0.88	0.60	0.40
Jan 1	86	215.9	128.7	88.8	50.0	0.70	0.98	0.92	0.72	0.40
Jan 15	86	202.3	128.6	85.7	50.0	0.70	1.00	0.92	0.70	0.40

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-10

Juvenile and Adult Rainbow Trout Flow and Optimum Habitat Values for the Little Spokane River at Elk

	Discharges (cfs)					**Rainbow Tout Juvenile/Adult Habitat Relative to Optimum Habitat**				
Date	MISF*	**Flow Exceedance**			WP	MISF*	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	38	50.1	45.3	39.4	32.0	0.90	0.74	0.79	0.88	0.94
Oct 15	39	52.3	45.0	39.4	32.0	0.89	0.74	0.80	0.88	0.94
Nov 1	40	54.7	44.5	38.8	32.0	0.87	0.73	0.80	0.89	0.94
Nov 15	40	52.1	45.4	39.7	32.0	0.87	0.74	0.79	0.88	0.94
Dec 1	40	58.2	48.0	38.9	32.0	0.87	0.73	0.75	0.89	0.94
Dec 15	40	56.7	46.6	42.8	32.0	0.87	0.73	0.78	0.83	0.94
Jan 1	40	62.4	49.4	41.4	32.0	0.87	0.73	0.75	0.86	0.94
Jan 15	40	70.3	48.1	41.4	32.0	0.87	0.73	0.75	0.86	0.94
Feb 1	40	73.4	51.1	41.1	32.0	0.87	0.72	0.74	0.86	0.94
Feb 15	43	82.2	53.0	43.9	32.0	0.83	0.70	0.74	0.81	0.94
Mar 1	46	89.4	62.0	44.5	32.0	0.79	0.68	0.73	0.80	0.94
Mar 15	50	86.6	64.7	45.9	32.0	0.74	0.69	0.74	0.79	0.94
Apr 1	54	112.9	72.1	53.1	32.0	0.74	N/A	0.72	0.74	0.94
Apr 15	52	120.8	80.0	58.9	32.0	0.74	N/A	0.70	0.73	0.94
May 1	49	115.2	77.1	57.0	32.0	0.75	N/A	0.71	0.73	0.94
May 15	47	98.2	70.3	55.2	32.0	0.77	N/A	0.73	0.73	0.94
Jun 1	45	86.8	66.2	49.0	32.0	0.80	0.68	0.73	0.75	0.94
Jun 15	43	76.5	59.7	47.5	32.0	0.83	0.71	0.73	0.76	0.94
Jul 1	41.5	71.4	55.1	42.3	32.0	0.85	0.72	0.73	0.84	0.94
Jul 15	39.5	65.0	50.9	43.4	32.0	0.88	0.74	0.74	0.82	0.94
Aug 1	38	56.2	47.4	39.7	32.0	0.90	0.73	0.76	0.88	0.94
Aug 15	38	52.1	45.6	39.6	32.0	0.90	0.74	0.79	0.88	0.94
Sep 1	38	51.7	44.7	38.2	32.0	0.90	0.74	0.80	0.90	0.94
Sep 15	38	51.0	42.9	37.8	32.0	0.90	0.74	0.83	0.90	0.94
					Average Habitat	0.84	0.71	0.76	0.83	0.94

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-11

Adult Mountain Whitefish Flow and Optimum Habitat Values for the Little Spokane River at Elk

	Discharges (cfs)					Mountain Whitefish Adult Habitat Relative to Optimum Habitat				
Date	MISF*	Flow Exceedance			WP	MISF*	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	38	50.1	45.3	39.4	32.0	0.81	0.91	0.87	0.82	0.74
Oct 15	39	52.3	45.0	39.4	32.0	0.82	0.93	0.87	0.82	0.74
Nov 1	40	54.7	44.5	38.8	32.0	0.83	0.95	0.86	0.82	0.74
Nov 15	40	52.1	45.4	39.7	32.0	0.83	0.93	0.87	0.83	0.74
Dec 1	40	58.2	48.0	38.9	32.0	N/A	N/A	N/A	N/A	N/A
Dec 15	40	56.7	46.6	42.8	32.0	N/A	N/A	N/A	N/A	N/A
Jan 1	40	62.4	49.4	41.4	32.0	N/A	N/A	N/A	N/A	N/A
Jan 15	40	70.3	48.1	41.4	32.0	N/A	N/A	N/A	N/A	N/A
Feb 1	40	73.4	51.1	41.1	32.0	0.83	1.00	0.92	0.84	0.74
Feb 15	43	82.2	53.0	43.9	32.0	0.85	0.99	0.94	0.86	0.74
Mar 1	46	89.4	62.0	44.5	32.0	0.88	0.98	0.99	0.86	0.74
Mar 15	50	86.6	64.7	45.9	32.0	0.91	0.98	0.99	0.87	0.74
Apr 1	54	112.9	72.1	53.1	32.0	0.95	N/A	1.00	0.94	0.74
Apr 15	52	120.8	80.0	58.9	32.0	0.93	N/A	0.99	0.98	0.74
May 1	49	115.2	77.1	57.0	32.0	0.90	N/A	1.00	0.97	0.74
May 15	47	98.2	70.3	55.2	32.0	0.88	N/A	0.99	0.96	0.74
Jun 1	45	86.8	66.2	49.0	32.0	0.87	0.98	0.99	0.90	0.74
Jun 15	43	76.5	59.7	47.5	32.0	0.85	1.00	0.98	0.89	0.74
Jul 1	41.5	71.4	55.1	42.3	32.0	0.84	1.00	0.95	0.85	0.74
Jul 15	39.5	65.0	50.9	43.4	32.0	0.82	0.99	0.92	0.86	0.74
Aug 1	38	56.2	47.4	39.7	32.0	0.81	0.96	0.88	0.83	0.74
Aug 15	38	52.1	45.6	39.6	32.0	0.81	0.93	0.87	0.82	0.74
Sep 1	38	51.7	44.7	38.2	32.0	0.81	0.93	0.86	0.81	0.74
Sep 15	38	51.0	42.9	37.8	32.0	0.81	0.92	0.85	0.81	0.74
					Average Habitat	0.85	0.96	0.92	0.86	0.74

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-12

Spawning Mountain Whitefish Flow and Optimum Habitat Values for the Little Spokane River at Elk

	Discharges (cfs)					Mountain Whitefish Spawning Habitat Relative to Optimum Habitat				
Date	MISF*	Flow Exceedance			WP	MISF*	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Dec 1	40	58.2	48.0	38.9	32.0	0.92	0.98	0.94	0.91	0.83
Dec 15	40	56.7	46.6	42.8	32.0	0.92	0.98	0.94	0.93	0.83
Jan 1	40	62.4	49.4	41.4	32.0	0.92	0.99	0.95	0.92	0.83
Jan 15	40	70.3	48.1	41.4	32.0	0.92	1.00	0.94	0.92	0.83
Average Habitat						0.92	0.99	0.94	0.92	0.83

*MISF – regulatory minimum instream flow per WAC 173-555

TABLE 6-13

Normalized Habitat Availability in Dragoon Creek Defined by Wetted Perimeter Analysis

Life Stage	Normalized Habitat at Wetted Perimeter Flow	
	40 cfs	9 cfs
Mountain Whitefish Adult	0.60	0.12
Mountain Whitefish Juvenile	0.78	0.22
Mountain Whitefish Fry	0.95	0.80
Mountain Whitefish Spawning	0.63	0.01
Rainbow Trout Juvenile/Adult	1.00	0.19
Rainbow Trout Fry	0.43	0.90
Rainbow Trout Spawning	0.67	0.19

TABLE 6-14

Normalized Habitat Availability in Deadman Creek Defined by Wetted Perimeter Analysis

Life Stage	Normalized Habitat at Wetted Perimeter Flow	
	13 cfs	6 cfs
Mountain Whitefish Adult	0.33	0.16
Mountain Whitefish Juvenile	0.44	0.25
Mountain Whitefish Fry	1.00	0.89
Mountain Whitefish Spawning	0.18	0.00
Rainbow Trout Juvenile/Adult	0.86	0.44
Rainbow Trout Fry	0.41	0.12
Rainbow Trout Spawning	0.38	0.70

TABLE 6-15

Normalized Habitat Availability in Otter Creek Defined by Wetted Perimeter Analysis

Life Stage	Normalized Habitat at Wetted Perimeter Flow (13 cfs)
Mountain Whitefish Adult	0.79
Mountain Whitefish Juvenile	0.81
Mountain Whitefish Fry	0.91
Rainbow Trout Juvenile/Adult	0.90
Rainbow Trout Fry	0.46

TABLE 6-16

Bankfull Discharge and Mean Annual Flow at Little Spokane River Instream Flow Needs Study Sites

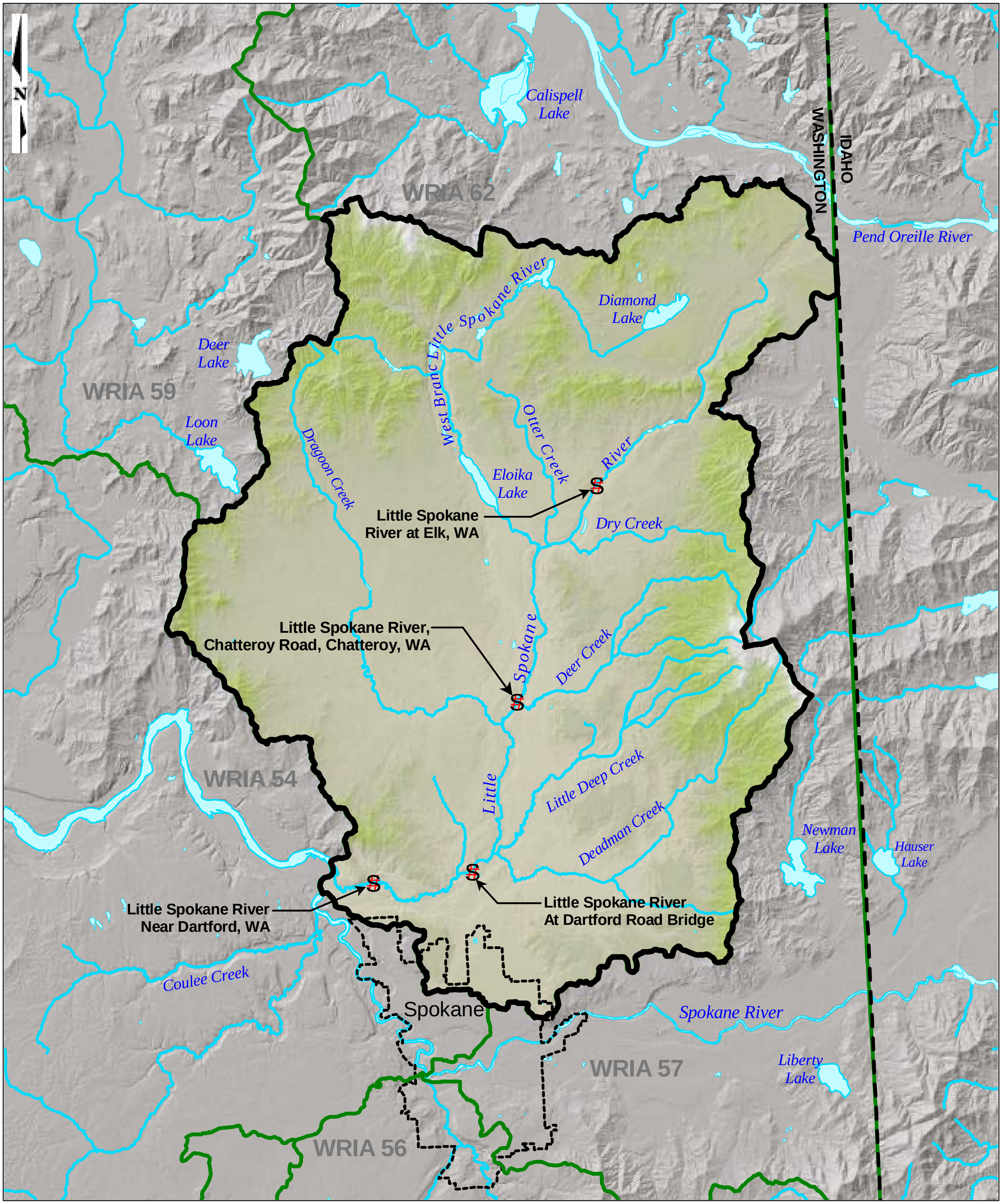
	LSR at Pine River Park	LSR at Chattaroy	LSR at Elk	Dragoon Creek	Deadman Creek	Otter Creek
Bankfull Discharge (cfs)	1100	375	120	400	320	50
Mean Annual Flow (cfs)	309.8	150.2	56.5	Undetermined	Undetermined	Undetermined

TABLE 6-17

Additional Instream Flow Analysis Results Compared to Existing Minimum Instream Flows (MISFs)

Study Site	MISF Flow Range (cfs)	200% MAF	0.8 – 1.6 Bankfull	1.25 Bankfull
LSR @ Dartford	115 – 250	620	880 - 1760	1375
LSR @ Chattaroy	57 – 165	300	300 – 600	469
LSR @ Elk	38 – 54	113	96 – 192	150
Dragoon Creek	Undetermined	Undetermined	320 – 640	500
Deadman Creek	Undetermined	Undetermined	256 - 512	400
Otter Creek	Undetermined	Undetermined	40 – 64	63

FIGURES



LEGEND

- Minimum Instream Flow
- Little Spokane River Basin Boundary
- Adjacent WRIA Boundaries
- City Limits
- State Border
- Lakes and Reservoirs
- Rivers and Streams

0 6

Scale 1" = 6 Miles

Map Projection: Washington State Plane North Zone, NAD83, Feet

Original Data Source: Washington Department of Ecology, USGS, WSDOT

This figure was originally produced in color. Reproduction in black and white may result in loss of information.

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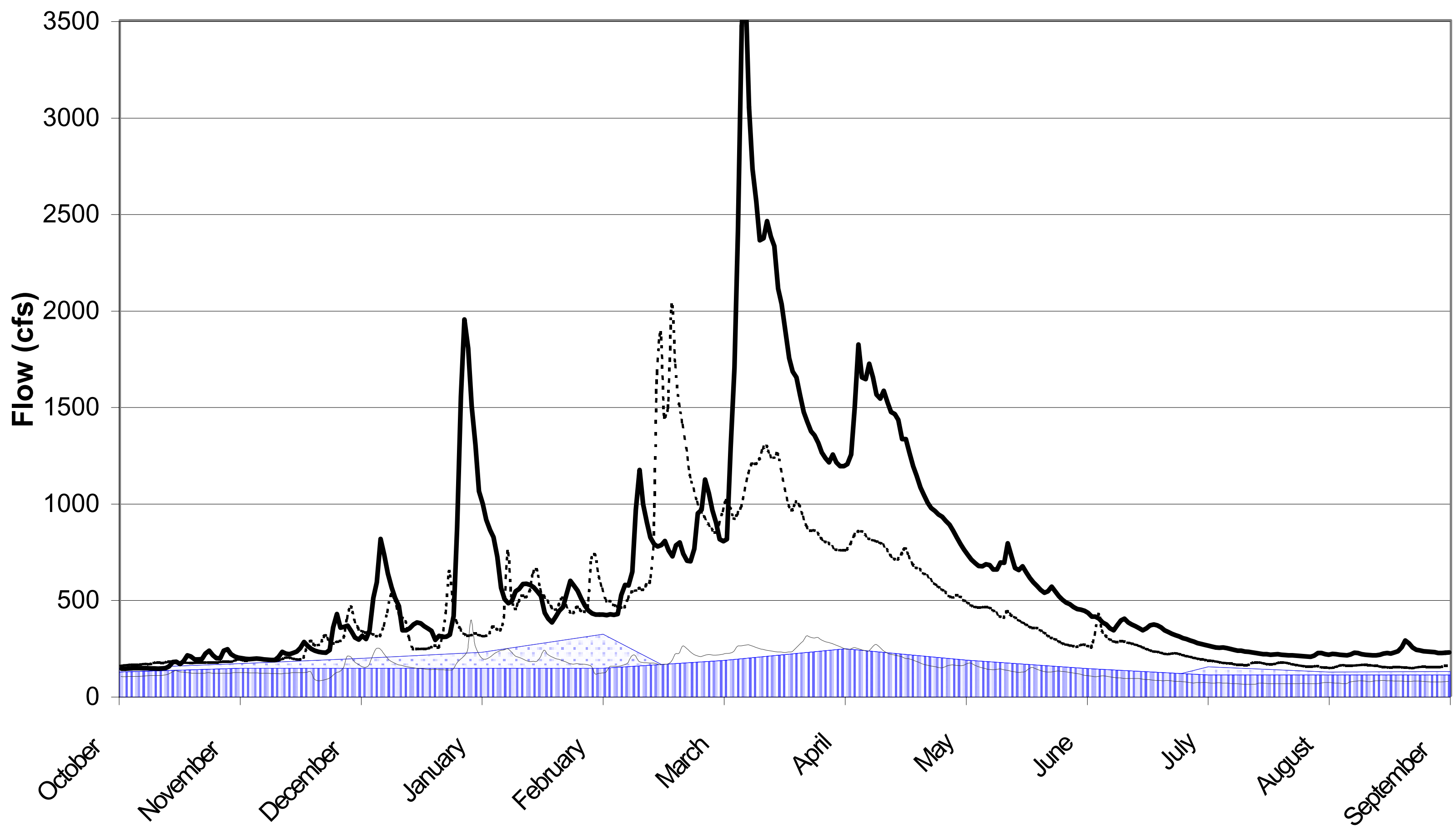
WRIA 55
Minimum Instream Flow
Control Points

Drawn: BBA	Revision: 3	Date: Dec 22, 2003	Figure: 1.1

01313722400_042903.apr



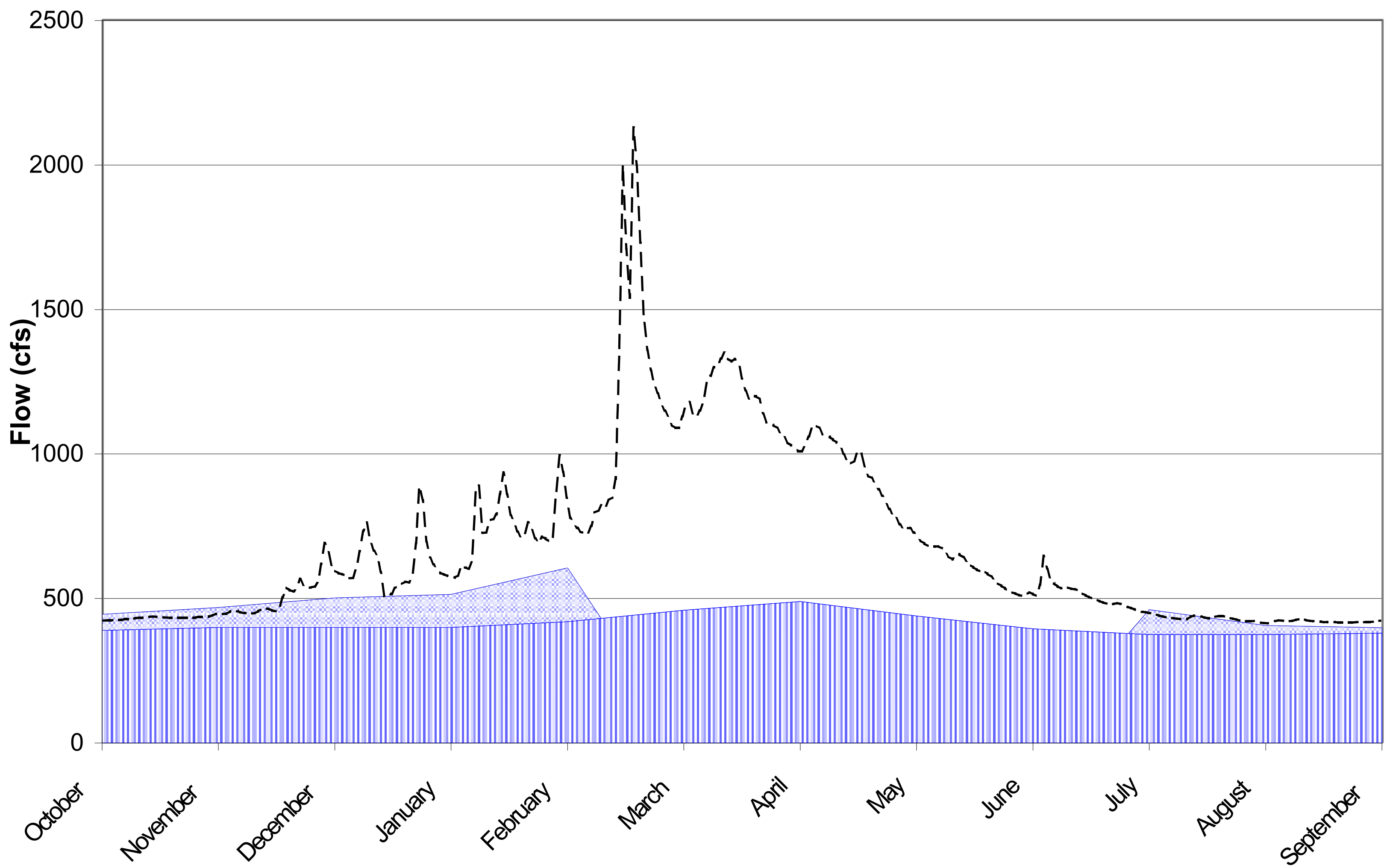
Legend

- Average Baseflow
- Instream Flow Requirements
- 1997 - Wet Year
- 1999 - Average Year
- 1994 - Dry Year

POR 1930 - 1932, 1948 - 1999.
Note: Baseflow not computed during spring thaw (March through June)

FIGURE 1.2a:
Little Spokane River Historical and Regulatory Flows at Dartford (USGS gage 12431000)
Spokane County
IFN Assessment
013-1372, id142 graphs.xls, 07/23/2001

Golder Associates



Legend

Average Baseflow

Instream Flow Requirements

— — — 1999 - Average Year

POR: 1949-1951, 1998-1999.

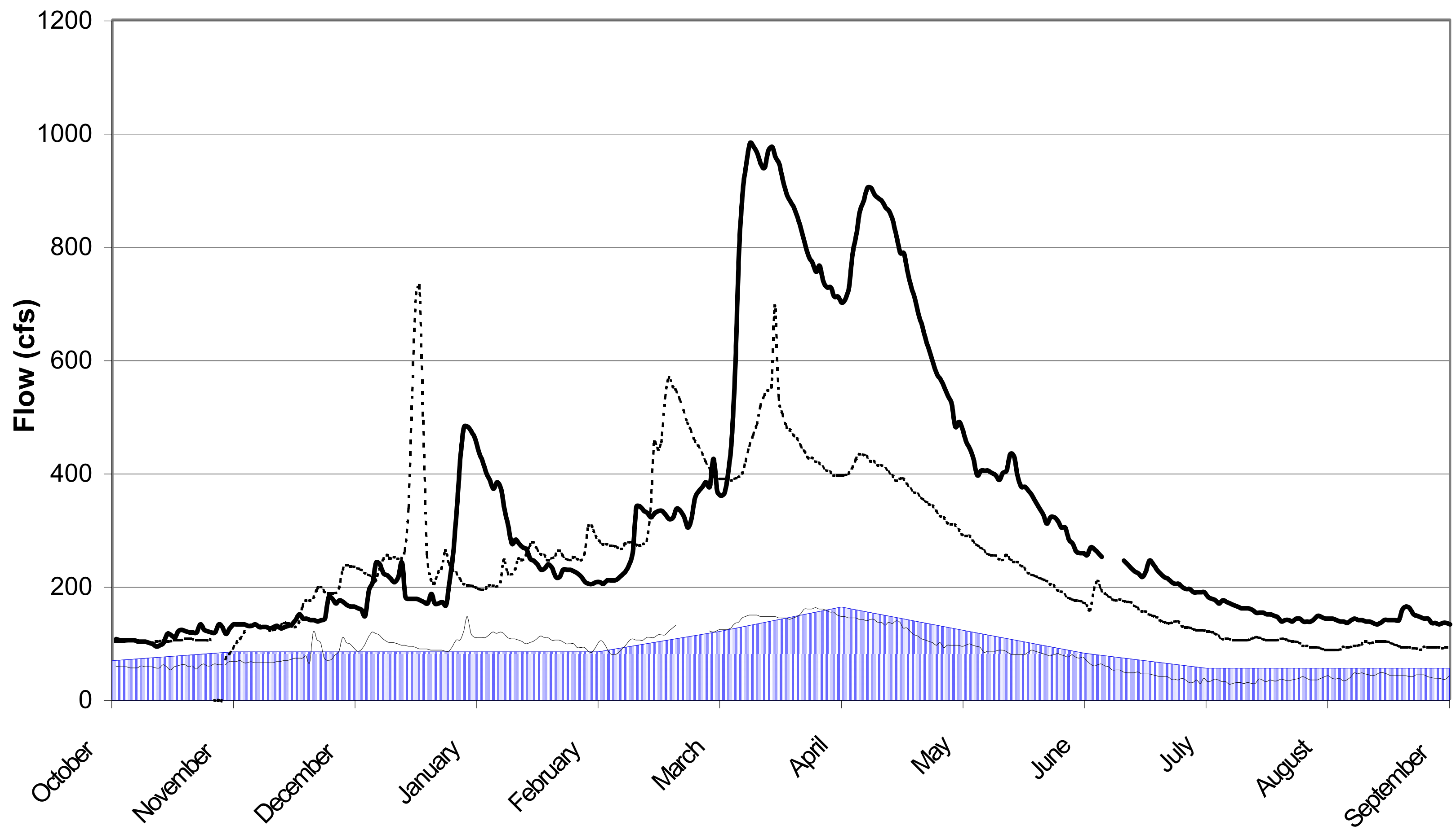
Note: Baseflow not computed during spring thaw (March through June).
Instream Flows are for Confluence Control Point downstream of this gage.

FIGURE 1.2b:
Little Spokane River Historical and Regulatory Flows at Dartford (USGS gage 12431500)

Spokane County
IFN Assessment

013-1392, id146 graphs.xls,

Golder Associates



Legend

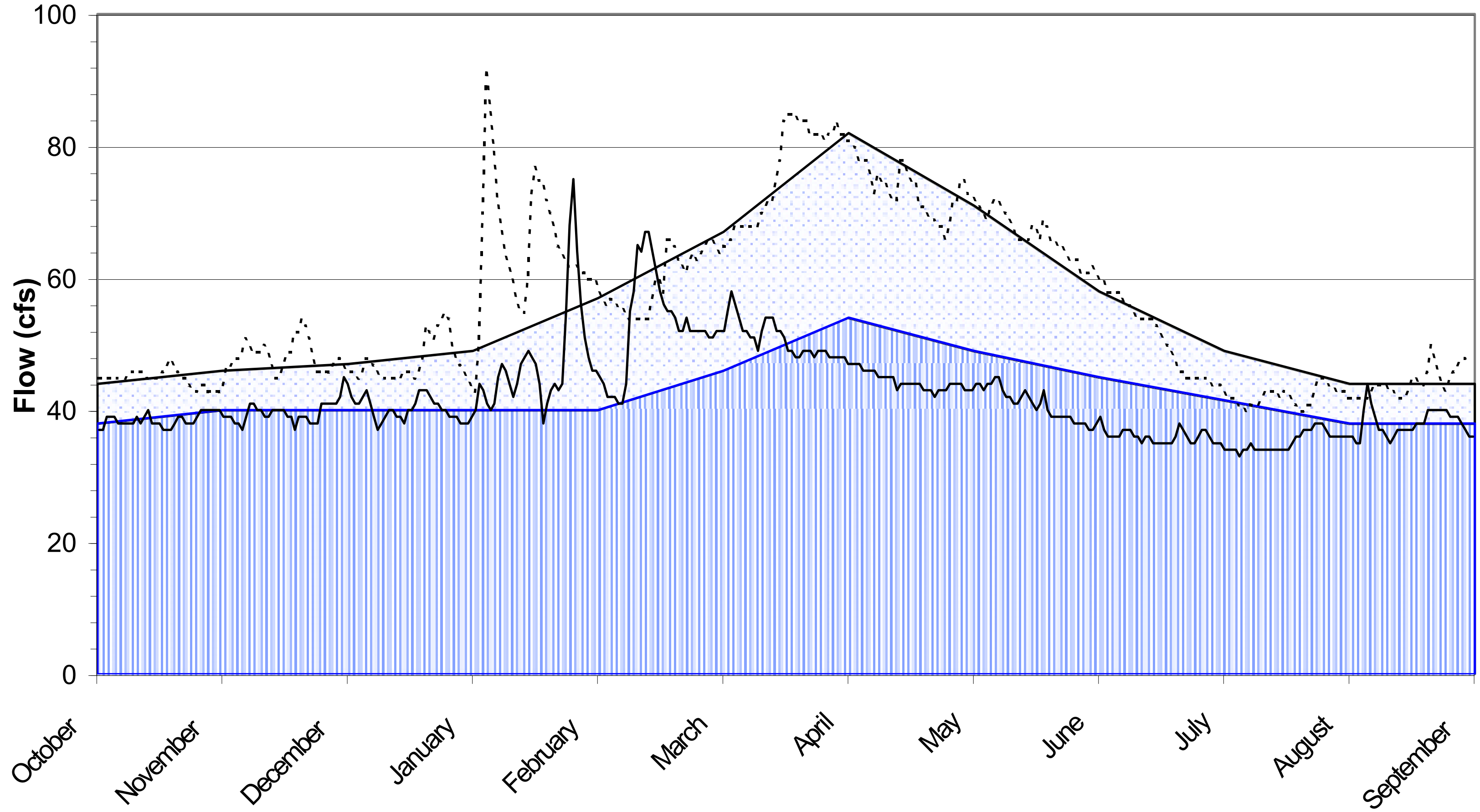
- Instream Flow Requirements
- 1994 - Dry Year
- 1999 - Average Year
- 1997 - Wet Year

POR 1976 - present.
Note: Baseflow estimates not available for this gage.

FIGURE 1.2c:
Little Spokane River Historical and Regulatory Flows at Chattaroy (SCC 001)
Spokane County
IFN Assessment

013-1392, id147 graphs.xls.

Golder Associates



Legend

- Average Baseflow
- Instream Flow Requirements
- 1959 - Average Year
- 1968 - Dry Year

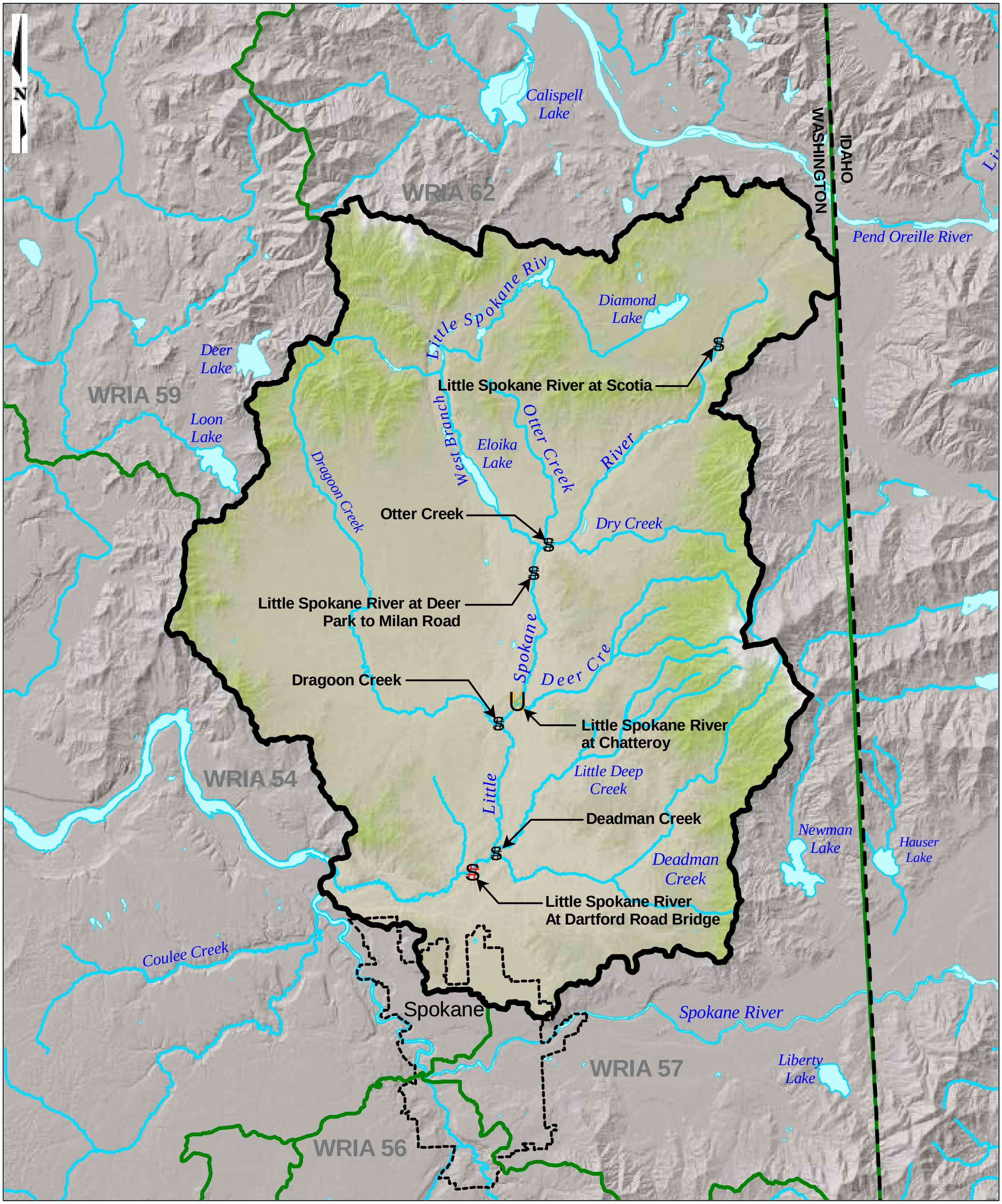
POR 1949-1971, Representative years used for Average and Dry Year
Note: Baseflow not computed during spring thaw (March through June).

FIGURE 1.2d:
Little Spokane River Historical and Regulatory Flows at Elk (USGS stn. 12427000)

Spokane County
IFN Assessment

013-1372, id143graphs.xls,

Golder Associates



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LEGEND

- Spokane County Conservation District Gages
- USGS
- Monitored by Spokane Community College
- Lakes and Reservoirs
- Little Spokane River Basin Boundary
- Adjacent WRIA Boundaries
- Rivers and Streams
- City Limits
- State Border

0 6

Scale 1" = 6 Miles

Map Projection: Washington State Plane North Zone, NAD83, Feet

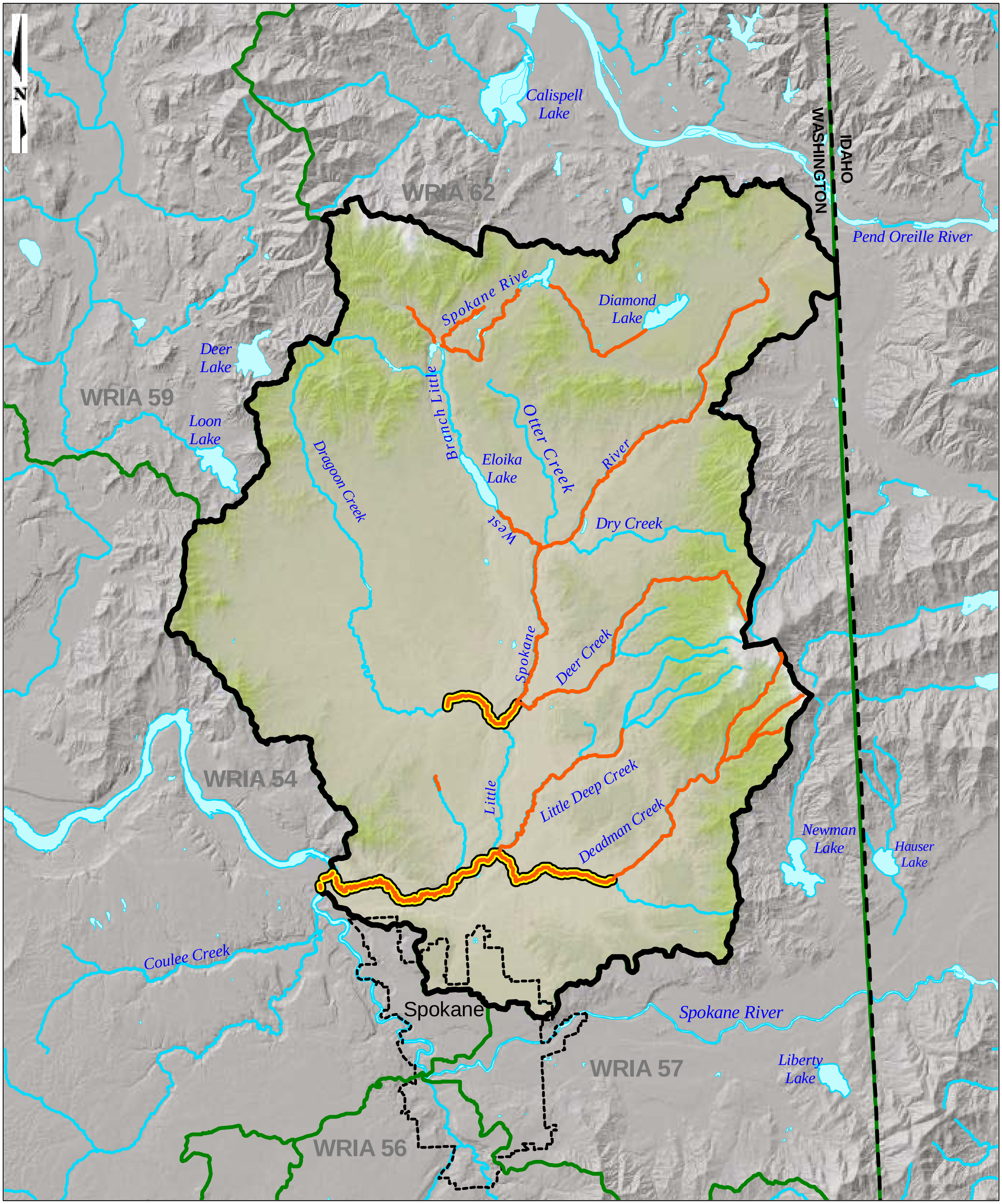
Original Data Source: Washington Department of Ecology, USGS, WSDOT

Golder Associates

Existing Stream Gaging Locations

Drawn: BBA	Revision: 3	Date: May 19, 2003	Figure: 2.1

01313722400_042903.apr



LEGEND

- Mountain Whitefish Distribution
- Rainbow Trout Distribution
- Little Spokane River Basin Boundary
- Adjacent WRIA Boundaries
- Rivers and Streams
- City Limits
- State Border

0 6

Scale 1" = 6 Miles

Map Projection: Washington State Plane North Zone, NAD83, Feet

Original Data Source: Washington Department of Ecology, USGS, WSDOT

This figure was originally produced in color. Reproduction in black and white may result in loss of information.

Golder Associates

Mountain Whitefish and Rainbow Trout Distribution from WDFW

Drawn: BBA	Revision: 3	Date: May 19, 2003	Figure: 3.1

01313722400_042903.apr

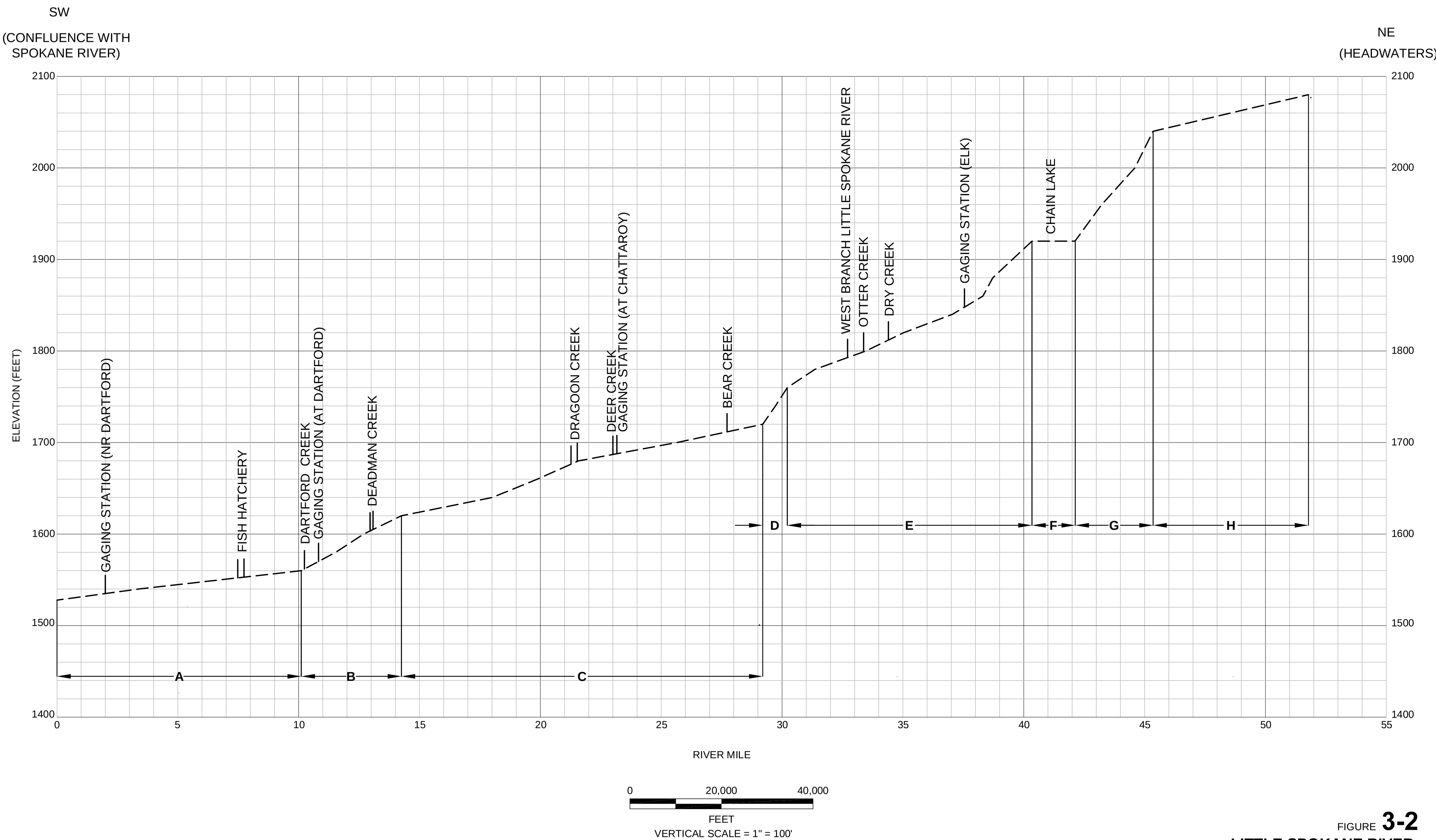
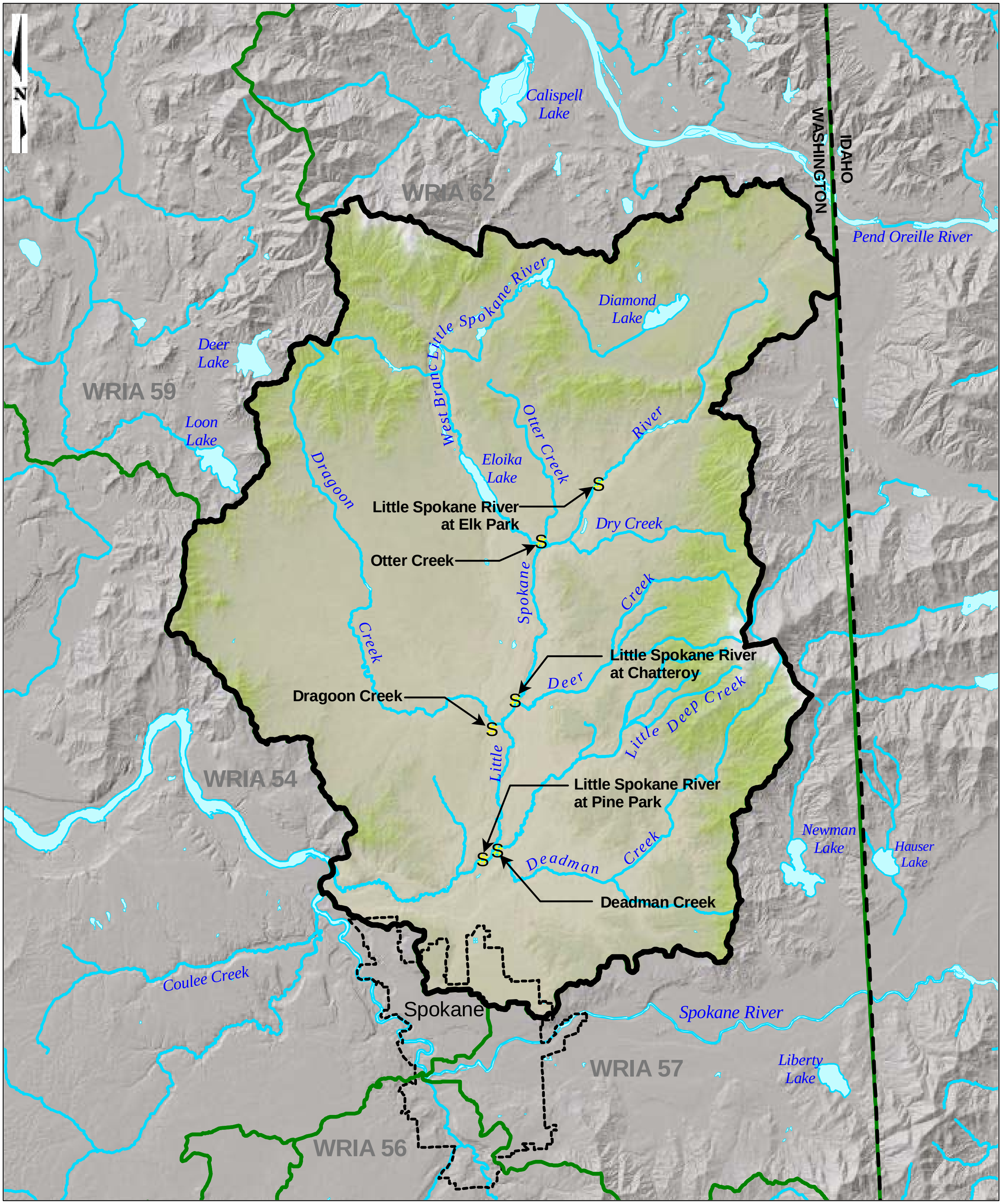


FIGURE **3-2**
LITTLE SPOKANE RIVER, ELEVATION PROFILE
WRIA 55 PLANNING UNIT IFN ASSESSMENT/WA

DCabe|K:\Projects\2001\0131372\2400\96447.dwg|05-21-03 18:56|x:-|i:-

Golder Associates



LEGEND

- S Instream Flow Needs Assessment Monitoring Locations
- Little Spokane River Basin Boundary
- Adjacent WRIA Boundaries
- City Limits
- State Border
- Lakes and Reservoirs
- Rivers and Streams

0 6

Scale 1" = 6 Miles

Map Projection: Washington State Plane North Zone, NAD83, Feet

Original Data Source: Washington Department of Ecology, USGS, WSDOT

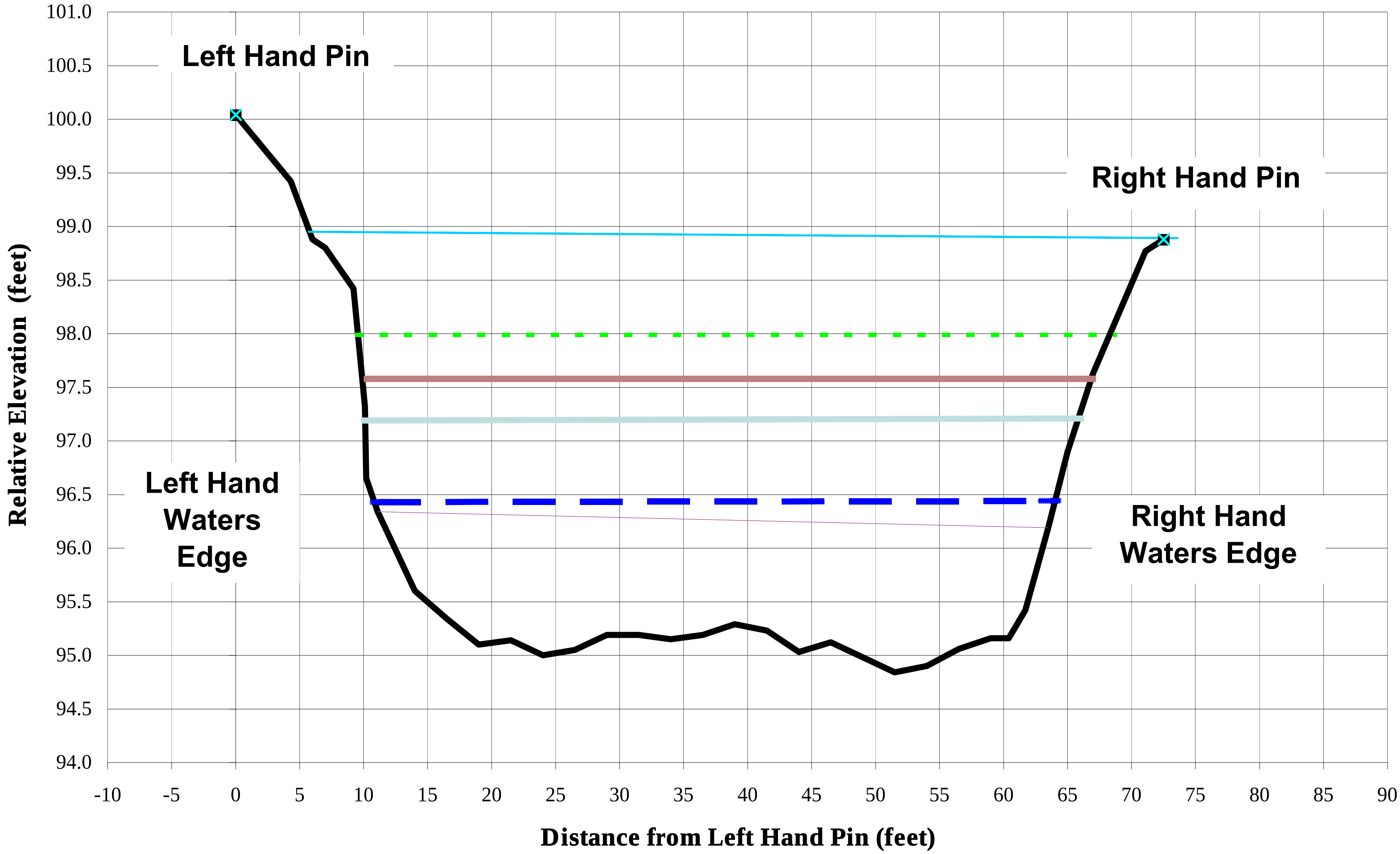
This figure was originally produced in color. Reproduction in black and white may result in loss of information.

