

## Memorandum

**To:** WRIA 54 and 55/57 Planning Units  
**From:** WRIA 54/57 Spokane River Instream Flow Work Group  
**Date:** June 9, 2008  
**Re:** Instream Flow Recommendations Memorandum for WRIA Planning Units 54 & 55/57

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- At a glance:*
- The formation and work of the Instream Flow Work Group is implementation of a WRIA 55/57 Watershed Plan recommendation (I.E.01).
  - The Instream Flow Work Group was charged with providing minimum instream flow recommendations and proposals to the WRIA 54 and WRIA 55/57 Watershed Planning Units.
  - A minimum instream flow is a state water right established to meet the minimum flows necessary to sustain fish and wildlife as well as to maintain the navigational values, recreation and aesthetic values and water quality of the given water body. A minimum flow established by rule has a priority date, and does not affect use, validity, extent, or priority of senior water rights. However, a change or transfer of a water right can only be approved if there is a finding that existing rights, including the instream flow established in rule, will not be impaired. (See RCW 90.03.380 (1) and RCW 90.44).
  - Instream flows are a framework for water resource management and future water rights decision-making.
  - The Spokane River Instream Flow Work Group provided recommendations on control points and instream flows in the Spokane River.
  - The WRIA 55/57 and WRIA 54 Watershed Planning Units now need to take the information developed by the Work Group to make minimum instream flows recommendations to the Department of Ecology (Ecology)
- Summary of Recommendations:*
- **Control points** – The Work Group agrees to specific control points for management of surface and ground water. See pages 4-5 and Table 1.
  - **Instream flows** – The Work Group did not reach consensus on one minimum instream flow at Spokane Gage, but instead provides several options and accompanying rationales. See pages 5-8 and Table 2a and 2b. The Work Group did not reevaluate the data supporting the 500 cfs summer flow at Barker Road established in the adopted WRIA 55/57 Watershed Plan, but chooses not to recommend changing it (See page 6).
  - **Exempt wells** – The Work Group determined that exempt wells are not a significant issue for the geographic area over the Spokane Valley Rathdrum Prairie (SVRP) Aquifer and recommended not addressing them in the water management rule. The Work Group, however, recommends that each WRIA consider whether or not the water management rule should address exempt wells that are located off the SVRP Aquifer (especially in WRIA 54).
  - **Mitigation** – The Work Group agrees that mitigation measures should be considered by Ecology when it evaluates future water rights

- applications.
- **WRIA 54 Tributaries.** A number of tributaries exist in WRIA 54. These were not addressed by the WRIA 55/57 & 54 Work Group, and it is recommended that this topic be addressed by the WRIA 54 Planning Unit.
  - **Elected officials meeting** – The Work Group recommended that an elected officials meeting should occur within the next 3 months.
  - **Evaluation of future human water needs** – The Work Group agreed that the county should conduct an initial evaluation that better quantifies future human water needs that potentially impact Spokane River flow.
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## Introduction

This Technical Memorandum summarizes the efforts made by the Watershed Resource Inventory Area (WRIA) 54/57 Instream Flow Work Group from July 2007 to May 2008. It is meant to provide the WRIA 54 and WRIA 55/57 Watershed Planning Units the information necessary to make recommendations on instream flows in their respective watersheds. This Technical Memorandum provides background information, control point recommendations, four minimum instream flow proposals made by Work Group participants, information on additional components of instream flows to consider, and next steps.

## Background

The Watershed Planning Act of 1998 (RCW 90.82) encourages local entities in WRIsAs in the State of Washington to develop local watershed plans by assessing and determining how to best manage water resources. To develop watershed plans for the Middle Spokane River and Little Spokane River, WRIsAs 55 and 57 formed a joint Planning Unit and the Lower Spokane River WRIA 54 formed its own Planning Unit. As part of the watershed planning process, Planning Units are given the opportunity to provide the Department of Ecology (Ecology) with a recommendation for an instream flow rule for waters within their WRIA. Further, RCW 90.82 stipulates that Ecology must attempt to achieve consensus within the Planning Unit on minimum flows before being adopted by Ecology. Because the WRIA 55/57 and WRIA 54 Planning Units chose to collaborate, they formed a joint Work Group to consider instream flows for the geographic area comprising WRIsAs 54 and 57 (WRIA 55 – Little Spokane River – was not included since it currently has an instream flow rule, which was adopted in 1976).

Instream flow rules are often referred to as water management rules since they encompass more than a minimum flow at a location for a particular period of time. This memorandum refers to recommendations for inclusion in a water management rule. Some of the components of water management rules include management of exempt wells beyond what is currently stipulated in state law; specific amounts of water not impacted by the instream flow rule, often called reserve water; closures to future appropriations for surface and groundwater; and enforcement, management and permitting actions/priorities.

According to the Department of Ecology Water Resources Program, “[t]he term ‘instream flow’ is used to identify a specific stream flow (typically measured in cubic feet per second, or cfs) at a specific location [a control point] for a defined time, and typically following seasonal variations.” A minimum instream flow is, in essence, a state water right established to ensure that junior water rights do not prevent streams from meeting minimum instream flows necessary to sustain fish and wildlife, to maintain the navigational values, recreation and aesthetic values and to preserve water quality of the given water body. It is important to note that the regulatory flow does not, by itself, ensure that values and uses are protected, or that the minimum instream flows will be met. The

“junior” status of a minimum instream flow means that senior water right holders still could withdraw water when river instream flows drop below the minimum established in the water management rule. An established instream flow gives Ecology the basis to make decisions on new appropriations that will impact the flow in the given water body. A new instream flow rule does not affect existing water rights, although certain changes in senior rights could be subject to the instream flow. Subsequent rights are junior and cannot impair the instream flow.

In August 2007, 27 members from the WRIA 55/57 and WRIA 54 Planning Units formed the WRIA 54/57 Spokane River Instream Flow Work Group (see attachment 1 for the roster of participants). Their goal was to evaluate existing information and studies and to work together to develop a consensus proposal that could be forwarded to each Planning Unit for consideration. Based on the Work Group proposal, the Planning Units would then make their recommendation to Ecology. From July 2007 until May 2008 the Work Group met eight times to discuss options, hear presentations and to share information about the options, alternatives, and proposals available to them. In the spring of 2008, Work Group members will report back to their respective Planning Units with a set of recommendations on how to proceed. This Technical Memorandum contains the results of the Work Group’s process.

### **Studies and Evaluations**

In its effort to develop instream flow recommendations for the Spokane River the following studies, model runs, and memos were reviewed, discussed, and cited frequently during the WRIA 54/57 Instream Flow Work Group’s eight meetings:

**Avista FERC relicensing studies.** These three documents are part of the Federal Energy Regulatory Commission (FERC) relicensing of the Spokane River Project, which includes four hydroelectric dams owned and operated by Avista Utilities:

- Aesthetics Study
- Instream Flow Study
- Recreation Study

**Instream Flow and Fish Habitat Assessment. Northwest Hydraulic Consultants and Hardin-Davis, Inc. June 2004.** This study was undertaken to provide information for the relicensing of the Spokane River Project and for the planning process on the middle Spokane River by WRIs 55/57. The relationship between instream flows and rainbow trout spawning, fry emergence, and summer rearing habitat were examined by employing a Physical Habitat Simulation (PHABSIM) model. This study focused on the mainstem Spokane River from the Post Falls Dam in Idaho, downstream to Evergreen Street, below the confluence with Latah Creek. For most of the study area, spawning and rearing life stages were evaluated. However, only spawning was assessed in the one-mile reach of WRIA 57 below the Monroe Street Bridge.

**Final Technical Report: Spokane River Instream Flow Studies, EES Consulting, May 2007.** EES Consulting conducted instream flow studies at the reach from the Spokane Gage to Seven Mile/Gun Club to characterize the weighted usable area for a collection of transects selected and weighted to represent much of the lower Spokane River. The study looked at habitat availability under various flow regimes for rainbow trout and mountain whitefish.

