The Hangman (Latah) Creek Water Resources Management Plan

APPENDICES

May 19, 2005

Appendix A

Watershed Management Act

The 1998 Watershed Planning Act

(excerpted from the Washington State Department of Ecology)
*URL **http://www.ecy.wa.gov/watershed/background.html***

The 1998 legislature passed HB 2514, codified into **RCW 90.82**, to set a framework for addressing the State's water resource, water quality issues as well as establishing instream flows and addressing salmon habitat needs. RCW 90.82 states: The legislature finds that the local development of watershed plans for managing water resources and for protecting existing water rights is vital to both state and local interests. The local development of these plans serves vital local interests by placing it in the hands of people: Who have the greatest knowledge of both the resources and the aspirations of those who live and work in the watershed; and who have the greatest stake in the proper, long-term management resources. The development of such plans serves the state's vital interests by ensuring that the state's water resources are used wisely, by protecting existing water rights, by protecting instream flows for fish and by providing for the economic well-being of the state's citizenry and communities. Therefore the legislature believes it necessary for units of local government throughout the state to engage in orderly development of these watershed plans.

RCW 90.82.005
Purpose.
The purpose of this chapter is to develop a more thorough and cooperative method of determining what the current water resource situation is in each water resource inventory area of the state and to provide local citizens with the maximum possible input concerning their goals and objectives for water resource management and development. It is necessary for the legislature to establish processes and policies that will result in providing state agencies with more specific guidance to manage the water resources of the state consistent with current law and direction provided by local entities and citizens through the process established in accordance with this chapter.

RCW 90.82.010
Finding.
The legislature finds that the local development of watershed plans for managing water resources and for protecting existing water rights is vital to both state and local interests. The local development of these plans serves vital local interests by placing it in the hands of people: Who have the greatest knowledge of both the resources and the aspirations of those who live and work in the watershed; and who have the greatest stake in the proper, long-term management of the resources. The development of such plans serves the state's vital interests by ensuring that the state's water resources are used wisely, by protecting existing water rights, by protecting instream flows for fish, and by providing for the economic well-being of the state's citizenry and communities. Therefore, the legislature believes it necessary for units of local government throughout the state to engage in the orderly development of these watershed plans.

RCW 90.82.020
Definitions.
Unless the context clearly requires otherwise, the definitions in this section apply throughout this chapter.
(1) "Department" means the department of ecology.

(2) "Implementing rules" for a WRIA plan are the rules needed to give force and effect to the parts of the plan that create rights or obligations for any party including a state agency or that establish water management policy.

(3) "Minimum instream flow" means a minimum flow under chapter 90.03 or 90.22 RCW or a base flow under chapter 90.54 RCW.

(4) "WRIA" means a water resource inventory area established in chapter 173-500 WAC as it existed on January 1, 1997.

(5) "Water supply utility" means a water, combined water-sewer, irrigation, reclamation, or public utility district that provides water to persons or other water users within the district or a division or unit responsible for administering a publicly governed water supply system on behalf of a county.

(6) "WRIA plan" or "plan" means the product of the planning unit including any rules adopted in conjunction with the product of the planning unit.

RCW 90.82.030
Principles.
In order to have the best possible program for appropriating and administering water use in the state, the legislature establishes the following principles and criteria to carry out the purpose and intent of chapter 442, Laws of 1997.

(1) All WRIA planning units established under this chapter shall develop a process to assure that water resource user interests and directly involved interest groups at the local level have the opportunity, in a fair and equitable manner, to give input and direction to the process.

(2) If a planning unit requests technical assistance from a state agency as part of its planning activities under this chapter and the assistance is with regard to a subject matter over which the agency has jurisdiction, the state agency shall provide the technical assistance to the planning unit.

(3) Plans developed under chapter 442, Laws of 1997 shall be consistent with and not duplicative of efforts already under way in a WRIA, including but not limited to watershed analysis conducted under state forest practices statutes and rules.

RCW 90.82.040

WRIA planning units -- Watershed planning grants -- Eligibility criteria -- Administrative costs.

(1) Once a WRIA planning unit has been initiated under RCW 90.82.060 and a lead agency has been designated, it shall notify the department and may apply to the department for funding assistance for conducting the planning. Funds shall be provided from and to the extent of appropriations made by the legislature to the department expressly for this purpose.

(2)(a) Each planning unit that has complied with subsection (1) of this section is eligible to receive watershed planning grants in the following amounts for three phases of watershed planning:

(i) Initiating governments may apply for an initial organizing grant of up to fifty thousand dollars for a single WRIA or up to seventy-five thousand dollars for a multi-WRIA management area in accordance with RCW 90.82.060(4);

(ii)(A) A planning unit may apply for up to two hundred thousand dollars for each WRIA in the management area for conducting watershed assessments in accordance with RCW 90.82.070, except that a planning unit that chooses to conduct a detailed assessment or studies under (a)(ii)(B) of this subsection or whose initiating governments choose or have chosen to include an instream flow or water quality component in accordance with RCW 90.82.080 or 90.82.090 may apply for up to one hundred thousand additional dollars for each instream flow and up to one hundred thousand additional dollars for each water quality component included for each WRIA to conduct an assessment on that optional component and for each WRIA in which the assessments or studies under (a)(ii)(B) of this subsection are conducted.

(B) A planning unit may elect to apply for up to one hundred thousand additional dollars to conduct a detailed assessment of multipurpose water storage opportunities or for studies of specific multipurpose storage projects which opportunities or projects are consistent with and support the other elements of the planning unit's watershed plan developed under this chapter; and

(iii) A planning unit may apply for up to two hundred fifty thousand dollars for each WRIA in the management area for developing a watershed plan and making recommendations for actions by local, state, and federal agencies, tribes, private property owners, private organizations, and individual citizens, including a recommended list of strategies and projects that would further the purpose of the plan in accordance with RCW 90.82.060 through 90.82.100.

(b) A planning unit may request a different amount for phase two or phase three of watershed planning than is specified in (a) of this subsection, provided that the total amount of funds awarded do not exceed the maximum amount the planning unit is eligible for under (a) of this subsection. The department shall approve such an alternative allocation of funds if the planning unit identifies how the proposed alternative will meet the goals of this chapter and provides a proposed timeline for the completion of planning. However, the up to one hundred thousand additional dollars in funding for instream flow and water quality components and for water storage assessments or studies that a planning unit may apply for under (a)(ii)(A) of this subsection may be used only for those instream flow, water quality, and water storage purposes.

(c) By December 1, 2001, or within one year of initiating phase one of watershed planning, whichever occurs later, the initiating governments for each planning unit must inform the department whether they intend to have the planning unit establish or amend instream flows as part of its planning process. If they elect to have the planning unit establish or amend instream flows, the planning unit is eligible to receive one hundred thousand dollars for that purpose in accordance with (a)(ii) of this subsection. If the initiating governments for a planning unit elect not to establish or amend instream flows as part of the unit's planning process, the department shall retain one hundred thousand dollars to carry out an assessment to support establishment of instream flows and to establish such flows in accordance with RCW 90.54.020(3)(a) and chapter 90.22 RCW. The department shall not use these funds to amend an existing instream flow unless requested to do so by the initiating governments for a planning unit.

(d) In administering funds appropriated for supplemental funding for optional plan components under (a)(ii) of this subsection, the department shall give priority in granting the available funds to proposals for setting or amending instream flows.
(3)(a) The department shall use the eligibility criteria in this subsection (3) instead of rules, policies, or guidelines when evaluating grant applications at each stage of the grants program.

(b) In reviewing grant applications under this subsection (3), the department shall evaluate whether:

(i) The planning unit meets all of the requirements of this chapter;

(ii) The application demonstrates a need for state planning funds to accomplish the objectives of the planning process; and

(iii) The application and supporting information evidences a readiness to proceed.

(c) In ranking grant applications submitted at each stage of the grants program, the department shall give preference to applications in the following order of priority:

(i) Applications from existing planning groups that have been in existence for at least one year;

(ii) Applications that address protection and enhancement of fish habitat in watersheds that have aquatic fish species listed or proposed to be listed as endangered or threatened under the federal endangered species act, 16 U.S.C. Sec. 1531 et seq. and for which there is evidence of an inability to supply adequate water for population and economic growth from:

(A) First, multi-WRIA planning; and

(B) Second, single WRIA planning;

(iii) Applications that address protection and enhancement of fish habitat in watersheds or for which there is evidence of an inability to supply adequate water for population and economic growth from:

(A) First, multi-WRIA planning; and

(B) Second, single WRIA planning.

(d) The department may not impose any local matching fund requirement as a condition for grant eligibility or as a preference for receiving a grant.

(4) The department may retain up to one percent of funds allocated under this section to defray administrative costs.

(5) Planning under this chapter should be completed as expeditiously as possible, with the focus being on local stakeholders cooperating to meet local needs.

(6) Funding provided under this section shall be considered a contractual obligation against the moneys appropriated for this purpose.

NOTES:
Finding -- Intent -- 2001 c 237: "The legislature is committed to meeting the needs of a growing population and a healthy economy statewide; to meeting the needs of fish and healthy watersheds statewide; and to advancing these two principles together, in increments over time.

The legislature finds that improved management of the state's water resources, clarifying the authorities, requirements, and timelines for establishing instream flows, providing timely decisions on water transfers, clarifying the authority of water conservancy boards, and enhancing the flexibility of our water management system to meet both environmental and economic goals are important steps to providing a better future for our state.

The need for these improvements is particularly urgent as we are faced with drought conditions. The failure to act now will only increase the potential negative effects on both the economy and the environment, including fisheries resources.

Deliberative action over several legislative sessions and interim periods between sessions will be required to address the long-term goal of improving the responsiveness of the state water code to meet the diverse water needs of the state's citizenry. It is the intent of the legislature to begin this work now by providing tools to enable the state to respond to imminent drought conditions and other immediate problems relating to water resources management. It is also the legislature's intent to lay the groundwork for future legislation for addressing the state's long-term water problems." [2001 c 237 § 1.]

Severability -- 2001 c 237: "If any provision of this act or its application to any person or circumstance is held invalid, the remainder of the act or the application of the provision to other persons or circumstances is not affected." [2001 c 237 § 33.]

Effective date -- 2001 c 237: "This act is necessary for the immediate preservation of the public peace, health, or safety, or support of the state government and its existing public institutions, and takes effect immediately [May 10, 2001]." [2001 c 237 § 34.]

Intent -- 2001 c 237: See note following RCW 90.66.065.

RCW 90.82.050
Limitations on liability.
(1) This chapter shall not be construed as creating a new cause of action against the state or any county, city, town, water supply utility, conservation district, or planning unit.

(2) Notwithstanding RCW 4.92.090, 4.96.010, and 64.40.020, no claim for damages may be filed against the state or any county, city, town, water supply utility, tribal governments, conservation district, or planning unit that or member of a planning unit who participates in a WRIA planning unit for performing responsibilities under this chapter.

RCW 90.82.060
Initiation of watershed planning -- Scope of planning -- Technical assistance from state agencies.
(1) Planning conducted under this chapter must provide for a process to allow the local citizens within a WRIA or multi-WRIA area to join together in an effort to: (a) Assess the status of the water resources of their WRIA or multi-WRIA area; and (b) determine how best to manage the water resources of the WRIA or multi-WRIA area to balance the competing resource demands for that area within the parameters under RCW 90.82.120.

(2) Watershed planning under this chapter may be initiated for a WRIA only with the concurrence of: (a) All counties within the WRIA; (b) the largest city or town within the WRIA unless the WRIA does not contain a city or town; and (c) the water supply utility obtaining the largest quantity of water from the WRIA or, for a WRIA with lands within the Columbia Basin project, the water supply utility obtaining from the Columbia Basin project the largest quantity of water for the WRIA. To apply for a grant for organizing the planning unit as provided for under RCW 90.82.040(2)(a), these entities shall designate the entity that will serve as the lead agency for the planning effort and indicate how the planning unit will be staffed.

(3) Watershed planning under this chapter may be initiated for a multi-WRIA area only with the concurrence of: (a) All counties within the multi-WRIA area; (b) the largest city or town in each WRIA unless the WRIA does not contain a city or town; and (c) the water supply utility obtaining the largest quantity of water in each WRIA.

(4) If entities in subsection (2) or (3) of this section decide jointly and unanimously to proceed, they shall invite all tribes with reservation lands within the management area.

(5) The entities in subsection (2) or (3) of this section, including the tribes if they affirmatively accept the invitation, constitute the initiating governments for the purposes of this section.

(6) The organizing grant shall be used to organize the planning unit and to determine the scope of the planning to be conducted. In determining the scope of the planning activities, consideration shall be given to all existing plans and related planning activities. The scope of planning must include water quantity elements as provided in RCW 90.82.070, and may include water quality elements as contained in RCW 90.82.090, habitat elements as contained in RCW 90.82.100, and instream flow elements as contained in RCW 90.82.080. The initiating governments shall work with state government, other local governments within the management area, and affected tribal governments, in developing a planning process. The initiating governments may hold public meetings as deemed necessary to develop a proposed scope of work and a proposed composition of the planning unit. In developing a proposed composition of the planning unit, the initiating governments shall provide for representation of a wide range of water resource interests.

(7) Each state agency with regulatory or other interests in the WRIA or multi-WRIA area to be planned shall assist the local citizens in the planning effort to the greatest extent practicable, recognizing any fiscal limitations. In providing such technical assistance and to facilitate representation on the planning unit, state agencies may organize and agree upon their representation on the planning unit. Such technical assistance must only be at the request of and to the extent desired by the planning unit conducting such planning. The number of state agency representatives on the planning unit shall be determined by the initiating governments in consultation with the governor's office.

(8) As used in this section, "lead agency" means the entity that coordinates staff support of its own or of other local governments and receives grants for developing a watershed plan.

RCW 90.82.070
Water quantity component.
Watershed planning under this chapter shall address water quantity in the management area by undertaking an assessment of water supply and use in the management area and developing strategies for future use.

(1) The assessment shall include:

(a) An estimate of the surface and ground water present in the management area;

(b) An estimate of the surface and ground water available in the management area, taking into account seasonal and other variations;

(c) An estimate of the water in the management area represented by claims in the water rights claims registry, water use permits, certificated rights, existing minimum instream flow rules, federally reserved rights, and any other rights to water;

(d) An estimate of the surface and ground water actually being used in the management area;

(e) An estimate of the water needed in the future for use in the management area;

(f) An identification of the location of areas where aquifers are known to recharge surface bodies of water and areas known to provide for the recharge of aquifers from the surface; and

(g) An estimate of the surface and ground water available for further appropriation, taking into account the minimum instream flows adopted by rule or to be adopted by rule under this chapter for streams in the management area including the data necessary to evaluate necessary flows for fish.

(2) Strategies for increasing water supplies in the management area, which may include, but are not limited to, increasing water supplies through water conservation, water reuse, the use of reclaimed water, voluntary water transfers, aquifer recharge and recovery, additional water allocations, or additional water storage and water storage enhancements. The objective of these strategies is to supply water in sufficient quantities to satisfy the minimum instream flows for fish and to provide water for future out-of-stream uses for water identified in subsection (1)(e) and (g) of this section and to ensure that adequate water supplies are available for agriculture, energy production, and population and economic growth under the requirements of the state's growth management act, chapter 36.70A RCW. These strategies, in and of themselves, shall not be construed to confer new water rights. The watershed plan must address the strategies required under this subsection.

(3) The assessment may include the identification of potential site locations for water storage projects. The potential site locations may be for either large or small projects and cover the full range of possible alternatives. The possible alternatives include off-channel storage, underground storage, the enlargement or enhancement of existing storage, and on-channel storage.

NOTES:
Intent -- 2001 2nd sp.s. c 19: "The legislature recognizes the potential for additional water storage as a solution to the water supply needs of the state. Last year the legislature created a task force to examine the role of increased water storage in providing water

supplies to meet the needs of fish, population growth, and economic development, and to enhance the protection of people's lives and their property and the protection of aquatic habitat through flood control facilities. One solution discussed by the task force to address the state's water supply problem is to store water when there is excess runoff and stream flow, and deliver or release it during the low flow period when it is needed. The task force discussed the need for assessments of potential site locations for water storage projects. The legislature intends this act to assist in obtaining the assessments relating to water storage."

RCW 90.82.080

Instream flow component -- Rules.

(1)(a) If the initiating governments choose, by majority vote, to include an instream flow component, it shall be accomplished in the following manner:

(i) If minimum instream flows have already been adopted by rule for a stream within the management area, unless the members of the local governments and tribes on the planning unit by a recorded unanimous vote request the department to modify those flows, the minimum instream flows shall not be modified under this chapter. If the members of local governments and tribes request the planning unit to modify instream flows and unanimous approval of the decision to modify such flow is not achieved, then the instream flows shall not be modified under this section;

(ii) If minimum stream flows have not been adopted by rule for a stream within the management area, setting the minimum instream flows shall be a collaborative effort between the department and members of the planning unit. The department must attempt to achieve consensus and approval among the members of the planning unit regarding the minimum flows to be adopted by the department. Approval is achieved if all government members and tribes that have been invited and accepted on the planning unit present for a recorded vote unanimously vote to support the proposed minimum instream flows, and all nongovernmental members of the planning unit present for the recorded vote, by a majority, vote to support the proposed minimum instream flows.

(b) The department shall undertake rule making to adopt flows under (a) of this subsection. The department may adopt the rules either by the regular rules adoption process provided in chapter 34.05 RCW, the expedited rules adoption process as set forth in *RCW 34.05.230, or through a rules adoption process that uses public hearings and notice provided by the county legislative authority to the greatest extent possible. Such rules do not constitute significant legislative rules as defined in RCW 34.05.328, and do not require the preparation of small business economic impact statements.

(c) If approval is not achieved within four years of the date the planning unit first receives funds from the department for conducting watershed assessments under RCW 90.82.040, the department may promptly initiate rule making under chapter 34.05 RCW to establish flows for those streams and shall have two additional years to establish the instream flows for those streams for which approval is not achieved.

(2)(a) Notwithstanding RCW 90.03.345, minimum instream flows set under this section for rivers or streams that do not have existing minimum instream flow levels set by rule of the department shall have a priority date of two years after funding is first received from the department under RCW 90.82.040, unless determined otherwise by a unanimous vote of the members of the planning unit but in no instance may it be later than the effective date of the rule adopting such flow.

(b) Any increase to an existing minimum instream flow set by rule of the department shall have a priority date of two years after funding is first received for planning in the WRIA or multi-WRIA area from the department under RCW 90.82.040 and the priority date of the portion of the minimum instream flow previously established by rule shall retain its priority date as established under RCW 90.03.345.

(c) Any existing minimum instream flow set by rule of the department that is reduced shall retain its original date of priority as established by RCW 90.03.345 for the revised amount of the minimum instream flow level.

(3) Before setting minimum instream flows under this section, the department shall engage in government-to-government consultation with affected tribes in the management area regarding the setting of such flows.

(4) Nothing in this chapter either: (a) Affects the department's authority to establish flow requirements or other conditions under RCW 90.48.260 or the federal clean water act (33 U.S.C. Sec. 1251 et seq.) for the licensing or relicensing of a hydroelectric power project under the federal power act (16 U.S.C. Sec. 791 et seq.); or (b) affects or impairs existing instream flow requirements and other conditions in a current license for a hydroelectric power project licensed under the federal power act.

(5) If the planning unit is unable to obtain unanimity under subsection (1) of this section, the department may adopt rules setting such flows.

NOTES:
***Reviser's note:** RCW 34.05.230 was amended by 2001 c 25 § 1, deleting the text that refers to expedited rules adoption. For expedited rules adoption, see RCW 34.05.353.

RCW 90.82.085
Instream flows -- Assessing and setting or amending.
By October 1, 2001, the department of ecology shall complete a final nonproject environmental impact statement that evaluates stream flows to meet the alternative goals of maintaining, preserving, or enhancing instream resources and the technically defensible methodologies for determining these stream flows. Planning units and state agencies assessing and setting or amending instream flows must, as a minimum, consider the goals and methodologies addressed in the nonproject environmental impact statement. A planning unit or state agency may assess, set, or amend instream flows in a manner that varies from the final nonproject environmental impact statement if consistent with applicable instream flow laws.

NOTES:
Finding -- Intent -- Severability -- Effective date -- 2001 c 237: See notes following RCW 90.82.040.

Intent -- 2001 c 237: See note following RCW 90.66.065.

RCW 90.82.090
Water quality component.
If the initiating governments choose to include a water quality component, the watershed plan shall include the following elements:

(1) An examination based on existing studies conducted by federal, state, and local agencies of the degree to which legally established water quality standards are being met in the management area;

(2) An examination based on existing studies conducted by federal, state, and local agencies of the causes of water quality violations in the management area, including an examination of information regarding pollutants, point and nonpoint sources of pollution, and pollution-carrying capacities of water bodies in the management area. The analysis shall take into account seasonal stream flow or level variations, natural events, and pollution from natural sources that occurs independent of human activities;

(3) An examination of the legally established characteristic uses of each of the nonmarine bodies of water in the management area;

(4) An examination of any total maximum daily load established for nonmarine bodies of water in the management area, unless a total maximum daily load process has begun in the management area as of the date the watershed planning process is initiated under RCW 90.82.060;

(5) An examination of existing data related to the impact of fresh water on marine water quality;

(6) A recommended approach for implementing the total maximum daily load established for achieving compliance with water quality standards for the nonmarine bodies of water in the management area, unless a total maximum daily load process has begun in the management area as of the date the watershed planning process is initiated under RCW 90.82.060; and

(7) Recommended means of monitoring by appropriate government agencies whether actions taken to implement the approach to bring about improvements in water quality are sufficient to achieve compliance with water quality standards.

This chapter does not obligate the state to undertake analysis or to develop strategies required under the federal clean water act (33 U.S.C. Sec. 1251 et seq.). This chapter does not authorize any planning unit, lead agency, or local government to adopt water quality standards or total maximum daily loads under the federal clean water act.

RCW 90.82.100
Habitat component.
If the initiating governments choose to include a habitat component, the watershed plan shall be coordinated or developed to protect or enhance fish habitat in the management area. Such planning must rely on existing laws, rules, or ordinances created for the purpose of protecting, restoring, or enhancing fish habitat, including the shoreline management act, chapter 90.58 RCW, the growth management act, chapter 36.70A RCW, and the forest practices act, chapter 76.09 RCW. Planning established under this section shall be integrated with strategies developed under other processes to respond to potential and actual listings of salmon and other fish species as being threatened or endangered under the federal endangered species act, 16 U.S.C. Sec. 1531 et seq. Where habitat restoration activities are being developed under chapter 246, Laws of 1998, such activities shall be relied on as the primary nonregulatory habitat component for fish habitat under this chapter.

RCW 90.82.110
Identification of projects and activities.
The planning unit shall review historical data such as fish runs, weather patterns, land use patterns, seasonal flows, and geographic characteristics of the management area, and also review the planning, projects, and activities that have already been completed regarding natural resource management or enhancement in the management area and the products or status of those that have been initiated but not completed for such management in the management area, and incorporate their products as appropriate so as not to duplicate the work already performed or underway.

The planning group is encouraged to identify projects and activities that are likely to serve both short-term and long-term management goals and that warrant immediate financial assistance from the state, federal, or local government. If there are multiple projects, the planning group shall give consideration to ranking projects that have the greatest benefit and schedule those projects that should be implemented first.

RCW 90.82.120
Plan parameters.
(1) Watershed planning developed and approved under this chapter shall not contain provisions that: (a) Are in conflict with existing state statutes, federal laws, or tribal treaty rights; (b) impair or diminish in any manner an existing water right evidenced by a claim filed in the water rights claims registry established under chapter 90.14 RCW or a water right certificate or permit; (c) require a modification in the basic operations of a federal reclamation project with a water right the priority date of which is before June 11, 1998, or alter in any manner whatsoever the quantity of water available under the water right for the reclamation project, whether the project has or has not been completed before June 11, 1998; (d) affect or interfere with an ongoing general adjudication of water rights; (e) modify or require the modification of any waste discharge permit issued under

chapter 90.48 RCW; (f) modify or require the modification of activities or actions taken or intended to be taken under a habitat restoration work schedule developed under chapter 246, Laws of 1998; or (g) modify or require the modification of activities or actions taken to protect or enhance fish habitat if the activities or actions are: (i) Part of an approved habitat conservation plan and an incidental take permit, an incidental take statement, a management or recovery plan, or other cooperative or conservation agreement entered into with a federal or state fish and wildlife protection agency under its statutory authority for fish and wildlife protection that addresses the affected habitat; or

(ii) part of a water quality program adopted by an irrigation district under chapter 87.03 RCW or a board of joint control under chapter 87.80 RCW. This subsection (1)(g) applies as long as the activities or actions continue to be taken in accordance with the plan, agreement, permit, or statement. Any assessment conducted under RCW 90.82.070, 90.82.090, or 90.82.100 shall take into consideration such activities and actions and those taken under the forest practices rules, including watershed analysis adopted under the forest practices act, chapter 76.09 RCW.

(2) Watershed planning developed and approved under this chapter shall not change existing local ordinances or existing state rules or permits, but may contain recommendations for changing such ordinances or rules.

(3) Notwithstanding any other provision of this chapter, watershed planning shall take into account forest practices rules under the forest practices act, chapter 76.09 RCW, and shall not create any obligations or restrictions on forest practices additional to or inconsistent with the forest practices act and its implementing rules, whether watershed planning is approved by the counties or the department.

RCW 90.82.130
Plan approval -- Public notice and hearing -- Revisions.
(1)(a) Upon completing its proposed watershed plan, the planning unit may approve the proposal by consensus of all of the members of the planning unit or by consensus among the members of the planning unit appointed to represent units of government and a majority vote of the nongovernmental members of the planning unit.

(b) If the proposal is approved by the planning unit, the unit shall submit the proposal to the counties with territory within the management area. If the planning unit has received funding beyond the initial organizing grant under RCW 90.82.040, such a proposal approved by the planning unit shall be submitted to the counties within four years of the date that funds beyond the initial funding are first drawn upon by the planning unit.

(c) If the watershed plan is not approved by the planning unit, the planning unit may submit the components of the plan for which agreement is achieved using the procedure under (a) of this subsection, or the planning unit may terminate the planning process.

(2)(a) The legislative authority of each of the counties with territory in the management area shall provide public notice of and conduct at least one public hearing on the proposed watershed plan submitted under this section. After the public hearings, the legislative authorities of these counties shall convene in joint session to consider the proposal. The counties may approve or reject the proposed watershed plan for the management area, but may not amend it. Approval of such a proposal shall be made by a majority vote of the members of each of the counties with territory in the management area.

(b) If a proposed watershed plan is not approved, it shall be returned to the planning unit with recommendations for revisions. Approval of such a revised proposal by the planning unit and the counties shall be made in the same manner provided for the original watershed plan. If approval of the revised plan is not achieved, the process shall terminate.

(3) The planning unit shall not add an element to its watershed plan that creates an obligation unless each of the governments to be obligated has at least one representative on the planning unit and the respective members appointed to represent those governments agree to adding the element that creates the obligation. A member's agreeing to add an element shall be evidenced by a recorded vote of all members of the planning unit in which the members record support for adding the element. If the watershed plan is approved under subsections (1) and (2) of this section and the plan creates obligations: (a) For agencies of state government, the agencies shall adopt by rule the obligations of both state and county governments and rules implementing the state obligations, the obligations on state agencies are binding upon adoption of the obligations into rule, and the agencies shall take other actions to fulfill their obligations as soon as possible; or (b) for counties, the obligations are binding on the counties and the counties shall adopt any necessary implementing ordinances and take other actions to fulfill their obligations as soon as possible.

(4) As used in this section, "obligation" means any action required as a result of this chapter that imposes upon a tribal government, county government, or state government, either: A fiscal impact; a redeployment of resources; or a change of existing policy.
[2001 c 237 § 4; 1998 c 247 § 9.]

NOTES:
Finding -- Intent -- Severability--Effective date -- 2001 c 237: See notes following RCW 90.82.040.

Intent -- 2001 c 237: See note following RCW 90.66.065.

RCW 90.82.140
Use of monitoring recommendations in RCW 77.85.210.
In conducting assessments and other studies that include monitoring components or recommendations, the department and planning units shall implement the monitoring recommendations developed under RCW 77.85.210.

NOTES:
Finding -- Intent -- 2001 c 298: See note following RCW 77.85.210.

RCW 90.82.900
Part headings not law -- 1997 c 442.
As used in this act, part headings constitute no part of the law.

RCW 90.82.901
Severability -- 1997 c 442.
If any provision of this act or its application to any person or circumstance is held invalid, the remainder of the act or the application of the provision to other persons or circumstances is not affected.

RCW 90.82.902
Captions not law -- 1998 c 247.
As used in this act, captions constitute no part of the law.

Appendix B

Memorandum of Agreement

MEMORANDUM OF AGREEMENT:
LOCAL WATERSHED PLANNING FOR WRIA 56
THE HANGMAN (LATAH) CREEK WATERSHED

WHEREAS, the Washington Watershed Management Act, Chapter 90.82 RCW, provides a process to plan and manage the uses of water within the Hangman (Latah) Creek Water Resources Inventory areas (WRIA 56); and

WHEREAS, the water resources planning process described in Chapter 90.82 RCW and this Agreement is not intended to formally determine or resolve any legal dispute about water rights under state or federal law or Indian Treaty. Rather, the process provides an alternative, voluntary process for cooperatively planning and managing the use of Washington's water resources; and

WHEREAS, effective watershed planning cannot take place without full participation, as Initiating Governments, Water Supply Utility, or other entities and stakeholders within the WRIA.

NOW, THEREFORE, the Initiating Governments and Water Supply Utility for WRIA 56 agree as follows:

1.0 Purpose: The primary purpose of this agreement is to designate a planning unit and a Lead Agency for purposes of assessing and managing the water resources of the Hangman (Latah) Creek Watershed and to pursue strategies that include the key elements of water quantity, quality, in stream flows and habitat.

2.0 Initiating Governments and Water Supply Utility: According to the provisions of Chapter 90.82 RCW, the eligible parties to this Agreement shall be Spokane County, Whitman County, the City of Spokane and the Hangman Hills Water District.

3.0 Scope: The Watershed Planning grant for WRIA 56 includes funding for Phase I elements of plan development as provided for in Chapter 90.82 RCW.

3.1 The main focus of Phase I will be determining the information needs for Phase II and developing a work plan for Phase II studies. The general Scope of Work for the program submitted with the grant application and approved by the Department of Ecology is included as Attachment A.

3.2 The intended scope of the work plan developed for Phase II will include water quantity, water quality, in stream flows and habitat. Existing data, studies and plans will be fully reviewed and those providing information consistent with the "best available science" tenets of this study will be used in developing a comprehensive watershed plan.

4.0 Lead Agency: Spokane County Conservation District will be the Lead Agency for the purposes of convening the Initiating Governments, Water Supply Utility and other Planning Unit members, administering the Watershed Planning Grant Funds and contracting services. Project budgets and utilization of consultants shall be agreed upon by the Initiating Governments, the Water Supply Utility and the Planning Unit members per the consensus process described in section 6.1 of this agreement.

5.0 Planning Unit: The Planning Unit is a committee formed pursuant to Chapter 90.82 RCW by the Initiating Governments and the Water Supply Utility to recommend water resource management policies for consideration by the counties.

5.1 The Planning Unit is composed of authorized representation from the Initiating Governments, the Water Supply Utility and other stakeholders with a wide range of water resource interests. The Planning Unit includes representation of both government and non-government entities. Attachment B is a listing of proposed entities for Planning Unit representation.

5.2 The Lead Agency, after consultation with authorized representatives of the Initiating Governments and the Water Supply Utility will develop a list of Planning Unit members that will be submitted to the legislative boards of the Initiating Governments and the Water Supply Utility, or their designee, for approval.

5.3 The Planning Unit may adopt rules for operating and decision making as long as they do not conflict with the elements of section 6.0 below.

6.0 Process:

6.1 Government and non-governmental participants in the Planning Unit shall conduct decision–making by consensus. Governments are those entities empowered with legislative or regulatory power by state statute. For purposes of this Agreement, consensus means general acceptance of the proposed action. The parties to a consensus agreement will not dispute that specific action in the future.

Government participants shall provide specific written approval of all Watershed Plan elements that would create an obligation on the government entity. "Obligation" means any required action that imposes fiscal impact, a re–deployment of resources or a change of existing policy.

6.2 All decisions will be based on best available science. This means all information is collected using methods generally accepted by professionals working in the field of concern and which has had appropriate quality control and assurance practices applied during collection. In addition to being commonly accepted by the scientific community, such information must be agreed upon by all representatives of local, state, and tribal governments.

6.3 The Planning Unit shall be the Policy recommendation committee for the watershed plan envisioned in Chapter 90.82 RCW. Non–governmental representation on the Planning Unit will be designated at the discretion of the Initiating Governments and the Water Supply Utility to provide representation of a wide range of water resources interests.

6.4 Technical advisory committee(s) and/or focus group(s) may be established by the Planning Unit to provide reports and recommendations on specific issues.

7.0 Funding:

7.1 This agreement does not obligate the Initiating Governments or the Water Supply Utility to pay any operating costs for watershed planning in WRIA 56. Any such obligation in the future shall require express written agreement.

7.2 Spokane County Conservation District shall be the Lead Agency for application and management of grant funds for this project. Annual budgets allocating the use of watershed planning funds shall be approved by the initiating governments. Grant funds shall be used for staff support and consultant support, including the preparation of technical reports for review by the Planning Unit and/or technical committees and/or focus groups. A Budget proposal for 2000 is included as part of Attachment A.

7.3 Participation in the Planning Unit and/or technical committees and/or focus groups by officials and staff shall be contributed time not eligible for reimbursement unless expressly approved by the Initiating Governments and the Water Supply Utility.

7.4 The Initiating Governments and the Water Supply Utility recognize the financial burden watershed planning may place on smaller units of government and support their effort to secure outside sources of funding to ensure effective participation by these entities. If approved by the Initiating Governments and the Water Supply Utility, annual budgets for Watershed Planning grant funds may include limited support for government and non-governmental agencies participating in watershed planning.

8.0 Duration:

8.1 This Agreement will operate for the duration of the watershed planning period, which will be no longer than four years from the date on which Phase II of the grant program is initiated by the Planning Unit unless extended by the Initiating Governments and the Water Supply Utility.

8.2 Any government entity shall have the right to withdraw from the planning process at any time. All parties agree that if any entity withdraws that entity shall not be deemed a party to any plan or agreement produced pursuant to Chapter 90.82 RCW and shall not be bound thereby.

9.0 Modification: This Agreement may be modified or amended only by a subsequent written document, signed by representatives of all Initiating Governments and the Water Supply Utility, expressly stating the intention to amend this Agreement. No amendment or alteration of this Agreement shall arise by implication, course of conduct or change in state law.

10.0 Agreement: The water resource planning process described in this Agreement is intended to result in cooperative management of water resources in WRIA 56 The parties agree that participation in the development of watershed plans for WRIA 56 shall not abrogate any member's authority or the reserved rights of any Tribe, except where an obligation has been accepted in writing pursuant to section 6.1 of this Agreement.

11.0 Effective Date: This agreement shall become effective and commence upon execution of the Agreement by all parties.

IN WITNESS WHEREOF, we the undersigned have executed this Agreement as of the date as indicated.

SPOKANE COUNTY:

By: _______________________________________ Date: ________________

John Roskelley, Chair

WHITMAN COUNTY:

By:_______________________________________ Date: ________________

Les Wigen, Chair

CITY OF SPOKANE:

By: _______________________________________ Date: ________________

Henry Miggins, City Manager

HANGMAN HILLS WATER DISTRICT:

By: _______________________________________ Date: ________________

Steve Bortfeld, Manager

SPOKANE COUNTY CONSERVATION DISTRICT:

By: _______________________________________ Date: ________________

Gerald Scheele, Chair

ATTACHMENT A

Description of Project

I. Introduction:

II. Project Objectives:

A. Initiate Watershed Planning Unit

B. Determine status of water supply and use; evaluate the amount of water available for new water rights.

C. Subject to approval of watershed committee, determine status of water quality and quantity, establish in stream flow, and determine status of fish and wildlife habitat.

I. Process to achieve objectives:

A. The lead agency will initiate a watershed committee and determine through consensus the resource issues we will address in the watershed assessment. The lead agency will work in cooperation with initiating governments and watershed committee to formulate a scope of work necessary to conduct an inventory and assessment of water resources.

Project Schedule:

• Project Start	February 2000
• Initiating Agency Agreement Complete	March 2000
• Initial Requests to Potential Planning Unit	March 2000
• Public Meetings	Feb. 2000 – Dec. 2000
• Annotated Bibliography Complete	March 2000
• Planning Unit Formation Complete	March, 2000
• Draft Recommendations and Phase II Scope	Sept. 30, 2000

Estimated Project Budget

Salaries	$ 23,625
Benefits	$ 7,875
Goods and Services	$ 5,000
Consultants	$ 10,000
Equipment	$ 1,000
Indirect Costs (5%)	$ 2,500
Total	**$ 50,000**

ATTACHMENT B

Planning Unit Members (Invited)

GOVERNMENTAL

Initiating Governments:

- City of Spokane
- Spokane County
- Whitman County
- Hangman Hills Water District

State Agencies (under one voice):

- Department of Ecology
- Department of Natural Resources
- Department of Fish and Wildlife
- Eastern Washington University
- Spokane Regional Health District
- Whitman Regional Health District
- Department of Transportation

Local Communities:

- City of Cheney
- City of Spangle
- City of Tekoa
- Town of Waverly
- Town of Tensed
- Town of Rockford
- Town of Latah

Other Agencies:

- The Spokane Tribe of Indians
- The Coeur d'Alene Tribe of Indians
- Fairchild Air Force Base

Ex officio Members (Non-voting, Advisory):

- Pine Creek Conservation District
- Benewah County Soil & Water Conservation District
- US Fish and Wildlife
- Natural Resources Conservation Service
- USDA Farm Services Agency
- Bureau of Land Management
- Spokane District Office

NON-GOVERNMENTAL

Agriculture:

- Wheat Growers Association
- Pea & Lentil Growers Association
- Cattlemen's Association
- Local Farmers
- Hay Growers Association

Businesses:

- The Ridge at Hangman
- Hangman Valley Golf Course
- Qualchan Golf Course
- AVISTA Corporation
- Burlington Northern/Sante Fe Railroad
- Intermountain Resources Inc.
- Yellowstone Pipeline Co.
- Inland Power & Light

Environmental/Ecological Groups:

- Marshall Creek Community Coalition
- The Lands Council
- Inland Northwest Land Trust
- Trout Unlimited
- Washington Environmental Council

Recreational:

- Spokane Canoe and Kayak Club

General Public:

- Latah Creek Stream Team
- Latah Creek Neighborhood Assoc.
- Private Citizens

Appendix C

Instream Flow Recommendation

Planning Unit (PU) Data Compilation
Instream Flow Recommendation for Hangman (Latah) Creek

In June of 2003, the PU began a series of instream flow development meetings to discuss the results of the HDI report and continue progress towards a final recommendation for WDOE. The PU discussions revolved around the statutorily protected instream resources and values for the watershed. The PU also considered instream and out-of-stream water uses and whether or not the recommended flow (or range of flows) would be scientifically defensible and hydrologically achievable. The PU followed the basic process described below.

The Instream Flow Process (as described in "A Guide to Instream Flow Setting in Washington State")

- Identify all statutorily protected instream resources and values present in the stream.
- Gather and evaluate existing watershed-specific information on instream resources, hydrology, diversions, existing water rights, applicable historical information, as well as other factors that may limit instream resources.
- Determine how to evaluate stream flows for the resources identified, including any additional information that is needed.
- Conduct studies, as needed, to determine what stream flows are needed to protect instream resources and to evaluate past, current, and the potential future hydrology in the basin.
- Review and evaluate study results to determine needs to protect and preserve the identified instream values and resources.
- Evaluate current and future water uses, including both in stream and out of stream uses.
- Consider management alternatives to meet instream and out of stream needs.
- Develop an instream flow recommendation, through the local evaluation and decision process, that protects instream resources.
- Develop and propose a rule to establish instream flow.

After months of discussion, the WRIA 56 PU could not come to consensus regarding an actual instream flow recommendation, but was able to agree on many components that will enable WDOE to develop a ruling in the near future. The following information is derived from the minutes of the WRIA 56 instream flow meetings. The written minutes and the actual tape recordings have been documented and archived at the SCCD.

Statutorily Protected Instream Resources and Values

The Hangman Creek Watershed is identified as a Class A Washington waterway in the Washington Administrative Code (WAC) Chapter 173-201A. All Class A streams and their associated tributaries are considered to be "excellent" waters of the state and provide the following general benefits and values. The water quality of this class shall meet or exceed the requirements for all or substantially all uses.

Chapters 90.82 and 90.54 RCW describe the statutory obligations of WDOE concerning stream flow. Chapter 90.82 is the Watershed Planning Act and 90.54 is related to the Water Resource Act of 1971. The State Legislature instructed WDOE to set stream flow levels in ruling to protect "instream flow resources." These flows are referred to as "minimum instream flows" and are essentially a water right for fish and instream values. The PU reviewed and discussed the specific instream resources and values listed for Hangman Creek. However, there are no set methods for meeting all these requirements other than the water quality element (state standards). The PU utilized the data from several different sources including a public survey to determine whether or not these beneficial uses are being met.

Hangman (Latah) Creek Recreation and Flow Aesthetics Survey
In the Hangman Creek watershed, the status of these beneficial uses is unknown. The PU decided that they could not fully determine whether or not Hangman (Latah) Creek was meeting all required beneficial uses without additional information. The PU reviewed available relevant information and further developed a survey to record personal accounts and perception from the residents living in the watershed. The survey was conducted at public events held throughout the watershed during 2003. In an effort to better understand these uses and the local perception of Hangman Creek, a survey was developed and given to a variety of watershed residents and people who recreate within the watershed. The results indicated below were separated into three categories: urban/non-residents, rural residents, and combined. The survey question and result is noted under each protected resource or value below.

A total of 69 residents completed the survey. 38 of the participants were delineated as either the urban or non-resident category. These participants lived either in a city center or lower portions of the watershed. Some did not reside in the watershed, but recreated there. The other category of rural was based on residents of the watershed who worked, lived and recreated in the watershed. The combined category utilizes the results of the other categories as the overall results for the watershed.

The first two questions gave the participant a choice of four pictures each. The participant was allowed to choose more than one answer for each question.

Question # 1: Pictoral choice of four different streamflow levels.
Picture A: High flood stage in lower portion of watershed (January, 10-20,000 cfs)
Picture B: Slow flow, covering streambed in upper portion of watershed (July)
Picture C: Low flow with exposed rocks in mid portion of watershed (July)
Picture D: Moderate flows in lower portion of watershed (June)

Category (%)	A	B	C	D	N/A
Urban/Nonresident	11	25	34	30	0
Rural	19	39	39	32	0
Combined avg.	15	31	36	31	0

The intent of this question was to evaluate what flow levels were aesthetically appealing. Each participant was asked to choose a picture from four different flow levels. The flow levels ranged from flood stage to summer base flow level. The urban group preferred C and D (low flow and moderate spring flow), whereas the rural group preferred B and C (lower flows) equally with D slightly behind at 32%. Overall, 36% responded in favor of picture C, the summer base flow over a rocky substrate. Pictures B and D received 31% each and represented higher flows. 15% of the participants chose picture A (flood stage).

Question # 2: Pictoral choice of four streamside settings.

Picture A: Full channel (calm water) with abundant riparian vegetation.

Picture B: Full channel (calm water) with plowed agricultural field up to edge and scarce shrubby riparian vegetation.

Picture C: Canyon setting with trees and streamflow over exposed rocks.

Picture D: Calm water setting with 5-7' vertically eroded stream banks and no shrubby vegetation.

Category (%)	**A**	**B**	**C**	**D**	**N/A**
Urban/Nonresident	33	11	53	2	0
Rural	45	13	65	3	0
Combined avg.	38	12	58	3	0

The intent of this question was to help determine what the residents considered to be scenic or aesthetically pleasing. The pictures illustrated four different riparian situations ranging from tranquil settings to agricultural cropping to the edge of the stream. 58% of the participants chose the rocky substrate with trees and a basalt cliff in the background. 38% chose the more tranquil riparian setting with dense vegetation. 12% chose the agricultural field coming to the edge of the straightened channel, and 3% chose the vertical eroding bank.

Question # 3 – Beneficial Use Support

The next set of questions requested information regarding different recreational or aesthetic beneficial uses in the watershed. The survey participants were asked to rate how well they believed each of these was supported in the watershed and whether or not they participated in the activity. A rating of 1 was considered poor or not supported and 5 was considered excellent.

Wading

Category (%)	**1**	**2**	**3**	**4**	**5**	**N/A**
Urban/Nonresident	13	16	29	3	5	34
Rural	6	19	23	19	10	23
Combined	10	17	26	10	7	29

42% of the participants considered wading to be fair to excellent. 7% ranked the activity as excellent and 10% considered wading to be poor to not supported. 29% could not accurately assess the activity.

19% of the respondents stated participation in the activity.

Swimming

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	26	24	13	3	0	34
Rural	16	39	13	3	3	26
Combined	22	30	13	3	1	30

17% of the participants considered swimming to be supported in Hangman Creek (fair to excellent rating). 1% ranked the activity as excellent and 22% rated the activity as poor or not well supported. 30% could not accurately assess whether swimming was supported.

16% of the respondents stated participation in the activity.

Fishing

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	24	13	21	11	0	32
Rural	16	16	19	19	0	29
Combined	20	14	20	14	0	30

34% of the participants claimed that fishing was supported in Hangman Creek (fair to good). No one ranked the fishing as excellent and 20% ranked the activity as poor or non-supported. 30% of the participants could not accurately assess the activity.

19% of the respondents stated participation in the activity.

Canoeing

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	21	5	21	11	3	39
Rural	10	29	19	10	10	23
Combined	16	16	20	10	6	32

36% of the participants believe that canoeing is supported at some level (fair to excellent). 6% ranked the activity as excellent and 16% ranked the activity as poor to non-supported. 32% of the residents could not accurately assess the activity.

12% of the respondents stated participation in the activity

Kayaking/Rafting

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	21	5	21	8	3	42
Rural	10	29	23	6	6	26
Combined	16	16	22	7	4	35

33% of the participants believe that kayaking and rafting on Hangman is supported (fair to excellent). 4% rated the activity as excellent and 16% ranked the activity as poor or not supported. 35% of the residents could not accurately assess the activity.

7% of the respondents stated participation in the activity.

Scenery

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	0	5	24	39	13	18
Rural	0	3	32	32	13	19
Combined	0	4	28	36	13	19

77% of the participants believe that the scenery in the watershed is supported (fair to excellent). 13% rated the scenery as excellent and no one thought it was poor or not supported. 19% could not accurately assess the scenery.

59% of the respondents stated to enjoy the scenery in the watershed.

Wildlife Viewing

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	0	0	34	29	18	18
Rural	0	13	26	35	10	16
Combined	0	6	30	32	14	17

76% of the participants believe that wildlife populations in the watershed are supported (fair to excellent). 14% rated the wildlife viewing to be excellent and no one thought it was poor or not supported. 17% could not accurately assess the wildlife.

52% of the respondents stated to participate in the activity.

Bird watching

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	0	0	34	24	18	24
Rural	0	6	35	23	13	23
Combined avg.	0	3	35	23	16	23

74% of the participants stated that bird watching in the watershed was supported (fair to excellent). 16% believed it is excellent and no one ranked it as poor or unsupported. 23% could not accurately assess the bird watching.

38% of the respondents stated to participate in the activity.

Hunting

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	37	8	11	11	0	34
Rural	0	19	26	19	13	23
Combined avg.	20	13	17	15	6	29

38% of the participants stated that hunting in the watershed was supported (fair to excellent). 6% believed it is excellent and 20% ranked the activity as poor or not supported. 29% could not accurately assess hunting activities.

22% of the respondents stated participation in the activity.

Hiking/Walking

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	12	13	28	14	12	22
Rural	0	10	35	23	16	16
Combined avg.	12	13	28	14	12	22

54% of the participants stated that hiking/walking in the watershed was supported (fair to excellent). 12% believed it is excellent and 12% ranked the activity as poor or not supported. 22% could not accurately assess the activity.

35% of the respondents stated participation in the activity.

Biking

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	37	8	13	11	0	32
Rural	16	19	23	10	0	32
Combined avg.	28	13	17	10	0	32

17% of the participants stated that biking was supported in the watershed (fair to good). No one ranked the activity as excellent and 28% ranked it as poor or not supported.

12% of the respondents stated participation in the activity.