Golder Associates

Instream Flow Needs Assessment SItes

Drawn: BBA	Revision: 3	Date: May 19, 2003	Figure: 3.3

01313722400_042903.apr



Data Source: IF Surveys

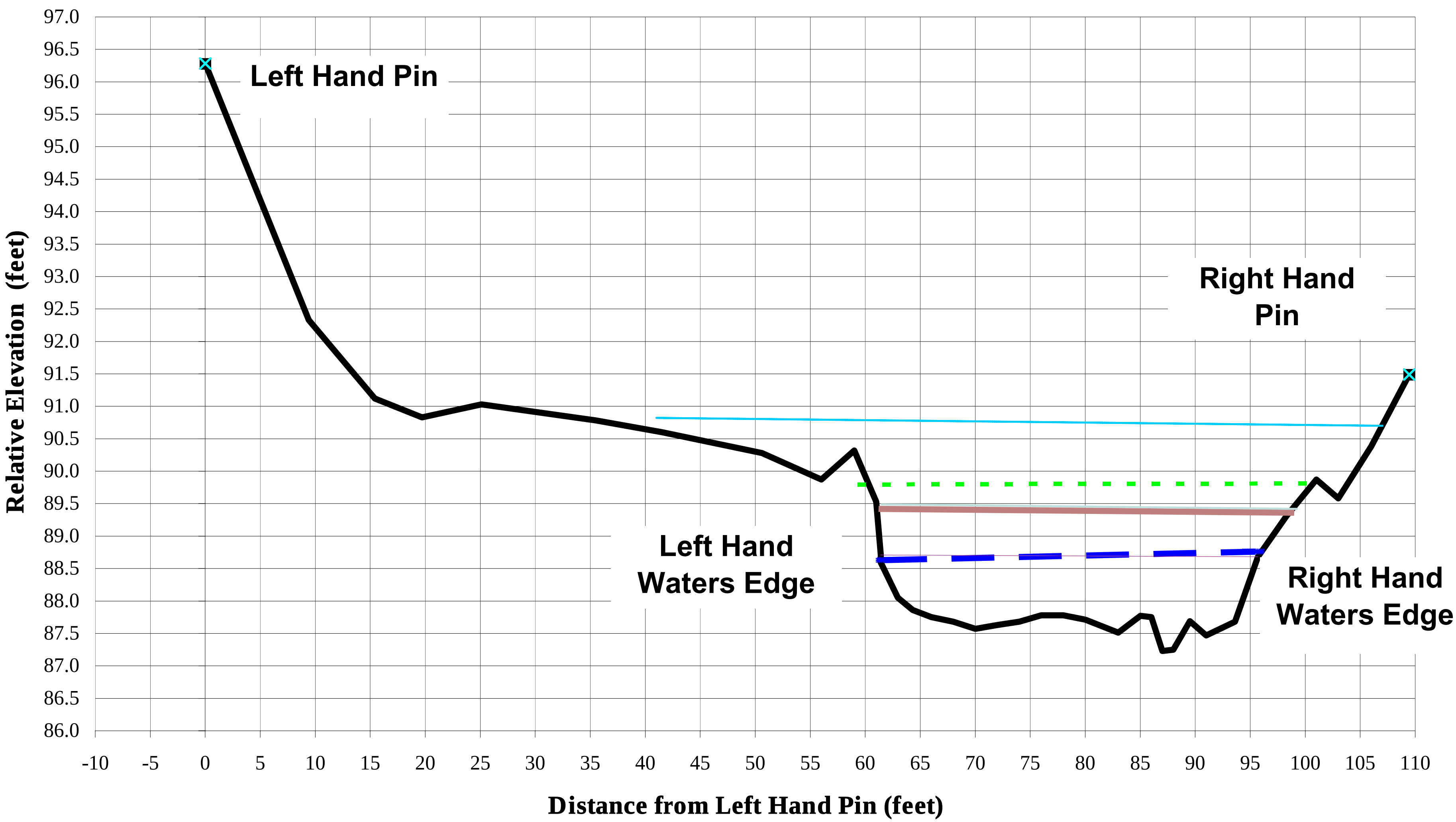
October 24, 2002; 119.5 cfs
September 25, 2002; 106 cfs
December 17,2002;340.6 cfs
January 9, 2003; 300.9 cfs
February 6, 2003; 549.4 cfs
March 26, 2003; 868.1 cfs

FIGURE 3.4: Little Spokane River at Pine River Park Cross Section

Spokane County / IFN Assessment / WA

Golder Associates

Figures 3.4 through 3.9.xls/Fig 3.4 LSR @ Pine Pk



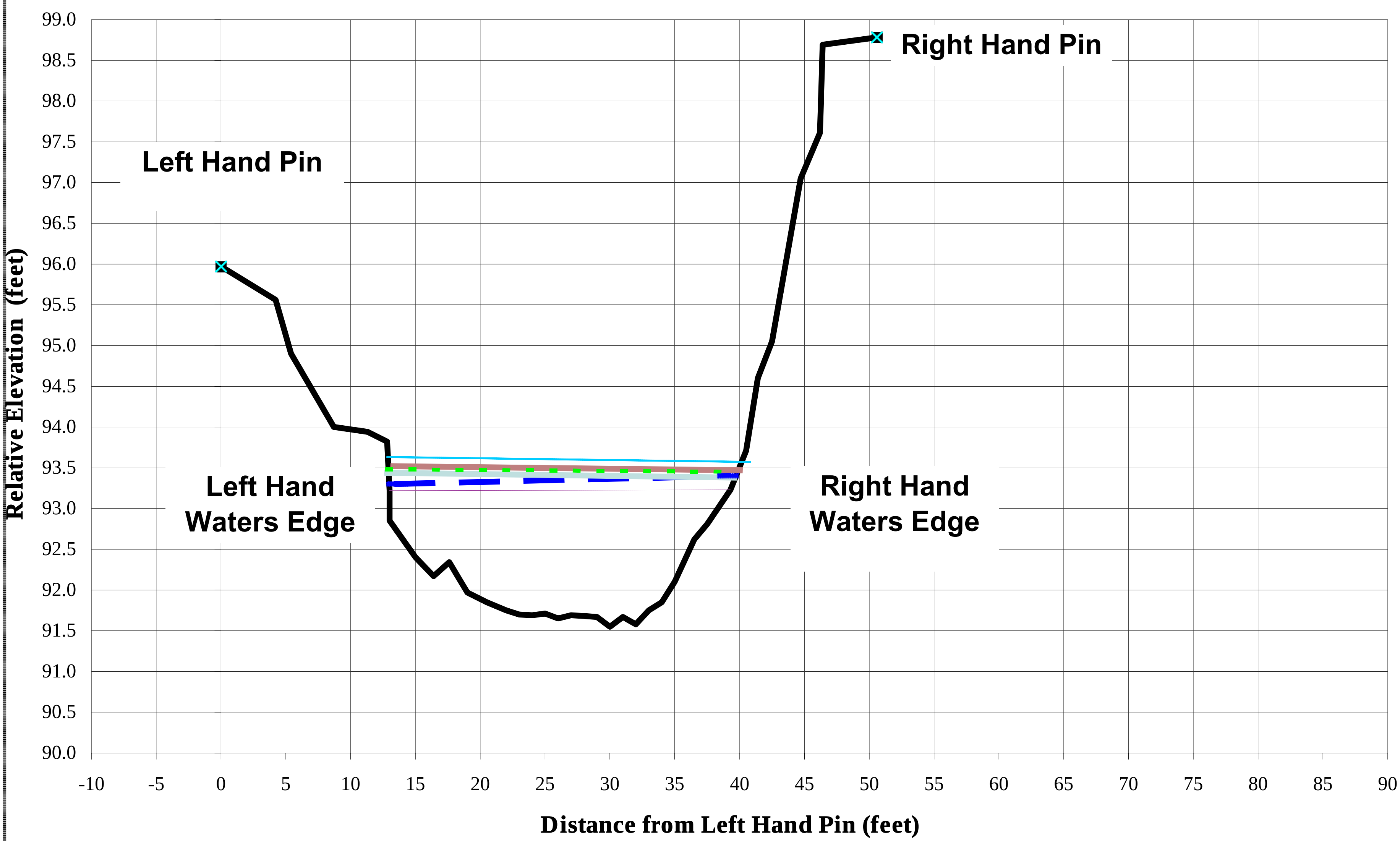
Data Source: IF Survey

- October 24, 2002; 75.9 cfs
- December 16, 2002; 152.4 cfs
- February 6, 2003; 312.0 cfs
- September 24, 2002; 69 csf
- January 9, 2003; 188.94 cfs
- March 26, 2003; 509.2 cfs

FIGURE 3.5: Little Spokane River at Chattaroy Cross Section

Spokane County / IFN Assessment/ WA

Golder Associates



Data Source: IF Surveys

October 25, 2002; 37 cfs
December 16,2002;48.9 cfs
February 7, 2003; 58.00 cfs
September 24, 2002; 32 cfs
January 8, 2003; 51.51 cfs
March 27, 2003; 69.2 cfs

FIGURE 3.6: Little Spokane River at Elk Park Cross Section

Spokane County / IFN Assessment / WA

Golder Associates

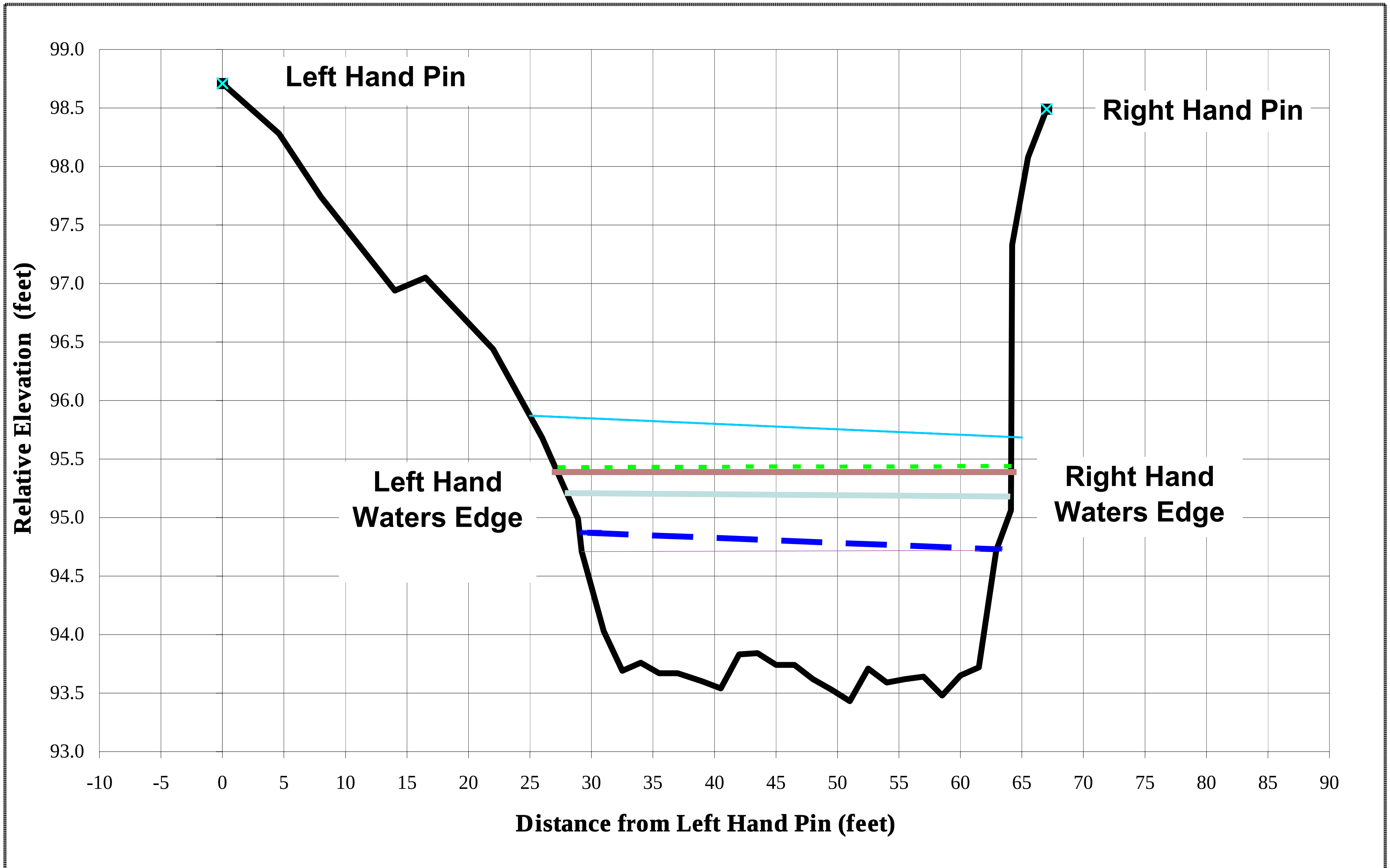
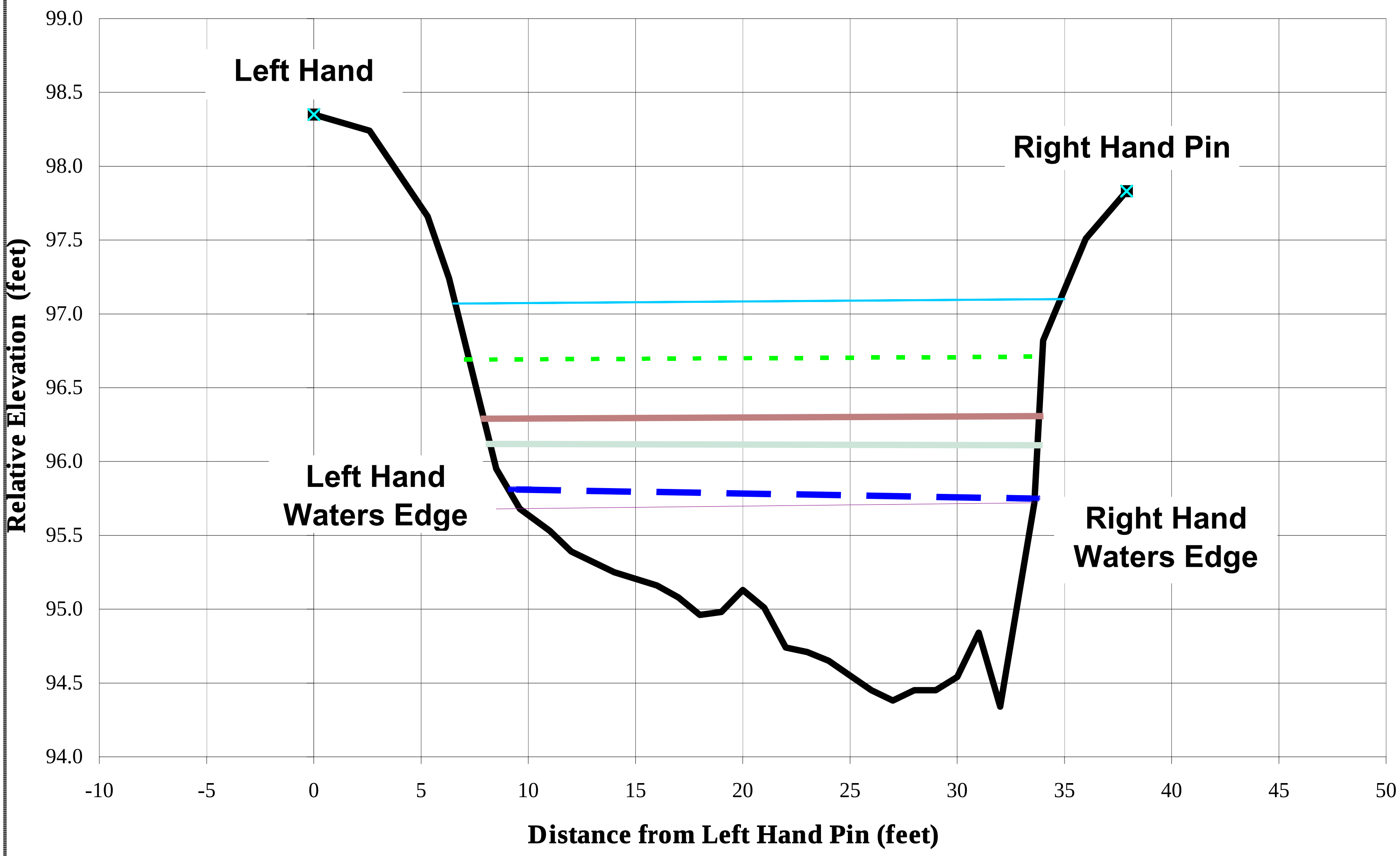


FIGURE 3.7: Dragoon Creek Cross Section

Spokane County / IFN Assessment / WA

Golder Associates



Data Source: IF Surveys

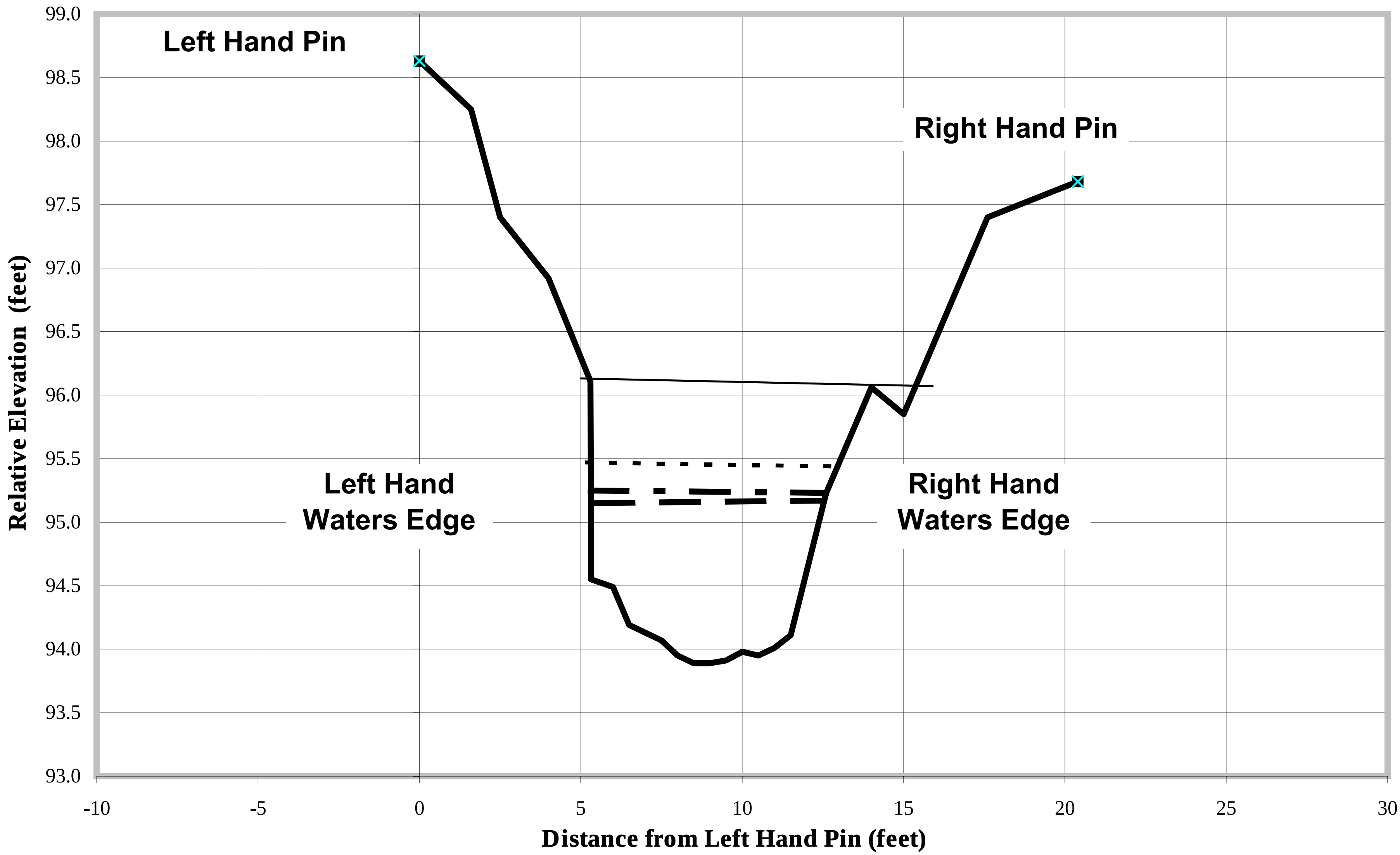
October 25, 2002; 8.2 cfs
January 9, 2003; 24.44 cfs
December 17, 2002 34.2 cfs
September 25, 2002; 5.5 cfs
February 6, 2003; 49.8 cfs
March 26, 2003; 152.0 cfs

FIGURE 3.8: Deadman Creek Cross Section

Spokane County / IFN Assessment / WA

Golder Associates

Figures 3.4 through 3.9.xls/Fig 3.8 - Deadman Creek



Data Source: IF Surveys

- October 31, 2002; 3 cfs
- September 24, 2002; 3.7 cfs
- February 7, 2003 5.33 cfs
- March 27, 2003; 13.7 cfs

FIGURE 3.9: Otter Creek Cross Section

Spokane County / IFN Assessment / WA

Golder Associates

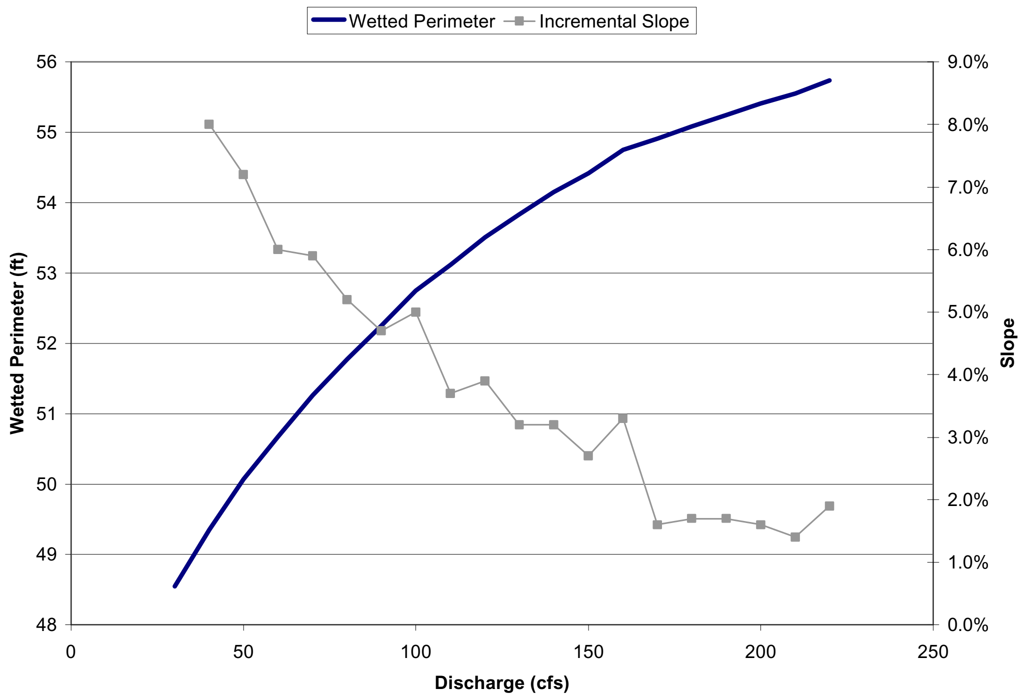


Figure 5.1: Wetted Perimeter Versus Discharge Plot for the Little Spokane River at Pine River Park

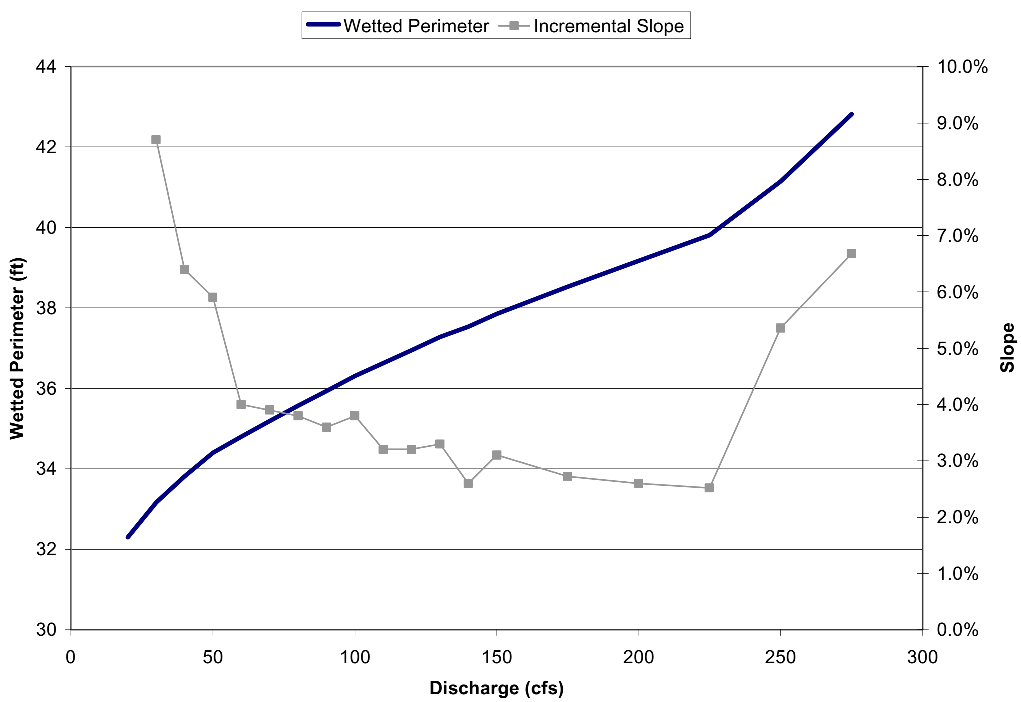


Figure 5.2: Wetted Perimeter Versus Discharge Plot for the Little Spokane River at Chattaroy

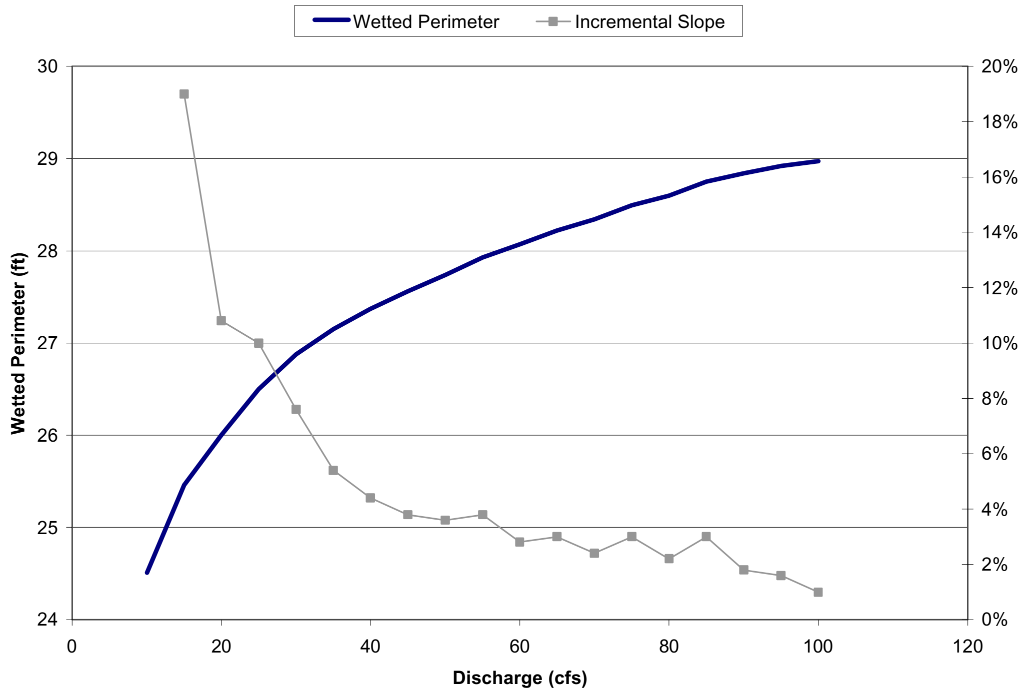


Figure 5.3: Wetted Perimeter Versus Discharge Plot for the Little Spokane River at Elk

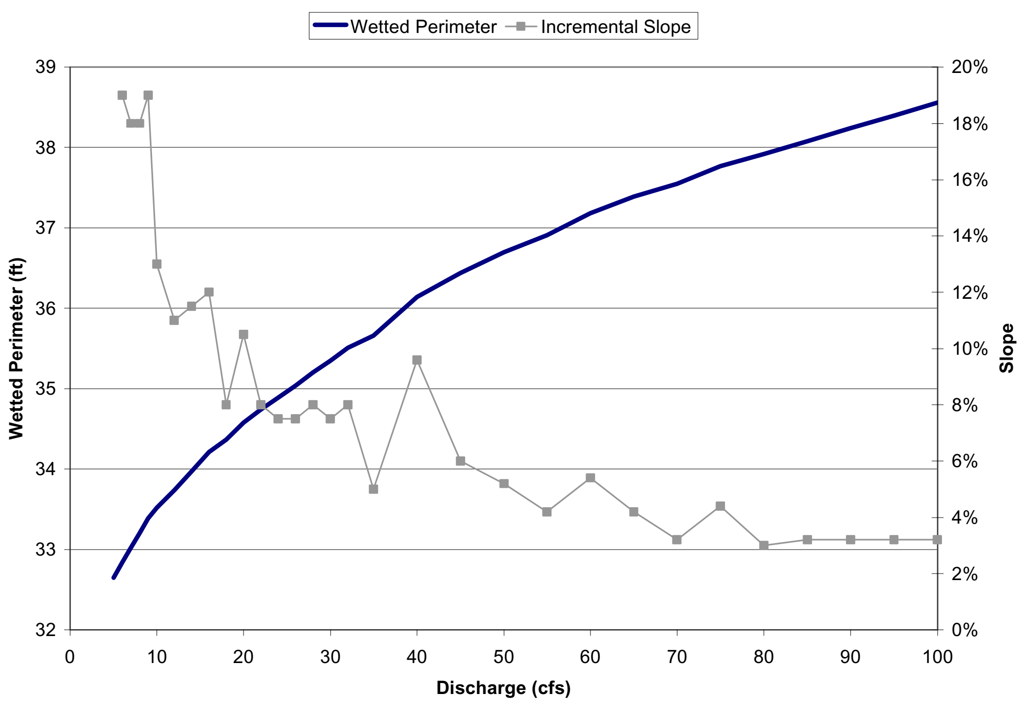


Figure 5.4: Wetted Perimeter Versus Discharge Plot for Dragoon Creek

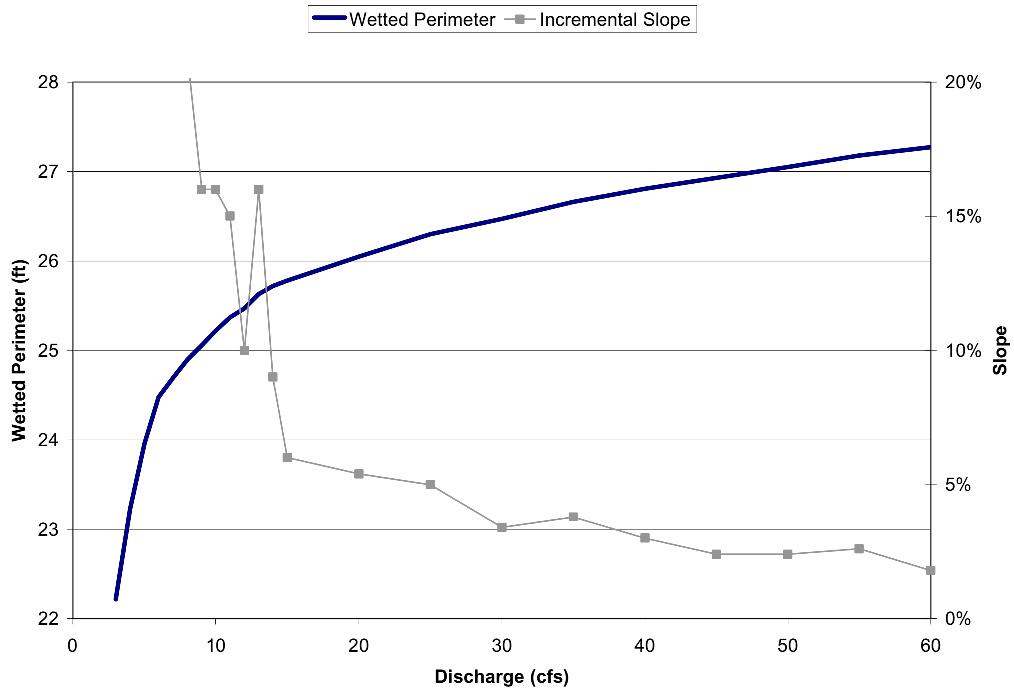


Figure 5.5: Wetted Perimeter Versus Discharge Plot for Deadman Creek

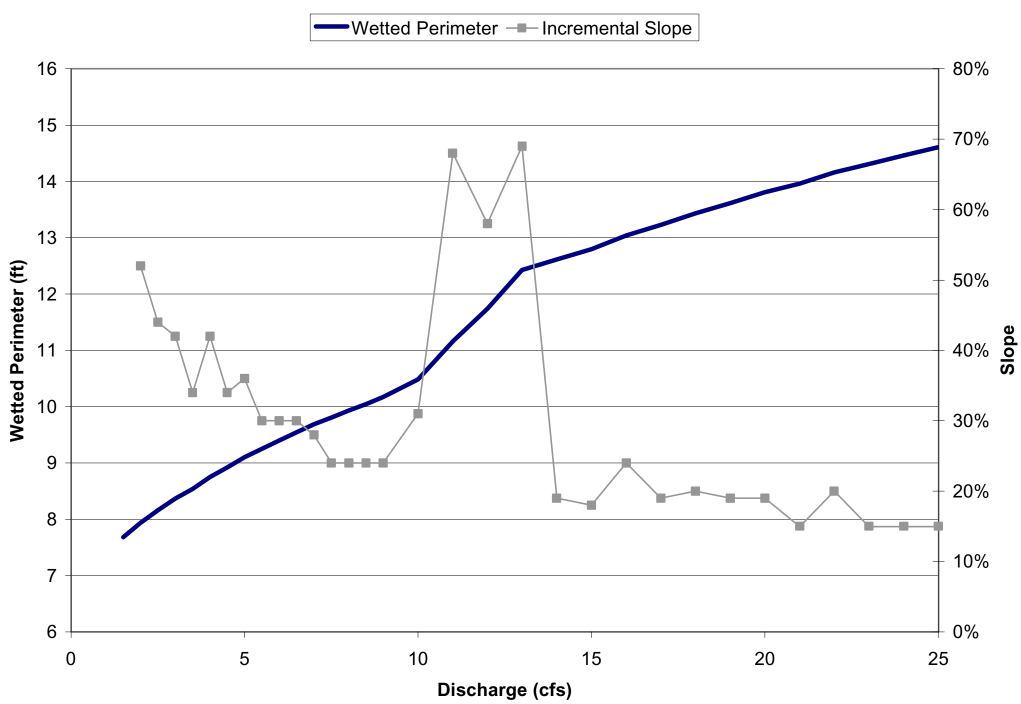


Figure 5.6: Wetted Perimeter Versus Discharge Plot for Otter Creek

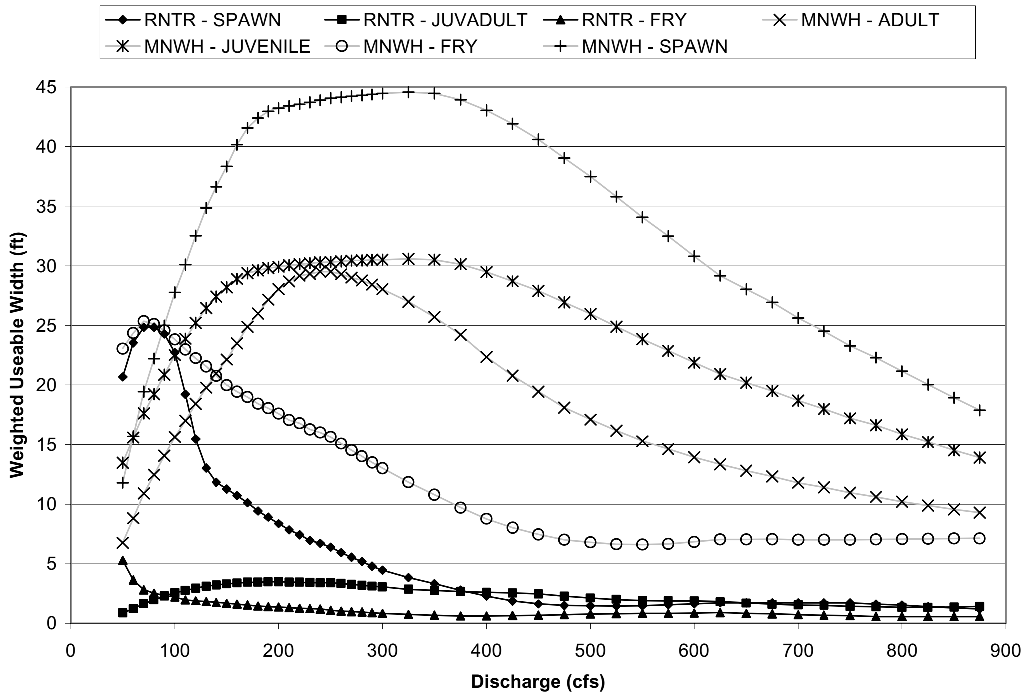


Figure 5.7a: Calculated WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for the Little Spokane River at Pine River Park

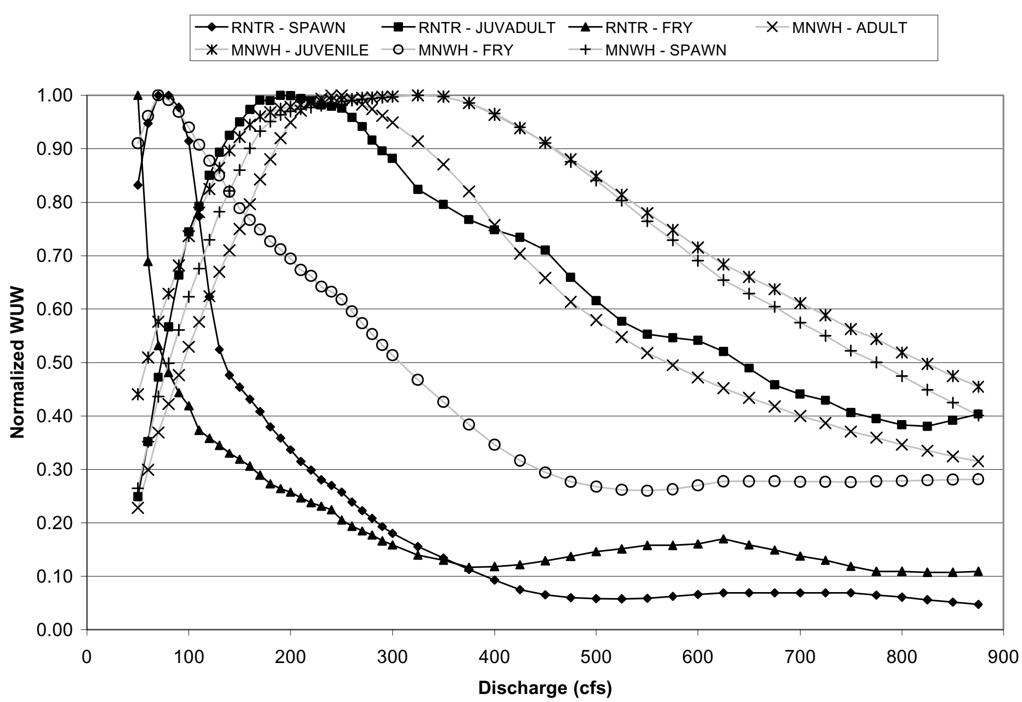


Figure 5.7b: Normalized WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for the Little Spokane River at Pine River Park

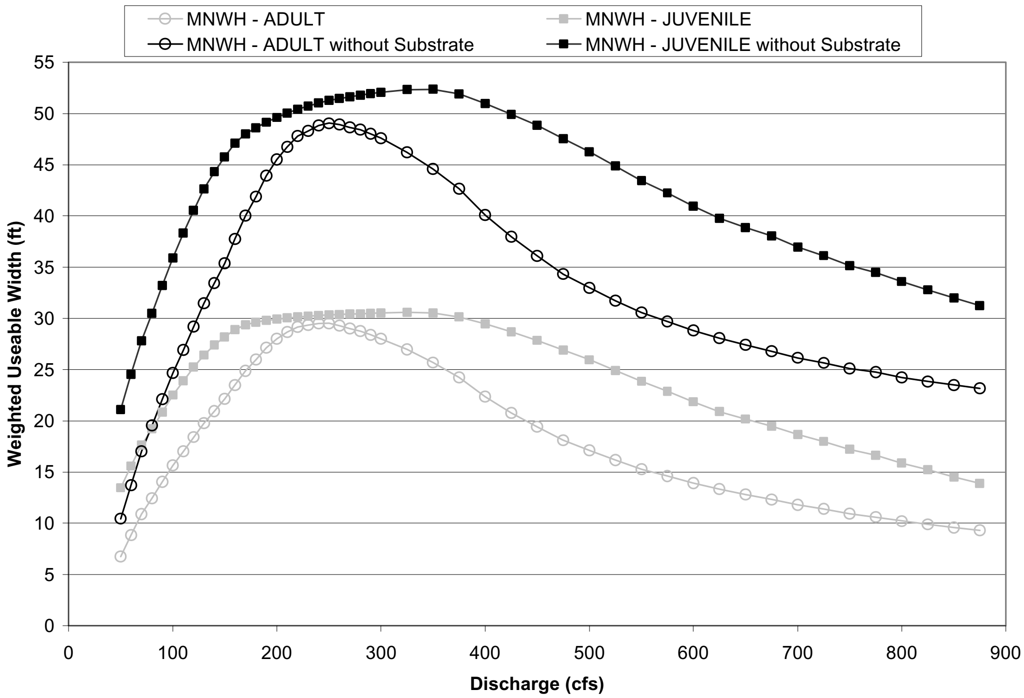


Figure 5.8a: Calculated Results of Mountain Whitefish Juvenile and Adult Habitat Availability With and Without Substrate at the Pine River Park Site