**Spokane Valley Rathdrum Prairie (SVRP) Aquifer Model Runs.** As part of a Planning Unit support grant from Ecology, Spokane County conducted a number of model scenarios to address numerous Work Group questions. These scenarios, included:

- Bi-state Aquifer Model: run of the use of 100% inchoate water right of Washington water purveyors

- Bi-state Aquifer Model: run on shifting major well locations across the aquifer
- Bi-state Aquifer Model: run on population growth in Idaho and Washington

**GIS Analysis of future exempt wells over the SVRP Aquifer.** Spokane County conducted a GIS analysis to estimate new permit-exempt well potential in the geographic area above the SVRP Aquifer. The analysis quantified the number of undeveloped lots that typically use an exempt well (5 acres and greater) that are outside a defined water service area according to the Spokane County Coordinated Water System Plan.

**Analysis of Instream Flow Results for WRIA 54 and 57 Studies.** Work Group member and consultant to Spokane County, Stan Miller, presented a memorandum at the October 23, 2007 Work Group meeting that provided analysis about water availability at Barker Road Gage, Spokane Gage, and at Monroe Street.

**Lower Spokane River minimum instream flow recommendations.** This joint-Ecology/Washington Department of Fish & Wildlife (WDFW) recommendation memorandum outlined analysis, as well as the state caucus approach to setting control points and instream flows. The Work Group used the analysis contained in this memorandum as a foundation for discussions about potential instream flows at Spokane Gage. The rationale and analysis is outlined in the following sections of this memorandum.

### **Control Points**

Control points are specific locations on a water body that have a designated minimum instream flow amount. In order to implement the rule it is necessary to have the ability to measure flow at that point, thus control points are usually established where there is an existing gauge or a location where one can be installed. Instream flows measured at specific control points can be used as proxies for nearby river reaches or tributaries. According to the joint Ecology/WDFW document titled, *A Guide to Setting Instream Flows in Washington State*, “[s]ince resources and management objectives may vary among sub basins, instream flow recommendations usually include multiple flow control points for a watershed. Additional control stations can provide data to focus and facilitate the development of water management solutions at the subbasin level.” Because of the dynamic nature of the Spokane River and its interaction with the SVRP Aquifer, choosing the appropriate control points that are both technically accurate and practical for use have been considered by the Work Group. The Spokane River Instream Flow Work Group proposes using control points to regulate both ground and surface water.

In December 2007, John Covert of Ecology presented background information about the pros and cons of using certain control points along the middle and lower reaches of the Spokane River. Potential control points included Barker Road Gage (already an established gage), Spokane Gage (already an established gage), Seven Mile/Gun Club (a stream flow gage at this site existed in the late 1940s and early 1950s, but was discontinued), Nine Mile Dam, and at the Little Falls Dam. The Work Group heard and discussed the advantages and disadvantages of using the various sites. Factors included:

- assessing the accuracy of measuring flows affected by hydropower operations
- practicality of using an established gage;
- technical considerations;
- avoiding the regulatory confusion of too many control points; and
- costs to establish, operate, and maintain a new gage.

The Work Group reached agreement on pursuing several options regarding surface and ground water control points located within the SVRP Aquifer area of WRIs 54 and 57. For surface

water applications, the Work Group reached consensus to use the Barker Road Gage for regulating surface water from Sullivan Road Bridge to the Idaho state line, and it agrees to use the Spokane Gage for regulating surface water from Sullivan Road Bridge to the Seven Mile Bridge (This control point boundary has also been referred to as the upper end of the Nine Mile pool. For the purposes of regulation, the Seven Mile Bridge provides a more consistent boundary, whereas the Nine Mile pool fluctuates according to pool depth.).

For new groundwater applications within the SVRP Aquifer from Seven Mile Bridge to the Idaho state line, the Work Group recommends using the Spokane Gage as the control point. An issue to be considered by the State of Washington is how groundwater within Hillyard Trough area will be managed (The Department of Ecology agreed to evaluate this and make a recommendation). Finally the Work Group supports the installation of an informational stream flow gage at the former gaging site at Nine Mile, if and when funding is available and if some technical issues are resolved with providing consistent measurements at the gaging site

Please see the following table for a summary of the control point recommendations supported by the Work Group:

**Table 1. Control Point Recommendations made by the Spokane River Instream Flow Work Group.**

Recommendation	Control Point	Type	Geographic Area	Notes
# 1	Barker Road Gage	- Surface water	- Controls surface water from Sullivan Road Bridge to the Idaho state line	The Work Group reached consensus on using this gage as a control point
#2	Spokane Gage	- Surface water - Ground water	- Controls surface water between Seven Mile Bridge and Sullivan Road Bridge  - Controls groundwater within the SVRP Aquifer from Seven Mile Bridge to the Idaho state line (with certain stipulations within the Hillyard Trough area)	Using the SVRP Aquifer model and tools under development, Ecology will define the area where the rule will apply for groundwater and will report back on their findings for consideration (area of control in WRIA 54 & 57).
# 3	Nine Mile	N/A	N/A	The Work Group supports the installation of a gage at Nine Mile with certain stipulations.

### Instream Flows

Establishing minimum instream flows are an important component to protecting instream watershed values, including the recreation, aesthetic, water quality, navigational values, and fish and wildlife habitat values of the Spokane River. Additionally, instream flows help provide certainty for future water management decisions within WRIAs 54 and 57. Ecology will use the

minimum instream flows established for the Spokane River by rule as they evaluate subsequent water right applications.

The Work Group proposes setting instream flows at two locations, Barker Road Gage and Spokane Gage. The Work Group did not analyze the data supporting the 500 cfs summer flow at Barker Road established in the adopted WRIA 55/57 Watershed Plan, but chose not to change that recommendation at this time (see Table 2a). Because the Barker Road Gage measures a reach of river that reflects releases from the reservoir behind Post Falls Dam, the minimum instream flow is limited to controlling surface water withdrawals upstream from Sullivan Road to the Idaho state line.

For considering minimum instream flows at the Spokane Gage, the Work Group began the instream flow recommendation process by discussing the various reports and findings. Members then requested that Ecology and WDFW make a recommendation to the Work Group prior to entertaining potential options. Following the State Caucus's presentation of its recommendation, Work Group members considered the State's recommendation as well as studies and analysis, specific Work Group member recommendations, and Work Group discussions. While the Group worked hard, members were not able to reach a consensus recommendation on instream flow numbers to provide the two Planning Units. Five instream flow proposals were developed for the Spokane Gage along with supporting rationale for four of the five proposals.

The WRIA 55/57 Watershed Plan recommendation for Barker Road Gage follows in Table 2a and the proposals for Spokane Gage are summarized in Table 2b:

**Table 2a. Minimum Instream Flow Recommendation at Barker Road Gage**

Date	Recommendation
June 16 – September 30	500 cfs

**Table 2b. Minimum Instream Flow Proposals at Spokane Gage from the Work Group.**

Date	State of Washington Caucus (Ecology and WDFW)	Spokane County	City of Spokane Environmental Programs	Environmental and Recreation Communities	Vera Water District
Oct. 1 – Dec. 31	1100 cfs	-	780 cfs	-	-
Jan. 1 – March 31	1100 cfs	-	1100 cfs	-	-
April 1- May 15	3000 cfs (pending revision)	-	2700 cfs	-	-
May 16 - June 15	3000 cfs (pending revision)	-	2300 cfs	-	-
June 16 – Sept. 30	850 cfs	850 cfs	565 cfs	1350 cfs	600 cfs

Rationales for Proposals:

**State of Washington Caucus (Ecology and WDFW).** The minimum instream flow recommendation by the State Caucus focuses on identifying suitable conditions for fish, specifically rainbow trout and mountain whitefish. The recommendations rely heavily on considering the weighted usable area (a combination of the elements of habitat quantity and habitat quality) of river habitat for the two species over the course of the water year. Depending on the life histories of each species, minimum instream flows emphasize the needs of one species or other at different periods of the year. Minimum instream flow recommendations in the fall and winter emphasize the fall spawning and the winter incubation, and adult rearing needs of mountain whitefish, whereas the spring instream flow recommendation reflects the needs of spawning rainbow trout. For the summer period we gave emphasis to the rearing needs of juvenile and adult rainbow trout and adult whitefish. The conclusions of the State recommendations are based on a ‘no harm’ principal that is technically defensible. The data underlying this proposal were gathered by the WRIA 54 Planning Unit (EES Consulting, 2007). The state’s analysis of those data is summarized in their complete proposal, attachment 2a.