Horseback Riding

Category (%)	1	2	3	4	5	N/A
Urban/Nonresident	32	5	11	8	0	45
Rural	10	13	16	19	10	32
Combined avg.	22	9	13	13	4	39

30% of the participants stated that horseback riding was supported in the watershed (fair to excellent). 5% ranked the activity as excellent and 22% ranked it as poor to not supported.

6% of the respondents stated participation in the activity.

Other

This survey could not possibly cover all the activities in the watershed. Therefore, an option for participants to list "other" activities in the watershed was given. There were four additional activities listed. Herbal collection (1), crawfishing (1), viewing (1), and sex (1).

Question # 4 – Water Quantity

Category (%)	Yes	No	N/A
Urban/Nonresident	39	50	11
Rural	39	45	16
Combined avg.	39	48	13

Participants were asked if Hangman Creek has enough water to support the activities that are important to them. 48% stated that there was not enough water. 39% stated there was enough water and 13% couldn't accurately assess the question. There was one additional comment that the water quantity depended upon the season.

Question # 5 – Water Quality

Category	Yes	No	N/A
Urban/Nonresident	24	58	18
Rural	29	42	29
Combined	26	51	23

Participants were asked if Hangman Creek, in their opinion, had good water quality. 51% stated that Hangman Creek does not have good water quality. 26% stated that it does have good water quality and 23% couldn't accurately assess the question. There was one additional comment that the creek does have good water quality up until it reaches the City of Spokane.

1. ***Water Supply (domestic, industrial, agricultural).*** The needs for water supply in the watershed are mainly limited to domestic, municipal, livestock, and minor irrigation uses. The following tables are from the draft document and describe the approximate current and projected water use in the watershed.

Provisional WRIA 56 USGS Water Use Data for 1995

	Withdrawal Ground Water (cfs)	Withdrawal Surface Water (cfs)	Consumptive Use (cfs)	Conveyance and Other Losses (cfs)
Total Public Water Supply	20.79	0.00	NA	2.21
Domestic	9.48	0.00	NA	NA
Commercial	6.53	0.00	NA	NA
Industrial	2.57	0.00	NA	NA
Self-Supply				
Domestic	1.56	0.00	1.32	NA
Commercial	1.50	0.00	1.61	NA
Industrial	1.58	6.84	2.2	NA
Livestock				
Stock	0.32	0.00	0.31	NA
Animal Specialties	0.02	0.00	0.02	NA
Irrigation (7,770 acres)	10.43	0.42	10.74	1.01
Mining	0.02	0.00	0.00	NA
Totals	60.51	7.26	16.20	3.22

Notes:

1. Data from USGS web site http://wwwdwatcm.wr.usgs.gov/wuse/main.huc8.95.tst.
2. cfs is cubic feet per second.
3. Public water supply is separated into domestic, commercial, industrial, and losses.
4. Data from 1995 report.
5. NA is not applicable.
6. Public water supply served 49,850 people and self supply served 8,060 people.
7. Wastewater treatment returned 0.74 cfs from 14 facilities, three public and 11 other.

Small Town Water Rights, Use, and Excess Capacity Summary

City	Water Rights (ac-ft/yr)	Current Annual Water Use (ac-ft/yr)	Current Excess Capacity (ac-ft/yr)	2020 Projected Water Use (ac-ft/yr)	2020 Excess Capacity (ac-ft/yr)
Waverly	52	33.5	18.5	61	(9.0)
Rockford	296	243	53	247	49
Spangle	135	67	68	212	(77)
Latah	100	5.66	94.3	89	11
Tekoa	800	334	466	326	474
Fairfield	208	135	73	261	(53)
Cheney	5,729	1,455	4,274	4,242	1,487

Notes:

1. Projected water use data is from Spokane County Water Quality Program (Reanette Boese, personal communication).
2. Projected water use is without water conservation in place, and is from water system plans and population projections.
3. ac-ft/yr is acre-feet per year.
4. Water right information supplied by the Washington Department of Ecology (Doug Allen, personal communication).
5. Annual water use for Rockford and Spangle were supplied by the Washington Department of Ecology, water use for Waverly was supplied by Spokane County, and the communities supplied all others.
6. Tekoa projected water use based on City of Tekoa 2020 population estimations.

Water availability for future growth was a factor considered by the PU. A water rights summary for Hangman Washington communities (excluding Spokane) was provided by Ecology (Table 34) along with current annual water use. Using the 2020 population projections, Rockford Latah, Tekoa, and Cheney appear to have adequate water rights for estimated water use through 2020. Waverly, Spangle, and Fairfield should evaluate the population projections used, current water rights, and water systems for future needs. There may be either be reporting errors or these communities may not have enough water if current growth rates are met in the future.

These uses were determined as not completely met for future needs. The communities of Waverly, Spangle, and Fairfield may not have enough water if the County's current growth projections are correct. The public survey the PU conducted did not assess the needs for domestic or municipal water supply.

Domestic Exempt Wells and Municipal Needs

The PU agreed that a one cfs reserve (724 acre feet per year) would be shared between Domestic and Municipal uses. The PU tentatively agreed that the Domestic reserve for exempt wells would be 500 acre feet a year. Livestock watering (free ranging operations utilizing 5000 gallons a day or less) are to be factored within this portion of the reserve. Municipal would receive 224 acre feet per year. The number of new houses this supports will depend upon restrictions for landscaping and water use. These recommendations are pending review and approval of local governmental staff.

2. *Stock Watering*
Livestock watering requirements in the watershed are minimal to moderate at best. There is no current estimate of livestock numbers within the watershed. However, this use was determined as being met due to the fact that several hundred acres of riparian areas are currently being accessed by livestock. Water is supplied either by direct access to tributaries and mainstem or water systems connected to wells.

3. *Fish and shellfish*
This use includes the migration, rearing, spawning, and harvesting of salmonids. Current information on fish populations, density, and habitat is incomplete. Recent assessment work indicates that populations of salmonids are depressed throughout the watershed due to habitat reduction and temperature. Spawning and rearing habitat information is lacking. However, fish survey work and harvesting indicates an abundance of warm water species such as suckers, squawfish, red-sided shiners, and dace. Shellfish harvesting does not occur on a commercial scale within the watershed. However, crayfish and freshwater mussels are found throughout the system.

This use was determined as not being met due to poor fishing opportunities due to the tremendous loss of habitat, water quality violations (eg. temperature), and sustained critical low flow periods in the summer.

4. *Wildlife (terrestrial)*
According to WDFW and the local residents, the wildlife present within the watershed is diverse and abundant. The majority of the habitat can be found within the headwater areas of Rock Creek, California Creek, and Hangman Creek. These areas contain extensive tracts of timber, scattered fields, and wooded riparian corridors. The agricultural portions of the watershed do provide limited, discontinuous sections of habitat along the stream corridor. However, local residents indicate that wildlife populations primarily utilize the headwater portions and tributaries more than the mainstem of the creek due to habitat limitations. Large intact balsalt canyon areas (Hangman mainstem, California Cr, Rock Cr, and Spangle Cr.) are well protected and provide valuable wildlife migration corridors.

This use may be met, but the PU could not fully determine this from the information available. Healthy populations of wildlife do exist, but habitat may be impaired in many areas, especially riparian corridors.

5. *Recreation.* Recreational uses in the watershed include:

a. Primary Contact - Swimming-complete submersion.

The PU could not determine whether or not this use was completely met. Conditions may not be optimal, but swimming is reported to be available in many large pool areas throughout the watershed even during low water years. Fecal coliform levels in the summer are a concern, but there have not been any health issues or warnings documented by the residents or the Department of Health.

b. Secondary Contact - Wading.

This type of recreation is currently supported at all flow levels.

c. Sport Fishing

Although fishing does occur within the watershed, sportfishing for salmonids is limited and/or depressed. This use was determined as not being met.

d. Boating

The creek supports limited use for recreational boaters. Use is primarily event driven for rafters and kayaking during spring high flows. This type of use is limited to approximately 5.9 days a year for white water enthusiasts. Canoeing is currently limited to the early part of the year, December-May. This is not conducive for most boaters due to the risk of high flows and cold temperatures. A majority of the creek is not easily navigable with flows under 200 cfs. However, this use was considered as being met as it is a run of the river situation.

6. *Water Quality Criteria.* Hangman Creek routinely fails various state water quality standards during both the summer months (low flows) and winder/spring runoff months. This use was determined to not be met a majority of the time.

a. Summer violations-temperature, DO, FC (high exceedence counts), pH

b. Winter violations-turbidity, total phosphorus, nitrogen ammonia, pH, FC (lower exceedence values)

7. *Aesthetics*. The flow in Hangman Creek is subject to the "run of the river". There are no anthropogenic control points and the flow is dependent upon precipitation and infiltration to recharge and sustain baseflow. Storage has been determined to be low.

Upon reviewing the aesthetics of different water levels in the creek, it has been determined that this value is not met during certain times/months of the year.

a. Low flows during summer periods – little to no water is not as aesthetically pleasing.

b. Smells/odors – In winter months, kayakers have reported an offensive odor presumed to be associated with agricultural chemical application or wastewater treatment discharge. Spring/Winter runoff events – Turbidity and high sediment loads cause discoloration of the water. The sediment loads are derived from several sources including stream bank erosion, decaying plant material, silt from agricultural fields, roads, and ditches.

Determine how to evaluate stream flows for the resources identified, including any additional information that is needed.

- The PU developed a scope of work and hired Hardin-Davis Inc. to conduct an instream flow study to evaluate the flow requirements.

Conduct studies, as needed, to determine what stream flows are needed to protect instream resources and to evaluate past, current, and the potential future hydrology in the basin.

- The PU has utilized information gathered for the Phase II Assessment Water balance (water rights, water uses, projected growth, etc..) and the instream flow study by HDI.
- Historical vegetation study (hydrological calculations indicate that there may have been less water available 120 years ago. But the base flow level reduction during the summer months was probably more gradual and lasted longer into the critical period).
- Historical hydrology (PLS data suggests that hydrology has not much different than 120 years ago). A pre-existing base flow conditions exercise was conducted by the SCCD before the HDI study. Results suggested that not more than approximately 26 cfs occurred near the current USGS gage below Marshall Creek and not more than approximately 11 cfs occurred above Marshall Creek.
- Current Hydrology (seepage run, gaging data)

Review and evaluate study results to determine needs to protect and preserve the identified instream values and resources.

The "run of the river" nature of the creek has some inherent limitations for certain instream values and resources. Some of these needs can be met through short and long-term management and policies to be set forth from the Watershed Planning Recommendations.

Evaluate current and future water uses, including both in stream and out of stream uses.

The PU evaluated the current and future water use (as described in table 18 and 34 above) and decided on the following allocation priorities and water reserve for the watershed.

The Planning Unit has considered the following prioritization for water allocation in the basin If approved, the allocations will be apportioned as follows. A reserve is established for the first two.

1. **Municipal (reserve - 224 acre feet/year)**
2. **Domestic (reserve – 500 acre feet/year)**
    a. Group, domestic exempt wells
    b. Exempt stock water (<5000 gallons/day – small, unconfined operations)
3. Light Industrial
4. Commercial
5. Stock water (> 5000 gallons/day – confined operations)
6. Agriculture (irrigated)
7. Heavy Industrial

Minimum Instream Flow Recommendation – Study Assessment

A watershed and its associated streams depend upon a variety of processes to remain both ecologically and hydrologically functional. These intricate processes provide the "life and health" of the watershed and its productivity. These processes are often compromised through other uses such as agriculture, domestic supply, industry, and others. The Hangman (Latah) Creek watershed is no different. The greatest need for water and the lowest instream flow levels often coincide in the dry summer months. These conditions have prompted the need to assess the availability of water and its uses, and develop recommendations to preserve instream flow levels for all beneficial uses including fisheries.

In accordance with the Local Watershed Planning Act, the Planning Unit (PU) pursued an instream flow recommendation for Hangman Creek in February of 2002. Hardin-Davis, Inc., (HDI) a consultant from Corvallis, Oregon was selected and hired to conduct the analysis. The following objectives were developed and agreed upon by the PU and HDI;

Study Objectives

1. Review the existing information on hydrology and assess the opportunities for increasing base flow

2. Use the Physical Habitat Simulation model (PHABSIM) to determine the relationship between discharge and fish habitat; recommend optimum flow levels for fisheries

3. Model water temperatures in the creek under current conditions, and estimate effects of potential improvements in shade and streamflow

4. Estimate the effects of improved flows and temperatures on other water quality parameters

5. Recommend optimum flow levels for recreation.

The work by HDI was conducted on five different sites from May through September 2002. A final report was submitted to the PU in May 2003. Data were collected on habitat conditions, flow levels, and water temperature. For additional details, a separate final report is available in Appendix L.

Planning Unit Instream Flow Recommendation For WRIA 56: Hangman Creek

In June of 2003, the PU members were asked to develop their own instream flow recommendation for Hangman Creek (Table 8, based on all available information). This exercise was valuable in understanding the PU interpretation of data and overall position.

The instream flow recommendations varied from as low as 6 cfs to 26 cfs near the mouth of Hangman Creek. These recommendations were discussed and evaluated at the July, 2003 meeting. Each PU member provided their justification for the recommendation they presented, but further discussions and voting found that all members believed that a recommendation of 10-

20 cfs was reasonable. However, the concern now focused on the restrictions to be placed on future water rights and the potential for a period of basin closure. Other concerns included;

- How do we avoid shutting down all water rights applications in the basin.
- What types of mitigation or restrictions would be placed on new water rights.
- We have to remember that flows at the USGS gage represents the downstream 4-5 miles (below Marshall Creek) approximately 15% of the basin. The remaining watershed above Marshall Creek has much less water than shown by the gage.
- There may be a need for more than one control point.
- The hydrology in the upper portion of the basin, above Rock Creek may behave differently that the rest of the basin.

The PU was then asked to develop a complete recommendation providing a flow number or range of numbers, when it would be set, the number of control points and other mitigating factors that should be administered.

In September of 2003, the entire group decided and agreed to the following;

1. A period of closure should be utilized for ease of administration and enforcement by WDOE.
2. Additional surface water rights (junior rights) would be conditioned.

The PU turned its discussions to a date approach and began to review what data is needed to establish the best dates for closure. WDOE stated that most of instream flow recommendations in the past had been set for numbers that were typically met 50 - 80% of the time. Other solutions have been to just close the basin and not issue any new water rights to protect flow levels for fish.

At this meeting, one local government, the City of Spokane, determined that 6 cfs was the only recommendation it would support based on exceedence values and the fact that the junior water rights would have to be conditioned. The City of Spokane contends that the PU would be issuing a water right for water that typically does not exist.

Table 8. WRIA 56 Planning Unit Member Instream Flow Recommendations (June 2003)

Planning Unit Member	cfs	**Location**	Additional Comments
City of Spokane	6	USGS gage at mouth	Average of daily averages over any one calendar month. Current and projected needs of municipalities are met. Establishment of local oversight board for junior water rights. We still need more information regarding future needs of the basin and actual water use versus paper rights.
State Caucus	15/20	Above/below Marshall Creek	Priority dates need to be set. The basin is closed to further surface water withdrawals. Groundwater withdrawals permitted under specific conditions.
	10	Rock Creek at Jackson Rd.	
	5	California Creek	
	10	Keevy Rd.	
	10	Hays Rd.	
SCCD	5/10	Above/below Marshall Creek	These values are achievable most years. We need to have realistic values to lend creditability to our numbers.
	2	Rock Creek at HC confluence	
	2	Hangman Creek at Rock Cr. confluence	
	2	Keevy Rd.	
	1	Hays Rd.	
CDA Tribe	26/50	Above/below Marshall Creek	Ultimate goal is to pave the way for future generations to harvest anadromous fish from Hangman Creek.
Gary Ostheller	15	USGS gage at mouth	The stream does not meet the requirements for salmon recovery and has been committed beyond its capability to produce. 15 cfs should be used to condition future surface water users and to try to keep other varieties of fish in certain sections of the stream.
Spokane County	N/A	N/A	N/A

Note:

1. The full text of justifications and additional comments are available from the SCCD.
2. cfs is cubic feet per second

In October of 2003, the PU continued discussions of instream flow setting by Ecology. The PU reviewed a more recent water right permit that utilized 13 cfs as an interruptible limit. This means that when the flow in Hangman at the gage falls to 13 cfs, this diversion would have to cease. It was then stated that most of the water rights after 1976 (for irrigation) were seasonal and based on the 13 cfs flow. There was no statistical evaluation or habitat evaluation completed to justify the 13 cfs flow.

The PU reviewed graphs and raw data for depicting exceedence curves for various flow levels and associated dates when these levels are typically reached (data from USGS)

- **The 90% exceedence curve for 15 cfs was reached near the 18th of June.**
- **The 80% exceedence curve for 15 cfs was reached near the 2nd of July.**
- **The 50% exceedence curve for 15 cfs was reached near the 27th of July.**

In reviewing the exceedence tables, the majority of the PU continued to agree that 15 cfs was appropriate for setting an instream flow. However, the City of Spokane maintained the support for only 6 cfs.

The PU further discussed the instream flow number and the following statements were stated and recorded against the use of 6 cfs.

- The use of 6 cfs as an instream flow cutoff is too stressful for fish. Between 15 and 6 is probably where they begin to feel the stress. If we allow water users to pump from the stream to bring it down to 6 cfs, then we are stressing those fish for longer periods of time.
- Water users will utilize their water rights to the extent of the law. If the experts say they can draw it down to 6 cfs, then that is what they will do.
- Agricultural growing seasons are not very conducive at 6 cfs or 15 cfs (a difference of about 43 irrigation days). Any irrigated crops would die in June or later July.
- A professional hydrologist believes that the flow duration statistics indicate that there is more than 10 cfs of flow in the creek throughout the summer for a majority of the years of record. The flow statistics also show that there was more than 15 cfs of flow in the creek for most of June through October period for a majority of the years on record.
- There are senior water rights currently in place with a condition of 13 cfs. These senior water rights would be upset to have to shut-off their use before junior water rights.
- Very few people would obtain new water rights anyway. Issuing letters would not a big burden, even if Ecology has to do it half the time.
- Tim Hardin, the consultant who conducted the instream flow study stated that 6 cfs was not a realistic minimum flow to set. It happens that, because of the shape of the WUA vs. flow curves that the “10 percent change per 1 cfs” threshold is reached at 6 cfs in the downstream reach, and 7 cfs in the combined upstream reaches. A conclusion from this that 6 cfs at the gage is in any way protective of the fishery was a big stretch.
- According to the HDI report, one could conclude that 6 cfs in the reach downstream of Marshall is below the critical level, and thus a very undesirable flow. And if it is 6 cfs at the mouth, it is about 1-2 cfs in Hangman Cr. above Marshall Creek. So a 6 cfs flow at

the gage means that flows in 80 -90 percent of the creek are far below the critical threshold. This is unacceptable for protecting habitat conditions.

The City of Spokane would not compromise on 6 cfs unless there was a reasonable way of obtaining more water to support a higher instream flow. The City of Spokane further suggested the potential of closing the basin altogether.

In order to continue progress, the PU tabled this topic until a later date. The issue of a closure period continued with the following discussions and proposals.

Closure Dates

Proposal # 1: The surface water rights of Hangman Creek would be closed on a seasonal basis from June 1st through October 31st. This would be conditioned on a minimum instream flow of 15 cfs at the USGS gage near the mouth.

All PU members agreed except for the City of Spokane. They proposed a cut-off date of July 1 and no set instream flow number.

Proposal # 2: The surface water rights of Hangman Creek would be closed on a seasonal basis from July 1st through October 31st. This would be conditioned on a minimum instream flow of 15 cfs at the USGS gage near the mouth.

All PU members agreed except for the City of Spokane. They proposed a cut-off date of July 1 and no set instream flow number.

The City of Spokane argued that there is no need for an actual instream flow number and that a date would be sufficient and protective of instream flow. It was argued that the flows could then be sucked down to zero before the effective shutoff date.

A third proposal was put forward (proxy vote, not official).

Proposal # 3: Surface water rights would be closed from June 1st through October 31st without a conditioned flow.

Three members of the PU could not support this, including the City of Spokane. It was viewed as too restrictive. The City could support it if the date were changed to July 1st

At this point, the PU decided to end the discussions of instream flow recommendations for Hangman Creek. It was apparent that the PU had arrived at an impasse that could not be easily resolved. It was agreed to compile the progress that the PU had completed to date and present it to the public for additional comment. After that, the report would be reviewed by the PU and submitted to the Ecology. Ecology would then become responsible for continuing the development of an instream flow ruling for Hangman Creek.

Instream Flow Public Meeting Results

Two public meetings were held in the watershed to discuss the status and gather input on the instream flow work in Hangman Creek.

Fairfield Community Center, June 17, 2004

Ten watershed residents attended this meeting. The majority of the residents at this meeting supported out-of-stream uses for the creek (60-40 split). They were not interested in aesthetics or fisheries issues.

Cascade Mobile Home Park, June 23, 2004

Seven watershed residents attended this meeting. These residents were more concerned about the amount of water available for aesthetics and aquatic biota. One resident mentioned that the water should be available for riparian plant irrigation.

The attendance of the two meetings was disappointing and may not fully represent the watershed community's stance on instream flow. Additional public meetings should be held to gather more input in the future.

Summary

The Planning Unit agrees on the following in regards to instream flow.

1. There is not enough water in the critical summer period to protect fisheries and some other beneficial uses.
2. The basin needs restrictions on water use.
3. A period of July 1st through October 31st should be used for conditioning new water rights.
4. A municipal reserve of 224 acre-feet per year should be set (under consideration).
5. A domestic exempt reserve of 500 acre-feet per year should be set (under consideration).
6. The basin may need to be closed to all further appropriations.

The City of Spokane disagrees on the following in regards to instream flow.

1. The application of any instream flow number to condition a water right.
2. The extension of using June 1st in the period of closure is far too restrictive.

According to the consultant, HDI, if the existing flow falls below 26 cfs in the main stem upstream of Marshall Creek, any additional flow withdrawal will adversely affect habitat conditions, reducing the habitat from optimum to minimum. Withdrawals will adversely affect minimum and critical habitat conditions if additional withdrawals cause existing flows to fall below 15 and seven cfs, respectively.

Appendix D

Planning Unit Membership

WRIA 56 Planning Unit Members
(As of 3/8/04)

Lead Agency: The lead agency is defined as the entity that coordinates staff support of its own or of other local governments and receives grants for developing a watershed plan.

- Spokane County Conservation District

Initiating Governments: The planning process could only be initiated if the following entities unanimously agreed to proceed with assessing the status of the water resources of WRIA 56. The initiating governments must include all counties, the largest city or town, and largest water supply utility obtaining the largest quantity of water in the WRIA. For WRIA 56, the following are defined as the initiating governments by RCW 90.82.

- Spokane County
- Whitman County
- City of Spokane
- Hangman Hills Water District

Other Voting Members

Several unsuccessful efforts to solicit membership to the Planning Unit were made throughout the first year. Infrequent attendance by some original participants evolved into a smaller core membership of ten individuals. Representation of the rural, tribal, commercial development, and private citizen interests were achieved.

- Agricultural/Rural – Gary Ostheller
- State Caucus – Doug Allen (Ecology)
- Private Residential Landowner - Peter Grunte
- Commercial Development - Mike Barber

Affected Tribes: – Tribes that do not have reservation lands in the management area, but may be impacted by planning process.

- Spokane Tribe
- Coeur d'Alene Tribe

WRIA 56 Voting Member Summary (Date Instated)	**Votes**	**Standing**
City of Spokane	1	In
Spokane County	1	In
*Whitman County	1	Out
Hangman Hills Water District	1	In
Gary Ostheller (7/16/02)	1	In

Coeur d'Alene Tribe (9/19/02)	1	In
WA State Department of Ecology	1	In
Spokane Conservation District	1	In
Peter Grunte (9/19/02)	1	In
Mike Barber (8/15/02)	1	In

* Whitman County has not officially responded to any level of participation
* The Spokane Tribe was offered voting status, but declined 8/02

Voting Requirements: A Quorum is required to make key decisions for the management plan. The Planning Unit has defined QUORUM as follows: 60% of voting members must be present at each meeting to constitute a quorum.

Appendix E

Planning Unit Operating Procedures/Public Awareness Program

Hangman (Latah) Creek 2514 Planning Unit

OPERATING PROCEDURES

(6/2000)

Purpose: Organize a Planning Unit; Develop a Scope of Work and Outline for a watershed plan for the Hangman (Latah) Creek Watershed, Water Resource Inventory Area (WRIA) 56 – per the 1998 Watershed Planning Act – RCW 90.82

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1. Project Area – WRIA 56 Hangman (Latah) Creek Watershed:

The project area for the Hangman (Latah) Creek Watershed Planning Process includes all land within the Hangman (Latah) Creek Watershed and its tributaries, comprised mostly within the area of Spokane County.

2. Name:

The Hangman (Latah) Creek Water Planning Unit will hereafter be referred to as the "Planning Unit".

3. Initiating Governments:

The four Initiating Governments for this project are: Spokane County, Whitman County, City of Spokane and the Hangman Hills Water District.

4. Lead Agency:

The Spokane County Conservation District has been designated as lead agency for this project by the Initiating Governments.

5. Membership:

The Planning Unit, established by the Initiating Governments and Spokane County Conservation District shall include a diverse group of interests including: Agricultural Groups; Businesses; Environmental Groups; Indian Tribes; Property Owner's Associations and Individual Property Owners; together with the Initiating Governments, Local, State and Federal Agencies.

**For a list of the standing groups on the Planning Unit, See Attachment A of this document*

a. **Membership Removals**: The Planning Unit may remove any member by a majority vote of the entire Planning Unit for un-represented absences totaling at least 3 consecutive regular meetings.

b. **Membership Vacancies**: Vacancies occurring may be filled as decided by the Planning Unit to try to ensure all interests are represented. Temporary alternates shall be allowed upon request. Permanent replacements need to be submitted by written request.

c. **Membership Additions**: New members can be added, as determined by majority vote of the Planning Unit, after attending three consecutive meetings.

d. **Membership Withdrawals**: Any Planning Unit member shall have the right to withdraw in writing from the planning process at any time. All members agree that if a member or interest group withdraws, it shall not be deemed part to any plan or agreement produced pursuant to REW 90.82 and shall not be bound thereby.

6. Rules and Responsibilities of the Planning Unit

a. Planning Unit Meetings:

1) Regular meetings shall be held the second Tuesday of the month, at the Spokane County Conservation District Office at 10:00 a.m. unless otherwise scheduled by the Planning Unit. The Lead Agency may also call emergency meetings if necessary with a minimum of 24 hour notice.

2) All meetings shall be open to the public. The public will be allowed to provide input or voice concerns during the first and last 15 minutes of the meetings. Written public comments are always welcome and will be added to meetings.

3) Meetings will start on time and end on time, unless extensions are approved by a majority vote at meetings.

4) If a Planning Unit member cannot attend a meeting, it is his/her responsibility to appoint an alternate representative and to catch up on missed information before the next meeting. Team members must contact the facilitator if they or their substitute cannot attend a meeting 24 hours prior to the meeting.

5) A list of informational material such as acronyms, definitions, watershed focus sheets, and maps will be provided at each meeting for newcomers and the public.

b. Planning Unit Decision-Making:

Voting and Non-Voting Team Members:

Planning Unit members will receive votes as follows:

- State Governments shall receive one vote total.

- Local governments, PUDs, and Municipalities shall receive one vote each.

  - All Non-Governmental Groups shall receive one vote

Ex Officio Members will be relied upon for technical advice and are to be considered non-voting members.

Quorum:

The Planning Unit has defined QUORUM as follows: 60% of voting members must be present at each meeting to constitute a quorum.

A quorum will be required to hold an official Hangman (Latah) Creek Water Planning meeting. If a quorum is not present, attending members can continue to meet and informally discuss topics.

Administrative Issues:

Administrative issues such as meeting times, places, and Planning Unit membership will be decided by a majority vote of the Planning Unit present at any official meeting.

Non-Administrative Issues:

The decision process will be as follows for non-administrative issues:

The Planning Unit shall operate by consensus for all decisions other than administrative issues except by as stated below in the step process. Consensus is defined as a general agreement or accord by all voting Planning Unit members. Consensus is not reached if one voting governmental representative votes “No.” However, if that representative “abstains” or says, “I cannot vote yes, but am willing to allow the process to go forward and will not take any action against the decision,” then the vote would be consensus. The issue will then also be listed as an agenda item for the following meeting where a second vote will be taken. Failure of any non-governmental team member to attend the second meeting will result in a sustained vote unless the member submits a dated signed vote to the facilitator prior to the second meeting. (See Step Process for governmental voting procedures.)

Step Process for All Non-Administrative Decisions:

Step1: As stated above in the non-administrative issues section, the entire Planning Unit shall operate by consensus. There must be consensus of governments to proceed with decision making. If consensus cannot be reached by the entire Planning Unit, then by majority vote of the Planning Unit, the process will move to Step 2.

Step 2: A vote must be taken of governmental members to ensure their consensus. If consensus is reached by the governments, then the process automatically moves to Step 3. (Members may choose to proceed by written ballot from this step forward.)

Step 3: Step 3 requires consensus by the governments and a 2/3 (two-third) majority vote by non-governmental members. At Step3, only one vote per each interest group will be allowed. At any time a 2/3 (two-third) majority vote cannot be reached by the non-governmental team members, then a vote by consensus of the governments will be taken to move to Step 4.

Step 4: Step 4 requires consensus of the governments and a simple majority of non-governmental members. At Step 4 only one vote per each non-governmental interest group will be allowed.

NOTE: Consensus will be required for approval of the watershed plan, but consensus is not required for the plan recommendations.

c. Planning Unit Responsibilities:

1) Identify and incorporate issues into a work plan

2) Develop a work plan for recommended sub-watersheds
3) Approve Requests for Proposals (RFPs), budgets and data collection needs
4) Any tasks completed or data collected in-house (by Planning Unit Members or their agencies) will require approval of the Planning Unit as to its authenticity and monetary value
5) Assure work is consistent with the 1998 Watershed Planning Act guidelines and criteria
6) Maximize use of grant funding to complete as much WRIA 56 work as possible
7) Obtain Community Input
8) Use best available science to develop the Watershed Plan
9) Recommend priority issues for project areas
10) Prioritize sub-watersheds for data collection
11) Encourage public involvement and cultivate leadership with the community

7. Roles and Responsibilities of the Lead Agency:

a. Assisting Planning Unit:

1) Function as facilitator, secretary, and treasurer by preparing notices, financial statements, meeting minutes (Meeting minutes will be sent to public attendees and all Members by mail or e-mail). NOTE: These documents are public records and are subject to public inspection.

2) Notify Planning Unit if meeting place or time is changed or if meeting is canceled.

3) Assist Planning Unit in accomplishing goals and assist in developing and maintaining a focused and measurable work plan.

b. Grant Requirements:

1) Leverage grant funding by using resources effectively and appropriately.

2) Submit quarterly reports and budgets on time and as requested.

3) Maintain regular contact with the Washington Department of Ecology Project Coordinator and immediately communicate any problems or concerns.

c. Public Relations:

1) Promote community involvement through effective communication within the community, Congressional offices, media representatives, special interest groups, and any other interested parties.

2) Remain a neutral party while involving a broad cross-section of the community in consensus building and decision-making.

3) Establish partnerships for implementing the Watershed Plan.

8. Procedural Order of Meetings:

a. Facilitator shall call the meeting to order and pass around the sign-in sheet.

b. Facilitator shall call for approval of previous meeting minutes

c. Facilitator shall all for amendments, then approval of the current agenda. The facilitator will then direct the meetings according to the written or amended agenda.

d. The facilitator can call for a vote to limit discussions or table the discussion for the next meeting.

e. The facilitator will open the meeting for 15 minutes at the beginning and end of each meeting for a public comment.

f. The facilitator shall close the meeting:

1) Set agenda items for the next meeting

2) Assign tasks

3) Schedule the next meeting

g. The facilitator shall call for adjournment of meeting.

9. Rules of Conduct at Meetings:

Basic ground rules for the Planning Unit members have been stated in Attachment A "Planning Unit Conduct," and agreed to by each Planning Unit Member. The following rules are specifically addressed for the Planning Unit meetings:

a. Meetings will be two hours in length. If the agenda is not covered, by majority vote the meeting will be continued until the agenda items are completed or the discussion is tabled for the next meeting.

b. Members need to be brief and concise as possible and keep to the topic.

c. A member shall raise their hand to speak, introduce themselves and may speak when recognized by the facilitator.

10. Media Releases:

No media or news releases from or for the Planning Unit shall be made unless approved by the Planning Unit to ensure context and accuracy of the data and statements.

11. Conflict of Interest:

Planning Unit members will not engage in any activity viewed as a conflict of interest, real or apparent, including participation in the selection, award or administration of a sub-grant or contract supported by grant funds. Conflict of interest shall include financial gain, employment, contracting or sub-contracting with the contractor.

No individual lobbying efforts outside the Planning Unit meetings by a Planning Unit member will be allowed during the watershed planning process, because these type of actions could easily undermine the trust level between Planning Unit members and the effectiveness of the entire process.

WRIA 56
Hangman (Latah) Creek Watershed Planning Unit

Attachment A

PLANNING UNIT CONDUCT

(6/2000)

1. ***I will work on solutions, not on people (no personal attacks).***

2. ***I will consider everyone in the Planning Unit valuable and I will treat them with respect and courtesy.***

3. ***I will listen attentively, without interrupting and avoid dominating the discussions.***

4. ***I will search for opportunities. Without creativity, the planning process cannot succeed.***

5. ***I will consider one person's concern the Planning Unit's concern.***

6. ***I will state needs, problems, and opportunities, but not positions. Positive candor is a little used, but effective tool.***

7. ***I will attempt to reach consensus on a plan.***

8. ***I understand communication with the news media and/or any legislative authority on watershed planning will occur through Planning Unit authorization, and not by individual members.***

9. ***I accept the responsibility to keep my friends and associates constructively informed of the watershed planning progress.***

10. ***I will call the facilitator before acting on rumors, and I will not jump to conclusions.***

11. ***I understand weapons of war are to be left at home (or at least left at the door).***

12. ***I will make a committed effort to resolve all differences, and to help the watershed planning process be successful.***

BEHAVIOR THAT HELPS THE WORK GROUP ACCOMPLISH OBJECTIVES:

1. **Initiate** – Suggest new ideas or a new way of looking at problem or goals. ("What about . . . ?")

2. **Information-seeking** – Ask for facts ("Are we sure . . . ?")

3. **Clarify** – Probe for understanding. ("Do you mean . . . ?")

4. **Information-giving** – Provide information or relate personal experience about task. ("I tried that and . . . ")

5. **Opinion-giving** – state belief or opinion about a suggestion. ("sounds good to me. ")

6. **Elaborate** – give examples, draw diagrams. ("It's like what my social club did last year ")

7. **Coordinate** – Show the relationships among various ideas; pull ideas and suggestions together. ("Looks like Betty and Bob have basically the same idea.")

8. **Orient** – Define the progress of the discussion or raise questions about the discussion direction. ("I think we've gotten off-track.")

BEHAVIOR THAT HELPS DEVELOP A FAVORABLE CLIMATE:

1. **Encourage** – Be friendly, warm, and responsive to others. Offer praise. Accept their contributions. "(What a good idea, Mary.")

2. **Mediate** – Harmonize, make compromises. Show that different points of view are o.k. ("We've got two good ideas here—can we fit them together by . . . ")

3. **Gate-keep** – Try to make sure everyone can contribute. Call on them by name, take turns around the group, or set a time limit per person. ("We haven't heard from Jim yet.")

4. **Set standards** – Establish guidelines for subject matter or procedures. (Let's make sure each issue is resolved before we move on.")

5. **Be a good listener** – Serve as an audience during group discussion. ("I really don't have an opinion; what was said was interesting.")

6. **Relieve tension** – Reduce negative feeling by joking, pacifying, putting situation in broader perspective. ("Seems like we're making a mountain out of a molehill.")

BEHAVIOR THAT HINDERS TEAMWORK:

1. **Being aggressive** – Criticizing or blaming others, attacking a person rather than their ideas, being hostile to the group or to an individual.

2. **Blocking** – Going off on tangents, citing personal experiences unrelated to the discussion, arguing too much beyond making a point, rejecting ideas without consideration.

3. **Seeing recognition** – Calling attention to self by talking on and on, giving extreme ideas, boasting.

4. **Social-pleading** – Always bringing up one's pet ideas. Covering own beliefs by speaking for other (the common, the housewives, the farmers, etc.).

5. **Withdrawing** - acting indifferent or passive, being much too formal for situation, doodling, whispering to others.

6. **Dominating** – Manipulating, "pulling rank," interrupting, giving orders.

PLANNING UNIT CONDUCT AGREEMENT

Master Signature Page

I have read and agree to the items contained in the PLANNING UNIT conduct document that are intended to help in the successful planning for the Hangman (Latah) Creek Watershed

Signature	**Date**

PUBLIC AWARENESS APPENDIX

Public Meetings/Presentations

Series 1: “Introduction to the Watershed Planning Process”
February 13, 2001 – Qualchan Golf Course
February 15, 2001 – Fairfield Grange

Series 2: “Introduction to Instream Flow Recommendation Process”
November 2001 – Spokane Conservation District Office

Series 3: “Watershed Planning/Instream Flow Progress Update”
January 2002 – Liberty Highschool
January 2002 – Freeman Jr. Highschool

Series 4: “Watershed Planning and Water Rights”
October 2003 – Cutter’s Café, Fairfield, WA
October 2003 – Cascade Mobile Home Community
October 2003 – St. Stephen’s Church, Spokane, WA

Series 5: “Watershed Planning Recommendations
November 11, 2004 – Fairfield Triangle Grange, Fairfield, WA
November 16, 2004 – St. Stephens Episcopal Church, Spokane, WA

Special Presentations/ Educational Displays

Hangman Creek Stream Team Meetings

- September 2000
- October 2000
- December 2000
- January 2001
- October 2001
- September 2002

Idaho Interagency Meetings

- December 2000
- September 2001
- October 2002
- June 2003
- June, 2004

Benewah County Conservation District Board Meeting

- December 2001

Hangman Creek Community Festival (Coeur d'Alene Tribe; Tensed, Idaho)

- July 2003

Southeast Spokane County Fair (Rockford, WA)

- September 2002
- September 2003
- September 2004

Country Ag Expo (Spokane, WA)

- February 2002
- February, 2003
- February, 2004

City/Town Council Meetings:

"Watershed Planning and How it Could Affect Me?"

Special presentations were provided to every City/Town Council in the watershed that may be affected by the overall management decisions of the PU.

- May 2002 – Tekoa, WA
- May 2002 – Latah, WA
- May 2002 – Waverly, WA
- May 2002 – Rockford, WA
- May 2002 – Fairfield, WA
- October 2002 – Spangle, WA
- October 2002 – Cheney, WA

"Final Recommendations" A presentation was provided to every City/Town Council in the watershed on the final recommendations of the Planning Unit.

- February 2004 – Waverly, WA
- February 2004 – Rockford, WA
- March 2004 – Tekoa, WA
- March 2004 – Latah, WA
- March 2004 – Fairfield, WA
- March 2004 – Spangle, WA
- March 2002 – Cheney, WA

Neighborhood Association Meetings

Highland Park Neighborhood Committee. 26 attendees, 11/20/02, 22 present

Presentations

Low Maintenance Landscape classes, 45 people, 9/26/02

"Your Guide to Stream Care" brochures and distributed them in meetings and classes

"Weed Management in Riparian Areas" at WSU Pesticide Recertification Program in Spokane, December 2002 and in Colville.

"Weed Management in Riparian Zones and Landscaping in Lake Communities", March 2003.

Water Quality program at Liberty School in Spangle, 6/26/03 15 kids, 2-6 graders

Hosted video conference on "Watershed Planning Groups", 17 in attendance, 5/31/02

Facilitated Ag. Producers meeting in Fairfield, 25 in attendance, 1/31.02

"Watershed Planning and Instream Flow Recommendations for Hangman Creek" Soil and Water Conservation Society, 2003 Annual Conference, Spokane WA (presentation)

"Hangman Creek Watershed Planning" Spokane County Conservation District, 2002, 2003 Annual Meeting

Media/Newsletters

KREM 2 interview/story – January 7, 2002

Hangman Country Newsletters (distribution of approx 500)

- Winter of 2001
- Spring of 2002
- Spring of 2003
- Fall of 2004
- Summer 2005

Conservation District Spotlight Newsletter (3 articles)

Focus Groups/Surveys

- Designed Focus Group interview July, 2002
- Prepared Educational materials for focus groups July August 2002
- Organized six volunteers to hand deliver invitations to homes in Hangman Creek area to attend focus groups August 2002
- Held focus group interviews August 18,19, and 21. Eighteen people attended.

Results
Number of people contacted at meetings and focus groups: 120.
Number of people contacted at classes on water quality issues: 90 adults, 15 youth.

Questionnaires were distributed to participants at the end of classes, meetings, and focus groups. The questionnaires were designed to evaluate how participant's knowledge levels changed for both watershed management in general and specifically for the Hangman Creek watershed (Tables 1 and 2).

Table 1: Questionnaire Data of Watershed Topics

Topic	Increase in Knowledge (percent)
Impact of landscaping on water quality	20
How to increase wildlife habitat	39
How to naturalize a landscape to conserve water	51
What is a watershed	32
Watershed management in general	78
Concern about water in Hangman Creek	15

Table 2: Hangman Creek Watershed Issue Summary

How Likely are You to:	Not Likely	Likely	Very Likely
Subscribe to HC News	3	8	16
Attend Latah Creek Neighborhood Mtgs	4	18	6
Give opinions to HC WPU	3	17	7
Learn more about water issues	1	14	12
Naturalize the landscape	1	5	11

Appendix F

Bibliography

Agidius, T. H. 1983. Idaho Agricultural Water Quality Program Application for Upper Hangman Creek. Benewah Soil and Water Conservation District. St. Maries, ID. [water quality – report is an application and work plan for monitoring. No data in the report.]

Brusven, M. and R. Biggam. 1996. Trend Changes in Aquatic Habitat and Benthic Macroinvertebrate Bioassessment Conditions in Upper Hangman Creek and Tributaries. University of Idaho, Division of Entomology, Moscow, Idaho. Project Completion Report submitted to the Coeur d'Alene Tribe, Plummer, Idaho. [fauna or flora – compares benthic work from 1985 and 1995. Data are good but are limited to Idaho areas only.]

Buchanan, J. and Associates. 1998. Wellhead Protection Plan, Fairchild Air Force Base, WA. Seismic Reflection Survey of Hangman Valley Aquifer and Estimation of Recharge to the Lower Spokane Aquifer. Addendum - Part A. [water quantity – evaluates the ground water movement from Hangman Creek Watershed to the Spokane River/aquifer. Data and results are good.]

Chiang, Robert Huai, 1982, Quantitative Geomorphology of the Hangman Creek Drainage Basin Washington and Idaho, A thesis presented to Eastern Washington University, Cheney, WA A Quantum analyze to determine discharge, drainage channel parameters, and drainage basin morphology. [descriptive, trend, or analysis – Characterizes geomorphic parameters for selected areas of the watershed. Data are generally fair to poor. Limited discharge data.]

City of Spokane, 1993. Latah Creek Specific Plan. [management plan – limited information from the Vinegar Flats area to Hatch Road.]

Coeur d’Alene Tribe, 1993. Hangman Creek Fish Survey Data, unpublished. [fauna or flora - Only a data table, no write up. This data has no methods or documentation.]

Fortis, B. and M. Hartz. 1991. Hangman Creek Post-Best Management Practices Implementation Study, Benewah County, Idaho 1989-1990. Water quality status report No. 95. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, ID. [water quality - This is a report of a follow-up study on the upper Hangman Creek Watershed. It looks at how sediment, nutrients and bacteria levels, have changed over a nine-year period. Sampling was done over a six-month period on tributaries and the main stem of Hangman Creek. Included are introduction, methods, results, tables and appendices.]

Hamilton, M., Stradling, D., and Derkey, R. 2001. Geology of the Hangman (Latah) Creek Flood Hazard Management Area. [informational or data - This report contains a detailed geologic map with definitions and descriptions of the geology of the Hangman Creek Flood Management Area. It also includes methods, bibliography, geologic cross sections and well log reports.]

Huber, V. 1971. The Past and Future Meet at Hangman Creek 1971. Spokesman Review December 5:Sunday Magazine (page 3-4,). [informational or data - This article about the history and the "current" state of Hangman Creek does not have any information referenced. Point of Interest: Mentions a dam proposal on the creek.]

Idaho Department of Health and Welfare, Division of Environmental Quality, 1982. Tensed/Lolo Project. Idaho Agricultural Water Quality Program. Closeout Report. [water quality - This report is a summary of the planning process for Tensed-Lolo Creek, a sub-watershed of Hangman Creek. It identifies non-point pollution sources although methods for obtaining that data are not included. It also identified future project areas.]

Ko, C., Mueller, A., Crosby III, J., Orsborn J., September 1974. Preliminary Investigation of the Water Resources of the Hangman Creek Drainage Basin, Research Report No. 74/15-81, Investigative objectives: Establish stratigraphic framework study of basin, determine hydrologic properties of rock units, evaluate well performance and aquifer characteristics, estimate surface and groundwater resources. 133 pages. [descriptive, trend, or analysis - A lengthy report investigating the stratigraphic framework, the hydrologic properties of rock units, the performance of wells and aquifers and the surface and groundwater resources of the Hangman Creek Drainage Basin. Methods, results, tables and appendices are also included. Contains information on selected discharges in the upper basin, ET, and ground water flow across the state line.]

Kruger, D. 1975. The Effects of the Cheney Sewage Effluent on the Water Quality of the Receiving Stream. Master's Thesis, Eastern Washington University [water quality - This report looks at the effect of Cheney sewage effluent on water quality on a small tributary to Latah Creek. Only looked at two sites on Latah Creek. Includes introduction, methods, results, discussion, list of references and a complete appendix.]

Laumeyer, P. and Maughan, O. 1973. Preliminary Inventory of Fishes in Hangman Creek. *Northwest Science*. 47(1):66-9. [fauna or flora - This study includes introduction, methods and a table of the results that lists data by site. They electro-shocked fish along eight sampling sites in Hangman Creek and recorded species, elevation, depth, width, vegetation, disturbance, and bottom type for each site.]

Leitz, G. 1999. A History of Waverly and Pioneer Life Along This Part of Hangman Creek. [informational or data – Historical account of life in Waverly, Washington. Interesting with accounts of local people.]

Marion, E. 1952. Hangman Creek is as Vivid in Story as in Name. Spokesman-Review. 28 September. Spokane, WA. [informational or data - Historical story about the settlers that passed through or settled and of the Native Americans. Author does not reference the information used in the story.]

Maughan, O., Laumeyer P. 1974. Further Information on the Inventory of Fishes in Hangman Creek. *Northwest Science*. 48(3)172-174. [fauna or flora - Compares Latah Creek fish species composition data from 1893 to that of 1971 in the form of a table. There are no methods included.]

Scholz, A., O'Laughlin, K., Geist, D., Peone, D., Uehara J., Fields, L., Kleist, T., Zozaya, I., Peone, T., and Teesatuskie, K. 1985. Compilation of information on salmon and steelhead total run size, catch and hydropower related losses in the Upper Columbia River basin, above Coulee Dam. Fisheries Technical Report No. 2. Eastern Washington University, Department of Biology. [fauna or flora - This document contains many well referenced and direct historical quotes about the quantity and type of salmon and steelhead fishing on the Spokane River and its tributaries. There are many references to the Spokane and Cour D'Alene Tribes. A bibliography is not included.]

Spokane County Conservation District (SCCD). 1994. Hangman (Latah) Creek Watershed Management Plan. Spokane, WA. [management plan – Basin wide management plan that provides information on water quality problems and basin conditions. The report outlines water quality objectives and provides a discussion of best management practices. The report prioritizes the subwatersheds for future work.]

Spokane County Conservation District (SCCD). 1998. Biological Assessment of Hangman (Latah) Creek Watershed. [fauna or flora – Six sites were samples for benthic macro invertebrates to evaluate the cumulative effects of human disturbance on the stream.]

Spokane County Conservation District (SCCD). 1998. A Chronicle of Latah (Hangman) Creek: Fisheries and Land Use. [informational or data – Historical interviews about fisheries in Hangman Creek.]

Spokane County Conservation District (SCCD). 1999. Hangman (Latah) Creek Water Quality Monitoring Report, Water Resources Public Data File 99-01. Spokane, WA. [water quality – Six stations were monitored over a three-year period from October 1994 through September 1997. Routine and high flow event water quality samples were taken to characterize the water quality of the Hangman Creek watershed.]