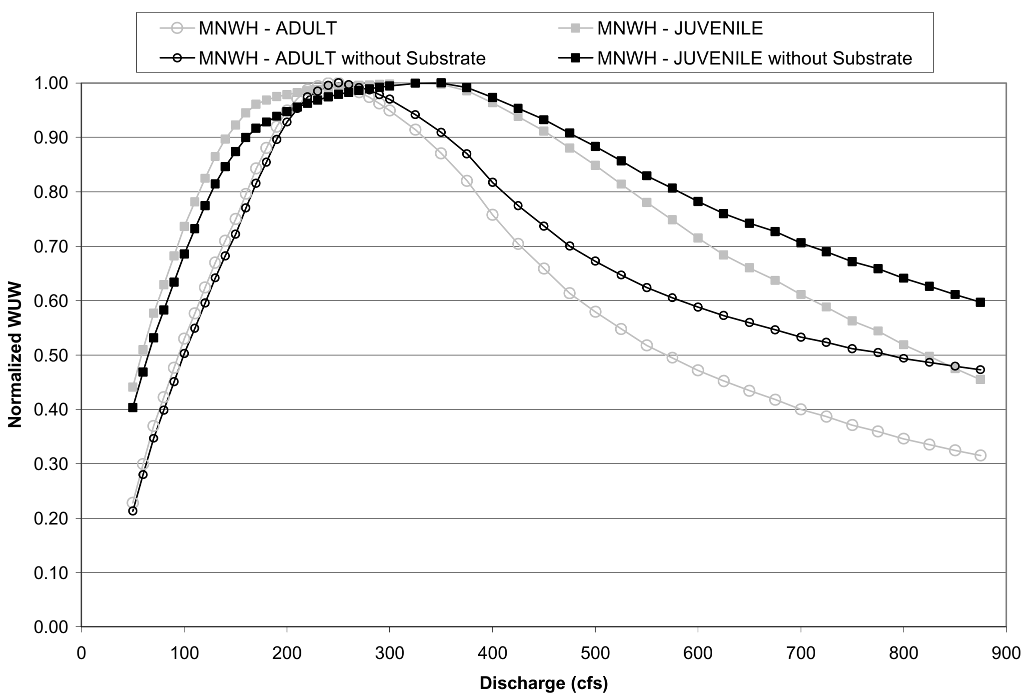


Figure 5.8b: Normalized Results of Mountain Whitefish Juvenile and Adult Habitat Availability With and Without Substrate at the Pine River Park Site

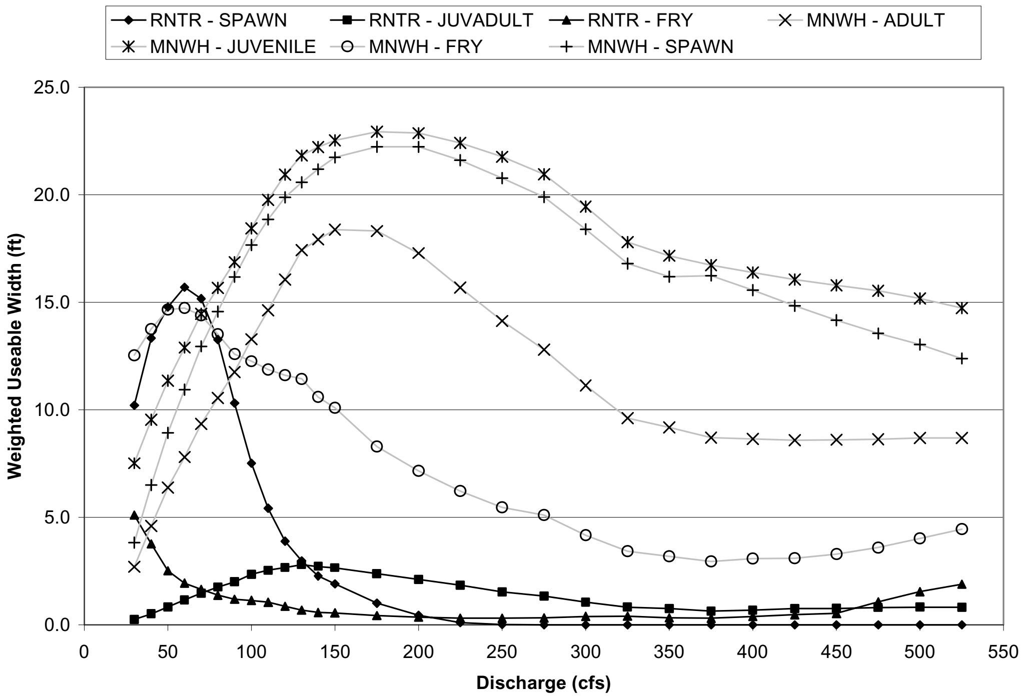


Figure 5.9a: Calculated WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for the Little Spokane River at Chattaroy

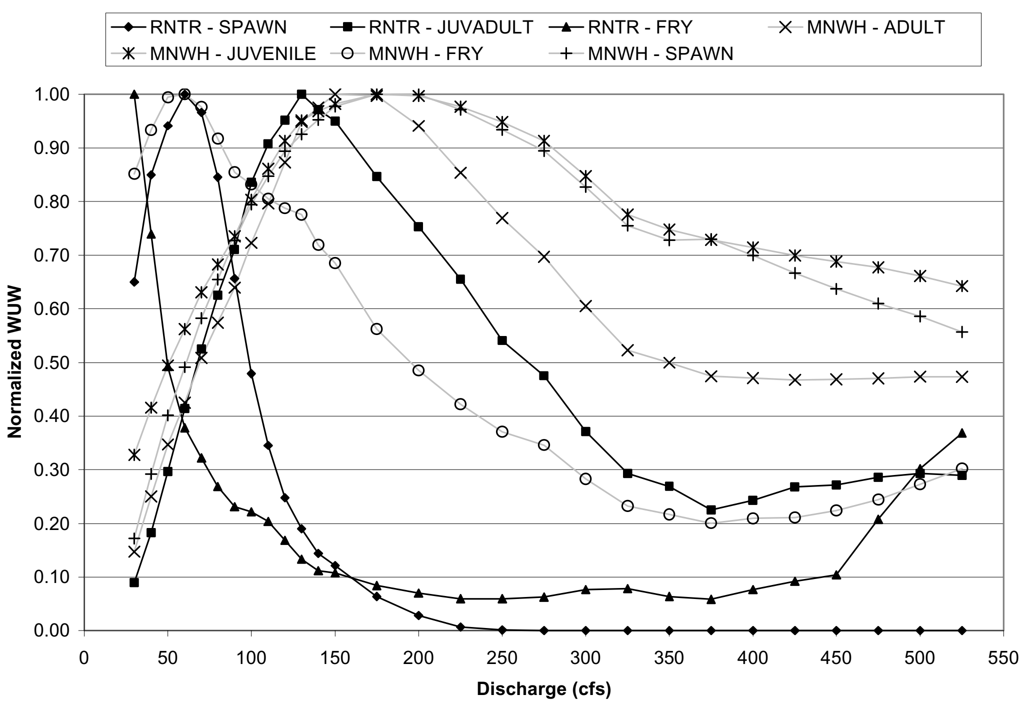


Figure 5.9b: Normalized WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for the Little Spokane River at Chattaroy

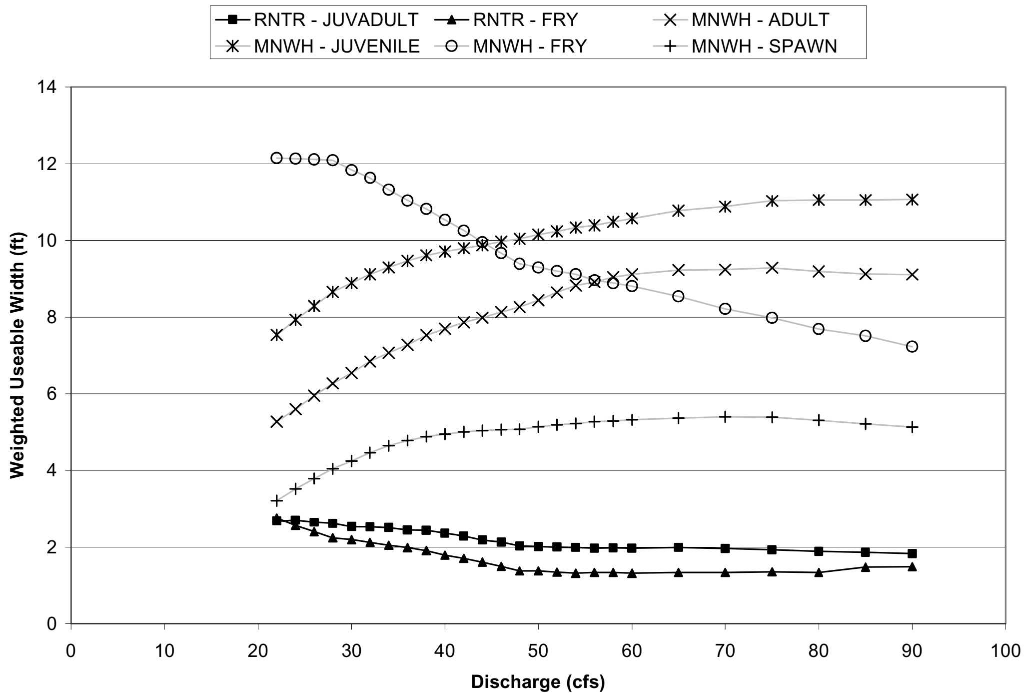


Figure 5.10a: Calculated WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for the Little Spokane River at Elk

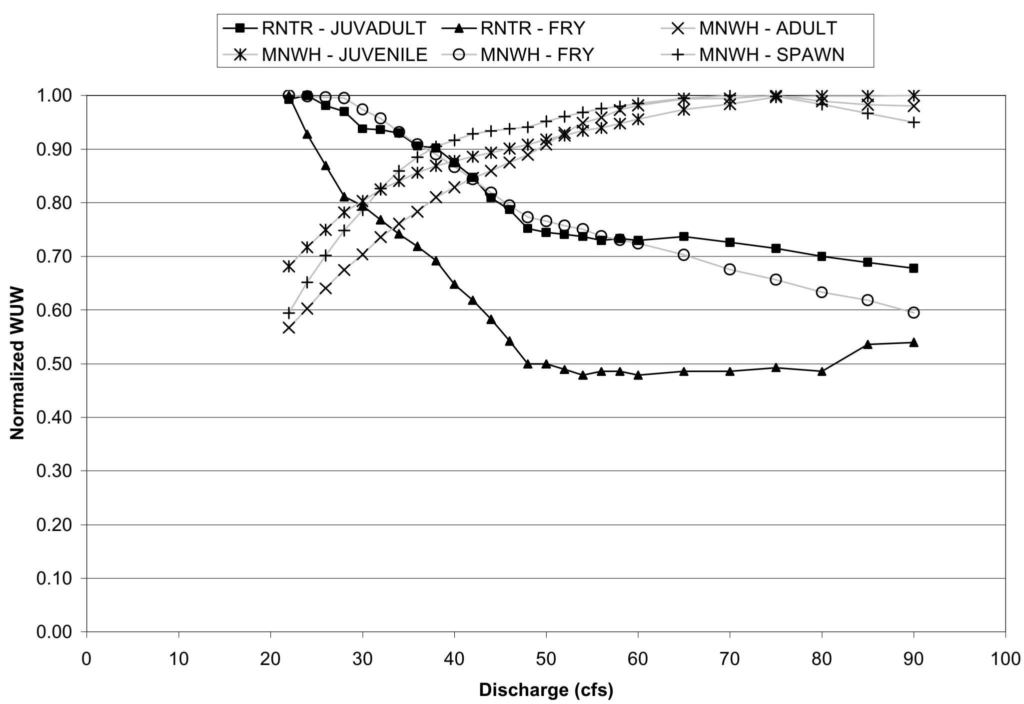


Figure 5.10b: Normalized WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for the Little Spokane River at Elk

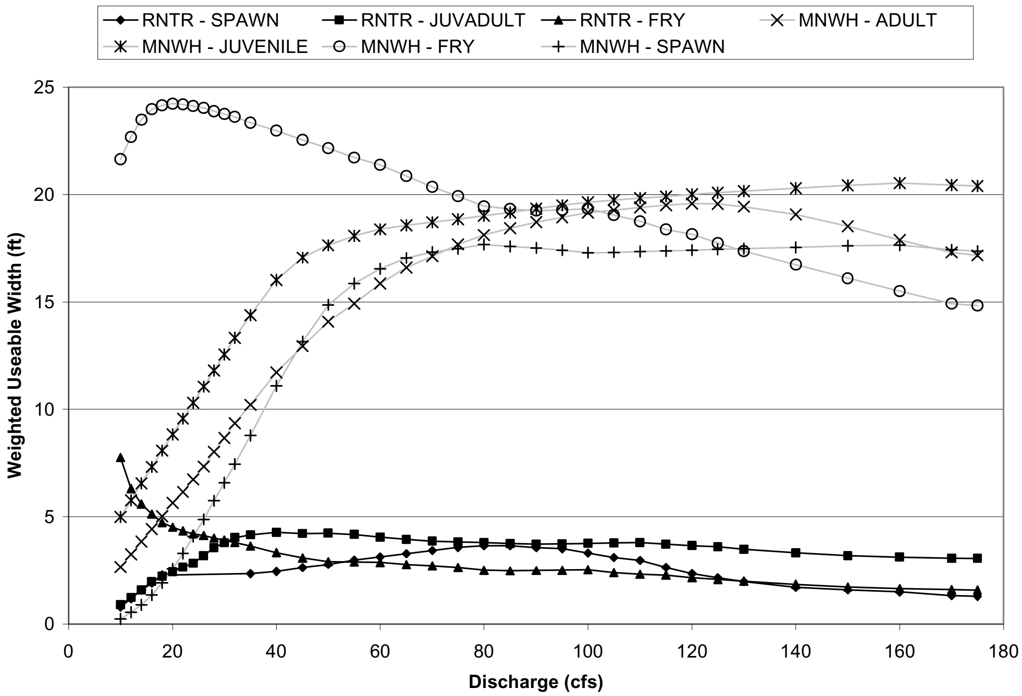


Figure 5.11a: Calculated WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) in Dragoon Creek

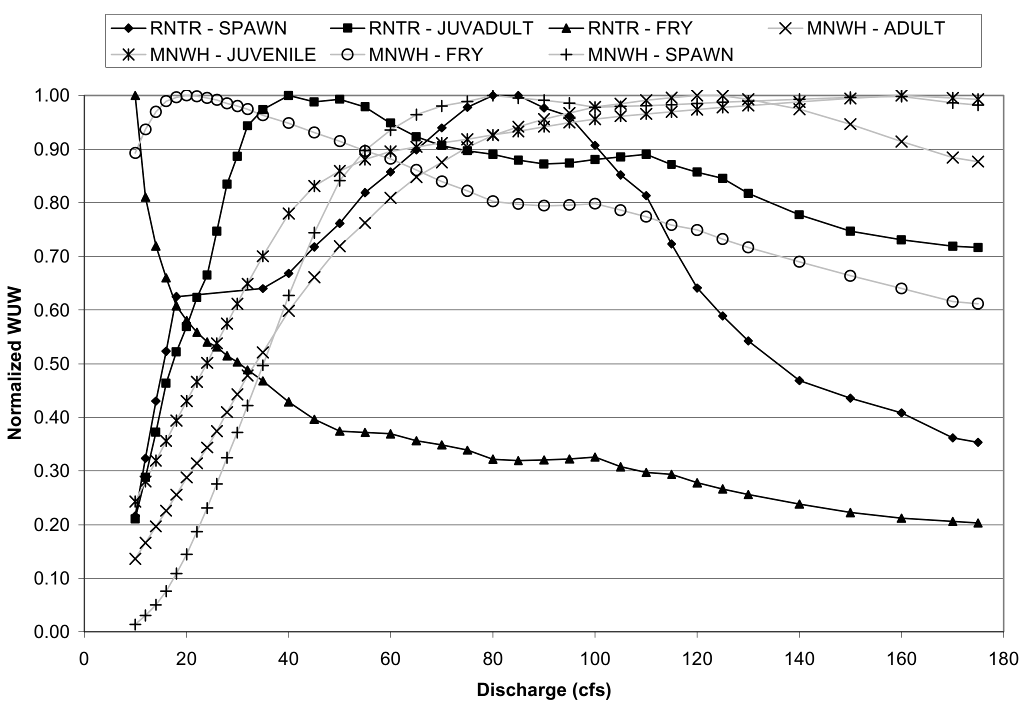


Figure 5.11b: Normalized WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) in Dragoon Creek

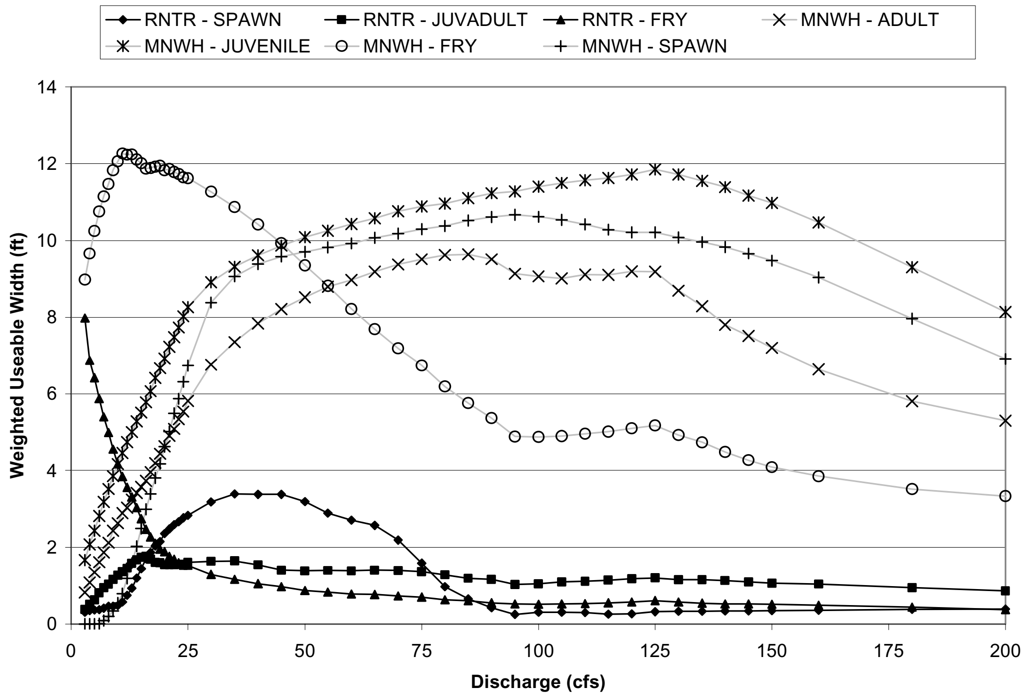


Figure 5.12a: Calculated WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) in Deadman Creek

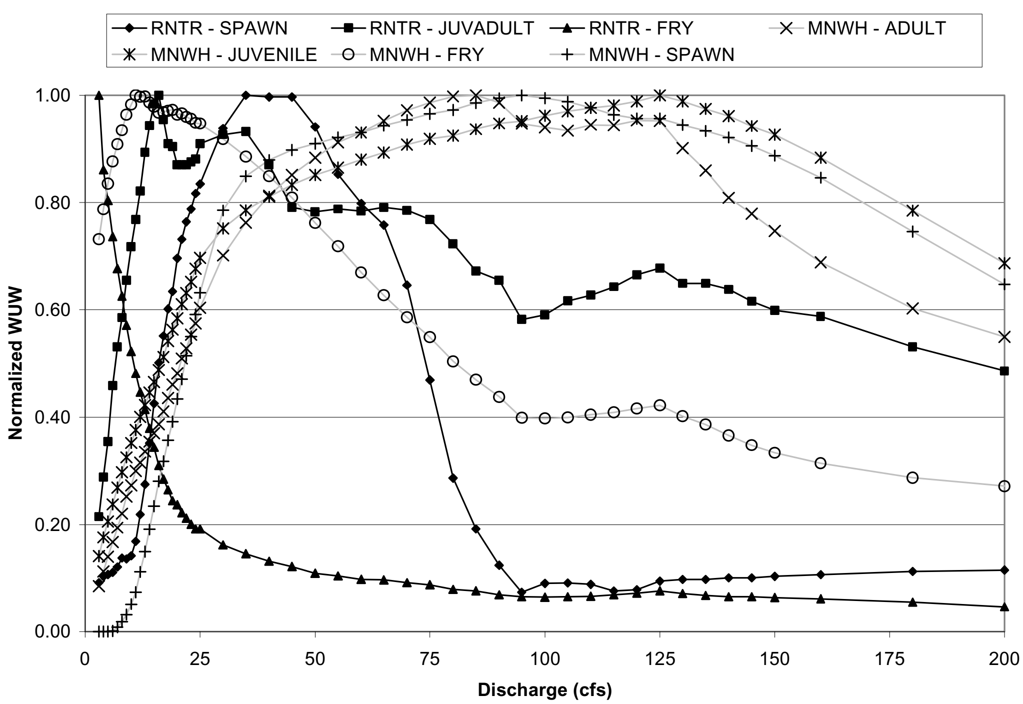


Figure 5.12b: Normalized WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) in Deadman Creek

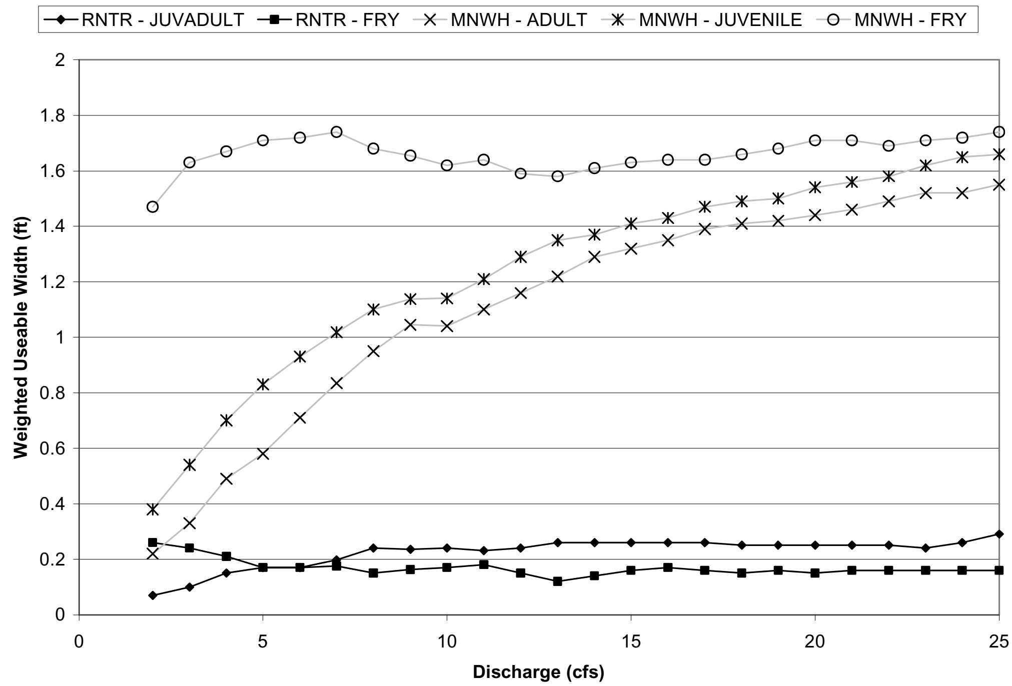


Figure 5.13a: Calculated WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for Otter Creek

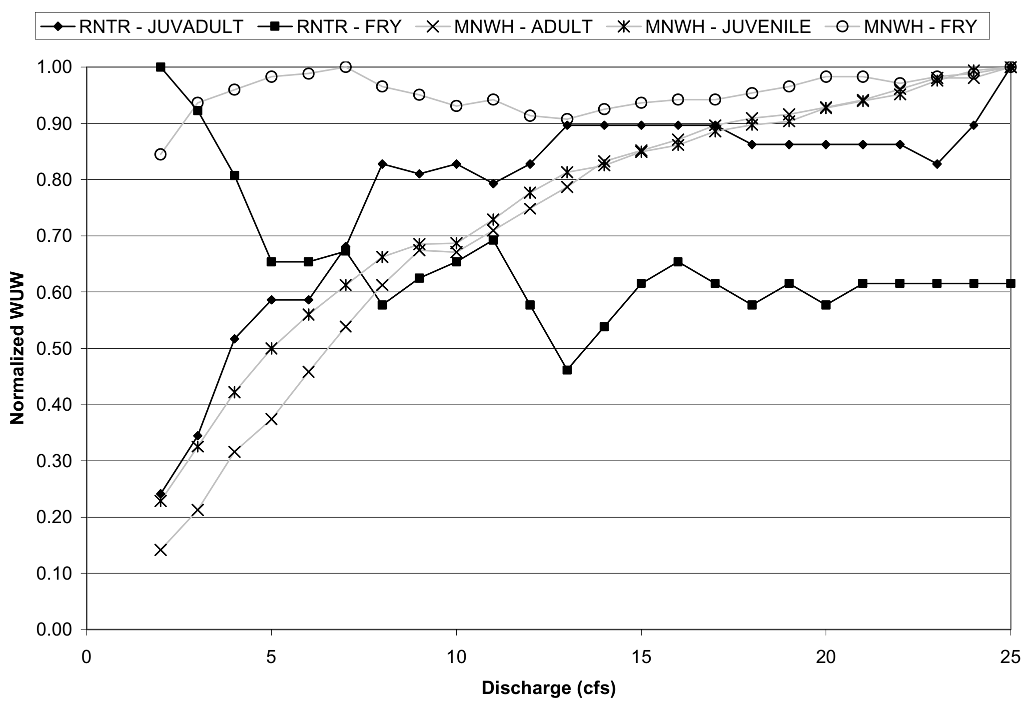


Figure 5.13b: Normalized WUW Curves for Rainbow Trout (RNTR) and Mountain Whitefish (MNWH) for Otter Creek.

APPENDIX A

MINIMUM INSTREAM FLOW

REGULATIONS (CH. 173-555 WAC)

CHAPTER 173–555 WAC
WATER RESOURCES PROGRAM IN THE LITTLE SPOKANE RIVER BASIN, WRIA 55

Last Update: 6/9/88

WAC 173–555–010 General provision. These rules, including any subsequent additions and amendments, apply to waters within and contributing to the Little Spokane River basin, WRIA–55 (see WAC 173–500–040). Chapter 173–500 WAC, the general rules of the department of ecology for the implementation of the comprehensive water resources program, applies to this chapter 173–555 WAC.
[Order DE 75–24, § 173–555–010, filed 1/6/76.]

WAC 173–555–020 Definition. "NONCOMMERCIAL AGRICULTURAL IRRIGATION" means beneficial use of water upon not more than three acres for the purpose of crops and livestock for domestic use.
[Order DE 75–24, § 173–555–020, filed 1/6/76.]

WAC 173–555–030 Establishment of base flows.

(1) Base flows are established for stream management units with monitoring to take place at certain control points as follows:

Stream Management Unit Information

Control Station Number, Stream Management Unit Name	Control Station Location by River Mile and Section, Township Range	Affected Stream Reach
No. 12–4270.00 Little Spokane River Elk	34.6 Sec. 8, T.29N., R.43 E.W.M.	From confluence with Dry Creek to the headwaters including tribu– taries except Dry Creek.
No. 12–4295.00 Little Spokane River Chattaroy	23.05 Sec. 34, T.28N., R.43 E.W.M.	From confluence with Deer Creek to confluence with Dry Creek including tribu– taries except Deer Creek.
No. 12–4310.00 Little Spokane River Dartford	10.8 Sec. 6, T.26N., R.43 E.W.M.	From confluence with Little Creek to confluence with Deer Creek including tribu– taries except Little Creek.
No. 12–4315.00 Little Spokane River Confluence	3.9 Sec. 3, T.26N., R.42 E.W.M.	From mouth to confluence with Little Creek including tributaries.

(2) Base flows established for the stream management units in WAC 173–555–030(1) are as follows:

Base Flows in the Little Spokane River Basin
(in Cubic Feet Per Second)

Month	Day	12–4270.00 Elk	12–4295.00 Chattaroy	12–4310.00 Dartford	12–4315.00 Confluence
Jan.	1	40	86	150	400
	15	40	86	150	400
Feb.	1	40	86	150	400
	15	43	104	170	420
Mar.	1	46	122	190	435
	15	50	143	218	460
Apr.	1	54	165	250	490
	15	52	143	218	460
May	1	49	124	192	440
	15	47	104	170	420
Jun.	1	45	83	148	395
	15	43	69	130	385
Jul.	1	41.5	57	115	375
	15	39.5	57	115	375
Aug.	1	38	57	115	375
	15	38	57	115	375
Sept.	1	38	57	115	375
	15	38	63	123	380
Oct.	1	38	70	130	385
	15	39	77	140	390
Nov.	1	40	86	150	400
	15	40	86	150	400
Dec.	1	40	86	150	400
	15	40	86	150	400

(3) Base Flow hydrographs, Figure II–1 in the document entitled "water resources management program in the Little Spokane River Basin" dated August, 1975 shall be used for definition of base flows on those days not specifically identified in WAC 173–555–030(2).

(4) All rights hereafter established shall be expressly subject to the base flows established in sections WAC 173–555–030 (1) through (3).

[Order DE 75–24, § 173–555–030, filed 1/6/76.]

WAC 173–555–040 Future allocations—Reservation of surface water for beneficial uses.

(1) The department determines that these are surface waters available for appropriation from the stream management units specified in the amount specified in cubic feet per second (cfs) during the time specified as follows:

(a) Surface water available from the east branch of the Little Spokane River, confluence with Dry Creek to headwaters, based on measurement at control station number 12–4270.00 at Elk are:

Month	May		June		July		Aug.		Sept.		Oct.	
Date	1	15	1	15	1	15	1	15	1	15	1	15
Amount	26	22	17	14	11	9	5	5	5	5	7	7

(b) Surface water available from the Little Spokane River from confluence with Little Creek at Dartford to Eloika Lake outlet, and to confluence with Dry Creek based on measurement at control station number 12–4310 at Dartford are:

Month	May		June		July		Aug.		Sept.		Oct.	
Date	1	15	1	15	1	15	1	15	1	15	1	15
Amount	340	236	152	103	62	34	11	11	11	11	20	20

(c) Available surface waters for those days not specified in (a) and (b) shall be defined from Figures II–3 and II–4 in the document entitled "water resources management program in the Little Spokane River basin" dated August, 1975.

(2) The amounts of waters referred to in WAC 173–555–040(1) above are allocated for beneficial uses in the future as follows:

(a) Three cubic feet per second from the amount available in the east branch of the Little Spokane River referred to in WAC 173–555–040 (1)(a) above and five cubic feet per second from the amount available in the Little Spokane River, besides east branch, referred to in WAC 173–555–040 (1)(b) are allocated to future domestic, stockwatering and noncommercial agricultural irrigation purposes within the stream reaches specified therein throughout the year.

(b) The remainder of the amount referred to in WAC 173–555–040 (1)(a) and (b) besides the amount specified in WAC 173–555–040 (2)(a) are allocated to consumptive and nonconsumptive uses not specified in WAC 173–555–040 (2)(a). These are further described in the figures appended hereto.

[Order DE 75–24, § 173–555–040, filed 1/6/76.]

WAC 173–555–050 Priority of future water rights during times of water shortage.

(1) As between rights established in the future pertaining to waters allocated in WAC 173–555–040 (2)(a) and (b), all rights established in (a) shall be superior to those pertaining to (b) regardless of the date of the priority of right.

(2) As between rights established in the future within a single use category allocation of WAC 173–555–040, the date of priority shall control with an earlier dated right being superior to those rights with later dates.

[Order DE 75–24, § 173–555–050, filed 1/6/76.]

WAC 173–555–060 Streams and lakes closed to further consumptive appropriations. The department, having determined there are no waters available for further appropriation through the establishment of rights to use water consumptively, closes the following streams to further consumptive appropriation except for domestic and normal stockwatering purposes excluding feedlot operation:

SURFACE WATER CLOSURES

Stream* Name	Affected Reach	Date of Closure	Period of Closure
Dry Creek	Mouth to	5–26–1952 headwaters	1 June–31 Oct.
Otter Creek	Mouth to	2–23–1971 headwaters	"
Bear Creek	Mouth to	4–13–1953 headwaters	"
Deer Creek headwaters	Mouth to	2–29–1968	"
Dragoon Creek	Mouth to	7–02–1951 headwaters	"
Deep Creek	Mouth to	6–14–1961 headwaters	"
Deadman Creek1/ headwaters	Mouth to	11–28–1961	"
Little Creek	Mouth to	4–13–1953 headwaters	"
W. Branch Little Spokane River	Outlet of Eloika Lake to headwaters	Date of adoption	"
All natural lakes in the basin		"	"

* Includes all tributaries in the contributing drainage area unless specifically excluded.
1/ An unnamed tributary flowing through Sec. 20, T26N., R.44E. is exempted from closure.

[Order DE 75–24, § 173–555–060, filed 1/6/76.]

WAC 173–555–070 Effect on prior rights. Nothing in this chapter shall be construed to lessen, enlarge or modify the existing rights acquired by appropriation or otherwise.
[Order DE 75–24, § 173–555–070, filed 1/6/76.]

WAC 173–555–080 Enforcement. In enforcement of this chapter, the department of ecology may impose such sanctions as are appropriate under authorities vested in it, including but not limited to the issuance of regulatory orders under RCW 43.27A.190 and civil penalties under RCW 90.03.600.

[Statutory Authority: Chapters 43.27A, 90.22 and 90.54 RCW. 88–13–037 (Order 88–11), § 173–555–080, filed 6/9/88.]

WAC 173–555–090 Appeals. All final written decisions of the department of ecology pertaining to permits, regulatory orders, and related decisions made pursuant to this chapter shall be subject to review by the pollution control hearings board in accordance with chapter 43.21B RCW.

[Statutory Authority: Chapters 43.27A, 90.22 and 90.54 RCW. 88–13–037 (Order 88–11), § 173–555–090, filed 6/9/88.]

WAC 173–555–100 Regulation review. The department of ecology shall initiate a review of the rules established in this chapter whenever new information, changing conditions, or statutory modifications make it necessary to consider revisions.

[Statutory Authority: Chapters 43.27A, 90.22 and 90.54 RCW. 88–13–037 (Order 88–11), § 173–555–100, filed 6/9/88.]

APPENDIX B

STUDY SCOPING AND MEETING MINUTES AND MEMORANDA

Excerpts From:
Meeting Summary
Planning Unit

Little Spokane River – Middle Spokane River Local Watershed Plan
October 17, 2001

Committee members recorded on the sign in sheet were:

Gary Fergen	Tom Hargreaves	Bryony Hansen
Neil White	Gus Koedding	Sarah Hubbard-Gray
Lloyd Brewer	Neil Beaver	Stan Miller
Harry McLean, Jr.	Rachael Pascal Osborn	Reanette Boese
Jani Gilbert	Steve Silkworth	Erin Cunningham
Roger Krieger	Ty Wick	John Covert

Little Spokane River Instream Flow Work: Stan Miller explained that a meeting was held on October 10, 2001 with representatives of the Washington Department of Ecology, Washington Department of Fish and Wildlife, and Golder Associates on the Little Spokane River (LSR) Instream Flow work. The strategy of starting work on the LSR first, and waiting to begin the Middle Spokane River instream flow work due to Avista's relicensing process was discussed. As part of the meeting, they discussed the existing LSR conditions and went on a field trip along the LSR to get familiar with the conditions. John Covert from the Department of Ecology explained that the existing instream flow value was not based on scientific data. The following items and strategies for the work were also discussed:

- The LSR work will consider existing Department of Fish and Wildlife data and fish species present.
- The tributary areas need to be included in the work as much as possible to evaluate the fish spawning habitat. It was recognized that there is not enough money to do all that is needed. Golder will look at existing analyses to identify similar habitat areas so more work can be done for less money.
- There will be coordination with the Conservation District to identify and use existing data, historic flow measurements, and cross section information that they have.

Stan Miller explained that Planning Unit members, along with resource agency representatives need to be involved with the development of the Instream Flow scope of work for the LSR. He indicated that it would probably take two to three meetings to develop the scope of work, and asked if the whole Planning Unit or a work group made up of Planning Unit representatives should be involved. The following questions and items were discussed and/or explained:

- How will the LSR work set the stage for the Middle Spokane River instream flow work? Stan Miller explained that the Middle Spokane River work will be independent and may not look like the LSR work or product.
- What is the relationship between the instream flow value that results from this study and the instream flow recommendation that the Planning Unit is supposed to make? The Planning Unit

discussed issues associated with this question -- the Planning Unit could recommend to keep the current regulated flow values, or different flow values could be recommended to align with the flow descriptions that Ecology is developing.

- This instream flow work will be based on biota and use best available science. Broad science areas and other considerations can be included.

The Planning Unit decided to form an Instream Flow Work Group made up of Planning Unit members with an interest and/or technical background in instream flow. This work group will assist in developing the draft scope of work which will be presented to the entire Planning Unit for review and comment. Planning Unit volunteers were identified, along with recommendations on others to request to participate. The scope of work needs to be finalized by the end of February 2002.

Excerpts From:
Meeting Summary
Planning Unit
Little Spokane River – Middle Spokane River Local Watershed Plan
December 5, 2001

Committee members recorded on the sign in sheet were:

Terry Liberty	Tom Hargreaves	Ty Wick
Lloyd Brewer	Ann Murphy	Bryony Hansen
Steve Skipworth	Gus Koedding	Stan Miller
Susan McGeorge	Jim Wilson	Reanette Boese
Doug Allen	Rachael Osborn	Erin Cunningham
Roger Krieger	Bruce Howard	Sarah Hubbard-Gray

Guests that attended the meeting and were recorded on the sign in sheet were: Jane Cunningham, Al Wetzel, and Larry Snyder.

Instream Flow Work Update: Stan Miller explained that the Instream Flow Work Group met on November 9, 2001. Susan McGeorge, Doug Allen, Neil White and Stan Miller attended the meeting. Stan passed out a memo that summarized the meeting. Stan explained that there are several decisions that need to be made, including: 1) What kind of recommendation does the Planning Unit want?, and 2) Where should the new compliance points be? There are four current regulated gauges used to determine when junior water rights are cut off. Other compliance points may better represent regionalized impacts (e.g., Pend Oreille County wants a gage that better represents their area).

In addition, the technical methods for conducting the aquatic biota flow studies need to be finalized and determinations made on where to apply the methods. John Whalen, a local fisheries expert at the Washington Fish and Wildlife Department, will provide input on the fish spawning habitat to support this effort.

The Planning Unit discussed the following points and questions:

- Doug Allen/Ecology explained that Ecology is looking at how to effectively develop instream flow recommendations for closed and non-closed basins. He indicated that for closed basins, like the Little Spokane River, they may not be looking for specific instream flow numbers. Whereas, non-closed basins, like the Middle Spokane River, may need to look at developing specific flow numbers and target numbers. Doug also explained that Ecology is developing a Programmatic EIS on Instream Flows, which is needed to adopt a new rule. The Planning Unit will need to do an EIS supplement for instream flow recommendations for each specific watershed, in addition to complying with the Growth Management Act and the State Environmental Policy Act. Doug passed out a copy of the RCW statutes relating to instream flows.

- It was expressed that it would be nice to have more information on where to add/move flow gauges, since the current gauges don't indicate what is happening on the tributary streams. Stan Miller indicated that they are looking at multiple points that may need additional gauging stations.

The next Instream Flow Work Group will meet on December 12, 2001 at 1:30 at Whitworth Water District. Tom Hargreaves, Gus Koedding, Bruce Howard, and Lloyd Brewer agreed to join the Work Group.

Excerpts From:
Meeting Summary
Planning Unit
Little Spokane River – Middle Spokane River Local Watershed Plan
February 20, 2002

Committee members recorded on the sign in sheet were:

Doug Allen	Bill Rickart (for Lloyd Brewer)	Tom Hargreaves
Rick Noll	Harry McLean	Donald Comine
Jim Wilson	Ty Wick	Bruce Howard
Walt Edelen	Julia McHugh	Dave Jones
Neil White	Susan McGeorge	Neil Beaver
Terry Liberty	Ann Murphy	Reanette Boese
		Erin Cunningham

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen, Chris Pitre, and Donna DeFrancesco of Golder Associates.

Update on Little Spokane River Instream Flow Work: Chris Pitrie of Golder Associates gave a presentation on instream flow on the Little Spokane River. His presentation covered the following points:

- The reasons to pursue instream flow work on the Little Spokane River -- because the basin is closed to additional allocations and because the existing instream flow requirements are not based on the needs of aquatic biota.
- An overview of instream flow regulations.
- The Department of Ecology's established step-wise process for conducting the instream flow work – Step A involves development of a detailed scope of work that specifies the reaches to study and the methodologies to be used. Step B involves doing the field work and applying the methodologies. Step C involves Planning Unit review of the data and development of a recommendation.
- A virtual tour of the Little Spokane River basin was presented that included mean annual flow information.
- An overview of instream flow methodologies, including IFIM, Wetted Perimeter, Toe Width, Tennant, and Correlation, was presented. An overview of their relative cost and scientific worth was discussed.
- A preliminary scope of work and budget for instream flow work on the Little Spokane River has been developed and need to be submitted to Ecology prior to final authorization of supplemental funds. Chris distributed the draft scope of work Golder prepared.
- Chris indicated that the draft scope of work had been prepared after consulting with Washington State Department of Fish and Wildlife staff (Hal Beecher and John Whalen). These experts felt that the Wetted Perimeter method is compatible with the Little Spokane River's flow regime. Chris explained that this method considers the relationship of flow and the wetted perimeter of the stream. The method assumes a positive relationship between wetted perimeter of the stream and fish habitat. Therefore, the wetted perimeter method

considers protection of salmonids (including trout), but is not species specific. This method provides a single instream flow number for rivers with a mean annual flow greater than ~215 cfs, and provides a range for rivers with a mean annual flow less than ~215 cfs.

A variety of questions, concerns, and comments were raised and discussed by members of the Planning Unit, including:

- Concern about not using the species specific IFIM methodology, which is the most rigorous and defensible, was raised. This includes concern that the wetted perimeter method skews the results toward habitat protection, not specific fish species protection. Chris explained that there is not enough budget to use the IFIM method at all the compliance points on the Little Spokane River. In addition, Department of Fish and Wildlife specialists feel that the Little Spokane River has the right morphology for the wetted perimeter method.
- Questions were asked about the proportion of the spawning habitat that is on the main stem versus that on tributaries. Concern was raised that the proposed study reaches are all on the main stem of the river rather than on the tributaries.
- Concern was raised that the Planning Unit has not been consulted and involved with the review of the methodology options and the selection of the instream flow methodology to be used.
- Questions were asked about the process used for arriving at the preliminary scope of work. It was explained that the Instream Flow Work Group met in November and December 2001, and that Stan Miller has provided updates at the previous Planning Unit meetings and has passed out memos regarding the Work Group and agency meetings. However, some Planning Unit members indicated that they do not recall receiving the memos that discussed the process and possibility of not using the IFIM method.
- Pend Oreille County is interested in gathering information that will allow flows to be specific to different segments of the river, and to more reflect conditions in Pend Oreille County. Chris acknowledged that the approach addresses this concern and considers several reaches along the river to develop meaningful recommendations for several reaches.
- One Planning Unit member indicated that setting instream flows is a mix of science and policy, and that the Planning Unit should have the opportunity to gain more information on specific species that can be considered along with the results of a study.

Chris Pitrie continued his presentation and detailed the pros and cons of the wetted perimeter methodology, reviewed the scope of work which focuses on using the wetted perimeter method on the main stem of the river, described the challenges of adding work on the tributaries to the study, and described the products that would be delivered to the Planning Unit for their use in developing instream flow recommendations (e.g., rating curves, data analysis, flow recommendations, comparisons with existing flows, discussion of aquatic biota protection, discussion of additional qualitative considerations such as water quality, maintenance of river regime, and temperature).

Because of the concerns and misunderstandings raised regarding the Little Spokane River Instream Flow work, and the difficulty of fully discussing the topic and background without Stan Miller, it was decided that an Instream Flow Work Group meeting to review the decision making process would be held and be open to all interested Planning Unit members. Stan Miller will coordinate this meeting the week February 25, 2002. In addition, time will be allocated at the March 20, 2002

Planning Unit meeting to review the outcome of the Work Group meeting and provide direction to Spokane County on how to proceed.

Note: The Instream Flow meeting was held on February 28, 2002. Please see the attached memo from Stan Miller regarding the meeting and its outcome.

Due to the extended time that was used to discuss the Little Spokane River Instream Flow work, it was decided that the review of the Planning Unit Memorandum of Agreement and discussion of the decision making process for plan recommendations will be carried over to the March 20, 2002 meeting. Everyone was asked to review the process section (6.0) of the Memorandum of Agreement and the water uses listed in questions 2 and 3 of the November 2001 Public Meeting Questionnaire to prepare for the discussion.

Meeting Summary
Planning Unit
Little Spokane River – Middle Spokane River Local Watershed Plan
May 15, 2002

Committee members recorded on the sign in sheet were:

Doug Allen	Julia McHugh	Dave Jones
Jim Wilson	Ty Wick	Rachael Pascal Osborn
Lloyd Brewer	Ken Kuhn	Stan Miller
Terry Liberty	Steve Skipworth	Reanette Boese
Don Comins	Gus Koedding	Erin Cunningham

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen of Golder Associates.

Guests that attended the meeting were: Jane Cunningham, the Lands Council, and Steve Silkworth, Avista..

Introductions: Sarah Hubbard-Gray called the meeting to order at 10:00 am. Committee members introduced themselves. Sarah provided an overview of the agenda and asked if there were comments on the April 17, 2002 Meeting Summary. It was recommended that the last sentence of the last bullet item under Planning Unit Voting Process on page 3 be changed to read: "Typically, discussions and consensus building will occur at one meeting, with a wrap up discussion and decision making occurring at the following meeting." There were no other comments on the meeting summary.

Update on Final Revisions to Draft Data Compilation and Assessment Report: Reanette Boese explained that she sent out an email to all of the Planning Unit members with the spreadsheet that outlined the Work Group recommendations for addressing the Draft Report comments. No comments or concerns were received from members of the Planning Unit. Reanette went on to explain the process for revising and finalizing the Draft Report, which includes:

- Spokane County staff doing some research to clarify some issues, making revisions to some of the chapters, and cross checking the references in the text with the appendixes,
- Avista to review and correct the revised text that describes their dam operation,
- Golder revising the remaining chapters,
- Golder finalizing the report by June 2002.

Planning Unit members commented that the Work Group process worked well to identify issues and develop revision strategies.

Update on Little Spokane River Instream Flow Work: Stan Miller distributed a memo summarizing the May 6, 2002 Instream Flow Work Group meeting (see enclosed copy) and gave an overview of the May 6 meeting. He reiterated Golder's recommendation to use the Wetted

Perimeter Methodology because it is well suited to this stream system and can be completed with the funds available from DOE for instream flow studies. Stan explained that, using the Wetted Perimeter method, the Instream Flow grant monies will be adequate to study at least four sites and would also provide information on aquatic biota sufficient for an initial evaluation of the current regulated flows.

Stan explained 1) that the Work Group agreed with this method as a first step in evaluating the instream flow needs of aquatic biota to develop recommendations for additional study and regulated flow changes, 2) the four regulated flow control points along the Little Spokane River with current and historic gauging stations, 3) that the Work Group felt that Elk should be given a high priority as a study site in order to evaluate Pend Oreille County water usage, 4) how the wetted perimeter would be applied and used to describe the relationship between habitat and stream flow, 5) that the wetted perimeter method may not be conclusive enough to recommended new regulated flows, 6) how Golder would evaluate the stream system using the wetted perimeter method, and 7) that an invertebrate study is being conducted by a graduate student insome of the stream reaches.