The State Caucus initially proposed a 3,000 cfs minimum instream flow during April 1-June 15 to protect rainbow trout spawning and incubation. However, during review of the Hardin-Davis, Inc. study (2004) during the drafting of the WA 401 certification of the Avista hydroelectric project (released April 7, 2008), WDFW and Ecology determined that it is essential to further evaluate spawning and incubation needs for rainbow trout.

The State of Washington Caucus provided subsequent technical perspectives and clarifications on instream flows and those are incorporated in the attached technical considerations 2b.

**Spokane County.** Spokane County based its analysis on the habitat studies conducted on the Spokane River by the WRIA 54 Planning Unit (EES Consulting, 2007). In the opinion of county staff, a minimum flow of 850 cfs adheres to the fundamental water resource management principles set by the legislature and declared in RCW 90.54. County staff determined that the large amount (approximately 250 cfs) of inchoate water available and not subject to an instream flow is sufficient to meet human needs for water well into the future, and further appropriation is not warranted. County staff acknowledges that the legislation that establishes the validity of Municipal inchoate water rights is currently facing its first legal challenge and there is a level of uncertainty associated with the validity of inchoate water rights. If in fact inchoate rights are determined invalid, county staff feels it will be essential to recommend a water management rule that recognizes instream needs and the needs of a growing community.

**City of Spokane Environmental Programs.** This proposal according to the City of Spokane Environmental Programs memorandum presented to the Work Group at the January 29, 2008 meeting, “attempts to maintain flexibility in meeting water demand for people while protecting instream flow needs for fish.” The proposed minimum instream flows also reflect the City’s concerns about the uncertainty of water availability in an environmental and legal sense: climate change, legal challenges to existing water law, future growth in Spokane and Idaho, and potential future challenges to water rights (i.e., adjudication). Setting the minimum instream flow close to the Spokane River’s current summer flows would make the prospects for acquiring new water rights greater in the event that the city lost its inchoate rights. The City notes that if minimum instream flows are set too high there will be fewer incentives for water purveyors to pursue a mitigation approach that would result in the issuance of new water rights. Finally, this flow proposal shows the City of Spokane Environmental Programs’ concern for aquatic habitat and human uses, but it rejects the argument that the City of Spokane and other purveyors are solely

responsible for the reduction of instream flows in the summer. For a more complete explanation of this proposal, please see attachment 3a and 3b (the latter document, dated May 5, provides revisions to the original instream flow proposal).

**Environmental and Recreation Communities.** The proposed instream flow is based on navigability needs as identified in the Avista Recreation Flow report. The Environmental and Recreation Communities' proposal is based on the concept of exceedance flows – that is, setting instream flows at a level that protects variability in the river hydrograph to mimic natural conditions (e.g., 90% exceedance levels). The river may not flow at 1350 cfs during summer months every year, but in those years when flows do reach that level, they will be protected from future water right allocations.

The 850 cfs summer low flow recommended by the State Caucus is protective of native fish and should be viewed as a hard target, with the goal of restoring flows to that level (in addition to stopping declining instream flows in the Spokane River). The environmental and recreation communities also believe that setting an instream flow at the 1350 cfs level for the summer/early fall will help the State of Washington negotiate water resource issues with the State of Idaho.

With respect to flows during other times of the year, the Environmental and Recreation proposal does not yet recommend specific flows for times other than the summer flow period, but may make recommendations in the future. A recommendation regarding spawning season will be forthcoming following review and possible revisions of the State Caucus recommendations.

#### **Additional Points to Consider**

The Work Group discussed additional factors to consider in recommending a water management rule. While no specific recommendations on these topics were reached through consensus, it is worthwhile to mention four of the issues that led to a significant amount of discussion at the Work Group meetings:

**Legal Availability of Water.** The Work Group had extensive discussion about this topic, and the following points were agreed upon:

- While there are significant municipal inchoate rights in the basin, there is a wide disparity in distribution of municipal inchoate water rights
- Water rights are not always where water demand is
- Water purveyors expressed hesitancy in requesting Ecology to assist with water right transfers
- New water rights are not being issued. Ecology cannot issue any new water rights that are not interruptible or fully mitigated
- There is concern about the observed decline in 7-day low flows in Spokane River
- Growth in use of municipal inchoate water rights will result in lowered Spokane River flows, as estimated by two groundwater/surface water models

**Exempt wells.** When water rights are not available often the only way to obtain water is through a permit-exempt well. In many areas of the state exempt well use has proliferated. In fact between 2000 and 2007 Spokane County has had the most new exempt wells installed of any county in the state. In an effort to protect stream flows, many water management rules specifically address permit exempt wells and restrict them in some manner beyond what is currently done. The question the Work Group considered was what is the relevance of permit exempt wells over the SVRP Aquifer to a Spokane River instream flow rule? After a GIS analysis was conducted by Spokane County the Work Group determined that exempt well provisions located over the SVRP



Aquifer in the Spokane River water management rule are not needed because virtually the entire aquifer boundary is within an established water district.

**Water quality.** The Work Group discussed concerns about water quality issues and setting instream flows at such a low point that lack of flow would negatively impact water quality. It was mentioned that dissolved oxygen modeling done for the proposed Spokane County Water Reclamation Facility was conducted at a flow of 623 cfs which is below the State instream flow recommendation but above the Spokane City Environmental Programs recommendation (HDR Engineering, 2002,) Dissolved oxygen modeling done for the Dissolved Oxygen Total Maximum Daily Load (TMDL) Water Quality Improvement Plan were conducted at a flow of about 500 cfs, which is below the City's recommendations.

**Temperature concerns.** Increased release of water from Post Falls dam would provide for fish habitat in the river down to Flora Road, or where the river is a "losing reach". Beyond the losing reach of the river, the cold water inflow from the aquifer reduces the water temperature, moderating the effects of the warmer discharge release. However, the relationship between releases of water from Post Falls dam, temperature, and effects on fish will be studied and flow releases adjusted, through adaptive management requirements in the FERC relicense/401 certifications (Avista's ID 401 certification, April 2008 draft; FERC License 2545 and 12606, FEIS, July 2008).

**Water reserves.** The Work Group discussed, but did not make a recommendation regarding water reserves. Typically, a reserve for municipal water supply is not included in an instream flow rule in a basin or sub basin where municipal inchoate water rights are adequate to meet future demand. When considering water reserves in other WRIAs Ecology has employed a 1-2% habitat loss standard. The amount is calculated using a flow that corresponds to a 1-2% loss of habitat during the low flow month of August during a low flow year (one-in-ten year low flow). The percentage of habitat loss would be determined by evaluating the WUA curves in the instream flow studies. This amount of a reserve flow is relatively small for human needs, especially when compared to inchoate rights on the order of approximately 250 cfs. The Work Group has questions about whether this formula applies to a larger river like the Spokane River. Ecology has indicated that the specifics of each water body and the watershed itself are considered when Ecology makes its decision, and the factors mentioned above are guidance.

**Mitigation/Restoration/Water Banking.** Various members of the Work Group discussed the importance of conservation and restoration measures in order to improve instream flows in the Spokane River and its tributaries. The Work Group agrees that mitigation measures should be considered by Ecology when it evaluates water right applications. Additionally the Work Group noted that water banking opportunities should be encouraged.