Spokane County Conservation District (SCCD). 2000. Hangman Creek Subwatershed Improvement Project Report, Water Resources Public Data File 00-01. Spokane, WA. [water quality – Two subwatersheds were monitored over a four-year period from October 1995 through October 1999. The monitoring was done to evaluate if the implementation of BMPs could be shown to improve the water quality of the receiving waters.]

Spokane County Conservation District (SCCD). 2000. Hangman (Latah) Creek Comprehensive Flood Hazard Management Plan, Water Resources Public Data File 00-02. Spokane, WA. [management plan – Evaluates and prioritizes flood prone areas from the mouth of Hangman Creek to Rock Creek.]

Spokane County Conservation District (SCCD). 2000. Hangman Creek Sediment Discharge Report for Water Years 1998 and 1999, Water Resources Public Data File 00-03. Spokane, WA. [water quality – Quantifies bedload and suspended sediment loads form Hangman Creek for water years 1998 and 1999.]

Spokane County Conservation District (SCCD). 2002. Hangman Creek Sediment Discharge Report for Water Years 1998 through 2001, in preparation, Spokane, WA. [water quality - Quantifies bedload and suspended sediment loads form Hangman Creek for water years 1998 through 2001. The report provides predictive regression equations to estimated the average annual bedload and suspended sediment load leaving the Hangman Creek watershed.]

United States Department of Agriculture, Soil Conservation Service (SCS). 1984. Floodplain Management Study, Town of Rockford. Spokane, WA. [management plan - This document identifies area of study, problem areas and gives a floodplain management plan that recommends land treatment and non-structural and structural flood control measures. Cites sources that contain methods for their data collection.]

United States Department of Agriculture, Soil Conservation Service (SCS). 1986. Watershed Protection Plan for Tensed/Lolo Land Treatment Project. St. Maries, ID. [management plan - This document identifies area of study, problem areas and gives a floodplain management plan that recommends land treatment and non-structural and structural flood control measures. Cites sources that contain methods for their data collection.]

United States Department of Agriculture, Soil Conservation Service (SCS). 1989. Floodplain Management Study, Town of Spangle. Spokane, WA. [management plan - This document identifies area of study, problem areas and gives a floodplain management plan that recommends land treatment and non-structural and structural flood control measures. Cites sources that contain methods for their data collection.]

United States Department of Agriculture, Soil Conservation Service (SCS). 1994. Floodplain Management Study, Fairfield, WA. [management plan - This document identifies area of study, problem areas and gives a floodplain management plan that recommends land treatment and non-structural and structural flood control measures. Cites sources that contain methods for their data collection.]

United States Department of Agriculture, Soil Conservation Service (SCS). 1994. Hangman Creek Watershed Preliminary Investigation - Benewah County, Idaho. Boise, ID. [descriptive, trend, or analysis – provides some water quality data, but no methods. Data are fair and are limited to Idaho]

United States Geological Survey (USGS), 1949-Present. Annual Water Resources Data Reports. [water quantity – Daily average discharges for Hangman Creek. Miscellaneous stream flow statistics, data good.]

United States Geological Survey (USGS), 1964. Drainage-Area Data for Eastern Washington. Open file Release, Tacoma, Washington, 197 pp. [informational or data - Included are, maps of Lower Hangman Creek Basin Basin, Little Spokane River Basin, Lower Spokane River Basin and a table of the drainage areas of the Spokane River Basin.]

United States Geological Survey (USGS), 1980. About Forty Last-Glacial Lake Missoula Jökulhlaups Through Southern Washington: Journal of Geology, v.88, p. 653-679. [descriptive, trend, or analysis – Journal of Geology article by USGS about outburst floods. Data are good.]

United States Geological Survey (USGS), 1985. Streamflow Statistics and Drainage-Basin Characteristics for the Southwestern and Eastern Regions, Washington, Volume II, Eastern Washington. Open-File Report 84-145-B, Tacoma, Washington. [informational or data – Provides statistical analysis for flood and low flow events. Methods and original data referenced, results are good.]

United States Geological Survey (USGS), 1998. Magnitude and Frequency of Floods in Washington, US Geological Survey Water-Resources Investigations Report 97-4277. [water quantity – provides flood statistics for Hangman Creek USGS gage. Data are good.]

United States Geological Survey (USGS), 1999. Summary of Information on Synthetic Organic Compounds and Trace Elements in Tissue of Aquatic Biota, Clark Fork-Pend Oreille and Spokane River Basins, Montana, Idaho, and Washington, 1974-96. Water-Resources Investigations Report 98-4254. [water quality - This study describes the contaminants in the tissue of riverine species. Six of the 16 sample sites were in the Spokane River Basin. They found elevated PCB that exceeded the guidelines for the protection of human health and predatory wildlife. Methods, results, discussion and references are included.]

United States Geological Survey (USGS), 2000. Concentrations of Selected Trace Elements in Fish Tissue and Streambed Sediment in the Clark Fork-Pend Oreille and Spokane River Basins, Washington, Idaho, and Montana, 1998. Water-

Resources Investigations Report 00-4159. [water quality - The purpose of this study was to summarize concentrations and distribution of selected trace elements in fish tissue and bed sediment to see if the concentrations were harmful to human health. The report evaluated if there is a relation between concentration in tissue and bed sediment and land use activities. Two out of the 16 sample sites were in the Spokane River watershed. Methods, results, tables, and bibliography were included.]

United States Geological Survey (USGS), 2001. PCB's in Tissue of Fish From the Spokane River, Washington, 1999. USGS Fact Sheet FS-067-01 [water quality - Using EPA methods, fish were collected at four sites on the Spokane River between Nine Mile Dam and the WA/Idaho border. Tissue samples were analyzed for PCB's by WDOE and were found to exceed the edible fish criterion by 10 times. Study includes methods, results and bibliography.]

Washington State Department of Ecology 1973. Memorandum: July 2, 1973, Efficiency Study at Cheney STP. [descriptive, trend, or analysis - Includes a memo, efficiency survey report, bacteriological results and water quality data summary sheet. No methods just raw data.]

Washington State Department of Ecology. 1974. Memorandum: January 21, 1974, Efficiency Study at Fairfield Lagoon. [descriptive, trend, or analysis - Includes a memo, efficiency study report, bacteriological results, sewage treatment plant operating and maintenance questionnaire for Fairfield, and water quality data summary sheet for Fairfield. No Methods, raw data.]

Washington State Department of Ecology. Memorandum: September 6, 1974, Rockford Lagoon Survey. [descriptive, trend, or analysis - Includes a memo, efficiency study report, bacteriological results, and water quality data summary sheet for Fairfield. No methods, just raw data.]

Washington State Department of Ecology. 1979. Memorandum: January 18, 1979, Tekoa Class II Inspection. [water quality – Water quality information related to discharge inspection. Reports results of the Tekoa sewage treatment plant inspection. The plant was tested to see if it removed an adequate amount of BOD and suspended solids. Includes methods and a table of results.]

Washington State Department of Ecology. 1994. City of Tekoa Wastewater Treatment Plant Class II Inspection, August 31 – September 1, 1993. Report # 94-33. [descriptive, trend, or analysis - Water quality information related to discharge inspection.]

Wetter, Fred. 1980. Hangman Creek Conservation Inventory. An RCA Project. July 1980. 23 pages. [informational or data - This document studies land uses and land management in the Idaho headwaters of Hangman Creek. It lists primary contributors to water quality and cropland deterioration and recommends solutions for those problems. It concentrates on agricultural solutions to erosion. No bibliography or methods on how data were acquired for the tables.]

Whalen, J. 2000. Spokane River Subbasin Summary, Draft. Northwest Power Planning Council. [descriptive, trend, or analysis - Details fish and wildlife resources, subbasin management and subbasin recommendations for the Spokane river basin.]

Appendix G

Surficial Geology Report

Geology
of
the

Hangman (Latah) Creek Flood Hazard
Management Area

by

Michael Hamilton, Dale Stradling, and Robert Derkey

June, 2001

A project supported by the Spokane County Conservation District
and Washington State Department of Natural Resources

Contents

Tables

Figures

GEOLOGY OF THE HANGMAN (LATAH) CREEK FLOOD HAZARD MANAGEMENT AREA, SPOKANE COUNTY, WASHINGTON

by: Michael M. Hamilton, Dale F. Stradling, and Robert E. Derkey

INTRODUCTION

This map fulfills a request by the Spokane County Conservation District to provide expanded geologic mapping for their Hangman Creek Comprehensive Flood Hazard Management Plan.

Previous Work

Previous geologic maps of this Management Area were small scale and lacked sufficient detail for management considerations. Pardee and Bryan (1926) noted the relationship between the Latah Formation and the Columbia River Basalt Group in the area. Griggs (1966) first published a 1:125,000-scale map of the western half of the Spokane 1x2 degree quadrangle. He later (1973) extended his mapping eastward and published a 1:250,000-scale map of the Spokane 1x2 degree quadrangle. On the latter map, he changed the designations of some of the pre-basalt units in the area; however, none of those changes occur on the Hangman valley geologic map. Joseph (1990) compiled a 1:100,000-scale map of the Spokane quadrangle that incorporated more detailed interpretations of Pleistocene glacial features (Kiver and others, 1979) and basalt stratigraphy based on Swanson and others (1979). In 1993-94 Wendy Gerstel, Charles Gulick, and Robert Derkey mapped the Quaternary deposits related to the Spokane aquifer recharge and aquifer sensitive areas at a 1:24,000 scale. Several thesis have focused on Hangman Creek geology, the most notable includes Rigby (1982), and Meyer (1999). The geology was entered into GIS by Bea Lackaff of the Spokane County Water Quality Management Program (WQMP). The Spokane County GIS geologic map was available to city and county officials since about 1996; however, it was not published.

Study Methods

This map was originally prepared as an overlay on the Spokane NW, Spokane SW, Spokane SE, Spangle East, and Spangle West 7.5-minute maps. It was digitized and entered into ArcView. Then orthophotos (DNR, 1995) and digital contours (furnished by Spokane County GIS) in ArcView were used to add to and refine contacts on the final version of the map.

Erosion and Landslide Problems

The sediments deposited in the Hangman Creek valley can be divided into a lower sequence of glacial flood deposits, a middle sequence of glacial lake deposits with interbedded glacial flood sediments, and an upper sequence of glacial flood sediments and post-glacial-flood alluvial material and volcanic ash. The presence of a lower sequence of glacial flood deposits is know only from water well logs. Sediments in the middle sequence (**Qglf**) consist of multiple layers of silt, fine-grained sand, and clay that accumulated in a glacial lake. Interbedded with the silt, fine-grained sand, and clay is a series of sand and gravel deposited by glacial outburst floods that flowed into the glacial lake. This middle unit occurs along the course of Hangman Creek. It also is found in the steep banks and slopes above Hangman Creek.

The Hangman Creek valley has experienced accelerated erosion and slope stability problems during the last several decades. Some of these problems appear to be a result of road building, housing and business development, as well as accelerated runoff caused by agriculture. Three major factors have contributed to these problems: 1) excavation of land causing slope instabilities and accelerated or redirected water runoff, 2) additional surface water due to irrigation, 3) the re-channeling of the Hangman Creek for road construction. Additionally, flooding of Hangman Creek is believed to be related to upstream, agricultural-induced accelerated runoff and land use changes and flood plain alterations.

The interbedded nature of low-permeability, fine-grained lake sediments and more permeable and coarser grained flood deposits results in flooding, silting of the stream, and landslide hazards. by both later aerial flood waters and stream erosion and covered by floods sediments. The silt/clay layers in the **Qglf** acts as a barrier locally to water descending from the surface. The water then tends to flow horizontally, becoming an agent for slope instability where this situation is combined with steep slopes. Also, these lake sediment layers are involved with block slumping when slopes fail. The interbeds of flood sand and gravel are also susceptible to stream and runoff erosion as are the **Qfs** and **Qfg** units since they are unconsolidated, loose sediments. While this unit was no doubt involved in historical erosional events, the removal of vegetation and the re-channeling of the Hangman Creek during the construction U.S. 195 has left the valley unstable.

ACKNOWLEDGMENTS

Eugene Kiver and Dale Stradling (1979) previously mapped the Quaternary geology of the Spokane area and accompanied us on numerous trips to examine those deposits. DNR geologist Wendy Gerstel refined the mapping of the Quaternary flood deposits under a contract with the Spokane County Water Quality Management Program (WQMP) in 1993-94. Her mapping was entered into Spokane County's GIS by Bea Lackaff; however, it was not published. Basalt stratigraphy was accomplished by whole-rock chemical analysis performed at the Geoanalytical Laboratory at Washington State University. Steve Reidel assisted us during a two-day visit in the field to examine Columbia River Basalt, and reviewed an earlier version of the map. The cartographic and editorial staff of the Division of Geology and Earth Resources edited and created the layout for publication.

DETAILED GEOLOGIC MAPPING, HANGMAN VALLEY AREA

A proposal submitted to:

Spokane County Conservation District

by

Washington Department of Natural Resources
Division of Geology and Earth Resources

Spokane office
904 W. Riverside, Rm 215
Spokane, Washington 99201-1011
509/456-3255

August 16, 2000

SUMMARY

This proposal is a request for funding to perform more detailed geologic field mapping of the Hangman Valley area (Location shown in figure 1, attached). DNR-Geology has already mapped, at 1:24,000 scale, the geology of the Spokane SE and SW quadrangles. Because of time factors, we were unable to map additional details of the geology along of the Valley. Rapid growth over the last five years in both the City and County portions of the drainage has brought development in contact with a number of geologic situations that can be considered geologic hazards or geologic constraints. A better, more detailed geologic map of the Hangman Valley area will help planners, developers, and others deal with the hazard problems of the drainage. We request $6,000 to cover a portion of the field costs for mapping and compilation of new geologic data in digital form. Our mapping will be integrated with our existing mapping of the Spokane SE and SW quads. We propose to complete the project by July 1, 2001.

PURPOSE AND JUSTIFICATION

Geologic mapping by DNR in the Spokane area initially focused on defining the nature and extent of glacial flood deposits that comprise the Spokane Valley-Rathdrum Prairie Aquifer in order to understand the geologic environment involved in protecting it. This mapping was done through support from the Spokane County Water Quality Management Program. We recognize a need for additional geologic mapping to address specific geologic hazards that are becoming increasingly more significant as the county experiences rapid growth. Issues include: 1) defining the relationship between bedrock basins filled with glacial flood deposits and the possible structural control for those basins in order to better interpret subsurface geology; 2) better mapping of basalt and underlying Latah Formation as it relates to potential for landslides; 3) detailed mapping and description of glacial deposits southwest of Spokane that have become unstable due to human activities; and 4) mapping of basalt and fine-grained sediment aquatard layers associated with flooding and poor drainage in southwest Spokane.

Our goal is to provide better geologic maps that City and County governments and developers can use to better plan and manage development in the Spokane area.

LOCATION

The Hangman Valley southwest corner of Spokane traverses the east side of the Spokane SW quadrangle and extends into the southwest corner of the Spokane SE quad (Figs. 1 and 2). Our proposal is to conduct more detailed mapping of the Valley to compliment and extend the detail of mapping already completed for the Spokane SW and SE quads. Figures 1 and 2. Our background for mapping in the Spokane area includes published mapping of the Mead, Dartford, and Spokane NE and SE quadrangles completed under the United States Geologic Survey's StateMap Program. The Airway Heights and Spokane NW and SW quadrangles were mapped in 1999-2000. They are in final preparation for peer review to be published as full-color geologic maps. When this review is completed, they will be published and also will be made available in digital format to the County and the City. Field mapping of the Spokane SW quad is now ready for digitizing. Plans are to publish it together with the Four Lakes quad.

GEOLOGY

Spokane area geology is divided into three separate sequences, (1) pre-Miocene igneous, sedimentary, and metamorphic rocks, (2) Miocene basalt and lacustrine and fluvial sediments, and (3) Pleistocene glacial flood deposits that host the Spokane Valley-Rathdrum Prairie Aquifer. Each of these sequences has diverse and unique characteristics with associated hazards and other socioeconomic problems.

Although there are limited exposures of pre-Miocene rocks in Hangman Valley, it is important to understand their geology, especially the presence of any faults that may control structures in the overlying rocks. Spokane lies at the junction of several major, pre-Miocene structural features, (1) mylonites of the Spokane dome, (2) the Lewis and Clark line (Montana lineament), and (3) the Purcell trench. Faults of the same trend as Hangman Creek valley have been identified and we believe more will be identified with detailed mapping. Hazards involving aquifer contamination, flooding, and environmental degradation, can be addressed through a better understanding of the structural features of the area.

The basalt stratigraphy at the eastern margin of the Columbia Basin is complex and not thoroughly understood. We now know from mapping in the Airway Heights and Spokane NW and SW quads that channels over 200 feet deep had formed prior to emplacement of the youngest basalt that reached the Spokane area. Geologic materials capable of providing groundwater for the area may be present in these channels.

Basalt often caps and protects the underlying and poorly consolidated Latah Formation from erosion. At the edges of capped bluffs, the basalt and sediments are exposed to the elements. The result is a complex of unstable, landslide and mass wasting areas. These slopes are very attractive to developers because they offer view properties overlooking broad valleys. Geologic hazards could result from disturbing these slopes in new developments. Locating the exposures of Latah Formation in the Hangmen Valley will confirm or identify where such occurrences are located. More accurate geologic maps can be used to design remediation and prevention measures.

The West Plains of Spokane in the Four Lakes and Airway Heights quads has a problem with poor drainage, water impoundment, and flooding. Parts of this area has been designated as an industrial park and is considered by Spokane planners as having a very important role to play in the future of the local economy. Poor drainage is related to shallow, poorly drained bedrock (mainly basalt) and possible aquatard layers of clay that fill the lower areas. In other areas with similar surface topography there is good drainage because pre-glacial valleys occur which are completely filled with flood sediments. Mapping on the West Plains would better delineate areas underlain by shallow bedrock aquatards, thus providing some geologic guidance to growth.

Flood deposits and basalt exposed in the Hangman Valley can be an excellent source of construction aggregate for the Spokane. Mapping will better outline any resource areas in the Valley.

LEGEND FOR HANGMAN CREEK MANAGEMENT AREA GEOLOGIC MAP

HALOCENE (RECENT) AND PLEISTOCENE ALLUVIUM AND GLACIAL FLOOD DEPOSITS

(Informal units, no formation or precise time or event definitions)

Recent Deposits

Recent deposits include units have been formed since the end of the Pleistocene by water (Qal, Qm), by water and gravity (Qaf), and by wind (Ql). In all cases, these deposits may have older components, but for the most part represent recent geologic processes at work on the earth's surface.

Qal--Alluvium (Holocene) -- Silt, sand, and gravel deposits in present-day stream channels, flood plains, and lower terraces. Consists of reworked glacial flood deposits (units Qfcg, Qfg, and Qfs) and reworked loess. May include small alluvial fans and minor mass wasting deposits that extend onto the flood plain from tributaries.

Qaf--Alluvial fan deposits (Holocene) -- Alluvium consisting of gravel, sand, and silt deposited in fans that form at the base of steep drainages in the map area. Most lack a large source drainage. Deposits are very poorly sorted and have minimal soil development.

Ql--Loess (Holocene and Pleistocene) -- Light to medium brown, unstratified silt with lesser amounts of clay. Locally includes small amounts of fine sand and volcanic ash. Clay is mostly montmorillonite and illite in a ratio of 3:1 as well as minor kaolinite (Hosterman, 1969). Sand and silt are composed of angular quartz with lesser amounts of feldspar and mica. The wind deposited loess depth increases to the southwest in the map area where flood erosion was less effective. Most deposits, except where eroded, will be capped by one or two feet of loess

Qb--Bog deposits (Holocene and Pleistocene) – Peat with lesser amounts of silt, ash, marl (bog lime), and gyttja (freshwater mud with abundant organic matter) deposits, predominantly in channeled scabland depressions, on basalt bedrock (Milne and others, 1975).

Glacial-Flood Deposits

Glaciers dammed the Clark Fork of the Columbia River near the Montana-Idaho state line. Glacial Lake Missoula formed behind the ice dam, and when it failed, gigantic volumes of water raced through the area carrying tremendous amounts and sizes of sediment into the Columbia Basin and downstream along the Columbia River to the Pacific Ocean. Ice-dam buildup and failure was repeated many times during the Pleistocene. In the Spokane area, deep channels of the ancestral Spokane River were filled with very coarse grained, poorly sorted gravel referred to here as flood channel gravel (unit Qfcg). The coarse gravel Qfcg is host to the Spokane aquifer. Outside of the deep channels, flood gravel deposits (unit Qfg) are thinner and, commonly, not as coarse grained. A third type of flood deposit is sand (unit Qfs) deposited when flood waters flowed into an existing glacial lake (glacial Lake Columbia). The sand unit (Qfs) is widespread and appears to be the uppermost or highest of the extensive flood deposits. Following deposition of this sand, flood events appear to have been smaller and cut down to established the present course of the Spokane River. Additional glacial deposits (unit Qglf) consist of glacial Lake Columbia deposits of silt and clay that formed in a lake that covered the Spokane area as a result of a ice dam downstream. These lake bed bottom deposits are interbedded with glacial flood deposits that entered the lake repeatedly making stacks of alternating layers of flood and lake sediments often referred to as rhythmites. The units are distinguished by the predominant clast size and contacts between the three units Qfcg, Qfg, Qfs, and Qglf are mostly indistinct. Mass-wasting deposits (unit Qmw) occurred during or shortly after catastrophic flood events, but they range in age up to the present.

Qfs--Glacial flood deposits, predominantly sand (Pleistocene) -- Gray, yellowish gray, or light brown; poorly to moderately well sorted, medium bedded to massive; subangular to subrounded; medium-fine to coarse sand and granules with sparse pebbles, cobbles, and boulders. The unit may contain beds and lenses of gravel. Some exposures appear speckled because of the mixture of light and dark fragments. Composed mainly of granitic and metamorphic detritus from sources to the east. Unit distribution and thickness is variable due to the irregular underlying topography and preservation when protected from the erosive action of later floods. The majority of the flood sands appear to have been subaqueously deposited when outburst floods flowed into glacial Lake Columbia and at lower energy deposition sites removed from major flood channels.

Qglf--Glacial lake/glacial flood deposits undifferentiated (Pleistocene) --Tan to gray, fine-grained sand and silt, massive- and thin-bedded lake deposits with interbedded and irregularly distributed glacial-flood sediments of sand and gravel. Unit is exposed in the bed of Hangman Creek and on adjacent bluffs. This unit probably filled most of valley before being dissected by later floods and post flood stream action.

Qfg--Glacial flood deposits, predominantly gravel (Pleistocene) -- Gray, yellowish gray, or light brown; poorly to moderately sorted; both matrix and clast supported; thick-bedded to massive mixture of boulders, cobbles, pebbles, granules, and sand; also may contain beds and lenses of sand and silt. Locally, boulders can comprise more than 50 percent of the volume in a matrix of mostly pebbles and coarse sand. Deposits in the Four Lakes and Spokane SW quads consist of granitic and metamorphic rocks similar to both local outcrops and those to the northeast and east in Idaho.

Qfcg--Glacial flood-channel deposits, predominantly gravel (Pleistocene)—Gray, yellowish gray, or light brown; poorly to moderately sorted; both matrix and clast supported (openwork); thick-bedded to massive mixture of boulders, cobbles, pebbles, granules, and sand; locally contains beds and lenses of sand and silt. Boulders often comprise more than 50 percent of the volume in a matrix of mostly pebbles and coarse sand and consist of granitic and metamorphic rocks similar to both local outcrops and those to the northeast and east in Idaho plus some locally derived basalt. Primarily, this unit occurs in the main flood channel, which is known to be several hundred feet deep and appears to be filled with flood gravel. Boundaries between flood-channel gravel (Qfcg) and flood gravel (Qfg) are transitional. Flood-channel gravel occurs in the Spokane Valley on the north side of the map.

Qmw--Mass-wasting deposits (Holocene and late Pleistocene) -- Landslide debris with lesser amounts of debris flow and rockfall deposits; often include interspersed flood deposits. Most mapped landslide debris consists of a mixture of basalt blocks and Latah Formation sediments. Angular basalt blocks range in size from several feet to tens of feet across. Because some of the landslides occurred during glacial flooding, scattered sand and pebble lenses are locally interspersed with the mass-wasting deposits.

PRE-PLEISTOCENE IGNEOUS AND SEDIMENTARY ROCK DEPOSITS

Columbia River Basalt Group

Subaerial lava flows of the Columbia River Basalt Group (CRBG) were deposited widely over the Columbia Basin. Two CRBG units have been identified in the Hangman Valley: (1) Grande Ronde Basalt, magnetostratigraphic unit R2 and (2) Wanapum Basalt, Priest Rapids Member, Rosalia chemical type (Derkey and others, 1998; Tolan and others, 1989). The Priest Rapids Member is the uppermost Columbia River Basalt Group unit identified in the Spokane area. Whole-rock chemical analyses were performed by the Geoanalytical Laboratory at Washington State University (see Table 1). Peter Hooper (Washington State Univ. Geology Dept., written commun., 1998-99) identified the basalt samples.

Twp--Wanapum Basalt, Priest Rapids Member (middle Miocene) -- Dark gray to black, fine-grained, dense, basalt containing plagioclase (20-30%), pyroxene (10-20%), and olivine (1-2%) in a mostly glass matrix (40-60%). Unit thickness is variable and in the parts of the Spokane SW 7.5-minute map where the basalt laps up upon pre-Miocene highlands it is very thin. Contact with the underlying Grande Ronde occurs between 2,200 and 2,300 feet elevation. Priest Rapids Member lies directly on pre-Miocene rocks, Latah Formation, or Grande Ronde Basalt. The Priest Rapids Member in the Spokane area is of the Rosalia chemical type, which has higher titanium and lower magnesium and chromium than other flows of Wanapum Basalt (Steve Reidel, Pacific Northwest National Laboratory, oral commun., 1998). The Priest Rapids Member is between 14.5 and 15.3 m.y. old and has reversed magnetic polarity (Reidel and others, 1989)

Tgr--Grande Ronde Basalt, magnetostratigraphic units R2 and N2 (middle Miocene) -- Dark gray to dark greenish gray, fine-grained basalt containing plagioclase (10-30%) as laths and sparse phenocrysts, and pale green augite and pigeonite grains (10-40%) in a matrix of black to dark brown glass (30-70%) and opaque minerals. The rock is locally vesicular with plagioclase laths tangential to vesicle boundaries. Some vesicles contain botryoidal carbonate and red amorphous secondary minerals. Due to the irregular underlying topography, variable thickness of water saturated Latah Formation (**Tl**) interbeds, and the probable invasive nature of at least some of the Grande Ronde Basalt flows in the area, the thickness is quite variable. Chemical analyses were used to identify magnetostratigraphic units R_2 and N_2 of Grande Ronde Basalt. N_2 basalt generally contains more than 4.5% MgO and less than 2% TiO2. The Grande Ronde Basalt is between 15.6 and 16.5 m.y. old (Reidel and others, 1989).

Miocene Sedimentary Rocks

The oldest CRBG flows did not reach the Spokane area; however, they did block ancestral drainage and large lake(s) formed. The pre-Miocene rocks were subjected to extensive weathering. Clay, silt, and sand from the adjacent highlands were deposited in the lake(s). These sediments are known as the Latah Formation. The Grande Ronde Basalt flows that reached the Spokane area often burrowed or sank into the poorly consolidated Latah sediments. They are called invasive flows. When preserved, Latah Formation lake beds are baked where they directly overlie Grande Ronde Basalt in the Spokane area (Robinson, 1991; Derkey and others, 1998).

Tl--Latah Formation (middle Miocene) -- Light gray to yellowish gray and light tan; poorly indurated; lacustrine and fluvial deposits of finely laminated siltstone, claystone, and minor sandstone. The unit commonly weathers brownish yellow with stains, spots, and seams of limonite. It unconformably overlies pre-Miocene rocks or is interbedded with Grande Ronde Basalt (Tgr). Floral assemblages in the Latah Formation indicate a Miocene age (Knowlton, 1926; Griggs, 1976). The Latah is easily eroded and it is commonly blanketed with a cover of colluvium, talus, and residual soils.

Igneous Rocks

Igneous rocks in the Hangman Valley appear to be multistage intrusive that are similar in composition but vary in texture, proportion of individual minerals, and minor assessory minerals. They range from slightly foliated to nonfoliated, suggesting that they intruded during and after the last major metamorphic event in the Spokane area about 50 million years ago. Most intrusive igneous rocks of the Spokane area are believed to be Cretaceous to Tertiary in age (Weis, 1968; Griggs, 1966, 1973; Joseph, 1990).

TKg-- Biotite-rich granitic rock (Eocene) -- light grey with some light pink feldspars, fine to course grained, some porphyritic with feldspar crystals up to 0.5 inches, contains minor hornblende, and zircon, biotite occurs in crystals up to 0.2 inches. The largest granite occurrence underlies the east valley wall at the junction of California and Hangman Creeks.

Basement Rocks

Pre-Tertiary basement rocks rock units in the Hangman Valley map area consist of an assortment of metamorphosed, deformed, and foliated sedimentary rocks that have placed by previous authors in the Precambrian Belt Supergroup, Ravalli Group (Griggs, 1973; Armstrong and others, 1987; Rehrig and others, 1987; Joseph, 1990). The metamorphosed sedimentary rocks are mostly quartz-feldspar rich and include quartzite, silltite, gneiss, and metasandstone.

Ymsr--Ravalli Group (Precambrian Y) -- White, light gray, gray-green, or pale yellowish orange feldspathic sandstone, and siltite; fine- to medium-grained; thin- to medium-bedded with some massive sections. Feldspathic sandstone typically contains 30-70% quartz, 20-30% feldspar, and 1-5% biotite. Siltite contains more feldspar and less quartz. Some quartz-biotite gneiss is exposed west of the junction of Hangman and California Creeks.

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Appendix H

Class A and B Water System Purveyors

System Name	System Type	Residential Connections	Total Connections	Residential Population
Ag Enterprises	B	0	1	0
Bell Motel	B	8	14	20
Benson Motel	B	1	9	1
Camp CO MI A	B	3	4	12
Cheney Rodeo Corporation	B	3	4	8
Cheney City	Comm	1622	1622	8220
Custom Building Supply, Inc.	B	0	1	0
D'Lauralee Kennels	B	1	2	2
Dyko, Inc.	NTNC	0	4	0
Eastern Washington U. - Turnbull	B	0	1	0
Eastern Washington University	Comm	1114	1178	2800
Fairfield, Town of	Comm	240	240	605
Four Lakes Water District 10	Comm	151	151	490
Freeman School Dist -	NTNC	0	5	0
Freeman Store	B	1	2	3
Garden Springs Church of God	B	2	3	5
Garden Springs Greenhouse	B	2	2	5
Hangman Hills Water Dist 15	Comm	199	200	498
Hayford Community Chruch	B	1	2	1
Hidden Hills Estates	B	14	14	24
Hideaway Trailer Park	Comm	71	71	200
Hilltop Mobile Home Park	Comm	33	46	56
Inland Power - Spring Hill B	B	0	1	0
Jacobson Greenhouse, Inc.	B	4	4	10
Kings Community Church	B	0	1	0
Latah, Town of	Comm	95	95	212
Liberty School District 362	NTNC	2	5	12
Marshall Community Water System	Comm			
McGregor Co, Inc	B	0	1	0
Mullen Hill Terrace MHP	Comm	118	118	207
Mutual Materials Company	NTNC	0	1	0
Nansons Greenhouse & Nursery	B	2	2	5
Northwest Bedding Co	B	0	1	0
Olia Meadows Trailer Park	B	6	6	15
Overland Station	TNC	7	27	18
Paffile Truck Lines	B	1	1	3
Peaceful Pines Trailer Court				
Pine Acres Mobile Home Park	Comm	40	40	100

System Name	System Type	Residential Connections	Total Connections	Residential Population
Pine Grove Apartments	B	6	6	15
Place USDA, The	B	2	3	5
Quadra-K Meats - USDA	B	1	2	2
Ranch Motel	TNC	6	18	20
Rockford, Town of	Comm	192	192	490
Rogers Motel	B	1	1	3
Rowand Machinery Co	B	1	1	3
Shady Pines Trailer Court	Comm	38	38	70
Skyline Motel	TNC	0	24	0
Sleepy Hollow Apts	Comm	16	16	35
Spangle, Town of	Comm	123	123	250
Spiral & Railing House, Inc.	B	0	1	0
Spokane County - Hangman Valley Golf Course	TNC	0	1	0
Spokane County - Hangman Valley Golf Course II	TNC	0	3	0
Spokane County - Old Meyers Resort	B	3	4	8
Spokane County Fire Dist 10 Station 2	B	0	1	0
Spokane County Fire Dist 8 Station 2	B	0	1	0
Starlight Motel & MHP	Comm	37	38	75
Sunset Apartments	B	5	5	13
Sunset Florist & Greenhouse	B	2	2	5
Sunset Park & Jet				
Tekoa, city of	Comm			
TTT Rentals	B	9	9	13
Upper Columbia Academy	Comm	27	36	340
Upper Columbia Conference	NTNC	1	2	3
Upper Columbia Mission Society	B	2	2	5
Valley of the Horses Water Dist 12	Comm	19	19	44
Valleyford Park	B	0	1	0
Valleyford Store	B	2	3	5
Vista Farm #4	B	1	2	3
Vista Farms II	B	4	5	10
Waverly, Town of	Comm	55	56	130
Windsor Baptist Church	B	1	2	3
Windsor Grange	B	3	4	5
Wood Truss Steel Buildings	B	1	1	3

Appendix I

Riparian Proper Functioning Condition Reach Descriptions

DRAFT

Hangman (Latah) Creek
Proper Functioning Condition Assessment
April – May 2003

Sponsored by

The Spokane County Conservation District
Water Resources Program

The Hangman (Latah) Creek
(WRIA 56)
Planning Unit

Summary

In the spring of 2003, the Spokane County Conservation District conducted an inventory to assess the functional status of riparian-wetlands along the main stem of Hangman (Latah) Creek. The extensive assessment evaluated over fifty-eight river miles within the Washington State portion of the watershed.

The assessment process followed the Bureau of Land Management's Proper Functioning Condition (PFC) methodology developed by the BLM, USDA Forest Service, and others (1993). The methodology is qualitative, but is based on quantitative science. A PFC team was formed to inventory and evaluate stream reaches based upon the interaction of vegetation, landform/soils, and hydrology.

The assessment determined that Hangman Creek has extensive riparian-wetland problems magnified by years of human perturbation. Approximately 29.6 miles (50%) of the watershed were considered to be nonfunctional with an additional 19.8 miles (34%) of functional-at-risk reaches. Only 9.1 miles (15%) was considered to be in properly functioning condition.

The lack of properly functioning riparian-wetland areas indicate that a majority of the main stem of Hangman Creek does not adequately provide the following ecological benefits

- Dissipate stream energy associated with high water flows
- Filter sediments, capture bedload, and aid flood plain development
- Improve flood-water retention and ground water recharge
- Develop root masses capable of withstanding cutting action
- Provide habitat and channel characteristics necessary for fish production

Water quality in Hangman Creek is intricately linked to the riparian-wetland areas in the watershed. This work, combined with additional information, has provided a new basis for identifying and categorizing the sources and degree of degradation within each reach. This information will allow for future management recommendations and priorities within the watershed.

Properly Functioning Condition Summary by Reach				
Reach Number	**River Mile**	**Length (mile)**	**Functional Rating**	**Trend**
1	58.5	4.7	Functional – At – Risk	Not Apparent
2	53.8	0.4	Functional – At – Risk	Not Apparent
3	53.4	2.6	Functional – At – Risk	Not Apparent
4	50.8	0.5	Functional – At – Risk	Not Apparent
5	50.3	3.6	Functional – At – Risk	Downward
6	46.7	5.3	Functional – At – Risk	Downward
7	41.4	1.4	Proper Functioning	
8	40.0	2.0	Functional – At – Risk	Not Apparent
9	38.0	1.5	Functional – At – Risk	Downward
10	36.5	1.1	Functional – At – Risk	Not Apparent
11	35.4	1.2	Functional – At – Risk	Downward
12	34.2	2.1	Functional – At – Risk	Not Apparent
13	32.1	7.4	Proper Functioning	
14A	24.7	1.9	Proper Functioning	
14B	22.8	1.1	Functional – At – Risk	Not Apparent
15	21.7	2.3	Functional – At – Risk	Not Apparent
16	19.4	0.8	Proper Functioning	
17	18.6	0.7	Proper Functioning	
18	17.9	3.3	Nonfunctional	
19	14.6	4.1	Functional – At – Risk	Downward
20	10.5	2.4	Functional – At – Risk	Not Apparent
21A	8.1	1.3	Functional – At – Risk	Upward
21B	6.8	1.0	Proper Functioning	
21C	5.8	3.8	Functional – At – Risk	Not Apparent
22	2.0	2.0	Proper Functioning	

	Number of Reaches	Combined Distance (miles)	Percent of Stream Length
Properly Functioning Condition	7	15.2	26
Functional –at-Risk	17	40.0	68
Nonfunctional	1	3.3	6

Reach 1: River Mile 58.5-53.8

Distance: 4.7 miles Date: 4-24-03

Geographic Description

This reach begins at the Washington State Line Bridge in Whitman County, WA. It flows west for approximately 0.5 miles then meanders north to northwest for approximately 2.0 miles where it enters the Town of Tekoa, WA. It continues to meander to the northwest and finishes at a SW aspect about a third of the way around a meander at river mile 53.8. Golf Course Road closely borders the first 2.5 miles of the creek on the right bank. The creek then meanders through the Town of Tekoa. On the downstream end of Tekoa, the reach is then constrained between State Highway 27 along the right bank and a county road along the left bank. Upland use is predominately annual crop production with a few residential sites and a small urban center.

Riparian Vegetation

The majority of the reach lacks adequate riparian vegetation. The riparian areas are dominated by reed canarygrass and tansy communities. Riparian tree and shrub communities are sparse and disconnected. Scattered recruitment of young riparian vegetation was noted in upper portions of the reach before Tekoa. There are several patches of good vegetation within the Town of Tekoa, but these are often associated with bedrock. Little to no recruitment can be found along the banks throughout the lower portions of this reach.

The reach bottom and banks are dominated with a monoculture of reed canarygrass (*Phalaris arundinacea*) for the entire length of the reach. Tansy ragwort (*Senecio jacobaea*), a noxious weed, is prominent on higher portions of the stream bank adjacent to the upland/agricultural land. Fragmented patches of Douglas hawthorns (*Crataegous douglasii*) comprise the majority of the shrub community. Willows (Salix spp.) and red-osier dogwood (*Cornus sericea var. occidentalis*), are not dominant, but single plants and small communities can occasionally be found throughout the reach.

Other species found within the reach include Black cottonwood (*Populus trichocarpa*), blue elderberry (*Sambucus cerulea*), common chokecherry (*Prunus virginiana*), stinging nettles (*Urtica dioica*), poison hemlock (*Conium maculatum*), teasle (*Dipsacus sylvestris)* and cow parsnip (*Heracleum lanatum*).

Wildlife Activity:

Beavers are active in the reach, but no dams are present. Mallards, woodpecker, red-winged blackbird

Geomorphological Character

Several sections of this reach have been straightened and channelized by prior management activities. However, the flood plain, in the upper portion of the reach was noted as naturally narrow. Bedrock outcrops were found and control the channel migration in some areas. The reach appears to be laterally and vertically stable. In most areas, the stream does not have access to an active flood plain, nor the ability to develop one due to its incision and other constraints. Slumping and bank erosion was highly evident in many sections. Reed canarygrass colonizes the slumped bank fragments and creates a braided channel in some areas. Riprap was noted near the Tekoa Golf Course.

The sinuosity for Reach 1 is approximately 1.4. The sinuosity appears to be controlled by bedrock outcrops observed along the reach. The gradient for the reach is approximately 0.0009. The width/depth ratio for most of the pools is 10 to 15. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, mostly limited to bank slumping. The banks have slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. Within the slumped banks, some areas of accelerated erosion were noted. The areas were generally scallops within the bank approximately 10 to 20 feet long and two to five feet deep. One area of longitudinal erosion that extended for several hundreds of feet was just downstream of the Tekoa golf course.

Agricultural Influence

The majority of the uplands are dominated by agricultural production. Cropping often occurs right down to the top of the stream bank unless prevented by bedrock or scab-rock areas. Two large ditches with culverts under the road were identified. Active grazing (relatively small pastured area) with direct access to the stream (horses) was located within the Town of Tekoa.

Anthropogenic Influence

The major anthropogenic influence in this reach is the Town of Tekoa. Approximately 2.0 miles of the stream is influenced by the golf course, the town, and the sewage treatment plant. There are three rural/farming residences adjacent to the stream in this reach and a total of 10 bridge crossings (foot, road, railroad). Only 1 water intake point was found (Tekoa Golf Course).

Summary

Reach 1 is influenced by multiple factors that indicate a degraded situation. It has inadequate riparian vegetative cover over most of its length, an urban center located in the lower portion, and it has been channelized and straightened in some areas. The flood plain is primarily inaccessible, but the channel is laterally and vertically stable. Although the reach has minimal vegetation, it appears to handle high energy flows. This may be due to the widening and deepening of the channel in the past to covey more water. Furthermore, the stream is confined and encroached upon by road systems on each bank and has 10 structural crossings.

Past agricultural influences have removed riparian vegetation and current cropping practices often abut the stream. Existing riparian vegetation is sparse, decadent, and lacks recruitment of young saplings. In areas without bedrock influence, erosion and stream bank slumping indicates the inability to dissipate high-energy flows. No significant large woody debris was evident in this reach.

Functional Rating:

Functional at Risk (no-apparent trend)

Photograph 1.1 Fields to edge


Photograph 1.2 Channel character and vegetation below Tekoa

Photograph 1.3 Functional-at-Risk site example

Reach 2: River Mile 53.8-53.4

Distance: 0.4 miles Date: 4-24-03

Geographic Description

This reach begins at river mile 53.8. It meanders a short distance and terminates where the stream enters a straight channel that parallels State Highway 27 to the north.

Riparian Vegetation

This reach begins with a remnant cottonwood grove on the left bank. Reed canarygrass still dominates the lower banks and common tansy is found on the upper banks. This reach exhibits moderate plant diversity, but does not demonstrate a wide age class distribution. This reach does not provide an adequate source of coarse woody debris and vegetation to stabilize banks and dissipate energy. The reach does maintain adequate vegetation through the first portion of the reach along the inside and outer curve of the first bend, but lessens to a narrow strip by the end of the reach.

Douglas Hawthorn (*Crataegous douglasii*), box-elder (*Acer negundo*), black cottonwood (*Populus trichocarpa*), and alder (Alnus spp.) form dense patches of trees, while red-osier dogwood (*Cornus sericea var. occidentalis*), willow (*Salix spp.*) blue elderberry (*Sambucus cerulea*), ninebark (*Physocarpus malvaceus*), and rose (*Rosa spp.*) comprise isolated patches of shrubs.

Unlike the first portion of the reach, the riparian area through the latter section is limited to a width of 5-55 feet due to encroachment of crop production and the road system into the riparian zone. This stretch is lined with a narrow strip of (*Acer negudo*) and sparse shrubs. Both banks are dominated by reed canarygrass (*Phalaris arundinacea*) to the water's edge where it extends into the upper and drier portions of the banks and mixes with noxious weeds such as tansy ragwort (*Senecio jacobaea*) poison hemlock (*Conium maculatum*), and teasle (*Dipsacus sylvestris*).

Wildlife Activity

Coyote (2 pups), ringneck pheasant, whitetail deer

Geomorphological Character

This reach appears to be vertically and laterally stable, but has lost the connectivity to an active flood plain (incised). Channel characteristics to dissipate energy of high stream flows are not present. However, some mid-channel bars colonized by reed canarygrass do exist. Active slumping and/or bank erosion is negligible in this reach.

The sinuosity for Reach 2 is approximately 1.2. The sinuosity appears to be controlled by bedrock outcrops and current land uses, mostly State Highway 27. The gradient for the reach is approximately 0.0014. The width/depth ratio for most of the pools is 10 to 15. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, mostly limited to bank slumping. The banks have slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. There is one area of longitudinal erosion that has vertical banks with no vegetation.

Agricultural Influence
The upland use is entirely annual crop production and borders the stream on both sides.

Anthropogenic Influence
US Highway 27 is present on the right bank for the extent of this reach. The influence is minimal due to its distance from the stream.

Summary
Although reed canarygrass and tansy are dominant plants near the water, this reach illustrates good plant diversity. The reach does not include a diverse age-class or exhibit vigorous plant growth, but is indicative of minimal riparian maintenance. The reach appears to be laterally and vertically stable.

Functional Rating:
Functional-at-Risk (no apparent trend)


Photograph 2.1 Channel and Riparian Vegetation


Photograph 2.2 Riparian/upland transition


Photograph 2.3 Historic flood plain and uplands


Photograph 2.4 Upland plant community

Reach 3: River Mile 53.4-50.8

Distance: 2.6 miles Date: 4-24-03

Geographic Description

The reach flows parallel to State Highway 27 in a west/northwesterly direction for approximately 1.0 mile before it turns south and meanders back north and ends up flowing west and adjacent to State Highway 27 again. It receives a number of small drainages and tributaries all of which lie within agricultural land. Some steep rock outcrops border the reach and serve to control the channel. Upland use is predominately agricultural production with a few rural/farming residential sites.

Riparian Vegetation

The majority of the reach lacks adequate riparian vegetation. The species composition does not exhibit high diversity or vigor. Similarly, there is little to no recruitment of young, woody riparian plants.

Both banks are dominated by reed canarygrass (*Phalaris arundinacea*) for the entire reach length. Reed canarygrass extends from inside the active stream channel to the drier upland where it mixes with herbaceous weeds, grasses, and an occasional stand of shrubs or trees. Small isolated thickets of old Douglas hawthorn (*Crataegous douglasii*) and remnant stands of black cottonwood (*Populus trichocarpa*) exist within the reach, but do not dominate the riparian area. Tansy Ragwort (*Senecio jacobaea*) a noxious weed is also prominent in higher portions on the stream terrace adjacent to the upland/agricultural land. Other species evident within the reach include stinging nettles (*Urtica dioica*), poison hemlock (*Conium maculatum*), teasle (*Dipsacus sylvestris)* and cow parsnip (*Heracleum lanatum*).

At approximately river mile 53.1, a steep rocky slope borders the riparian area and shelters a remnant bunchgrass community (Idaho fescue-common snowberry/*Festuca idahoensis-Symphoricarpus albus*) plant association (Daubenmire 1970). Similar small communities can be found throughout this reach (See photograph 3.3).

Wildlife Activity

Beavers are active in this reach, but no dams are present. Other wildlife observed include: mallards, Canada geese, ring-necked pheasant, various songbirds, and kingfishers.

Geomorphological Character

The majority of the stream channel in this reach is bedrock controlled and there are some areas where the flood plain is accessible during large flow events. The channel becomes braided in some areas by the active toe erosion and continual slumping of the banks during high flows. The slumps are then colonized by reed canarygrass. Concrete fill also confines natural movement through one portion of the reach.

The sinuosity for Reach 3 is approximately 1.5. The sinuosity appears to be controlled by bedrock outcrops and current land uses, mostly State Highway 27. The gradient for the reach is approximately 0.0013. The width/depth ratio varies from 10 to 20 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, mostly limited to bank slumping. The banks have slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. Within the slumped banks, some areas of accelerated erosion were noted. The scalloped areas are approximately 15 to 20 feet long and two to five feet deep. There is one area of longitudinal erosion that has vertical banks with no vegetation.

Agricultural Influence

Agricultural production borders the entire reach. Some areas have large grassy buffers, but many of the fields are plowed directly to the edge of the stream bank.

Anthropogenic Influence

State Highway 27 follows the length of the reach on the right bank, but only comes into close contact with the stream in a few areas. The highway tends to follow the outside edge of the meander belt on the right bank. There are two rural/farming residences within the reach.

Summary

This reach has very little to no woody riparian plant community throughout its entire length. Several agricultural fields have plowed up to the top of the stream bank and further inhibit the establishment of a functional riparian area. Other stresses to this reach include past removal of riparian vegetation, road encroachment, and stream channelization. Bank slumping and erosion within the reach indicate unstable banks and the inability to dissipate high-energy flows.

Functional Rating

Functional-at-Risk (no apparent trend)

Photograph 3.1. Channel and riparian vegetation

Photograph 3.2. Agriculture extending into riparian zone

Photograph 3.3. Remnant prairie/shrub-steppe plant community

Photograph 3.15. Slumping banks and plowed fields to edge

<u>Reach 4:</u> River Mile 50.8-50.3

Distance: 0.5 miles Date: 4-24-03

<u>Geographic Description</u>
The reach flows to the northwest from river mile 50.8 and parallels State Highway 27, which lies to the east. It is generally a straight stretch of stream with a few subtle bends. The upland use is dominated by agriculture, however some grasslands and rocky outcrops border the stream.