The following comments and issues were discussed:

- Ty Wick asked what the wetted perimeter method would tell us and expressed concern about the adequacy of the method. Stan Miller explained that wetted perimeter method evaluates the relationship between stream flows and habitat. In other words, the method evaluates the relationship between stream flow and the amount of the stream bed that needs to be wet to provide adequate instream habitat. Doug Allen clarified that the difference between the toe width method and the wetted perimeter method is that wetted perimeter adds a safety factor into the evaluation.
- Doug Allen also indicated that the regulatory requirements associated with flow control points need to be considered when picking the study site locations.
- Stan Miller explained that the study would occur over a one-year period and that due to the characteristics of the evaluation, precipitation and flow may not significantly affect the study results.
- Lloyd Brewer asked if biological and fisheries elements would be incorporated into the proposed wetted perimeter study. Stan Miller explained that fish and wildlife would be considered in the study, but would be limited by budgetary constraints.
- Rachael Pascal Osborn expressed concern that using the wetted perimeter method would not provide adequate information for the Planning Unit to recommend modifications to regulated instream flow, that the method doesn't consider the stream health needs, and that a more holistic study methodology is needed. She distributed information on a watershed planning satellite downlink production and gave some examples of different approaches being used in other parts of the state. She expressed the opinion that wetted perimeter methodology is only one piece of a more holistic study that is needed and that she is not comfortable that the wetted perimeter method will provide enough information for the Planning Unit to be able to make any recommendation regarding regulated flows.
- Doug Allen reiterated that the Planning Unit would need to consider the data gathered under the instream flow study and make a recommendation to the state, but clarified that the recommendation can be to leave the current regulated flow unchanged.

- It was acknowledged that other methodologies were focused on in early Planning Unit discussions on this subject. Further, because the wetted perimeter was not part of the initial discussions, it has been problematic for the Planning Unit to understand and accept the proposal that wetted perimeter method is the method best suited to this system for the funding available. Stan reminded the group that there is not enough grant funding available from DOE to utilize a more holistic approach/method.
- The applicability of results of a wetted perimeter method study to future holistic studies was discussed. It was explained that fisheries experts from Washington Department of Fish and Wildlife and Golder Associates consulted and agreed that the wetted perimeter method is well suited for the Little Spokane River system and that it would provide valuable information. However, the results of a wetted perimeter study will not provide data that can be directly used to conduct an IFIM study in the future. However, the results may be able to be used in/applied to more holistic stream studies.
- The Planning Unit was reminded that one full water year of data is needed for a wetted perimeter study, that the current grant monies are available through the end of June 2002 and for use during the next fiscal year; additional monies may not be available in the subsequent fiscal year.
- Gus Koedding asked if grant monies could be used to study fewer sites using a more intense method like IFIM. Concern was raised about limiting the number of sites and therefore limiting the study to a small geographic area.

Following the discussion, several of the Planning Unit members expressed concern about using the wetted perimeter method, but indicated that they would support using it. Planning Unit members were asked to explain and respond to the various opinions. Ty Wick indicated that he could not support spending the money to complete a study using the wetted perimeter method since it would likely not provide enough information for the Planning Unit to use to recommend a new minimum flow requirement. Rachael Pascal Osborn and Gus Koedding agreed with Ty that it would be better to spend public monies on a method that would provide more useful information. Others expressed their opinion that this method is a good stepping stone to gather more information and that it may be adequate to characterize instream flow requirements for this stream system.

The Initiating Agencies previously reached consensus on moving forward with an instream flow study using the wetted perimeter method. In order to move forward and gather the needed data for a full water year and have it coincide with the fiscal year that grant funds are available, Stan Miller needed a decision from the Planning Unit in May 2002. The group was asked if the Little Spokane River instream flow work should move forward. Planning Unit members were not in consensus. Since Stan needed a decision at this meeting, it was decided that Planning Unit members would vote. It was noted that this was the first time a vote of Planning Unit members had been called. The Initiating Agency members did not vote, and 5 of the 9 Planning Unit members present voted against moving forward with instream flow analysis using the wetted perimeter method. This vote resulted in the postponement of the proposed Little Spokane River instream flow work until further clarification to the scope of work and adequate support was generated from the Planning Unit.

Continue Discussion of Decision Making Process for Plan Recommendations: Further discussion on this topic was postponed until the June 2002 Planning Unit meeting.

Other Items of Public or Committee Concern: The following items were shared with the group:

- The Interim Steering Committee for the proposed inter-state aquifer study will be holding an all day educational meeting on June 20, 2002. Representatives Nethercutt and Otter submitted a $3.5 million bill in the house to fund the study.
- Rachael Pascal Osborn announced a meeting on the Bellingham watershed planning process and a watershed planning satellite downlink program at the Cooperative Extension on May 31, 2002.

The next meeting was set for 10:00 am on June 19, 2002 at the Spokane County Conservation District.

EXCERPTS FROM:
Meeting Summary
Planning Unit

Little Spokane River – Middle Spokane River Local Watershed Plan
June 19, 2002

Committee members recorded on the sign in sheet were:

Doug Allen
Jim Wilson
Lloyd Brewer
Harry McLean
Terry Liberty
Don Comins
Jane Cunningham
Megan Harding
Karin Divens
Julia McHugh
Ty Wick
Ken Kuhn
Gus Koedding
Susan McGeorge
Steve Silkworth, for B. Howard
Rick Noll
Dave Jones
Rachael Pascal Osborn
Tom Hargreaves
Ann Murphy
Stan Miller
Reanette Boese

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen of Golder Associates.

Guests that attended the meeting were: Lee Mellish, Liberty Lake Sewer and Water District, and Virginia Darrell, Washington State Department of Health.

Update on Little Spokane River Instream Flow Work: Stan Miller indicated that since the Planning Unit could support moving forward with the instream flow work as outlined in the scope of work discussed at the May 15, 2002 Planning Unit meeting, the Little Spokane River (LSR) Instream Flow Work Group met twice and revised the approach and scope of work. Stan passed out 1) Summary of June 12, 2002 LSR Instream Flow Work Group Meeting, and 2) June 19, 2002 Action Item – Instream Flow Proposal for the Little Spokane River. Stan informed the Planning Unit that the June 4, 2002 conference call with Hal Beecher, Washington Department of Fish and Wildlife, had been very productive. At the meeting the work group agreed that the wetted perimeter method, plus the following items, would be the best way to proceed:

1. A description of the substrate at transects,
2. Transect information from the vegetation line and information of the vegetation of the riparian zone, and,
3. The depth of the water above the substrate.

It was explained that Hal Beecher felt that this approach would be adequate to create a defensible recommendation on instream flows. Stan then informed the group that Hal Beecher had conference called with the Hangman Creek group on June 5, 2002 and had said that only one transect representative of a reach (and not five as originally defined by Golder within a traditional wetted perimeter method) would be needed and suggested that the group complete 7 measurements of the parameters at this one transect at 7 different flows.

Stan asked the Planning Unit to read over the items passed out as well as the Summary of the June 4, 2002 LSR Instream Flow Work Group Meeting (which was included with the June 19, 2002 meeting notice/agenda) before the July 8, 2002 meeting. Stan stressed to the Planning Unit that a decision on the following items would need to be made by the Planning Unit at the July 8 meeting so the necessary instream flow work can be completed over the summer:

1. Verify that the Planning Unit agrees to proceed with the wetted perimeter method plus the three items described above.
2. Decide if the Planning Unit wants to adopt Hal Beecher's approach of using one transect and 7 measurements (which will allow study of additional sites over and above the four defined by Golder).
3. Decide on sites to study in order or priority.

Stan also provided: 1) copies of Golder's October 17, 2001 memo on the Spokane October 10, 2001 instream flow meeting; and 2) a review of instream flow study methods used in Washington State.

Excerpts From:
Meeting Summary
Planning Unit

Little Spokane River – Middle Spokane River Local Watershed Plan
July 8, 2002

Committee members recorded on the sign in sheet were:

Doug Allen	Ty Wick	Dave Jones
Lloyd Brewer	Susan McGeorge	Rachael Pashcal Osborn
Harry McLean	Steve Skipworth	Tom Hargreaves
Terry Liberty	Roger Krieger	Dave Jones
Don Comins	Walt Edelen	Stan Miller
Jane Cunningham	Megan Harding	Reanette Boese

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen of Golder Associates.

Guests that attended the meeting were: Kevin Robinette, Washington State Department of Fish and Wildlife.

Continued Discussion on Revised Instream Flow Scope of Work, Planning Unit Decision on using Wetted Perimeter Plus method: Stan Miller provided an overview of the modifications made to the previous Little Spokane River instream flow scope of work and handed out the June 19, 2002 proposal that summarized the revised approach for the Planning Unit's consideration. He explained that the Instream Flow Work Group had met on June 4 and 12, 2002, that Department of Fish and Wildlife representatives had attended those meetings and provided input, and that members of the Work Group support the modified scope of work which uses the wetted perimeter method plus supplemental data collected on aquatic biota, substrate, water depth, and velocity.

Kevin Robinette, from the Washington State Department of Fish and Wildlife, passed out a July 3, 2002 memo from Jason McLellan titled "Little Spokane River Fish Habitat Requirements and Distribution Table". Kevin went over the memo contents, explained that rainbow trout and mountain whitefish are the appropriate fish to consider as indicator species for the study, and explained that Hal Beecher supports the revised Wetted Perimeter Plus method for the Little Spokane River instream flow study. The Planning Unit members then asked questions and provided comments. Members of the Little Spokane River Instream Flow Work Group (including Doug Allen, Tom Hargreaves, Susan McGeorge, and Rachael Pashcal Osborn) confirmed their support for the modified approach and explained why.

Stan Miller explained recent input from Hal Beecher and proposed modifying the June 19, 2002 Instream Flow Proposal scope of work items to reflect his recommendations. The modifications include:

1. Perform field data collection for wetted perimeter analysis on at least six selected ~~sites~~ reaches.

~~a. Measure five transects at each primary site~~
~~b.~~ a. Reaches should be 300 to 1000 feet long
~~c. Measurements will be made at High, Medium and Low flow for each site~~

~~2. Alternative approach to wetted perimeter~~
~~a.~~ b. Select a representative transect on each study reach, selected by a fisheries expert
~~b.~~ c. Measurements will be made on the transect at seven flows in the range from near low flow to near high flow

In addition, it was recommended that the following phase be added to the scope of work:

- Over the course of the study, project staff will work with the Washington Department of Fish and Wildlife as appropriate and as much as they are available.

The Planning Unit was asked if they support the June 19, 2002 Instream Flow proposal for the Little Spokane River with the scope of work modifications listed above. It was approved by consensus.

Excerpts From:
Meeting Summary
Planning Unit

Little Spokane River – Middle Spokane River Local Watershed Plan
September 18, 2002

Committee members recorded on the sign in sheet were:

Doug Allen	Ty Wick	Rachael Pashcal Osborn
Lloyd Brewer	Susan McGeorge	Tom Hargreaves
Harry McLean	Steve Skipworth	Karin Divens
Terry Liberty	Walt Edelen	Stan Miller
Jane Cunningham	Megan Harding	Reanette Boese
Ken Kuhn	Rick Noll	

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen of Golder Associates.

Guests that attended the meeting were: Bruce Lang and Susanne Canwell, Eastern Washington University.

Report on Little Spokane River Instream Flow Scope of Work and Field Study: Stan Miller reviewed the approved scope of work that covers data collection at 6 sites. He explained that on Monday September 23, 2002 field work with Golder Associates staff will begin. They will be starting to collect data at the bottom of the hydrograph so a full water year of data can be collected. It is typically preferred to start at the top of the hydrograph, but starting at the bottom will work, especially if we don't get a huge runoff. Stan also explained that Spokane Community College water resource group, under Erin Cunningham's direction, will be helping with the stream gauges.

Excerpts From:
Meeting Summary
Planning Unit

Little Spokane River – Middle Spokane River Local Watershed Plan
October 23, 2002

Committee members recorded on the sign in sheet were:

Doug Allen
Lloyd Brewer
Harry McLean
Jane Cunningham
Ken Kuhn
Jim Wilson
Ty Wick
Julia McHugh
Steve Skipworth
Walt Edelen
Megan Harding
Rick Noll
Rachael Pashcal Osborn
Roger Krieger
Dave Jones
Stan Miller
Reanette Boese

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen of Golder Associates.

Guests that attended the meeting were: None.

Report on Little Spokane River Instream Flow Work: Stan Miller explained the status of the Little Spokane River Instream Flow work. Bryony Hansen gave a presentation on the work performed to date. Her presentation covered:

- Objectives and methodology being used (Wetted Perimeter plus habitat characterization)
- Six transect site locations and data collected
- September 23 to 25, 2002 initial survey field work
- Preliminary observations, which indicate that the wetted perimeter does not increase or decrease significantly with increased or decreased flows due to the channel morphology (i.e., incised channel configurations)
- Options for continued data collection, including 1) continue with current approach, 2) cluster measurements around the low flow time frame to assess habitat at low flows, and 3) add more cross sections to possibly catch inflection points.

Planning Unit discussion followed and included:

- Stan Miller explained how the channel morphology relates to the wetted perimeter.
- Bryony Hansen confirmed that Golder feels the cross sections are representative of the stream channels.
- Adequacy of low flows to protect fish, affect of irrigation withdrawal on stream flows, basis for choosing wetted perimeter method, possible mathematical techniques for estimating wetted perimeter during lower flows, etc.

Bryony Hansen indicated that Golder recommends using option 2 (cluster measurements around the low flow time frame to assess habitat at low flows). Stan Miller explained that he would insure that Hal Beecher at the Washington Dept. of Fish and Wildlife is aware of the proposed modifications and that changes would be implemented only after consideration of his input/recommendations on how to move forward with the field studies. Any proposed modifications to the study approach will be emailed to the Planning Unit and an Instream Flow Work Group meeting will be scheduled to discuss the study approach with Hal Beecher and Golder representatives.

MEMORANDUM

10th Floor, 940 - 6 Ave. S.W.
Calgary, Alberta, Canada
T2P 3T1

Golder Associates

Golder Associates Ltd.
Telephone No.: 403-299-5600
Fax No.: 403-299-5606

DATE:	January 20, 2003	Proj No 013-1372-2400
TO:	Hal Beecher, WDFW	
CC:	Chris Pitre, GAI Donna DeFrancesco, GAI	
FROM:	Dave Fernet	
RE:	Habitat Suitability Criteria, Mountain Whitefish	

Hal:

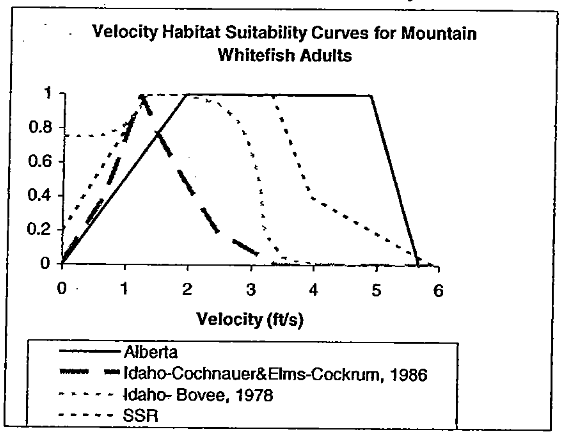
We have examined several sets of mountain whitefish habitat preference criteria to determine the criteria best-suited for use in an analysis of the instream flow requirements for the Little Spokane River: two from Idaho - Bovee 1978, Cochnauer & Elms-Cockrum 1986; the most recent set developed from field observations in Alberta (Red Deer River, Golder 1999), referenced as Alberta in the legend on the attached figures; and, a set Allan Locke developed within the past year through a Delphi process to facilitate ongoing evaluations of the South Saskatchewan River Basin in Alberta, referenced as SSR on the attached figures).

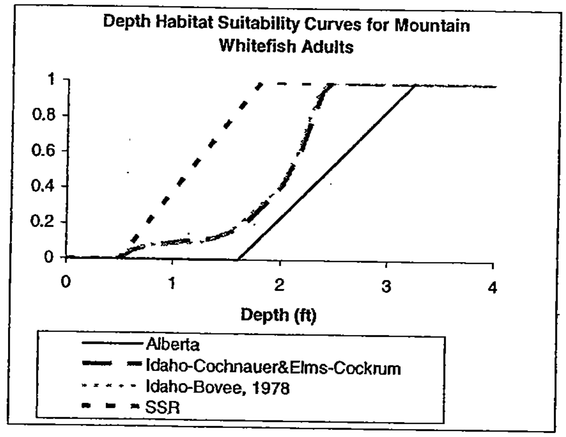
In general, there is a good deal of agreement between the curves, with the exception of the velocity preference for mountain whitefish fry. One set of Idaho curves suggest no preference for low/no velocity, whereas the other three sets of curves indicate low/no velocity is optimal for this life stage. Our observations in Alberta suggest that mountain whitefish fry do prefer areas of low velocity soon after they finish their post-larval drift life stage.

In general, the curves developed by Allan at the Delphi workshop for the most part envelope the other data sets. As such, and without the benefit of any data to validate any of the data sets, I propose to use the curves developed using the Delphi process for the Little Spokane River analysis.

I look forward to your comments on this proposal.

Mountain Whitefish Adult Suitability Curves- Comparison of Alberta and Idaho Methods





From: Fernet, Dave [mailto:Dave_Fernet@golder.com]
Sent: Tuesday, January 21, 2003 8:36 AM
To: 'Hal Beecher'
Cc: Pitre, Chris; DeFrancesco, Donna; Allan Locke; SMiller@spokanecounty.org
Subject: RE: Mountain Whitefish Habitat Preference Criteria

You're right Hal - we wouldn't expect to see juveniles in water much shallower than 0.5 ft (0.15 m), which is the begining of suitable depths as reported by Cochnauer and Elms-Cochrum and Bovee for Idaho. If you concur, we'll start the curve at 0.5 ft (i.e., suitability 0), and indicate a suitability of 1 at 1 ft (0.3 m).

We also atempted to compare substrate criteria, but because everybody seems to use different codes, we couldn't do this without the raw data. In general, we don't consider mountain whitefish to be substrate dependent, even for spawning as they are broadcast spawners, but they typically spawn in riffles. If it's all right with you, we'll use the substrate curves we developed for the Red Deer River, or, alternatively, just use depth and velocity criteria in the analysis.

Dave

From: Hal Beecher [mailto:BEECHHAB@dfw.wa.gov]
Sent: Tuesday, January 21, 2003 8:28 AM
To: beechhab@dfw.wa.gov; Dave_Fernet@golder.com
Cc: CPitre@golder.com; ddefrancesco@golder.com; Allan Locke; SMiller@spokanecounty.org
Subject: Re: Mountain Whitefish Habitat Preference Criteria

Dave - Thanks for the graphs. I generally concur with Allan's South Saskatchewan River Delphi curves. The one exception would be the depth curve for juveniles. The juvenile depth curve starts at 0,0 and goes up, but I would expect some threshold depth greater than 0 at which it starts up. Do juveniles use 0.1 ft (0.03 m)? 0.2? The fry and adult curves are consistent with my snorkel observations (never quantified, just impressions).

Hal

comparing the predicted amount of mountain whitefish habitat at a range of flows, with and without a consideration for substrate type.

Best Regards,

Dave

-----Original Message-----
From: Clipperton, Kasey
Sent: Friday, March 28, 2003 3:06 PM
To: Fernet, Dave
Subject: Little Spokane River Flows

Dave,

Here is a summary of the data that has been collected to date.

<u>LSR@ Pine River Park</u>

Field data flow range: 106cfs - 868cfs with good overlap in all flow ranges for modelling.

Existing base flow range: 115cfs - 250cfs

Mean annual flow: 303cfs

<u>LSR@ Chattaroy</u>

Field data flow range: 69cfs - 509cfs with good overlap in all flow ranges for modelling.

Existing base flow range: 57cfs - 165cfs

<u>Deadman Creek</u>

Field data flow range: 5.5cfs - 151cfs with good overlap in all flow ranges for modelling.

<u>Dragoon Creek</u>

Field data flow range: 17cfs - 172cfs with good overlap in all flow ranges for modelling.

The above four sites have a very good range of discharges with good stage-discharge relationships. Modelling flows half of the lowest measured flow and at least double the highest flow should not be a problem. The intermediate discharges are evenly spaced and therefore no single flow will need to be extrapolated beyond the "rule-of-thumb" ranges of 0.5 - 2.5 times the measured flow to achieve an overlap of modelling results between measured flows.

From: Fernet, Dave [mailto:Dave_Fernet@golder.com]
Sent: Thursday, March 27, 2003 10:01 AM
To: 'Miller, Stan'
Cc: Pitre, Chris
Subject: RE: Little Spokane River IFN Analysis

Stan - I think the Planning Unit will be pleased with what they see with WinHabSim, as will Hal. Given that we're using the model now, and if we have info at 850 cfs at Dartford, we'll be able to push the model up to at least 1500 cfs at Dartford (as long as our stage/discharge relationship is tight), with a high degree of confidence. Therefore, any flow measurements at Dartford in the 1000 to 1500 cfs range wouldn't provide much additional information. The flows on some of the tribs, as well as the headwaters of the LSR fall within a very tight range - we're waiting to see what we got yesterday at these stations. If it looks like there is an opportunity to increase the flow ranges measured at those locales, we may try to go after them.

We'll keep you in the loop.

Dave

-----Original Message-----
From: Miller, Stan [mailto:SMiller@spokanecounty.org]
Sent: Thursday, March 27, 2003 10:31 AM
To: 'Fernet, Dave'
Subject: RE: Little Spokane River IFN Analysis

Dave

Sorry I didn't get back to you sooner. The idea of running through WinHabSim with the Planning Unit sounds good. I'd like to avoid duplication of effort if we can – hopefully Hal will buy off on this.

Looks like we are going to get some good data. The crew went out yesterday to measure the LSR and tribs. The flow at Dartford was right at 850 cfs all day in spite of the rain and snow in the basin. Given where we are with snowpack this may be close to the peak of what we will see. I'm sure we will get a few 24 hour excursions to over 1000 cfs, but unless we get lucky we probably won't be able to get a crew in the field fast enough to sample everything while the flows are high. Any thoughts on how to prioritize data collection if we get another pulse above 1000?

Thanks
Stan Miller
Spokane County Utilities Division
Mail Stop PWB-4
1116 W Broadway
Spokane, WA 99260

509 477-7259
509 477-4715 FAX

-----Original Message-----
From: Fernet, Dave [mailto:Dave_Fernet@golder.com]
Sent: Monday, March 17, 2003 4:11 PM
To: SMiller (E-mail)
Cc: Pitre, Chris; Clipperton, Kasey
Subject: Little Spokane River IFN Analysis

Hi Stan - For looking at the useable area on each transect that has been measured in the LSR Basin, Hal Beecher indicated a preference for doing the analysis through the use of a series of spreadsheets, with the output of each being combined to come up with the useable amount of habitat on each transect for the various life stages of rainbow trout and mountain whitefish. While this can be done, and in fact we had started the process, we feel that there is a more efficient way of conducting the analysis that gives us more flexibility in the type of information we can produce.

By using a windows version of the IFIM PHABSIM group of models, we can essentially trick the model into thinking the transect is essentially a hydraulic study site. We have the stage-discharge curve from the field measurements to drive the model, and measured depth, velocity and substrate distributions to run the model for each flow that has been measured, By using the habitat suitability information that we have agreed to, the model will calculate the amount of useable habitat at each of the measured flows. With a little bit of calibration, we can actually get the model to simulate habitats present between the flows that were measured, and, assuming the stage-discharge curves look good, we can actually model flows below those that we measured, and, more importantly, model flows that are higher than what we have been able to measure. This will be important to us if we don't see much of a runoff this spring (i.e., higher than the 500 cfs we have measured).

I talked over the approach with Hal today, and he was OK with it. He pushed the spreadsheet approach so that people had to work through the analysis, and make sure it made sense to them, but more importantly, the folks receiving the information would be able to see the intermediate steps so that it didn't look like the information came out of a black box. We can provide as much information as folks want, in terms of the steps between data input and output. In addition, there are quite a few built in QA/QC checks that we can use to make sure the data are robust.

If you want to discuss this approach, or have any concerns, please give me a call at (403) 299-5605.

Best Regards

Dave

Meeting Summary
Planning Unit
Little Spokane River – Middle Spokane River Local Watershed Plan
February 19, 2003

Committee members recorded on the sign in sheet were:

Doug Allen, *Dept. of Ecology*
Lloyd Brewer, *City of Spokane*
Harry McLean, Jr., *City of Spokane Water*
Jim Hollingsworth, *The Lands Council*
Ken Kuhn, *Pend Oreille County Planning*
Julia McHugh, *SAJB*
Jim Wilson, *Association of Realtors*
Gus Koedding, *Spokane Homebuilders Assoc.*
Steve Skipworth, *Vera Water*
Rick Noll, *Spokane County Conservation District*
Terry Liberty, *Spokane County Planning*
Susan McGeorge, *Whitworth Water District*
Walt Edelen, *Spokane County Conservation District*
Tom Hargreaves, *Friends of Little Spokane Valley*
Ty Wick, *Spokane Aquifer Joint Board*
Megan Harding, *Dept. of Health*
Karin Divins, *Dept of Fish and Wildlife*
Stan Miller, *Spokane County*
Reanette Boese, *Spokane County*
Bill Gilmour, *Spokane County*

Consultants that attended the meeting were: Sarah Hubbard-Gray of Hubbard Gray Consulting and Bryony Hansen of Golder Associates.

Guests that attended the meeting were: none.

Introductions: Sarah Hubbard-Gray called the meeting to order at 10:05 am. Committee members introduced themselves. Sarah asked if there were comments on the January 15, 2003 Meeting Summary. No comments or corrections to the meeting summary were requested.

Status of Spokane River Instream Flow Agreement: Sarah Hubbard-Gray reminded the Planning Unit that at the January 2003 meeting Stan Miller was asked to submit the Middle Spokane River Step A instream flow funding application by the January 30th deadline, with the understanding that a final Planning Unit decision would be made at the February 2003 meeting. Stan Miller indicated that the grant funding application had been submitted which requested $11,000 for Step A and that $2500 had been approved through June 2003. Stan also explained that Avista's relicensing efforts will evaluate the affect of dam operation modifications on water quality and fisheries in the Spokane River, that they have selected two contractors to conduct the evaluations. Stan explained that:

- The Planning Unit's work would be coordinated with Avista's work, will not duplicate efforts, and will consider Avista's fisheries/spawning results when an instream flow recommendation is developed.
- Step A work will be coordinated with Hal Beecher and other representatives of the Department of Fish and Wildlife and identify methods to use to conduct the instream flow evaluation.

Following a short discussion, all of the Planning Unit members present confirmed the decision to move forward with the Middle Spokane River Step A Instream Flow work.

Continued Discussion on Non-aquatic Biota Instream Flow Elements for Little Spokane River: Sarah Hubbard-Gray reviewed the recommendations that the Planning Unit sub-groups developed at the January 2003 meeting. The recommendations were posted wall charts and discussed. The Planning Units confirmed the following Overall objectives and Aquatic Biota objectives and criteria:

Overall

Objectives:

- Assure that recommended instream flows for the Little Spokane River protect all designated beneficial uses.

Aquatic Biota

Objectives:

- Assure that instream flow recommendations resulting from this plan meet the needs of selected fish species (rainbow trout and mountain whitefish) and other representative aquatic biota.

Criteria:

- Are the flows adequate for salmonid spawning and rearing in the mainstream and major tributaries?
- Do the high flow levels provide adequate flow to cleanse deposited silt, without increasing erosion or excessive silt deposits?
- Do the flows support diverse aquatic biota production (e.g., macroinvertebrates, frogs, salamanders)?
- Is the existing instream flow rule sufficiently protective of fish habitat?
- Are changes to the existing instream flow needed to protect selected fish species?

However, the remaining Water Quality, Recreation and Aesthetics, and Power Production objectives and criteria were not confirmed at the meeting. It was decided that an Instream Flow work group would be formed to develop recommended objectives and criteria for these remaining elements and address additional instream flow issues/needs for both the Little Spokane and Middle Spokane instream flow work. A sign up sheet was sent around the room and a work group meeting was scheduled for March 4, 2003 at 2:00 pm at the Spokane County Conservation District office.

Scenarios for Model Use: None of the Planning Unit members brought proposals for model runs to the meeting. Stan Miller provided some suggestions for possible model runs that could provide information to help the Planning Unit form recommendations. It was decided that a work group would be formed address model use. A sign up sheet was passed around the room and a work group meeting was scheduled for March 11, 2003 at 2:00 pm.

Other items of Public or Committee Concern: Planning Unit members provided the following reminders/information:

- A Watershed Planning training session is scheduled for March 25 and 26, 2003. Call Doug Allen for information.
- Doug Allen reminded the Planning Unit that Ecology has $10,000 held for them for storage work. Stan Miller indicated that he did not see the need for, or ability to do, any storage work by June 2003. The rest of the Planning Unit members concurred.

The next meeting was set for Wednesday March 19, 2003 at 10:00 am at the Spokane County Conservation District. The meeting adjourned at 12:05 pm.

APPENDIX C

HABITAT SUITABILITY CRITERIA

APPENDIX C TABLE OF CONTENTS

TABLES:

FIGURES:

TABLE C-1

Substrate Code Definitions

CODE	SUBSTRATE TYPE
1	Silt/Clay
2	Sand
3	Small Gravel (0.1"- 0.5")
4	Medium Gravel (0.5"- 1.5")
5	Large Gravel (1.5"- 3")
6	Small Cobble (3"- 6")
7	Large Cobble (6"- 12")
8	Boulder (>12")
9	Bedrock

TABLE C-2
Mountain Whitefish Fry Substrate Coding

SUBSTRATE CODE	WEIGHTING FACTOR	SUBSTRATE CODE	WEIGHTING FACTOR
0	0.25	56.5	0.88
11.5	0.25	56.9	0.78
13.9	0.25	57.5	0.88
14.5	0.50	57.9	0.78
14.9	0.30	58.5	0.88
15.5	0.50	58.9	0.78
15.9	0.30	59.5	0.63
16.5	0.63	59.9	0.73
16.9	0.33	61.5	0.63
17.5	0.63	61.9	0.93
17.9	0.33	62.5	0.63
18.5	0.63	62.9	0.93
18.9	0.33	63.5	0.63
19.5	0.38	63.9	0.93
19.9	0.28	64.5	0.88
21.5	0.25	64.9	0.98
23.9	0.25	65.5	0.88
24.5	0.50	65.9	0.98
24.9	0.30	66.5	1.00
25.5	0.50	68.9	1.00
25.9	0.30	69.5	0.75
26.5	0.63	69.9	0.95
26.9	0.33	71.5	0.63
27.5	0.63	71.9	0.93
27.9	0.33	72.5	0.63
28.5	0.63	72.9	0.93
28.9	0.33	73.5	0.63
29.5	0.38	73.9	0.93
29.9	0.28	74.5	0.88
31.5	0.25	74.9	0.98
33.9	0.25	75.5	0.88
34.5	0.50	75.9	0.98
34.9	0.30	76.5	1.00
35.5	0.50	78.9	1.00
35.9	0.30	79.5	0.75
36.5	0.63	79.9	0.95
36.9	0.33	81.5	0.63
37.5	0.63	81.9	0.93
37.9	0.33	82.5	0.63
38.5	0.63	82.9	0.93
38.9	0.33	83.5	0.63
39.5	0.38	83.9	0.93
39.9	0.28	84.5	0.88
41.5	0.50	84.9	0.98
41.9	0.70	85.5	0.88
42.5	0.50	85.9	0.98
42.9	0.70	86.5	1.00
43.5	0.50	88.9	1.00
43.9	0.70	89.5	0.75
44.5	0.75	89.9	0.95
45.9	0.75	91.5	0.38
46.5	0.88	91.9	0.48
46.9	0.78	92.5	0.38
47.5	0.88	92.9	0.48
47.9	0.78	93.5	0.38
48.5	0.88	93.9	0.48
48.9	0.78	94.5	0.63
49.5	0.63	94.9	0.53
49.9	0.73	95.5	0.63
51.5	0.50	95.9	0.53
51.9	0.70	96.5	0.75
52.5	0.50	96.9	0.55
52.9	0.70	97.5	0.75
53.5	0.50	97.9	0.55
53.9	0.70	98.5	0.75
54.5	0.75	98.9	0.55
54.9	0.75	99.5	0.50
55.5	0.75	99.9	0.50
55.9	0.75		

TABLE C-3
Mountain Whitefish Juvenile/Adult Substrate Coding

SUBSTRATE CODE	WEIGHTING FACTOR	SUBSTRATE CODE	WEIGHTING FACTOR
0	0.25	56.5	0.75
11.5	0.25	56.9	0.55
13.9	0.25	57.5	0.75
14.5	0.38	57.9	0.55
14.9	0.28	58.5	0.75
15.5	0.38	58.9	0.55
15.9	0.28	59.5	0.50
16.5	0.63	59.9	0.50
16.9	0.33	61.5	0.63
17.5	0.63	61.9	0.93
17.9	0.33	62.5	0.63
18.5	0.63	62.9	0.93
18.9	0.33	63.5	0.63
19.5	0.38	63.9	0.93
19.9	0.28	64.5	0.75
21.5	0.25	64.9	0.95
23.9	0.25	65.5	0.75
24.5	0.38	65.9	0.95
24.9	0.28	66.5	1.00
25.5	0.38	68.9	1.00
25.9	0.28	69.5	0.75
26.5	0.63	69.9	0.95
26.9	0.33	71.5	0.63
27.5	0.63	71.9	0.93
27.9	0.33	72.5	0.63
28.5	0.63	72.9	0.93
28.9	0.33	73.5	0.63
29.5	0.38	73.9	0.93
29.9	0.28	74.5	0.75
31.5	0.25	74.9	0.95
33.9	0.25	75.5	0.75
34.5	0.38	75.9	0.95
34.9	0.28	76.5	1.00
35.5	0.38	78.9	1.00
35.9	0.28	79.5	0.75
36.5	0.63	79.9	0.95
36.9	0.33	81.5	0.63
37.5	0.63	81.9	0.93
37.9	0.33	82.5	0.63
38.5	0.63	82.9	0.93
38.9	0.33	83.5	0.63
39.5	0.38	83.9	0.93
39.9	0.28	84.5	0.75
41.5	0.38	84.9	0.95
41.9	0.48	85.5	0.75
42.5	0.38	85.9	0.95
42.9	0.48	86.5	1.00
43.5	0.38	88.9	1.00
43.9	0.48	89.5	0.75
44.5	0.50	89.9	0.95
45.9	0.50	91.5	0.38
46.5	0.75	91.9	0.48
46.9	0.55	92.5	0.38
47.5	0.75	92.9	0.48
47.9	0.55	93.5	0.38
48.5	0.75	93.9	0.48
48.9	0.55	94.5	0.50
49.5	0.50	95.9	0.50
49.9	0.50	96.5	0.75
51.5	0.38	96.9	0.55
51.9	0.48	97.5	0.75
52.5	0.38	97.9	0.55
52.9	0.48	98.5	0.75
53.5	0.38	98.9	0.55
53.9	0.48	99.5	0.50
54.5	0.50	99.9	0.50
55.9	0.50		

TABLE C-4
Mountain Whitefish Egg Incubation Substrate Coding

SUBSTRATE CODE	WEIGHTING FACTOR
0	0
11.5	0
29.9	0
31.5	0.5
31.9	0.9
32.5	0.5
32.9	0.9
33.5	1
37.9	1
38.5	0.5
38.9	0.9
39.5	0.5
39.9	0.9
41.5	0.5
41.9	0.9
42.5	0.5
42.9	0.9
43.5	1
47.9	1
48.5	0.5
48.9	0.9
49.5	0.5
49.9	0.9
51.5	0.5
51.9	0.9
52.5	0.5
52.9	0.9
53.5	1
57.9	1
58.5	0.5
58.9	0.9
59.5	0.5
59.9	0.9
61.5	0.5
61.9	0.9
62.5	0.5
62.9	0.9
63.5	1
67.9	1
68.5	0.5
68.9	0.9
69.5	0.5
69.9	0.9
71.5	0.5
71.9	0.9
72.5	0.5
72.9	0.9
73.5	1
77.9	1
78.5	0.5
78.9	0.9
79.5	0.5
79.9	0.9
81.5	0
82.9	0
83.5	0.5
83.9	0.1
84.5	0.5
84.9	0.1
85.5	0.5
85.9	0.1
86.5	0.5
86.9	0.1
87.5	0.5
87.9	0.1
88.5	0
92.9	0
93.5	0.5
93.9	0.1
94.5	0.5
94.9	0.1
95.5	0.5
95.9	0.1
96.5	0.5
96.9	0.1
97.5	0.5
97.9	0.1
98.5	0
99.9	0

TABLE C-5
Rainbow Trout Fry Substrate Coding

SUBSTRATE CODE	WEIGHTING FACTOR	SUBSTRATE CODE	WEIGHTING FACTOR
03.9	0.19	48.9	1.00
04.5	0.55	49.5	0.55
04.9	0.19	49.9	0.91
05.5	0.55	50.5	0.55
05.9	0.19	50.9	0.91
06.5	0.55	51.5	0.55
06.9	0.19	51.9	0.91
07.5	0.55	52.5	0.55
07.9	0.19	52.9	0.91
08.5	0.55	53.5	1.00
08.9	0.19	58.9	1.00
09.5	0.10	59.5	0.55
09.9	0.10	59.9	0.91
10.5	0.10	60.5	0.55
13.9	0.19	60.9	0.91
14.5	0.55	61.5	0.55
14.9	0.19	61.9	0.91
15.5	0.55	62.5	0.55
15.9	0.19	62.9	0.91
16.5	0.55	63.5	1.00
16.9	0.19	68.9	1.00
17.5	0.55	69.5	0.55
17.9	0.19	69.9	0.91
18.5	0.55	70.5	0.55
18.9	0.19	70.9	0.91
19.5	0.10	71.5	0.55
19.9	0.10	71.9	0.91
20.5	0.10	72.5	0.55
23.9	0.19	72.9	0.91
24.5	0.55	73.5	1.00
24.9	0.19	78.9	1.00
25.5	0.55	79.5	0.55
25.9	0.19	79.9	0.91
26.5	0.55	80.5	0.55
26.9	0.19	80.9	0.91
27.5	0.55	81.5	0.55
27.9	0.19	81.9	0.91
28.5	0.55	82.5	0.55
28.9	0.19	82.9	0.91
29.5	0.10	83.5	1.00
29.9	0.10	88.9	1.00
30.5	0.55	89.5	0.55
30.9	0.91	89.9	0.91
31.5	0.55	90.5	0.10
31.9	0.91	92.9	0.10
32.5	0.55	93.5	0.55
32.9	0.91	93.9	0.19
33.5	1.00	94.5	0.55
33.9	1.00	94.9	0.19
38.9	1.00	95.5	0.55
39.5	0.55	95.9	0.19
39.9	0.91	96.5	0.55
40.5	0.55	96.9	0.19
40.9	0.91	97.5	0.55
41.5	0.55	97.9	0.19
41.9	0.91	98.5	0.55
42.5	0.55	98.9	0.19
42.9	0.91	99.5	0.10
43.5	1.00	99.9	0.10

TABLE C-6
Rainbow Trout Juvenile/Adult Substrate Coding

SUBSTRATE CODE	WEIGHTING FACTOR	SUBSTRATE CODE	WEIGHTING FACTOR
03.9	0.10	56.5	0.40
04.5	0.15	56.9	0.32
04.9	0.11	57.5	0.50
05.5	0.20	57.9	0.34
05.9	0.12	58.5	0.65
06.5	0.30	58.9	0.37
06.9	0.14	59.5	0.30
07.5	0.40	60.5	0.30
07.9	0.16	60.9	0.46
08.5	0.55	61.5	0.30
08.9	0.19	61.9	0.46
09.5	0.20	62.5	0.30
09.9	0.12	62.9	0.46
10.5	0.10	63.5	0.30
13.9	0.10	63.9	0.46
14.5	0.15	64.5	0.35
14.9	0.11	64.9	0.47
15.5	0.20	65.5	0.40
15.9	0.12	65.9	0.48
16.5	0.30	66.5	0.50
16.9	0.14	66.9	0.50
17.5	0.40	67.5	0.60
17.9	0.16	67.9	0.52
18.5	0.55	68.5	0.75
18.9	0.19	68.9	0.55
19.5	0.20	69.5	0.40
19.9	0.12	69.9	0.48
20.5	0.10	70.5	0.40
23.9	0.10	70.9	0.64
24.5	0.15	71.5	0.40
24.9	0.11	71.9	0.64
25.5	0.20	72.5	0.40
25.9	0.12	72.9	0.64
26.5	0.30	73.5	0.40
26.9	0.14	73.9	0.64
27.5	0.40	74.5	0.45
27.9	0.16	74.9	0.65
28.5	0.55	75.5	0.50
28.9	0.19	75.9	0.66
29.5	0.20	76.5	0.60
29.9	0.12	76.9	0.68
30.5	0.10	77.5	0.70
33.9	0.10	77.9	0.70
34.5	0.15	78.5	0.85
34.9	0.11	78.9	0.73
35.5	0.20	79.5	0.50
35.9	0.12	79.9	0.66
36.5	0.30	80.5	0.55
36.9	0.14	80.9	0.91
37.5	0.40	81.5	0.55
37.9	0.16	81.9	0.91
38.5	0.55	82.5	0.55
38.9	0.19	82.9	0.91
39.5	0.20	83.5	0.55
39.9	0.12	83.9	0.91
40.5	0.15	84.5	0.60
40.9	0.19	84.9	0.92
41.5	0.15	85.5	0.65
41.9	0.19	85.9	0.93
42.5	0.15	86.5	0.75
42.9	0.19	86.9	0.95
43.5	0.15	87.5	0.85
43.9	0.19	87.9	0.97
44.5	0.20	88.5	1.00
44.9	0.20	88.9	1.00
45.5	0.25	89.5	0.65
45.9	0.21	89.9	0.93
46.5	0.35	90.5	0.20
46.9	0.23	90.9	0.28
47.5	0.45	91.5	0.20
47.9	0.25	91.9	0.28
48.5	0.60	92.5	0.20
48.9	0.28	92.9	0.28
49.5	0.25	93.5	0.20
49.9	0.21	93.9	0.28
50.5	0.20	94.5	0.25
50.9	0.28	94.9	0.29
51.5	0.20	95.5	0.30
51.9	0.28	95.9	0.30
52.5	0.20	96.5	0.40
52.9	0.28	96.9	0.32
53.5	0.20	97.5	0.50
53.9	0.28	97.9	0.34
54.5	0.25	98.5	0.65
54.9	0.29	98.9	0.37
55.5	0.30	99.5	0.30
55.9	0.30	99.9	0.30

TABLE C-7
Spawning Rainbow Trout Substrate Coding

SUBSTRATE CODE	WEIGHTING FACTOR	SUBSTRATE CODE	WEIGHTING FACTOR
02.9	0	54.5	0.9
03.9	0	54.9	0.82
06.5	0	55.9	0.8
06.9	0	56.5	0.75
10.5	0	56.9	0.95
13.9	0	57.5	0.5
14.5	0	57.9	0.9
20.5	0	58.5	0.5
23.9	0	58.9	0.9
26.9	0	59.5	0.5
27.5	0	59.9	0.9
29.9	0	60.5	0.25
30.5	0.4	60.9	0.45
30.9	0.72	61.5	0.25
31.5	0.4	61.9	0.45
31.9	0.72	62.5	0.25
32.5	0.4	62.9	0.45
32.9	0.72	63.5	0.65
33.5	0.8	63.9	0.53
33.9	0.8	64.5	0.75
34.5	0.9	64.9	0.55
34.9	0.82	65.5	0.65
35.5	0.8	65.9	0.53
35.9	0.8	66.5	0.5
36.5	0.65	66.9	0.5
36.9	0.77	67.5	0.25
37.5	0.4	67.9	0.45
37.9	0.72	68.5	0.25
38.5	0.4	68.9	0.45
38.9	0.72	69.5	0.25
39.5	0.4	69.9	0.45
39.9	0.72	70.5	0
40.5	0.5	72.9	0
40.9	0.9	73.5	0.4
41.5	0.5	73.9	0.08
41.9	0.9	74.5	0.5
42.5	0.5	74.9	0.1
42.9	0.9	75.5	0.4
43.5	0.9	75.9	0.08
43.9	0.98	76.5	0.25
44.9	1	76.9	0.05
45.5	0.9	77.5	0
45.9	0.98	77.9	0
46.5	0.75	82.9	0
46.9	0.95	83.5	0.4
47.5	0.5	83.9	0.08
47.9	0.9	84.5	0.5
48.5	0.5	84.9	0.1
48.9	0.9	85.5	0.4
49.5	0.5	85.9	0.08
49.9	0.9	86.5	0.25
50.5	0.4	86.9	0.05
50.9	0.72	87.5	0
51.5	0.4	92.9	0
51.9	0.72	93.5	0
52.5	0.4	96.9	0
52.9	0.72	97.5	0
53.5	0.8	99.9	0
53.9	0.8		