**WRIA 54 Tributaries.** A number of tributaries exist in WRIA 54. These were not addressed by the WRIA 55/57 & 54 Work Group, and it is recommended that this topic be addressed by the WRIA 54 Planning Unit.

## **Next Steps**

**Elected Officials Meeting.** The Work Group decided it would be important to hold an elected officials meeting on June 26. Members expressed an interest to present elected officials with the specifics and issues surrounding setting instream flows information. Such a meeting would allow all elected officials to be presented information in one setting so that what they hear is consistent. A policy discussion would also occur that could lead to policy directions for the two Planning Units.

**Future Human Water Use Estimate.** The Work Group agreed that Spokane County should develop information on what the estimated future human water needs are in the basin so that instream flows can be balanced against future demands.

## References & Resources

EES Consulting, *Final Technical Report: Spokane River Instream Flow Studies*, Spokane County Public Works Department and WRIA 54 & 57 Watershed Planning Units, May 2007.

HDR Engineering, Inc., *2002 Spokane County Wastewater Facilities Plan (Final)*, Spokane County Public Utilities. Spokane, WA. December 2002.  
(<http://www.spokanecounty.org/utilities/RptDoc/fwwfp/FFP%2000aCover.pdf>, accessed June 9, 2008).

Northwest Hydraulic Consultants and Hardin-Davis, Inc. 2004. *Instream Flow and Fish Habitat Assessment*, FERC Project No. 2545, Avista Corporation. Prepared for the Avista Corporation and WRIA 55/57 Watershed Planning Units.

Revised Code of Washington RCW 90.03.380 (1), Right to water attaches to land — Transfer or change in point of diversion — Transfer of rights from one district to another — Priority of water rights applications — Exemption for small irrigation impoundments.  
(<http://apps.leg.wa.gov/RCW/default.aspx?cite=90.44>, accessed June 9, 2008).

Revised Code of Washington RCW 90.44, Regulation of public groundwaters  
(<http://apps.leg.wa.gov/RCW/default.aspx?cite=90.03.380>, accessed June 9, 2008).

Revised Code of Washington RCW 90.54, Water Resources Act of 1971  
(<http://apps.leg.wa.gov/rcw/default.aspx?Cite=90.54>, accessed June 9, 2008).

Revised Code of Washington RCW 90.82, Watershed Planning  
(<http://apps.leg.wa.gov/rcw/default.aspx?cite=90.82>, accessed June 9, 2008).

Spokane County. Spokane River Instream Flow Work Group: WRIA 55/57 & WRIA 54 Watershed Planning Units (<http://www.spokanecounty.org/wqmp/ISFWG/asp/Home.asp>, accessed March 23, 2008).

Washington State Department of Ecology, *A Guide to Instream Flow Setting in Washington State*. Lynne D. Geller ed., Water Resources Program, Washington Department of Ecology; Habitat Program, Washington Department of Fish & Wildlife, March 2003.

Washington State Department of Ecology, *Instream Flows in Washington*. Water Resources Division Information Page. (<http://www.ecy.wa.gov/programs/wr/instream-flows/isfhm.html>, accessed March 23, 2008).

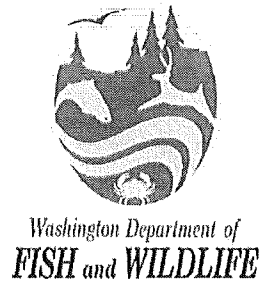
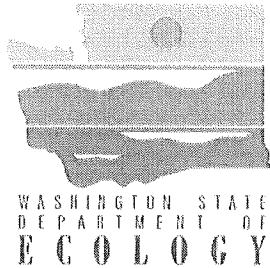
## Attachments

Please see the following attachments that were referenced in *Instream Flow Recommendations Memorandum for WRIA Planning Units 54 & 55/57*:

- **Attachment 1:** WRIA 54/57 Spokane River Instream Flow Work Group Roster
- **Attachment 2a:** Lower Spokane River minimum instream flow recommendations. (Joint Ecology/WDFW memorandum)
- **Attachment 2b:** Technical Comments from the State Caucus
- **Attachment 3a:** January 29, 2008 Instream Flow Proposal from the City of Spokane Environmental Programs
- **Attachment 3b:** May 5, 2008, Instream Flow Proposal from the City of Spokane Environmental Programs

**Attachment 1: WRIA 54/57 Spokane River Instream Flow Work Group Roster**

1. Albert Tripp – *City of Airway Heights*
2. Bart Haggin – *Lands Council*
3. Bea Lackaff – *Citizen/Landowner*
4. Brian Crossley – *Spokane Tribe*
5. Brian Walker – *Lands Council*
6. Charlie Peterson - *Spokane County Conservation District*
7. Craig Volosing – *Palisades Neighborhood/Landowner*
8. David Luders – *Fairchild Air Force Base, Indian Village Estates Water Association*
9. Guy Gregory – *Department of Ecology*
10. Hank Nelson – *Avista Utilities*
11. Harry Mclean – *City of Spokane*
12. Jeanne Barnes – *Lake Spokane Park Homeowners Association*
13. John Covert – *Department of Ecology*
14. John Patrouch – *Northwest Whitewater Association, Spokane Canoe and Kayak Club*
15. Kristine Graf – *City of Spokane*
16. Lloyd Brewer – *City of Spokane*
17. Mark Wachtel – *Washington Department of Fish and Wildlife*
18. Mike Hermanson – *Spokane County*
19. Rachael Paschal Osborn – *Sierra Club & Center for Environmental Law and Policy*
20. Reanette Boese – *Spokane County*
21. Rob Lindsay – *Spokane County*
22. Sara Hunt – *Department of Ecology*
23. Stan Miller – *Consultant to Spokane County*
24. Steve Skipworth – *Vera Water District*
25. Tim Vore – *Avista Corporation*
26. Ty Wick – *Aquifer Joint Board*
27. Wes McCart – *Stevens County Farm Bureau, Stevens County Water Conservancy Board*



January 14, 2008

TO: Rob Lindsay, Spokane River Watershed Planning Units 54 and 55/57  
Spokane County Public Works Department, Water Resources

FROM: Sara Hunt, Watershed Lead *Sara Hunt*  
Department of Ecology

SUBJECT: Lower Spokane River minimum instream flow recommendations

### Summary

As explained below, our recommended minimum instream flows as measured at the Spokane 'at Spokane gage' are:

January 1 – April 1	1,100 cfs
April 1 – June 15	3,000 cfs
June 16 – September 30	850 cfs
October 1 – December 31	1,100 cfs

### Introduction

The State Caucus, composed of the Washington Departments of Ecology (Ecology) and Fish and Wildlife (WDFW), present these recommendations for minimum instream flows for the Lower Spokane River and for a Control Point to implement those flows. These recommendations are based on the Final Technical Report: Spokane River Instream Flow Studies prepared for Spokane County Public Works Department and WRIA 54 & 57 Watershed Planning Units; EES Consulting; May 2007. We believe these recommendations represent technically appropriate, defensible minimum instream flow values that protect and preserve instream resources as required under Chapters 90.22, 09.54, and 90.82 RCW. We look forward to meeting with the planning units and the Instream Flow Work Group to answer any questions you may have.

### Control Point

The Control Point recommended by the state caucus to be used to implement these minimum flows is the existing USGS streamflow gaging station known as the Spokane River 'at Spokane' gage (ID# 12422500). This gage site was chosen for practical as well as technical considerations:

- This gage is the oldest operating site in the state of Washington, measuring flows continuously since 1891.
- It is telemetered, allowing real-time access to flow information from the Internet.
- It has a funding mechanism in place (Avista and the City of Spokane).