<u>Riparian Vegetation</u>
The reach maintains two notable Douglas hawthorn (*Crataegous douglasii*) stands that contain sufficient age distribution and species diversity. The first stand is located along the left bank at river mile 50.8 and the latter along the right bank after the bridge at river mile 50.5. The hawthorn thickets contain a herbaceous understory dominated by Solomon's seal (photo 4.2). A native bunchgrass community exists on a rocky outcrop along the right bank at river mile 50.8, before the bridge. Balsamroot arrowleaf (*Balsamrhiza saggitatta*) is abundant in this remnant community (photo 4.3).

Despite this reach's healthy hawthorn thickets and remnant prairie grasslands, the width of the riparian area is limited along both sides of the bank due to agricultural production, bridge abutments, and road encroachment.

Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks and extends from the water's edge upward to the border of the fields, joining a narrow strip of mixed grasses and weeds between the water surface and agricultural fields. In addition, isolated patches of red-osier dogwood (*Cornus sericea var. occidentalis*) are reestablishing along both banks. Tansy Ragwort (*Senecio jacobaea*) a noxious weed is also prominent on the upper terrace of the riparian area, adjacent to the upland/agricultural land and the rock outcroppings. Beaver activity is evident, but no dams are present.

<u>Wildlife Activity</u>
(2) Beavers, but no dams are present. (2) Great horned owls

<u>Geomorphological Character</u>
The stream is slightly entrenched and appears to be laterally and vertically stable. The stream does have limited access to an active flood plain but does not exhibit maintenance nor development of one due to its confinement from the highway and adjacent agricultural land. Slumping and bank erosion was evident, but not excessive. Mature riparian plants protect the banks along part of this reach (photo 4.4). However, the channel does not have adequate structural components to dissipate energy such as large woody debris or rocks.

The sinuosity for Reach 4 is approximately 1.0. The sinuosity appears to be controlled by bedrock outcrops and current land uses, mostly State Highway 27. The gradient for the reach is approximately 0.0027. The width/depth ratio varies from 10 to 15 in the polls. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, mostly limited to bank slumping. The banks have slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. There is one area of longitudinal erosion that has vertical banks with no vegetation.

Agricultural Influence

Agricultural production is the dominant land use on the left bank. Open grassy areas exist on the right bank.

Anthropogenic Influence

State Highway 27 is located on the right bank and does have some influence on the stream. There is one rural/farming residences within this reach, but it is located on the other side of the highway away from the stream. There is one bridge structure spanning the stream (Fairbanks Rd.) and one remnant bridge abutment.

Summary

The reach contained viable, healthy stands of hawthorns and other obligate riparian vegetation to maintain certain functions in places, but lacked proper channel characteristics to compliment the vegetation. The reach has limited potential to establish a flood plain or meander due to its proximity to Highway 27 and adjacent agricultural land. Photo 4.5 is representative of Reach 4 channel characteristic and riparian vegetation.

Functional Rating

Functional-at Risk (no apparent trend)

Photograph 4.1. Old bridge abutment.

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Photograph 4.2. Understory vegetation in hawthorn thicket

Photograph 4.4. Stable bank with mature vegetation.

Photograph 4.5. Channel and riparian vegetation

<u>Reach 5:</u> River Mile: 50.3-46.7

Distance: 3.6 miles Date: 4-24-03

<u>Geographic Description</u>

This reach flows to the northwest through four meander curves and breaks a few hundred yards downstream from the Town of Latah, WA. It parallels State Highway 27 for approximately 1.0 mile then bends west and parallels a county road to the end of the reach. The reach is bordered on both banks by agricultural fields. The Town of Latah, WA is located in the lower portion of the reach.

<u>Riparian Vegetation</u>

This reach does not support any significant woody riparian plant community (Photo 5.1). The width of the riparian area ranges from five to 40 feet. Scattered pockets of red-osier dogwood (*Cornus sericea var. occidentalis*), willows (*Salix spp.*), and Douglas hawthorns (*Crataegous douglasii*) can be found within the reach. Only one vigorous stand of cottonwoods (*Populous trichocarpa*) appears along the right bank in the town of Latah, WA.

Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks and extends from the water's edge upward to the border of the fields. A narrow strip of mixed grasses and weeds lies between the stream and agricultural fields. This strip ranges from 5-40 ft (Photo 5.2). The agricultural fields extend to the edge of the stream in some areas (Photo 5.3). Tansy Ragwort (*Senecio jacobaea*) a noxious weed is also prominent in this grass strip adjacent to the upland/agricultural land and can is also found at the base of rock outcroppings. False Hellebore was also found in this reach.

<u>Wildlife Activity</u>

Canada goose, mallards, owl, Great blue heron, common merganser, coyote, ringneck pheasant

<u>Geomorphological Character</u>

The stream is incised, but was determined to be laterally and vertically stable. The stream does not have access to an active flood plain, and does not exhibit maintenance or development of one due to its confinement from the highway and adjacent agricultural land. Slumping and bank erosion is evident, especially in the portions of the reach that are actively grazed. Some areas of this reach are highly braided and form a somewhat indistinguishable stream channel.

The sinuosity for Reach 5 is approximately 1.2. The sinuosity appears to be controlled by bedrock outcrops and current land uses, mostly State Highway 27 and farming. The gradient for the reach is approximately 0.0011. The width/depth ratio varies from 10 to 20 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, mostly limited to bank slumping. The banks have slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. Within the slumped banks, some areas of accelerated erosion were noted. The areas were generally scallops within the bank approximately 15 to 20 feet long and two to five feet deep. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence

The agricultural fields often encroach into the riparian areas within this reach. Streamside grazing does occur near river mile 49.0 along the left bank.

Anthropogenic Influence

Two rural/farming residences occur in this reach, but one is located on the other side of State Highway 27 on the right bank. The Town of Latah, WA borders the stream for approximately 0.5 mile. There are two bridges within this reach.

Summary

This reach lacks an adequate woody riparian plant community and has no access to an active flood plain. It is unable to maintain or develop a flood plain due to its' entrenchment, road proximity, urban development, and agricultural influences. Water quality and bank stability is further threatened by extensive unrestricted grazing through RIVER MILE 49.0-50.0 (photo 5.5).

Functional Rating

Functional-at-Risk (downward trend)

5.1 Absence of woody riparian plant communities

5.2 Mixed grass buffer between stream and fields

5.3 Fields plowed to the water's edge

5.4 Livestock access to water

Reach 6: River Mile 46.7-41.4

Distance: 5.3 miles Date: 4-25-03

Geographic Description

This reach begins at a southwest meander and eventually straightens out at river mile 45.7. It then flows relatively straight north approximately 3.0 miles. A county road runs adjacent to the stream for these first 3.0 miles. At river mile 42.5 the stream encounters State Highway 27 for a short distance. The stream turns west at river mile 43.6 and meanders northeast where the reach ends at river mile 41.1 (adjacent to the junction of State Highway 27 and Waverly Road). The upland use is dominated by agricultural production with a substantial area of grazed land from river mile 46.5 to 45.0.

Riparian Vegetation

This reach has relatively little to no woody riparian vegetation (Photo 6.1). Sparse thickets of Douglas hawthorn (*Crataegous douglasii*) are found throughout the reach. The width of the riparian area is limited to 0-40 feet in areas where it historically could have been more than 200 feet. No significant sources of vegetation exist to adequately protect banks or dissipate high-energy flows, although scattered pockets of red-osier dogwood (*Cornus sericea var. occidentalis*) and coyote willow (*Salix exigua*) appear in places. A vigorous patch of Douglas hawthorns can be found along the right bank at river mile 45.9 (an actively grazed section of the reach).

Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks and extends from the water's edge upward to the border of the fields, joining a narrow strip of mixed grasses and weeds between the water surface and agricultural land. Tansy Ragwort (*Senecio jacobaea*) a noxious weed is prominent on this grass buffer zone adjacent to the upland/agricultural land.

The grazed section of this reach supported vigorous small communities of rushes (*Juncus spp.*), sedges (*Carex spp.*) and bulrush (*Scirpa spp.*) within the reed canarygrass stands. Non-grazed portions of the reach supported the same plants, but only scattered populations.

Wildlife Activity

Mallards, common merganser, Great blue heron, ringneck pheasant

Geomorphological Character

The stream is entrenched, but was determined to be laterally and vertically stable. The stream does not have access to an active flood plain and does not exhibit maintenance or development of one due to its confinement from the highway and adjacent agricultural land. An old road grade with riprap borders the left bank at river mile 46.0 (Photo 6.2) to further control natural stream movement. Bedrock was observed in places. Stream bank slumping and erosion has resulted in significant braiding in some sections of this reach.

The sinuosity for Reach 6 is approximately 1.2. The sinuosity appears to be controlled by bedrock outcrops and current land uses, mostly state and county roads, along with farming. The gradient for the reach is approximately 0.0010. The width/depth ratio varies from 10 to 15 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally high, and consists of general bank slumping and longitudinal vertical banks. The banks have generally slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence

Agricultural production borders the stream channel and occasionally meets the top of the bank. A large portion of this reach supports active, unrestricted livestock grazing. Three old tiling drains and one natural drainage (ditch) were observed. The tiles were barely running.

Anthropogenic Influence

The left bank near river mile 46 has riprap protecting a county road for approximately 0.5 mile. A small dumping site is located near river mile 46.2. Another county road parallels the right bank for a majority of the reach until it meets State Highway 27 at river mile 42.5. There are two rural/farming residences located within the reach. One bridge (Robert's Rd.) is located in the lower portion of the reach.

Summary

This reach lacks an adequate riparian plant community and has no access to an active flood plain. It is unable to maintain or develop a flood plain due to its entrenchment and proximity to the roads and agricultural land. Water quality and bank stability is further threatened by extensive unrestricted streamside grazing through river mile 45.0 - 46.5 (Photo 5.5). Tiling and ditch drainage of agricultural lands was also observed in sections of this reach.

Functional Rating

Functional-at-Risk (downward trend)

6.1 Absence of a viable riparian plant community

6.2 Riprap along county road


6.3 Stream channel braiding and riparian area


6.4 Ditch entering the main channel

Reach 7: River Mile 41.4-40.0

Distance: 1.4 miles Date: 4-25-03

Geographic Description

This reach flows north for approximately 0.6 miles until it begins a sharp meander west and finishes at river mile 40.0. The first quarter of the reach is bordered by old agricultural land on the right bank, while steep, forested banks and rock outcrops border the left, creating a canyon-like environment. As the stream begins to meander, both banks are forested and have evidence of previous grazing and timber harvest. Riparian/bank restoration efforts (tree planting) through the federal Continuous CRP are currently underway on both sides of the stream.

Riparian Vegetation

Steep banks and rocky outcrops along the left bank at the beginning of this reach support a mature, forested plant community dominated by Ponderosa pine (*Pinus pondersoa*) and associated understory herbs such as Balsamroot arrowleaf (*Balsamrhiza saggitata*) (photo 7.1). Mock orange (*Philadelphus lewisii*) and snowberry (*Symphoricarpos albus*) shrubs were also identified. These steep slopes do not support a distinct riparian plant community, but some sparse patches of red-osier dogwood (*Cornus sericea var. occidentalis*) were present at the water's edge.

A true flood plain is maintained throughout most of this reach. Associated riparian plants such as red-osier dogwood, Douglas hawthorn (*Crataegous douglasii*), willow (*Salix spp.*), and box elder (*Acer negudo*) are present on the active flood plain and the right bank. Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks.

Wildlife Activity

(2) River otters, Great blue heron, various waterfowl

Gemorphological Character

The stream was determined to be laterally and vertically stable based on the occurrence of bedrock outcroppings (photo 7.2). The stream has access to an active flood plain and exhibits maintenance of the flood plain. Large woody debris and rocks were present to dissipate energy during high flows, however some slumping and bank erosion was observed.

The sinuosity for Reach 7 is approximately 1.2. The sinuosity appears to be controlled by bedrock outcrops and current land uses, mostly county roads and farming. The gradient for the reach is approximately 0.0027. The width/depth ratio varies from 10 to 15. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is low, mostly limited to minor bank slumping and longitudinal vertical banks. The bank slumping along this reach was significantly less due to the bedrock, upland vegetation, and replantings. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence
Agricultural production is located in uplands away from the stream. Livestock grazing in this reach is currently terminated and new riparian plantings have been established.

Anthropogenic Influence
Waverly Road runs parallel to the stream on the right bank. Influence appears to be minimal until the end of the reach. Two rural/farming residences are within the reach, but are located on the other side of the road.

Summary
This reach maintains an active flood plain that supports isolated communities of riparian plants. Erosion impacts appear to be minimal. Sources of large woody debris and instream bedrock help dissipate energy and stabilize banks. Livestock grazing and forest harvesting are currently not active and riparian rehabilitation efforts are underway. The reach appears to be on an upward trend.

Functional Rating
Proper Functioning Condition


7.1 Steep forested slopes bordering left bank


7.3 Rocky outcrops with shrubs


7.3 Area of restoration efforts of riparian plants


7.4 Stream channel and riparian characteristics

Reach 8: River Mile 40.0-38.0

Distance: 2.0 miles Date: 4-25-03

Geographic Description

This reach flows west/southwest for approximately 0.8 miles and bends back to the north/northwest through the Town of Waverly, WA. Waverly borders the stream to the north and east. The stream meanders again to the northeast for approximately 0.2 miles and then takes a sharp turn west to finish the reach at river mile 38.0.

Riparian Vegetation

The majority of this reach lacks a healthy riparian plant community (Photo 8.1). As the stream enters the Town of Waverly, a small stand of black cottonwood (*Populus trichocarpa*) and Douglas hawthorn (*Crataegous douglasii*) can be found along the left bank (photo 8.2). Just beyond town, a strip of red-osier dogwood (*Cornus sericea*) was well established along the right bank. Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks and extends from the water's edge to join a strip of mixed grasses and weeds that border the agricultural lands. Tansy Ragwort (*Senecio jacobaea*) a noxious weed is prominent on this grass strip adjacent to the upland/agricultural land.

Wildlife Activity

Great blue heron, waterfowl

Geomorphological Character

The reach was determined to be laterally and vertically stable based on the occurrence of bedrock control. However, the stream is further confined by riprap, a bridge, and urban development on both sides. The stream does not have frequent access to a majority of the flood plain, but some areas are inundated every other year. The reach contains sections that were channelized (river mile 39.7 - 40.0 and 38.0 - 38.1). Stream bank slumping and moderate erosion were noted (photo 8.3). No sources of large woody debris or rocks were present to dissipate energy during high flows. Reed canarygrass has colonized slumped portions of the bank and depositional areas, creating a highly braided channel through the first portion (photo 8.4).

The sinuosity for Reach 8 is approximately 1.1. The sinuosity appears to be controlled by bedrock outcrops and urban development (Waverly). The gradient for the reach is approximately 0.0019. The width/depth ratio varies from 10 to 15. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is moderate, mostly minor bank slumping and longitudinal vertical banks. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence

The first portion of the reach is bordered by agricultural land along the left bank. Just downstream of the town, livestock grazing is evident along the left bank. Rock outcrops along the right bank and agriculture along the left bank are characteristic at the end of the reach.

Anthropogenic Influence

Waverly Road borders the reach on the right bank before it enters the town. This part of the channel has been confined by riprap. The stream then passes under one bridge and evidence of old bridge abutments were found downstream of town. As the stream travels through Waverly, residential sites and an agricultural chemical plant border the stream.

Summary

This reach lacks riparian vegetation and is constricted by natural bedrock, riprap, road encroachment, a bridge, and urban development. The channel is highly braided in areas, slightly entrenched, and without complete access to its natural flood plain.

Functional Rating

Functional-at-Risk (with areas of Proper Functioning Condition –no apparent trend)

8.1 Lack of riparian woody vegetation

8.2 Riparian community at Waverly, WA

8.3 Bank slumpage

8.4 Reed canarygrass creates a braided channel

Reach 9: River Mile 38.0-36.5

Distance: 1.5 miles Date: 4-25-03

Geographic Description

This reach flows northwest for approximately 0.8 miles, meanders west under the Spangle-Waverly Road Bridge at river mile 37.3, and terminates at river mile 36.5.

Riparian Vegetation

This reach lacks a vigorous riparian plant community throughout the majority of its length (photo 7.1). However, scattered stands of willow (*Salix spp*.) and red-osier dogwood (*Cornus sericea*) appear to be establishing in selected areas. In addition, one remnant black cottonwood (*Populus trichocarpa*) was observed at river mile 36.9. Small communities of basin wildrye (*Elymus cinereus*) were observed on the left bank through the meander and steep slopes.

Reed canarygrass (*Phalaris arundinacea*) is well established throughout the reach and extends up onto the upper terrace where it transitions to a mixture of grasses and weeds that border the agricultural lands.

Wildlife Activity

None observed

Geomorphological Character

The stream channel is slightly entrenched and was determined to be laterally and vertically stable. A small flood plain (river mile 37.0 - 38.0) is accessible during higher flows on one or both sides of the channel. However, this flood plain is poorly maintained by frequent spring flows and does not currently support riparian plant communities. There is no large woody debris present in the reach, but an adequate amount of rock helps to dissipate energy. Eroded vertical banks from high flow events were prevalent.

The sinuosity for Reach 9 is approximately 1.2. The sinuosity appears to be controlled by bedrock outcrops. The gradient for the reach is approximately 0.0025. The width/depth ratio varies from 10 to 15. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is moderate, mostly minor bank slumping and longitudinal vertical banks. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence

Agricultural production and some small forested tracts surround this reach. Livestock grazing occurs throughout the reach and is impacting the stream banks and suppressing woody riparian vegetation (photo 9.2). Large pieces of concrete have been dumped in one area as an attempt to curb erosion (photo 9.1).

Anthropogenic Influence

The reach passes under one bridge and contains one rural/farming residence on the right bank near the bridge. The Spangle-Waverly Road parallels the stream for approximately 0.5 miles.

Summary

This reach was determined to be vertically and laterally stable with adequate sources of rock to dissipate energy. It maintains a small active flood plain, but is unable to support required populations of woody riparian plants. Livestock grazing within the riparian area impacts the banks and suppresses the establishment of woody riparian plants.

Functional Rating

Functional-at-Risk (downward trend)

9.1 Right bank erosion and fill material

9.2 Grazing has accelerated erosion along bank

Reach 10: River Mile 36.5-35.4

Distance: 1.1 mile Date: 4-25-03

Geographic Description
This reach flows east from river mile 36.5 and turns north through a few gentle bends and ends at river mile 35.4 (Hays Road Bridge). It is entirely surrounded by agricultural land on both sides.

Riparian Vegetation
This reach lacks adequate riparian plant communities to stabilize banks or dissipate energy. Small, scattered willow (*Salix spp*.) and red-osier dogwood (*Cornus sericea*) plants appear to be establishing in selected areas, but there is limited age-class distribution.

Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks and extends up onto the upper terrace where it transitions to a mixture of grasses and weeds, including Tansy ragwort (*Senecio jacobaea*).

Wildlife Activity
Great blue heron, waterfowl

Geomorphological Character
The channel is slightly entrenched without access to an active flood plain. Slumping and bank erosion was evident, but not excessive. The channel does not contain adequate structural features such as rock or woody debris to dissipate high energy flows and stabilize banks. Reed canarygrass, as seen in photos 10.1 and 10.2 has colonized slumped stream banks and depositional features on the channel floor, creating a braided channel through most of the reach.

The sinuosity for Reach 10 is approximately 1.2. The sinuosity appears to be controlled by farming practices, but bedrock is probably also controlling the sinuosity in this reach. The gradient for the reach is approximately 0.0017. The width/depth ratio varies from 10 to 15 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, and consists of general bank slumping and longitudinal vertical banks. The banks have generally slumped to approximately a 45-degree angle, although some areas were flatter, and have been stabilized with reed canarygrass. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence
The reach is bordered on both sides by agricultural production. The fields have encroached upon the once-active flood plain. Some ditches/drainages exist.

Anthropogenic Influence
There is one bridge located at the end of the reach (river mile 35.5).

Summary
This reach lacks adequate riparian plant communities and exhibits moderate erosion and bank slumping. It has limited access to an active flood plain, but is determined to be vertically and

laterally stable. It lacks adequate sources of rocks, vegetation, and large woody debris to dissipate energy.

Functional Rating

Functional-at-Risk (no apparent trend)

10.1 Reed canarygrass creates braided channel

10.2 Channel and riparian characteristics

<u>Reach 11:</u> River Mile 35.-34.2

Distance: 1.2 mile   Date: 5-2-03

<u>Geographic Description</u>
This reach flows north and nearly straight for approximately 1.5 miles before it enters a new reach at river mile 34.2. The right bank is dominated by production agriculture on rolling hills. Hays Road parallels the stream on a steep ridge along the left bank covered by open Ponderosa pine. Evidence of grazing was observed along both banks.

<u>Riparian Vegetation</u>
This reach lacks riparian plant communities along its banks (photo 11.1). Small, scattered willow (*Salix spp*.) and red-osier dogwood (*Cornus sericea*) plants are establishing in some areas, but do not exhibit natural age-class diversity. Reed canarygrass (*Phalaris arundinacea*) is well established throughout the entire reach along both banks and extends up onto the upper terrace where it transitions to a mixture of grasses and weeds, including Tansy ragwort (*Senecio jacobaea*). Small rush (*Juncus spp*.) and sedge (*Carex spp*.) communities appear to thrive within the grazed areas (photo 11.1).

<u>Wildlife Activity</u>
None observed

<u>Geomorphological Character</u>
The channel is slightly entrenched without access to an active flood plain. Stream bank slumping and erosion is evident, but not excessive. The channel does not contain adequate structural features such as rock or woody debris to dissipate high energy flows and stabilize banks. Riprap was placed along the left bank and attempts to control the movement of the channel (photo 11.2).

The sinuosity for Reach 11 is approximately 1.1. The sinuosity appears to be controlled by bedrock outcrops. The gradient for the reach is approximately 0.0027. The width/depth ratio varies from 10 to 20 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, and consists of general bank slumping and longitudinal vertical banks. The banks have generally slumped to approximately a 45-degree angle and have been stabilized with reed canarygrass. There are several areas of longitudinal erosion that have vertical banks with no vegetation.

<u>Agricultural Influence</u>
Agricultural production influences are negligible in this reach. Livestock grazing impacts to streambanks and vegetation is evident.

<u>Anthropogenic Influence</u>
There are no apparent Anthropogenic influences in this reach

Summary

This reach lacks adequate riparian plant communities, has several areas of moderate erosion and bank slumping, and has limited access to its natural flood plain. It was determined to be vertically and laterally stable but lacks adequate sources of rocks or woody debris to dissipate energy.

Functional Rating

Functional-at-Risk (downward trend)

11.1 Lack of riparian plant, but presence of rushes

11.2 Riprap serves to stabilize bank and control lateral movement

<u>Reach 12:</u> River Mile 34.2-32.1

Distance: 2.1 miles Date: 5-2-03

<u>Geographic Description</u>

This reach flows to the northwest for 0.3 miles until it begins a series of large meanders surrounded by basaltic outcrops, and steep slopes. The reach also runs through some flatter areas. At river mile 32.9, the stream passes under West Bradshaw Road at the confluence of Rattler's Run Creek.

<u>Riparian Vegetation</u>

This reach maintains a healthy riparian plant community. However, some sections, such as river mile 33.5-33.9 along the right bank, are less vigorous or absent (photo 12.1). Based on a diverse age class and species composition, the species present are capable of recruitment of younger stands (photo 12.2), can withstand high energy flows, and provide varying amounts of coarse woody debris for stream channel maintenance. Riparian species present are, but not limited to the following: coyote willows (*Salix exigua*), drummond willow (*Salix drummondiana*), red-osier dogwood (*Cornus sericea*), black cottonwood (*Populus trichocarpa*), Douglas hawthorn (*Crataegous douglasii*), and bulrush (*Scirpa spp.*) (photo 12.4)

The steeper upland slopes surrounding this reach support a Ponderosa pine (*Pinus ponderosa*) plant association. Upland/transitional shrubs extend to the high water mark and consist of blue elderberry (*Sambucus cerulea*), snowberry (*Symphoricarpos albus*), currant (*Ribes aureum*) and chokecherry (*Prunus virginiana*) (photo 12.3).

Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length, but is not dominant where woody riparian plants (eg. willows) are well established.

<u>Wildlife Observed</u>

None observed

<u>Geomorphological Character</u>

An active flood plain exists and is accessible through most portions of this reach, although some sites are disconnected. The stream appears to be in balance with its natural sinuosity, and is vertically and laterally stable. There is no excessive erosion or deposition through this reach. Adequate structural features such as rock and large woody debris are present to stabilize banks and dissipate energy.

The sinuosity for Reach 12 is approximately 1.1. The sinuosity appears to be controlled by bedrock outcrops. The gradient for the reach is approximately 0.0030. The width/depth ratio varies from 5 to 15 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, and consists of longitudinal vertical banks. The banks have some minor slumping, but it is generally much less than in previous reaches. There are areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence
Livestock grazing occurs along some of the slopes as well as the flats. Agricultural crop production is present on the upper terrace, but not directly adjacent to the stream.

Anthropogenic Influence
West Bradshaw Road Bridge is located near the end of the reach.

Summary
This reach maintains a healthy riparian plant community. Riparian species were numerous, vigorous, and diverse in both age-class distribution and species composition. The stream has access to a flood plain and is able to maintain its' lateral and vertical movement by the presence of bedrock, river rock and large woody debris. A few sites within this reach are less vigorous than others or do not have access to the flood plain. Unrestricted livestock grazing occurs throughout portions of the reach.

Functional Rating
Functional-at-Risk (no apparent trend)


12.1 Stream channel and riparian characteristics


12.2 Young cottonwoods establishing


12.3 Shrubs extend to high water mark


12.4 Bulrush spp.

<u>Reach 13:</u> River Mile 32.1-24.7

Distance: 7.4 miles Date: 5-2-03

<u>Geographic Description</u>
This reach flows through a long stretch of sharp meanders that descend through a deep, narrow, forested canyon of high basalt bluffs (photo 13.1). The reach and the canyon approximately end at river mile 24.7

<u>Riparian Vegetation</u>
The majority of this reach is bordered by steep forested hills and Basalt cliffs that descend to the water's edge. All exposures are dominated by Ponderosa pine (*Pinus ponderosa*), but Douglas-fir (*Psuedostuga menziesiia*) and western larch (*Larix occidentalis*) can be found along the north and east exposures (photo 13.2). Quaking aspen (*Populus tremuloides*) was observed on the some of the upland bluffs.

The steep slopes and high velocities through the canyon inhibit the development of large riparian plant communities. In flatter areas where a small flood plain has been developed, stands of black cottonwood (*Populus trichocarpa*), willows (*Salix spp*.) and red-osier dogwood (*Cornus sericea*) are well established. Sapling recruitment is maintained in this reach (photo 13.3). The riparian plant communities that exist are highly vigorous.

Reed canarygrass (*Phalaris arundinacea*) is well established in slower sections where there is alluvial deposition. However, a large portion of the canyon is a bedrock substrate that is more likely to be established with mosses or an herbaceous understory (photo 13.4).

<u>Wildlife Observed</u>
Whitetail deer, hawks, kingfishers, Bald eagle

<u>Geomorphological Character</u>
The channel lies in a steep canyon surrounded by basalt bluffs. The current is swift and the channel is comprised of a series of rapids and pools. The channel is bedrock controlled and vertically and laterally stable. Large woody debris and rocks are adequate to dissipate energy and protect banks. Occasional areas of natural erosion occur due to high flow and high velocity (photo 13.5).

The sinuosity for Reach 13 is approximately 1.5. The sinuosity appears to be controlled by bedrock outcrops. The gradient for the reach is approximately 0.0076. The width/depth ratio varies from 5 to 205 in the pools. For the riffle areas, the width/depth ratio was varies from five to 10. Erosion along this reach is generally low, and consists of longitudinal vertical banks that are associated with natural erosion from the high flows encountered in the canyon.

<u>Agricultural Influence</u>
The steep rocky character of this reach inhibits agricultural use. Evidence of small timber operations, minimal livestock grazing, and primitive roads was observed.

Anthropogenic Influence
The reach contains two bridges (North Kentuck Trails and Keevy Road).

Summary
This reach exhibits a narrow, well-established riparian area. The flood plain is often small, but accessible to higher flows. Human disturbance is minimal due to its topography and rocky character. The adjacent forested slopes provide shade to the stream channel and the bedrock substrate dissipates energy and protects the areas that are vulnerable to erosion.

Functional Rating
Proper Functioning (with areas of Functional-at-Risk)


13.1 Forest canyon


31.2 Western larch and Douglas-fir forest


13.3 Cottonwood recruitment


13.4 Herbaceous understory


13.5 Natural erosion and re-establishment of bank


13.6 Channel characteristics and riparian area

Reach 14(A): River Mile 24.7-22.8

Distance: 1.9 miles   Date: 5-2-03

Geographic Description
This reach begins at the end of the canyon and flows through a wide-open valley surrounded by gentle, forested hills. It flows northwest for approximately 1.9 miles and ends.

Riparian Vegetation
The riparian areas in portions of this reach are naturally limited due to the upland slopes descending right to the water's edge. They are composed of Ponderosa pine (Pinus ponderosa), and associated understory grasses, shrubs, and herbs and extend to the water's edge. However, some stands of red-osier dogwood (*Cornus sericea*), Douglas hawthorn (*Crateagus douglasii*), alder spp. (*Alnus spp.*) are established at the toe of these slopes near the water's margin. This vegetation aids in stabilizing the steep banks.

The stream has been channelized and straightened. The riparian area is limited to 15 feet or less due to the large artificial rock berms and adjacent agriculture. However, small pockets of cottonwoods (*Populus trichocarpa*), willows (*Salix spp*) and red-osier dogwood (*Cornus sericea*), are establishing and exhibit high vigor along the toe of the berms and lateral bars.

Wildlife Observed
Whitetail deer, waterfowl, ringneck pheasants

Geomorphological Character
The majority of the reach has been straightened and confined by the development of large rock berms on both sides of the channel. One hardened crossing was constructed in the berms. This channelization restricts lateral movement, prevents active use of flood plain, and increases local velocities during high flow events. The adjacent forested slopes provide adequate sources of large woody debris capable of being recruited to the stream channel to help dissipate high-energy flows.

The sinuosity for Reach 14A is approximately 1.0. The sinuosity is controlled by large berms. The gradient for the reach is approximately 0.0040. The width/depth ratio varies from 10 to 15 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is generally low, and consists of longitudinal vertical banks outside the channalized areas. The banks have some minor slumping, but most of the erosion is from the areas of longitudinal erosion that have vertical banks with no vegetation.

Agricultural Influence
The valley bottoms in this reach are impacted by agricultural production and/or livestock grazing.

Anthropogenic Influence
Extensive rock berms have been built up on both sides of the channel in some areas.

Summary

The reach has been constrained by rock berms, but has fairly good riparian plant communities establishing within the berms. Additional bedrock and large woody debris are present to dissipate energy and stabilize banks. The reach consists of areas that have properly functiong riparian areas. These naturally narrow bands of riparian species are providing proper functions, but are often opposite of the large rock berms.

Functional Rating

Proper Functioning Condition

14.1 Berm straightening channel

14.2 Vegetation protecting banks from high flows

14.3 Riparian plants along banks

14.4 Reach character

<u>Reach 14(B):</u> River Mile 22.8-21.7

Distance: 1.1 miles Date: 5-2-03

<u>Geographic Description</u>
This reach begins where the rock berms in reach 14(A) end. It flows to the north for approximately 0.9 miles. At this point it turns west and begins to develop small meanders until river mile 21.7.

<u>Riparian Vegetation</u>
In this reach, rushes (*Juncus spp.*) were observed at the water's edge, but no significant woody plant communities were noted. Reed canarygrass (*Phalaris arundinacea*) is well established for the entire length along both banks and extends up onto the upper terrace where it transitions to a mixture of grasses and weeds, including Tansy ragwort (*Senecio jacobaea*), wormwood (*Artemisia absinthium*), and teasle (*Dipsacus sylvestris*), that border the agricultural lands.

<u>Wildlife Observed</u>
Whitetail deer, common merganser

<u>Geomorphological Character</u>
Reach 14B is similar to reach 14A without the channelization. The riparian area is naturally narrow due to forested slopes. Agricultural influences and reed canarygrass communities have reduced riparian vegetation.

The sinuosity for Reach 14B is approximately 1.1. The sinuosity appears to be controlled by bedrock outcrops. The gradient for the reach is approximately 0.0043. The width/depth ratio varies from 5 to 15 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is moderate, and consists of longitudinal vertical banks. The banks have some minor slumping, but the amount of longitudinal erosion is greater that in Reach 14A. The areas of longitudinal erosion have vertical banks with no vegetation.

<u>Agricultural Influence</u>
Unrestricted livestock grazing occurs through the riparian area. Livestock have trampled banks, suppressed woody vegetative growth and accelerated erosion.

<u>Anthropogenic Influence</u>
No influences observed.

<u>Summary</u>
This reach lacks riparian woody vegetation and has lost connectivity to an active flood plain in some areas, but it is laterally and vertically stable with minor erosion.

<u>Functional Rating</u>
Functional-at-Risk (no apparent trend)

14. 5 Grazing impacts

14.5 Cut bank from high velocities

14.6 Characteristic of Reach 14B

Reach 15: River Mile 21.7-19.4

Distance: 2.3 miles Date: 5-5-03

Geographic Description

This reach flows to the north, gently meandering through a wide alluvial flood plain. The confluence of Rock Creek enters the mainstem at river mile 20.2. The reach turns to the northwest, ending at river mile 19.4.

Riparian Vegetation

This reach contains a fairly vigorous, but discontinuous riparian plant community (Photo 15.1). Vigorous stands (river mile 21.2) of cottonwoods (*Populus trichocarpa*), alders (*Alnus spp.)*, and scattered red-osier dogwood (*Cornus sericea*) and Douglas hawthorn (*Crataegus douglasii*) communities can be found throughout the reach (photo 15.2). However, there are larger areas that have little to no woody riparian species and tend to be highly eroded. Reed canarygrass (*Phalaris arundinacea*) is well established and usually extends from the water to the edges of the agricultural fields.

The forested hills surrounding the valley are dominated by Ponderosa pine (*Pinus ponderosa*). The eastern exposures support a number of Douglas-fir (*Psuedostuga menziesii*) and western larch (*Larix occidentalis*).

A stream bank revegetation project is underway at river mile 21.5 along the left bank

Wildlife Observed

Bald eagle, Canada goose, bufflehead

Geomorphological Character

The channel flows through a large alluvial flood plain surrounded by steep basaltic bluffs. It has incised to a stable, bedrock floor and created exposed vertical banks on both sides of the channel (photo 15.3). The channel is disconnected from an active flood plain and continues to move laterally to develop a new flood plain (horizontally unstable). The reach has limited ability to dissipate high-energy flows due to a lack of large woody debris, or rock. The active bank cutting delivers high quantities of sediment to the system.

The sinuosity for Reach 15 is approximately 1.3. The sinuosity appears to be natural within the bedrock bluffs. The gradient for the reach is one of the lowest measured at approximately 0.0004. The width/depth ratio varies from 10 to 20 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is high and consisted of longitudinal vertical banks. The banks have some minor slumping, but it is generally much less than in previous reaches. The areas of longitudinal erosion have vertical banks with no vegetation.

Agricultural Influence

The immediate upland use is dominated by agricultural production with some livestock grazing. The surrounding hills are forested with basalt outcroppings.

Anthropogenic Influence
The stream passes under Valley Chapel Road (bridge) at river mile 19.8 and then runs parallel the road. Four rural/residential homes are located within the historic flood plain.

Summary
The reach contains excessive bank erosion, constricted lateral movement, an inaccessible flood plain, and an absence of adequate riparian plants. It is further impacted by the confluence with Rock Creek and constriction of Valley Chapel Road.

Functional Rating
Functional-at-Risk (no apparent trend)


15.1 Lack of riparian plants


15.2 Alder stand along left bank (river mile 21.2)


15.3 Excessive erosion from bank cutting


15.4 Channel and riparian characteristics

Reach 16: River Mile 19.4-18.6

Distance: 0.8 miles Date: 5-5-03

Geographic Description
This reach flows straight north along a vertical slope of basalt for approximately 0.8 miles. It ends at the Valley Chapel Road Bridge near river mile 18.6.

Riparian Vegetation
This reach includes comparatively continuous, vigorous expanses of riparian trees and shrubs along the stream (indicating good maintenance of soil moisture retention). Thickets of Douglas hawthorn (*Crataegus douglasii*) are abundant, while patches of cottonwood (*Populus trichocarpa*), quaking aspen (*Populus tremuloides*), and red-osier dogwood (*Cornus sericea*) are present to a lesser extent. The presence of mature cottonwoods provides structural integrity to the reach by protecting banks and creating pools. The vertical rock slopes along the right bank support Ponderosa pine (*Pinus ponderosa*) and are capable in providing large woody debris to the system. Reed canarygrass (*Phalaris arundinacea*) is present along both banks, but is not dominant.

Wildlife Observed
Canada Goose (and goslings)

Geomorphological Character
The reach is relatively straight, with a swift current and a series of riffles and pools. The bedrock in this reach provides lateral and vertical stability to the stream. Additionally, the reach contains adequate large woody debris for energy dissipation. At river mile 18.7, an overflow channel exists along the right bank and aids in dissipating energy during high flows. Mid-channel bars are revegetating with riparian species. No excessive erosion was evident through this reach.

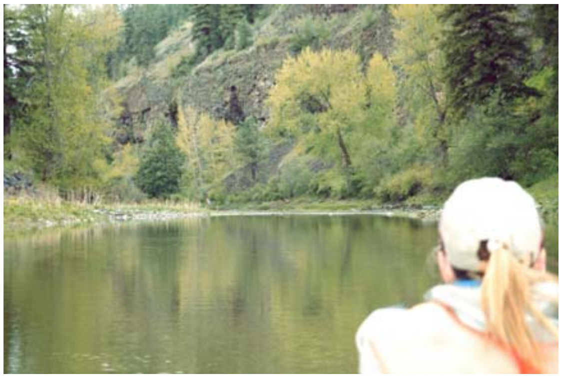
The sinuosity for Reach 16 is approximately 1.0. Bedrock outcrops control the sinuosity. The gradient for the reach is approximately 0.0036. The width/depth ratio varies from 10 to 25 in the pools. For the riffle areas, the width/depth ratio is approximately five to 10. Erosion along this reach is very low because of the bedrock and road locations.

Agricultural Influence
Minor agricultural land uses, including livestock grazing, occur on the left bank.

Anthropogenic Influence
Three rural/farming residences lie within this reach. Valley Chapel Road runs parallel to the stream on the left bank for the entire length and crosses (bridge) the stream at the end of the reach.

Summary
The reach is bedrock controlled with little or no erosion potential. It maintains fairly healthy riparian communities with minor agricultural influences. Road encroachment on the left bank constrains the reach and prevents lateral movement.

Functional Rating
Proper Functioning Condition


16.1 Riparian vegetation and vertical basalt walls


16.2 Channel and riparian characteristics

Reach 17: River Mile 18.6-17.9

Distance: 0.7 miles Date: 5-5-03

Geographic Description
This reach begins at the Valley Chapel Road Bridge at river mile 18.6 and flows northwest. It meanders through a narrow, open valley bordered by forested slopes. The confluence of California Creek is located at river mile 18.3. The reach ends at approximately river mile 17.8

Riparian Vegetation
This reach contains vigorous communities of riparian plants, indicating soil moisture retention and stability in the system. Thickets of Douglas hawthorn (*Crataegus douglasii*) mixed with other species support an abundant riparian understory (photo 17.1) along the left bank and provides significant wildlife habitat (photo 17.2). Large groves of multi-aged cottonwood (*Populus trichocarpa*) and quaking aspen (*Populus tremuloides*) persist in overflow channels. Red-osier dogwood (*Cornus sericea*) and willows (*Salix spp.*) are present to a lesser extent. The hills on both sides of the valley support Ponderosa pine (*Pinus ponderosa*). Reed canarygrass (*Phalaris arundinacea*) is present and well established along the edge of the water

Wildlife Observed
Porcupine, Hawks, Kingfishers, Red-winged blackbird, whitetail deer, killdeer, and beaver activity.

Geomorphological Character
This reach maintains a small flood plain that is adequate to maintain soil moisture to the riparian plants and slow velocities during high flow events (photo 17.3). An overflow channel along the toe of the left slope also provides energy dissipation. The system appears to be vertically and laterally stable with minimal erosion (photo 17.4).

The sinuosity for Reach 17 is approximately 1.1. The sinuosity appears to be natural within the small valley. The gradient for the reach is approximately 0.0027. The width/depth ratio varies from 10 to 15 in the pools. For the riffle areas, the width/depth ratio is approximately 10. Erosion along this reach is low.

Agricultural Influence
No current agricultural influences are present. Evidence of past grazing and agriculture exist.

Anthropogenic Influence
Valley Chapel Road parallels the right bank of the stream for a short distance (0.2 miles).

Summary
This reach was determined to be proper functioning. The channel maintains an adequate, stable flood plain that supports riparian plants and wildlife. Road encroachment may threaten a small stretch of this reach, but functionality can persist if current upland use is sustained. Photo 17.5 is representative of riparian and channel characteristics of Reach 17.

Functional Rating
Proper Functioning Condition


17.1 Understory herbs of hawthorn thicket


17.2 Porcupine enjoying the view


17.3 Accessible flood plain


17.4 Minimal erosion or slumping


17.5 Reach channel and riparian characteristics

Reach 18: River Mile 17.9-14.6

Distance: 3.3 miles   Date: 5-5-03

Geographic Description

This reach flows through a series of small meanders that cut through a coarse sandy alluvium, (photo 18.1). The reach flows north to river mile 17 and turns west for approximately 1.0 mile. The reach then turns north again and ends at river mile 14.6 (just before Hangman Valley Golf Course).

Riparian Vegetation

The reach supports relatively few intact riparian communities due to continual stream bank cutting and sloughing. The result is vertical banks unable to support riparian plant communities. Reed canarygrass (*Phalaris arundinacea*) is dominant through this reach. Some mature willows (*Salix spp.*) can be found and provide some localized bank stability. However, these plants are scattered and the recruitment of young saplings is absent. Beaver damage appears to be significant (photo 18.2). Similarly, red-osier dogwood (*Cornus sericea*) can be found, but are sparse.

Surrounding areas, dominated by Ponderosa pine (*Pinus ponderosa*) forest, contain adequate sources of large woody debris. However, active recruitment of significant dead wood from these areas to stabilize banks is not extensive.

Wildlife Observed

Beaver activity was observed, but no dams are present. Canada Goose, Great blue heron

Geomorphological Character

A major geological change has occurred within this reach. This reach is located within the expanses of the Great Missoula Flood deposits. The channel in this reach is constantly moving out laterally due to the alluvial nature of the stream banks and associated high flow events (indicating a geologically "young" system). Active degrading and aggrading processes keep this reach in constant flux. The stream is incised and disconnected from an active flood plain. Highly eroded and slumping stream banks are characteristic throughout the reach (photo 18.3).

The sinuosity for Reach 18 is approximately 1.4. The sinuosity appears to be natural within the bedrock bluffs. The gradient for the reach is approximately 0.0013. The width/depth ratio varies from 10 to 15 in the pools. For the riffle areas, the width/depth ratio is less than 10. Erosion along this reach is high and consisted of longitudinal vertical banks. The higher banks in this reach have some slumping that produces larger slump blocks than seen in earlier reaches. The areas of longitudinal erosion have vertical banks with no vegetation. Several of the high sediment bluffs have large scree slopes of unconsolidated sediment at their bases.

Agricultural Influence

Agricultural production is the primary upland use throughout the reach. It often abuts the stream leaving a minimal buffer. Pasture and fallow grasslands can also be found.

Anthropogenic Influence

Several rural residences are found in the reach, but most are located on the upper terrace away from the stream.

Summary

This reach is characterized by eroded and slumping stream banks with little to no adequate riparian vegetation. It is highly impacted by agricultural influences and is susceptible to erosion if no riparian vegetation is established. Some sections appear to have been channelized to create more farmable land, and riparian vegetation may have been removed to facilitate farming.

Functional Rating

Nonfunctional

18.1 Sandy vertical banks

18.2 A mature willow and beaver evidence

18.3 Bank slumping

18.4 Reach characteristics

<u>Reach 19:</u> River Mile 14.6-10.5

Distance: 4.1 miles Date: 5-5-03

<u>Geographic Description</u>
This reach begins at the upstream end of Hangman Valley Golf Course (river mile 14.6) and travels through an open valley bottom surrounded by forested slopes. It moves through a series of large meanders as it carves a course through sandy alluvium, creating high vertical banks along most of its margins (photo 19.1). The reach ends at approximately river mile 10.5 (Grunte property)

<u>Riparian Vegetation</u>
Small, sporadic stands of riparian plant communities are established along the waterline of this reach (photo 19.2). Isolated stands of willow (*Salix spp.*), are maintaining young saplings. Other more scattered plants line the banks. In particular, a vigorous stand of willows can be found at river mile 13.8 within the Hangman Valley Golf Course. Other trees and shrubs observed through this reach include Mockorange (*Philadelphus lewisii*), golden currant (*Ribes auerum.*), chokecherry (*Prunus virginiana*), box elder (*Acer neguda*), blue elderberry (*Sambucus cerulea*). Occasional thickets of Douglas hawthorn (*Crataegus douglasii*) can be found.

Reed canarygrass (*Phalaris arundinacea*) is dominant through this reach. Other grasses and herbs are present and can be found revegetating freshly exposed upland banks (photo 19.3). Surrounding slopes are comprised of Ponderosa pine (*Pinus ponderosa*) and provide sources of large woody debris to the stream.

<u>Wildlife Observed</u>
Canada Goose (goslings)

<u>Geomorphological Character</u>
This reach can be characterized as slightly entrenched to severely entrenched based on the degree of bank erosion at a given point. Some areas experience high cut banks and sloughing, typified by bare, newly exposed soil that is unstable and incapable of supporting a riparian community. Some slopes have reached the angle of repose and have become stabilized with a riparian community of plants that are capable of withstanding high flows (photo 19.4). The reach also contains sites where point bars are developing and revegetating with riparian species.

The system appears to be vertically and laterally stable, however the degree of erosion present is not in balance with its natural limits. The channel in some areas is shallow due to the excessive deposition of sediments. The natural sinuosity of this reach has been inhibited in some areas by road building and bank hardening projects.

The sinuosity for Reach 19 is approximately 1.3. The sinuosity appears to be natural within the valley walls, except where cut off by roads. The gradient for the reach is approximately 0.0010. The width/depth ratio varies from 10 to 15 in most of the pools, but was well above 20 downstream of the golf course. For the riffle areas, the width/depth ratio is usually less than 10, but some reaches have a width/depth ratio of near 10. Erosion along this reach is moderate and consisted of longitudinal vertical banks and sediment bluffs. The higher banks in this reach have minor slumping. The areas of longitudinal erosion have vertical banks with no vegetation. Several of the high sediment bluffs have large scree slopes of unconsolidated sediment at their bases. Some of the scree slopes in this reach, up to 150 feet high, are vegetated and stable, even though they are on the outside of a meander bends. These stable scree slopes are in balance with the stream energy dissipation requirements.

Agricultural Influence

Agricultural production right to the top of the streambank impacts the reach in some areas. Livestock grazing occurs near river mile 11.0, but it is managed and fenced away from the stream.

Anthropogenic Influence

The first 1.0 mile of the stream meanders through Hangman Valley Golf Course and a housing development to river mile 13.0. The banks throughout the golf course have been stabilized with riprap and softer bioengineering techniques. There are two spanning bridges within the golf course. Hangman Valley Road parallels the stream on the right bank and abuts the stream in one instance (river mile 11.5). A large residential development (Ridge at Hangman) is located upslope on the right bank. Nine residential homesites can be found in this reach, but most are located up and away from the flood plain.

Summary

This reach exhibits some areas of significant erosion whereas other areas are well vegetated and stable. A minor flood plain is accessible in some areas, but it lacks large woody debris and rock to dissipate high energy. The golf course and other development issues plague this reach and could result in further degradation.