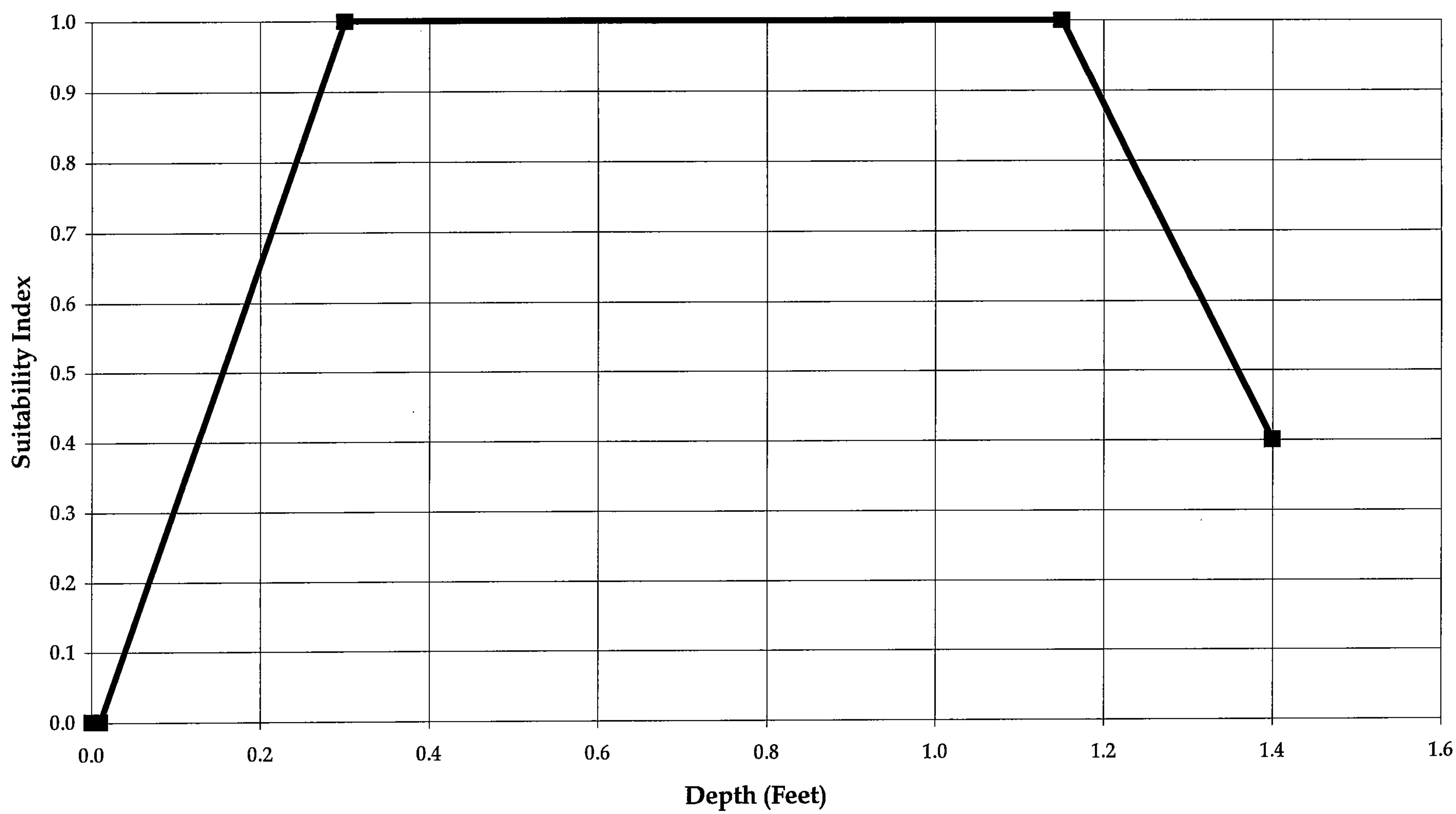
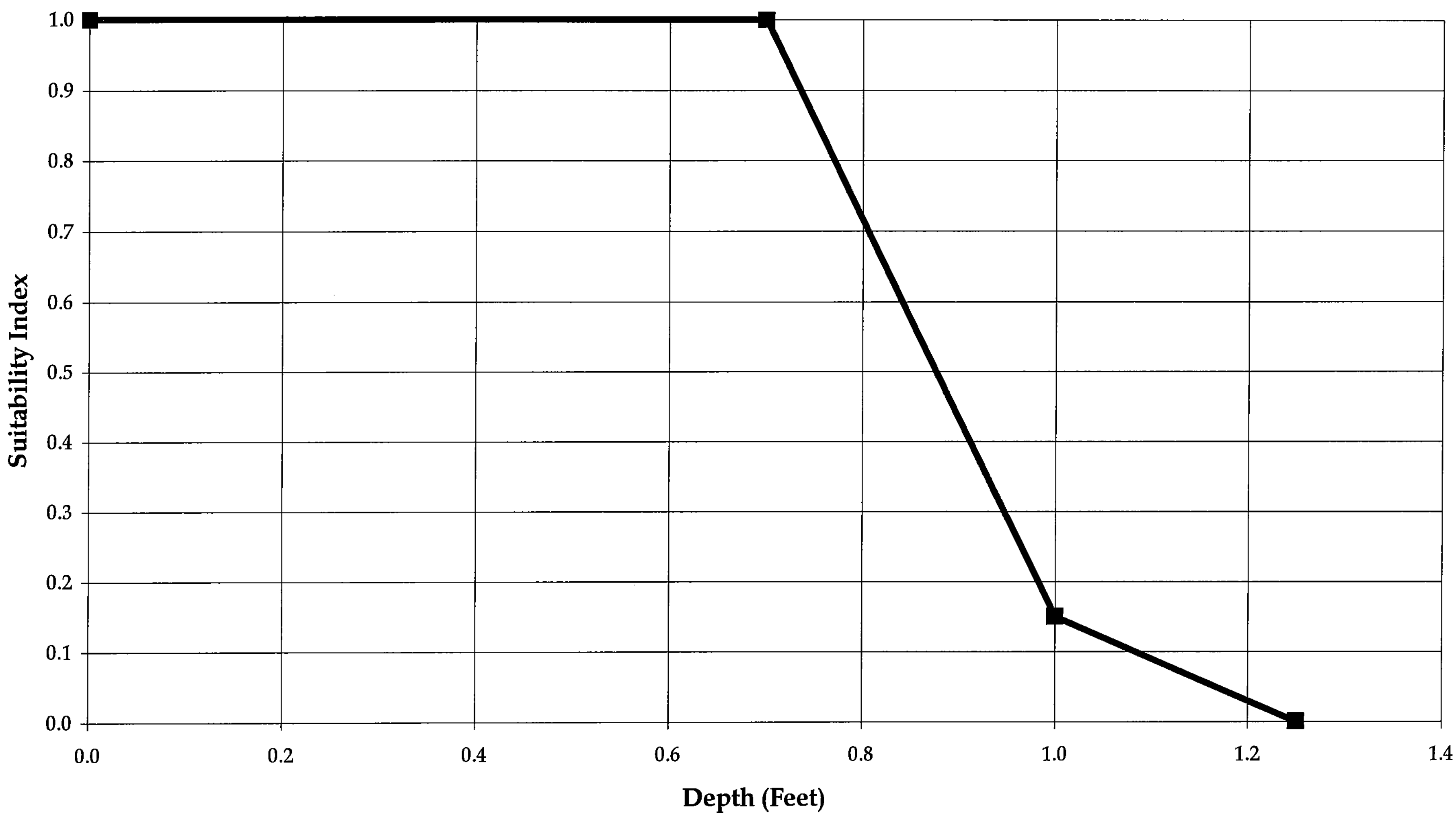


FIGURE C-1: Depth Suitability Index Curve for Mountain Whitefish Fry

WRIA 55 Planning Unit/ IFN Assessment / WA

Golder Associates

Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

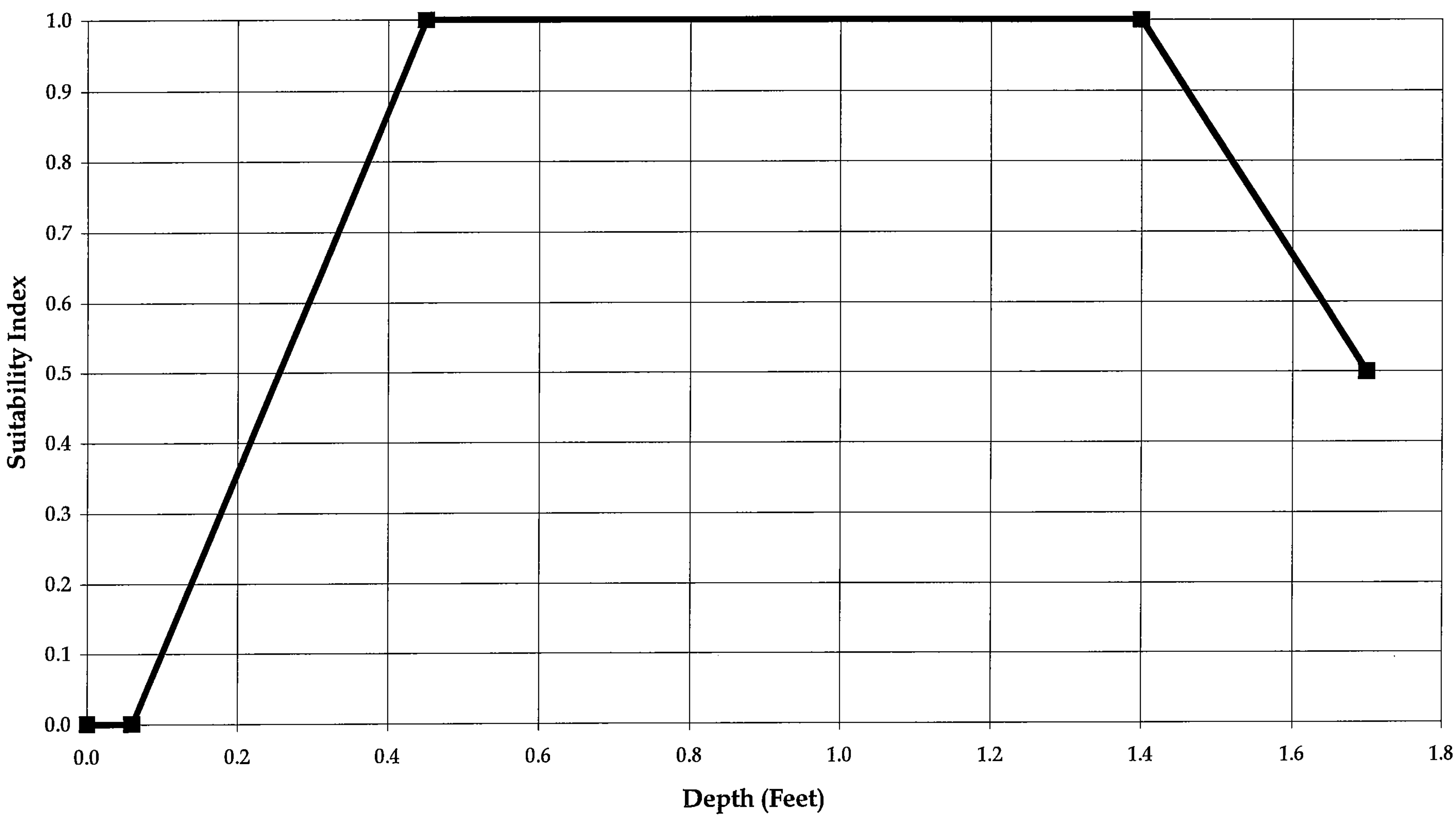


Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

FIGURE C-2: Velocity Suitability Index Curve for Mountain Whitefish Fry

WRIA 55 Planning Unit / IFN Assessment / WA

Golder Associates

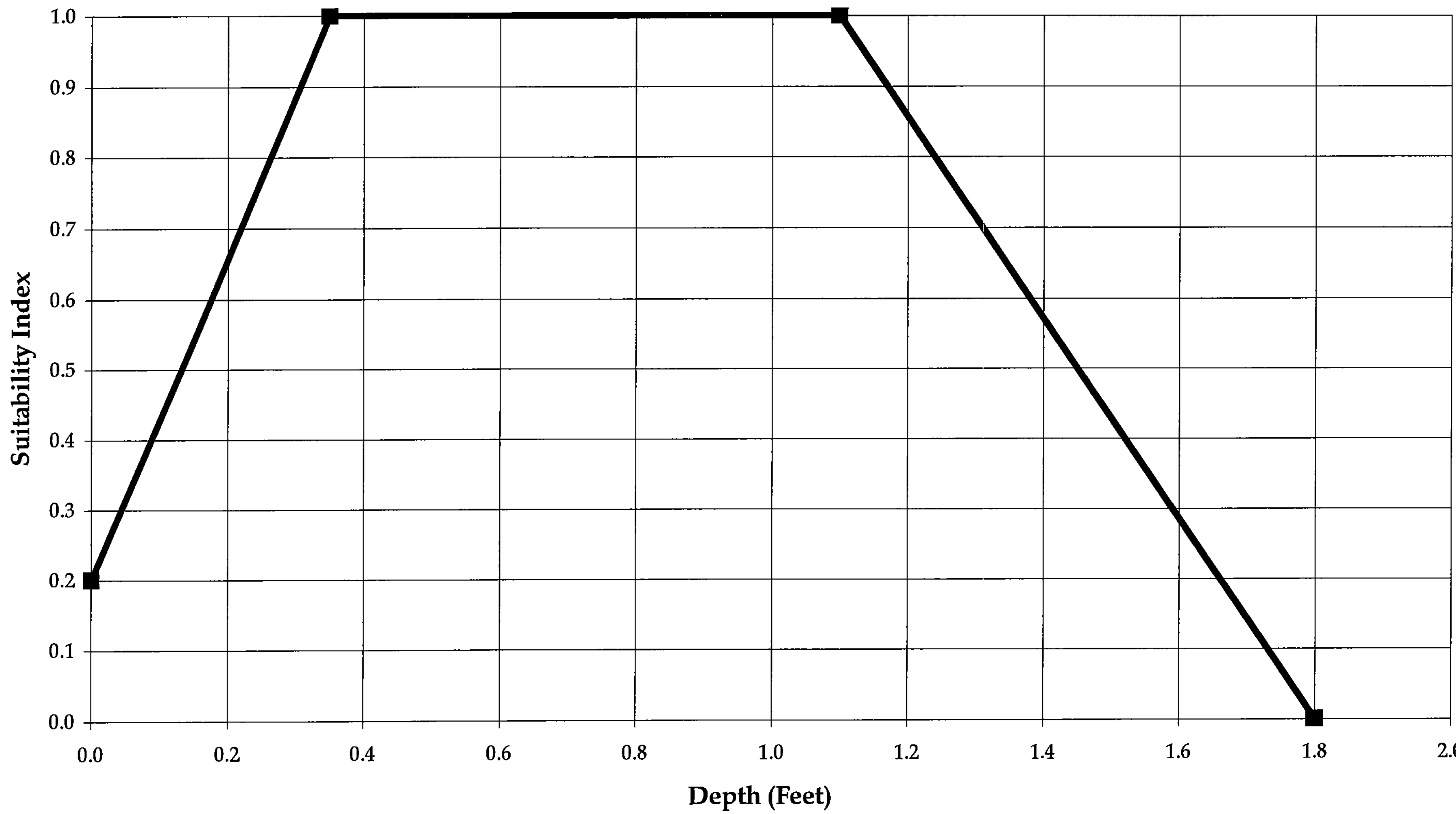


Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

FIGURE C-3: Depth Suitability Index Curve for Mountain Whitefish Juveniles

WRIA 55 / IFN Assessment / WA

Golder Associates



Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

FIGURE C-4: Velocity Suitability Index Curve for Mountain Whitefish Juveniles

WRIA 55 / IFN Assessment / WA

Golder Associates

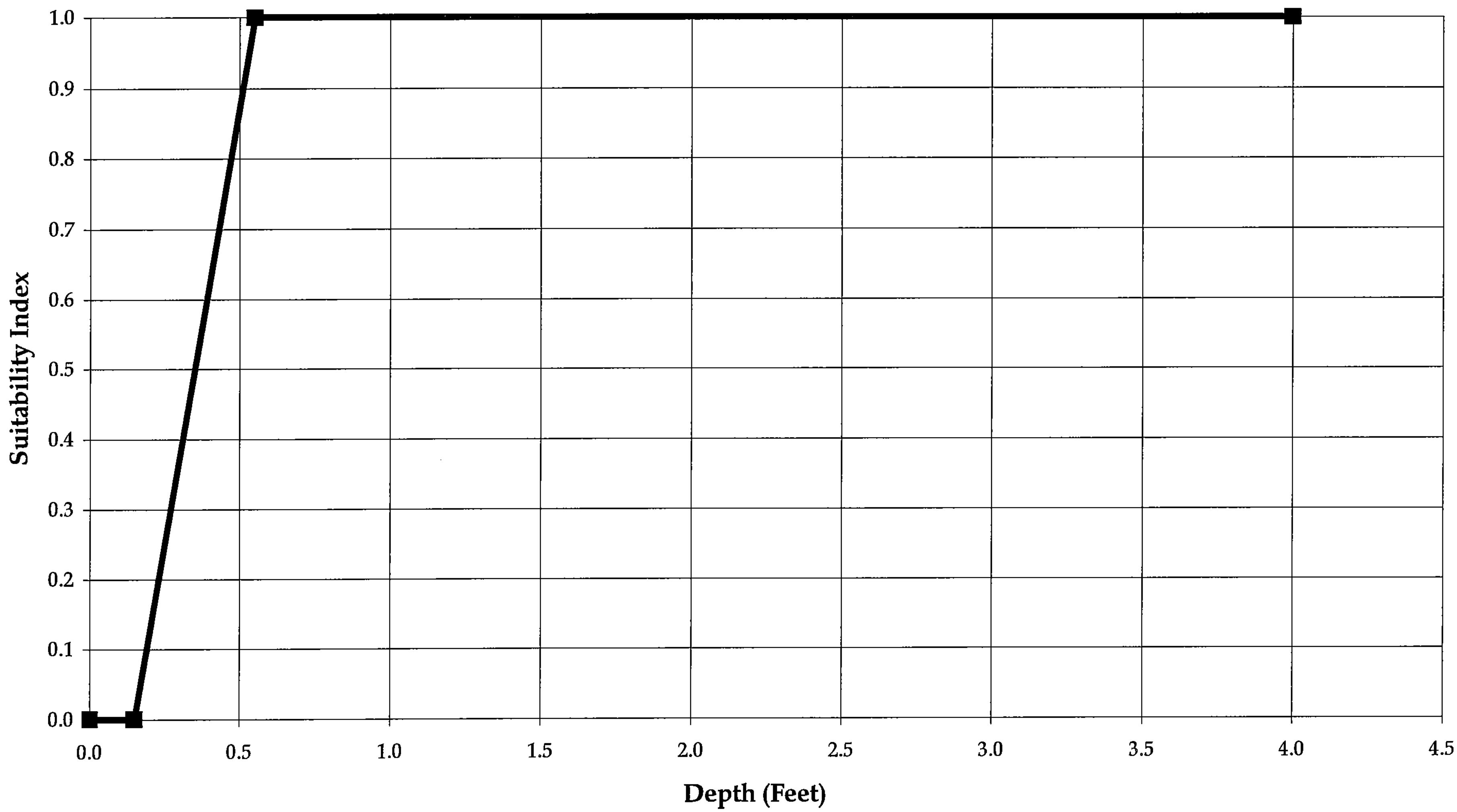
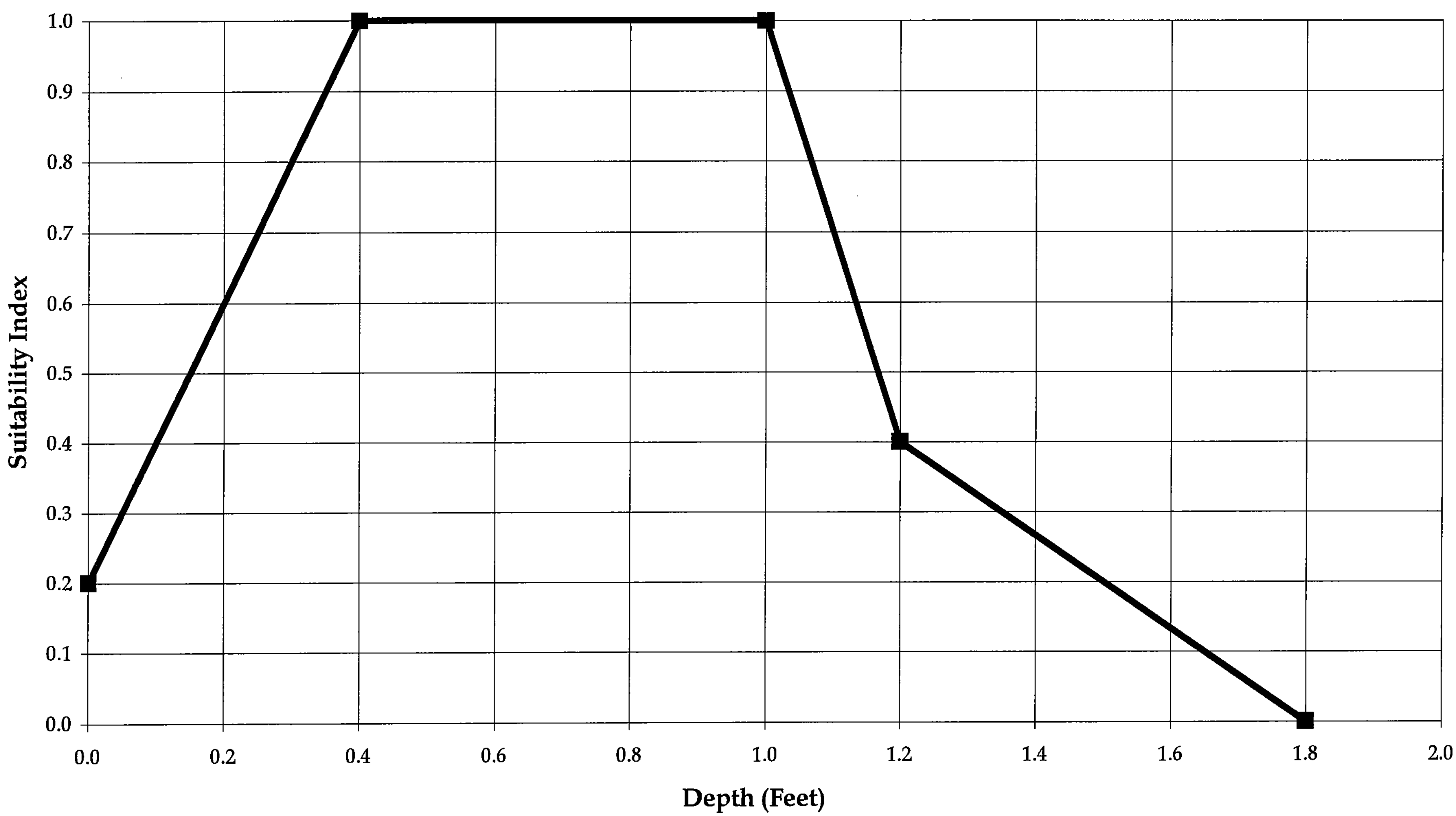


FIGURE C-5: Depth Suitability Index Curve for Mountain Whitefish Adults

WRIA 55 / IFN Assessment / WA

Golder Associates

Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

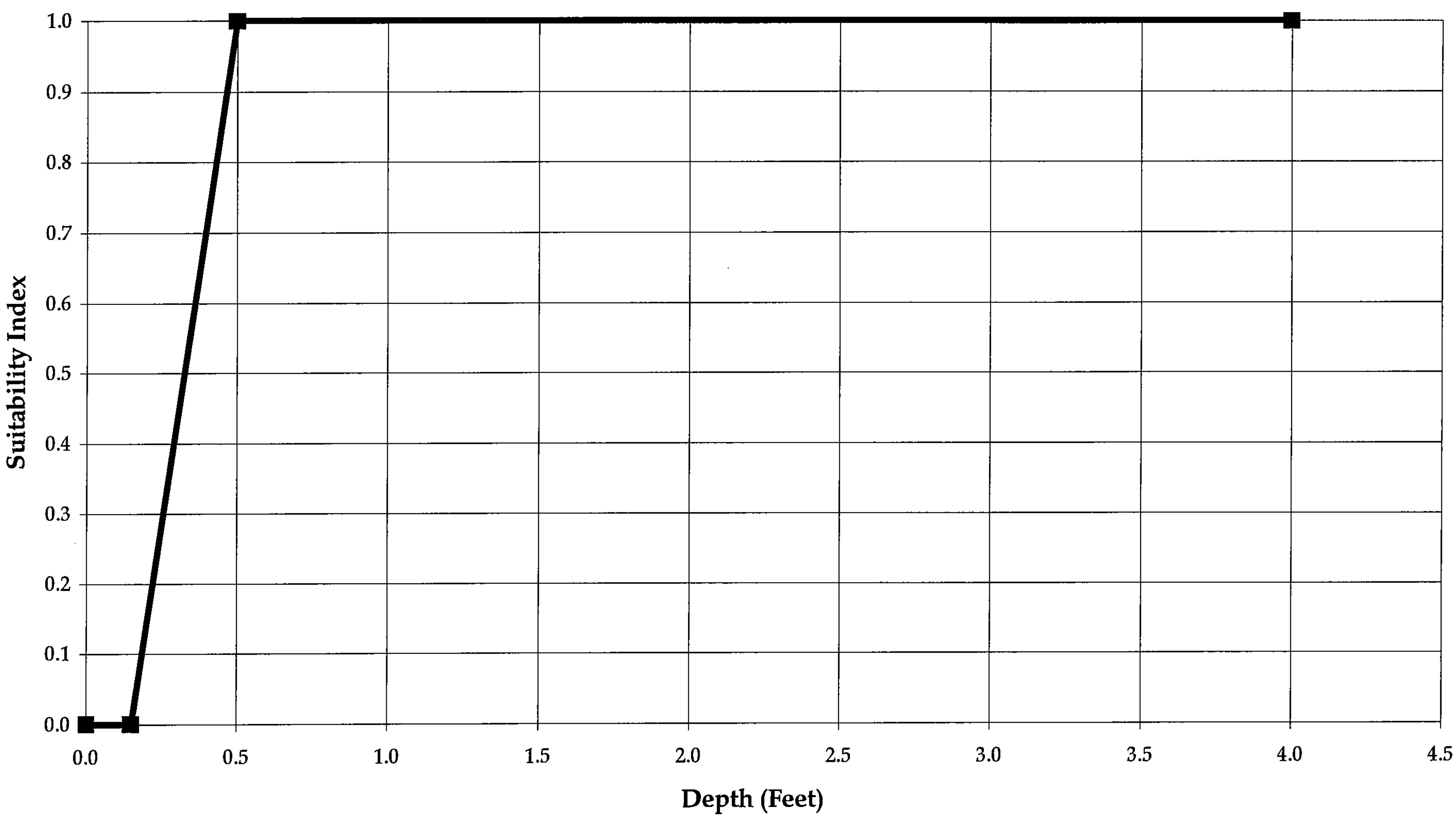


Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

FIGURE C-6: Velocity Suitability Index Curve for Mountain Whitefish Adults

WRIA 55 / IFN Assessment / WA

Golder Associates

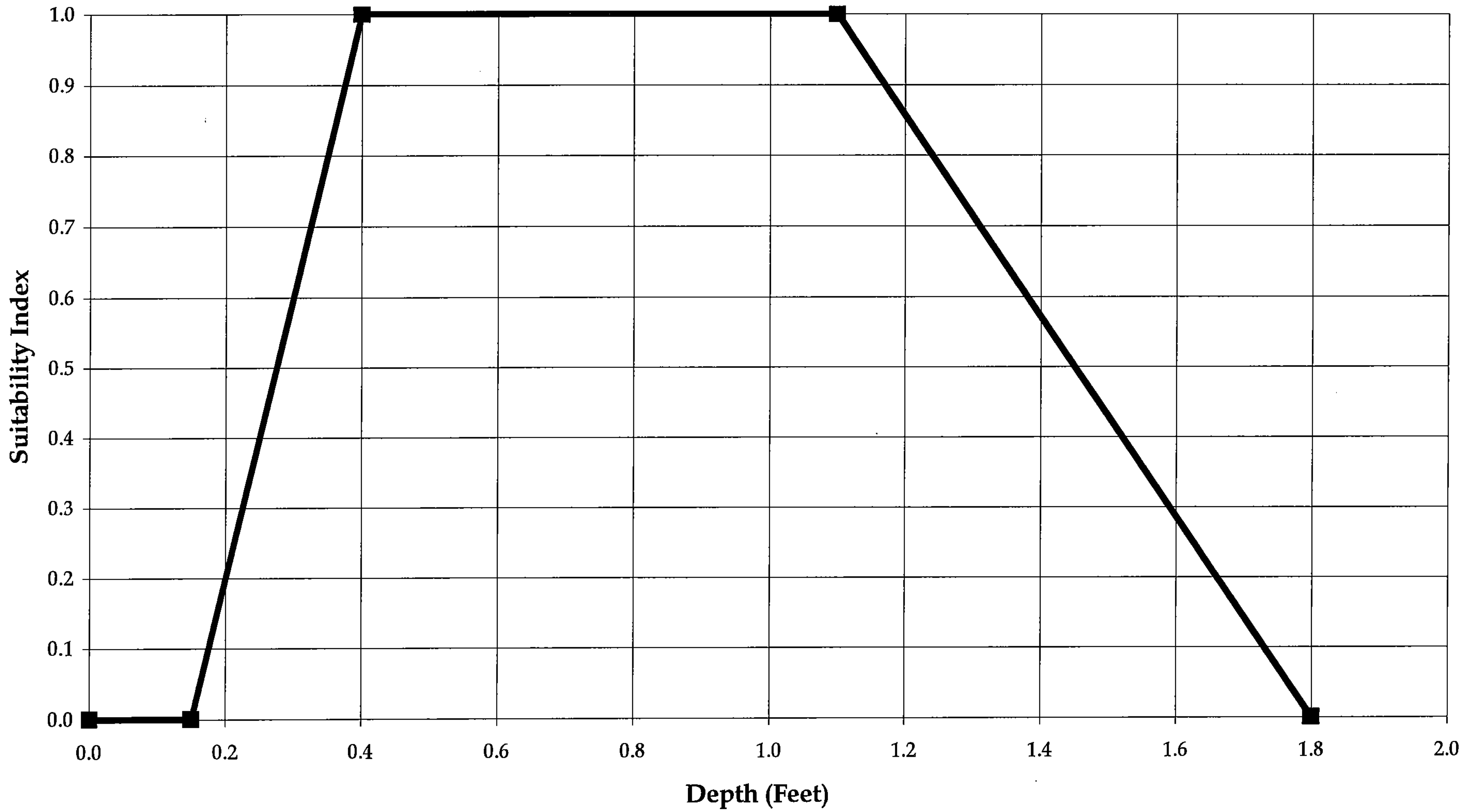


Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

FIGURE C-7: Depth Suitability Index Curve for Spawning Mountain Whitefish

WRIA 55 / IFN Assessment / WA

Golder Associates

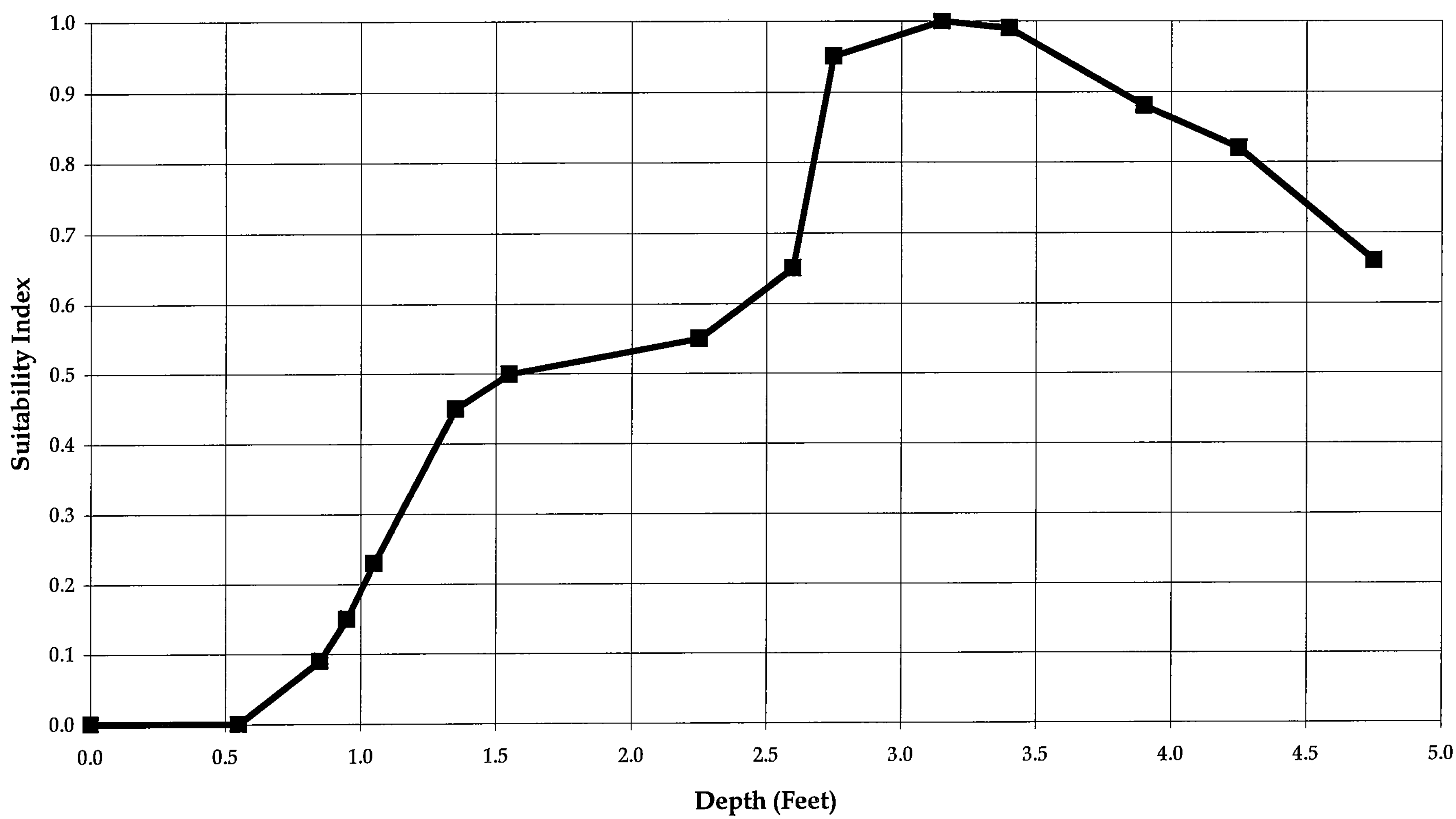


Data Source: July 12-13, 2001 Expert Workshop on Habitat Suitablity Criteria for Alberta Fish Species (Addley et al., 2001).

FIGURE C-8: Velocity Suitability Index Curve for Spawning Mountain Whitefish

WRIA 55 / IFN Assessment / WA

Golder Associates



Data Source: Instream Flow Study Guidelines (Washington Department of Fish and Wildlife and Washington State Department of Ecology, 1996).

FIGURE C-9: Depth Suitability Index Curve for Rearing Juvenile and Adult Rainbow Trout

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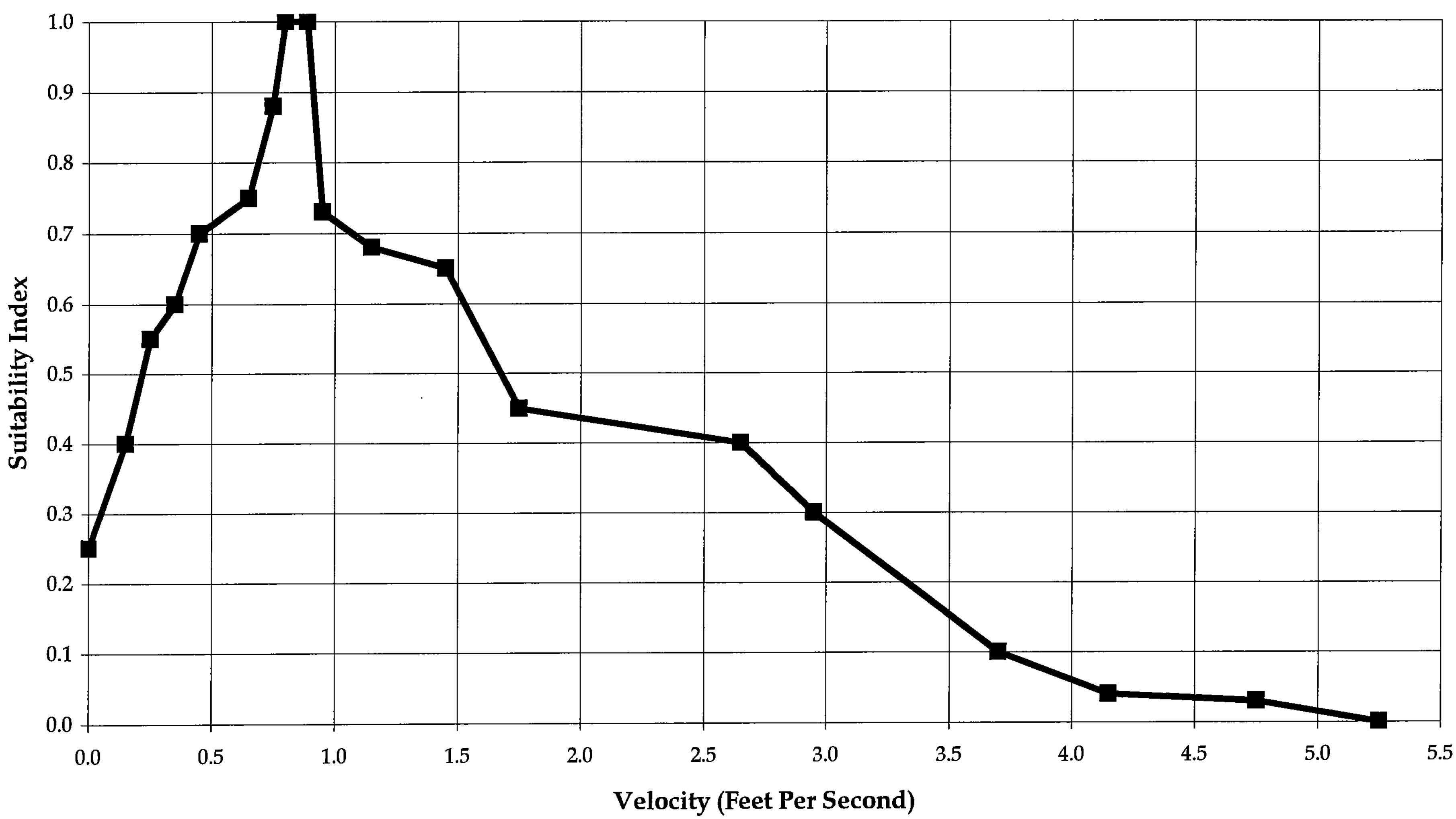

Data Source: Instream Flow Study Guidelines (Washington Department of Fish and Wildlife and Washington State Department of Ecology, 1996).

FIGURE C-10: Velocity Suitability Index Curve for Rearing Juvenile and Adult Rainbow Trout

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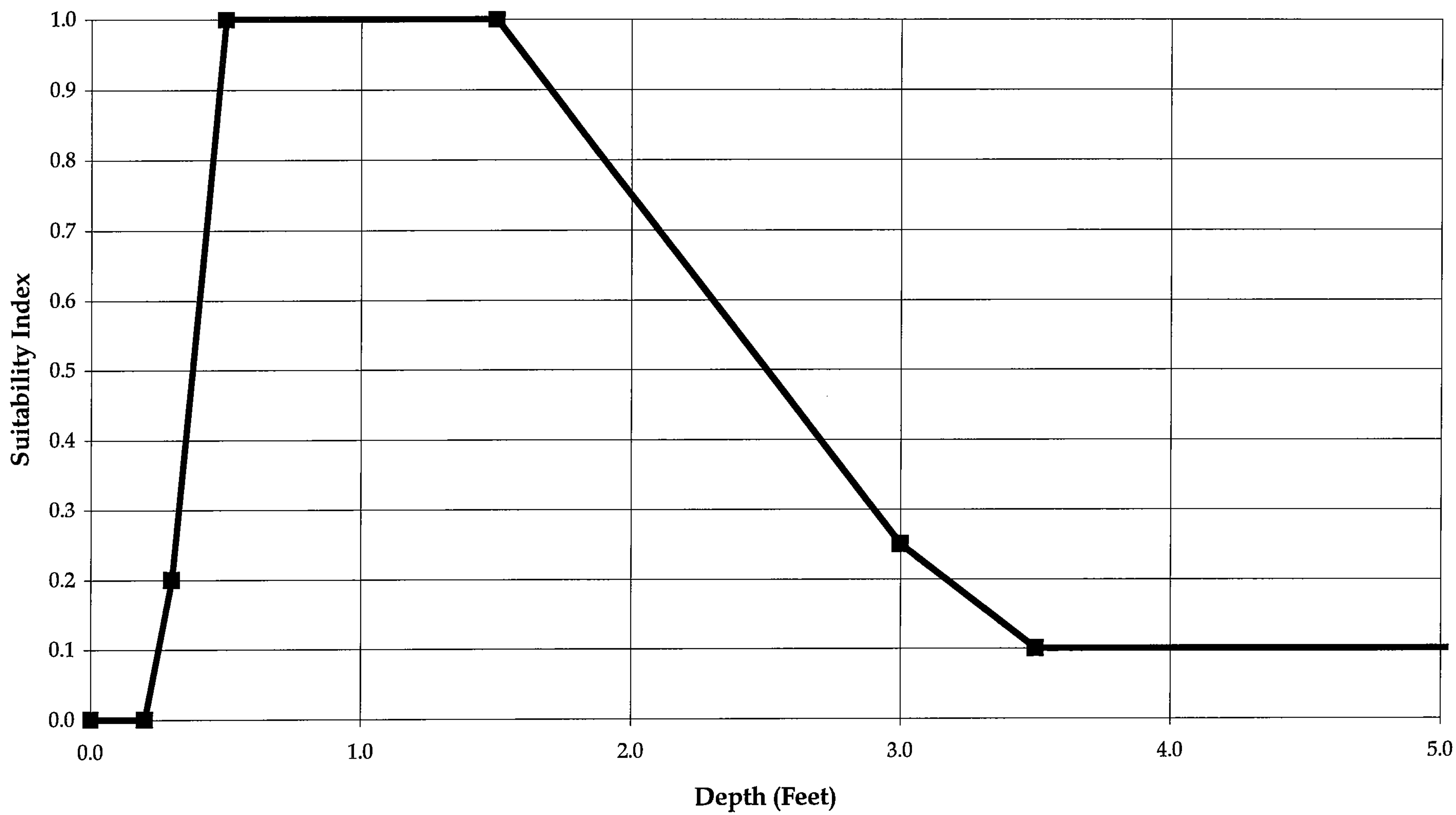
Golder Associates



Data Source: Instream Flow Study Guidelines (Washington Department of Fish and Wildlife and Washington State Department of Ecology, 1996).

FIGURE C-11: Depth Suitability Index Curve for Rearing Juvenile and Adult Rainbow Trout During Winter Months

WRIA 55 / IFN Assessment / WA

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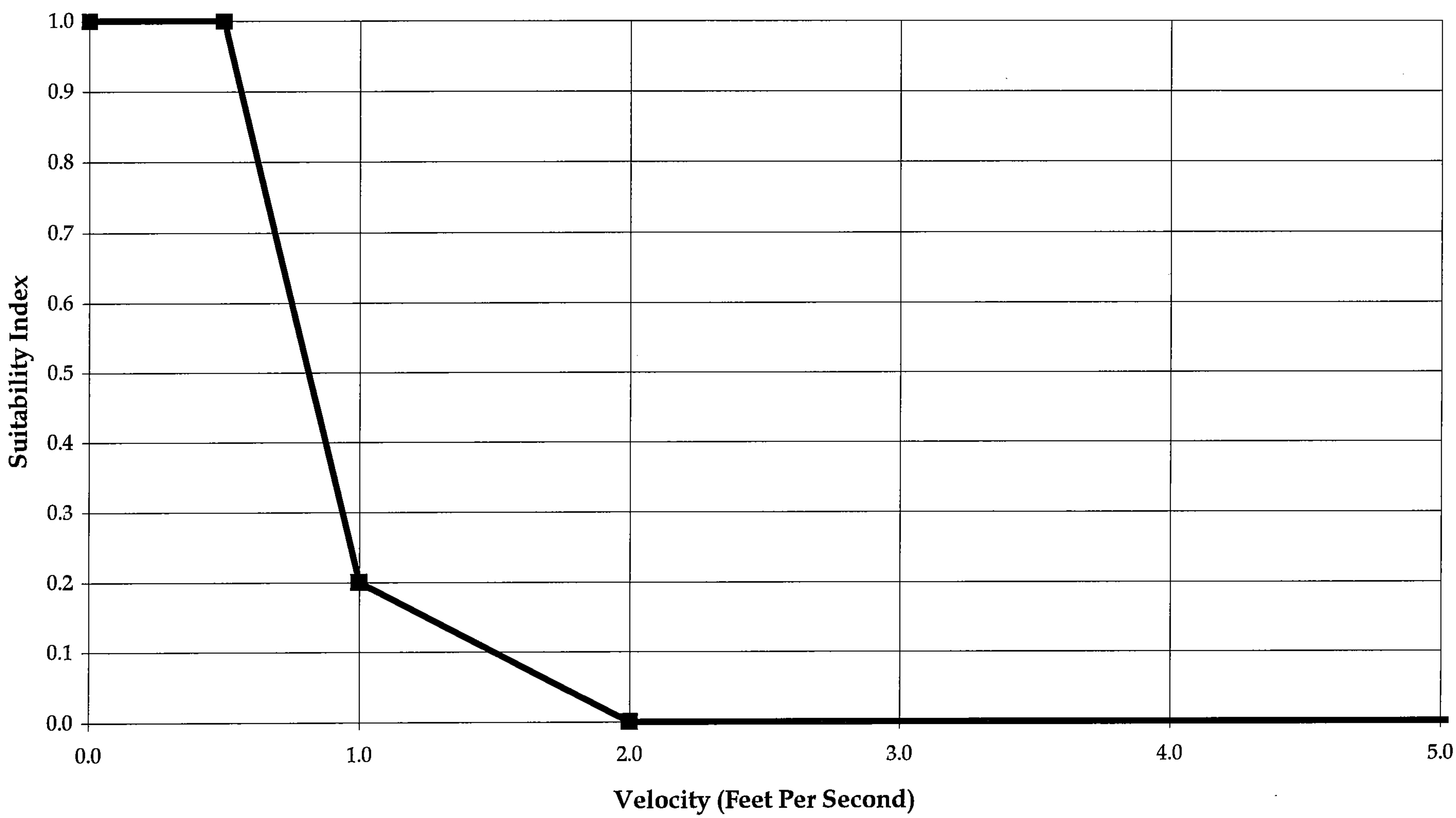
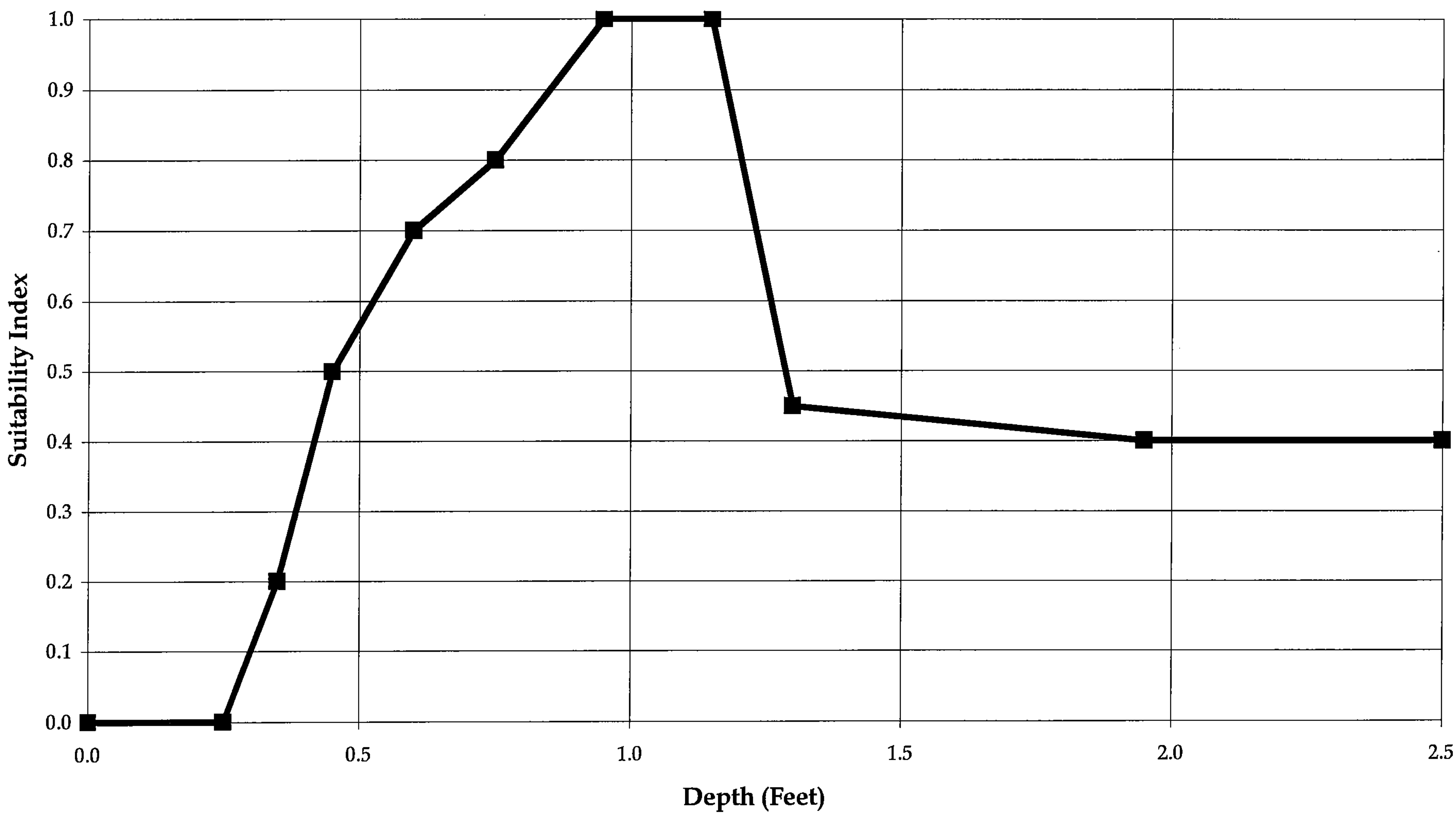


Data Source: Instream Flow Study Guidelines (Washington Department of Fish and Wildlife and Washington State Department of Ecology, 1996).