The alternative site, the 'Gun Club' site, is the location of a gaging station operated by the USGS for a brief period in the late 1940s and early 1950s. To re-establish this site as a Control Point requires securing a funding mechanism (in perpetuity) to pay for operating the gage, telemetry equipment, establishment of a new rating curve, and compilation of the data.

The recommended instream flow value for the "summer low flow" period (June 16 – September 30) is based on data collected at both the 'at Spokane' and 'Gun Club' sites. The flow/habitat numbers are weighted to account for increases in flow that occur between the upstream and downstream locations. As such, the recommended minimum flow represents habitat values at both locations.

In the 'at Spokane' section of the River, rainbow trout spawning habitat is much more sensitive to flow fluctuation in the critical spring time period than is habitat at the 'Gun Club' location because of the presence of lateral gravel bars in the river channel. This sensitivity leads the 'at Spokane' site to be chosen as the Control Point.

Establishing a single Control Point for this section of the River eliminates the regulatory confusion that would result from two independent instream flows established at two sites located within 10 river miles of each other.

#### **Minimum Instream Flow Recommendations**

Field work characterizing the weighted usable area (WUA) for various transects in the Spokane River between downtown Spokane and the Gun Club (River Miles 73.8 to 63.8) was conducted by EES Consulting under contract with the WRIA 54 and 57 Watershed Planning Units. Fisheries biologists for the Washington Department of Fish and Wildlife and the Washington Department of Ecology have analyzed the data and derived instream flow recommendations.

#### *Combined weighted useable area curve*

We reviewed the lower Spokane River instream flow study results and compiled WUA results as depicted in the combined percentages graphic (Figure 1). The combined WUA curve was derived giving 80% weight to the Gun Club site and 20% weight to the site near the Spokane gage; giving equal weighting of rainbow trout juvenile/adult with whitefish adult; and allowing for 200 cubic feet per second (cfs) more at Gun Club than at Spokane gage.

Weighting values were derived from the dataset. When EES Consultants evaluated habitat at different transects to see if they were adequately covering the reach of interest, they placed markers at regular intervals along the river from the falls to the Nine-Mile Reservoir backwater (full pool). As these were placed at regular intervals, the number of

markers was proportional to the length of the reach. Eighty percent were in the WRIA 54 reach and 20% were in the WRIA 57 reach. As each site represented its respective reach, with transect weighting to ensure representation, weighting the two sites 80-20% should reflect the general character of the lower Spokane River. The weighting is consistent with guidance provided by WDFW's Fish Program staff in Spokane.

As noted above, flows listed in this memo relate back to measurements from the 'at Spokane' gage. Linear interpolation is used where necessary to calculate WUA at Spokane when Gun Club equivalent flow was not listed in the EES report table.

#### *Summer minimum instream flows*

The weighted combination of rainbow and whitefish peaks at 1,100 cfs. This is 81% of rainbow WUA (peak at 400 cfs) and 95% of whitefish WUA (peak at 1,500 cfs). See Figure 1. To achieve similar WUA levels for both species (about 88% of peak WUA), a flow of 850 cfs should be protected. Thus, we recommend 850 cfs as the summer (June 16-September 30) instream flow measured at the Spokane gage.

#### *Fall and winter minimum instream flows*

In fall and winter (October 1-March 31), we emphasized whitefish in the balance of the two species. A flow of 1,100 cfs would have to be protected which is consistent with WDFW Fish Program guidance. Rainbow trout juvenile and adult WUA were used in conjunction with whitefish for fall and winter, rather than winter rainbow trout only, because while rainbow juvenile and adult response is appropriate at least through October and some of November, rainbow trout winter criteria were developed in small, steep mountain streams and are not directly analogous to this situation. Rainbow trout winter WUA peaks at the lowest flow modeled (350 cfs). Alternatively, whitefish spawning peaks at 1,500 cfs in the lower river and is a fall behavior. In winter, rainbow trout have lower metabolic rates and tolerate more crowding than when they are active, thus the risks to rainbow trout by seeing natural (existing range) winter flows is not great; we do not believe that winter flow-dependent habitat is a major limiting factor for rainbow trout in the Spokane River, nor that decreasing winter flows would result in significant benefits for trout. The winter flow thus emphasizes protection of whitefish spawning.

#### *Spring minimum instream flows*

In the lower river, rainbow trout spawning WUA peaks at 1,000 cfs, but in the "at Spokane" reach, where spawning habitat is much more sensitive to flow fluctuation because of lateral gravel bars, spawning WUA peaks at 3,200 cfs. Incubation flows are at least as important as spawning flows to maximize effective spawning, but these vary depending on actual flows during spawning. It is important to keep redds (nests) wetted during incubation. Flows considerably higher than 3,000 cfs can be expected during spawning season most years. If flows of 3,000 cfs measured at the Spokane gage are protected from April 1-June 15, most spawning and incubation will be protected.

#### **General Considerations in Evaluating Potential Instream Flows**

Native fish have survived natural flows for thousands of years. We should be very cautious about expectations of improvement (increased fish production) through flow

reduction. Where several species and life stages coexist, all must be considered. Much like the physicians' rule, "First, do no harm," we need to consider individual responses and avoid conditions that sharply reduces habitat for any one species or life stage or stream segment.

### **Recommendations**

Based on the discussions above, our flow (cfs at Spokane 'at Spokane' gage) recommendations are:

January – April 1	1,100 cfs
April 1 – June 15	3,000 cfs
June 16 – September 30	850 cfs
October 1 – December 31	1,100 cfs

Please refer to Figure 2, two exceedance probability curves for the Spokane River 'at Spokane' gage, which include the instream flow recommendations for comparison.

Cc:

Bob Wheeler, Triangle Assoc.  
Hal Beecher, WDFW  
Doug Robison, WDFW  
Mark Wachtel, WDFW  
Brad Caldwell, Ecology  
John Covert, Ecology  
Guy Gregory, Ecology  
Brian Farmer, Ecology  
Dave Knight, Ecology