Functional Rating

Functional-at-Risk (downward trend)

19.1 Sandy vertical banks

19.2 Waterline vegetation well established and maintained


19.3 Reach channel and riparian characteristics


19.4 Older eroded bank, re-established and stable

Reach 20: River Mile 10.5-8.1

Distance: 2.4 miles Date: 5-6-03

Geographic Description
This reach begins at river mile 10.5 and flows through an open valley bottom surrounded by forested slopes. It turns north through a series of small meanders that cut through the coarse, sandy, alluvial banks. The reach begins to parallel US Highway 195 at river mile 8.5. It then travels north a short distance and ends at river mile 8.1 (Hatch Road Bridge).

Riparian Vegetation
Riparian vegetation through this reach is abundant yet discontinuous. Small, scattered patches of riparian plant communities are established along the waterline of this reach. Plant establishment appears to be dictated by the degree of stabilization. Sites that have been hardened by stabilization projects exhibit vigorous vegetation and recruitment of young saplings. Willows (*Salix spp.*) are the most common, but thickets of Douglas hawthorn (*Crataegus douglasii*) are also present. Additionally, the toe of eroded banks in this reach has well-established vegetation (photo 20.1). A significant riparian community lies along the right bank at river mile 10.0 and is comprised primarily of box elder (photo 20.2). Mockorange (*Philadlephus lewisii*), and red-osier dogwood (*Cornus sericea*) are present in small homogeneous stands. Reed canarygrass (*Phalaris arundinacea*) is also dominant throughout the stream bottom in this reach.

Wildlife Observed
Waterfowl, Great blue heron

Geomorphological Character
The stream channel is mostly entrenched through this reach, with the exception of a few sites were meanders have developed point bars and small floodplains (photo 20.2). The channel morphology does not contain adequate characteristics to absorb or dissipate energy such as overflow channels, large woody debris, or rocks. Bank erosion is evident by large sandy bluffs, (photo 20.3). The encroachment of Highway 195 inhibits the lateral movement of the system, but the channel does appear to be vertically stable.

The sinuosity for Reach 20 is approximately 1.3. The sinuosity appears to be natural within the valley walls, except where cut off by roads. The gradient for the reach was approximately 0.0009. The width/depth ratio varies from 10 to 15 in most of the pools, but is well above 25 at the start of the reach. For the riffle areas, the width/depth ratio is usually near 10. Erosion along this reach is moderate to severe, and consisted of longitudinal vertical banks and sediment bluffs. The higher banks in this reach have minor slumping. The areas of longitudinal erosion have vertical banks with no vegetation. Several of the high sediment bluffs have large scree slopes of unconsolidated sediment at their bases. Most of the scree slopes in this reach are not in balance with the stream and supply large amounts of course sediment to the stream each year.

Agricultural Influence
Minor, passive forms of agriculture exist in this reach.

Anthropogenic Influence
The reach contains 5 rural residential homesites, but most are located away from the stream and active flood plain. Hangman Valley Road encroachment cutoff a portion of a meander near river mile 10.5 and US Highway 195 impacts the stream from river mile 8.4-8.1.

Summary
The reach contains a wide range of variability regarding bank stability and riparian vegetation. Similarly, some banks retain and support vegetation, while others do not. Impacts from road building have affected the meander belt and riparian plant communities. Chronic erosion persists throughout most of the reach.

Functional Rating
Functional-at-Risk (no apparent trend)


20.1 Willows establishing at toe of eroded bank


20.2 Box elder stands border the right bank


20.3 Point bar and flood plain development


20.4 High sandy bluffs deliver sediment to stream

Reach 21(A): River Mile 8.1-6.8

Distance: 1.3 miles Date: 5-6-03

Geographic Description

This reach begins at the Hatch Road Bridge (river mile 8.1) and flows through an open valley, bordered on the east by forested slopes and US Highway 195 to the west. It ends near the first meander of the Bridlewood development at river mile 6.8.

Riparian Vegetation

Riparian vegetation through this reach is relatively vigorous and abundant. Willows (*Sailx spp.*) are revegetating at the toe of tall sandy bluffs where riprap has been laid down to protect the banks from further erosion (photo 21.2). Patches of red-osier dogwood (*Cornus sericea*) and Douglas hawthorn (*Crataegus douglasii*) are common. The forested slopes provide adequate sources of large woody debris for recruitment to the stream banks.

Wildlife Observed

None observed

Geomorphological Character

US Highway 195 and hardened stream banks in this area impedes natural sinuosity and controls lateral movement. The stream channel is mostly entrenched, with the exception of a few points were meanders have created point bars and a small flood plain is being developed. However, the stream has no frequent access to an active flood plain. The channel morphology does not contain adequate characteristics to absorb or dissipate energy. The channel constraints have increased the gradient in this reach. The channel is laterally unstable but vertically stable in most areas. Bank erosion is extensive and evident by large sandy bluffs. These bluffs provide significant amounts of bedload during high flow events.

The sinuosity for Reach 21A is approximately 1.3. The sinuosity is constrained by Highway 195, and only a single large meander prevents the sinuosity from being 1.1 or 1.0. The gradient for the reach is approximately 0.0012. The width/depth ratio varies from 10 to 15 in some of the pools, but is well above 25 at the start of the reach. The high width/depth ratio reflects the input of large amounts of sediment from the upstream scree slopes. For the riffle areas, the width/depth ratio is usually near 10. Erosion along this reach is moderate to severe, and consisted mostly of sediment bluffs. The banks along Highway 195 are generally armored to reduce erosion. Several of the high sediment bluffs have large scree slopes of unconsolidated sediment at their bases. Most of the scree slopes in this reach are not in balance with the stream and supply large amounts of course sediment to the stream each year. A few of the scree slopes are re-vegetating at this time.

Agricultural Influence

No agricultural influences.

Anthropogenic Influence

The reach passes under Hatch Road at river mile 8.1. Riprap has been placed at the toe of the banks in several areas to prevent channel migration. US Highway 195 constrains small portions of the channel on the left bank.

Summary

This reach is not in balance with the energy of the system. The highway prevents migration of the channel on the left bank and riprap placement prevents migration on the right bank. The channel continues to move out laterally where possible and causes excessive erosion.

However, the hardened banks do allow the riparian shrubs to establish at the toe of the slopes. Vigorous growth can be found in several areas, but there is not enough to dissipate the energy of high flow events.

Functional Rating

Functional-at-Risk (upward trend)

21A.1 Entering Reach 21A

21A.2 Highway encroachment along left bank

21A.3 Riprap and willows along toe

21A.4 Channel and riparian characteristics

<u>Reach 21(B):</u> River Mile 6.8-5.8

Distance: 1.0 miles   Date: 5-6-03

<u>Geographic Description</u>
This reach extends from the Bridlewood development to the beginning of the Qualchan Golf Course at river mile 5.8.

<u>Riparian Vegetation</u>
Riparian vegetation through this reach is relatively vigorous and continuous. Willows (*Sailx spp.*), red-osier dogwood (*Cornus sericea*), and Douglas hawthorn (*Crataegus douglasii*) are common. The forested slopes provide adequate sources of large woody debris for recruitment to the stream banks. A majority of the reach has adequate vegetative establishment to dissipate high flow events. Bedrock can be found in some areas.

<u>Wildlife Observed</u>
Waterfowl

<u>Geomorphological Character</u>
The beginning of this reach is a truncated meander (caused by the location and riprap placement associated with US Highway 195). Accelerated flows have resulted in some erosion throughout the reach. The stream channel is mostly entrenched, with the exception of a few points were meanders have created point bars and a small flood plain is being developed. The stream has frequent access to areas that provide an active flood plain. The channel morphology does contain some characteristics to absorb or dissipate energy (bedrock and root systems). The channel exhibits areas of laterally instability but appears to be vertically stable. Bank erosion is minor/moderate (one large sandy bluff and one large area of bank erosion).

The sinuosity for Reach 21B is approximately 2.7, the highest measured. The high sinuosity for this reach is from the fact that the entire reach is a single large meander within the stream system. The sinuosity appears to be natural within the valley walls, and is controlled by bedrock in several areas. The gradient for the reach is approximately 0.0019. The width/depth ratio varies from 10 to 15 in most of the pools. For the riffle areas, the width/depth ratio is usually near 10. Erosion along this reach is moderate, and consisted of one or two longitudinal vertical banks. The areas of longitudinal erosion have vertical banks with no vegetation.

<u>Agricultural Influence</u>
No agricultural influences.

<u>Anthropogenic Influence</u>
The reach flows around the Bridlewood development. The landowners maintain small backyards and a moderately sized natural buffer to the stream. Bank hardening has occurred in some areas and more may be required in the future to prevent channel migration and flooding damage. One bridge (entrance to Qualchan Golf Course) exists in this reach.

Summary

The reach has a relatively vigorous and continuous riparian corridor. The vegetation that exists is capable of withstanding high flow events and provides good habitat. However, there are sites of accelerated erosion due to meander restriction and bank hardening. The flood plain is accessible in some areas, although the bridge restricts flood conveyance to some extent.

Functional Rating

Proper Functioning Condition (with areas of Functional-at Risk)

21B.1. Active flood plain and vegetation

21B.2. Riparian vegetation and rock

21B.3. Erosion on right bank

21B.4 Stable, vegetated banks

21B.5. Root mass

21B.6. Protected toe of bank

Reach 21(C): River Mile 5.8-2.0

Distance: 3.8 miles Date: 5-6-03

Geographic Description
This reach begins at the upstream end of Qualchan Golf Course (river mile 5.8) and ends upstream of Vinegar Flats (river mile 2.0).

Riparian Vegetation
The riparian vegetation in this reach is discontinuous, but has several large areas that support vigorous communities. Many of the point bar formations contain young recruitment of cottonwoods and willows. Areas bound by riprap tend to have well-established woody vegetation. Willows (*Sailx spp.*) are re-vegetating the toe of several tall sandy bluffs where riprap has been laid down to protect the banks from further erosion. Isolated stands of red-osier dogwood (*Cornus sericea*) and Douglas hawthorn (*Crataegus douglasii*) are common. A vigorous and diverse stand of riparian forest exists at river mile 3.1. Cottonwoods (*Populus trichocarpa*) , box elder (*Acer spp*.), alder (*Alnus spp*.), willow and hawthorn are found within this site.

Wildlife Observed
Waterfowl

Geomorphological Character
The majority of the reach is entrenched. The construction of US Highway 195 (channel straightening), bank hardening projects, and meander cutoffs have constrained the channel. This has resulted in streambed lowering, channel widening (severe erosion in some areas), and channel aggradation (river mile 3.4 – river mile 4.3). The channel is laterally unstable, but the majority of the reach appears to be vertically stable (rock).

This reach does not contain adequate natural characteristics to absorb or dissipate energy. Erosion is extensive and evident by large sandy bluffs and vertical banks.

The sinuosity for Reach 21C is approximately 1.3. The sinuosity appears to be natural within the valley walls, except where cut off by roads, constrained by bridges, or diked (just upstream of Vinegar Flats). The gradient for the reach is approximately 0.0032. The width/depth ratio varies from 10 to 15 in most of the pools, but is above 20 in some areas of the reach. For the riffle areas, the width/depth ratio is usually near 10. Erosion along this reach is moderate to severe, and consisted of longitudinal vertical banks and sediment bluffs. The higher banks in this reach have minor slumping. The areas of longitudinal erosion have vertical banks with no vegetation. Several of the high sediment bluffs have large scree slopes of unconsolidated sediment at their bases. Most of the scree slopes in this reach are not in balance with the stream and supply large amounts of course sediment to the stream each year.

Agricultural Influences
No agricultural influences throughout this reach

Anthropogenic Influences

The reach is highly impacted by road construction and riprap confinement. Several large – scale bank hardening projects have prevented natural sinuosity. Urban development, a golf course, and structures abut the stream throughout the reach (5 bridge crossings). A USCE dike is present at river mile 3.0.

Summary

This reach is highly constrained by road construction and riprap placement. Riparian vegetative communities do exist, but are often discontinuous and/or limited in extent. Although the reach is impacted by multiple factors, the riparian communities have established in many areas and provide some benefits despite their limited potential. (Eg. The toes of large eroded stream banks and point bar formations have good recruitment of young woody species. Access to the flood plain occurs in many areas.

Functional Rating

Functional-at-Risk (no apparent trend)

21C.1. Severe erosion (river mile 3.8)

21C.2 Point bar recruitment

21C.3 Willow recruitment along toe

21C.4 Large sandy bluff (river mile 4.4)

Reach 22: River Mile: 2.0-0.0

Distance: 2.0 miles Date: 5-6-03

Geographic Description

This reach flows through the Vinegar Flats community and into a narrow valley bordered by high, basaltic bluffs along the left bank and sloping hills or flats along the right. It runs under the Interstate 90 Bridge and railroad trestle bridge just before entering High Bridge Park near the confluence of the Spokane River. The stream flows swiftly through this reach passing by residential sites, basalt outcroppings and bridge abutments.

Riparian Vegetation

The riparian area for this reach has naturally limited potential. The steep, basalt bluffs along the left bank prohibit the establishment of an extensive riparian community. However, the right bank does not achieve its potential in some sections due to roads and development. Still, riparian vegetation through this reach is relatively continuous and vigorous where it occurs. Willows (*Sailx spp.*) and cottonwoods (*Populus trichocarpa*) are common, especially where riprap has been laid down to protect the banks from erosion and thus creating a stable environment for tree establishment. The construction of roads and bridges through this area have constrained the reach.

Wildlife Observed

Great blue heron, kingfisher

Geomorphological Character

The first section of this reach flows through Vinegar Flats community where the channel has been straightened and reinforced by riprap to protect property from lateral movement of the stream. It does not have frequent access to the flood plain. The channel is bedrock controlled and is vertically stable. Erosion is not a problem in this reach as rocks and vegetation provide adequate structure to dissipate energy.

The sinuosity for Reach 22 is approximately 1.0. The sinuosity is controlled by the bedrock and development within Vinegar Flats. The gradient for the reach is approximately 0.0033. The width/depth ratio varies from 10 to 15 in most of the pools. For the riffle areas, the width/depth ratio varies from five to 10. Erosion along this reach is low, and consists of longitudinal vertical banks and sediment bluffs in the lower reach downstream of the I-90 overpass. One high sediment bluff near the confluence with the Spokane River has a large scree slope of unconsolidated sediment at its base.

Agricultural Influence

None

Anthropogenic Influence

Residential community (Vinegar Flats), 4 bridges

Summary
Because this reach exhibits adequate plant communities for its potential, and shows no evidence of massive erosion, it is determined to be functional. However, based on the proximity to roads, development, the amount of riprap, and the swift current of this reach, it is determined to be at extreme risk to further degradation therefore rated with a downward trend in functionality. It should be noted that risk to degradation is inherent in this reach based on the confinement of the system by artificial means. Photo 22.2 is representative of channel and riparian characteristics for Reach 22

Functional Rating
Proper Functioning Condition


22.1 Riprap and vegetation


22.2 Reach channel and riparian character

Appendix J

Historic Vegetation Report

Pre-Settlement Vegetation of the Hangman Creek Watershed

(DRAFT)

June 26, 2003

Sponsored by

The Spokane County Conservation District

The Hangman Creek Watershed Planning Unit (WRIA 56)

Introduction and Background Information

The degraded water quality observed throughout the Hangman Creek watershed raises questions regarding the historical conditions of the watershed. The water quality problems associated with high peak flows and low summer flows compound the water quantity issues in the watershed. There is a common perception that summer water levels were significantly higher in the past, but have fallen throughout the 20th century due to human impacts in the watershed. This investigation provides an assessment of the historic condition of the native vegetative cover and estimates how changes in land use throughout the watershed have influenced the overall water availability and soil loss.

Pre-settlement watershed conditions were evaluated using historic plant community cover as described in early section line surveys. The section line surveys were part of the Public Land Survey System (PLSS) conducted under standards set forth in the 1785 Land Ordinance (BLM, 2003). The rectangular survey system, also know as the cadastral survey, subdivided public lands into townships, ranges, and sections across the western United States.

The original land surveys of Washington were conducted by the Surveyor General's Office in Olympia, WA during the late 19th Century. Similarly, surveys of the Idaho portions of the watershed were supervised by the Surveyor General's Office in Boise, ID in the early 20th Century. Copies of the surveyor notes and plats (maps) are stored at the Cadastral Survey's office on microfiche at Bureau of Land Management regional offices throughout the United States.

Surveys established each Township into six-mile squares. Each township has 36 square miles, and each square mile is called a Section. Surveyors walked each six-mile township boundary line and each one-mile section line. They recorded observations in their field notes, and drew plats and designated boundaries along the line walked. In general, most surveyors' field notes included descriptions of vegetation, landforms, soil type, water availability, and suitability for settlement. These qualitative descriptions of vegetation found in the field notes, along with the hand drawn plats, were used to estimate the historic vegetation cover for the Hangman Creek watershed. The information from the original PLSS was gathered and processed in ArcView 3.2 GIS.

Native vegetative cover in the watershed was once a combination of various shrub/steppe and forested habitat types. These habitat types were described by Daubenmire (1942, 1970) and Daubenmire and Daubenmire (1968). The Palouse bioregion, which composes those plant communities indicative of forming on loessal soils, is now listed as one of most endangered ecosystems in the United States. The onset of settlement in the Palouse region of southeast Washington has resulted in widespread conversion of native prairie and forested lands to agriculture (Black et. al.). This conversion has resulted in the loss of wildlife habitat and native biological diversity for the region.

Alteration of land cover combined with other cumulative effects has contributed to water quality concerns and may directly influence the water availability in the watershed. For example, forest removal can increase peak flows and contribute to valley flooding (EPA, 1991). Activities such as channelization, removal of riparian vegetation, grazing, road building and increasing urbanization has influenced the water quality and quantity.

Hangman Creek has been listed on the Washington State Department of Ecology 303(d) list of impaired waterways for exceedences of high temperature, pH, and fecal coliform bacteria. These water quality issues are further influenced by high sediment concentrations from nonpoint sources, lack of adequate riparian vegetation cover, and extremely low summer flows (SCCD, 1994).

The degradation in water quality raises questions about the historical conditions of the watershed. Based on accounts from Native Americans and early settlers, the watershed at one time supported a salmon fishery. Recent federal Endangered Species listing of five native salmonids found in Washington waterways has the restoration of fish habitat throughout the Northwest a top priority. After the completion of the Grand Coulee Dam in 1942, anadromous salmon were no longer able to migrate and spawn in Hangman Creek. However, recent studies by Eastern Washington University have located small populations of resident redband trout in the tributaries of Hangman Creek. This finding, coupled with the changes in peak floods and low summer flows, brings added attention to water quantity issues in the watershed. There is a common belief that water levels have fallen due to human impacts in the watershed. This report provides an assessment on the historic condition of the native vegetative cover.

Assumptions necessary to use the PLSS

The information contained in the PLSS is qualitative and was sometimes difficult to interpret. Surveyors often used different terminology to describe common plant species and other observations. The vegetative communities and individual species listed in the notes often required interpretation because the surveyors did not use uniform vegetation information. The surveyors did not typically provide detailed accounts of species abundance or use scientific names. Loose terminology, and/or vernacular were often used to describe vegetation. Similarly, handwriting on both the plats and in the notes was sometimes not very clear.

The Washington State surveys ranged from 1869 to 1880, and are considered by the BLM to be the first official surveys for the area. It was assumed that the vegetation observed by surveyors was native and that the conversion to agriculture and the introduction of non-native plants was not yet widespread. Settlements were cited as early as 1870, but the largest farm recorded at that time was approximately 55 acres in T 25 N, R 42 E, sec. 23 & 26.

The earliest reliable Idaho State surveys available for this project ranged from 1903 to 1906. Earlier Idaho surveys were considered fraudulent by the BLM. Settlement was widely expanding into Idaho by this time. Inferences of historical vegetative communities were based on topography and available field notes describing the surrounding landform and plant species. The GIS maps reflect some settlements in Washington, whereas the Idaho settlements were changed to estimates of the original vegetation.

Vegetative Community Delineation

Vegetation types described by the surveyors were categorized into seven major groups based on plant communities and dominant landforms. The categories included:

- Bunchgrass prairie
- Open Ponderosa pine and grasses
- Open Ponderosa pine on rocky surface
- Wetland or lake
- Evergreen forest
- Cottonwood, alder, or willow groves
- Cultivated

In most cases, surveyors wrote a summary labeled "General Description" for each section. The general descriptions, notes, and plats were used to assign the plant community type for each section. The vegetative communities in each section were adjusted using the features and landforms on the surveyor's plat. GIS tools were utilized to produce a historical vegetation map (Figure 1) and to calculate the area of each vegetative community. These areas were further divided into five sub-watersheds (Table 1) to re-calculate a historical water balance similar to the work conducted by Buchanan and Brown (2003).

Table 1: Historic Vegetation Coverage for the Hangman Creek Watershed

	Vegetation Area by Sub-watershed (acres)					
Vegetation Types	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	Watershed Total
Bunch grass Prairie	110,236	13,650	8,999	33,257	662	166,803
Open Ponderosa Pine with grasses	32,295	24,175	22,798	40,365	8,554	128,186
Open Ponderosa Pine on rocky surface	3,583	4,058	6,546	239	449	14,875
Wetland or Lake	0	645	1,995	0	0	2,640
Evergreen Forest	67,976	2,734	0	39,821	6,276	116,796
Cottonwood, alder, or willow groves	172	570	0	908	0	1,650
Cultivated	135	114	22	0	0	271

Notes:

1. Several categories, such as wetlands and lakes, were not originally recorded within several sub-watersheds. This may be a result of details provided by different surveyors and does not infer that they did not exist.
2. The bunchgrass prairie vegetative cover included areas defined as shrub steppe.

Methods

Interpreting the PLSS

Interpreting handwriting and terminology was difficult at times. For example, many recorded what they called "sunflowers". These were most likely *Balsamorhiza sagittata* or arrowleaf balsamroot. Despite the vague and obscure descriptions, the size and species of important overstory trees were recorded. The overstory trees included two trees at each quarter section marker and section corners, trees that served as guide trees for directional bearings, and any trees directly on the section line. This provided the dominant species for an area and possible habitat types and plant associations. In addition to vegetation descriptions, other landmarks such as "Indian" trails, pioneer roads, creeks, springs, settlements and farms were recorded and labeled on the plats.

Since surveyors used non-uniform descriptions for the vegetation, the interpretation of observed species was based on plant names provided by the surveyors and referenced to their occurrence for a given habitat type found in the area as described by Daubenmire (1970). Names given to a plant not found in this region were correlated to a local species within the same genus or family. Such was the case for "buck brush", a common name for a species found in the South and Midwest United States of the same genus as the common snowberry (*Symphoricarpus albus*). A species list, interpretation of terms used for the plant observed by surveyors, and comments relating to the plants observed can be found in Table 2.

Water Balance

The current water balance for the Hangman Creek watershed incorporated precipitation and ET rates for existing vegetation based on land uses supplied by the USGS. The water balance provided an estimate of how much water (surplus) is available for infiltration to groundwater systems or as surface run-off measured by the USGS. A surplus of 192,854 acre-feet per year was estimated for the entire watershed using data provided by Buchanan and Brown (2003). The same method was then used to predict a water balance for pre-settlement conditions using the historic vegetation map. Table 3 lists the vegetation categories and the corresponding ET values that were used in the historic water balance.

Results and Discussion

Pre-settlement Vegetation Cover

The map in Figure 1 represents the estimated vegetative cover for the Hangman Creek watershed prior to mass settlement. Large changes have occurred in the conversion of prairie/grasslands and open Ponderosa pine communities to agriculture. Table 4 lists the total acres by vegetation types for each sub-watershed based on the PLSS.

Pre-settlement Vegetation Cover of Hangman Creek Watershed (based on PLSS)

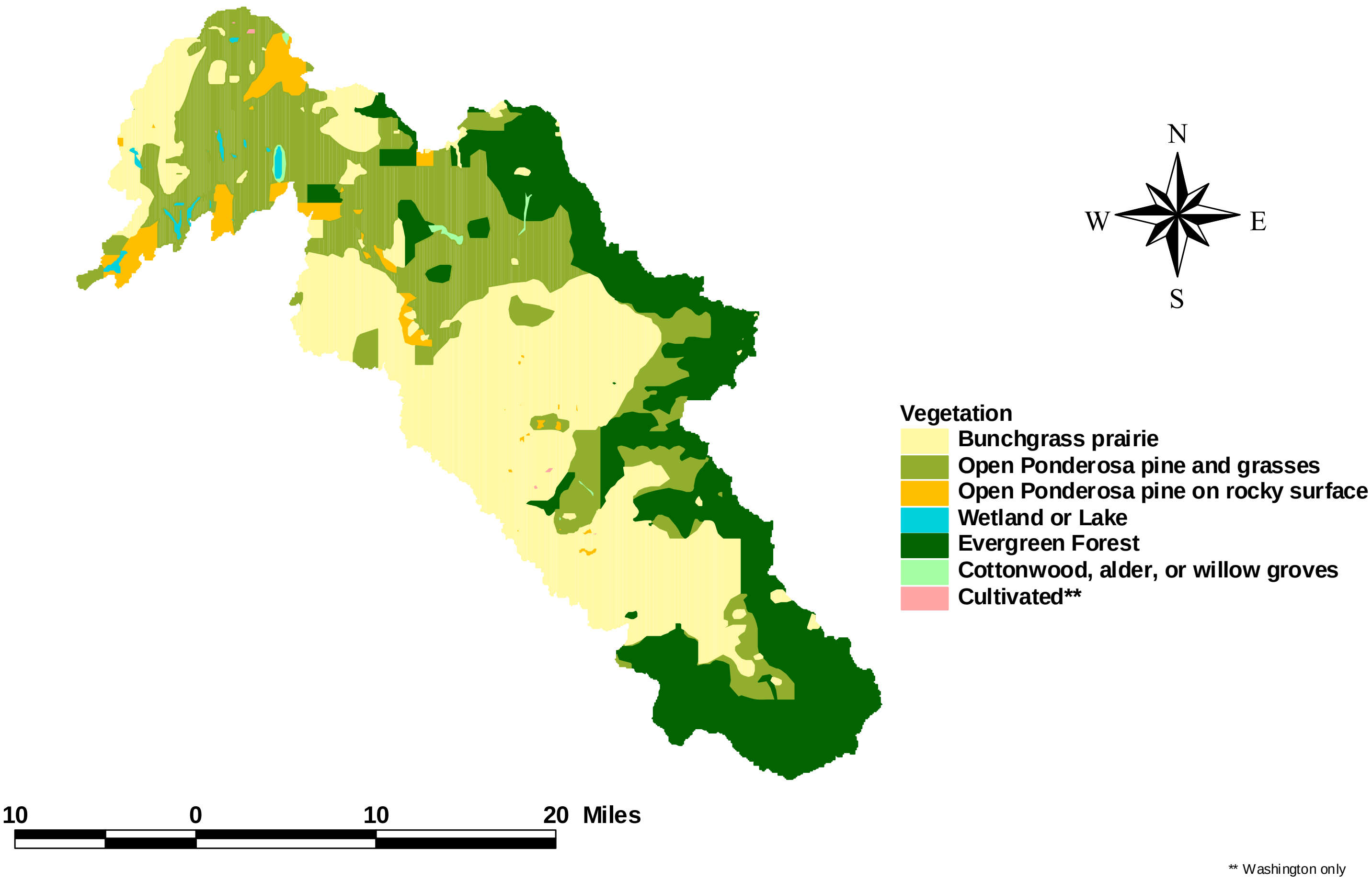


Figure 1.0

The historical vegetative communities in the Hangman Creek watershed prior to settlement were significantly different than today (Table 5). The watershed was primarily covered with rolling hills of bunchgrass prairie that extended into scattered populations of Ponderosa pine (*Pinus ponderosa*) forests. The Ponderosa pine communities often included a shrub understory such as snowberry (*Symphoricarpus albus*) and wood's rose (*Rosa woodsii*).

Table 2: Public Land Survey Terms and Descriptions

Original Vegetation Type	**Description**	**Comments**
Rolling prairie	Native bunchgrasses with or without shrubs	Surveyors often used the term "rolling prairie" to describe rolling grasslands that were easily cultivated and often cited "prairie soil", "1st rate soil", or "black loam", thus indicating prairie/grasslands.
Open Ponderosa pine	Open or scattered stands of Ponderosa pine with variable understory of grasses, shrubs, and herbs	Surveyors used the term "Yellow Pine" and often referred to these areas as "scattering timber".
Open Ponderosa on rocky substrate	Open Ponderosa pine on rocky scabland	Surveyors often referred to this area as "scattering timber and rocky". It is delineated from the Open Ponderosa pine vegetation type because it was not farmable and considered to be "grazing land" and not suitable for farming.
Wetland or lake	Standing, perennial water and/or wetland	Surveyors often used terms like "marsh", "swamp", "bog", or "lake" to describe these sites. These are not well documented.
Mixed Conifer	Closed canopy forest composed of two or more conifer species.	Surveyors often used the term "heavy forest" and listed multiple species including fir, tamarack, pine, cedar, and hemlock.
Willow, alder, cottonwood, or aspen	This includes any area where willows, alder, cottonwood, or aspen were prominent	These areas were not well documented by most surveys, but did occur and were recorded to some extent.
Level prairie	Bunchgrass prairie	Surveyors often used the term "level prairie" when the land was not rolling and easily tilled.
Cultivated	Any area that had been farmed	Surveyors recorded the presence of a few farms early as 1870.

Table 3: Historic Vegetation Evapotranspiration Rates

Vegetation Type	Evapotranspiration Rate (inches)
Bunchgrass prairie	11
Open Ponderosa pine	17
Open Ponderosa pine on rock	17
Wetland or lake	47
Mixed conifer	22
Cottonwood, alder, aspen, willow	40
Cultivated	16
Notes: Evaportransporation rates based on Buchanan and Brown (2003)	

Table 4: Historic Vegetation Coverage for the Hangman Creek Watershed

	Area of Vegetation Types by Watershed (acres)					
Vegetation Types	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	Hangman Creek
Bunchgrass Prairie	110,236	13,650	8,999	33,257	662	166,803
Open Ponderosa Pine	32,295	24,175	22,798	40,365	8,554	128,186
Open Ponderosa Pine on Rock	3,583	4,058	6,546	239	449	14,875
Wetland or Lake	0	645	1,995	0	0	2,640
Mixed Conifer Forest	67,976	2,734	0	39,821	6,276	116,796
Cottonwood, alder, aspen, or willow	172	570	0	908	0	1,650
Cultivated	135	114	22	0	0	271

The streams, springs and drainages were densely vegetated with various shrubs and small trees including; hawthorn (*Crataegus*) willows (*Salix*), aspen and cottonwood (*Populus*), alders (*Alnus*), serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*). Higher elevations, canyon lands, and northern aspects supported a mix of coniferous forest species including Western Larch (*Larix occidentalis*), Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmanni*), Western hemlock (*Tsuga heterophylla*), and Western red cedar (*Thuja plicata*).

Table 5: Land Use Changes in Hangman Creek (approximately 1870 to 2003)

Sub-watershed	Land Use	Land Uses: Pre-settlement (acres)	Land Uses: Current (acres)	Net Change (percent)
California Creek	Agriculture	0	8,801	NA
	Developed	0	332	NA
	Forested	15,257	3,687	(-)75.8
	Rock/Transitional	0	41	NA
	Shrub/Steppe	662	3,018	(+)357
	Wetland or Lake	0	29	NA
Lower Hangman	Agriculture	114	13,697	(+)11,915
	Developed	0	6,554	NA
	Forested	30,820	8,329	(-)73.0
	Rock/Transitional	0	103	NA
	Shrub/Steppe	13,547	16,730	(+)23.5
	Wetland or Lake	1,207	193	(-)84.0
Marshall Creek	Agriculture	21	10,624	(+)50,490
	Developed	0	2,243	NA
	Forested	28,655	13,906	(-)51.5
	Rock/Transitional	0	338	NA
	Shrub/Steppe	8,706	11,032	(+)26.7
	Wetland or Lake	1,930	919	(-)52.4
Rock Creek	Agriculture	0	92,634	NA
	Developed	0	1,524	NA
	Forested	81,062	11,181	(-)86.2
	Rock/Transitional	0	98	NA
	Shrub/Steppe	33,058	8,324	(-)74.8
	Wetland or Lake	902	73	(-)91.9
Upper Hangman	Agriculture	133	149,750	(+)112,494
	Developed	0	2,798	NA
	Forested	102,935	45,335	(-)56.0
	Rock/Transitional	0	1,128	NA
	Shrub/Steppe	109,404	12,271	(-)88.8
	Wetland or Lake	169	140	(-)17.2

Notes:
1. Agriculture is historic cultivated.
2. Developed and rock/transitional have no historic equivalent.
3. Forested is historic open Ponderosa pine, Ponderosa pine on rocks, and mixed conifers.
4. Shrub steppe is historic bunchgrass prairie.
5. Wetland or lake is historic wetland or lake and alder, cottonwoods, aspen, or willow groves.

Agriculture has become the dominant land use for the watershed at over 275,000 acres. This is approximately the pre-settlement prairie and forested areas combined. Overall forestland cover reductions average between 50 to 75 percent for the sub-watersheds with the exception of Rock Creek (approximately 86 percent). The harvest and conversion of these of forested areas, especially in headwater tributaries, probably had significant impacts to the hydrology of the watershed.

The base flow of Hangman Creek may have been affected by the early land use conversions at the turn of the century. Actual increases of base flows following the removal of forested land have been reported in many different studies (Bates and Henry 1928; Troendle 1983; Van Haveren 1988). However in arid environments with high evapotranspiration rates, such as eastern Washington, these increases may be more dependent upon sufficient summer precipitation.

Local watershed residents have reported that summer flows during the 1940 and 50s were much higher than what is currently observed (SCCD, 1998). This may have been a response to the clearing of forest canopies throughout the watershed. For the months of July through October (1948 – 1959), the USGS records indicate that the average monthly flow was never less than 12 cfs. However, based on the USGS low flow statistics, during the critical base flow period (July – October) for Hangman Creek, there is a 50 percent probability that the 30-day low flow will be less than 12 cfs.

Historical Water Balance

The historical water balance was developed through the application of the pre-settlement vegetative communities for each sub-watershed. The same methodology used by Buchanan and Brown (2003) was applied to calculate a new water balance. The most significant adjustment to the calculation, besides the vegetative cover, was the new evapotranspiration (ET) rates.

The ET rates of pre-settlement times were, on average, greater than the current rates due to the amount and density of the vegetation. One of the major current vegetation land uses is small grains. Small grains have ET rates of approximately 11 inches per year, whereas the previously existing forested areas had ET rates ranging between 17 and 22 inches per year. This change in vegetation type results in an increased water surplus because less water is currently taken up and used by the vegetation than in historic times.

The historical water balance suggests that there was less water during pre-settlement times than what is seen today. The current estimated watershed surplus is 192,854 acre-feet per year. The historical water balance calculations indicated a surplus of only 152,773 acre-feet per year (Table 6). A 40,000 acre-feet per year difference is probably minor, but this data strongly suggests that there was less water historically than there is today.

The increased moisture surplus seems reasonable when one looks at the land use changes that have occurred. In the Hangman Creek watershed, thousands of acres of forest canopy have been lost. This likely resulted in a substantial reduction of snow and rain interception. However, the rate of snowmelt would be increased. The additional snowpack accumulation and the frequent rain on snow events would melt the snow faster and substantially increase the size of peak flows in major flood events. It is during these major storm events that Hangman Creek suffers severe stream bank and channel damage along with significant sediment transport.

In December of 1996 and January of 1997, heavy snowfall and rains triggered successive flooding events that severely impacted Hangman Creek. The 1997 event recorded a flow of over 21,000 cfs. This was the peak flood of record. The small towns, residential homes, golf courses, and businesses within the floodplain experienced extensive damage. The damage costs for these two recent events totaled over three million dollars.

Sediment transport through the Hangman Creek system is significant, especially during extreme flood events. A cooperative study by the SCCD and USGS (1998-2001) estimated annual sediment discharge (suspended and bedload) ranging from 4,740 to 189,000 tons. The SCCD also estimated the total sediment load from 1906 to 1996 to be approximately 27.6 million tons. These studies illustrate the magnitude of water quality problems in the watershed.

Table 6: Historic and Current Water Balance Parameters and Surplus

Water Balance Sub-Watershed Parameter	Sub-Watershed					Total Hangman Watershed
	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	
Area (acres)	214,383	45,947	40,359	114,590	15,942	431,221
Precipitation (inches)	22.3	17.8	17.4	19.6	19.9	NA
Historic ET (inches)	15.5	16.2	17.1	17.2	18.7	NA
Current ET (inches)	14.9	15.9	15.6	14.7	19.5	NA
Historic Surplus (acre-feet per year)	121,168	6,051	860	23,125	1,569	152,773
Current Surplus (acre-feet per year)	132,203	7,275	6,054	46,791	531	192,854
Change in Surplus Historic to Current (acre-feet per year)	11,035	1,223	5,194	23,666	-1,037	40,081

Notes:
1. ET is evapotranspiration.
2. NA is not applicable.
3. Evapotranspiration is a weighted value based on percentage of vegetation type for each sub-watershed.

Soil Erosion and Possible Changes in Erosion Rates

The evaluation of historic soil erosion was done using the NRCS Revised Universal Soil Loss Equation (NRCS Field Office Guide Book). This equation is usually used to predict soil loss from different farm practices and crop rotations. The historic soil loss was based on changes that would affect different factors in the soil loss equation and historic erosion rates. The final estimation of soil loss is based on a percentage of current possible losses.

A percentage is used because the actual RUSLE soil losses for the entire watershed cannot be estimated. The factors that would change in the equation and how the predicted soil losses would also change can be evaluated. The soil loss equation is:

A = RKLSCP, where

A is the computed soil loss per unit area, usually expressed in tons per year
R is the rainfall and runoff factor
K is the soil erodibility factor
L is the slope-length factor
S is the slope-steepness factor
C is the cover and management factor
P is the support practice factor

Of all these factors, R, K, L, and S will be approximately the same for both current and pre-settlement conditions. The only conditions that would change are the cover and management conditions and the support practice factors. When these are evaluated, it is assumed that pre-settlement conditions would have been most like the no-till/low-till grass conditions with support practices better than contour farming. The assumed historic conditions are evaluated against current conditions of winter wheat, fallow, peas and spring grain crop rotations with support practices of up and down hill and contour farming.

For the cover and management factor C, the percent decrease in soil loss is approximate:

Percent of current soil loss for C factor = (0.01/.10)*100 = 10 percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

For the support practice factor P, assuming the pre-development conditions would be approximately half of the contour-farming factor. The current P factor is based on the average of up and down hill and contour farming (approximately 0.70). The percent decrease in soil loss is approximately:

Percent of current soil loss for P factor = (0.25/.70)*100 ≈ 37 percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

The total estimated soil loss would be approximately the reduction in C times the reduction in P, or

Total percent of current soil loss = (10 percent)(37 percent) = (0.10)(0.37) ≈ 4 percent of the current soil loss from farmland.

This represents a decrease in soil loss rates of approximately 96 percent. Using the PSIAC estimated soil loss from farmland (SCCD, 1994) for the entire Hangman Creek watershed of 176,000 tons, the pre-settlement non-bank erosion soil loss is estimated to have been approximately 7,000 tons per year. As a check on the validity of this estimation, during recent suspended sediment measurements, the suspended sediment measured by the USGS for water year 2001 was less than 3,500 tons. The 2001 overland flow conditions probably reflect conditions similar to the overland flow on the pre-settlement watershed vegetation as outlined by the section line surveyors.

Another factor resulting in the net increase of water availability may be the effects from the past removal of riparian vegetation. The removal of streamside areas that were once composed of woody, wetland species presumably sequestered and transpired water at a high rate. The removal of vegetative communities may contribute to the current increase in water surplus. This analysis did not reflect the historic condition of riparian vegetation or its conversion to other uses. However, the removal of riparian vegetation along the creeks was a widespread practice of early farmers that was encouraged by the Soil Conservation Service around World War II (Edelen and Allen, 1998).

Current Land Use within the Historic Extent of Prairie (shrub/steppe) Vegetation in Upper Hangman Sub-Watershed

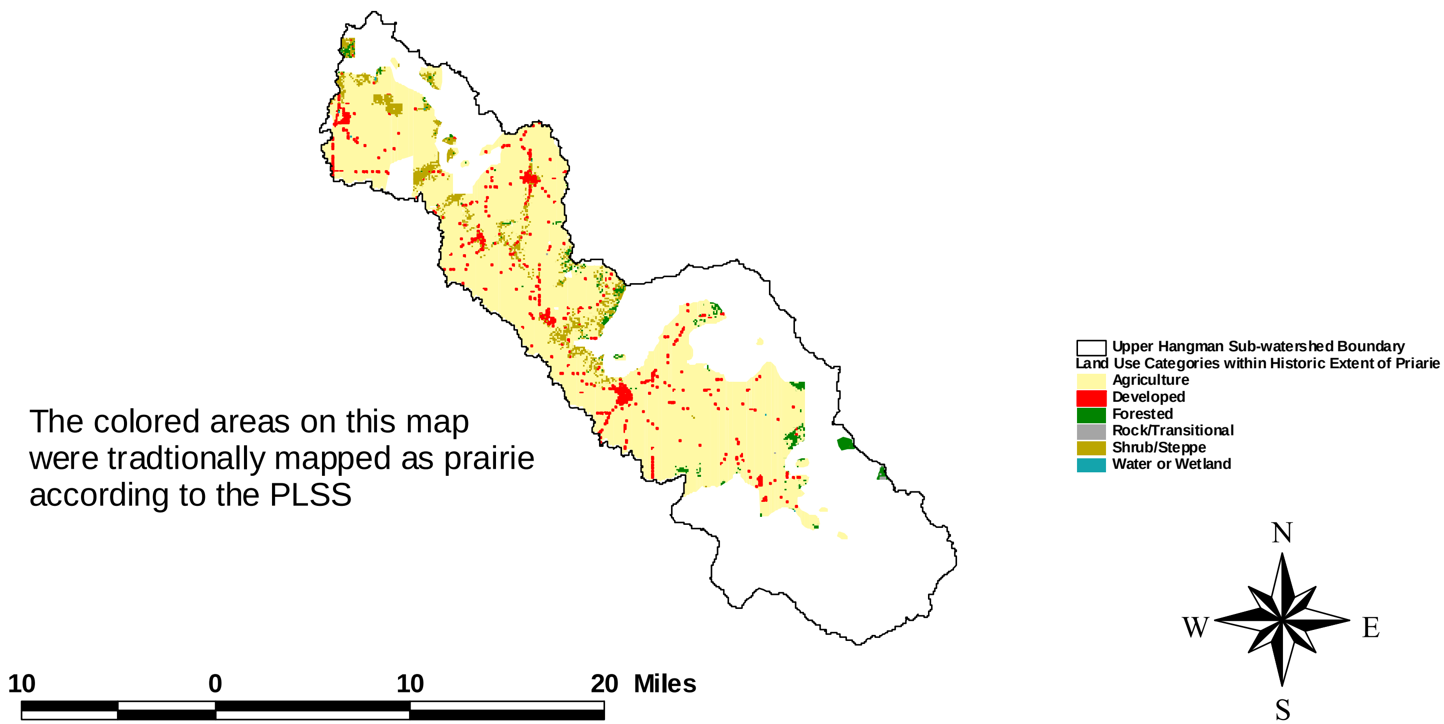


Figure 2

Species list and interpreted terms for plants observed by surveyors

Terms used by Surveyors	Species list as interpreted by SCCD	Comments on observations
"sunflowers"	Arrowleaf balsamroot Balsamorhiza sagittata	Often found in association with Ponderosa pine or bunchgrass prairies
"weeds"	Any herbaceous understory plant	Surveyors who used the term "weeds" did not elaborate on species, use a common names, or describe these plants
"buck brush"	Common snowberry Symphoricarpos albus	"buck brush" is a common name for a similar species found in the southern Midwest of the US that surveyors may have been more common with. They often found this in forested hills of Idaho and grasslands of Washington
"pine grass"	Pine reedgrass Calamagrotosis rubescens	Noted amidst pine stands and prairies
"bunchgrass"	Bluebunch wheatgrass Pseudorogeneria spicata or Idaho fescue *Festuca Idahoensis*	Found in prairies and as dominant understory in many forested communities described by surveyors
"rye grass"	Basin wild rye *Leymus cinereus* or *Lolium spp.*	Rye grass is mentioned is association with other grasses
"service"	Serviceberry Amelanchier alnifolia	Commonly found in grassland and forested communities
"tamarack"	Western larch *Larix occidentalis*	Tamarack is the common name for Eastern larch (*Larix laricina*) found in the Northeastern US and was presumably observed as the same species
"rose"	Nutka rose *Rosa nootkana* or Pearhip rose *Rosa woodsii*	Found in prairies and forested communities
"willow"	*Salix spp.* Or *Scouler willow* Salix scouleriana	Willows were found in both ravines or streams and in forested, upland communities. When found in the upland situation, it is assumed to be Scouler willow
"cherry"	Choke cherry *Prunus virgiana* or Bitter cherry *Prunus emarginata*	Cited as an understory plant in forested communities
"thornbush" or "thicket"	Douglas hawthorn (*Crataegus douglasii*)	Often describe as being in ravines, which is characteristic of Douglas hawthorn

Terms used by Surveyors	Species list as interpreted by SCCD	Comments on observations
"maple"	Rocky mountain maple *Acer glabrum*	Observed in forested communities as understory
"yellow pine"	Ponderosa pine *Pinus ponderosa*	Yellow pine is an accepted common name for Ponderosa pine. Old growth Ponderosas were often referred to as "yellow bellies" by pioneers because of the yellowish bark found only on old, large trees.
"red fir" or "fir"	Douglas fir *Pseudostuga menziesii*	Found in association with Ponderosa pine and in mixed forests in the upper watershed
"white fir"	Grand fir *Abies grandis*	Found mostly in the Idaho portions of the upper watershed
"white pine"	Western white pine *Abies monticola*	Once abundant in northern Idaho, but populations were decimated by white pine blister rust in the early 1900s
"black pine"	Unknown	Observed in Idaho in mixed conifer stands. Possibly young Ponderosa pines, which often exhibit black bark.
"spruce"	Engelmann spruce *Picea Engelmanni*	Found only in the upper reaches of watershed in Idaho
"cedar"	Western red cedar *Thuja plicata*	Observed in drainages and northern facing slopes of hills amidst mixed conifers
"hemlock"	Western hemlock *Tsuga heterophylla*	Often found with western red cedar in draws or north facing slopes
"cottonwood"	Black cottonwood *Populus tricocarpa*	Often found along creeks
"aspen"	Quaking aspen *Populus tremuloides*	Often observed adjacent to wetlands or creeks
"alder"	Thinleaf alder *Alnus incana* Or Red alder *Alnus rubra*	Often found in ravines, but usually only mentioned in the General Description of a section
"hazel"	Unknown	"Hazel" was cited as an understory plant in many forested areas. Possibly, the surveyor confused red alder or thinleaf alder for hazel alder *Alnus serrulata* found in throughout the Midwest and Eastern states

Sub-watershed Evapotranspiration Calculations

Upper Hangman Sub-Watershed ET Calculations

Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	108,730	0.50	71.0	11.0	5.7
Open Ponderosa	31,854	0.20	42.0	17.0	2.6
Ponderosa on Rock	3,534	<0.01	42.0	17.0	0.3
Mixed Conifer	67,036	0.30	42.0	22.0	7.0
Cottonwood, alder, aspen, willow	169	<0.01	91.0	40.0	0.0
Cultivated	133	<0.01	83.0	16.0	0.0
Total	211,456	1.0	NA	NA	15.6

Rock Creek Sub-Watershed ET Calculations

Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	33,058	0.29	199.4	11.0	3.2
Open Ponderosa	40,123	0.35	242.0	17.0	6.0
Ponderosa on Rock	238	0.00	1.4	17.0	0.0
Mixed Conifer	39,582	0.35	238.7	22.0	7.6
Cottonwood, alder, aspen, willow	902	0.01	5.4	40.0	0.3
Total	113,903	1.00	NA	NA	17.1

California Creek Sub-watershed ET Calculations

Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	661	0.04	71.0	11.0	0.5
Open Ponderosa	8,535	0.54	42.0	17.0	9.1
Ponderosa on Rock	448	0.03	42.0	17.0	0.5
Mixed Conifer	6,262	0.39	42.0	22.0	8.7
Total	15,906	1.00	NA	NA	18.8