FIGURE C-12: Velocity Suitability Index Curve for Rearing Juvenile and Adult Rainbow Trout During Winter Months

WRIA 55/ IFN Assessment / WA

Golder Associates

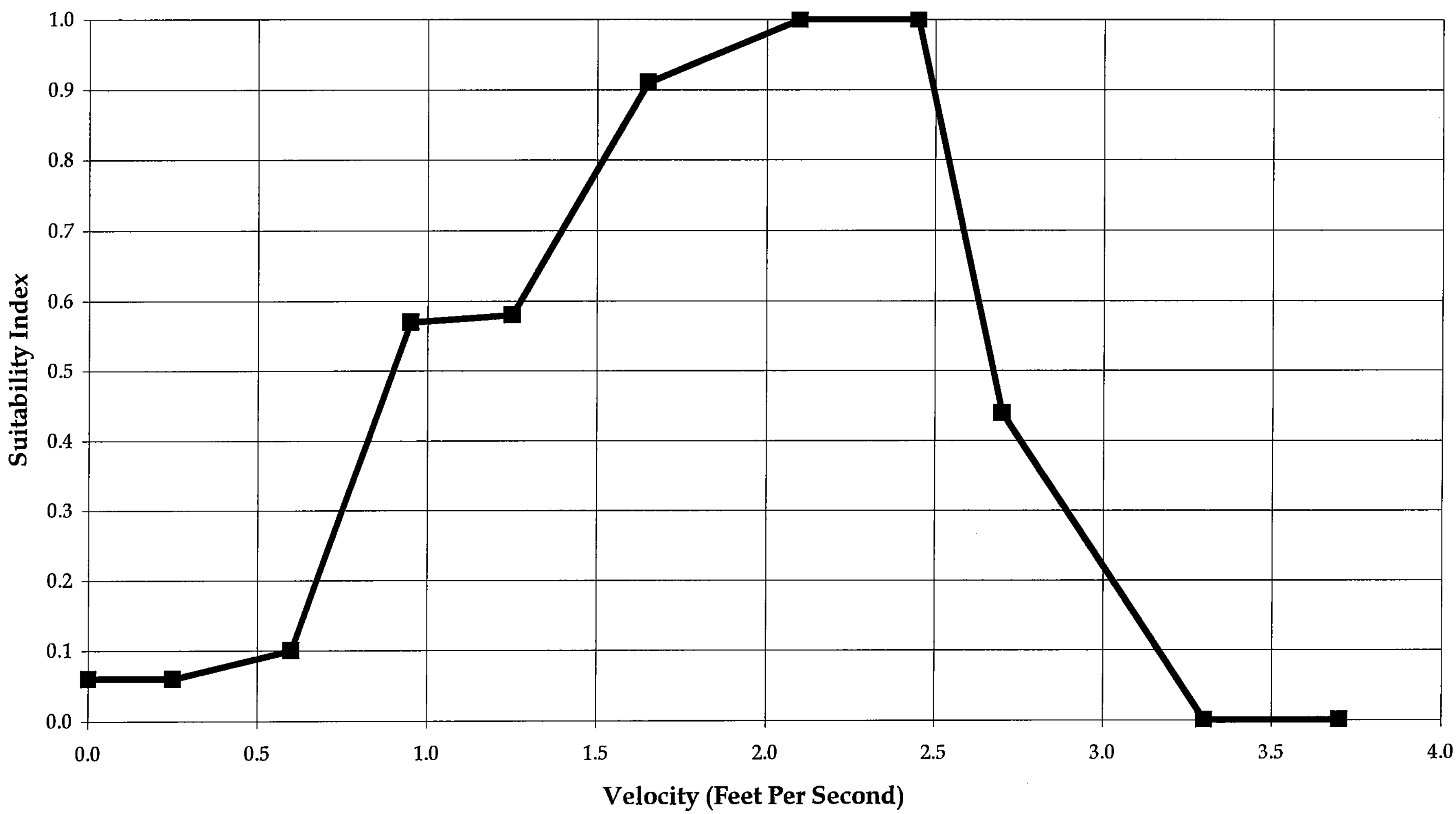


Data Source: Instream Flow Study Guidelines (Washington Department of Fish and Wildlife and Washington State Department of Ecology, 1996).

FIGURE C-13: Depth Suitability Index Curve for Spawning Rainbow Trout

WRIA 55 / IFN Assessment / WA

Golder Associates



Data Source: Instream Flow Study Guidelines (Washington Department of Fish and Wildlife and Washington State Department of Ecology, 1996).

FIGURE C-14: Velocity Suitability Index Curve for Spawning Rainbow Trout

WRIA 55 / IFN Assessment / WA

Golder Associates

APPENDIX D

FIELDWORK MEMORANDA

Memorandum 1: 9/24/02 & 9/25/02 Instream Flow Data Collection

Memorandum 2: 10/24/02, 10/25/02 & 10/31/02 Instream Flow Data Collection

Memorandum 3: 12/16/02 and 12/17/02 Instream Flow Data Collection

Memorandum 4: 1/8/2003 and 1/9/2003 Instream Flow Data Collection

Memorandum 5: 2/6/03 & 2/7/03 Instream Flow Data Collection

Memorandum 6: 3/26/03 and 3/27/03 Instream Flow Data Collection

MEMORANDUM

TO:	Instream Flow File	**DATE:**	May 2003
FR:	Donna DeFrancesco (Golder Associates)	**OUR REF:**	013-1372.2400
RE:	9/24/02 & 9/25/02 Instream Flow Data Collection		

1.0 SEPTEMBER 2002 DATA COLLECTION SUMMARY

Streamflow gaging sites were established at each of the three sites of the Little Spokane River and sites on Deadman, Dragoon and Otter Creeks as selected by the Planning Units. Streamflow data was collected at six sites on September 24th and 25th, 2002. Field collection was completed by Chris Bjornsen (Golder Associates Instream Flow Biologist), Donna DeFrancesco (Golder Associates Ecologist), Bryony Hansen (Golder Asociates Hydrogeoloist) Reanette Boese (Spokane County) and Blake Mee (Spokane Community College on September 24th and 25th

1.1 Sampling Regimen

Data collection included initial site establishment, stream discharge (including depth and velocity) using a Swoffer meter, as well as headpin elevation and water level elevation measured at the cross-section and at 20 feet above and below the cross-section on both sides of the stream, using a laser level. Monitoring sites were established in representative riffle with stable banks within the area of the sites selected by the Planing Unit. An effort was made to place the monitoring sites as close to the existing permenant stream gages as possible.

For Otter Creek, no representative rifle area ocured within the general site locale. A run area representative of most of the stream in this area was selected for site monitoring.

Velocity and hiding cover information was collected for fry, juvenile and adult fish life stages. Percent substrate composition of various substrate size clases was also recorded across the transect at all sites. Vegetation (both aquatic and terrestrial) was also assessed across each transect, as was a description of terrestrial vegetation at the high water mark. A description of transect information from the vegetation line was recorded. Vegetation species, type, condition, and cover was recorded for 10 feet upstream and downstream of each transect.

Initial site establishment included placement of headpins (2.5 ft rebar, ¾” diameter) at ends of the transect. These head pins were counter sunk at each transect end point and marked with pink survey flagging and a woden stake. Distance and compass direction from a benchmark was documented for each pin location. Each pin was documented for location with GPS tools.

Channel cros-sectional morphology was also measured for each transect during this field visit. Two end points were established at each cross-section location. Cross sections were oriented perpendicular to flow, from the left terrace across the river to the right terrace. Cross sections were surveyed using a laser level and graduated rod with laser detector. A tagline marked in one-foot increments was stretched across the channel between the two pins. The tagline was zeroed on the left downstream bank headpin. Horizontal and vertical coordinates were then obtained across the channel.

Major topographic breaks were surveyed and a minimum of 20 measurements across the channel were made. In addition, the following features were noted for each cross-section: left pin; left terrace; left edge of water; right edge of water; right terrace; and, right pin.

Flows were collected at the following times and with the following corresponding flows at the USGS Dartford gage.

1.2 Issues

Digital photos showing upstream and downstream views were taken at each of the six designated sampling locations.

MEMORANDUM

TO:	Instream Flow File	**DATE:**	February 10, 2003
FR:	Lisa Vaughn (Golder Associates)	**OUR REF:**	013-1372.2400
RE:	10/24/02, 10/25/02 & 10/31/02 Instream Flow Data Collection		

1.0 OCTOBER 2002 DATA COLLECTION SUMMARY

Streamflow data was collected at six sites on the Little Spokane River on October 24th, 25th and 31, 2002. Field collection was completed by Lisa Vaughn (Golder Associates Biologist) and Reanette Boese (Spokane County) on October 24th and 25th. Due to insufficient channel elevation data at Dragoon Creek and Otter Creek, a second field visit was required to obtain this data. Bryony Hansen (Golder Hydrogeologist) and Reanette Boese made the second field visit to these two stations on October 31st, 2002.

1.1 Streamflow Variation

Weather patterns preceding and during this sampling period were stable and created little streamflow variability on the Little Spokane River and tributaries during the sampling period. There was no precipitation and air temperatures remained fairly constant throughout the original sampling period from October 24 through October 25. Air temperatures for this sampling period averaged 35°F and 33°F, respectively for October 24 and 25. There was no precipitation during the second sampling period, October 31, 2002, and the average air temperature for this day, 21°F, was quite a bit lower than the averages for the initial sampling period. A very small amount of precipitation (0.01 inches) fell three days prior to this second sampling period, on October 28, 2002. There was likely little to no significant streamflow variation between the two gaging periods.

1.2 Sampling Regimen

Data collection included stream discharge (including depth and velocity) using a Swoffer meter, as well as headpin elevation and water level elevation measured at the cross-section and at 20 feet above and below the cross-section on both sides of the stream, using a laser level. Instream flow sites were sampled in the following order. Please note that two measurements were taken at both Dragoon Creek and Otter Creek due to insufficient channel elevation data. The October 31st data was collected to replace the October 24th data and will be used in the analysis.

1. Little Spokane River @ Chattaroy – October 24th, 13:30

2. Dragoon Creek – October 24th, 15:00 and October 31st, 15:00

3. Little Spokane River @ Elk – October 25th, 10:30

4. Otter Creek – October 24th, 12:00 and October 31st, 13:00

5. Deadman Creek – October 25th, 12:20

6. Little Spokane River @ Pine River Park – October 25th, 13:20

1.3 Observations

Flows at Dartford were quite stable during the initial field visit on October 24 and 25 and ranged from 130-132 cfs on these days. Due to the time elapsed between field visits, there is some inconsistency in flow between the initial field visit and the October 31st field visit. Flows at Dartford on October 31st were a bit more variable and ranged from 123-130 cfs between 13:00 and 16:00.

Date	Temperature Max. (°F)	Temperature Min. (°F)	Temperature Average (°F)	Precipitation Inches
October 22, 2002	55	38	47	0.00
October 23, 2002	54	22	38	0.00
October 24, 2002	53	17	35	0.00
October 25, 2002	52	14	33	0.00
October 29, 2002	35	22	29	0.00
October 30, 2002	34	7	21	0.00
October 31, 2002	38	3	21	0.00

Climate Data Source: NOAA Past Monthly Climate Data website: http://www.wrh.noaa.gov/Spokane/cli.htm

Site	Measured discharge (cfs)	Corresponding discharge on LSR @ Dartford (cfs)	Comments
LSR @ Chattaroy	75.9	132	October 24th @ 13:30
Dragoon Creek	27.8	126-130	October 31st @ 15:00
LSR @ Elk	40.0	130	October 25th @ 10:30
Otter Creek	3.0	123	October 31st @ 13:00
Deadman Creek	8.2	130-132	October 25th @ 12:20
LSR @ Pine River Park	119.5	130	October 25th @ 13:20

1.4 Issues

Due to inadequate channel elevation data, flow data for all six sites were not collected within a concise period of time. Because of this, flows at Dartford are somewhat variable between the sites. The range on October 24 and 25 was 130-132 cfs and the range on October 31 was 123-130 cfs.

Use of a tape measure is likely to introduce some level of inaccuracy due to difficulties in keeping the tape taut throughout the gaging period. Windy conditions present further complications and for this reason, a Kevlar tagline is recommended because it provides improved accuracy.

Digital photos showing upstream and downstream views were taken at each of the six designated sampling locations.

MEMORANDUM

TO:	Instream Flow File	**DATE:**	February 10, 2003
FR:	Lisa Vaughn (Golder Associates)	**OUR REF:**	013-1372.2400
RE:	12/16/02 and 12/17/02 Instream Flow Data Collection		

1.0 DECEMBER 2002 DATA COLLECTION SUMMARY

Streamflow data was collected at six sites on the Little Spokane River on December 16 and 17, 2002. Field collection was completed by Donna DeFrancesco (Golder Associates Ecologist) and Reanette Boese (Spokane County) on December 16th and by Donna DeFrancesco, Reanette Boese and Blake Mee (Spokane County Community College) on December 17th.

1.1 Streamflow Variation

Weather patterns preceding and during this sampling period created a highly variable flow pattern on the Little Spokane River. Air temperature for the days of sampling averaged 39°F and 33°F, respectively for December 16th and 17th. The two days prior to this were much warmer with average temperatures of 50°F and 46°F, for December 14th and 15th respectively. Precipitation occurred on all four days, but a larger amount occurred on December 14th (0.65 in) and December 16th (0.59 in). On December 16th, most of this precipitation occurred in the morning prior to sampling with slight precipitation occurring through early afternoon. Climate data is summarized below.

The two days of precipitation resulted in a rapid increase in streamflow. On December 16th, the first day of sampling, flow at USGS gage on Little Spokane River at Dartford was 300 cfs throughout the day. During the overnight period stream flow increased by 100 cfs. By the morning of December 17th (second day of sampling) the streamflow at Dartford was 400 cfs.

This increase in streamflow reflects the increase in precipitation for the period of December 14th and December 16th. For each approximately 0.5 cfs of precipitation there was an approximate 100 cfs increase in streamflow occurring over the 12 –24 hour period following the precipitation event.

1.2 Sampling Regimen

Data collection included stream discharge (including depth and velocity) using a Swoffer meter, as well as headpin elevation and water level elevation measured at the cross-section and at 20 feet above and below the cross-section on both sides of the stream, using a laser level. Instream flow sites were sampled in the following order.

1. Little Spokane River @ Chattaroy –December 16th 11:30

2. Dragoon Creek--December 16th 13:15

3. Little Spokane River @ Elk – December 16th 14:45

4. Otter Creek – December 16th 16:15

5. Little Spokane River @ Pine River Park – December 17th 9:30

6. Deadman Creek – December 17th 11:15

1.3 Observations

An increase in flow occurred between December 16th and 17th. LSR @ Chatteroy and Dragoon Creek, the first sites sampled, were sampled when the Little Spokane River @Dartford was at 300 cfs. LSR @ Pine River Park and Deadman Creek, the last sites sampled, were sampled when the Little Spokane River @ Dartford was at 400 cfs. The middle sites sampled, Otter Creek and LSR @ Elk were sampled late on December 16th, and I believe that these areas, which are far upstream of Dartford, were reflecting an increase in cfs that would appear later in the evening at Dartford and is not portrayed in the 318 cfs that was recorded at Dartford.

In addition, water level was near bankfull at several of the sites during this period of measurement. LSR @Pine River Park and Deadman Creek were within 1.5 ft of overflowing the banks when the Little Spokane River at Dartford was measuring 400 cfs; LSR@ Chattaroy and Otter Creek were within 1.0 to 1.5 feet of overflowing the banks when the Little Spokane River at Dartford measured 300-320 cfs.

Date	Temperature Max. (°F)	Temperature Min. (°F)	Temperature Average (°F)	Precipitation Inches
December 14, 2002	55	44	50	0.65
December 15, 2002	52	39	46	0.15
December 16, 2002	46	32	39	0.59
December 17, 2002	37	29	33	0.02

Climate Data Source: NOAA Past Monthly Climate Data website: http://www.wrh.noaa.gov/Spokane/cli.htm

Site	Measured discharge (cfs)	Corresponding discharge on LSR @ Dartford (cfs)	Comments
LSR @ Elk	48.9	318	At 12/16/2002 @ 14:45
LSR @ Chattaroy	152.4	305	At 12/16/2002 @ 11:30
LSR @ Pine River Park	340.5	400	At 12/17/2002 @ 9:30
Otter Creek	7	318	At 12/16/2002 @ 16:15
Dragoon Creek	73.5	305	At 12/16/2002 @ 13:15
Deadman Creek	34.5	400	At 12/17/2002 @ 11:15

1.4 Issues

The changing variability in stream flow resulting from storm events should be avoided during future sampling events. This can be addressed by avoiding sampling during periods where large weather events appear imminent.

As in previous field visits, use of a tape measure is likely to introduce some level of inaccuracy due to difficulties in keeping the tape taut throughout the gaging period. Windy conditions present further complications and for this reason, a Kevlar tagline is recommended because it provides improved accuracy.

Photographs were taken during site visits and should continue to be taken throughout the sampling periods at various flows from the same locale.

Unfortunately, photos existed on the digital camera at the time of the survey and prior to leaving the hotel during the survey period. However, after coming off the plane and downloading photos in Redmond, the camera was empty and showed no recorded pictures, including a great blue heron one taken by Reanette. In this instance the digital camera was included in checked baggage and perhaps was erased as a result of airport baggage scanning. In the future it would be best to download the camera prior to boarding the aircraft if possible or take the camera as carry on luggage.

MEMORANDUM

TO: Instream Flow File | **DATE:** February 10, 2003

FR: Lisa Vaughn (Golder Associates) | **OUR REF:** 013-1372.2400

RE: 1/8/2003 and 1/9/2003 Instream Flow Data Collection

1.0 JANUARY 2003 DATA COLLECTION SUMMARY

Streamflow data was collected at six sites on the Little Spokane River on January 8 and 9, 2003. Field collection was completed by Lisa Vaughn (Golder Associates Biologist) and Reanette Boese (Spokane County) on both of these days.

1.1 Streamflow Variation

Weather patterns preceding and during this sampling period were stable and created little streamflow variability on the Little Spokane River and tributaries during the sampling period. There was no precipitation and air temperatures remained fairly constant throughout the sampling period, averaging 26°F and 31°F on January 8th and 9th, respectively. The most recent precipitation event occurred on January 4, 2003, when 0.28 inches of rain fell.

1.2 Sampling Regimen

Data collection included stream discharge (including depth and velocity) using a Swoffer meter, as well as headpin elevation and water level elevation measured at the cross-section and at 20 feet above and below the cross-section on both sides of the stream, using a laser level. Instream flow sites were sampled in the following order.

1. Dragoon Creek – January 8th, 13:25
2. Little Spokane River @ Elk – January 8th, 15:10
3. Otter Creek – January 8th, 16:20
4. Little Spokane River @ Chattaroy – January 9th, 10:00
5. Little Spokane River @ Pine River Park – January 9th, 11:30
6. Deadman Creek – October 25th, 12:45

1.3 Observations

Flows at Dartford on January 8, 2003 ranged from 322-329 cfs and declined slightly throughout the day. Flows on January 9, 2003 remained constant at 308 cfs throughout the field data collection.

Date	Temperature Max. (°F)	Temperature Min. (°F)	Temperature Average (°F)	Precipitation Inches
January 6, 2003	40	26	33	0.00
January 7, 2003	37	23	30	0.00
January 8, 2003	28	24	26	0.00
January 9, 2003	38	23	31	0.00

Climate Data Source: NOAA Past Monthly Climate Data website: http://www.wrh.noaa.gov/Spokane/cli.htm

Site	Measured discharge (cfs)	Corresponding discharge on LSR @ Dartford (cfs)	Comments
LSR @ Chattaroy	188.9	308	January 9 @ 10:00
Dragoon Creek	54.6	329	January 8 @ 13:25
LSR @ Elk	51.5	325-322	January 8 @ 15:10
Otter Creek	3.7	322-325	January 8 @ 16:20
Deadman Creek	24.4	308	January 9 @ 12:45
LSR @ Pine River Park	300.9	308	January 9 @ 11:30

1.4 Issues

There were no issues during this sampling round. Upstream and downstream photographs were taken at all six sites.

As in previous visits, use of a tape measure is likely to introduce some level of inaccuracy due to difficulties in keeping the tape taut throughout the gaging period. Windy conditions present further complications and for this reason, a Kevlar tagline is recommended because it provides improved accuracy.

MEMORANDUM

TO: Chris Pitre (Golder Associates) **DATE:** February 10, 2003

FR: Lisa Vaughn (Golder Associates) **OUR REF:** 013-1372.2400

RE: 2/6/03 & 2/7/03 Instream Flow Data Collection

1.0 FEBRUARY 2003 DATA COLLECTION SUMMARY

Streamflow data was collected at six sites on the Little Spokane River on February 6and 7, 2003. Field collection was completed by LisaVaughn (Golder Associates Biologist), Dave Hrutfiord (Golder Associates Geophysicist) and Reanette Boese (Spokane County) on both of these days. High flow sampling was required for two of the six sites and is discussed below in greater detail.

1.1 Streamflow Variation

Weather patterns preceeding and during this sampling period were stable and created little streamflow variability on the Little Spokane River and tributaries during the sampling period. There was no precipitation and air temperatures remained fairly constant throughout the sampling period. Air temperature for the days of sampling averaged 32°F and 30°F, February 6th and 7th for respectively. The two days prior had similar average temperatures of 34°F and 31°F, for February 4th and 5th respectively. The most recent rainfall event occurred on February 3, 2003, when approximately 0.12 inches of rain and 0.3 inches of snow fell.

1.2 Sampling Regimen

Data collection included stream discharge (including depth and velocity) using a Swoffer meter, as well as headpin elevation and water level elevation measured at the cross-section and at 20 feet above and below the cross-section on both sides of the stream, using a laser level. Streamflows at two sites, the Little Spokane River at Chattaroy and the Little Spokane River at Pine River Park were measured using a high flow sampling technique. This technique required the use of a zodiac boat, an outboard motor and a tagline to obtain depth and velocity measurements across the study transects. This methodology is described Section 1.3 of this memo. Instream flow sites were sampled in the following order.

1. Little Spokane River @ Chattaroy – February 6th, 10:00

2. Dragoon Creek – February 6th, 12:00

3. Little Spokane River @ Pine River Park – February 6th, 14:00

4. Little Spokane River @ Elk – February 7th, 9:45
5. Otter Creek – February 7th, 10:50
6. Deadman Creek – February 7th, 16:30

1.3 High Flow Sampling

The following sections provides a description of equipment and the procedure used to measure flows in high flow stream environments. This technique was required to measure flows on the Little Spokane River at Chattaroy and the Little Spokane River at Pine River Park.

1.3.1 Equipment

- Life Vests/Safety Ropes
- Inflatable boat (3 meter long Zodiac)
- Outboard Motor (use size appropriate for river)
- Poly Rope (3/4”)
- Anchor posts (1/2” diameter x 4’ long rebar)
- Slide Hammer and/or Sledge Hammer
- Caribiners (4”)
- Swoffer flow meter and wading rod

1.3.2 High Flow Sampling Procedure

1. All staff review and sign Health and Safety Plan
2. Pound anchor posts into banks on transect, one upslope of each of the transect headpins.
3. Tie ¾-inch rope to anchor post on the ‘zero’ bank with the zero mark over the top of the headpin.
4. Wade or use motorboat to stretch rope to opposite bank. Secure rope to opposite anchor pin.

5. Tighten rope using simple rope knot techniques.

6. Stretch the marked tagline or tape measure between headpins and secure.

7. Attach the boat to the rope using a carabiner to allow the boat to slide along the rope. Move the boat across the transect along the rope to take measurements at each of the stations.

8. One person remains on shore at all times with safety rope; this person retains health and safety plan and cell phone at all times.

9. Measure water depth and velocity using the flow meter and the wading rod according to the standard flow measurement technique.

In small watercourses the measurements will be made over the side of the boat using the wading rod if the maximum depth is less than 4.25 feet. Based on previous measurements, depths greater than 4.25 feet are not anticipated.

10. Gather all equipment after measurement and ensure its proper storage

11. Review field books between sites to ensure no missing or incorrect data before leaving site.

Date	Temperature Max. (°F)	Temperature Min. (°F)	Temperature Average (°F)	Precipitation Inches
February 4, 2003	42	25	34	0.00
February 5, 2003	40	21	31	0.00
February 6, 2003	42	21	32	0.00
February 7, 2003	37	22	30	0.00

Climate Data Source: NOAA Past Monthly Climate Data website: http://www.wrh.noaa.gov/Spokane/cli.htm

Site	Measured discharge (cfs)	Corresponding discharge on LSR @ Dartford (cfs)	Comments
LSR @ Chattaroy	312.0	525	February 6 @ 10:00
Dragoon Creek	123.2	525	February 6 @ 12:00
LSR @ Elk	58.0	496	February 7 @ 9:45
Otter Creek	5.3	496	February 7 @ 10:50
Deadman Creek	49.8	520	February 6 @ 16:30
LSR @ Pine River Park	549.4	525-520	February 6 @ 14:00

1.4 Observations

Flows at Dartford on February 6, 2003 ranged from 520-525 cfs and declined slightly throughout the day. Flows on February 7, 2003 remained constant at 496 cfs throughout the field data collection.

1.5 Issues

As in previous field visits, use of a tape measure is likely to introduce some level of inaccuracy due to difficulties in keeping the tape taut throughout the gaging period. Windy conditions present further complications and for this reason, a Kevlar tagline is recommended because it provides improved accuracy.

The high flow sampling technique described above was used to measure flows on both the Little Spokane River at Chattaroy and at Pine River Park. The aluminum Swoffer rod used for gaging on the Little Spokane River and tributaries was not heavy duty enough for the flow velocities in some locations on the Little Spokane River at Pine River Park and vibrated during some measurements. Swoffer makes steel rods that would be more stable in high flows. At high flows, a larger prop may be appropriate. Swoffer should be consulted on this.

The aluminum Swoffer rod is not marked for 8/10's measurements for depths over about 3'. A ruled piece of paper was used to set the prop to the correct depth for 8/10's measurements. This worked well, but does introduce some error. The steel Swoffer rod is graduated to allow for 8/10's measurements in deep water.

No digital photos were taken during this round of stream gaging. Once flows at Dartford reach 500 cfs again, photos will be taken to provide views of channel conditions at each of the six sites for comparison with other flow levels. Digital photos should be taken during each field visit from the same location to provide a visual comparison of channel conditions at various flow levels.

4. Little Spokane River @ Elk – February 7th, 9:45

5. Otter Creek – February 7th, 10:50

6. Deadman Creek – February 7th, 16:30

1.3 High Flow Sampling

The following sections provides a description of equipment and the procedure used to measure flows in high flow stream environments. This technique was required to measure flows on the Little Spokane River at Chattaroy and the Little Spokane River at Pine River Park.

1.3.1 Equipment

- Life Vests/Safety Ropes
- Inflatable boat (3 meter long Zodiac)
- Outboard Motor (use size appropriate for river)
- Poly Rope (3/4”)
- Anchor posts (1/2” diameter x 4’ long rebar)
- Slide Hammer and/or Sledge Hammer
- Caribiners (4”)
- Swoffer flow meter and wading rod

1.3.2 High Flow Sampling Procedure

1. All staff review and sign Health and Safety Plan
2. Pound anchor posts into banks on transect, one upslope of each of the transect headpins.
3. Tie ¾-inch rope to anchor post on the ‘zero’ bank with the zero mark over the top of the headpin.
4. Wade or use motorboat to stretch rope to opposite bank. Secure rope to opposite anchor pin.

5. Tighten rope using simple rope knot techniques.

6. Stretch the marked tagline or tape measure between headpins and secure.

7. Attach the boat to the rope using a carabiner to allow the boat to slide along the rope. Move the boat across the transect along the rope to take measurements at each of the stations.

8. One person remains on shore at all times with safety rope; this person retains health and safety plan and cell phone at all times.

9. Measure water depth and velocity using the flow meter and the wading rod according to the standard flow measurement technique.

In small watercourses the measurements will be made over the side of the boat using the wading rod if the maximum depth is less than 4.25 feet. Based on previous measurements, depths greater than 4.25 feet are not anticipated.

10. Gather all equipment after measurement and ensure its proper storage

11. Review field books between sites to ensure no missing or incorrect data before leaving site.

Date	**Temperature Max. (°F)**	**Temperature Min. (°F)**	**Temperature Average (°F)**	**Precipitation Inches**
February 4, 2003	42	25	34	0.00
February 5, 2003	40	21	31	0.00
February 6, 2003	42	21	32	0.00
February 7, 2003	37	22	30	0.00

Climate Data Source: NOAA Past Monthly Climate Data website: http://www.wrh.noaa.gov/Spokane/cli.htm

Site	**Measured discharge (cfs)**	**Corresponding discharge on LSR @ Dartford (cfs)**	**Comments**
LSR @ Chattaroy	312.0	525	February 6 @ 10:00
Dragoon Creek	123.2	525	February 6 @ 12:00
LSR @ Elk	58.0	496	February 7 @ 9:45
Otter Creek	5.3	496	February 7 @ 10:50
Deadman Creek	49.8	520	February 6 @ 16:30
LSR @ Pine River Park	549.4	525-520	February 6 @ 14:00

1.4 Observations

Flows at Dartford on February 6, 2003 ranged from 520-525 cfs and declined slightly throughout the day. Flows on February 7, 2003 remained constant at 496 cfs throughout the field data collection.

1.5 Issues

As in previous field visits, use of a tape measure is likely to introduce some level of inaccuracy due to difficulties in keeping the tape taut throughout the gaging period. Windy conditions present further complications and for this reason, a Kevlar tagline is recommended because it provides improved accuracy.

The high flow sampling technique described above was used to measure flows on both the Little Spokane River at Chattaroy and at Pine River Park. The aluminum Swoffer rod used for gaging on the Little Spokane River and tributaries was not heavy duty enough for the flow velocities in some locations on the Little Spokane River at Pine River Park and vibrated during some measurements. Swoffer makes steel rods that would be more stable in high flows. At high flows, a larger prop may be appropriate. Swoffer should be consulted on this.

The aluminum Swoffer rod is not marked for 8/10's measurements for depths over about 3'. A ruled piece of paper was used to set the prop to the correct depth for 8/10's measurements. This worked well, but does introduce some error. The steel Swoffer rod is graduated to allow for 8/10's measurements in deep water.

No digital photos were taken during this round of stream gaging. Once flows at Dartford reach 500 cfs again, photos will be taken to provide views of channel conditions at each of the six sites for comparison with other flow levels. Digital photos should be taken during each field visit from the same location to provide a visual comparison of channel conditions at various flow levels.

MEMORANDUM

TO:	Instream Flow File	**DATE:**	April 1, 2003
FR:	Lisa Vaughn (Golder Associates)	**OUR REF:**	013-1372.2400
RE:	3/26/03 and 3/27/03 Instream Flow Data Collection		

1.0 MARCH 2003 DATA COLLECTION SUMMARY

Streamflow data was collected at six sites on the Little Spokane River on March 26 and 27, 2003. Field collection was completed by Nina Talayco (Golder Associates Biologist), Dave Hrutfiord (Golder Associates Geophysicist) and Reanette Boese (Spokane County) on both of these days. An additional County employee was present for half of the day on March 26th. Blake Mee, a student volunteer from Spokane Community College, assisted with gaging and channel elevation measurements on March 27th. High flow sampling was required for two of the six sites and is discussed below in greater detail.

1.1 Streamflow Variation

Weather patterns preceding and during this sampling period created some streamflow variability on the Little Spokane River and tributaries during the sampling period. Air temperatures for March 26th and 27th averaged 40°F for both of these days. Approximately 0.41 inches of precipitation fell on the 26th, which likely created an increase in streamflow on the Little Spokane and tributaries between the two sampling days. The two days prior to sampling had no precipitation and similar average temperatures of 36 and 43°F, for March 24th and 25th respectively.

1.2 Sampling Regimen

Data collection included stream discharge (including depth and velocity) using a Swoffer meter, as well as headpin elevation and water level elevation measured at the cross-section and at 20 feet above and below the cross-section on both sides of the stream, using a laser level. Streamflows at two sites, the Little Spokane River at Chattaroy and the Little Spokane River at Pine River Park were measured using a high flow sampling technique. This technique required the use of a zodiac boat, an outboard motor and a tagline to obtain depth and velocity measurements across the study transects. This methodology is described Section 1.3 of this memo. Instream flow sites were sampled in the following order.

1. Little Spokane River @ Chattaroy – March 26th, 10:00
2. Little Spokane River @ Pine River Park – March 26th, 13:00
3. Deadman Creek – March 26th, 15:00
4. Dragoon Creek – March 26th, 16:30

5. Little Spokane River @ Elk – March 27th, 10:15

6. Otter Creek – March 27th, 11:40

1.3 High Flow Sampling

High flow sampling techniques were required to attain streamflow measurements at both LSR at Chattaroy and LSR at Pine River Park. These techniques are described in detail below.

1.3.1 Equipment

- Life Vests/Safety Ropes
- Inflatable boat (3 meter long Zodiac)
- Outboard Motor (use size appropriate for river)
- Poly Rope (3/4")
- Anchor posts (1/2" diameter x 4' long rebar)
- Slide Hammer and/or Sledge Hammer
- Carabineers (4")
- Swoffer flow meter and wading rod

1.3.2 High Flow Sampling Procedure

1. All staff review and sign Health and Safety Plan
2. Pound anchor posts into banks on transect, one upslope of each of the transect headpins.
3. Tie ¾-inch rope to anchor post on the 'zero' bank with the zero mark over the top of the headpin.
4. Wade or use motorboat to stretch rope to opposite bank. Secure rope to opposite anchor pin.
5. Tighten rope using simple rope knot techniques.
6. Stretch the marked tagline or tape measure between headpins and secure.

7. Attach the boat to the rope using a carabiner to allow the boat to slide along the rope. Move the boat across the transect along the rope to take measurements at each of the stations.

8. One person remains on shore at all times with safety rope; this person retains health and safety plan and cell phone at all times.

9. Measure water depth and velocity using the flow meter and the wading rod according to the standard flow measurement technique.

In small watercourses the measurements will be made over the side of the boat using the wading rod if the maximum depth is less than 4.25 feet. Based on previous measurements, depths greater than 4.25 feet are not anticipated.

10. Gather all equipment after measurement and ensure its proper storage

11. Review field books between sites to ensure no missing or incorrect data before leaving site.

Date	Temperature Max. (°F)	Temperature Min. (°F)	Temperature Average (°F)	Precipitation Inches
March 24, 2003	47	24	36	0.00
March 25, 2003	50	35	43	No Data
March 26, 2003	51	28	40	0.41
March 2, 2003	51	28	40	0.00

Climate Data Source: NOAA Past Monthly Climate Data website: http://www.wrh.noaa.gov/Spokane/cli.htm

Site	Measured discharge (cfs)	Corresponding discharge on LSR @ Dartford (cfs)	Comments
LSR @ Chattaroy	509.2	823-828	March 26th @ 10:00
Dragoon Creek	172.2	828-832	March 26th @ 16:30
LSR @ Elk	69.2	894	March 27th @ 10:15
Otter Creek	10.1	894	March 27th @ 11:40
Deadman Creek	152.0	828	March 26th @ 15:00
LSR @ Pine River Park	868.1	828	March 26th @ 13:00

1.4 Observations

Flows at Dartford on March 26, 2003 ranged from 823-832 cfs and increased throughout the day due to precipitation. Flows on March 27, 2003 remained constant at 894 cfs throughout the field data collection and no precipitation fell on this day.

1.5 Issues

In windy conditions and wide channels, a kevlar tagline provides more accuracy than a tape measure. The tagline remains taut in the wind. A tagline, provided by Nina Talayco, was used on the 26th and 27th. Use of a kevlar tagline is preferable and it is recommended for future gaging endeavors.

High flow sampling protocol was used to measure flows on two sites, the Little Spokane River at Chattaroy and the Little Spokane River at Pine River Park. The aluminum Swoffer rod used for gaging on the Little Spokane River and tributaries was not heavy duty enough for the flow velocities in the streams during this visit. It vibrated intensely while measuring the 3 largest streams. At the Little Spokane River at Chattaroy, the propeller was lost when the vibrations loosened the lock nut at the tip of the prop. It may not have been screwed on tightly enough, but Nina Talayco did check it before measuring, to be sure it was at least moderately secure. No more tips were lost after that event. Swoffer has steel rods that would be more stable in high flows. At high flows, a larger prop may be appropriate. Swoffer should be consulted on this.

The aluminum Swoffer rod is not marked for 8/10's measurements for depths over about 3'. A ruled piece of paper was used to set the prop to the correct depth for 8/10's measurements. This worked well, but does introduce some error. The steel Swoffer rod is graduated to allow for 8/10's measurements in deep water.

At the sites where we used a boat and the water was ripping by, it was difficult to hold the rod perfectly vertical. However this is not likely to be a major concern, but use of a steel Swoffer rod is recommended for future measurements.

APPENDIX E

PHOTOGRAPHS

PHOTOGRAPH 1. LSR @ CHATTAROY – DOWNSTREAM VIEW. 9/24/2002, 8:00. Measured Flow: 68.7 cfs. Flow at Dartford: 119 cfs.

PHOTOGRAPH 2. LSR @ CHATTAROY – DOWNSTREAM VIEW. 10/24/2002, 13:00. Measured Flow: 75.9 cfs. Flow at Dartford: 132 cfs.

PHOTOGRAPH 3. LSR @ CHATTAROY – DOWNSTREAM VIEW. 1/9/2003, 10:00. Measured Flow: 188.9 cfs. Flow at Dartford: 308 cfs.

PHOTOGRAPH 4. LSR @ CHATTAROY – DOWNSTREAM VIEW. 4/8/2003, 13:00. Flow at Dartford: 550 cfs.

PHOTOGRAPH 5. LSR @ CHATTAROY – DOWNSTREAM VIEW. 3/26/2003, 10:00. Measured Flow: 509.2 cfs. Flow at Dartford: 823-828 cfs.

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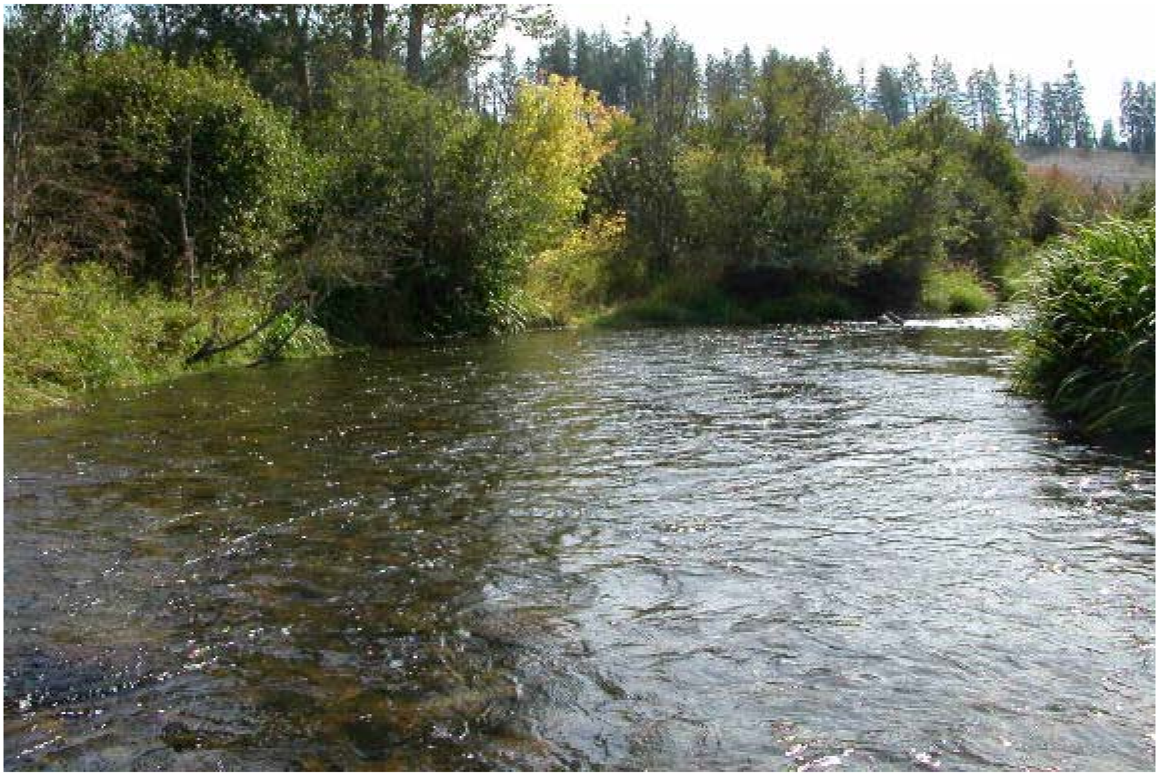

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PHOTOGRAPH 5. LSR @ CHATTAROY – DOWNSTREAM VIEW. 3/26/2003, 10:00. Measured Flow: 509.2 cfs. Flow at Dartford: 823-828 cfs. Weather: Rainy. Streamflow Conditions: Slightly Variable.

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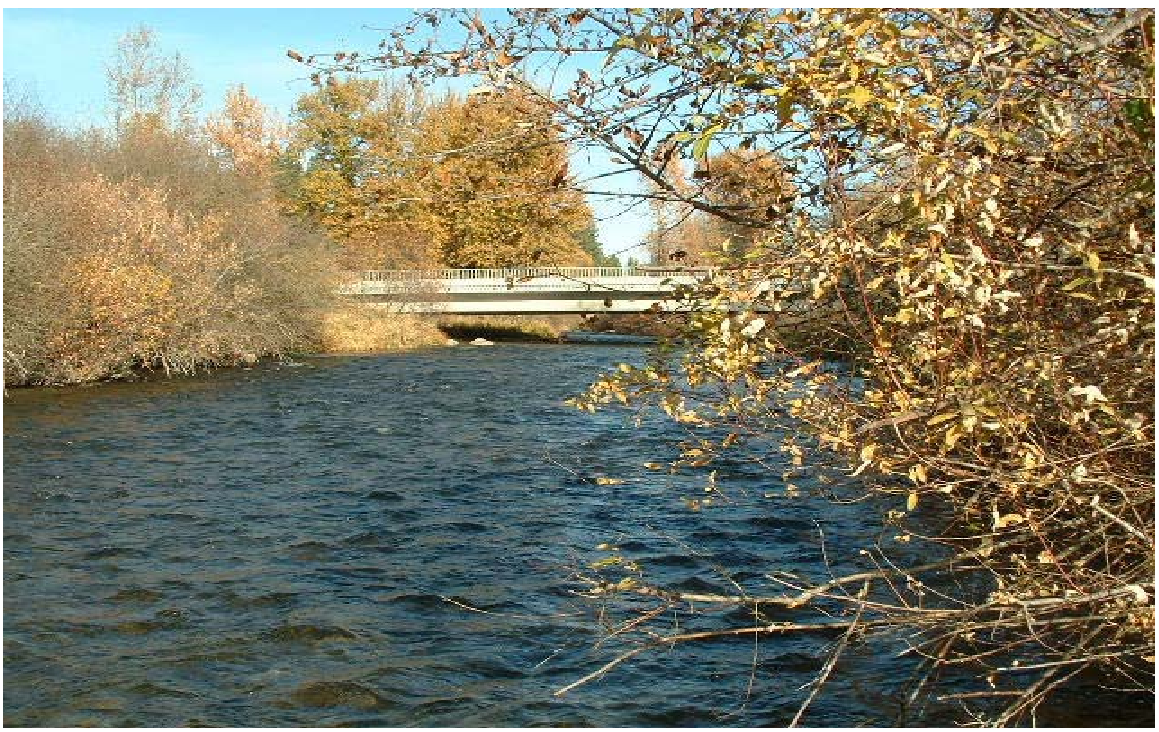

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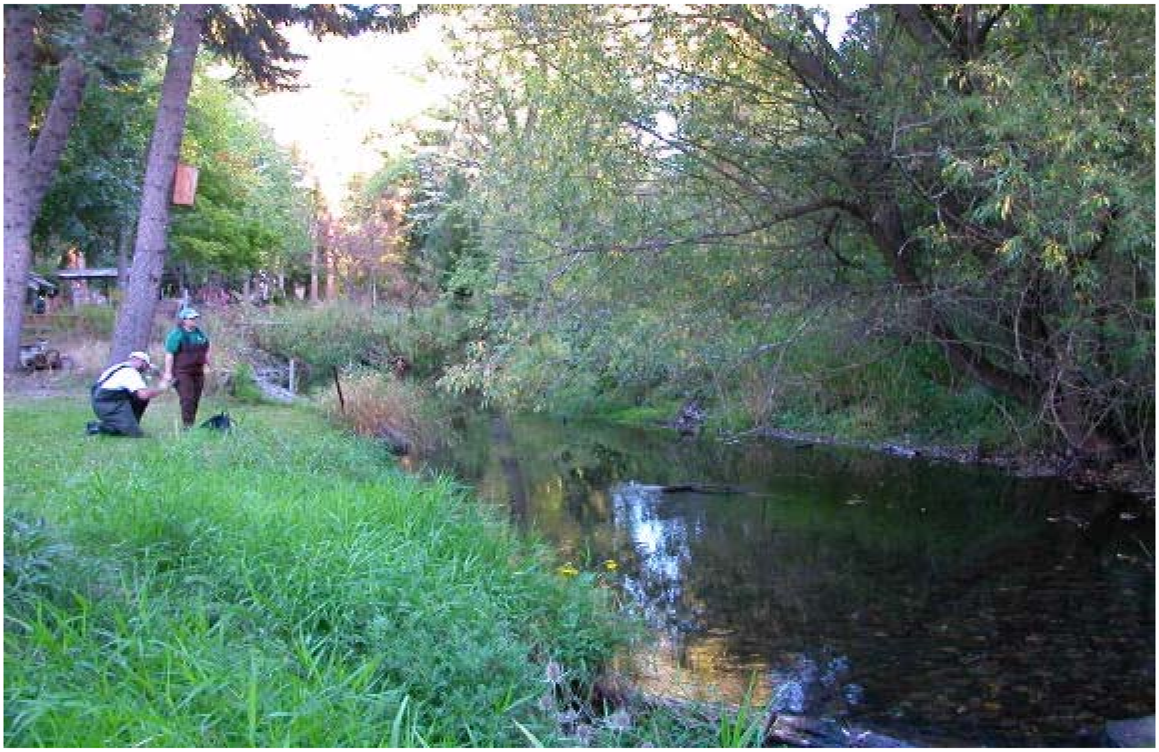
PHOTOGRAPH 34. DEADMAN CREEK – DOWNSTREAM VIEW. 4/8/2003, 14:10. Flow at Dartford: 554 cfs. Weather: Partly Sunny. Streamflow Conditions: Stable.