Figure 1

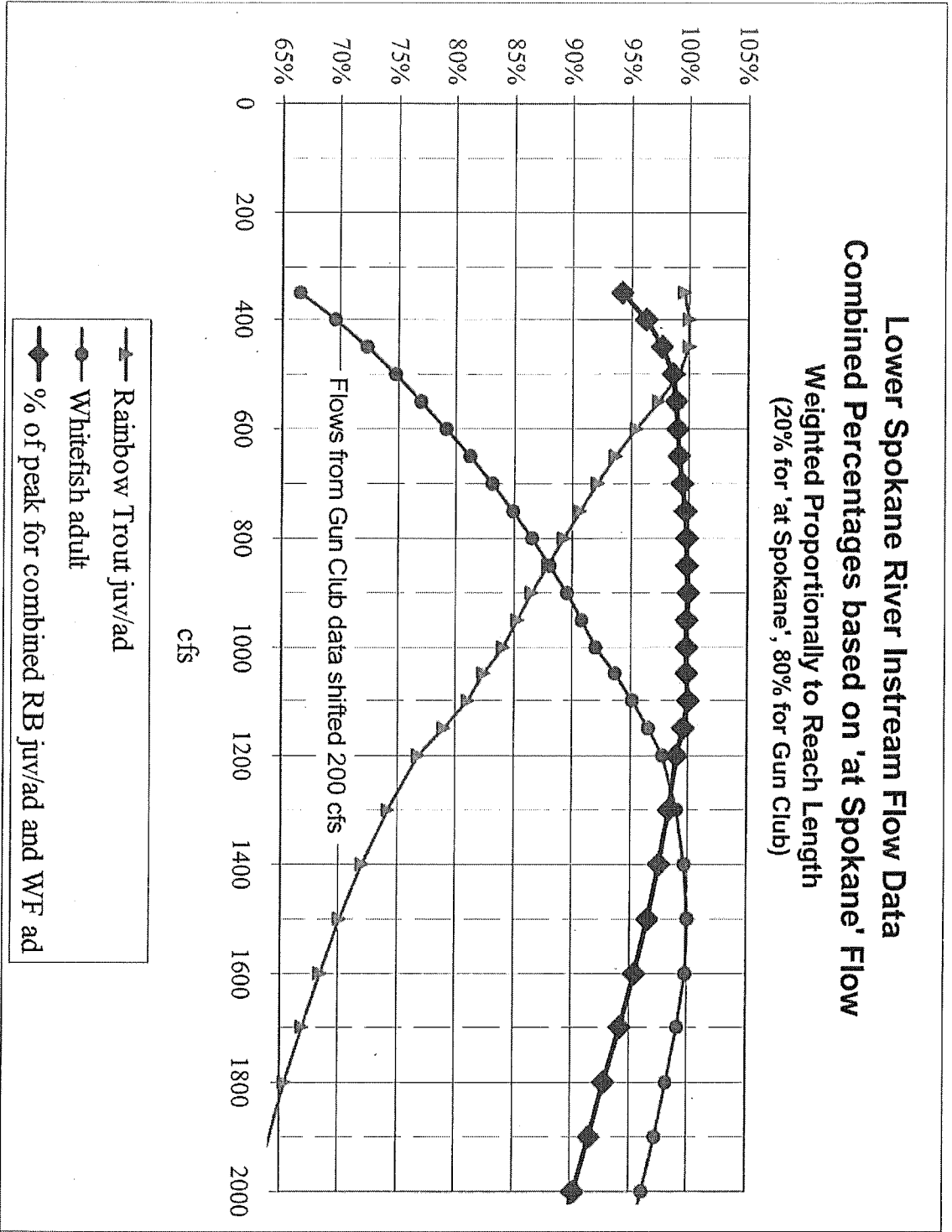
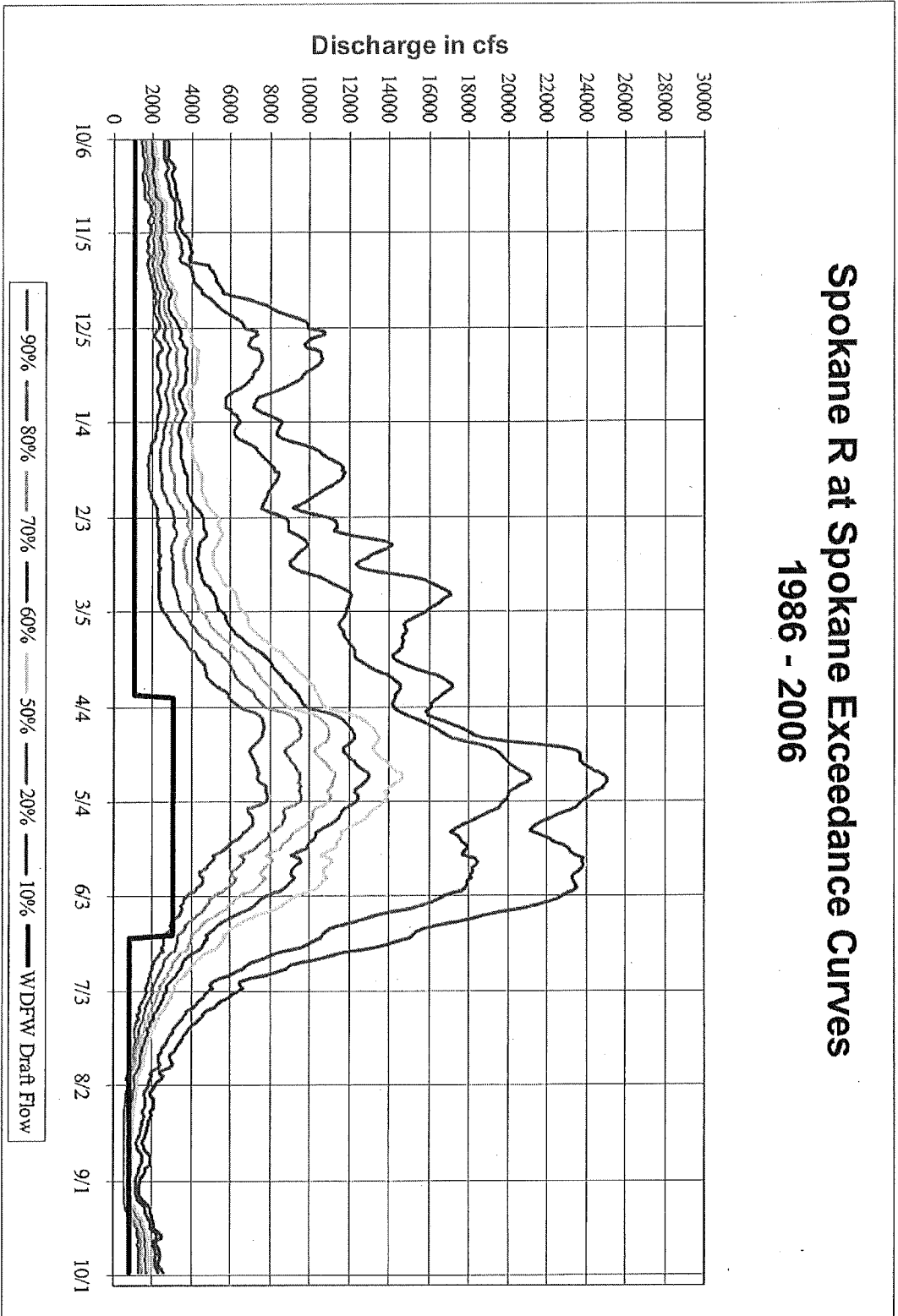