Lower Hangman Creek Sub-watershed ET Calculation

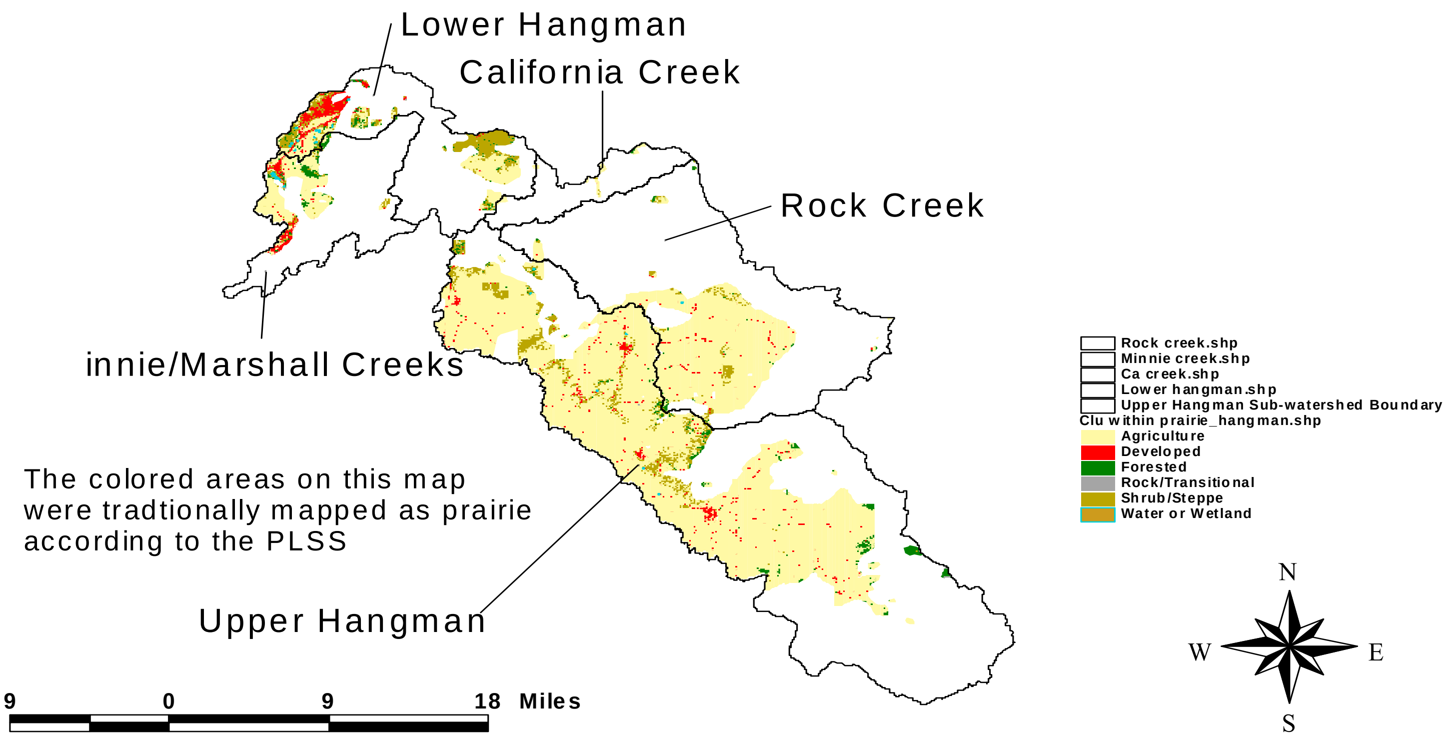
Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	13,547	0.30	71	11	3.3
Open Ponderosa	23,993	0.53	42	17	8.9
Ponderosa on Rock	4,027	0.09	42	17	1.5
Mixed Conifer	566	0.01	91	40	0.5
Cottonwood, alder, aspen, willow	2,714	0.06	42	22	1.3
Cultivated	114	0.00	83	16	0.0
Wetland/Lake	641	0.01	11	47	0.6
Total	45,602	1.00	NA	NA	16.1

Minnie/Marshall Creek Sub-watershed ET Calculation

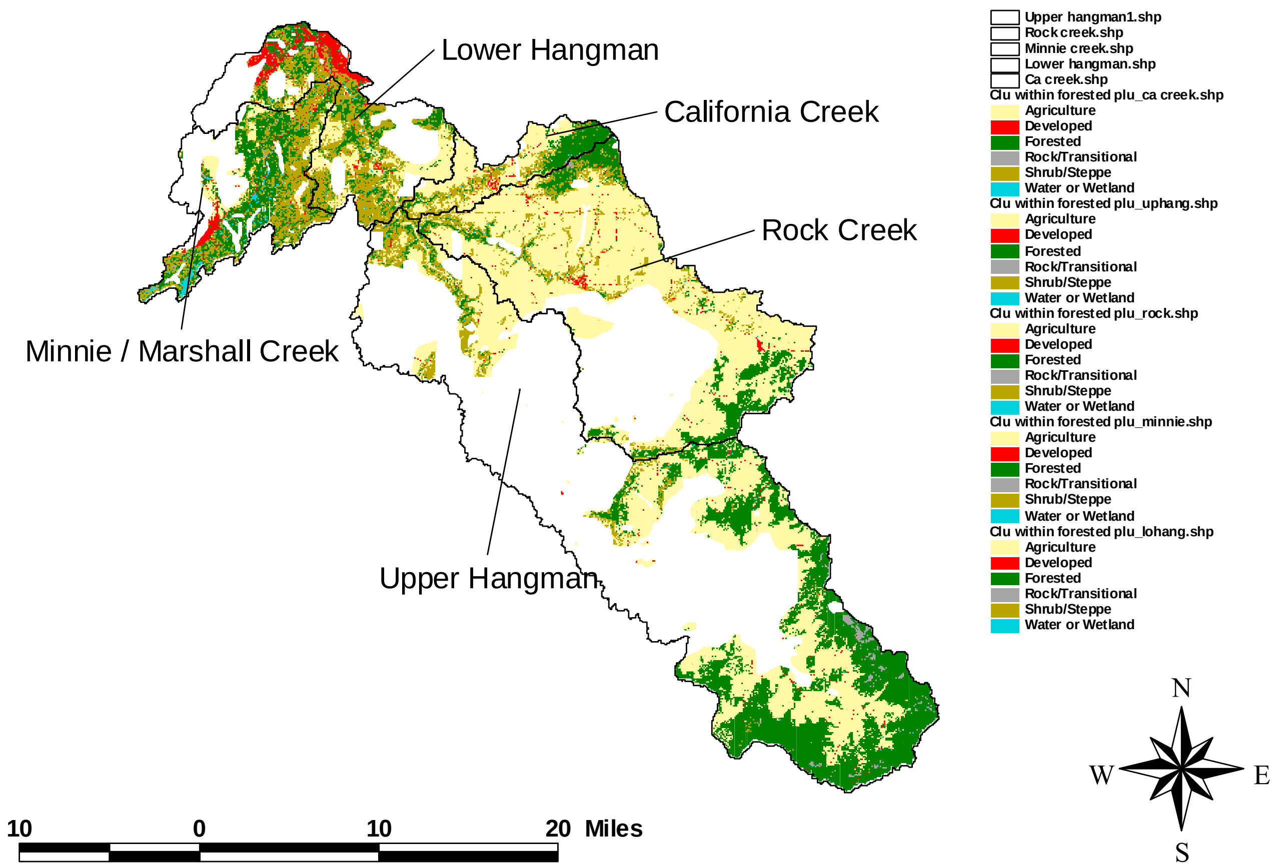
Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	8,706	0.22	71	11	2.5
Open Ponderosa	22,056	0.56	42	17	9.6
Ponderosa on Rock	6,333	0.16	42	17	2.8
Cultivated	21	<0.01	83	16	0.0
Wetland/Lake	1,930	0.05	11	47	2.3
Total	39,046	0.99	NA	NA	17.2

Current Land Use Maps Depicting Conversion of Shrub/Steppe and Forested Historic Vegetation Types

Current Land Use within the Historic Extent of Prairie (Shrub/Steppe) Vegetation in the Hangman Creek Watershed



Current Land Use within Historic Extent of Forested Areas in Hangman Creek Watershed



Tabular Data Generated by ArcView 3.2 to Illustrate Changes in Acres of Pre-Settlement Vegetation to Current Land Use

Changes in Land Use by Sub-Watershed				
Sub-Watershed	Land Use	Pre-Settlement (acres)	Current (acres)	Net Change (acres)
California Creek	Agriculture	0	8801	8801
	Developed	0	332	332
	Forested	15257	3687	-11570
	Rock/Transitional	0	41	41
	Shrub/Steppe	661	3018	2357
	Water or Wetland	0	29	29
Lower Hangman	Agriculture	114	13697	13583
	Developed	0	6554	6554
	Forested	30820	8329	-22491
	Rock/Transitional	0	103	103
	Shrub/Steppe	13547	16730	3183
	Water or Wetland	1207	193	-1014
Marshall Creek	Agriculture	21	10624	10603
	Developed	0	2243	2243
	Forested	28655	13906	-14749
	Rock/Transitional	0	338	338
	Shrub/Steppe	8706	11032	2326
	Water or Wetland	1930	919	-1011
Rock Creek	Agriculture	0	92634	92634
	Developed	0	1524	1524
	Forested	81062	11181	-69881
	Rock/Transitional	0	98	98
	Shrub/Steppe	33058	8324	-24734
	Water or Wetland	902	73	-829
Upper Hangman	Agriculture	133	149750	-149617
	Developed	0	2798	-2798
	Forested	102935	45335	57600
	Rock/Transitional	0	1128	-1128
	Shrub/Steppe	109404	12271	97133
	Water or Wetland	169	140	29

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Appendix K

Previous Water Quality Sampling Site Data

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Moctileme Creek (Idaho)	Coeur d'Alene Tribe	1998-2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
		1999-2002	RL100	
		2002	Fecal Coliform	
Indian Creek (Idaho)	Coeur d'Alene Tribe	1997-2002	Temperature, D.O. pH, Cond.	Not Reported
		1998-2002	TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	
		1998-2002	RL100	
		2002	Fecal Coliform	
LoLo Creek (Idaho)	Coeur d'Alene Tribe	2000	TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
Andrew Springs Creek (Idaho)	Coeur d'Alene Tribe	2000, 2002	TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
Mission Creek (Idaho)	Coeur d'Alene Tribe	2000	TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Smith Creek (Idaho)	Coeur d'Alene Tribe	2000	TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
Hangman Creek @ Sanders Rd (Idaho)	Coeur d'Alene Tribe	2002	Fecal Coliform	Not Reported
Hangman Creek @ Idaho State Line	SCCD	1994-1995	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	Fecal - 16% >200 col/100 ml Total Phosphorus - (10), Temperature - (7), D.O. - (7)
	Coeur d'Alene Tribe	1997-2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
Hangman Creek @ Tekoa	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Not Reported

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Little Hangman Creek @ Whistocken (Idaho)	Coeur d'Alene Tribe	1998-2002	RL100	Not Reported
		2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	
Little Hangman Creek @ Agency (Idaho)	Coeur d'Alene Tribe	2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP, Fecal, Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
Little Hangman Creek @ State Line	SCCD	1994-1995	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	Temps. - (5), Turbidity (high-Q's) -(6), Turbidity (low-Q's) - (7), NO_2/NO_3 - (1) Fecal - 24% >200 col/100 ml, Total Phosphorus - (18), D.O. - (8)
		1996-1997	TSS, Turbidity	Not Reported
	Coeur d'Alene Tribe	1997-2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
		1999-2002	RL100	
		2002	Fecal Coliform	

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Little Hangman Creek @ State Line	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	D.O. - (1)
Hangman Creek @ Marsh Rd. (Latah)	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Not Reported
Cove Creek	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Not Reported
Hangman Creek Paired Watershed u/s of Waverly (Southern)	SCCD	1995-1999	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Total Phosphorus, TSS, Turbidity	Total Phosphorus - (34), Turbidity (>50 NTU) - (21), Fecal - 15% >200 col/100 ml D.O. - (6), NO_3 - (1)
Hangman Creek Paired Watershed u/s of Waverly (Northern Composite)	SCCD	1995-1999	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Total Phosphorus, TSS, Turbidity	Total Phosphorus - (18), Turbidity (>50 NTU) - (11), D.O. - (6), Fecal - 14% >200 col/100 ml

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Hangman Creek @ Roberts Rd.	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Not Reported
Rattler Run Creek u/s of Hangman Creek Confluence (RR-4)	SCCD	1994-1997	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	Temps. - (1), Turbidity (high-Q's) - (6), Turbidity (low-Q's) - (7), NH_3 - (4), NO_3 - (14), NO_2 - (2), Fecal - 30% >200 col/100 ml, Total Phosphorus - (57), pH - (8), D.O. - (1)
		10/4/2001	Temperature, pH, Conductivity,	Total Phosphorus - (1)
		2/25/2002	D.O., Fecal, NO_3, NO_2, NH_3, TKN, Total Phosphorus, E.coli	Total Phosphorus - (1)
		9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Fecal (1), Total Phosphorus (1)
Rattler Run Creek above Fairfield (RR-0)	SCCD	2/25/2002	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, TKN, Total Phosphorus, E.coli	Total Phosphorus - (1)

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Rattler Run Creek u/s of Treatment Facility (RR-1)	SCCD	10/4/2001 2/25/2002	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, TKN, Total Phosphorus, E.coli	Total Phosphorus - (1) Total Phosphorus - (1)
Rattler Run Creek d/s of Treatment facility (RR-2)	SCCD	10/4/2001	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, TKN, Total Phosphorus, E.coli	D.O. - (1), NH_3 - (1), Total Phosphorus - (1)
		2/25/2002		Total Phosphorus - (1)
Rattler Run Creek @ Darknell Rd. (RR-3)	SCCD	10/4/2001	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, TKN, Total Phosphorus, E.coli	D.O. - (1), Total Phosphorus - (1)
		2/25/2002		Total Phosphorus - (1)
Hangman Creek @ Bradshaw Rd.	SCCD	1995	Temperature, pH, Conductivity, D.O.	Temps. - (11), pH - (5), Total Phosphorus - (14), Turbidity (high-Q's) - (14), Turbidity (low-Q's) - (1), D.O. - (6), Fecal - 15% >200 col/100 ml
		1996 1997	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	
	D.O.E.	1998 1999	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	Temperature - (2), D.O. - (2), Fecal (2)
	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1), D.O. - (1)

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Hangman Creek @ Keevy Rd.	SCCD	1995 1996	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	Not Reported
		9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1), pH - (1)
Hangman Creek u/s of Rock Creek	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1), pH - (1)
N.FK. Rock Creek @ HWY 58 (Idaho)	Coeur d'Alene Tribe	1998-2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	Not Reported
N.FK. Rock Creek @ R.R. (Idaho)	Coeur d'Alene Tribe	1998-2002	RL100	Not Reported
		1999-2002	Temperature, D.O. pH, Cond. TSS, Turbidity, TKN, TP Nutrients (Cl, F, SO_4, NO_2, NO_3, Ortho-Phosphate)	

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
N.FK. Rock Creek @ Hatchery (Idaho)	Coeur d'Alene Tribe	1999-2002	RL100	Not Reported
		2000	Temperature, D.O. pH, Cond.	
Rock Creek @ Mouth	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1), pH - (1), Fecal (1)
Rock Creek @ Jackson Rd.	SCCD	1994-1997	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	D.O. - (7), pH - (3), NO_3 - (3), Turbidity (high-Q's) - (46), Turbidity (low-Q's) - (6), Fecal - 27% >200 col/100 ml Temps. - (14), Total Phosphorus - (34)
Hangman Creek u/s of California Creek (Duncan)	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1), pH - (1)
California Creek	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Fecal (1)

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
California Creek	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Fecal (1)
Hangman Creek d/s of H.V. Golf Course	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1), pH - (1)
Hangman Creek 2 mi. South of Hatch Rd.	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1)
Hangman Creek @ Yellowstone P.L.	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1)

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Hangman Creek u/s of Marshall Creek	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1)
Marshall Creek @ Confluence w/HC	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	D.O. - (1), Fecal - (1)
Marshall Creek @ "Headwaters" (Site A)	Cheney High School	7/27/1999	Fecal, NO_3, NO_2, Total Phosphorus, Sol. Reactive Phosphorus	Not Reported
		7/13/2000 7/19/2000 8/9/2000 8/17/2000	Temperature, D.O.	Not Reported
Marshall Creek @ "Horton's R.R. Bridge" (Site B)	Cheney High School	7/27/1999	Fecal, NO_3, NO_2, Total Phosphorus, Sol. Reactive Phosphorus	Not Reported
		7/13/2000 7/19/2000 8/9/2000 8/17/2000	Temperature, D.O.	Not Reported
Marshall Creek @ "Green's Property" (Site C)	Cheney High School	7/27/1999	Fecal, NO_3, NO_2, Total Phosphorus, Sol. Reactive Phosphorus	Not Reported

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Marshall Creek @ "Shepard's Crossing" (Site D)	Cheney High School	7/27/1999	Fecal, NO_3, NO_2, Total Phosphorus, Sol. Reactive Phosphorus	Not Reported
Marshall Creek @ "Miller's Reach"	Cheney High School	7/13/2000 7/19/2000 8/9/2000 8/17/2000	Temperature, D.O.	Not Reported
Marshall Creek @ "Fowler's Reach"	Cheney High School	7/13/2000 7/19/2000 8/9/2000 8/17/2000	Temperature, D.O.	Not Reported
Marshall Creek @ "Cemetary Site" (Site E)	Cheney High School	7/27/1999	Fecal, NO_3, NO_2, Total Phosphorus, Sol. Reactive Phosphorus	Not Reported
		7/13/2000 7/19/2000 8/9/2000 8/17/2000	Temperature, D.O.	

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Hangman Creek @ Mouth (Near USGS Gage)	D.O.E.	1970	NO_3, NO_2	Not Reported
		1972-1973	Temperature, pH, Conductivity, Fecal, D.O., Turbidity, NH_3, Total Phosphorus	
		1976	Temperature, Conductivity, D.O., Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	
		1977-1980	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	
		1981-1987	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NH_3, Total Phosphorus	
		1988-1993	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, Total Phosphorus	
		1994-2000	Temperature, pH, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, TPN, Total Phosphorus	Temps. - (8), pH - (11), Total Phosphorus - (3), Turbidity (NTU) - (2), D.O.- (7), NO_2/NO_3 - (3), NH_3 - (6), Fecal - (11)
	USGS	1999-2000	Temperature, pH, NO_3/NO_2, NH_3, $CACO_3$, CA, MG, NA, SO_4, CL, F SIO_2, Total Phosphorus, Ortho-Phosphate *Also Sampled for Metals	Not Reported

Sampling Locations	Sampling Agency	Years	Parameters	Exceedences
Hangman Creek @ Mouth (Near USGS Gage)	SCCD	9/6/2001 Seepage Run	Temperature, pH, Conductivity, D.O., Fecal, NO_3, NO_2, NH_3, Cl, TKN, Total Phosphorus, SO_4, Mg, CO_3+HCO_3, Ca, Enterococcus	Temperature - (1)
	D.O.E.	2001-2002	Temperature, pH, Conductivity, D.O., Fecal, TSS, Turbidity, NO_3, NO_2, NH_3, TPN, Total Phosphorus	Temps. - (4), pH - (6), Total Phosphorus - (1), Turbidity (NTU) - (1), D.O. - (1), NO_2/NO_3 - (5), NH_3 - (1), Fecal - (2), Conductivity - (1)

Appendix L

HDI Instream Flow Report

LATAH CREEK INSTREAM FLOW STUDY: FINAL REPORT

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

We would like to thank the Latah (Hangman)Creek Watershed (WRIA 56) Planning Unit for the opportunity to carry out this study. As part of the Planning Unit, the Spokane County Conservation District (SCCD) carried out many tasks to ensure the success of this project; without their assistance our task would have been much more difficult. Walt Edelen was extremely helpful at every step, coordinating access to the sites, providing background materials, and generally making sure that everything ran smoothly for us from start to finish. Charlie Peterson and Rick Noll provided valuable data on streamflows and temperatures and estimates of water use in the basin; they also provided logistical support during our field studies. Dan Ross of SCCD provided key assistance with the habitat mapping. Many members of the Planning Unit provided valuable comments on earlier drafts of the report. Doug Allen of the Washington Department of Ecology assisted with study design and review of products. Several landowners generously granted access to our crews throughout the field season.

Kristine Uhlman provided hydrological analyses and interpretation, and directed the piezometer measurements. Dr. John Bartholow (USGS, Fort Collins) and Dr. Robert Beschta (Oregon State University) provided advice on SNTEMP modeling and restoration opportunities.

LIST OF ACRONYMS

cfs	cubic feet per second
HSC	Habitat suitability criteria
HSI	Habitat suitability index
IFG-4	A hydraulic simulation model developed by the Instream Flow Group
IFIM	Instream Flow Incremental Methodology
PHABSIM	Physical Habitat Simulation
RHABSIM	Riverine Habitat Simulation (a version of PHABSIM developed by TR Payne)
RM	River mile; distance from the mouth to a given site
SCCD	Spokane County Conservation District
SNTEMP	Stream Network Temperature model
USGS	United States Geological Survey
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fisheries and Wildlife
WDG	Washington Department of Game
WDOE	Washington Department of Ecology
WUA	Weighted Usable Area (index of fish habitat)

EXECUTIVE SUMMARY

Habitat conditions in Latah Creek and its tributaries were studied using PHABSIM, SNTEMP, and hydrological investigations. PHABSIM studies indicated that rainbow trout physical habitat conditions were low at flows below 15-20 cfs. At these low flow levels, the rate of change in WUA for adult rainbow trout was 5% or more per 1 cfs change in flow. In general, WUA values for suckers and minnows were higher than those for trout, particularly at low flows.

Based on WUA vs. flow, and the low-flow season hydrograph, flow recommendations were developed for three levels of resource protection. Optimal flows, providing 80% of maximum WUA, were 50 cfs below Marshall Creek and 26 cfs above Marshall Creek. Minimum flows, at which 1 cfs changed WUA by 5% or more, were 15 cfs below and above Marshall Creek. Critical flows, at which 1 cfs changed WUA by 10% or more, were 6 cfs and 7 cfs below and above Marshall Creek, respectively.

Recommended flows developed in this study apply to the low-flow period. The minimum and critical levels indicate flows below which physical habitat for salmonids is greatly reduced. Recommendations for overall ecosystem health would need to consider flows during other times of the year, and for other purposes.

Temperature, as measured directly and as modeled by SNTEMP, appears to be a limiting factor for salmonids in most of Latah Creek. Additional flow, if it could be provided, would provide only limited temperature reductions under present-day conditions, due to lack of shade over much of the reach. When existing shade conditions (approximately 20% shade) were increased in the simulation to 70% shade, a significant decrease (1-2 C) in water temperature over most of the reach resulted.

Limited storage capacity in the Washington portion of the watershed, and low rainfall indicate that the current condition of low summer flows is difficult to improve significantly. Low flows and high summer air temperatures also make it difficult to bring high stream temperatures within State guidelines for salmonid-bearing streams. Restoration within the study area is unlikely to make the entire Washington portion of the mainstem suitable for salmonids year-round. However, the PHABSIM study indicates that even small additions to flow during the summer period would result in large WUA increases. The SNTEMP study indicates that shade restoration could significantly increase the length of stream usable by salmonids compared to present conditions. Improving both conditions simultaneously would provide the greatest benefits. Further flow and temperature improvements might be possible with restoration in the tributaries and in the upper (Idaho) basin.

I. INTRODUCTION

A. Geographic setting

Latah Creek (Hangman Creek), a major tributary of the Spokane River, originates in Benewah and Kootenai Counties, Idaho and flows NW into Washington, crossing the border near the town of Tekoa. From the Washington border to the confluence with the Spokane River is approximately 58 river miles. Significant tributaries are Little Hangman Creek, Rattler's Run, Rock Creek, California Creek, and Marshall Creek (Figure 1).

Latah Creek drains a land area of approximately 689 square miles south of Spokane, Washington, and is a significant tributary to the Spokane River, eventually discharging to the Columbia River. The Latah Creek watershed area lies within the Columbia Plateau, which is characterized by narrow, east-west trending ridges, separated by broad basins. The land surface is roughly parallel to the dip of the numerous basalt flows of the Plateau. Regional drainage is strongly influenced by a series of erosional features, resulting in the topography characterized as 'scablands', formed during the Pleistocene Missoula Floods. Other than that portion of the Creek that enters urban Spokane, the drainage area land use is generally rural.

The historic Latah Creek uplands have been characterized as heavily forested while the lower canyons contained scattered stands of pine with bunchgrass understory. Riparian vegetation was composed of cottonwood, aspen, alder and willow communities. Riparian vegetation is sparse over much of the creek today, or is dominated by reed canary grass. Present day upland land cover is about 50% annual crops, 28% woodland, and a variety of other uses (Edelen & Allen 1998).

Within the area of the investigation, Latah Creek flows in a northwest direction and is believed to be following the lineament of structural faults in the Latah Valley (The Latah Fault, Hamilton et al. 2001). The stream channel flows over, and at some locations cuts into, the middle Miocene aged Columbia River Basalt. Topographic uplands are mantled with Holocene and Pleistocene aged loess which forms dune-shaped rolling hills known regionally as Palouse. Holocene alluvium of silt, sand, and gravel is found in stream channels, flood plains, and terraces, and consists of reworked glacial Missoula flood deposits and reworked loess (USDA SCS 1994). The volume of deposited alluvium within Latah Valley is observed to vary considerably along the reach, and will be discussed with more detail for each transect location.

B. Hydrological conditions

The mean annual flow in Latah Creek (measured near the mouth) is 241 cfs; mean monthly flows range from 14 to 740 cfs (Figure 2). Latah Creek has a flashy hydrograph, with high flows (2000-5000 cfs) in the spring. During the summer, the median flow at the USGS gage is less than 15 cfs (Figure 3).

Flows measured at the USGS gage, near the mouth of Latah Creek, are not representative of conditions over most of its length. This is particularly true of low-flow conditions. Data collected in 2002 by the Spokane County Conservation District (SCCD) at three temporary gages indicate that when flows fall to 8-10 cfs at the gage, they are as low as 1-2 cfs above the confluence of Rock and California Creeks (Figure 4).

C. Fishery

Historically, Latah Creek supported salmon and steelhead runs in the mainstem all the way to the headwaters. Anadromous fish were blocked by the construction of Little Falls Dam in 1910. Resident trout still occur in Latah Creek, but the numbers and distribution are sparse (Edelen & Allen 1998). Low summer flows and high temperatures are thought to be the main limiting factors to salmonid populations today. At present, the Latah Creek fishery is dominated by minnows (Cyprinidae) and suckers (Catostomidae). Based on recent collections, at least 12 species occur in Latah Creek (Edelen and Allen 1998; Laumeyer and Maughan 1973, 1974); 3 of these are introduced (Table 1).

D. Study goals

In the 1990's the SCCD initiated studies on Latah Creek to quantify current conditions and identify opportunities for restoration (SCCD 1994; Edelen & Allen 1998). To further these goals, SCCD hired Hardin-Davis Inc. in 2002 to carry out an instream flow study for Latah Creek, from the Idaho border to its confluence with the Spokane River.

The objectives of this study were to:

6. Review the existing information on hydrology and assess the opportunities for increasing base flow

7. Use the Physical Habitat Simulation model (PHABSIM) to determine the relationship between discharge and fish habitat; recommend optimum flow levels for fisheries

8. Model water temperatures in the creek under current conditions, and estimate effects of potential improvements in shade and streamflow

9. Estimate the effects of improved flows and temperatures on other water quality parameters

10. Recommend optimum flow levels for recreation.

E. Instream flow assessment

Many methods have been developed to quantify instream flows for fisheries and other needs. Among those in wide use in the state of Washington are the Tennant method, toe width, and IFIM; the latter two are commonly used by the state in making flow recommendations.

Tennant: The Tennant method is one of the simplest and most widely used. Briefly, flow recommendations follow directly from average flow data from a USGS gage. The recommendations can be summarized (Tennant 1976) as:

Flow	Fishery condition
10% of average flow	minimum, short-term survival
30% of average flow	satisfactory fish habitat
60% of average flow	excellent to outstanding habitat

The Tennant method has value for making first-cut recommendations and for generating results when time and budget are lacking or non-existent. A major drawback to generalized application of the method is that two streams with very different natural hydrographs can have identical mean annual flows. For example, a spring-fed stream can have a near-constant flow all year, while a desert stream may be nearly dry much of the time, with occasional flood flows. The Tennant method would recommend a flow far below natural low flows in the first case, and far above natural low flows in the second case.

Toe width: The toe-width method was developed by the Washington Department of Fisheries (WDF), Washington Department of Game (WDG), and the U.S. Geological Service (USGS) in the 1970s. The toe-width is the distance across the channel measured from the toe (location where bank angle and substrate change from terrestrial to aquatic) of one streambank to the toe of the other streambank . This width of the stream is used in a power function equation to derive the flow needed for spawning and rearing salmon and steelhead (Swift 1976 and 1979). Washington Dept. of Fish and Wildlife (WDFW) and Washington Dept. of Ecology (WDOE) also use the criteria for rearing steelhead to estimate flow needs for resident trout.

IFIM: The Instream Flow Incremental Methodology (Stalnaker et al. 1994; Bovee 1982) refers to a group of methods for studying the incremental effects of flows on microhabitat, water quality, sediment transport, and other parameters. The most widely used part of IFIM is the Physical Habitat Simulation (PHABSIM).

The basic premises of PHABSIM are that numbers of fish are positively correlated with the amount of physical habitat; that physical habitat is related to discharge; and that physical habitat can be quantified in terms of depth, velocity, substrate, and cover. The four principal components of PHABSIM are field measurements, a hydraulic model, habitat suitability criteria, and a habitat model.

Field measurements are used to quantify the matrix of depth, velocity, substrate, and cover combinations that occurs along representative transects at a particular flow. A hydraulic model is then used to simulate this matrix over a range of flows. Habitat suitability criteria (HSC) describe the value to a species of any combination of physical variables. A habitat model combines HSC with output from the hydraulic model to generate an index of habitat value, termed Weighted Usable Area (WUA), as a function of flow. Thus, for any given flow, PHABSIM sums all the usable habitat. When the model is used over a range of flows, it generates a WUA vs. flow curve. This curve is used as a basis for making flow recommendations.

Because of its adaptability and general acceptance by resource agencies, the PHABSIM model was selected as the primary tool for assessing flows in Latah Creek. The Tennant and toe-width models were also used in order to compare results.

The PHABSIM study of Latah Creek followed procedures outlined by the Instream Flow Group (Bovee 1982). It also complied with guidelines established by the State of Washington (WDFW and WDOE 2000). The PHABSIM study consisted of the following steps.

- Mapping and transect selection
- Model selection
- Field data collection
- Computer simulation of hydraulics
- Development of habitat suitability criteria (HSC)
- Determination of weighted usable area (WUA) as a function of flow
- Interpretation of WUA results, and recommended flows

The habitat quantified by PHABSIM does not include temperature or other water quality parameters. SNTEMP, a stream temperature model developed for relating downstream temperatures to changes in flow and shade, is often applied concurrently with PHABSIM to evaluate the combined habitat value of physical space and temperature (Bovee 1982; Bartholow 1989).

II. METHODS

A. Hydrological investigations

1. Field evaluations:

The objective of the hydrogeologic portion of the study was to evaluate subsurface soils and geology, topography, and correlation of the geomorphic setting for an initial assessment of the interrelationship between the surface and ground water along the stream reach. The field component of this study was accomplished by a hydrogeologic evaluation the week of September 3, 2002, during low-flow conditions. The investigation included the installation of temporary miniature piezometers, limited streambed hydraulic conductivity testing, and data evaluation. The piezometers facilitated the mapping of key segments of Latah Creek that exhibited influent and effluent conditions, and characterization of those portions of the effluent stream that are sensitive to subsurface perched or ground water conditions. Hydraulic conductivity of bed sediment was evaluated in order to determine the relationship between stream flow and groundwater.

The method of miniature piezometer construction and installation is described by Lee and Cherry (1978), and has been employed successfully to investigate the hydrologic interactions between ground water and surface water. Five sites in the watershed were evaluated: three in mainstem Latah Creek, and one each in Rock Creek and California Creek. The cross section locations were selected for accessibility, stream bed characteristics, and representativeness of the stream profile, and correspond with the five PHABSIM sites.

The piezometers were installed along each cross section. Static ground water potentiometric elevations in relation to the stream level were determined for each piezometer. Difference in hydraulic head was measured for 15 piezometers at five cross section locations. Small differences in hydraulic head relative to the surface water were measured using a manometer. Static water levels were measured before and after piezometer surging and development and in many piezometers the ground water hydraulic head was measurably different from the free-flowing stream surface.

To measure the hydraulic conductivity of the sediment adjacent to the piezometer screen, a falling head test was conducted for a number of installations. The equations and method used to calculate the hydraulic conductivity (K) of aquifer material were first developed by Hvorslev (1951) for the U.S. Army Corps of Engineers. The equation used in this application is based on field data generated from falling head tests and is a simple method of obtaining order-of-magnitude estimates of hydraulic conductivity. The method consists of measuring the rate at which the elevation within the piezometer falls after being drawn upward by suction. With K values greater than approximately 3 ft/day (such as in coarse sands and gravels), the rate at which the water level falls within the piezometer is too rapid to measure.

The method assumes a screened piezometer of length L in an unconfined aquifer material. The equation is:

$$K = r^2 / 2L(t_2 - t_1)\, ln\, (L/R)\, ln\, (S_1/S_2)$$

Where: r = radius of screen intake (0.125 in.)
R = internal radius of piezometer (0.125 in.)
t_1 = initial time (seconds)
t_2 = elapsed time (seconds)
S_1, S_2 = drawdown within piezometer, at time t_1 and t_2
ln = natural log

For this method to be valid, the piezometer must be constructed so that the screen does not inhibit ground water flow; a clogged screen or silting of the piezometer would generate erroneous data. Piezometers installed in coarse sands or within gravels would not be capable of measuring hydraulic conductivities greater than approximately 3 ft/day.

2. Basin geology and geomorphology review:
Reports on the geology, hydrology, and geomorphology of the Latah basin in Washington were reviewed in order to determine hydrologic conditions and the potential for greater basin storage.

3. Hydrograph interpretation:
Streamflow data from the USGS gauge near the mouth were evaluated in order to determine long-term trends. The annual 3,7, and 30-day minima and maxima were plotted, as well as annual mean flow for the period of record (1948-present).

B. Physical habitat assessment (PHABSIM)

1. Habitat mapping
Measurements made at a study site must be put into the context of the entire reach being studied. Habitat was mapped in the vicinity of each of our study sites in order to quantify the percentages of habitat units (mesohabitats) near the site, and to have an estimate of the percentages in the entire study area.

The study area was subdivided into five reaches for the PHABSIM study. These five reaches - Denny (RM35.4), Keevy (RM29.2), Paintball (RM2.5), Rock Creek, and California Creek - are shown in Figure 1. Within each reach, a two-person crew walked a length of stream (0.5 to 2.5 miles) in July 2002, making measurements at each habitat unit; habitat units were classified following definitions in W.T. Helm (1985). (Table 2). Percentages of each habitat type within the reach were calculated, and these percentages were used to weight the PHABSIM transect measurements. Habitat mapping results are included in Appendix 1.

Toe width measurements were taken at appropriate sites (generally pool tail-outs) during the habitat mapping. The Hardin-Davis crew collected 22 toe width measurements near the five PHABSIM sites.

2. Site selection

Due to time and budget limitations, the entire study area could not be mapped. The study team relied on local expertise, topographic maps, and two days of field reconnaissance to select study sites. The sites were meant to be typical of the watershed in terms of riparian conditions, gradient, and fish habitat. Three study sites(RM35.4, RM29.2, RM2.5) were selected in mainstem Latah Creek, and two in the tributaries (Rock Creek and California Creek). At each site, 6-7 transects were placed across different habitat types. Site locations and characteristics are listed in Table 3.

3. Collection of flow data

Field measurements were made at each of the five study sites in May, June, and September 2002 (Table 4). During the week of May 20, 2002, water surface and velocity measurements were taken at every transect. At the middle and low flows, water surface elevations were re-surveyed, and discharge was measured at one or two transects per site. Substrate and cover data based on WDFW (2000) guidelines, were collected during the lowest flow (Table 5). The highest flows, 42 to 85cfs in the mainstem, 6-35 cfs in the tributaries) were measured in May. Lowest flows (1 to 7 cfs in the mainstem, 0.2-0.7 in the tributaries) were measured in September. (Note: “high flow” in this study refers to the upper end of the low-flow period, and not to higher flows that occur in Latah Creek in the spring).

4. Computer Simulation of Hydraulics

Immediately after the field measurements, data were entered into a format for the hydraulic simulation program known as IFG-4 (Bovee 1982). Various error-checks were carried out with programs in the RHABSIM (Riverine Habitat Simulation) model. Discharge was calculated for each set of measured velocities, and compared to the known discharge for the field date. Stage-discharge relationships at each transect were examined for abnormalities. Simulated and measured velocities were compared at the observed discharges; simulated velocities were also examined at the upper and lower bounds of extrapolation to make sure the predicted values were reasonable. Once the error checking was complete, the IFG-4 program was used to generate hydraulic data for the flow range of interest. Based on the performance of the IFG4 model at the measured flows, a range of flows was determined that could be modeled for each site (Table 6).

WDFW and WDOE(2000) maintains a list of data for evaluation of the accuracy of instream flow data modeling studies. This includes information on water surface elevations at all measured flows, accuracy of velocity prediction, and other information listed below. Based on these guidelines, the following information was supplied to WDFW and WDOE in April 2003:

- Input file including bed elevations, water surface elevations, velocities, substrate/ cover, and calibration discharges for IFG-4;
- Table for each transect of "calibration details" with simulated velocities paired with corresponding measured velocities for each calibration flow;

- Table of velocity adjustment factors (VAF) for each transect and each simulated flow over the proposed range of the model;

- Table of stage differences between flows and between transects.

5. Habitat suitability criteria (HSC) development

HSC data were developed from literature sources. Data were available for four of the species potentially found in Latah Creek. For a fifth, largescale sucker, data on the closely-related white sucker and Sacramento sucker were used. HSC curves were created for summer habitat conditions for adult and juvenile life stages of these five species, based on the literature. These candidate curves were approved by WDFW. Separate HSC were developed for rainbow trout in California Creek. Since it is a much smaller channel than Latah or Rock Creek, depth and velocity criteria were revised based on literature data from smaller streams. A list of the HSC, and the sources used, is in Table 7. Final HSC curves are in Appendix 2.

C. Temperature modeling

1. SNTEMP

The Stream Network Temperature Model (SNTEMP) is a steady-state model that incorporates all of the significant sources of heat gain and loss in a moving stream (Theurer et al. 1984; Bartholow 1989). It was specifically designed to evaluate the downstream temperature impacts of changes in flow regime, but it can also be used to evaluate changes in shade.

SNTEMP is a DOS-based model that uses a group of interrelated input files, containing data on stream geometry, shade, discharge, and meteorology (Table 8). At each location in the stream network (Figure 5), SNTEMP predicts average water temperature for each time period of interest. For Latah Creek, a weekly time step, which was most appropriate based on the estimated travel time, was used.

The study length for SNTEMP modeling was from Hays Road to the mouth, a total of 35.4 river miles (RM). Flows in SNTEMP needed to be supplied at each location in the network. These flows were estimated based on the USGS gage (mouth of Latah Creek) and SCCD gages at Bradshaw Rd. (RM32.9), Duncan (RM18.7), and Rock Creek. Data from the 2001-2 seepage runs (SCCD 2002) were also incorporated. Table 9 lists the site-by-site flow estimates, and the underlying data and assumptions.

Approximately 20 inputs are required in the SNTEMP model. Sources of data include field measurements, published data, and default values (Table 10). Default values were applied only for variables that generally have a negligible effect on model predictions (Bartholow 1989). The variables that generally exert the greatest influence on predicted water temperatures are beginning water temperature, discharge, air temperature, shade, and relative humidity. Stream width can also be important in some cases.

In order to calibrate the model, simulated vs. measured weekly average stream temperatures were compared at 11 locations (Table 11). Minor adjustments were made to the wind speed to improve the agreement between modeled and measured water temperatures.

Once calibrated, the SNTEMP results represented existing conditions. Three other scenarios were then compared to existing conditions, in order to estimate the potential benefits from different management options. It is important to note that the scenarios incorporate simplifying assumptions, and do not represent actual proposed alternatives. Instead, they were created to evaluate the relative potential of changes in shade and streamflow. The three scenarios were

Increased shade: The shade values at each site were increased to simulate 70% of the streambanks being lined with trees, compared to current conditions of about 20%. Natural shading conditions were not known; this simulation was intended to approximate restored conditions.

Increased flow: It was assumed for the purpose of the study that increased flow could take two general forms: surface water and ground water. Simulated additions were 1, 2, and 3 cfs. The additional inflow was simulated by increasing the flow at the top of the SNTEMP site (Hays Rd, RM35.5).

For surface water addition, the temperature of this added water was set to be the same as that of the flow already existing at the site (ambient water temperature). Additional groundwater, if it could be provided, would enter Latah Creek at more than one location. However, for the purposes of the simulation, the additional water was also treated as though it all entered at Hays Rd. Simulated additions were 1,2, and 3 cfs. The temperature of the inflow water was assumed to be 5C below ambient. Therefore, depending on the relative quantities, the resulting instream temperature at the Hays Road site was reduced by 0.25 to 3.5 C.

Increased shade plus flow: In this scenario, increased shade and increased flow were combined into the same simulations.

D. Other water quality

Other water quality parameters were reviewed, based on WDOE measurements. Parameters on the 303d list included temperature, as well as coliform bacteria, dissolved oxygen, and pH. The number of water quality exceedances for the latter three parameters were tabulated.

E. Recreation

In order to ascertain the recreational use of Latah Creek, local boaters and the Latah Creek Streamkeeper were consulted, and additional observations were made during habitat mapping and IFIM investigations. Hardin-Davis staff did not float the creek due to insufficient flows throughout the field season.

III. RESULTS

A. Hydrology

1. Streamflow/groundwater interaction

Figure 6 illustrates the hydrologic setting of Latah Creek. As the creek cut down into the basalt bedrock, sediments were deposited within the flood plain, with the grain size of the sediments a function of source material and stream velocity. The Holocene-aged alluvium consists of silt, sand, and gravel of reworked glacial Missoula flood deposits and reworked loess (USDA SCS 1994). The volume of deposited alluvium within Latah Valley varies considerably along the reach, and is contained within the bedrock and bounded on each side by bedrock. The Holocene alluvial aquifer material stores ground water, and is recharged during periods of high flow. Within the Holocene aquifer, groundwater flow direction is generally in the same direction as stream flow; however, the stream meanders across the aquifer with the direction of stream flow at times nearly perpendicular to groundwater flow. Ground water sustains the base flow within the stream, and as ground water elevations drop, the base flow is reduced and may diminish to no observable flow within the stream channel. In this setting, at conditions of low flow, ground water may enter and exit the stream, exhibiting both influent and effluent conditions within the same reach. The installation of miniature piezometers allowed for the measurement of influent/effluent conditions at several locations along the main channel and tributaries.

Of the twenty-nine miniature piezometers installed in the main channel and two tributaries, fifteen produced reliable data. Rocky streambed conditions prohibited data collection from the other installation locations. Flow at the USGS gauging station averaged 9 cfs for the 3-day period of investigations. Site names and transect numbers are taken from the PHABSIM study.

As Latah Creek meandered across the incised channel, the cross section topography typically consisted of a steep bank on one side and an alluvial plane on the opposite side. The ground water – surface water relationship in this setting typically consists of ground water discharge to the stream along the steep bank, and influent stream conditions on the opposite, lower elevation bank. This result is consistent with the longitudinal variability in base flow found by SCCD. This type of surface water – ground water interrelationship is typical for streams in low-flow conditions, where the aquifer is in balance with the stream discharge. Overall, the stream would not exhibit consistent influent conditions unless the surface water elevation remained above the water table, and this is likely only under high flow or flooding conditions. Due to the limited areal extent and thickness of the aquifer, the stream would not exhibit consistent effluent conditions because the major source of recharge to the Holocene aquifer is the stream.

RM 35.4 SITE, TRANSECT 7: After alternative piezometer installation procedures and materials were tested and the field procedure was refined, measurements were recorded, as shown on Table 12. The creek at this transect location was approximately 40 feet wide and 0.5 to 1.3 feet in depth. The streambed material varied from silts and gravels to large cobbles, and land surface topography varied from a steep bank that rose to hills and ridges to the west and low, relatively level alluvial plain to the east. Flow at this site on September 3 was 1.1 cfs.

The static water level in the piezometers varied across the section, with effluent conditions observed adjacent to the steep bank (ground water recharging the stream) and influent conditions (stream water draining to ground water) observed over most of the stream (Figure 7). Falling head hydraulic conductivity testing was attempted and is discussed below.

RM 29.2 SITE, TRANSECT 2: This cross section lies within a canyon eroded into the basaltic bedrock. Streambed materials consisted of bedrock, boulders, sand, gravel, and cobbles; the bed was approximately 32 feet wide. Water depth varied between 0.7 – 1.0 ft. Piezometer installation was difficult and after several attempts, only two measurements were made. Ground water discharges to the stream along this reach, maintaining baseflow. Flow at this site on September 3 was 0.9 cfs.

Falling head hydraulic conductivity testing failed (rate of fall too fast to measure) suggesting the hydraulic conductivity is greater than 3 feet/day.

ROCK CREEK SITE, TRANSECT 4: The topographic setting of this cross section is similar to that at the RM35.4 site: the stream channel is adjacent to a steep bank (north) and a low-lying alluvial plain exists along the opposite bank (south). Rock Creek is a tributary to Latah Creek, and is approximately 30 feet wide at this location. Stream depth ranged from 0.4 to 1.2 ft. at the piezometer testing locations. Flow at this site on September 4 was 0.7 cfs.

The stream exhibited effluent conditions adjacent to the north bank, and influent conditions to the south. Although the stream bed consisted of more sands and finer grain materials than the rocky channels encountered at the two upper cross sections, falling head rates were too rapid to obtain measured results.

CALIFORNIA CREEK SITE, TRANSECT 4: At the California Creek site, streambed sediments were coarse-grained sands and the stream channel was approximately ten feet wide, with water depth 0.2 to 0.4 ft. Piezometer installation was difficult; piezometers equilibrated quickly, suggesting a highly transmissive hydraulic conductivity. Flow at this site on September 4 2002 was 0.2 cfs.

Both piezometer measurements indicated influent conditions, meaning surface water was discharging to ground water along this reach.

RM 2.5 SITE, TRANSECT 2:
The coarse sands within the stream channel of this cross section resulted in difficulties in measuring falling heads, again suggesting relatively high hydraulic conductivity. The three successful piezometer installations all exhibited effluent stream conditions, with ground water discharging to and maintaining base flow. The channel was approximately 42 feet wide and the depth of water ranged from 1.0 to 1.9 ft. Flow at this site on September 5 2002 was 7.4 cfs.

2. Hydraulic Conductivity Testing

Falling head tests were attempted at four of the five stream sections – in all tests the rate of piezometer drawdown was equivalent to or more rapid than aquifer materials exhibiting a K value of 3 feet/day—highly transmissive streambed sediments. Observations of stream bed conditions along the transects were consistent with these findings; coarse sands and gravels were noted at each transect. This suggests close communication between the stream and ground water -- there are no significant deposits of fine-grained sediment to retard flow or to perch stream flow above the water table.

3. Basin geology and geomorphology review

Reviews of the geology of the watershed (Hamilton et al. 2001, USDA 1994) indicate a lack of available aquifer storage. Alluvial sediments have been deposited within the main channel of the creek and tributaries, but the areal extent and storage volume of these sediments is limited. The majority of the watershed's drainage network is incised into basalt bedrock, with ground water storage capacity limited to fractures and cracks within the massive rock. Loess soils are deposited along the bedrock highlands, but within the lower Latah watershed these areas of potential aquifer storage are typically perched above the incised stream channel. The storage capacity of perched seepage and bank storage along the basalt canyons contributes little to the stream baseflow of the watershed.

4. Hydrograph interpretation

The record over this period indicates two trends: increasing seasonal flow variability, and a gradually decreasing mean flow. Mean annual discharge at the USGS gage show a slight (statistically-insignificant) downward trend over the 1948-to-present period of record (Figure 8). The average from 1949-1974 was 257 cfs, vs. 213 cfs from 1975 to present. The high flows (3,7, and 30 day maxima) were also lower in the 1975-2001 period. Low flows (3, 7, and 30 day annual minima) showed a slight downward trend, and higher variability, in the 1975-2001 period.

5. Precipitation/streamflow relationship

Figure 9 presents the stream flow data recorded for the Latah Watershed at the USGS gauging station located near the mouth of the creek. The Latah Creek watershed responds rapidly to rainfall, draining and discharging the precipitation as it is collected by the tributaries and main channel of the creek.