PHOTOGRAPH 35. DEADMAN CREEK – DOWNSTREAM VIEW. 3/26/2003, 15:00. Measured Flow: 152.0 cfs. Flow at Dartford: 828 cfs. Weather: Overcast; Scattered Showers. Streamflow Conditions: Stable



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PHOTOGRAPH 49. OTTER CREEK – DOWNSTREAM VIEW. 9/24/2002, 17:00. Measured Flow: 3.7 cfs. Flow at Dartford: 119 cfs. Weather: Sunny. Streamflow Conditions: Stable.

PHOTOGRAPH 50. OTTER CREEK – DOWNSTREAM VIEW. 10/31/2002, 13:00. Measured Flow: 3.0 cfs. Flow at Dartford: 123-125 cfs. Weather: Overcast, Very Cold. Streamflow Conditions: Stable.

PHOTOGRAPH 51. OTTER CREEK – DOWNSTREAM VIEW. 1/8/2003, 16:00. Measured Flow: 3.7 cfs. Flow at Dartford: 322 cfs. Weather: Overcast. Streamflow Conditions: Stable.

PHOTOGRAPH 52. OTTER CREEK – DOWNSTREAM VIEW. 4/8/2003, 13:40. Flow at Dartford: 550 cfs. Weather: Partly Sunny. Streamflow Conditions: Stable.

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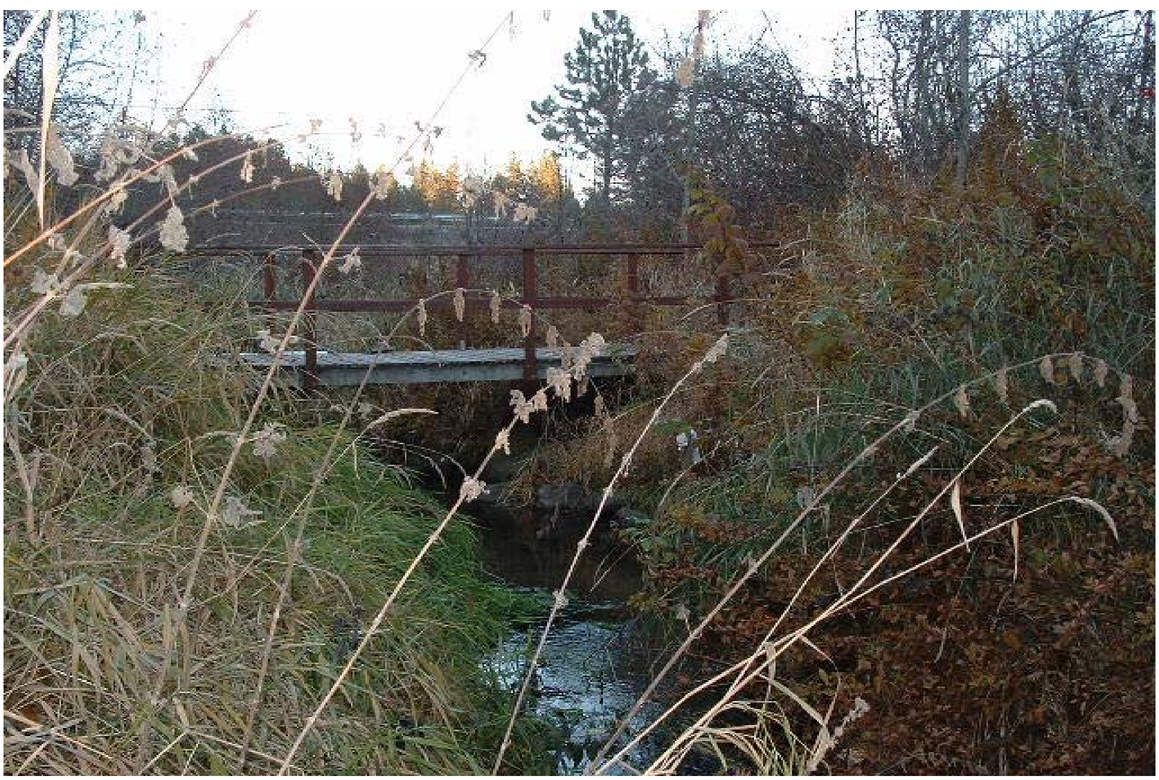

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APPENDIX F

HYDRAULIC CALIBRATION AND SIMULATION DETAILS

Table F-1
Little Spokane River at Pine River Park Velocity Adjustment Factors

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
106.1	50.0	0.94
106.1	60.0	0.94
106.1	70.0	0.94
106.1	80.0	0.95
106.1	90.0	0.96
106.1	100.0	0.97
106.1	106.1	0.97
106.1	110.0	0.98
106.1	120.0	0.98
106.1	130.0	0.99
106.1	140.0	1.00
106.1	150.0	1.01
106.1	160.0	1.02
106.1	170.0	1.03
106.1	180.0	1.04
106.1	190.0	1.04
106.1	200.0	1.05
106.1	210.0	1.06
106.1	220.0	1.06
106.1	230.0	1.08
106.1	240.0	1.08
300.9	160.0	0.86
300.9	170.0	0.87
300.9	180.0	0.89
300.9	190.0	0.89
300.9	200.0	0.91
300.9	210.0	0.92
300.9	220.0	0.92
300.9	230.0	0.93
300.9	240.0	0.94
300.9	250.0	0.95
300.9	260.0	0.95
300.9	270.0	0.97
300.9	280.0	0.97
300.9	290.0	0.98

Table F-1 continued

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
300.9	300.0	0.98
300.9	300.9	0.99
300.9	325.0	1.00
300.9	350.0	1.01
300.9	375.0	1.01
300.9	400.0	1.02
300.9	425.0	1.02
300.9	450.0	1.02
300.9	475.0	1.03
300.9	500.0	1.03
300.9	525.0	1.04
300.9	550.0	1.04
300.9	575.0	1.05
300.9	600.0	1.05
868.1	400.0	0.95
868.1	425.0	0.96
868.1	450.0	0.96
868.1	475.0	0.97
868.1	500.0	0.97
868.1	525.0	0.98
868.1	550.0	0.98
868.1	575.0	0.98
868.1	600.0	0.99
868.1	625.0	0.99
868.1	650.0	1.00
868.1	675.0	1.00
868.1	700.0	1.01
868.1	725.0	1.01
868.1	750.0	1.02
868.1	775.0	1.02
868.1	800.0	1.02
868.1	825.0	1.03
868.1	850.0	1.03
868.1	868.1	1.03
868.1	875.0	1.03

Table F-2
Little Spokane River at Pine River Park Calibration Details

Calibration Discharge 106.1 cfs				Calibration Discharge 300.9 cfs				Calibration Discharge 868.1 cfs			
Vertical	Cal. Velocity	Sim. Velocity	Diff.	Vertical	Cal. Velocity	Sim. Velocity	Diff.	Vertical	Cal. Velocity	Sim. Velocity	Diff.
10.1				10.1				5.7			
10.2	0	0	0	10.5	0.01	0.01	0	12	0.43	0.44	0.01
11.1	0	0.04	0.04	12.8	0.41	0.41	0	14	0.84	0.86	0.02
14	0.79	0.77	-0.02	14.8	0.98	0.97	-0.01	17	2.33	2.37	0.04
16.5	1.5	1.46	-0.04	16.8	2.2	2.18	-0.02	20	2.9	2.95	0.05
19	1.84	1.79	-0.05	18.8	2.35	2.33	-0.02	23	5.04	5.13	0.09
21.5	1.49	1.45	-0.04	20.8	2.39	2.37	-0.02	26	5.01	5.1	0.09
24	1.78	1.73	-0.05	22.8	3.09	3.06	-0.03	29	5.11	5.2	0.09
26.5	1.58	1.54	-0.04	24.8	2.75	2.72	-0.03	31	5.15	5.24	0.09
29	1.6	1.56	-0.04	26.8	2.59	2.57	-0.02	33	5.45	5.55	0.1
31.5	2.03	1.98	-0.05	28.8	2.48	2.46	-0.02	36	5.57	5.67	0.1
34	2.36	2.3	-0.06	30.8	3.51	3.48	-0.03	39	5.3	5.39	0.09
36.5	2.26	2.2	-0.06	32.8	3.26	3.23	-0.03	42	5.76	5.86	0.1
39	2.17	2.12	-0.05	34.8	3.25	3.22	-0.03	45	5.47	5.57	0.1
41.5	2.11	2.06	-0.05	36.8	3.67	3.64	-0.03	48	5.49	5.59	0.1
44	1.65	1.61	-0.04	38.8	3.38	3.35	-0.03	50	5.52	5.62	0.1
46.5	1.96	1.91	-0.05	40.8	3.5	3.47	-0.03	52	4.53	4.61	0.08
49	1.84	1.79	-0.05	42.8	3.69	3.66	-0.03	55	3.96	4.03	0.07
51.5	2.17	2.11	-0.06	44.8	3.73	3.69	-0.04	58	3.09	3.14	0.05
54	2.23	2.17	-0.06	46.8	3.3	3.27	-0.03	62	1.36	1.38	0.02
56.5	2.03	1.98	-0.05	48.8	3.08	3.05	-0.03	66	0.65	0.66	0.01
59	2.06	2.01	-0.05	50.8	3.08	3.05	-0.03	72.8	0.01	0	-0.01
60.4	0.38	0.37	-0.01	52.8	2.91	2.88	-0.03	73.6			
61.7	0.69	0.67	-0.02	54.8	3.03	3	-0.03				
63.5	0	0.21	0.21	56.8	2.64	2.61	-0.03				
65				58.8	2.25	2.23	-0.02				
				65.5	0.01	0.01	0				
				66.1							
Average Difference			-0.03	Average Difference			-0.02	Average Difference			0.07

Table F-3
Little Spokane River at Chattaroy Velocity Adjustment Factors

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
68.7	30.0	1.09
68.7	40.0	1.10
68.7	50.0	1.11
68.7	60.0	1.13
68.7	68.7	1.15
68.7	70.0	1.14
68.7	80.0	1.17
68.7	90.0	1.18
68.7	100.0	1.20
68.7	110.0	1.22
68.7	120.0	1.23
188.9	100.0	0.96
188.9	110.0	0.98
188.9	120.0	1.00
188.9	130.0	1.01
188.9	140.0	1.04
188.9	150.0	1.04
188.9	175.0	1.08
188.9	188.9	1.10
188.9	200.0	1.11
188.9	225.0	1.15
188.9	250.0	1.18
312.0	200.0	0.89
312.0	225.0	0.92
312.0	250.0	0.95
312.0	275.0	0.98
312.0	300.0	0.99
312.0	312.0	1.04
312.0	325.0	1.03
312.0	350.0	1.01
509.2	300.0	1.22
509.2	325.0	1.19
509.2	350.0	1.17
509.2	375.0	1.15
509.2	400.0	1.13
509.2	425.0	1.11
509.2	450.0	1.09
509.2	475.0	1.08
509.2	500.0	1.06
509.2	509.2	1.06
509.2	525.0	1.05

Table F-4
Little Spokane River at Chattaroy Calibration Details

Calibration Discharge 68.7 cfs				Calibration Discharge 188.9 cfs			
Vertical	Calibration Velocity	Simulation Velocity	Diff.	Vertical	Calibration Velocity	Simulation Velocity	Diff.
61	0			61	0		
61.4	0	0.05	0.05	61.5	0		
63	0.13	0.15	0.02	63.8	2.17	2.3	0.13
64.3	1.32	1.51	0.19	65.3	2.99	3.18	0.19
66	2.42	2.77	0.35	66.8	3.45	3.67	0.22
68	2.01	2.3	0.29	68.3	3.81	4.05	0.24
70	1.82	2.08	0.26	69.8	3.41	3.63	0.22
72	1.28	1.47	0.19	71.3	3.12	3.32	0.2
74	1.86	2.13	0.27	72.8	2.7	2.87	0.17
76	1.63	1.86	0.23	74.3	2.86	3.05	0.19
78	1.5	1.72	0.22	75.8	2.88	3.07	0.19
80	1.72	1.97	0.25	77.3	2.59	2.76	0.17
83	1.89	2.17	0.28	78.8	2.22	2.37	0.15
85	1.82	2.08	0.26	80.3	2.57	2.74	0.17
86	2.31	2.64	0.33	81.8	2.84	3.03	0.19
87	1.96	2.25	0.29	83.3	3.05	3.26	0.21
88	1.98	2.27	0.29	84.8	3.53	3.77	0.24
89.5	2.44	2.79	0.35	86.3	3.42	3.65	0.23
91	2.14	2.45	0.31	87.8	3.03	3.25	0.22
93.6	1.75	2	0.25	89.3	3.68	3.94	0.26
95.7	0	0.14	0.14	90.8	3.09	3.3	0.21
98.3	0			92.3	3.51	3.74	0.23
				93.8	2.36	2.52	0.16
				98.4	0.01	0.01	0
				99.3	0		
		Average Difference	0.24			Average Difference	0.19

Table F-4 continued

Calibration Discharge 312.0 cfs				Calibration Discharge 509.2cfs			
Vertical	Calibration Velocity	Simulation Velocity	Diff.	Vertical	Calibration Velocity	Simulation Velocity	Diff.
59	0			41	0		
59.5	0	0.01	0.01	54.5	0.25	0.25	0
61.8	0.13	0.14	0.01	64	3.72	3.89	0.17
63.9	2.89	3.02	0.13	66	4.57	4.78	0.21
65.9	3.93	4.1	0.17	68	4.97	5.19	0.22
67.9	4.41	4.6	0.19	70	4.85	5.08	0.23
69.9	4.16	4.34	0.18	71.8	4.34	4.54	0.2
70.9	4.17	4.35	0.18	74	4.08	4.27	0.19
71.9	5.08	5.3	0.22	76	4.18	4.38	0.2
72.9	5	5.22	0.22	78	4.49	4.71	0.22
74.9	4.07	4.25	0.18	80	4.15	4.35	0.2
76.9	4.1	4.28	0.18	82	4.06	4.25	0.19
78.9	3.97	4.14	0.17	84	4.7	4.93	0.23
80.9	2.86	2.98	0.12	86	4.97	5.21	0.24
81.9	3.4	3.55	0.15	88	4.99	5.23	0.24
82.9	4.38	4.57	0.19	90	5.18	5.42	0.24
84.9	2.61	2.72	0.11	92	4.93	5.16	0.23
86.9	4.52	4.71	0.19	94	3.6	3.77	0.17
88.9	4.55	4.75	0.2	96	0.52	0.54	0.02
90.9	4.44	4.63	0.19	98	0.2	0.21	0.01
92.9	4.19	4.37	0.18	100	0.13	0.13	0
93.9	3.37	3.52	0.15	107	0	0	0
100.4	0	0.09	0.09				
101	0	0	0				
103	0	0.74	0.74				
		Average Difference	0.17			Average Difference	0.17

Table F-5
Little Spokane River at Elk Velocity Adjustment Factors

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
32.3	22.0	0.79
32.3	24.0	0.83
32.3	26.0	0.87
32.3	28.0	0.90
32.3	30.0	0.93
32.3	32.0	0.96
32.3	34.0	1.00
32.3	36.0	1.03
32.3	38.0	1.06
32.3	40.0	1.09
32.3	42.0	1.12
32.3	44.0	1.15
32.3	46.0	1.17
58.0	30.0	0.71
58.0	32.0	0.73
58.0	34.0	0.76
58.0	36.0	0.79
58.0	38.0	0.80
58.0	40.0	0.82
58.0	42.0	0.84
58.0	44.0	0.86
58.0	46.0	0.88
58.0	48.0	0.90
58.0	50.0	0.92
58.0	52.0	0.93
58.0	54.0	0.95
58.0	56.0	0.97
58.0	58.0	0.99
58.0	60.0	1.00
58.0	65.0	1.04
58.0	70.0	1.09
58.0	75.0	1.12
58.0	80.0	1.16
58.0	85.0	1.18
58.0	90.0	1.22

Table F-6
Little Spokane River at Elk Calibration Details

Calibration Discharge 32.3 cfs				Calibration Discharge 58.0 cfs			
Vertical	Calibration Velocity	Simulation Velocity	Diff.	Vertical	Calibration Velocity	Simulation Velocity	Diff.
12.8	0			12.8	0	0	0
13	0.01	0.01	0	14.5	0.02	0.02	0
15	0.06	0.06	0	15.5	0.43	0.43	0
16.4	0.62	0.6	-0.02	16.5	0.63	0.63	0
17.6	0.17	0.16	-0.01	17.5	0.31	0.31	0
19	0.08	0.08	0	18.5	1.57	1.56	-0.01
20.5	0.67	0.64	-0.03	19.5	2.05	2.05	0
22	1.57	1.51	-0.06	20.5	1.86	1.85	-0.01
23	2.24	2.15	-0.09	21.7	2.45	2.43	-0.02
24	3.16	3.03	-0.13	22.7	2.02	2	-0.02
25	0.68	0.65	-0.03	23.5	3.1	3.07	-0.03
26	2.37	2.27	-0.1	25.1	3.08	3.05	-0.03
27	1.33	1.28	-0.05	26.3	2.92	2.89	-0.03
28	1.09	1.05	-0.04	27.5	0.9	0.89	-0.01
29	0.94	0.9	-0.04	28.5	1.81	1.79	-0.02
30	0.59	0.57	-0.02	29.5	2.32	2.3	-0.02
31	0.32	0.31	-0.01	30.5	1.12	1.11	-0.01
32	1.9	1.82	-0.08	31.5	2.28	2.26	-0.02
33	2.03	1.95	-0.08	32.5	2.65	2.63	-0.02
34	1.28	1.23	-0.05	33.5	1.7	1.69	-0.01
35	0.29	0.28	-0.01	34.5	0.63	0.62	-0.01
36.5	0.03	0.03	0	35.5	0.11	0.11	0
37.5	0.01	0.01	0	39.4	0	0.01	0.01
39.3	0						
		Average Difference	-0.04			Average Difference	-0.01

Table F-7
Dragoon Creek Velocity Adjustment Factors

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
17.2	10.0	0.74
17.2	11.0	0.77
17.2	12.0	0.81
17.2	13.0	0.83
17.2	14.0	0.87
17.2	15.0	0.89
17.2	16.0	0.91
17.2	17.0	0.94
17.2	17.2	0.95
17.2	18.0	0.97
17.2	19.0	0.99
17.2	20.0	1.01
17.2	21.0	1.05
17.2	22.0	1.06
17.2	23.0	1.08
17.2	24.0	1.11
17.2	25.0	1.13
17.2	26.0	1.16
17.2	27.0	1.17
17.2	28.0	1.20
17.2	29.0	1.21
17.2	30.0	1.23
17.2	31.0	1.26
17.2	32.0	1.26
17.2	33.0	1.29
17.2	34.0	1.31
17.2	35.0	1.33
54.6	26.0	0.71
54.6	27.0	0.72
54.6	28.0	0.73
54.6	29.0	0.74
54.6	30.0	0.76
54.6	31.0	0.77
54.6	32.0	0.78
54.6	33.0	0.79

Table F-7 continued

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
54.6	34.0	0.81
54.6	35.0	0.82
54.6	40.0	0.87
54.6	45.0	0.93
54.6	50.0	0.98
54.6	54.6	1.02
54.6	55.0	1.03
54.6	60.0	1.07
54.6	65.0	1.11
54.6	70.0	1.16
54.6	75.0	1.20
54.6	80.0	1.24
54.6	85.0	1.28
54.6	90.0	1.32
54.6	95.0	1.36
172.2	100.0	0.76
172.2	105.0	0.77
172.2	110.0	0.79
172.2	115.0	0.81
172.2	120.0	0.83
172.2	125.0	0.85
172.2	130.0	0.87
172.2	140.0	0.90
172.2	150.0	0.93
172.2	160.0	0.96
172.2	170.0	0.99
172.2	172.2	1.00
172.2	175.0	1.00

Table F-8
Dragoon Creek Calibration Details

Calibration Discharge 17.2 cfs				Calibration Discharge 54.6 cfs				Calibration Discharge 172.2 cfs			
Vertical	Cal. Velocity	Sim. Velocity	Diff.	Vertical	Cal. Velocity	Sim. Velocity	Diff.	Vertical	Cal. Velocity	Sim. Velocity	Diff.
29.2	0	0	0	28.1	0			22			
31	0.01	0.01	0	30.6	0.2	0.2	0	25	0	0.04	0.04
32.5	0.01	0.01	0	32.1	0.35	0.36	0.01	31	0.5	0.49	-0.01
34	0.03	0.03	0	33.6	0.34	0.34	0	32.5	1.06	1.04	-0.02
35.5	0.41	0.39	-0.02	35.1	0.94	0.95	0.01	34	1.19	1.17	-0.02
37	0.61	0.59	-0.02	36.6	1.37	1.39	0.02	35.5	2.73	2.69	-0.04
39	0.42	0.4	-0.02	38.1	1.48	1.5	0.02	37	2.57	2.53	-0.04
40.5	0.82	0.79	-0.03	39.6	2.13	2.16	0.03	38.5	3.41	3.36	-0.05
42	0.39	0.37	-0.02	41.1	1.14	1.16	0.02	40	4.23	4.17	-0.06
43.5	0.93	0.89	-0.04	42.6	1.65	1.67	0.02	41.5	3.41	3.36	-0.05
45	0.88	0.84	-0.04	44.1	1.4	1.42	0.02	43	4.15	4.08	-0.07
46.5	0.94	0.9	-0.04	45.6	1.37	1.39	0.02	44.5	3.67	3.61	-0.06
48	1	0.96	-0.04	47.1	1.22	1.24	0.02	46	3.2	3.15	-0.05
49.5	0.75	0.72	-0.03	48.6	1.55	1.57	0.02	47.5	3.85	3.79	-0.06
51	1.02	0.98	-0.04	50.1	1.27	1.29	0.02	49	3.03	2.98	-0.05
52.5	1.02	0.98	-0.04	51.6	1.75	1.78	0.03	50.5	2.9	2.86	-0.04
54	0.5	0.48	-0.02	53.1	0.83	0.84	0.01	52	2.7	2.66	-0.04
55.5	0.42	0.4	-0.02	54.6	1.35	1.37	0.02	53.5	2.65	2.61	-0.04
57	0.75	0.72	-0.03	56.1	0.99	1	0.01	55	2.24	2.2	-0.04
58.5	0.06	0.06	0	57.6	0.77	0.78	0.01	56.5	1.83	1.8	-0.03
60	0.01	0.01	0	59.1	0.14	0.14	0	58	1.35	1.33	-0.02
61.5	0.01	0.01	0	63.6	0.01	0.01	0	59.5	0.84	0.83	-0.01
62.9	0			63.8	0			61	0.01	0.01	0
								65	0	0	0
Average Difference			-0.02	Average Difference			0.01	Average Difference			-0.03

Table F-9
Deadman Creek Velocity Adjustment Factors

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
5.5	3.0	0.76
5.5	4.0	0.88
5.5	5.0	0.99
5.5	6.0	1.08
5.5	7.0	1.17
5.5	8.0	1.24
8.2	5.0	0.82
8.2	6.0	0.90
8.2	7.0	0.97
8.2	8.0	1.06
8.2	9.0	1.11
8.2	10.0	1.18
8.2	11.0	1.24
8.2	12.0	1.31
8.2	13.0	1.35
8.2	14.0	1.41
8.2	15.0	1.47
24.4	12.0	0.66
24.4	13.0	0.68
24.4	14.0	0.71
24.4	15.0	0.74
24.4	16.0	0.77
24.4	17.0	0.79
24.4	18.0	0.81
24.4	19.0	0.83
24.4	20.0	0.87
24.4	21.0	0.88
24.4	22.0	0.91
24.4	23.0	0.93
24.4	24.0	0.95
24.4	24.4	0.96
24.4	25.0	0.97
24.4	30.0	1.07
24.4	35.0	1.16
24.4	40.0	1.25

Table F-9 continued

Calibration Discharge (cfs)	**Simulated Discharge (cfs)**	**Velocity Adjustment Factor**
24.4	45.0	1.34
24.4	50.0	1.42
24.4	55.0	1.50
24.4	60.0	1.58
98.6	50.0	0.73
98.6	55.0	0.77
98.6	60.0	0.81
98.6	65.0	0.84
98.6	70.0	0.88
98.6	75.0	0.91
98.6	80.0	0.95
98.6	85.0	0.98
98.6	90.0	1.01
98.6	95.0	1.05
98.6	98.6	1.06
98.6	100.0	1.08
98.6	105.0	1.11
98.6	110.0	1.13
98.6	115.0	1.16
98.6	120.0	1.19
98.6	125.0	1.22
152.0	100.0	0.89
152.0	105.0	0.91
152.0	110.0	0.93
152.0	115.0	0.95
152.0	120.0	0.97
152.0	125.0	0.99
152.0	130.0	1.02
152.0	135.0	1.03
152.0	140.0	1.05
152.0	145.0	1.07
152.0	150.0	1.09
152.0	160.0	1.13
152.0	170.0	1.16
152.0	180.0	1.20
152.0	190.0	1.22
152.0	200.0	1.26

Table F-10
Deadman Creek Calibration Details

Calibration Discharge 5.5 cfs				Calibration Discharge 8.2 cfs				Calibration Discharge 24.4 cfs			
Vertical	Cal. Velocity	Sim. Velocity	Diff.	Vertical	Cal. Velocity	Sim. Velocity	Diff.	Vertical	Cal. Velocity	Sim. Velocity	Diff.
8.5	0	0	0	9.6	0	0	0	8.2	0	0	0
9.6	0	0.01	0.01	11.4	0.13	0.13	0	8.9	0.01	0.01	0
11	0.04	0.04	0	13.1	0.06	0.06	0	10.2	0.37	0.36	-0.01
12	0.02	0.02	0	13.4	0.11	0.11	0	11.2	0.19	0.19	0
14	0.09	0.1	0.01	14.4	0.24	0.25	0.01	12.2	0.43	0.42	-0.01
16	0.37	0.39	0.02	15.4	0.31	0.32	0.01	13.2	0.94	0.92	-0.02
17	0.24	0.25	0.01	16.2	0.36	0.37	0.01	14.2	0.78	0.76	-0.02
18	0.42	0.44	0.02	17.4	0.35	0.36	0.01	15.2	0.82	0.8	-0.02
19	0.49	0.51	0.02	18.4	0.37	0.38	0.01	16.2	1.03	1	-0.03
20	0.5	0.53	0.03	19.4	0.46	0.48	0.02	17.2	1.04	1.01	-0.03
21	0.44	0.46	0.02	20.4	0.52	0.54	0.02	18.2	1.16	1.12	-0.04
22	0.43	0.45	0.02	21.4	0.45	0.47	0.02	19.2	1.07	1.04	-0.03
23	0.2	0.21	0.01	22.4	0.43	0.45	0.02	20.2	1.23	1.19	-0.04
24	0.49	0.51	0.02	23.4	0.34	0.35	0.01	21.2	1.23	1.19	-0.04
25	0.36	0.37	0.01	24.4	0.62	0.65	0.03	22.2	1.29	1.25	-0.04
26	0.53	0.55	0.02	25.4	0.53	0.55	0.02	23.2	1.11	1.07	-0.04
27	0.36	0.37	0.01	26.4	0.58	0.61	0.03	24.2	1.28	1.24	-0.04
28	0.33	0.34	0.01	27.4	0.46	0.48	0.02	25.2	1.25	1.21	-0.04
29	0.11	0.11	0	28.2	0.36	0.38	0.02	26.2	1.19	1.15	-0.04
30	0.17	0.18	0.01	29.4	0.27	0.28	0.01	27.2	1.19	1.15	-0.04
31	0.08	0.08	0	30.4	0.38	0.4	0.02	28.2	1	0.97	-0.03
32	0	0.04	0.04	30.9	0.29	0.3	0.01	29.2	0.6	0.58	-0.02
33.6	0	0	0	33.9	0		0	30.2	0.56	0.54	-0.02
								31.2	0.43	0.42	-0.01
								33.2	0.01	0.01	0
								33.8	0	0	0
Average Difference			0.01	Average Difference			0.01	Average Difference			-0.03

Table F-10 continued

Calibration Discharge 98.6 cfs				Calibration Discharge 152.0 cfs			
Vertical	Calibration Velocity	Simulation Velocity	Diff.	Vertical	Calibration Velocity	Simulation Velocity	Diff.
7.2	0	0	0	5.3	0	0	0
8.8	0.61	0.65	0.04	6.5	0.01	0	-0.01
9.8	0.49	0.52	0.03	8	0.21	0.22	0.01
10.8	1.25	1.33	0.08	9	0.96	1.02	0.06
11.8	1.43	1.52	0.09	10	1.76	1.88	0.12
12.8	1.97	2.1	0.13	11	2.5	2.68	0.18
13.8	2.25	2.4	0.15	12	3.06	3.27	0.21
14.8	2.61	2.78	0.17	13	3.11	3.33	0.22
15.8	2.73	2.91	0.18	14	3.08	3.3	0.22
16.8	2.79	2.97	0.18	15	3.56	3.82	0.26
17.8	3.2	3.41	0.21	16	3.62	3.88	0.26
18.8	3.18	3.39	0.21	17	3.15	3.38	0.23
19.8	3.17	3.38	0.21	18	3.3	3.54	0.24
20.8	2.98	3.17	0.19	19	3.66	3.93	0.27
21.9	3.44	3.66	0.22	20	3.98	4.27	0.29
22.8	2.88	3.07	0.19	21	3.79	4.08	0.29
23.8	2.66	2.83	0.17	22.5	3.79	4.08	0.29
24.8	3.48	3.71	0.23	24	3.61	3.89	0.28
25.8	3.11	3.31	0.2	25.5	4.16	4.49	0.33
26.8	2.74	2.92	0.18	27	2.34	2.52	0.18
27.8	2.44	2.6	0.16	28.5	1.37	1.48	0.11
28.8	1.88	2	0.12	30	0.25	0.27	0.02
29.8	0.86	0.92	0.06	31.5	0.51	0.55	0.04
30.8	0.84	0.89	0.05	33	0	0.48	0.48
31.8	0.38	0.4	0.02				
33.9	0	0	0				
		Average Difference	0.14			Average Difference	0.20

Table F-11
Otter Creek Velocity Adjustment Factors

Calibration Discharge (cfs)	Simulated Discharge (cfs)	Velocity Adjustment Factor
3.7	2.0	0.78
3.7	2.5	0.85
3.7	3.0	0.89
3.7	3.5	0.95
3.7	4.0	0.99
3.7	4.5	1.04
3.7	5.0	1.07
3.7	5.5	1.12
3.7	6.0	1.15
3.7	6.5	1.18
3.7	7.0	1.21
3.7	7.5	1.25
3.7	8.0	1.28
3.7	8.5	1.31
3.7	9.0	1.34
13.7	7.0	0.85
13.7	7.5	0.87
13.7	8.0	0.89
13.7	8.5	0.91
13.7	9.0	0.93
13.7	9.5	0.94
13.7	10.0	0.95
13.7	10.5	0.97
13.7	11.0	0.98
13.7	11.5	1.00
13.7	12.0	1.02
13.7	12.5	1.02
13.7	13.0	1.04
13.7	13.5	1.05
13.7	14.0	1.06
13.7	15.0	1.09
13.7	16.0	1.10
13.7	17.0	1.12
13.7	18.0	1.14
13.7	19.0	1.15
13.7	20.0	1.17
13.7	21.0	1.19
13.7	22.0	1.20
13.7	23.0	1.21
13.7	24.0	1.23
13.7	25.0	1.24

Table F-12
Otter Creek Calibration Details

Calibration Discharge 3.7 cfs				Calibration Discharge 13.7 cfs			
Vertical	Calibration Velocity	Simulation Velocity	Diff.	Vertical	Calibration Velocity	Simulation Velocity	Diff.
5.3	0.01	0.01	0	5	0	0	0
6	0.01	0.01	0	5.5	0.11	0.11	0
6.5	0.01	0.01	0	6	0.27	0.28	0.01
7	0.21	0.21	0	6.5	0.55	0.57	0.02
7.5	0.38	0.39	0.01	7	0.56	0.58	0.02
8	0.72	0.73	0.01	7.5	1.06	1.1	0.04
8.5	0.89	0.9	0.01	8	1.24	1.28	0.04
9	0.76	0.77	0.01	8.5	1.34	1.39	0.05
9.5	0.81	0.82	0.01	9	1.27	1.32	0.05
10	0.8	0.81	0.01	9.5	1.25	1.29	0.04
10.5	0.83	0.84	0.01	10	1.33	1.38	0.05
11	0.43	0.44	0.01	10.5	1.26	1.3	0.04
11.5	0.01	0.01	0	11	1.17	1.21	0.04
12.6	0	0	0	11.5	0.94	0.97	0.03
				12	0.58	0.59	0.01
				12.5	0.26	0.15	-0.11
				13.2	0.35	0.33	-0.02
				15.9	0	0	0
Average Difference			0.01	Average Difference			0.02

Figure F-1

Simulated velocity distributions for the Little Spokane River at Pine River Park at 50 cfs and 240 cfs using the low flow calibration model (106.1 cfs), at 600 cfs using the medium flow calibration model (300.9 cfs), and at 875 cfs using the high flow calibration model (868.1 cfs).

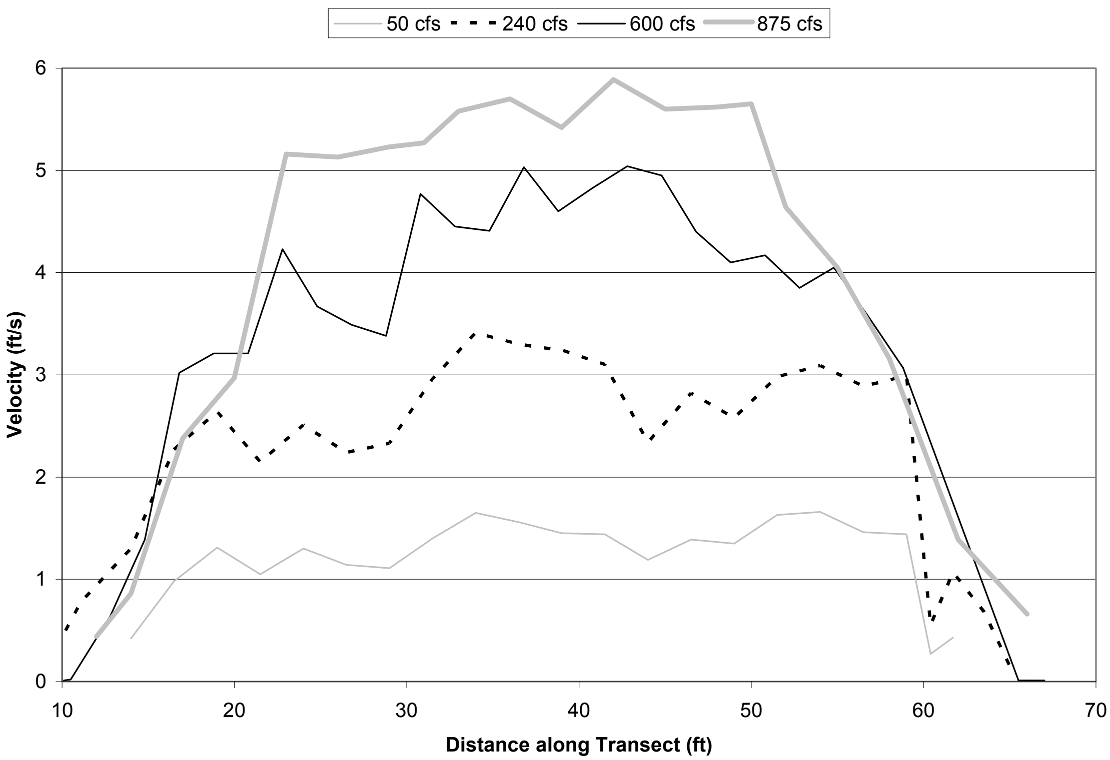


Figure F-2

Simulated velocity distributions for the Little Spokane River at Chattaroy at 30 cfs and 120 cfs using the low flow calibration model (68.7 cfs), at 250 cfs using the medium flow calibration model (188.9 cfs), at 350 cfs using the high flow calibration model (312.0 cfs), and at 525 cfs using the very high calibration model (509.2 cfs).

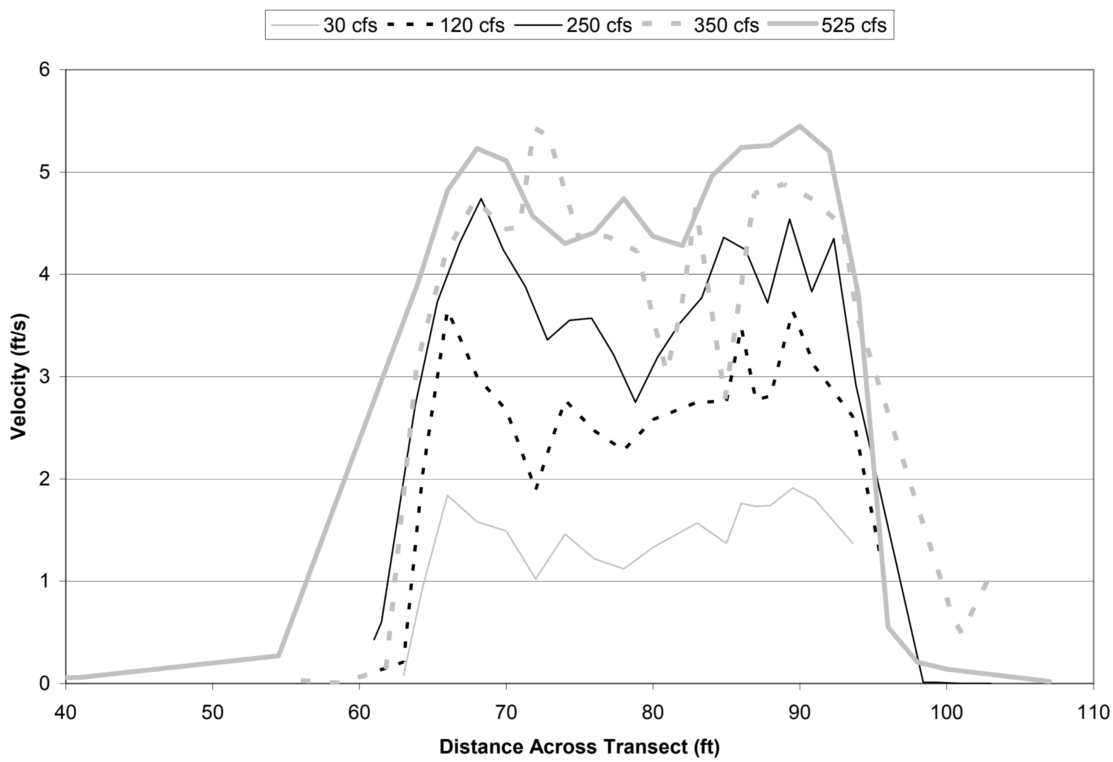


Figure F-3

Simulated velocity distributions for the Little Spokane River at Elk Park at 22 cfs and 46 cfs using the low flow calibration model (32.3 cfs), and at 90 cfs using the medium flow calibration model (58.0 cfs).

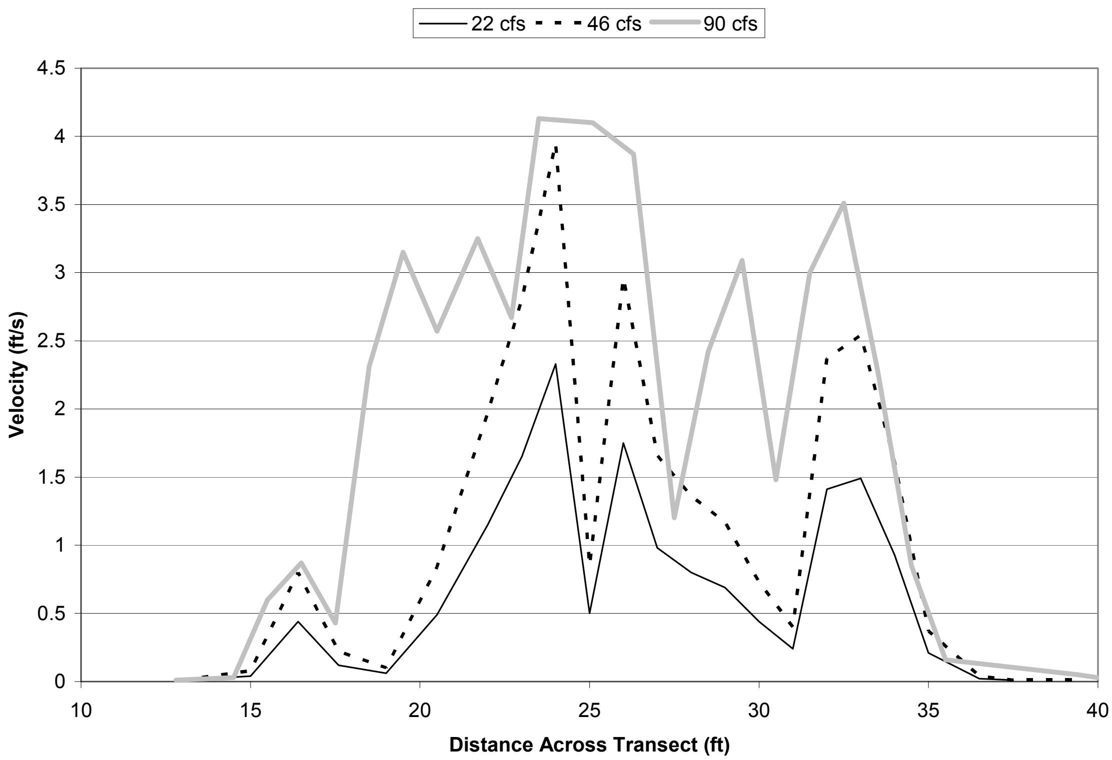


Figure F-4

Simulated velocity distributions for Dragoon Creek at 10 cfs and 35 cfs using the low flow calibration model (17.2 cfs), at 95 cfs using the medium flow calibration model (54.6 cfs), and at 175 cfs using the high flow calibration model (172.2 cfs).

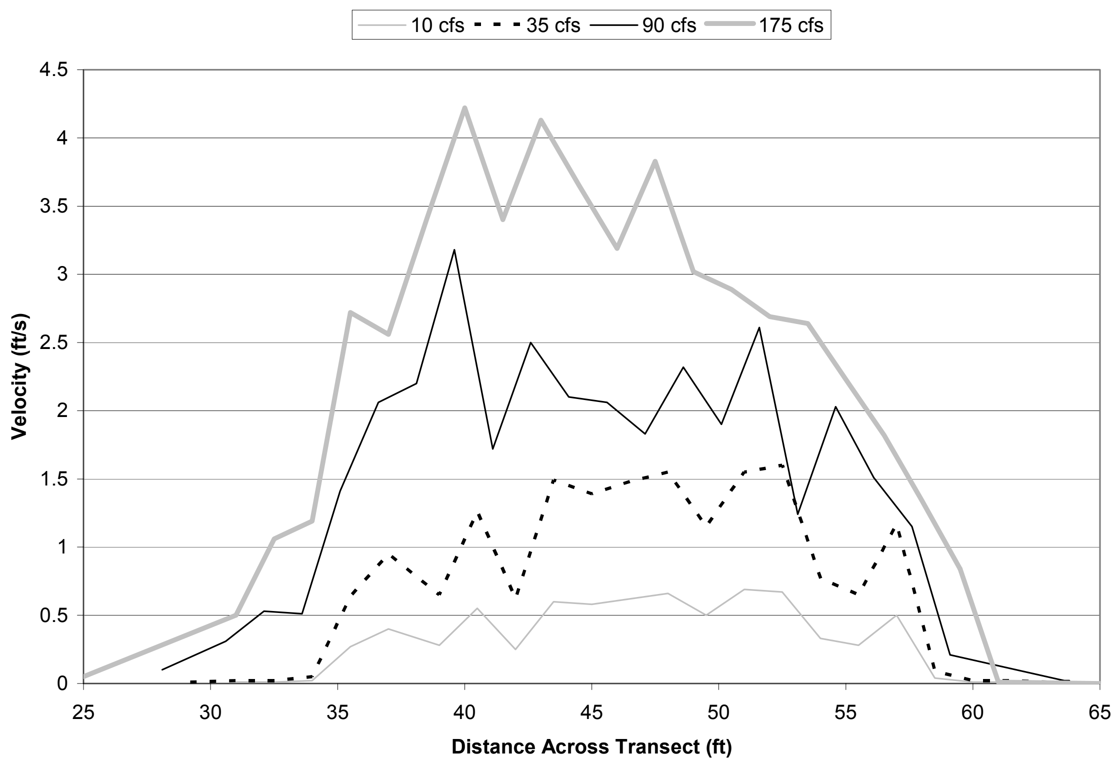


Figure F-5

Simulated velocity distributions for Deadman Creek at 3 cfs and 8 cfs using the very low flow calibration model (5.5 cfs), at 15 cfs using the low flow calibration model (8.2 cfs), at 60 cfs using the medium flow calibration model (24.4 cfs), at 125 cfs using the high flow calibration model (98.6 cfs), and at 200 cfs using the very high calibration model (152.0 cfs).