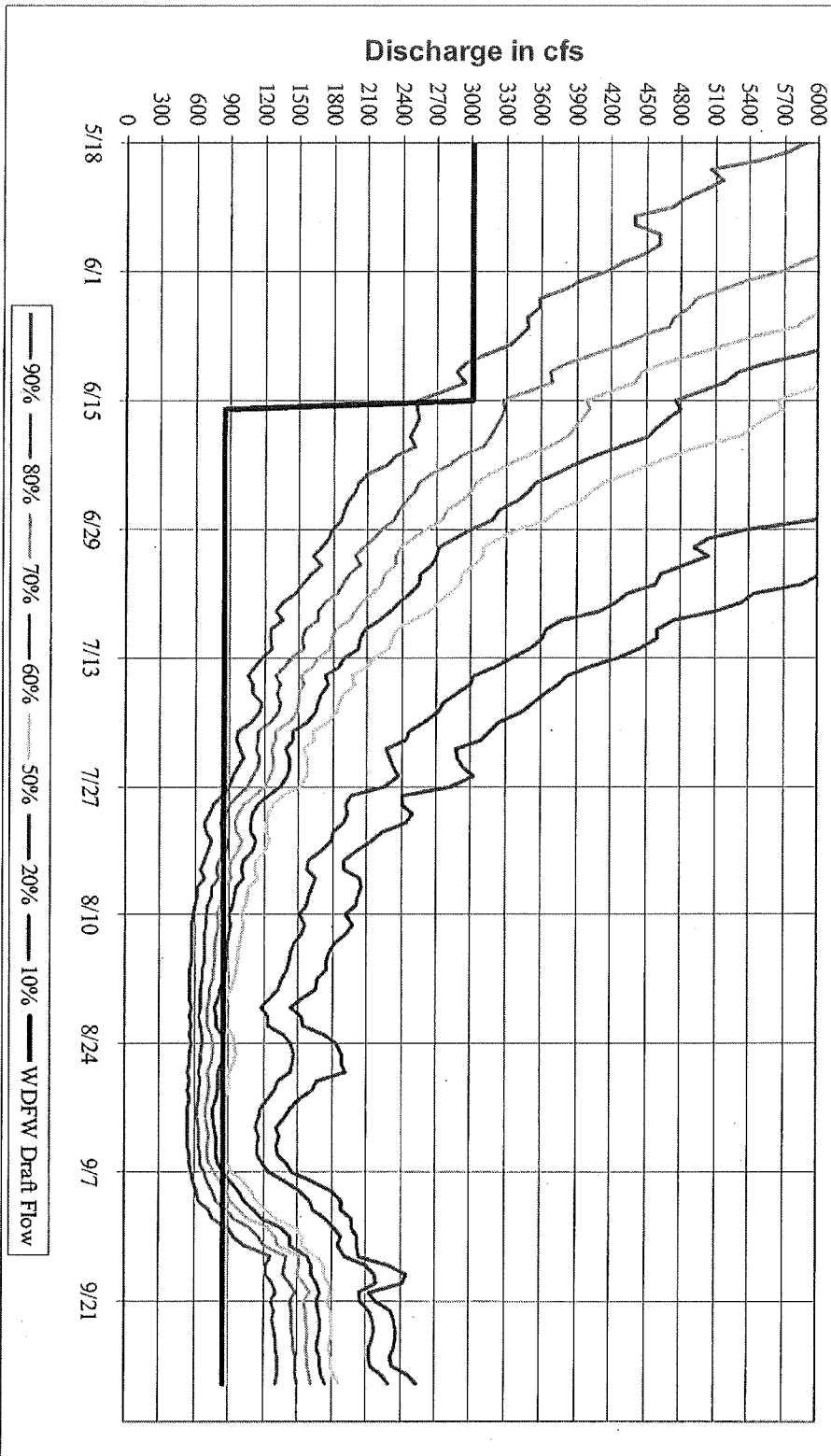


Figure 2

# Spokane R at Spokane Exceedance Curves 1986 - 2006



# Spokane R at Spokane Exceedance Curves 1986 - 2006



## Attachment 2b: Technical Comments from the State Caucus

**Fish Habitat.** The EES instream flow study stated they omitted a key lower river spawning area in the vicinity of Peaceful Valley below the falls (see the earlier study conducted by Dr. Hardin for the upper river, which also addressed spawning at Peaceful Valley). Hardin's lowest study site was Peaceful Valley, not far upstream from the uppermost EES transect. Hardin assessed transects in a spawning area that Avista and WDFW had identified as an important lower river spawning area. According to a Parametrix (2003) survey, important spawning habitat occurs at T.J. Meenach Springs (RM 70.1) and Riverbend Bar (RM 68.4), approximately 3.5 miles above the WRIA 54 study site. These areas are probably the most important spawning areas in the lower river. In the upper river (e.g., at Barker) the state caucus did not recommend spring spawning-incubation flows, either, for an instream flow rule. Instead, they addressed spring spawning-incubation flows through real-time flow management as part of the Avista relicensing. Nevertheless, the instream flow needed to protect spawning and incubation at this sensitive lower river spawning area needs to be addressed more effectively in the rule. The rule and real-time flow management for hydroelectric project mitigation are related but not identical processes. It is necessary to develop recommendations so that the two processes are consistent, even if the rules and conditions are different.

The City's proposal maximizes Weighted Useable Area (WUA) for rainbow trout during the summer, but provides only about 77% of whitefish habitat. The model probably understates rainbow trout habitat at higher flows, but is probably realistic from 450 cfs down to lower flows (as discussed below). This is because PHABSIM models trout habitat based on water velocity at 60% of the depth, which is reasonable for wadeable streams (where habitat suitability criteria for trout were developed), but in a bigger, deeper river such as the Spokane, trout will be deeper, avoiding the faster water at 60% depth. Whitefish, on the other hand, are almost always in bigger rivers and suitability criteria for them are based on their being in big rivers.

In spring, the concern is for rainbow trout spawning and incubation. Spawning flows are quite different from year to year. If flow is reduced too rapidly, incubating eggs will be lost. Detailed analysis based on spawning flows would be needed to determine the sensitivity of incubation at the City's proposed flow, and it would be different in different years, depending on magnitude of spring runoff flows.

The Weighted Useable Area (WUA) results from the EES study show that 1350 cfs at the Spokane gage (Spokane River at Spokane) provides about 99.5% of maximum WUA for mountain whitefish, the most abundant salmonid fish in the Spokane River. Mountain whitefish peaks at 1,500 cfs (using the weighted 80% WRIA 54 and 20% WRIA 57 results). Clearly, 1350 cfs is not harmful to whitefish, compared to the proposed state caucus flow in summer. Whitefish normally inhabit bigger rivers, so the habitat suitability criteria are appropriate for the Spokane River.

Rainbow trout juvenile and adult rearing during summer have a maximum WUA at 400 cfs, with 88% at 850 and 73% at 1350 cfs. Although strict reference to WUA suggests loss of habitat from 400 to 850 to 1350 cfs, this assessment should be tempered by the circumstances for the habitat suitability determination. Habitat suitability criteria for rainbow trout were determined (through measurement of depths and velocities selected and not selected by fish during snorkeling observations) in streams much smaller than the Spokane River, with generally slower and shallower water available to them. Rainbow trout juvenile and adult WUA declines at higher flows as velocities in cells exceed optimal velocities. In very high velocity streams (e.g., Sullivan Creek near Metaline Falls), we see fish staying close to the bottom in deep water, indicating a

behavioral accommodation of the fish to deep, fast water by staying in a lower velocity layer; that would suggest that in deeper water, such as the Spokane River in the canyon, fish will use water that the model, which simulates velocity at 60% of the depth rather than 80-95% of the depth, predicts to be less usable. The outcome would be that habitat does not decline at higher flows as much as the model implies, although the lower flow end of the model is probably reliable.

WDFW and Ecology are unaware of any rivers in the Pacific Northwest where high flow during summer is a limiting factor for fish. In most cases all evidence suggests that summer low flows limit fish.

**Water Quality.** The waste load allocations for phosphorus under the proposed Dissolved Oxygen (DO) Water Quality Improvement Plan (or TMDL) for the Spokane River were developed using the CE-QUAL-W2 model based on 2001 flows in the river (*Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load. Water Quality Improvement Report.* WA Department of Ecology Publication No. 07-10-0703. September 2007). This year was a drought year, and minimum low flows of about 500 cfs were reached. The State recommended 850 cfs would be protective of minimum flows needed to dilute the phosphorus at the current load allocations. If use of inchoate rights would cause river flows to drop below 500 cfs, water quality impacts are likely as the waste load allocations are modeled on a summer low flow of about 500 cfs. In this scenario it will be difficult to meet the minimum water quality standards for phosphorus and other parameters.

CITY OF SPOKANE ENVIRONMENTAL PROGRAMS

Dave Mandyke, Acting Director Public Works & Utilities  
Lloyd Brewer, Environmental Programs Manager



29 January 2008

WRIA In-stream Flow Subcommittee:

City Environmental Programs recommends the following minimum instream flow settings for the Spokane River at the Cochran gage (USGS Spokane at Spokane):

January 1 through March 31	800
April 1 through June 15	1500
June 16 through September 30	425
October 1 through December 31	550

These recommendations are made in the spirit of open discussion in the collaborative process and therefore should not be considered final City of Spokane positions. The Spokane City Council and the Administration have made it clear that while Environmental Programs staff are authorized to participate in these discussions, the Council and Administration reserve the right under the Watershed Planning Act to engage in any final decision regarding minimum instream flow recommendations that the Watershed Planning Units might forward to Ecology.

The City recommendation at this time attempts to maintain flexibility in meeting water demand for people while protecting instream flow needs of fish. We are in a very unsettled time due to climate change, and changes and challenges in water law, where human need for water, and the need to get that water in a very energy efficient manner, may easily come in conflict with where water is, and who has what rights to it. Water right that the City holds which is not currently put to beneficial use (inchoate water) is water that remains in the ground and the City's use of that right is regulated by law including requirements for conservation. When minimum instream flow rules restrict water availability pressure is brought to bear on those who have inchoate right. These pressures, both economic and political, will result in the use of the water but not necessarily in the most environmentally responsible way. The City's proposed minimum flows attempt to relieve some of this pressure thereby maintaining some flexibility for regulators and purveyors alike in meeting and balancing future needs.