Both Figures 8 and 9 are important to understanding the nature of flow in Latah Creek. The flow is 'flashy', responding quickly to rainfall with little opportunity to be stored in the Holocene aquifer. This lack of storage opportunity is due to the physical dimensions of the alluvial channel and shallow depth to bedrock. This setting is typical of a young stream incised into bedrock. As the stream ages (over geologic time) the physical volume of the aquifer will increase with more deepening of the incised channel and deposition of alluvial material.

Since the geomorphologic setting of Latah Creek is that of a young, flashy stream, the relationship between rainfall and stream flow is likely to have been historically consistent. Periods of higher flows would be associated with above-average precipitation. However, historical records do not show any clear trend in annual precipitation.

B. Physical Habitat

1. Hydraulic simulations:

Average discharge for each site, at each flow level, is listed in Table 6. Water surface elevations and velocities simulated by IFG4 showed good agreement with measured values. There were no significant problems with the hydraulic model at any of the sites. Very few calibration adjustments were needed, since the models were not extrapolated much beyond measured flows (Table 6).

2. Habitat

WUA was calculated for 5 species, and for 1-2 life stages per species for each site, for the range of flows determined above. All WUA values are reported in Appendix 3. For the purpose of illustrating habitat responses to flow, three species (one life stage each) were selected from the array available. These three WUA curves together represent most of the physical habitat types available in Latah Creek.

-Rainbow trout adults were selected because they are a species of primary interest; their WUA curve represents primarily moderate-to-deep water, with moderate-to-high velocity.

- Largescale sucker adult WUA represents deep, slow water.

-Speckled dace adult WUA represents shallow water with low-to-moderate velocity.

RM35.4 site: Rainbow trout adult WUA increased with discharge over the 1-40 cfs range modeled; the rate of increase appeared to taper off at the upper end of the range. Largescale sucker and WUA increased, but leveled off after about 20 cfs. Speckled dace WUA decreased at flows above 5 cfs (Figure 10).

Increasing flow generates more WUA for trout at this site, because depth is not limiting, and moderate to high velocities are more prevalent at higher flow. Largescale sucker WUA increases, then levels off; this is because greater depths initially increase WUA , but velocities increase at higher discharge, reducing WUA. Speckled dace habitat decreases above 5 cfs, indicating shallow water of low-moderate velocity is less available at higher flows. Overall, WUA values are higher for sucker vs. trout (Figure 10); this is because about half the site is dominated by fine substrates.

RM29.2 site: Rainbow trout adult WUA increased with discharge over the 1-40 cfs range modeled, and appeared to be increasing sharply at flows beyond 40 cfs . Largescale sucker WUA increased up to 40 cfs, where the WUA increase appeared to be leveling off. Speckled dace WUA increased at low flows, and leveled off at 10-15 cfs. (Figure 11).

In this site, the trout WUA curve is very steep, increasing over the modeled flow range and likely beyond. This site is dominated by boulder cover; as flow comes up, velocities remain in the optimum range for salmonids, rather than surpassing the range as in a channel with no cover. Speckled dace WUA remains high compared to other species (Figure 11) probably because edge habitats with shallow depths are available over a wide range of flows.

RM2.5 site: Rainbow trout adult WUA showed the same general relationship as at the RM29.2 site, increasing with discharge over the 1-40 cfs range modeled. Largescale sucker WUA increased up to about 25 cfs, then began to level off. Speckled dace WUA leveled off at about 10 cfs (Figure 12).

This site is low-gradient, with instream cover. For this reason, the WUA curves for trout is steep. Increasing flow brings more habitat into the optimum depth range, and velocities do not increase too rapidly at higher flows. Largescale sucker WUA is higher overall than other species; this is probably due to the presence of a large pool and fine substrates, both of which favor suckers over trout.

Rock Creek: The WUA results here were very similar to those at the RM2.5 site. The general similarities of the sites are in width, low gradient, and the presence of a large pool. Rainbow trout WUA increased with flow up to and beyond 40 cfs. Largescale sucker adult WUA peaked at around 20 cfs. Speckled dace WUA increased up to 15 cfs then leveled off (Figure 13). Speckled dace WUA is relatively high at all flows; this is due to the fact that in this wide site, edge habitat with shallow depths is available over a range of flows.

California Creek: WUA increased over the range 1-10 cfs for small-stream rainbow trout, with the rate of increase leveling off at 8 to 9 cfs. For largescale sucker, the peak occurred at 4 cfs. For speckled dace adults, the WUA curve was flat, with the maximum occurring at 3-4 cfs (Figure 14).

All sites: Overall, the WUA results indicate that habitat at low flows is better for catostomids and cyprinids than for salmonids. Low velocities are the primary reason, though fine substrates also contribute. At higher flows, WUA for catostomids and cyprinids decreases, while trout WUA continues to increase.

3. Toe width flow calculations

Toe width measurements were averaged near each of the five PHABSIM sites. The average toe width measurement was then used with the power function developed for rearing steelhead, with the assumption that this would produce a reasonable estimate for resident trout (B. Caldwell, WDOE, personal communication). The resulting flow recommendations varied from 9 to 25 cfs on the mainstem; recommendations were 4.8 cfs in California Creek and 14.1 cfs in Rock Creek (Table 13) .

C. Temperature (SNTEMP)

1. Calibration

Only minor adjustments were needed in the SNTEMP model to match measured temperatures. The wind speed parameter in SNTEMP is the primary calibration tool. When the weekly average wind speed input values were varied from 4 to 16 miles per hour (Table 14), the modeled temperatures showed good agreement with measured temperatures during most weeks, and at most sites. Figures 15-18 show the prediction errors longitudinally for weeks 24, 28, 32, and 36. Table 15 summarizes the errors at all sites and weeks; the median absolute error was 0.56 C, and 79% of the errors were less than 1C. Root mean squared errors were under 1C for most weeks and sites. Given this level of agreement, no further calibration adjustments were made.

Weeks 27 and 33 had the poorest agreement; simulated temperatures were too high by an average of 1.5C in week 27, and too low by 0.75 C in week 33. These results could have been due to discrepancies between conditions at the meteorological station (Spokane Airport) and local conditions. Among the sites, RM29.2 and Avista Substation Bridge (RM3.6) had the largest errors. SNTEMP overpredicted temperature at RM29.2 by an average of 1.05C; this may have been because the actual topographic shading effect in the canyon was greater than estimated. The model underpredicted by 0.81 at Avista Substation Bridge, probably because groundwater cooling was less than estimated (Table 15).

Weekly average temperatures at all sites (Appendix 4) showed a peak at week 28 (mid-July), and a secondary peak at week 34 (late August). The simulated behavior was consistent with measured values. Longitudinally, the pattern was more complex. Depending on the week, the temperature either increased gradually from RM35.5 to RM8.8, or varied erratically. In either case, water temperature was at or near its longitudinal maximum at RM8.8. Temperature dropped sharply from there to RM3.6; SNTEMP followed the measured data closely over this distance (Figures 15-18).

Maximum temperatures (weekly average maxima) measured by SCCD were 1.0 to 5.2 C greater than weekly averages (Figures 19-22). The greatest differences were in the upstream portion of the reach, where shade and groundwater are minimal (Figure 22). SNTEMP is designed for best results with average, as opposed to maximum temperatures; thus, no comparisons were made between measured and simulated maxima. The effects of scenarios on temperature maxima were not simulated with SNTEMP.

<u>2. Scenarios</u>:
In order to illustrate the results and compare scenarios, figures are included for Weeks 24, 28, 32, and 36. These weeks represent mid June, July, August and September, thus spanning most of the summer low-flow, high-temperature period.

<u>Increased flow</u>: Increased flow at ambient temperature made almost no difference in predicted water temperatures throughout the 35.5 mile SNTEMP study area. With a 3 cfs addition at Hays Road (RM35.5), weekly temperatures were unchanged at individual sites, and also longitudinally. Increased flow with cold water did reduce downstream temperatures, but only between RM35.5 and 29.2. Downstream of RM29.2, the temperatures with 3 cfs of cold inflow were virtually the same as with existing conditions (Figures 23-30).

<u>Restored shade</u>. With restored shade, simulated water temperatures were 1.0 to 1.5 C lower than existing conditions at most sites; this difference decreased in the vicinity of Marshall Creek (RM4.4), where groundwater input is high (Figure 31-34).

<u>Flow plus shade</u>: Increased flows of 1 to 3 cfs at ambient temperature did not add to the effect of shade alone. Addition of cold inflow added to the shade effect only at the upstream end of the SNTEMP study reach (Figures 35-38).

<u>D. Water quality</u>

Data on coliform bacteria, pH, and dissolved oxygen are displayed in Figures 39 - 41. The numbers of exceedances are shown for two sites- one near the mouth, and the other at RM33.

E. Recreation

Compared to other creeks in the region, Latah Creek receives limited use by recreational boaters. The predominantly agricultural character of the stream and its surrounding landscape limits its attractiveness to casual boaters. The canyon section between river miles ca25-35 offers attractive scenery, but is generally too steep for casual boaters. Furthermore, flows necessary to float the creek generally exist only in the winter to spring, when the weather and stream temperature and turbidity are typically not conducive to leisurely paddling. Consequently, the greatest boating use of Latah Creek is by whitewater enthusiasts--principally kayakers.

The two sections that are floated most commonly by whitewater paddlers are the canyon section and the lower section . Kayakers usually put in at the monument off North Kentuck Trails Road, and take out at the Valley Chapel Road bridge just downstream from the Rock Creek confluence. The flow range for best kayaking of this reach is approximately 2000 to 5000 cfs at the USGS gauge, although it is considered runnable down to around 500 cfs. The put-in for the lower section is most often the Hatch Road bridge, and the take-out at the Riverside Avenue bridge. The optimal flow range for this reach is approximately 1000 to 2000 cfs, but as in the upper reach is runnable down to around 500 cfs. The highest flow advised for experienced boaters is in the neighborhood of 8000 to 12000 cfs for either run.

The two sections favored by kayakers, as well as other parts of the creek, could conceivably be run at flows lower than 500 cfs in shallow-draft craft such as inflatable rafts and kayaks. However, a trip of any reasonable length at flows below 500 cfs would involve extensive boat-dragging over rocks and other debris.

The average number of days per year that provide flows sufficient for enjoyable whitewater boating is limited, particularly at the higher flows (Table 16). Optimal flows (1000-2000 cfs in the lower section, and 2000-5000 cfs in the canyon section, based on the USGS gauge) occur most frequently from January to April, and are generally of short duration. A flow at the gauging station of 500 cfs is considered to be the lowest runnable flow, and would involve considerable rock-scraping in many of the riffle and cascade sections of the creek. Finally, the warmer months of the year (June-September) have an average of less than 1 day per year where flow is greater than 250 cfs.

In addition to boating, other recreational uses occur on Latah Creek (SCCD personal communication). Fishing occurs on a limited basis in the spring months, and is hindered by high flows and turbidity. Summer fishing for trout is limited by high temperatures. Swimming occurs in the study area in some locations. Large swimming holes are heavily used by local teenagers in summer months. Wading is a frequent use by local residents.

IV. INTERPRETATION

A. Hydrology:

While many factors influence the response of a stream to rainfall, the subsurface storage capacity of a basin often exerts the strongest influence. Watersheds with limited subsurface retention cannot absorb large enough volumes of water to provide long-term base flow in the dry season. Surface conditions, such as vegetative cover and land use, have some impact on the rate of overland flow and infiltration, but cannot change the storage capacity of the aquifer.

Latah Creek is incised into bedrock within the study area, and aquifer storage is limited to sediments deposited by the stream within the incised channel. Deeper upland sediments are generally perched and effectively isolated from the stream network. The limited bank storage capacity and volume of connected aquifer storage does not allow for retention of recharge, resulting in a ‘flashy’ hydrograph response to precipitation. Due to the physical limitations for retention of stream flow within the lower (Washington) portion of the Latah Creek Watershed, little opportunity exists to improve baseflow with alternative land management activities. The hydrologic system is controlled by the physical characteristics of geology and storage capacity.

Artificial retention of high flows and engineered storage facilities would allow for dampening of the peak flood events, however the storage capacity of the underlying aquifer and stream banks would soon reach their physical capacity to store the surplus water. Consequently, a storage project would not add substantially to base flow. However, artificial storage could potentially allow for augmented flows throughout the low-flow season.

Dry-land farming is the predominant land use in the Palouse soils above Latah Creek. If irrigated faming had been predominant, opportunities for water management could have been implemented to enhance stream base flow. The watershed is capable of sustaining dry-land farming, which suggests a hydrologic system in balance. Short of increased precipitation, little opportunity exists within the study area to improve base flow significantly.

The upper reaches of the Latah Watershed (beyond the current study area) exhibit geologic conditions that may indicate the presence of a larger aquifer and greater storage capacity. Additional study of the upstream watershed is recommended. Changes in land management activities within an aquifer with higher storage capacity could result in increased baseflow.

Conclusions generated by this investigation reflect a ‘snapshot’ of the local ground water flow conditions measured during stream low-flow conditions. Variation in potentiometric head and hydraulic conductivity may be expected depending on seasonal flow, flow velocity, and stream bed sediment characteristics.

B. PHABSIM

Flow recommendations are not directly generated by PHABSIM, as with the Tennant or toe width methods. Factors that are generally considered in developing flow recommendations from PHABSIM data are: key species and life stages, the raw WUA results, the natural hydrograph, and the percentage change in WUA per unit change in flow.

Rainbow trout adults are the primary life stage of interest, thus the PHABSIM flow recommendations that follow are based on this life stage alone. If the WUA curves are considered by themselves, without reference to the hydrograph, it would appear that the recommended flow for salmonids would be at or above the maximum flow modeled by PHABSIM. In other words, in the absence of other information, this would yield a flow "recommendation" of 40 cfs or more in the study area above Marshall Creek, and over 80 cfs below Marshall Creek.

For management purposes, it is important to know not only the raw WUA values, but the rate of change in WUA per unit of flow. When the PHABSIM results are plotted as the percentage increase in WUA per unit (cfs) of water added, the results show that the effect on habitat of adding of 1 cfs depends greatly on the existing flow level. When flows are low, a high percentage of WUA is gained per 1 cfs addition. Figures 42-44 illustrate this relationship for the 3 mainstem sites; figures 45-46 show the relationship in the two tributary sites.

Recommended flows are given for two different parts of mainstem Latah Creek. The portion below Marshall Creek, where tributary and groundwater inflow significantly increase the late-summer flows, is represented by the RM2.5 (Paintball) site. The portion between the Idaho border and Marshall Creek is represented by the combined results from RM29.2 and RM35.4 (Keevy and Denny) sites. Based on the longitudinal profile, the relative weighting of these two sites was estimated at 0.28/0.72. Figure 47 shows the percentage change in WUA per 1 cfs for these two sites combined.

Flow recommendations are presented for the June to October period. For each time period, three different recommended flow levels are possible:

-Optimum: the flow providing 80% of the maximum WUA
-Minimum: The flow at which the change in WUA per 1 cfs is 5%
-Critical: The flow at which the change in WUA per 1 cfs is 10%

For each recommended flow level (Table 17) , and each time period, the flow exceedance is given. Since flows are significantly higher in June compared to the other four months, exceedance values were calculated separately for June. Flow exceedances at the RM2.5 site were taken directly from the USGS records for 1948 to present. Exceedance values for flows upstream of Marshall Creek were estimated based on SCCD flows measured in 2002 at RM33 (temporary Bradshaw gage). The relationship between average weekly flows at the Bradshaw and USGS gages from June to September, 2002, was approximately:

Flow at USGS gage	percent of USGS flow at RM33
<12 cfs	20%
12-40 cfs	30%
>40 cfs	35%

The flows presented in Table 17 can be interpreted as follows. In the mainstem upstream of Marshall Creek, when the existing flow is 26 cfs or less, flow withdrawal will adversely affect optimum habitat conditions. Withdrawals will adversely affect minimum and critical habitat conditions, respectively, when existing flows are 15 and 7 cfs. The same interpretation can be placed on flows of 50, 15, and 6 cfs in the section downstream of Marshall Creek.

Flow recommendations are compared for various methods in Table 18. Agreement among the methods is relatively good. This is probably because all the methods are fundamentally based on the width and shape of the channel. PHABSIM gives more usable results than the other two methods, because any increment of flow change, for any species, can be evaluated.

It is important to note that the numbers given in Table 17 for PHABSIM are narrowly defined. They are low-flow period recommendations, below which physical habitat for salmonids is greatly reduced. Recommendations for overall ecosystem health would need to consider flows during other times of the year, and for other purposes.

C. SNTEMP

The SNTEMP model accurately reproduced existing conditions from RM35.5 to the mouth of Latah Creek. The scenarios examined indicated that improved shade could reduce summer water temperatures by 1-1.5 C in most locations. Increased flow, on the other hand, had little or no effect on simulated stream temperatures. This indicates that direct solar heating has the biggest effect on water temperature in the reach, and this solar heating is capable of quickly canceling any temperature reductions that might come from flow increases. Reduction of solar heating (via improved shade) could lead to lower stream temperatures over long reaches of Latah Creek.

Superimposed on the SNTEMP results are two temperatures relevant for salmonid potential (B. Caldwell, WDOE, personal communication). Above 19C, metabolism of trout becomes inefficient, with little or no growth possible. Above 23C, lethal effects begin, meaning trout have difficulty surviving in a reach where temperatures exceed 23C for extended periods.

In Week 28, simulated temperatures are above 23 C for most of the reach, even with added inflow or restored shade (Figures 26, 32). In other weeks, simulated temperatures above 19C occur over much of the reach. Restored shade (and to a lesser extent, cool inflow) reduce the length of reach, and the number of weeks, that these temperature thresholds are surpassed. However, these results are from a model, and are not precise enough to predict the future thermal conditions for trout. The results indicate that shade could improve the situation, but the exact amount of improvement is harder to pin down.

Published temperature standards are an indication of habitat conditions, but not absolute thresholds that exclude trout populations. It is well documented that rainbow trout can adapt to temperatures much higher than published standards. Behnke (1992) noted active feeding at temperatures above 28C in a desert population of redband rainbow trout. E. Andersen (WDFW, unpublished) found a population of rainbow trout in Skookumchuck Creek surviving at 28.9C. In addition to genetic adaptation, cool nighttime temperatures and the presence of groundwater seeps are factors that can contribute to survival of rainbow trout populations in waters where temperatures are above published standards.

Interaction of temperature and physical habitat: From the Idaho border to the mouth, Latah Creek is 58 river miles. During the summer, much of the creek has very low physical habitat (WUA) due to low flows; it also has temperatures above published guidelines for salmonids over much of the length. Physical habitat would increase substantially for each 1 cfs of added flow during the low-flow period (Figures 42-44). The length of stream with suitable temperatures could also be increased by shade restoration. Taken together, the increase in total habitat area (added length plus increased WUA) could be significant (Bovee 1982).

Figure 48 illustrates the combined benefits of increased flow and reduced temperature. The baseline condition is given for the RM29.2 site (Keevy) at a summer flow of 3cfs, and it is assumed for the example that temperatures are adequate for trout over a length of 10,000 feet. If flow is increased by 2 cfs, or if shade restoration is accomplished in the reach, total WUA in the reach increases as shown in the first two bars of the graph. But if both improvements are combined, the increase in total WUA exceeds the sum of the two separate improvements.

D. Water quality

Small increases in flow and decreases in temperature may have other water quality benefits. Pollutants such as coliforms could be slightly diluted by higher discharges. Dissolved oxygen would be slightly higher (other things being equal) with lower temperatures. The benefits would be minor compared to the benefits of cutting off the sources of pollution.

E. Recreation

The lack of flows adequate for boating during summer months makes Latah Creek an unpopular choice for most boating enthusiasts. Winter flows attract some whitewater enthusiasts during the few days of higher (near flood stage) flows. Incremental gains in summer base flow would not alter these circumstances.

V. SUMMARY AND CONCLUSIONS

The geology and climate of the watershed indicate that large increases in baseflow are unlikely. However, significant physical habitat gains could be produced with very small increments of flow addition. Each 1 cfs of additional water in the mainstem would add 5% or more to physical habitat values during the low-flow season.

Physical habitat increase alone may not improve salmonid potential, because stream temperatures are very warm over most of the distance. Even with a simulated additional inflow of cool water, stream temperatures were improved over only a short distance. Therefore, it appears that flow augmentation would need to be combined with temperature reduction to improve trout habitat significantly.

Simulations with SNTEMP indicate that shade restoration could significantly lower stream temperatures. Shade could thus increase the total length of the mainstem available for salmonids, even without flow augmentation.

Shade restoration and flow augmentation, if combined, could yield the biggest improvement in the amount of habitat suitable for salmonids in Latah Creek. There would be increases in usable area (WUA), and there would be an increase in the length of the creek with suitable temperatures. Flow and temperature improvement have a positive synergistic effect on habitat (Figure 48).

Improvements made in the major tributaries (Rock and California Creek) could contribute to better flow and temperature conditions in Latah Creek. Improvements made in the upper watershed could also make such a contribution.

No single action (e.g. change of flow) will restore salmonid habitat conditions to its maximum potential. However, the combined effects of several projects (riparian restoration, upper watershed improvement, increased flows from tributaries) could significantly improve fish habitat in Latah Creek.

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FIGURES

TABLES

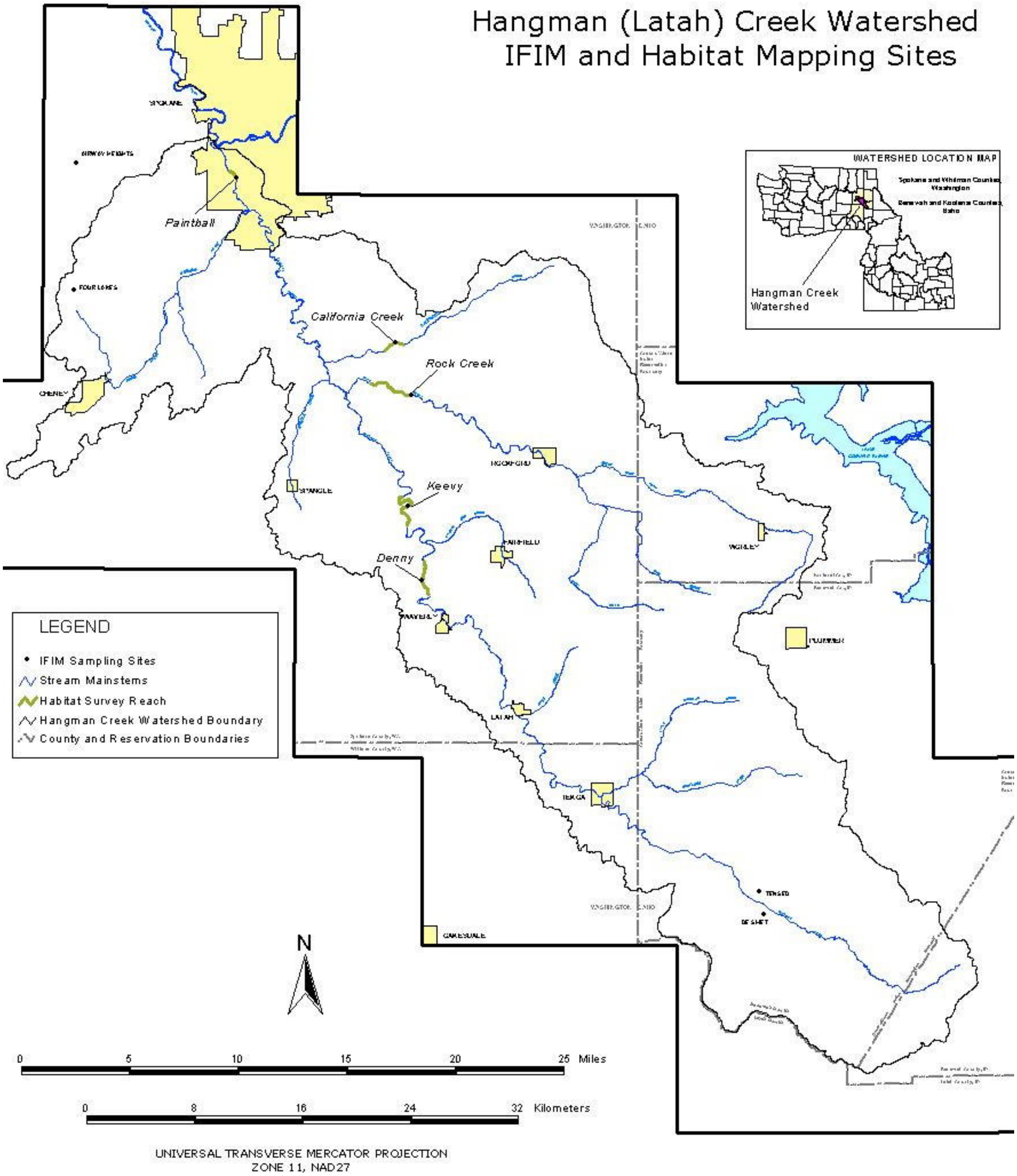


Figure 1. Site location, IFIM sampling sites, and habitat mapping sites.

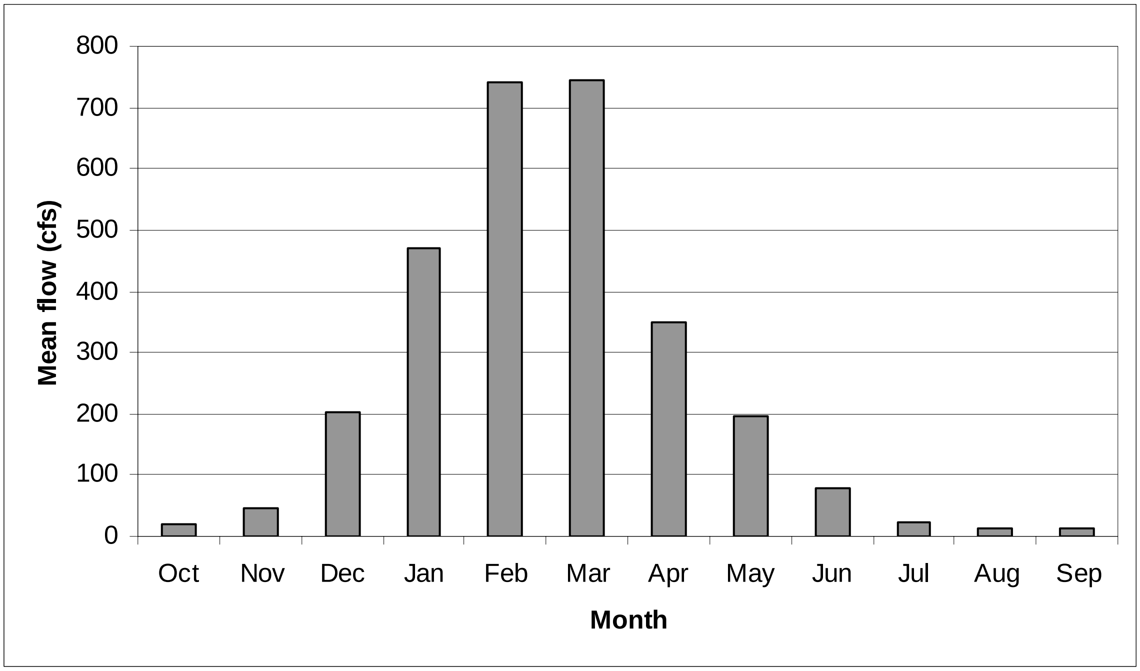


Figure 2. Mean monthly flows in Latah Creek.

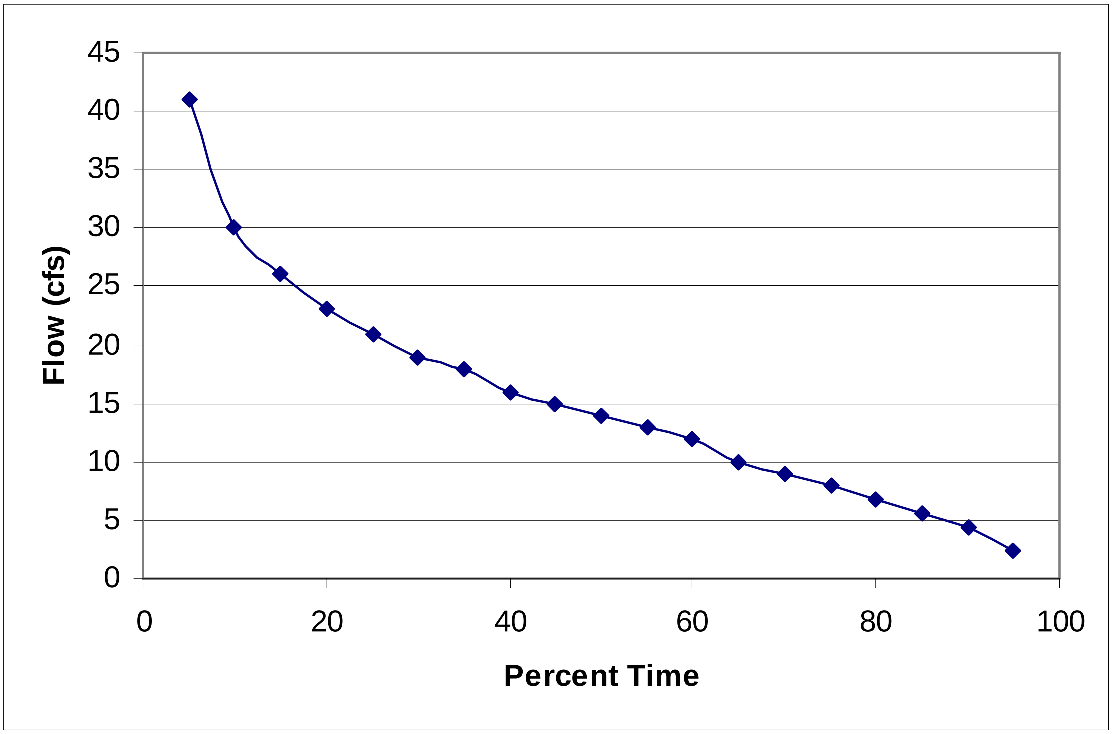


Figure 3. Flow exceedance at USGS gage, July-October (1948-2002 data).

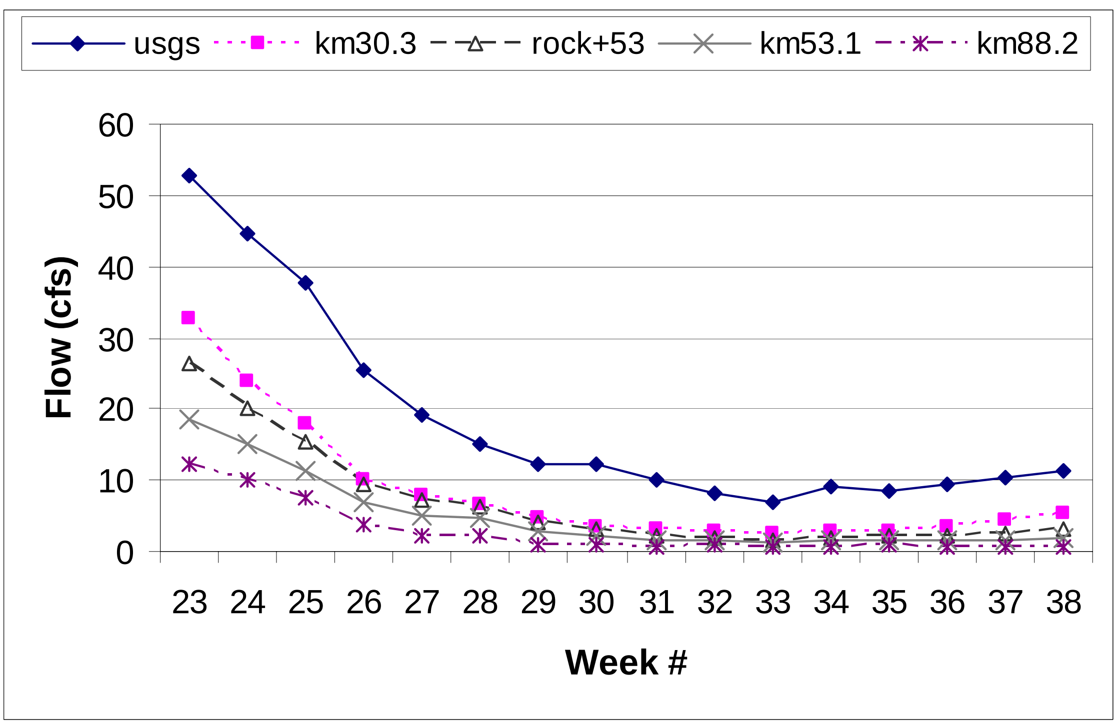


Figure 4. Relationship between gages during low flow period.

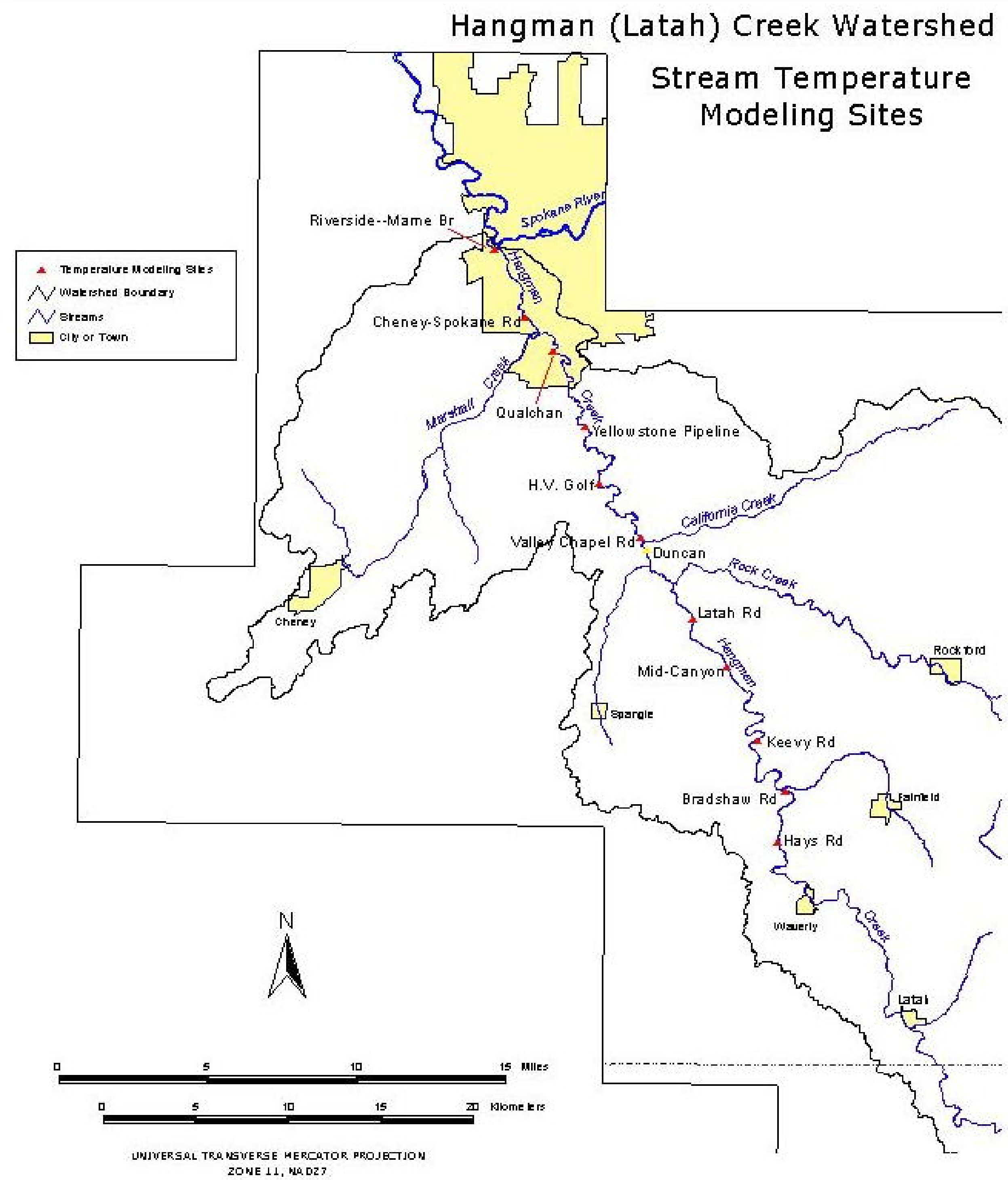
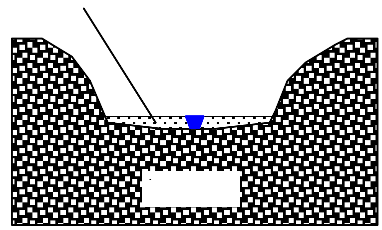


Figure 5. Map of study area with temperature model reference locations.



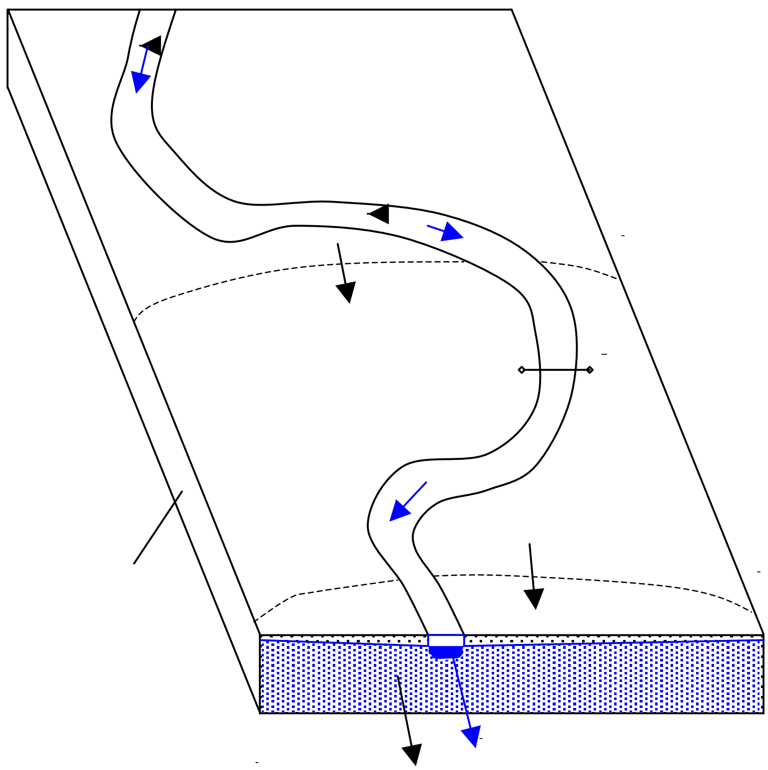


Figure 6. Schematic representation of the hydrological setting of Latah Creek.

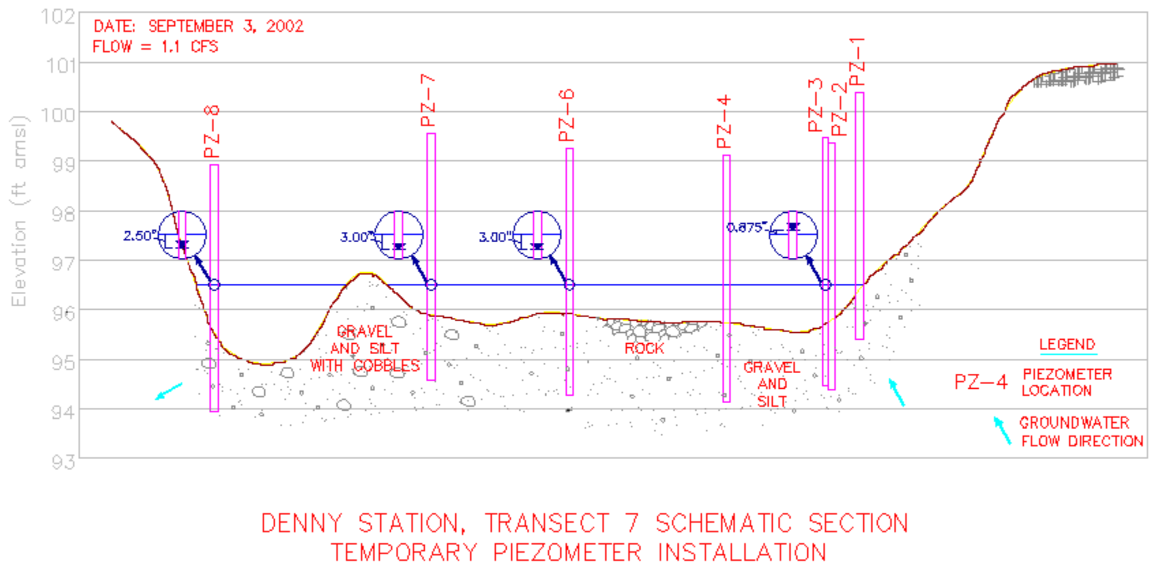


Figure 7. Schematic representation of cross section 7 at RM 35.4 (Denny site).

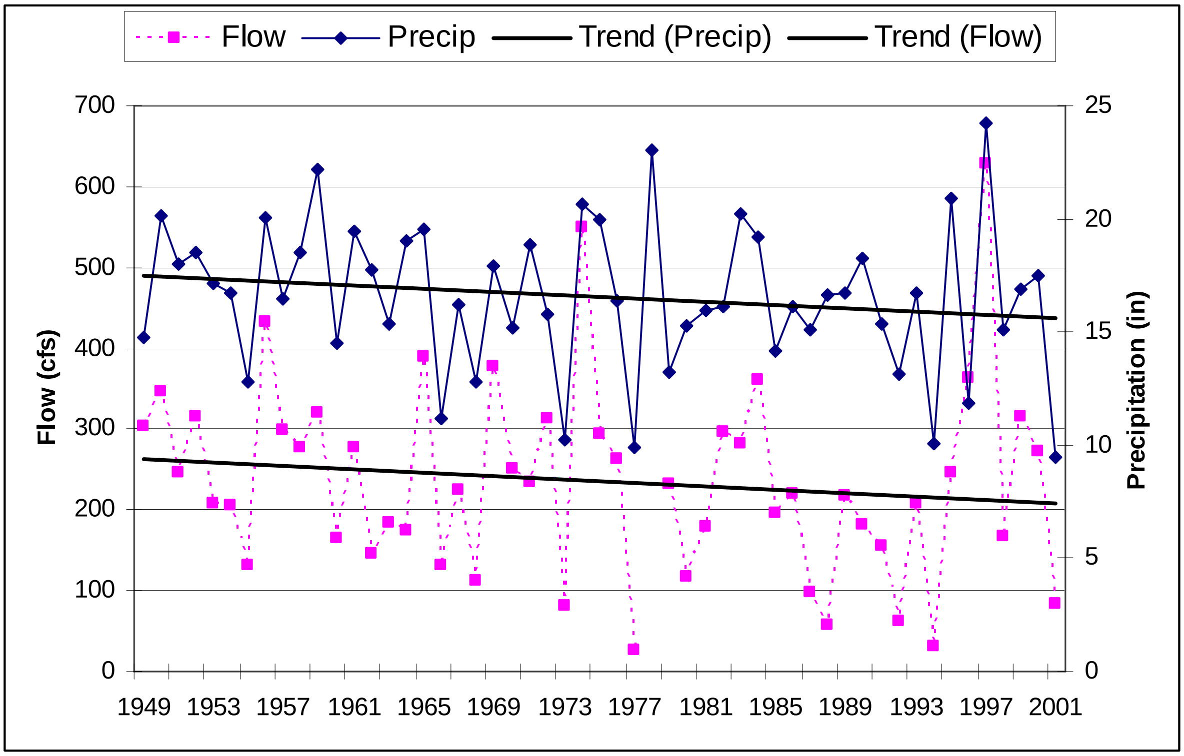


Figure 8. Mean annual discharge and annual precipitation in Latah Creek 1949-2001 (flow data from USGS gage at mouth, precip data from Spokane Airport).

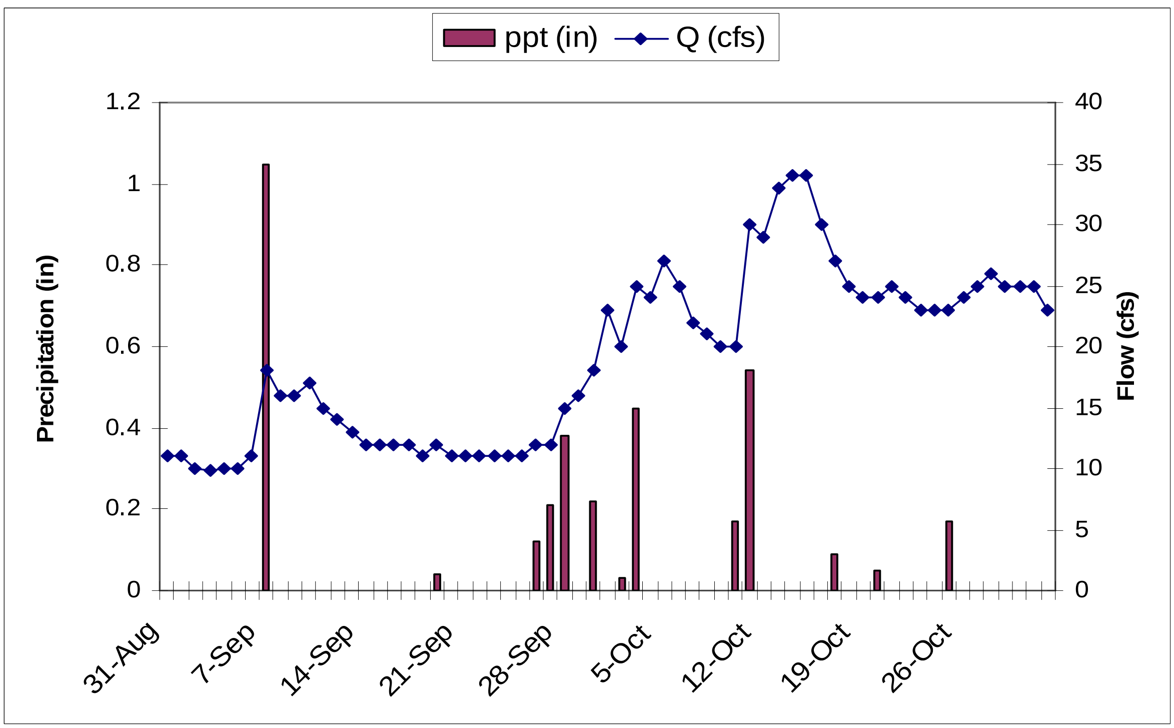


Figure 9. Event-scale hydrograph, September to October, 1995 (flow data from USGS gage at mouth, precip data from Spokane Airport).

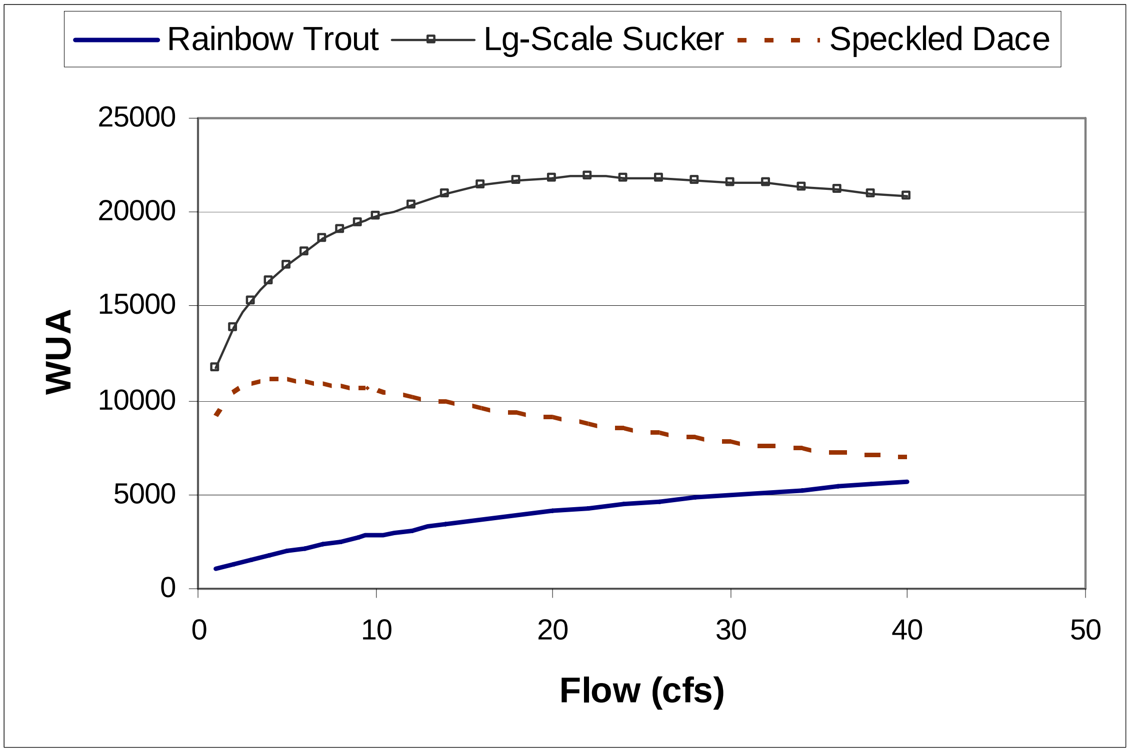


Figure 10. Weighted useable area at RM 35.4 for three species.