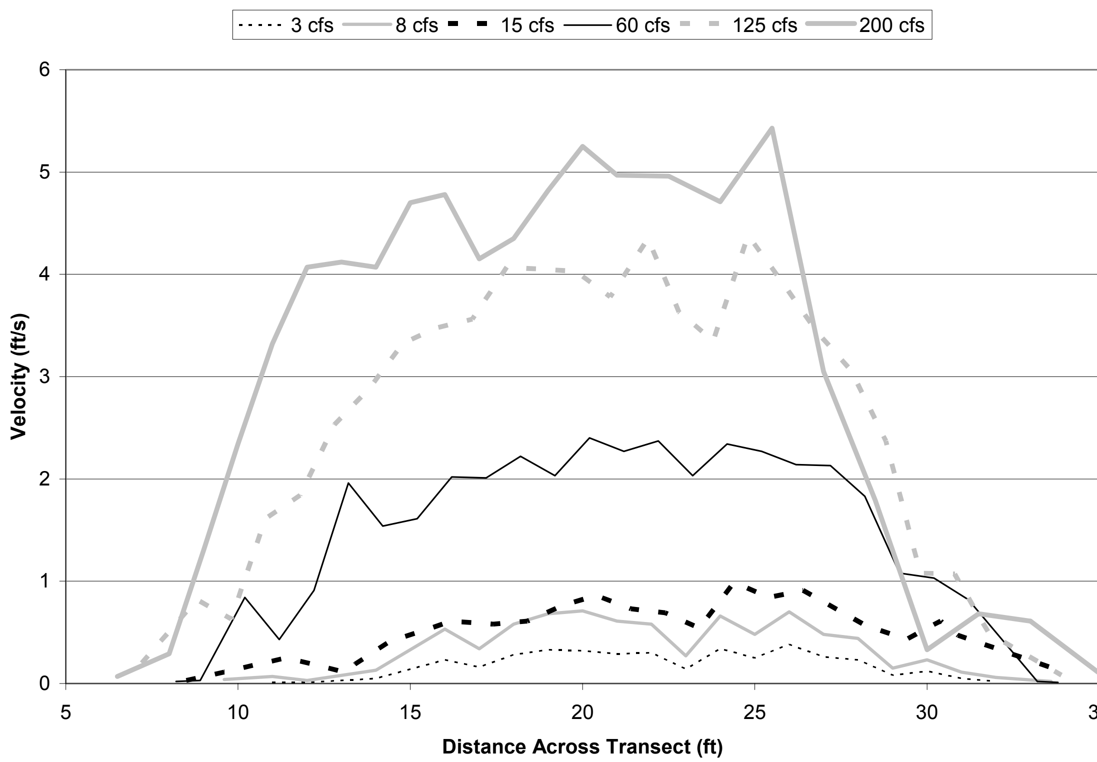
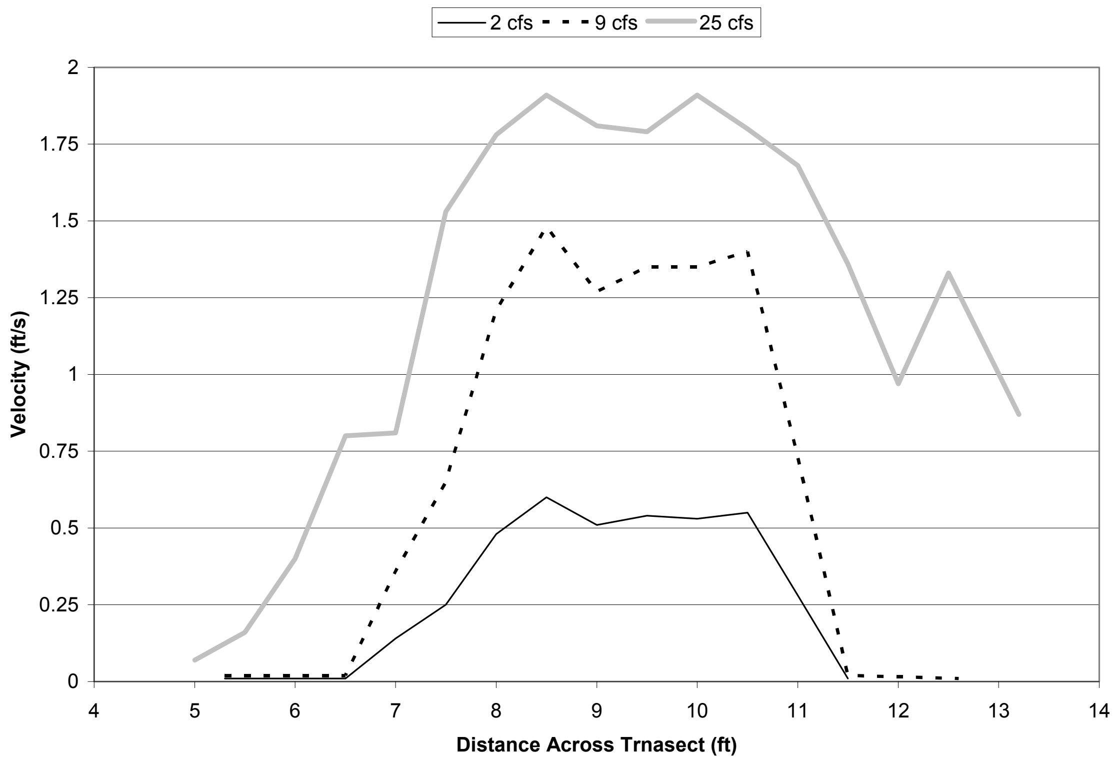


Figure F-6

Simulated velocity distributions for Otter Creek at 2 cfs and 9 cfs using the low flow calibration model (3.7 cfs), and at 25 cfs using the medium flow calibration model (13.7 cfs).



APPENDIX G

COMPARISON OF MOUNTAIN WHITEFISH HABITAT AVAILABILITY RESULTS WITH AND WITHOUT SUBSTRATE CODING

Figure G-1: Comparison of mountain whitefish (MNWH) weighted useable width results with and without channel index (CI) suitability criteria for the Pine River Park site. Substrate criteria were used for the channel index.

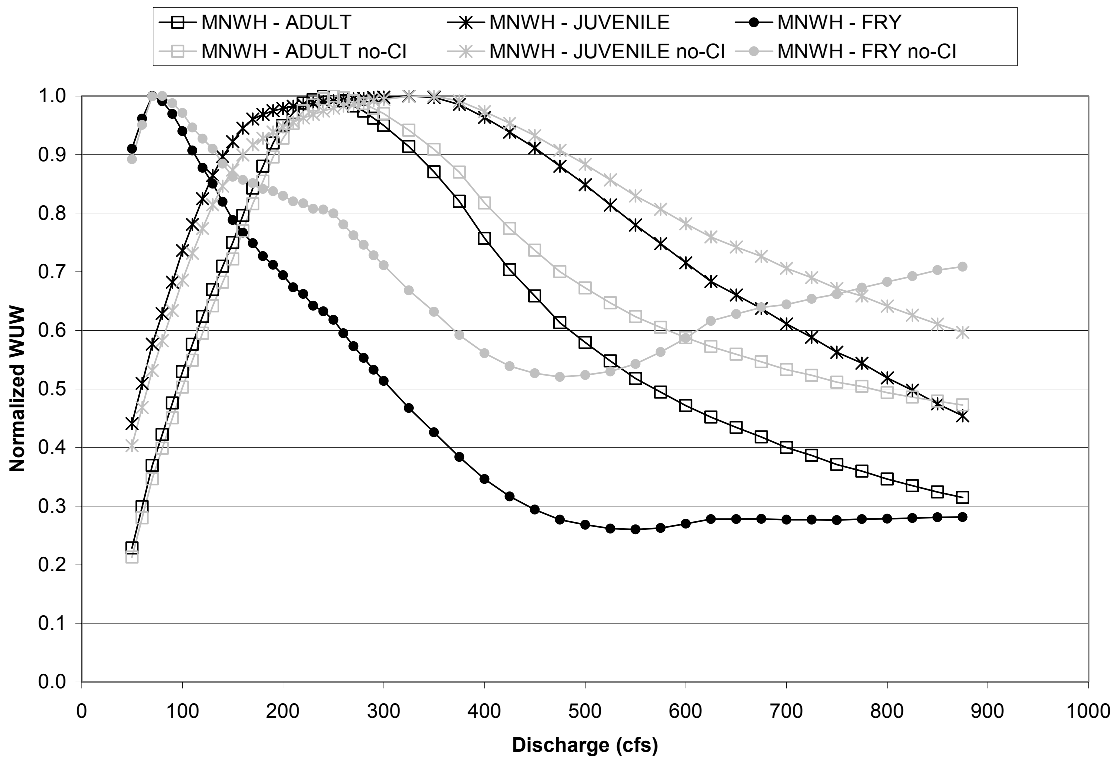


Figure G-2: Comparison of mountain whitefish (MNWH) weighted useable width results with and without channel index (CI) suitability criteria for the Chattaroy site. Substrate criteria were used for the channel index.

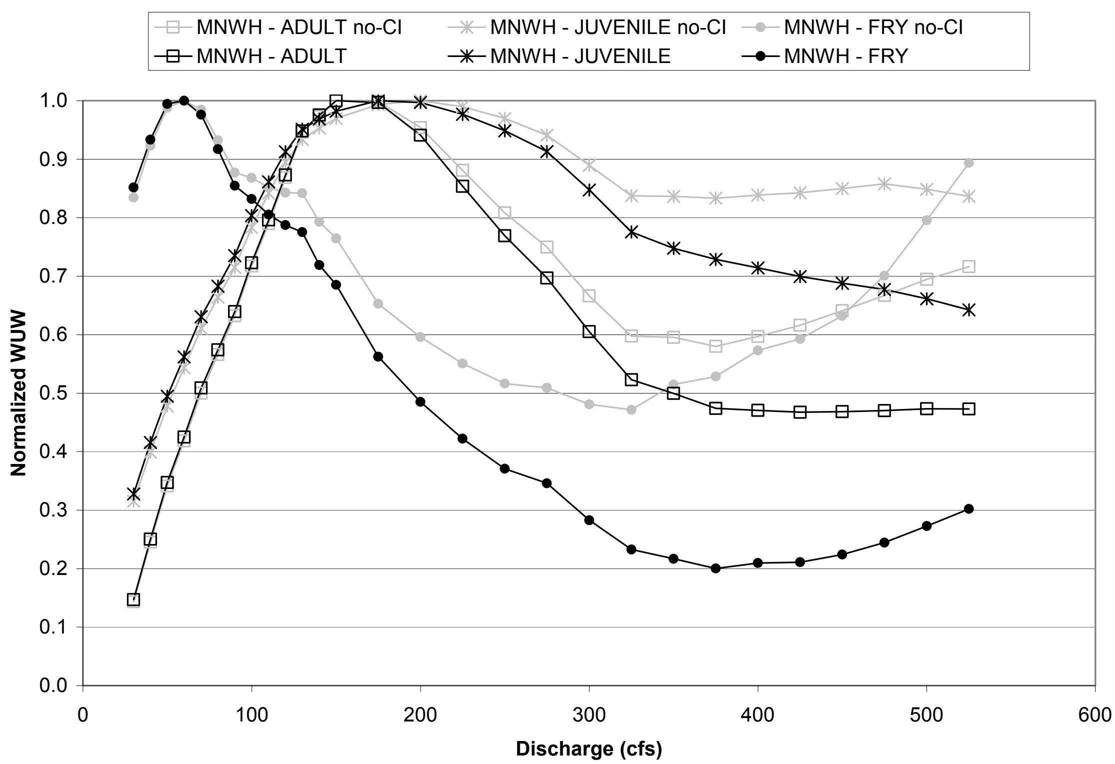


Figure G-3: Comparison of mountain whitefish (MNWH) weighted useable width results with and without channel index (CI) suitability criteria for the Elk Park site. Substrate criteria were used for the channel index.

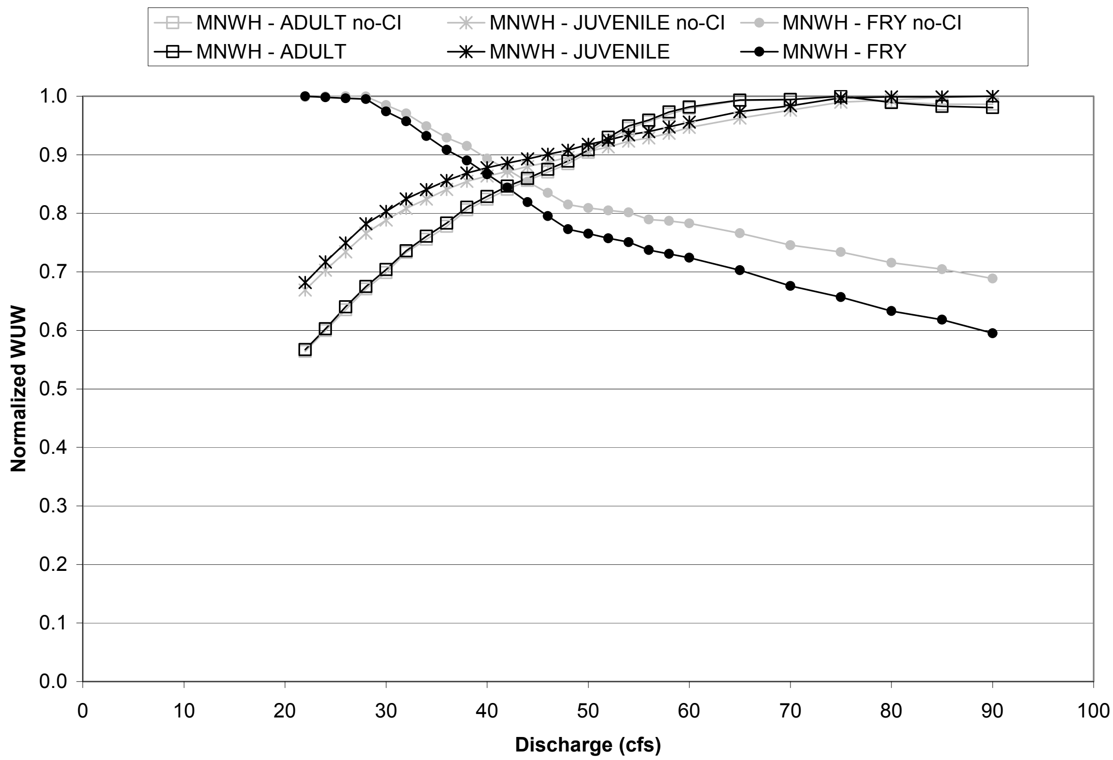


Figure G-4: Comparison of mountain whitefish (MNWH) weighted useable width results with and without channel index (CI) suitability criteria for the Dragoon Creek. Substrate criteria were used for the channel index.

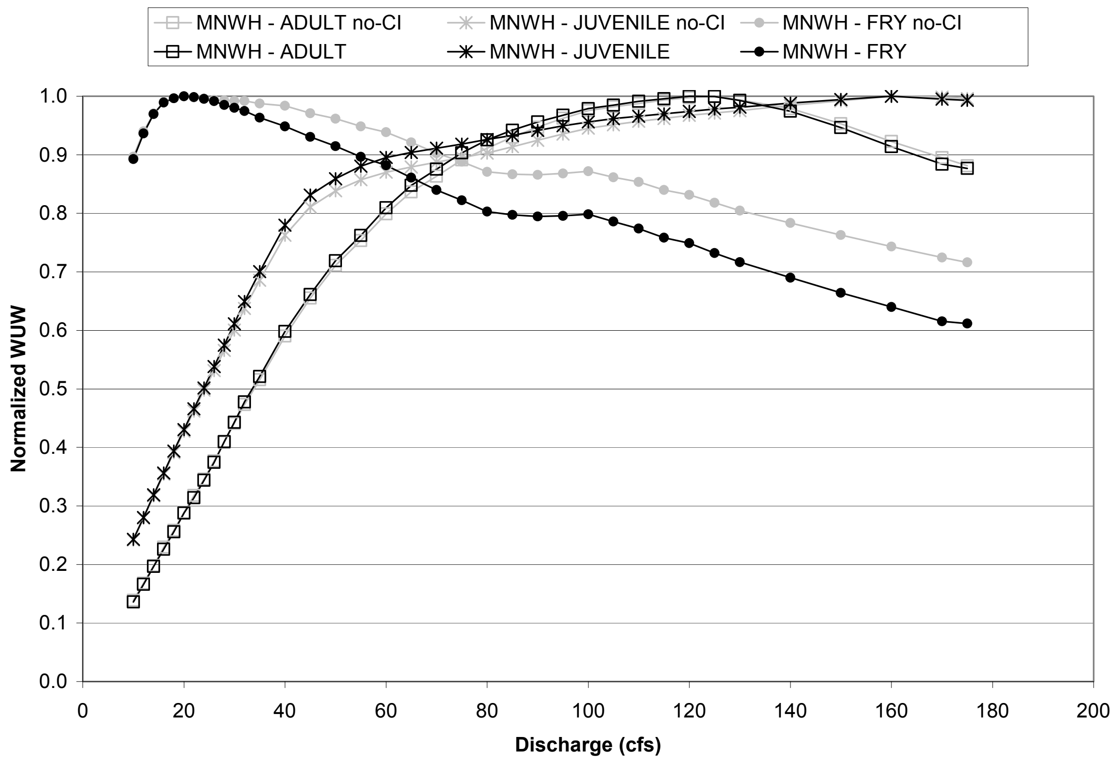


Figure G-5: Comparison of mountain whitefish (MNWH) weighted useable width results with and without channel index (CI) suitability criteria for the Deadman Creek. Substrate criteria were used for the channel index.

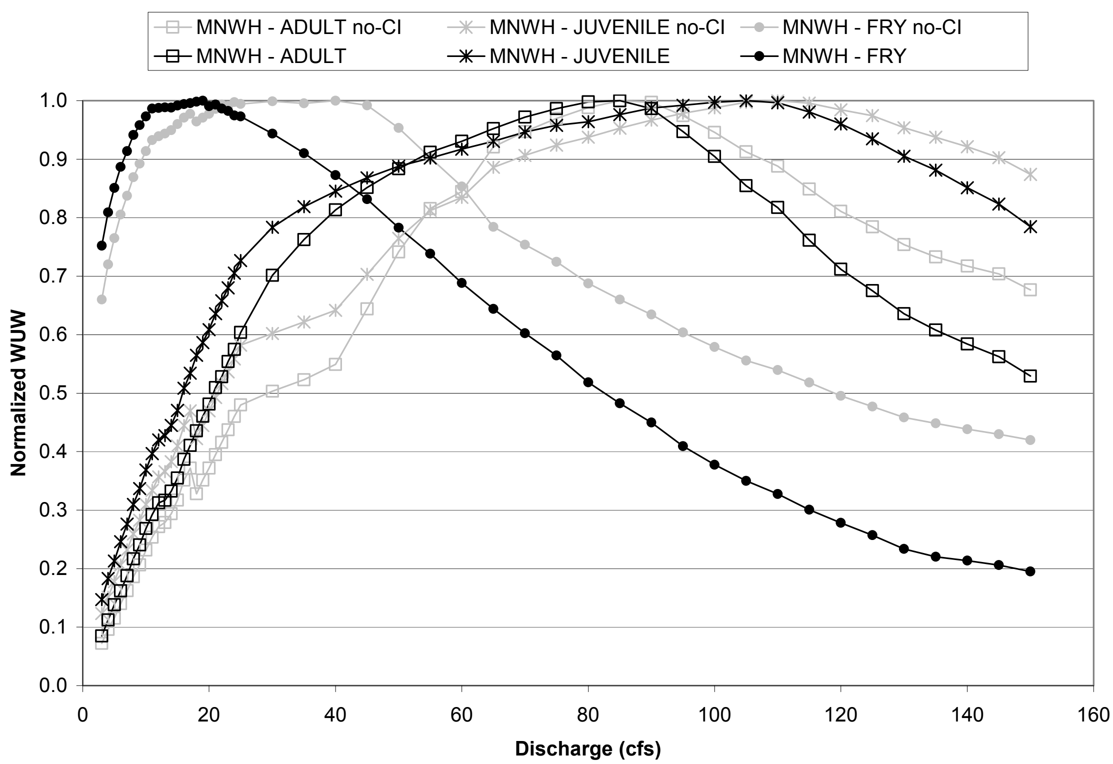
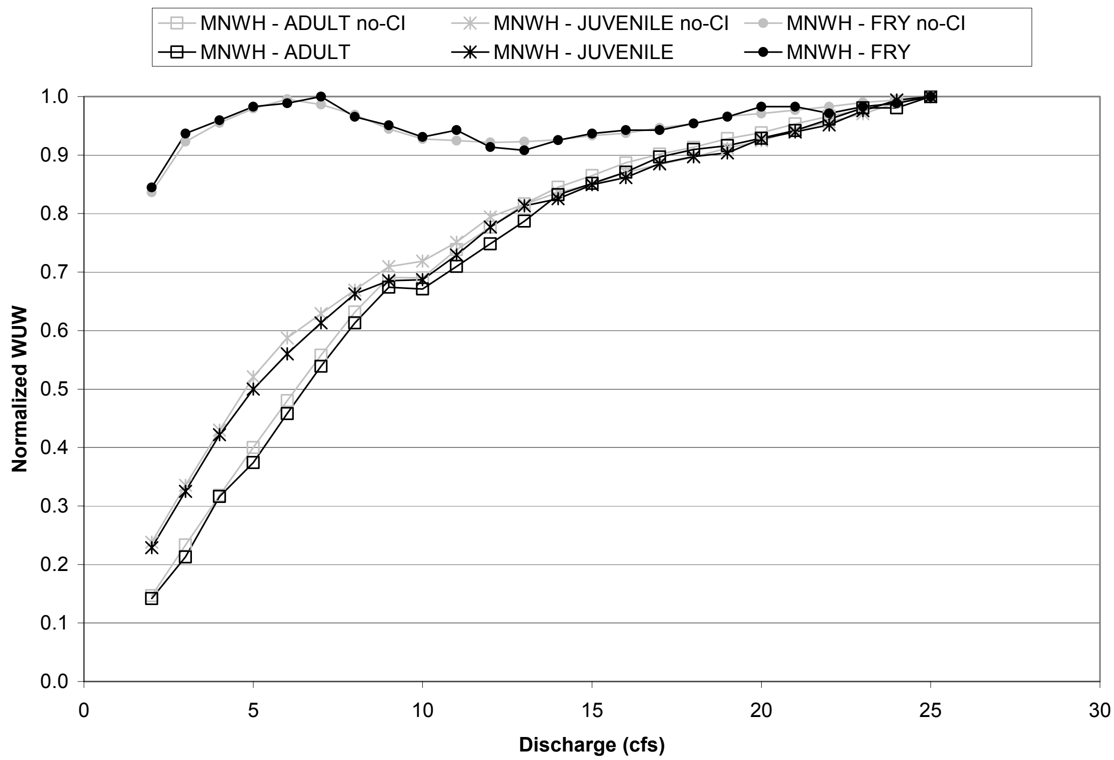


Figure G-6: Comparison of mountain whitefish (MNWH) weighted useable width results with and without channel index (CI) suitability criteria for the Otter Creek. Substrate criteria were used for the channel index.



APPENDIX H

DETAILED HABITAT RESULTS FOR RAINBOW TROUT FRY AND MOUNTAIN WHITEFISH FRY AND JUVENILE

Table H-1: Flows and habitat values for the Little Spokane River at Pine River Park rainbow trout fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-2: Flows and habitat values for the Little Spokane River at Pine River Park mountain whitefish fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-3: Flows and habitat values for the Little Spokane River at Pine River Park mountain whitefish juvenile life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-4: Flows and habitat values for the Little Spokane River at Chattaroy rainbow trout fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-5: Flows and habitat values for the Little Spokane River at Chattaroy mountain whitefish fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-6: Flows and habitat values for the Little Spokane River at Chattaroy mountain whitefish juvenile life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-7: Flows and habitat values for the Little Spokane River at Elk rainbow trout fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-8: Flows and habitat values for the Little Spokane River at Elk mountain whitefish fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-9: Flows and habitat values for the Little Spokane River at Elk mountain whitefish juvenile life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP).

Table H-1 Flows and habitat values for the Little Spokane River at Pine River Park rainbow trout fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					**Rainbow Trout Fry Habitat Relative to Optimum Habitat**				
Date	MISF	**Flow Exceedance**			WP	MISF	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	130	170	150	109	160	0.35	0.29	0.32	0.38	0.31
Oct 15	140	193	154	103	160	0.33	0.26	0.31	0.40	0.31
Nov 1	150	214	160	113	160	0.32	0.24	0.31	0.37	0.31
Nov 15	150	233	180	123	160	0.32	0.23	0.27	0.35	0.31
Dec 1	150	287	187	123	160	0.32	0.17	0.27	0.35	0.31
Dec 15	150	324	209	132	160	0.32	0.14	0.25	0.34	0.31
Jan 1	150	336	214	130	160	0.32	0.14	0.24	0.35	0.31
Jan 15	150	437	227	150	160	0.32	0.13	0.23	0.32	0.31
Feb 1	150	514	234	162	160	0.32	0.15	0.23	0.30	0.31
Feb 15	170	750	277	176	160	0.29	0.12	0.18	0.28	0.31
Mar 1	190	839	409	200	160	0.26	0.11	0.12	0.26	0.31
Mar 15	218	898	470	222	160	0.24	0.11	0.14	0.24	0.31
Apr 1	250	1175	563	248	160	0.21	0.10	0.16	0.21	0.31
Apr 15	218	1107	582	230	160	0.24	0.11	0.16	0.23	0.31
May 1	192	1017	523	220	160	0.26	0.11	0.15	0.24	0.31
May 15	170	628	435	194	160	0.29	0.17	0.12	0.26	0.31
Jun 1	148	566	325	152	160	0.32	0.16	0.14	0.32	0.31
Jun 15	130	462	263	141	160	0.35	0.13	0.19	0.33	0.31
Jul 1	115	305	211	120	160	0.37	0.15	0.25	0.36	0.31
Jul 15	115	241	166	105	160	0.37	0.22	0.30	0.40	0.31
Aug 1	115	192	148	99	160	0.37	0.26	0.32	0.42	0.31
Aug 15	115	175	134	94	160	0.37	0.28	0.34	0.43	0.31
Sep 1	115	176	132	99	160	0.37	0.28	0.34	0.42	0.31
Sep 15	123	174	135	102	160	0.35	0.28	0.34	0.41	0.31
					Average Habitat	0.31	0.18	0.24	0.33	0.31

Table H-2 Flows and habitat values for the Little Spokane River at Pine River Park mountain whitefish fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					Mountain Whitefish Fry Habitat Relative to Optimum Habitat				
Date	MISF	Flow Exceedance			WP	MISF	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	130	170	150	109	160	0.85	0.75	0.79	0.91	0.77
Oct 15	140	193	154	103	160	0.82	0.71	0.78	0.93	0.77
Nov 1	150	214	160	113	160	0.79	0.67	0.77	0.90	0.77
Nov 15	150	233	180	123	160	0.79	0.64	0.73	0.87	0.77
Dec 1	150	287	187	123	160	0.79	0.54	0.72	0.87	0.77
Dec 15	150	324	209	132	160	0.79	0.47	0.68	0.85	0.77
Jan 1	150	336	214	130	160	0.79	0.45	0.67	0.85	0.77
Jan 15	150	437	227	150	160	0.79	0.31	0.65	0.79	0.77
Feb 1	150	514	234	162	160	0.79	0.26	0.64	0.76	0.77
Feb 15	170	750	277	176	160	0.75	0.28	0.56	0.74	0.77
Mar 1	190	839	409	200	160	0.71	0.28	0.34	0.69	0.77
Mar 15	218	898	470	222	160	0.66	0.28	0.28	0.66	0.77
Apr 1	250	1175	563	248	160	0.62	0.29	0.26	0.62	0.77
Apr 15	218	1107	582	230	160	0.66	0.28	0.26	0.64	0.77
May 1	192	1017	523	220	160	0.71	0.28	0.26	0.66	0.77
May 15	170	628	435	194	160	0.75	0.28	0.31	0.70	0.77
Jun 1	148	566	325	152	160	0.79	0.26	0.47	0.78	0.77
Jun 15	130	462	263	141	160	0.85	0.29	0.59	0.82	0.77
Jul 1	115	305	211	120	160	0.89	0.50	0.67	0.88	0.77
Jul 15	115	241	166	105	160	0.89	0.63	0.76	0.92	0.77
Aug 1	115	192	148	99	160	0.89	0.71	0.80	0.94	0.77
Aug 15	115	175	134	94	160	0.89	0.74	0.84	0.96	0.77
Sep 1	115	176	132	99	160	0.89	0.74	0.84	0.94	0.77
Sep 15	123	174	135	102	160	0.87	0.74	0.84	0.93	0.77
					Average Habitat	0.79	0.47	0.60	0.82	0.77

Table H-3 Flows and habitat values for the Little Spokane River at Pine River Park mountain whitefish juvenile life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					Mountain Whitefish Juvenile Habitat Relative to Optimum Habitat				
Date	MISF	Flow Exceedance			WP	MISF	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	130	170	150	109	160	0.86	0.96	0.92	0.78	0.95
Oct 15	140	193	154	103	160	0.90	0.98	0.93	0.75	0.95
Nov 1	150	214	160	113	160	0.92	0.98	0.94	0.79	0.95
Nov 15	150	233	180	123	160	0.92	0.99	0.97	0.84	0.95
Dec 1	150	287	187	123	160	0.92	1.00	0.97	0.84	0.95
Dec 15	150	324	209	132	160	0.92	1.00	0.98	0.87	0.95
Jan 1	150	336	214	130	160	0.92	1.00	0.98	0.86	0.95
Jan 15	150	437	227	150	160	0.92	0.93	0.99	0.92	0.95
Feb 1	150	514	234	162	160	0.92	0.83	0.99	0.95	0.95
Feb 15	170	750	277	176	160	0.96	0.56	1.00	0.97	0.95
Mar 1	190	839	409	200	160	0.97	0.48	0.95	0.98	0.95
Mar 15	218	898	470	222	160	0.98	0.45	0.89	0.99	0.95
Apr 1	250	1175	563	248	160	0.99	0.45	0.76	0.99	0.95
Apr 15	218	1107	582	230	160	0.98	0.45	0.74	0.99	0.95
May 1	192	1017	523	220	160	0.98	0.45	0.82	0.99	0.95
May 15	170	628	435	194	160	0.96	0.68	0.93	0.98	0.95
Jun 1	148	566	325	152	160	0.92	0.76	1.00	0.93	0.95
Jun 15	130	462	263	141	160	0.86	0.90	0.99	0.90	0.95
Jul 1	115	305	211	120	160	0.80	1.00	0.98	0.82	0.95
Jul 15	115	241	166	105	160	0.80	0.99	0.95	0.76	0.95
Aug 1	115	192	148	99	160	0.80	0.98	0.92	0.73	0.95
Aug 15	115	175	134	94	160	0.80	0.96	0.88	0.70	0.95
Sep 1	115	176	132	99	160	0.80	0.97	0.87	0.73	0.95
Sep 15	123	174	135	102	160	0.84	0.96	0.88	0.74	0.95
Average Habitat						0.90	0.82	0.93	0.87	0.95

Table H-4 Flows and habitat values for the Little Spokane River at Chattaroy rainbow trout fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					**Rainbow Trout Fry Habitat Relative to Optimum Habitat**				
Date	MISF	**Flow Exceedance**			WP	MISF	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	70	102.7	67.6	47.3	50.0	0.32	0.22	0.34	0.56	0.49
Oct 15	77	107.1	64.4	37.5	50.0	0.28	0.21	0.35	0.80	0.49
Nov 1	86	125.9	70.0	51.9	50.0	0.25	0.15	0.32	0.47	0.49
Nov 15	86	144.8	83.7	67.0	50.0	0.25	0.11	0.25	0.34	0.49
Dec 1	86	184.5	101.5	76.7	50.0	0.25	0.08	0.22	0.29	0.49
Dec 15	86	197.8	118.1	71.9	50.0	0.25	0.07	0.17	0.31	0.49
Jan 1	86	215.9	128.7	88.8	50.0	0.25	0.06	0.14	0.24	0.49
Jan 15	86	202.3	128.6	85.7	50.0	0.25	0.07	0.14	0.25	0.49
Feb 1	86	240.2	114.9	89.3	50.0	0.25	0.06	0.19	0.23	0.49
Feb 15	104	285.4	119.4	82.0	50.0	0.21	0.07	0.17	0.26	0.49
Mar 1	122	435.8	181.9	99.3	50.0	0.16	0.10	0.08	0.22	0.49
Mar 15	143	478.4	222.9	117.8	50.0	0.11	0.22	0.06	0.18	0.49
Apr 1	165	610.4	245.5	139.2	50.0	0.09	0.36	0.06	0.11	0.49
Apr 15	143	460.5	292.2	133.5	50.0	0.11	0.15	0.07	0.13	0.49
May 1	124	422.5	252.5	120.7	50.0	0.15	0.09	0.06	0.17	0.49
May 15	104	347.6	183.0	92.5	50.0	0.21	0.07	0.08	0.23	0.49
Jun 1	83	281.4	152.0	70.8	50.0	0.26	0.07	0.11	0.32	0.49
Jun 15	69	283.0	130.7	61.9	50.0	0.33	0.07	0.13	0.37	0.49
Jul 1	57	209.5	108.8	60.1	50.0	0.41	0.07	0.21	0.38	0.49
Jul 15	57	176.4	94.0	51.4	50.0	0.41	0.08	0.23	0.48	0.49
Aug 1	57	133.8	77.9	41.0	50.0	0.41	0.13	0.28	0.71	0.49
Aug 15	57	103.4	65.4	33.6	50.0	0.41	0.22	0.35	0.91	0.49
Sep 1	57	103.8	64.9	35.7	50.0	0.41	0.21	0.35	0.85	0.49
Sep 15	63	105.6	61.0	40.4	50.0	0.36	0.21	0.37	0.73	0.49
					Average Habitat	0.27	0.13	0.20	0.40	0.49

Table H-5 Flows and habitat values for the Little Spokane River at Chattaroy mountain whitefish fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					Mountain Whitefish Fry Habitat Relative to Optimum Habitat				
Date	MISF	Flow Exceedance			WP	MISF	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	70	102.7	67.6	47.3	50.0	0.98	0.82	0.98	0.98	0.99
Oct 15	77	107.1	64.4	37.5	50.0	0.93	0.81	0.99	0.91	0.99
Nov 1	86	125.9	70.0	51.9	50.0	0.88	0.78	0.98	1.00	0.99
Nov 15	86	144.8	83.7	67.0	50.0	0.88	0.70	0.89	0.98	0.99
Dec 1	86	184.5	101.5	76.7	50.0	0.88	0.53	0.83	0.94	0.99
Dec 15	86	197.8	118.1	71.9	50.0	0.88	0.49	0.79	0.97	0.99
Jan 1	86	215.9	128.7	88.8	50.0	0.88	0.45	0.78	0.86	0.99
Jan 15	86	202.3	128.6	85.7	50.0	0.88	0.48	0.78	0.88	0.99
Feb 1	86	240.2	114.9	89.3	50.0	0.88	0.39	0.80	0.86	0.99
Feb 15	104	285.4	119.4	82.0	50.0	0.82	0.32	0.79	0.91	0.99
Mar 1	122	435.8	181.9	99.3	50.0	0.79	0.22	0.54	0.83	0.99
Mar 15	143	478.4	222.9	117.8	50.0	0.71	0.25	0.43	0.79	0.99
Apr 1	165	610.4	245.5	139.2	50.0	0.61	0.32	0.38	0.72	0.99
Apr 15	143	460.5	292.2	133.5	50.0	0.71	0.23	0.30	0.76	0.99
May 1	124	422.5	252.5	120.7	50.0	0.78	0.21	0.37	0.79	0.99
May 15	104	347.6	183.0	92.5	50.0	0.82	0.22	0.54	0.85	0.99
Jun 1	83	281.4	152.0	70.8	50.0	0.90	0.33	0.68	0.97	0.99
Jun 15	69	283.0	130.7	61.9	50.0	0.98	0.33	0.77	1.00	0.99
Jul 1	57	209.5	108.8	60.1	50.0	1.00	0.46	0.81	1.00	0.99
Jul 15	57	176.4	94.0	51.4	50.0	1.00	0.56	0.85	1.00	0.99
Aug 1	57	133.8	77.9	41.0	50.0	1.00	0.75	0.93	0.94	0.99
Aug 15	57	103.4	65.4	33.6	50.0	1.00	0.82	0.99	0.88	0.99
Sep 1	57	103.8	64.9	35.7	50.0	1.00	0.82	0.99	0.90	0.99
Sep 15	63	105.6	61.0	40.4	50.0	0.99	0.82	1.00	0.94	0.99
Average Habitat						0.88	0.51	0.76	0.90	0.99

Table H-6 Flows and habitat values for the Little Spokane River at Chattaroy mountain whitefish juvenile life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					Mountain Whitefish Juvenile Habitat Relative to Optimum Habitat				
Date	MISF	Flow Exceedance			WP	MISF	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	70	102.7	67.6	47.3	50.0	0.63	0.82	0.61	0.47	0.49
Oct 15	77	107.1	64.4	37.5	50.0	0.67	0.84	0.59	0.39	0.49
Nov 1	86	125.9	70.0	51.9	50.0	0.71	0.94	0.63	0.51	0.49
Nov 15	86	144.8	83.7	67.0	50.0	0.71	0.98	0.70	0.61	0.49
Dec 1	86	184.5	101.5	76.7	50.0	0.71	1.00	0.81	0.67	0.49
Dec 15	86	197.8	118.1	71.9	50.0	0.71	1.00	0.90	0.64	0.49
Jan 1	86	215.9	128.7	88.8	50.0	0.71	0.98	0.95	0.73	0.49
Jan 15	86	202.3	128.6	85.7	50.0	0.71	1.00	0.95	0.71	0.49
Feb 1	86	240.2	114.9	89.3	50.0	0.71	0.96	0.89	0.73	0.49
Feb 15	104	285.4	119.4	82.0	50.0	0.83	0.89	0.91	0.69	0.49
Mar 1	122	435.8	181.9	99.3	50.0	0.92	0.69	1.00	0.80	0.49
Mar 15	143	478.4	222.9	117.8	50.0	0.97	0.68	0.98	0.90	0.49
Apr 1	165	610.4	245.5	139.2	50.0	0.99	0.66	0.95	0.97	0.49
Apr 15	143	460.5	292.2	133.5	50.0	0.97	0.68	0.87	0.96	0.49
May 1	124	422.5	252.5	120.7	50.0	0.93	0.70	0.94	0.92	0.49
May 15	104	347.6	183.0	92.5	50.0	0.83	0.75	1.00	0.75	0.49
Jun 1	83	281.4	152.0	70.8	50.0	0.70	0.90	0.98	0.63	0.49
Jun 15	69	283.0	130.7	61.9	50.0	0.62	0.89	0.95	0.57	0.49
Jul 1	57	209.5	108.8	60.1	50.0	0.54	0.99	0.85	0.56	0.49
Jul 15	57	176.4	94.0	51.4	50.0	0.54	1.00	0.76	0.50	0.49
Aug 1	57	133.8	77.9	41.0	50.0	0.54	0.96	0.67	0.42	0.49
Aug 15	57	103.4	65.4	33.6	50.0	0.54	0.82	0.60	0.36	0.49
Sep 1	57	103.8	64.9	35.7	50.0	0.54	0.83	0.60	0.38	0.49
Sep 15	63	105.6	61.0	40.4	50.0	0.58	0.84	0.57	0.42	0.49
Average Habitat						0.72	0.87	0.82	0.64	0.49

Table H-7 Flows and habitat values for the Little Spokane River at Elk rainbow trout fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					**Rainbow Trout Fry Habitat Relative to Optimum Habitat**				
Date	MISF	**Flow Exceedance**			WP	MISF	**Flow Exceedance**			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	38	50.1	45.3	39.4	32.0	0.69	0.50	0.56	0.66	0.77
Oct 15	39	52.3	45.0	39.4	32.0	0.67	0.49	0.56	0.66	0.77
Nov 1	40	54.7	44.5	38.8	32.0	0.65	0.48	0.57	0.68	0.77
Nov 15	40	52.1	45.4	39.7	32.0	0.65	0.49	0.55	0.65	0.77
Dec 1	40	58.2	48.0	38.9	32.0	0.65	0.48	0.50	0.67	0.77
Dec 15	40	56.7	46.6	42.8	32.0	0.65	0.49	0.53	0.60	0.77
Jan 1	40	62.4	49.4	41.4	32.0	0.65	0.48	0.50	0.63	0.77
Jan 15	40	70.3	48.1	41.4	32.0	0.65	0.49	0.50	0.63	0.77
Feb 1	40	73.4	51.1	41.1	32.0	0.65	0.49	0.49	0.63	0.77
Feb 15	43	82.2	53.0	43.9	32.0	0.60	0.51	0.48	0.58	0.77
Mar 1	46	89.4	62.0	44.5	32.0	0.54	0.54	0.48	0.57	0.77
Mar 15	50	86.6	64.7	45.9	32.0	0.50	0.54	0.49	0.54	0.77
Apr 1	54	112.9	72.1	53.1	32.0	0.48	0.44	0.49	0.48	0.77
Apr 15	52	120.8	80.0	58.9	32.0	0.49	0.41	0.49	0.48	0.77
May 1	49	115.2	77.1	57.0	32.0	0.50	0.43	0.49	0.49	0.77
May 15	47	98.2	70.3	55.2	32.0	0.52	0.51	0.49	0.48	0.77
Jun 1	45	86.8	66.2	49.0	32.0	0.56	0.54	0.49	0.50	0.77
Jun 15	43	76.5	59.7	47.5	32.0	0.60	0.49	0.48	0.51	0.77
Jul 1	41.5	71.4	55.1	42.3	32.0	0.63	0.49	0.48	0.61	0.77
Jul 15	39.5	65.0	50.9	43.4	32.0	0.66	0.49	0.50	0.59	0.77
Aug 1	38	56.2	47.4	39.7	32.0	0.69	0.49	0.51	0.66	0.77
Aug 15	38	52.1	45.6	39.6	32.0	0.69	0.49	0.55	0.66	0.77
Sep 1	38	51.7	44.7	38.2	32.0	0.69	0.49	0.57	0.69	0.77
Sep 15	38	51.0	42.9	37.8	32.0	0.69	0.49	0.60	0.69	0.77
Average Habitat						0.61	0.49	0.51	0.60	0.77

Table H-8 Flows and habitat values for the Little Spokane River at Elk mountain whitefish fry life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					Mountain Whitefish Fry Habitat Relative to Optimum Habitat				
Date	MISF	Flow Exceedance			WP	MISF	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	38	50.1	45.3	39.4	32.0	0.89	0.77	0.80	0.87	0.96
Oct 15	39	52.3	45.0	39.4	32.0	0.88	0.76	0.81	0.87	0.96
Nov 1	40	54.7	44.5	38.8	32.0	0.87	0.75	0.81	0.88	0.96
Nov 15	40	52.1	45.4	39.7	32.0	0.87	0.76	0.80	0.87	0.96
Dec 1	40	58.2	48.0	38.9	32.0	0.87	0.73	0.77	0.88	0.96
Dec 15	40	56.7	46.6	42.8	32.0	0.87	0.74	0.79	0.83	0.96
Jan 1	40	62.4	49.4	41.4	32.0	0.87	0.71	0.77	0.85	0.96
Jan 15	40	70.3	48.1	41.4	32.0	0.87	0.67	0.77	0.85	0.96
Feb 1	40	73.4	51.1	41.1	32.0	0.87	0.66	0.76	0.85	0.96
Feb 15	43	82.2	53.0	43.9	32.0	0.83	0.63	0.75	0.82	0.96
Mar 1	46	89.4	62.0	44.5	32.0	0.80	0.60	0.72	0.81	0.96
Mar 15	50	86.6	64.7	45.9	32.0	0.77	0.61	0.70	0.80	0.96
Apr 1	54	112.9	72.1	53.1	32.0	0.75	0.56	0.67	0.75	0.96
Apr 15	52	120.8	80.0	58.9	32.0	0.76	0.54	0.63	0.73	0.96
May 1	49	115.2	77.1	57.0	32.0	0.77	0.55	0.65	0.73	0.96
May 15	47	98.2	70.3	55.2	32.0	0.78	0.58	0.67	0.74	0.96
Jun 1	45	86.8	66.2	49.0	32.0	0.81	0.61	0.70	0.77	0.96
Jun 15	43	76.5	59.7	47.5	32.0	0.83	0.65	0.73	0.78	0.96
Jul 1	41.5	71.4	55.1	42.3	32.0	0.85	0.67	0.74	0.84	0.96
Jul 15	39.5	65.0	50.9	43.4	32.0	0.87	0.70	0.76	0.83	0.96
Aug 1	38	56.2	47.4	39.7	32.0	0.89	0.74	0.78	0.87	0.96
Aug 15	38	52.1	45.6	39.6	32.0	0.89	0.76	0.80	0.87	0.96
Sep 1	38	51.7	44.7	38.2	32.0	0.89	0.76	0.81	0.89	0.96
Sep 15	38	51.0	42.9	37.8	32.0	0.89	0.76	0.83	0.89	0.96
					Average Habitat	0.84	0.68	0.75	0.83	0.96

Table H-9 Flows and habitat values for the Little Spokane River at Elk mountain whitefish juvenile life stage associated with the existing minimum flows (MISF), weekly flow statistics (10%, 50% and 90% exceedence flows), and the Wetted Perimeter flow (WP). The habitat values are normalized and are relative to the maximum useable habitat across the transect based on the peak of the WUW curve.

	Discharges (cfs)					Mountain Whitefish Juvenile Habitat Relative to Optimum Habitat				
Date	MISF	Flow Exceedance			WP	MISF	Flow Exceedance			WP
		10%	50%	90%			10%	50%	90%	
Oct 1	38	50.1	45.3	39.4	32.0	0.87	0.92	0.90	0.88	0.82
Oct 15	39	52.3	45.0	39.4	32.0	0.87	0.93	0.90	0.87	0.82
Nov 1	40	54.7	44.5	38.8	32.0	0.88	0.94	0.89	0.87	0.82
Nov 15	40	52.1	45.4	39.7	32.0	0.88	0.93	0.90	0.88	0.82
Dec 1	40	58.2	48.0	38.9	32.0	0.88	0.95	0.91	0.87	0.82
Dec 15	40	56.7	46.6	42.8	32.0	0.88	0.94	0.90	0.89	0.82
Jan 1	40	62.4	49.4	41.4	32.0	0.88	0.96	0.91	0.88	0.82
Jan 15	40	70.3	48.1	41.4	32.0	0.88	0.98	0.91	0.88	0.82
Feb 1	40	73.4	51.1	41.1	32.0	0.88	0.99	0.92	0.88	0.82
Feb 15	43	82.2	53.0	43.9	32.0	0.89	1.00	0.93	0.89	0.82
Mar 1	46	89.4	62.0	44.5	32.0	0.90	1.00	0.96	0.89	0.82
Mar 15	50	86.6	64.7	45.9	32.0	0.92	1.00	0.97	0.90	0.82
Apr 1	54	112.9	72.1	53.1	32.0	0.93	0.99	0.99	0.93	0.82
Apr 15	52	120.8	80.0	58.9	32.0	0.92	0.98	1.00	0.95	0.82
May 1	49	115.2	77.1	57.0	32.0	0.91	0.98	1.00	0.94	0.82
May 15	47	98.2	70.3	55.2	32.0	0.90	1.00	0.98	0.94	0.82
Jun 1	45	86.8	66.2	49.0	32.0	0.90	1.00	0.98	0.91	0.82
Jun 15	43	76.5	59.7	47.5	32.0	0.89	1.00	0.95	0.91	0.82
Jul 1	41.5	71.4	55.1	42.3	32.0	0.88	0.99	0.94	0.89	0.82
Jul 15	39.5	65.0	50.9	43.4	32.0	0.88	0.97	0.92	0.89	0.82
Aug 1	38	56.2	47.4	39.7	32.0	0.87	0.94	0.91	0.88	0.82
Aug 15	38	52.1	45.6	39.6	32.0	0.87	0.93	0.90	0.88	0.82
Sep 1	38	51.7	44.7	38.2	32.0	0.87	0.92	0.90	0.87	0.82
Sep 15	38	51.0	42.9	37.8	32.0	0.87	0.92	0.89	0.87	0.82
Average Habitat						0.89	0.96	0.93	0.89	0.82

APPENDIX H

ALL STUDY RESULTS

Minimum Instream Flows (MISFs) at Control Points in the Little Spokane River Basin (cfs).

Month	Day	Elk	Chattaroy	Dartford	Confluence
January					
	1	40	86	150	400
	15	40	86	150	400
February					
	1	40	86	150	400
	15	43	104	170	420
March					
	1	46	122	190	435
	15	50	143	218	460
April					
	1	54	165	250	490
	15	52	143	218	460
May					
	1	49	124	192	440
	15	47	104	170	420
June					
	1	45	83	148	395
	15	43	69	130	385
July					
	1	41.5	57	115	375
	15	39.5	57	115	375
August					
	1	38	57	115	375
	15	38	57	115	375
September					
	1	38	57	115	375
	15	38	63	123	380
October					
	1	38	70	130	385
	15	39	77	140	390
November					
	1	40	86	150	400
	15	40	86	150	400
December					
	1	40	86	150	400
	15	40	86	150	400