The City recognizes the legal framework that Ecology and the watershed planning unit operate in. In particular we know that flow recommendations must be made with the protection and benefit of the fishery in mind. While the average daily flows we are recommending today are below those that have been experienced at this gage in the past (other than one man caused low flow for construction), we are confident that the TMDL improvements in water quality (which represent a very large regional commitment of resources) in combination with the proposed flow minimums will result in a net enhancement of fishery conditions.

The City appreciates the importance of the aquatic habitat and the importance both to fish and people of healthy flows in our rivers, but we reject the argument that the City of Spokane and other local purveyors are collectively, solely responsible for the summer reduction in minimum flows. The City has worked through the Federal Energy Regulatory Commission – Avista collaborative process to get a minimum flow at Post Falls which we believe will benefit the river and help meet Washington water needs, but we are frustrated by the long running process which does not implement agreements until the new license is fully in effect.

We support the aesthetics flows, recreational flows, and fisheries flows recommendations agreed to by many participants in the FERC-Avista collaborative. Those recommendations provided for the needs of people while cognizant of the variability of flows in the watershed. It is our understanding that the proposed white-water park will be constructed to take advantage of the wide range of flows that the Spokane provides including its minimums.

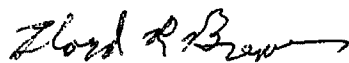
The above recommendations represent a significant shift from our preliminary suggestion of a flow of 550 at Rifle Club (to be adjusted for, and measured below Nine Mile Dam). Our preliminary recommendation was based on an example provided by the WRIA instream flow consultant labeled as having "The priority is maximum ability and flexibility to withdraw water while limiting effects on fish habitat". The Bi-State Aquifer Study found a 268 cfs aquifer contribution to Spokane River flow from the Spokane Gage to Nine Mile Dam<sup>1</sup>. In wastewater permitting the Department of Ecology assumes a gain in flow of 200 cfs between the Spokane Gage and the City of Spokane's Wastewater Treatment Plant<sup>2</sup>. Therefore the summer 550 proposal previously made could reasonably be translated into a flow recommendation of 250 at the Cochran Street Gage.

We continue to believe it is important for the region to know what flows are below Nine Mile Dam as that is apparently the only place that accurate surface flow measurements can quantify water flowing above and below ground through the lower Spokane.

<sup>1</sup> US Geological Survey Report 2007-5041; page 21; Table 2; "Outflow from aquifer"; Hydrogeologic Framework and Ground-Water Budget of the SVRP Aquifer, Washington and Idaho; Kahle & Bartolino; 2007.

<sup>2</sup> draft FACT SHEET FOR NPDES PERMIT WA-002447-3; page 17; last paragraph; Koch, R.; September 2007.

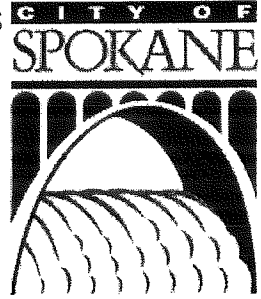
Sincerely yours,



Lloyd R. Brewer

CITY OF SPOKANE ENVIRONMENTAL PROGRAMS

Dave Mandyke, Director Public Works & Utilities  
Lloyd Brewer, Environmental Programs Manager



5 May 2008

WRIA In-stream Flow Subcommittee:

Given the recent draft 401 Certification positions taken by Ecology and Idaho Department of Environmental Quality as regards the Avista projects relative to Spokane River minimum instream flow, and assuming such positions are in the final Certifications to the Federal Energy Regulatory Commission, City Environmental Programs recommends the following minimum instream flow settings for the Spokane River at the Cochran gage (USGS Spokane at Spokane):

January 1 through March 31	1100	a
April 1 through May 15	2700	b
May 16 through June 15	2300	b
June 16 through September 30	565	c
October 1 through December 31	780	d

a – Ecology’s Proposed flow though shorter period.

b – Proposed flow is about one in fifty year recurrence interval.

c – Proposed flow derived by adding half the difference between 500 cfs and the average of period of record low flows out of Post Falls at or below 600 cfs, to the Spokane gage’s one in twenty year recurrence interval flow from the summer low period. That is:  $500 \text{ cfs} - 340 = 160$  then divide by  $2 = 80$  and add  $485 = 565$ .

d – Proposed flow is about a one in fourteen year recurrence interval.

We have significantly modified our previous proposal in light of the bi-state agency support for a fixed minimum flow at both the Post Falls gage and the Spokane Gage to be met by Avista through dam operations. The agencies appear to be supportive of the collaborative dam re-licensing process outcomes as participated in by City staff. That said, I believe the State of Washington’s proposal in the WRIA process attempts to claim any gain in minimum river flow for the fish and it was our intent in the Avista collaborative to meet both the needs of fish and man. The proposed flows above we believe better represent that shared use of the resource. In particular it is our intent to facilitate some water during high flow periods being available for diversion to storage in the aquifer or elsewhere for summer use.

These recommendations are made in the spirit of open discussion in the collaborative process and therefore should not be considered final City of Spokane positions. The Spokane City Council and the Administration have made it clear that while Environmental Programs staff are authorized to participate in these discussions, the Council and Administration reserve the right under the Watershed Planning Act to engage in any final decision regarding minimum instream flow recommendations that the Watershed Planning Units might forward to Ecology.

The City recommendation at this time attempts to maintain flexibility in meeting water demand for people while protecting instream flow needs of fish. We are in a very unsettled time due to climate change, and changes and challenges in water law, where human need for water, and the need to get that water in a very energy efficient manner, may easily come in conflict with where water is, and who has what rights to it. Water right that the City holds which is not currently put to beneficial use (inchoate water) is water that remains in the ground and the City's use of that right is regulated by law including requirements for conservation. When minimum instream flow rules restrict water availability pressure is brought to bear on those who have inchoate right. These pressures, both economic and political, will result in the use of the water but not necessarily in an environmentally responsible way. The City's proposed minimum flows attempt to relieve some of this pressure thereby maintaining some flexibility for regulators and purveyors alike in meeting and balancing future needs.

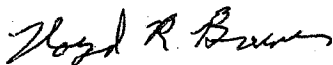
The City recognizes the legal framework that Ecology and the watershed planning unit operate in. In particular we know that flow recommendations must be made with the protection and benefit of the fishery in mind. The minimum "average daily" flows we are recommending today are above those that have been experienced at this gage in the past. We are confident that the TMDL improvements in water quality (which represent a very large regional commitment of resources) in combination with the proposed flow minimums, especially those minimums designed to protect the fish eggs & fry, will result in a net enhancement of fishery conditions.

The City appreciates the importance of the aquatic habitat and the importance both to fish and people of healthy flows in our rivers, but we reject the argument that the City of Spokane and other local purveyors are collectively, solely responsible for the summer reduction in minimum flows. The City has worked through the Federal Energy Regulatory Commission – Avista collaborative process to get a minimum flow at Post Falls which we believe will benefit the river and help meet Washington water needs, but we are frustrated by the long running process which does not implement agreements until the new license is fully in effect.

We support the aesthetics flows, recreational flows, and fisheries flows recommendations agreed to by many participants in the FERC-Avista collaborative. Those recommendations provided for the needs of people while cognizant of the variability of flows in the watershed. It is our understanding that the proposed white-water park also is planned to be constructed to take advantage of a wide range of flows that the Spokane provides.

We continue to believe it is important for the region to know what flows are below Nine Mile Dam as that is apparently the only place that accurate surface flow measurements can quantify water flowing above and below ground through the lower Spokane River arm.

Sincerely yours,



Lloyd R. Brewer