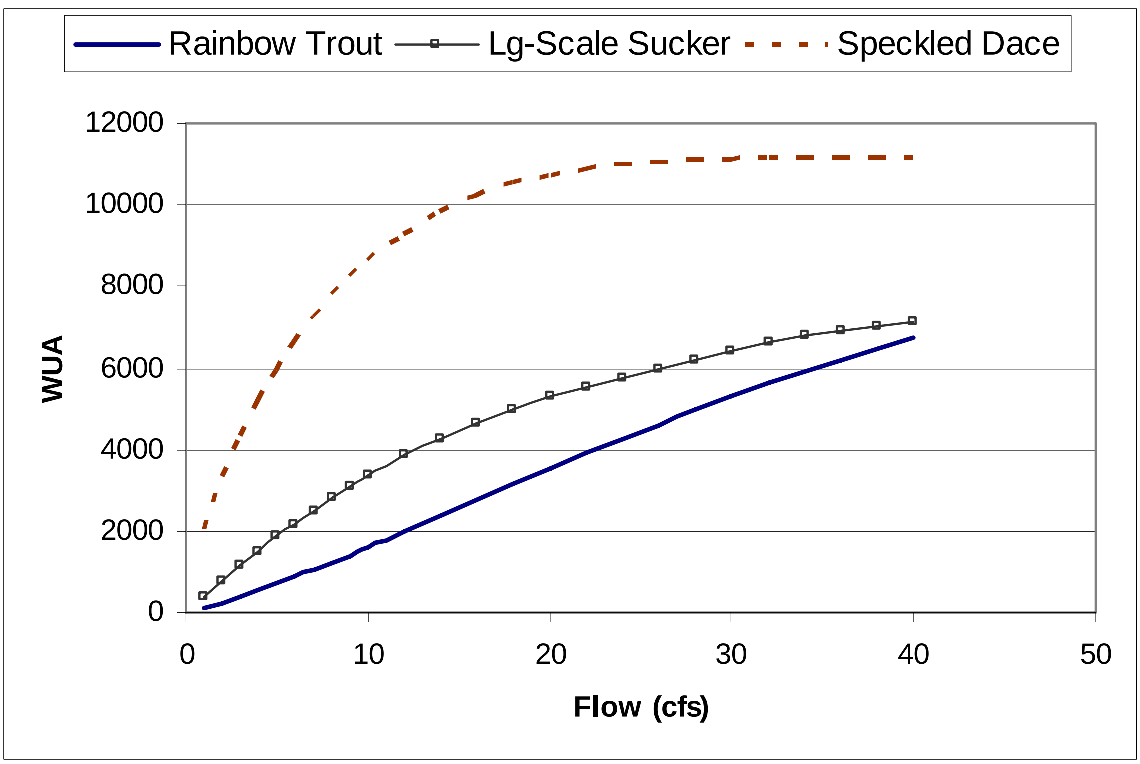


Figure 11. Weighted useable area at RM 29.2 for three species.

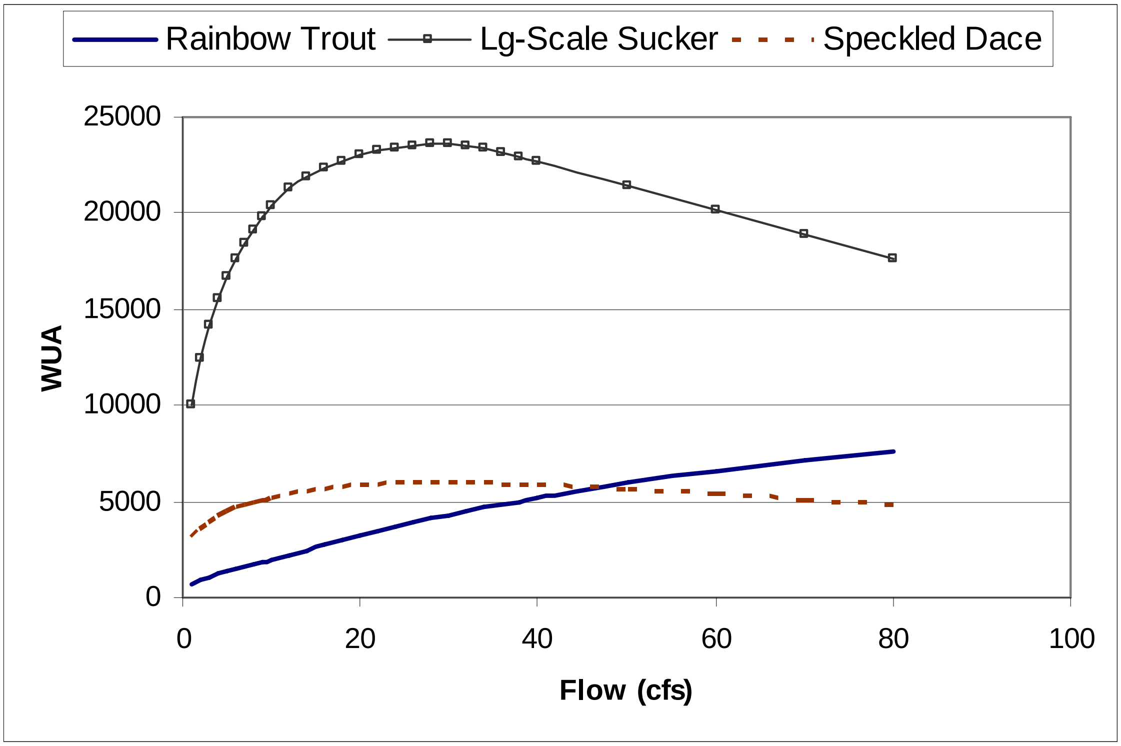


Figure 12. Weighted useable area at RM 2.5 for three species.

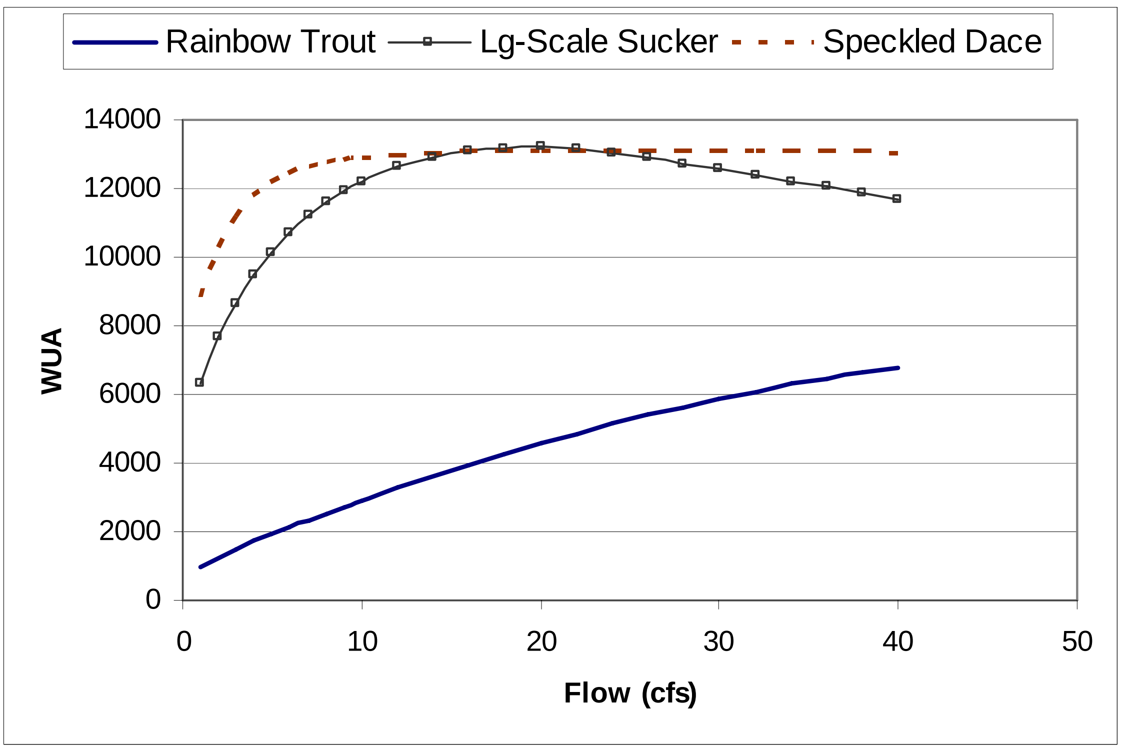


Figure 13. Weighted useable area at the Rock Creek site for three species.

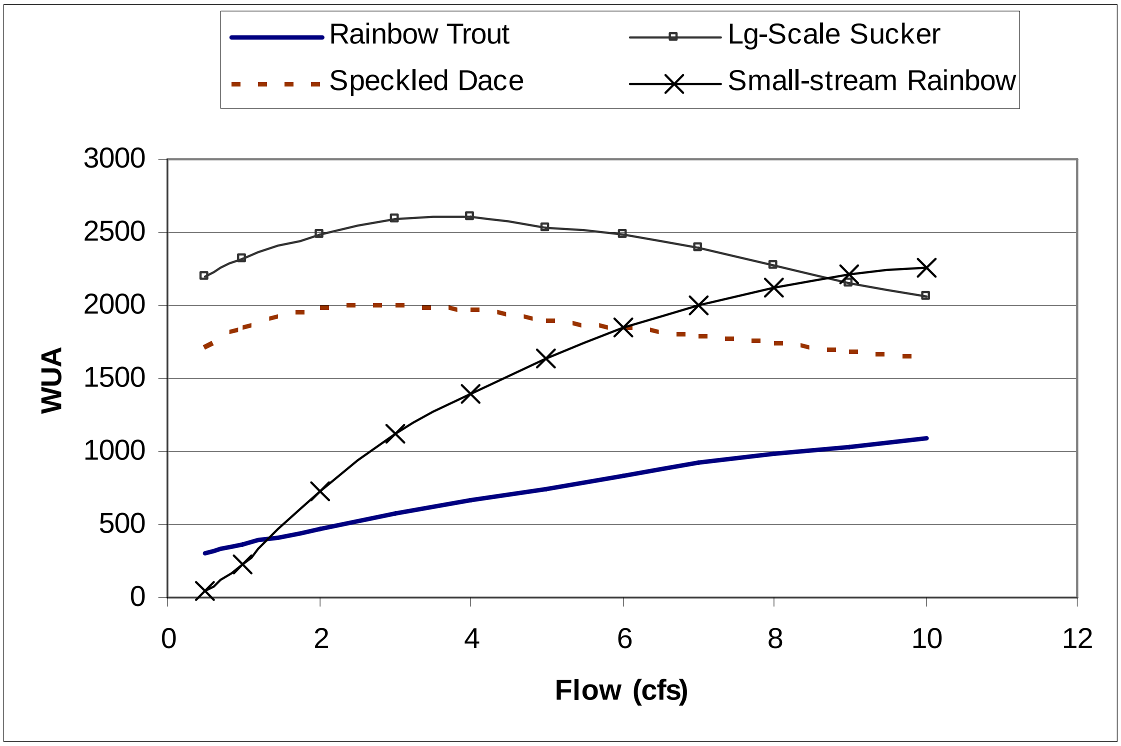


Figure 14. Weighted useable area at the California site for three species.

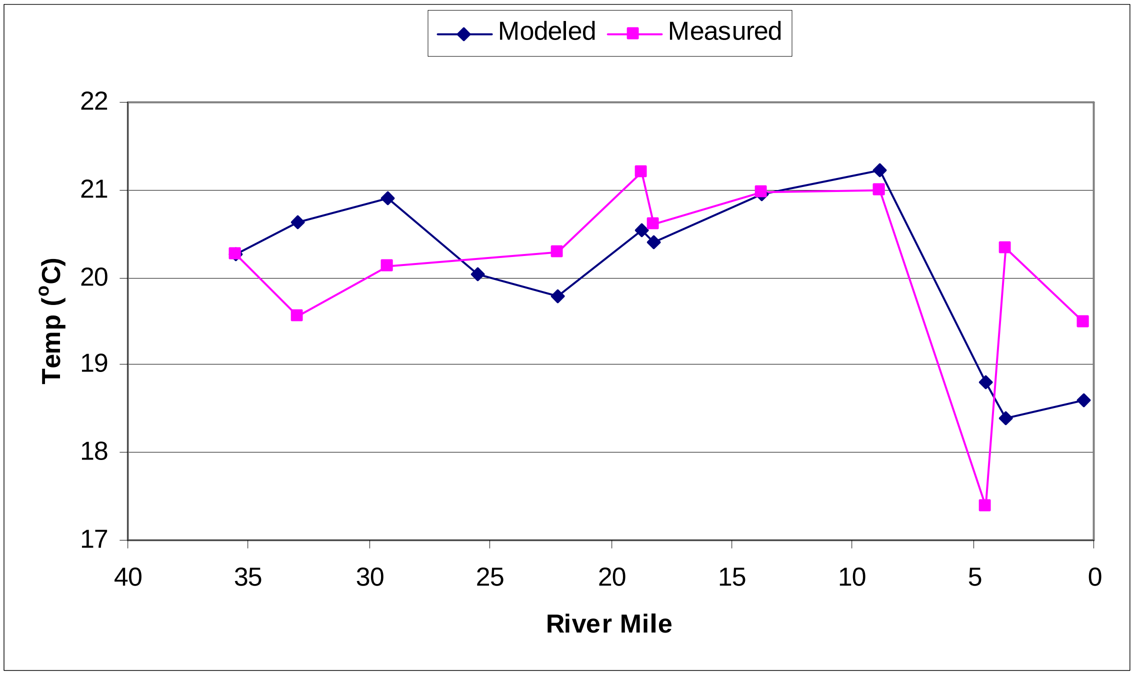


Figure 15. Measured and modeled stream temperatures for week 24.

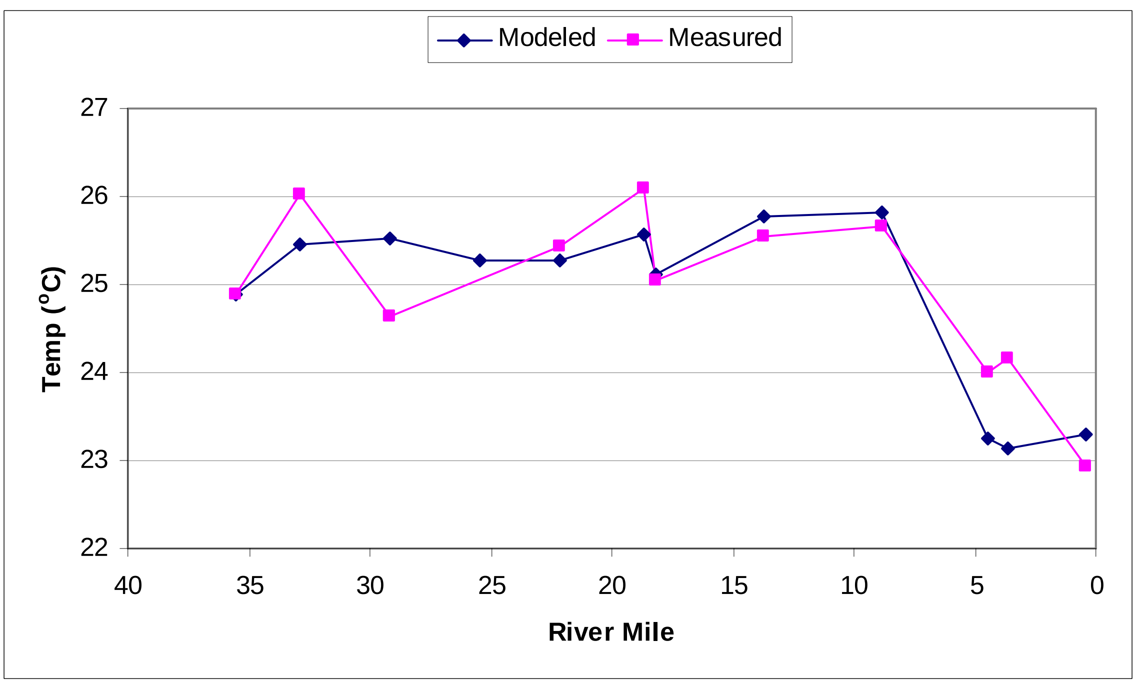


Figure 16. Measured and modeled stream temperatures for week 28.

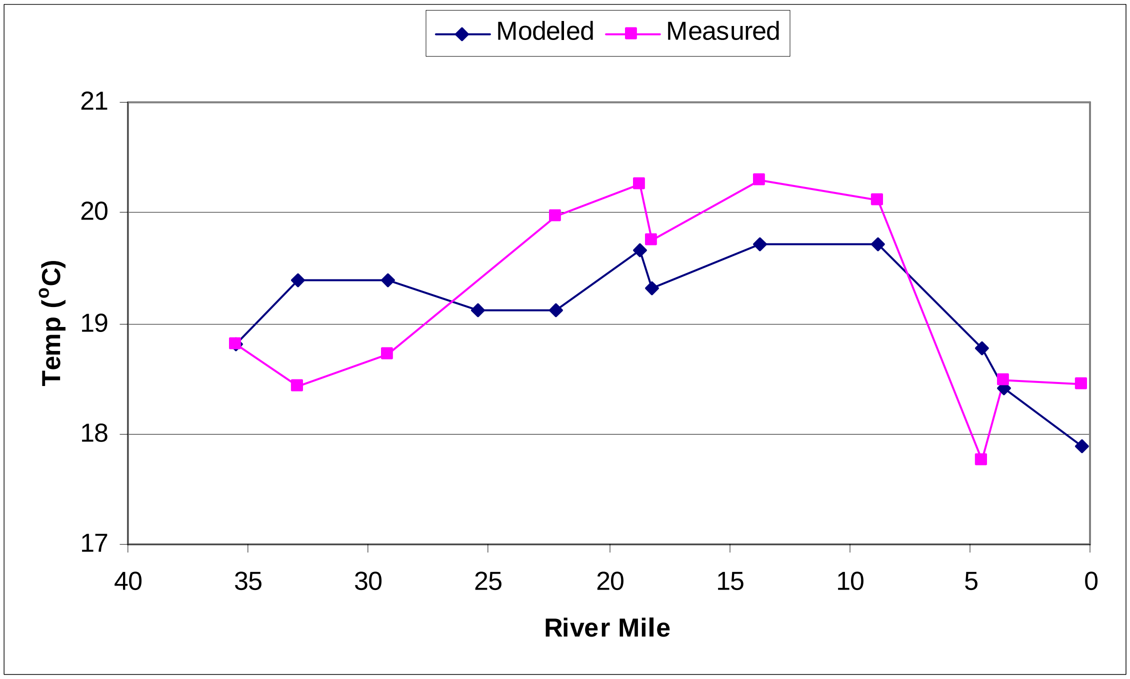


Figure 17. Measured and modeled stream temperatures for week 32.

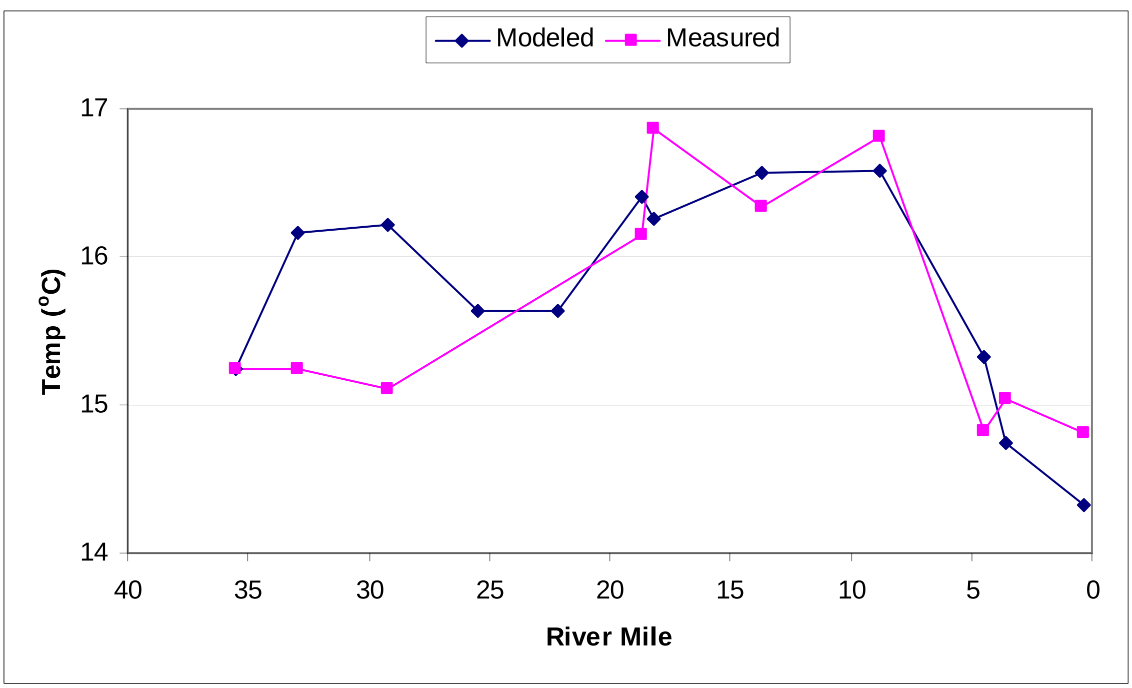


Figure 18. Measured and modeled stream temperatures for week 36.

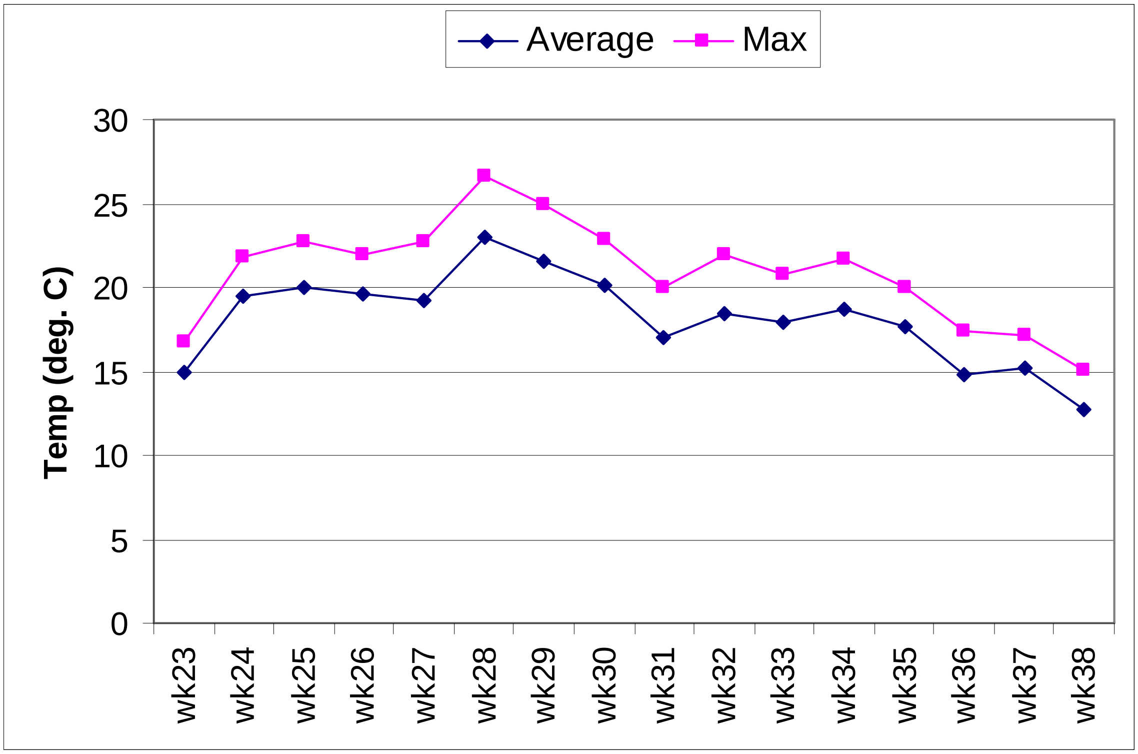


Figure 19. Measured weekly mean and maximum stream temperatures, RM 0.4.

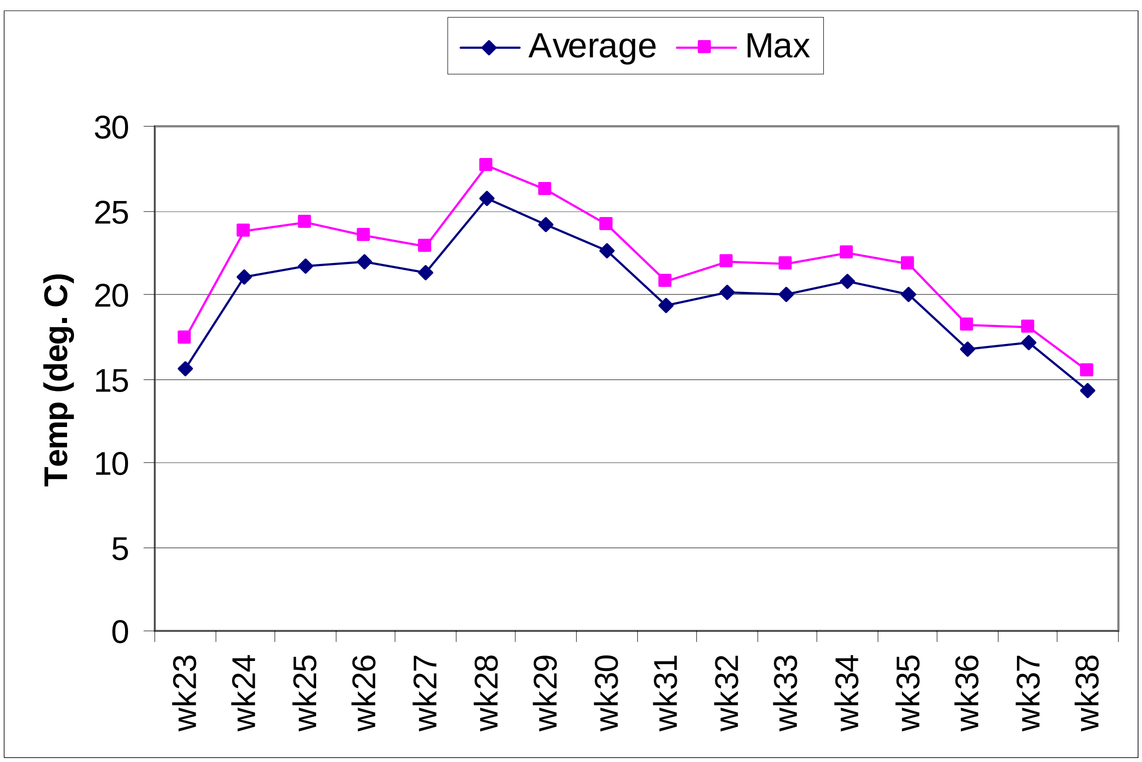


Figure 20. Measured weekly mean and maximum stream temperatures, RM 8.8.

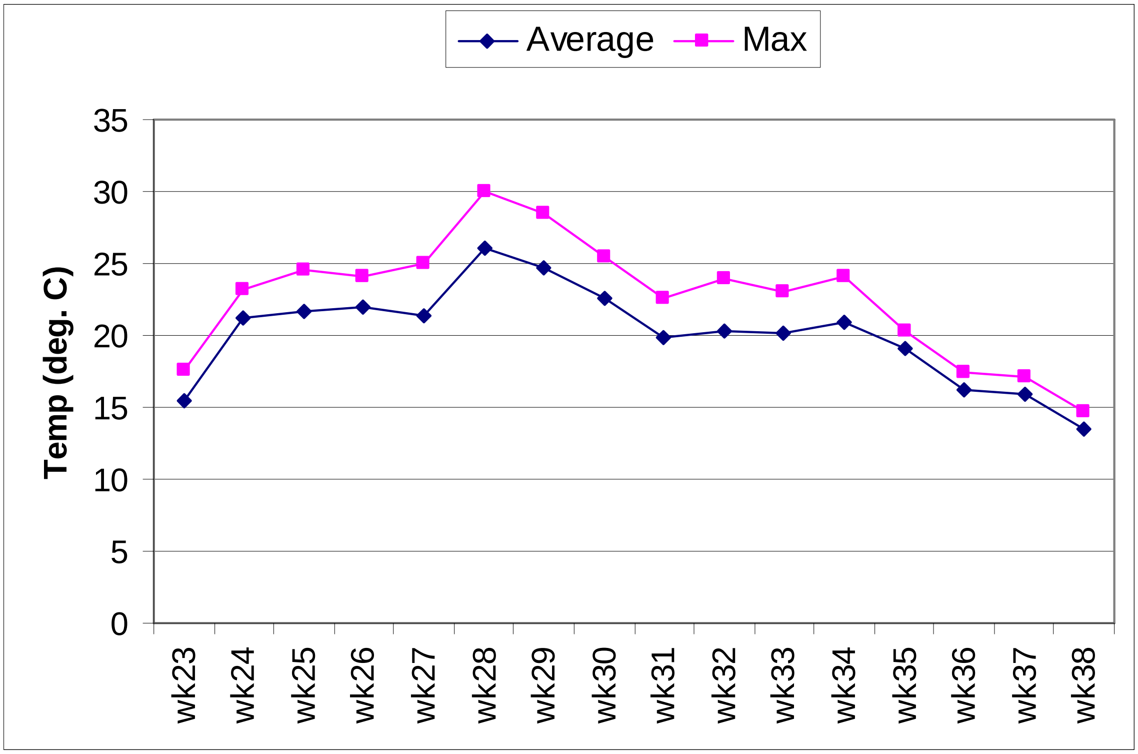


Figure 21. Measured weekly mean and maximum stream temperatures, RM 18.7.

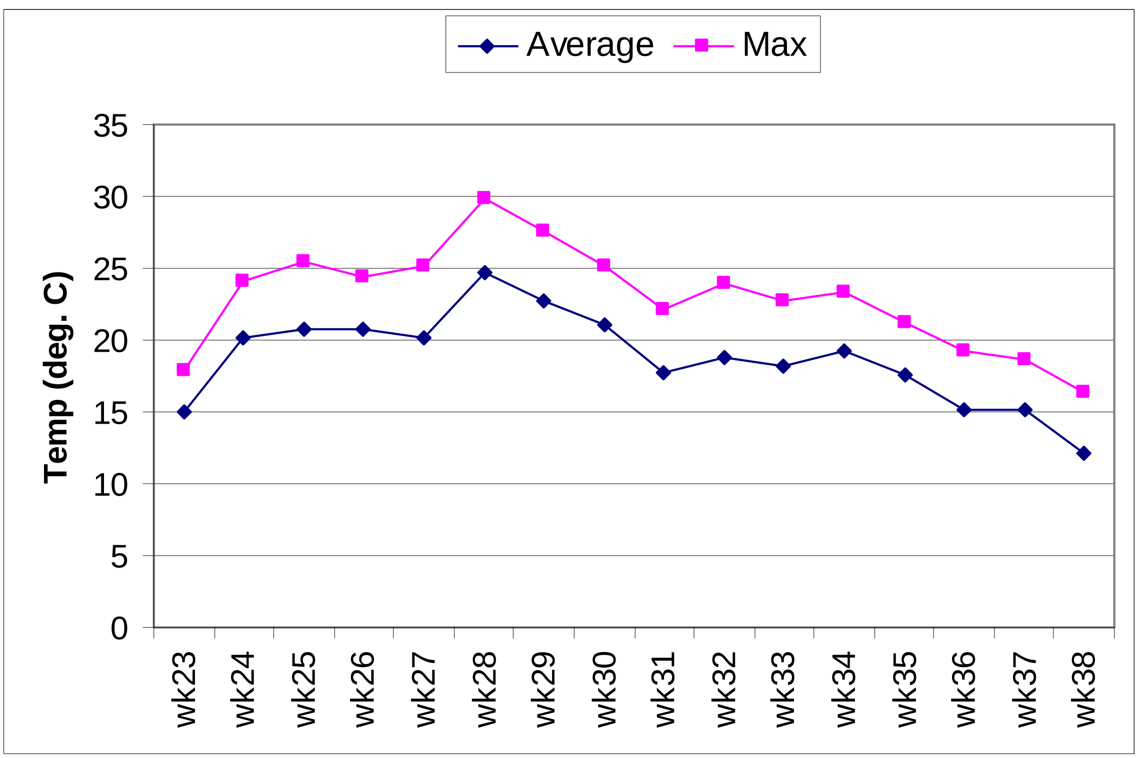


Figure 22. Measured weekly mean and maximum stream temperatures, RM 29.2.

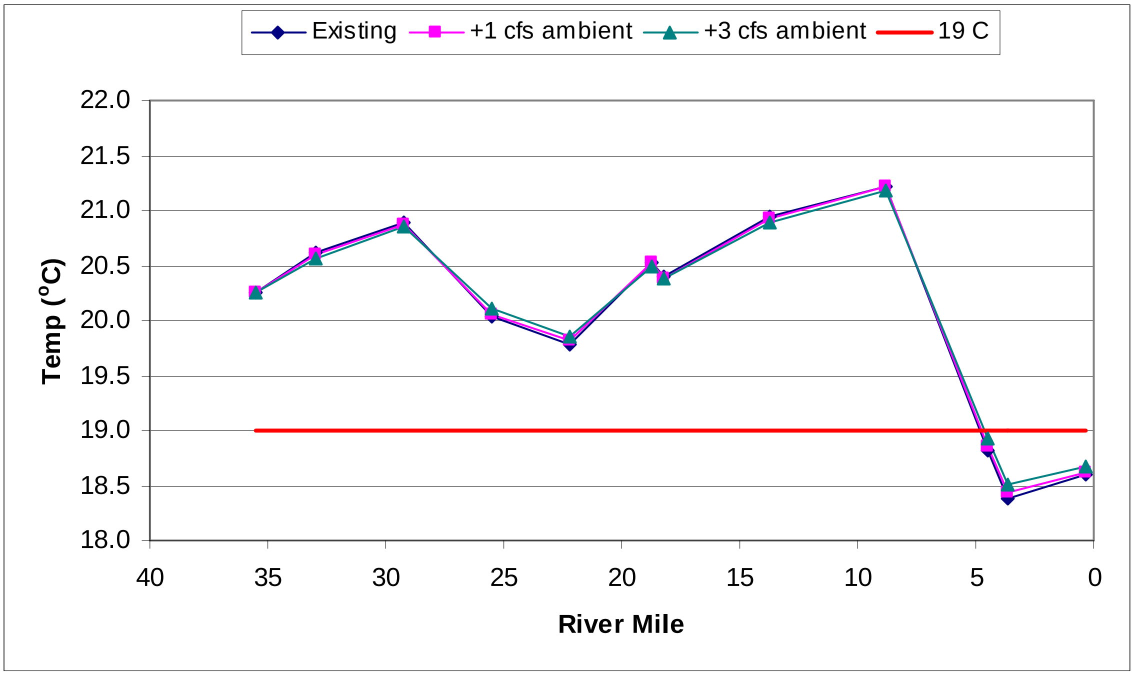


Figure 23. Longitudinal Temperature Comparison, Week 24 – simulated ambient inflow.

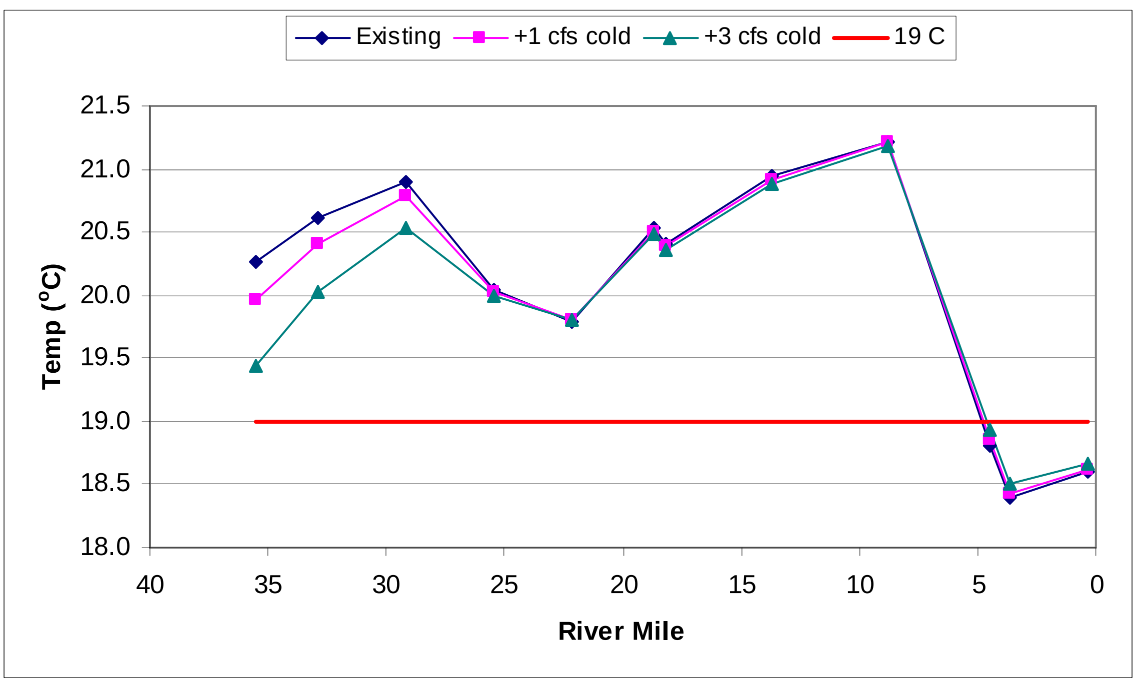


Figure 24. Longitudinal Temperature Comparison, Week 24 – simulated cold inflow.

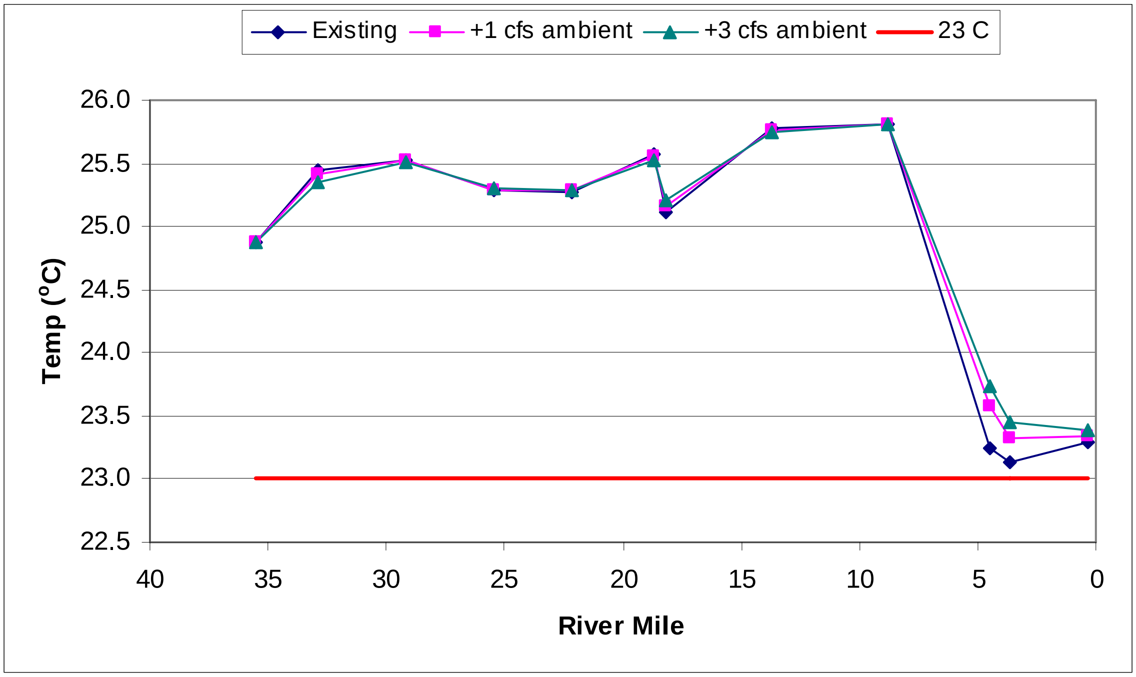


Figure 25. Longitudinal Temperature Comparison, Week 28 – simulated ambient inflow.

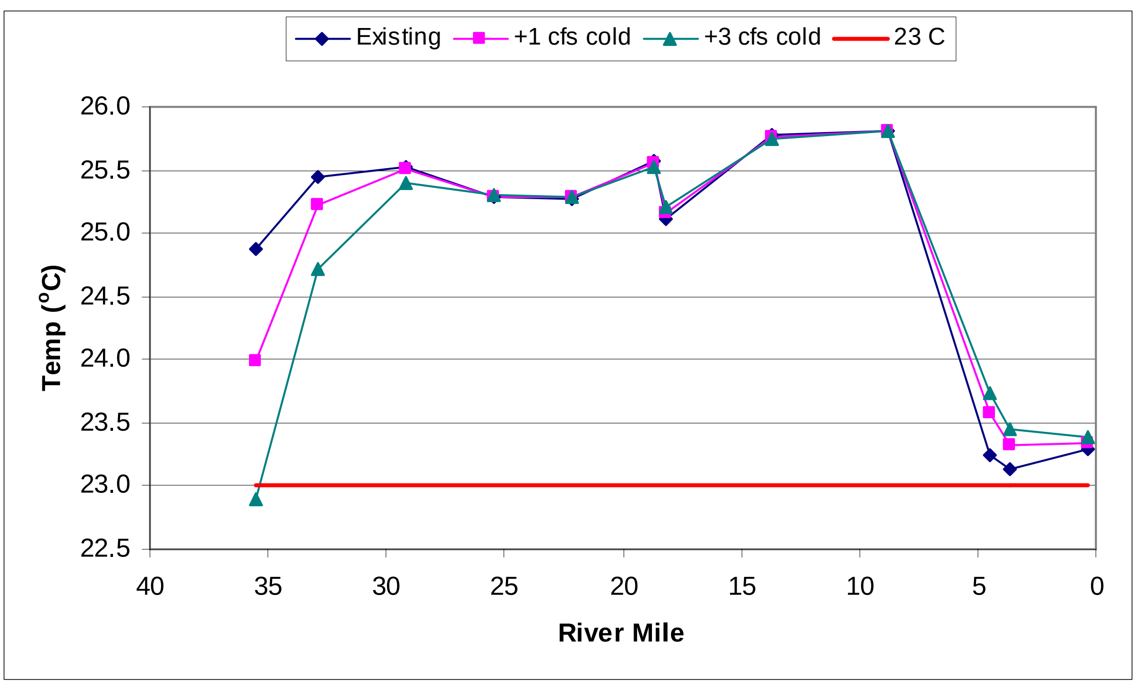


Figure 26. Longitudinal Temperature Comparison, Week 28 – simulated cold inflow.

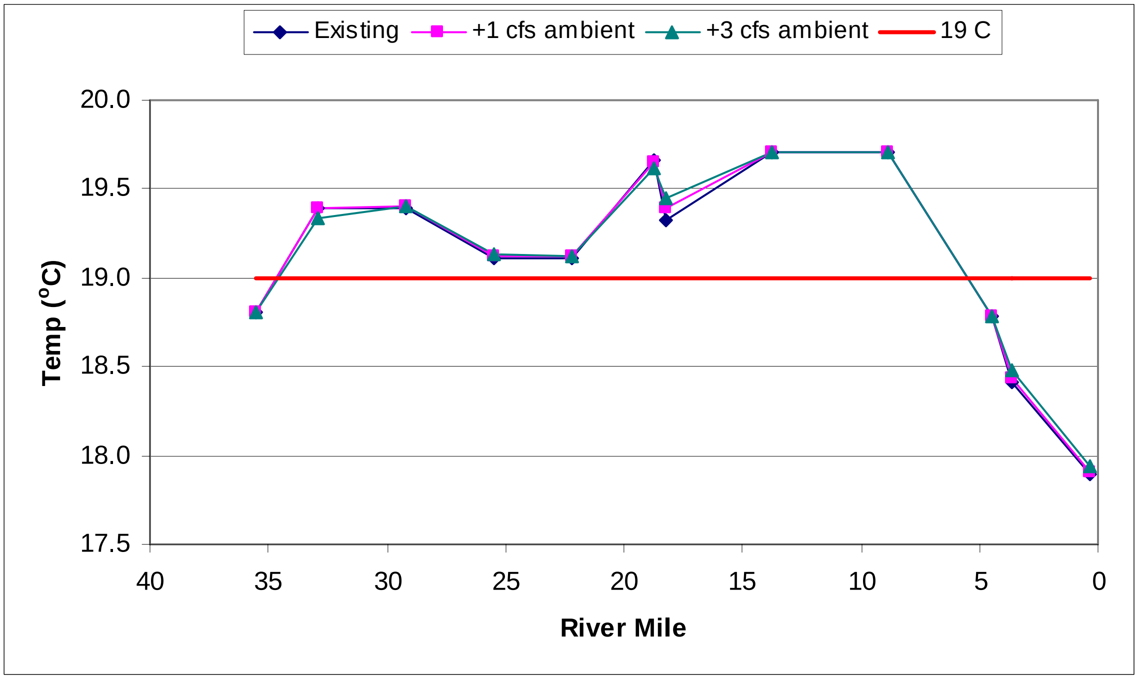


Figure 27. Longitudinal Temperature Comparison, Week 32 – simulated ambient inflow.

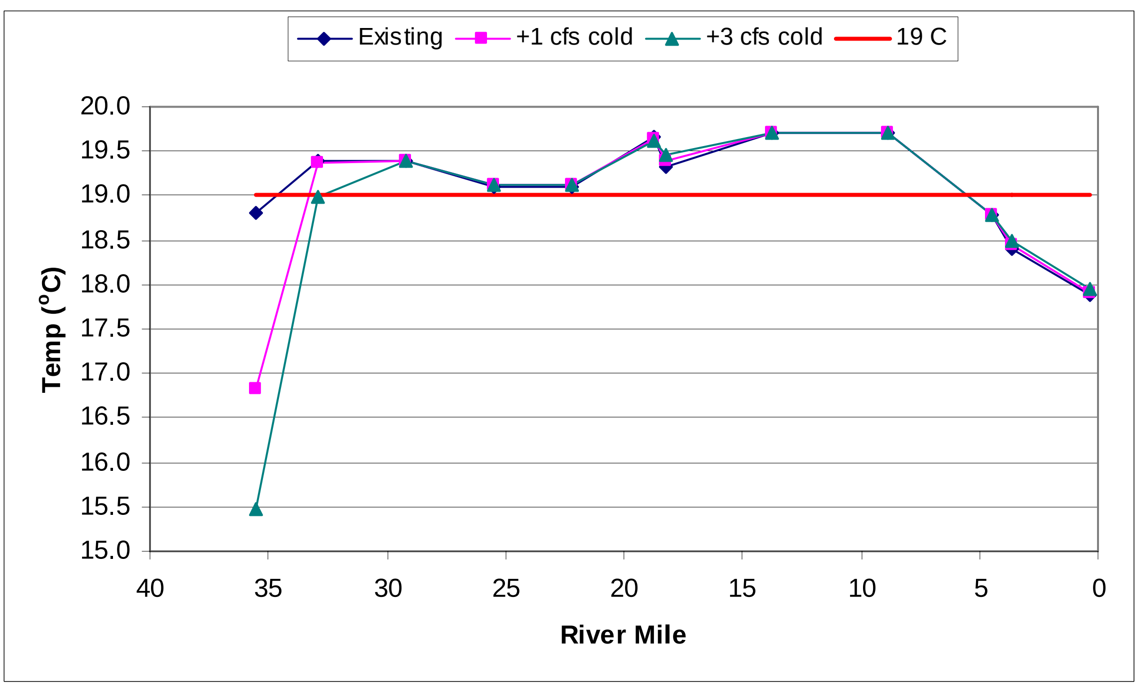


Figure 28. Longitudinal Temperature Comparison, Week 32 – simulated cold inflow.

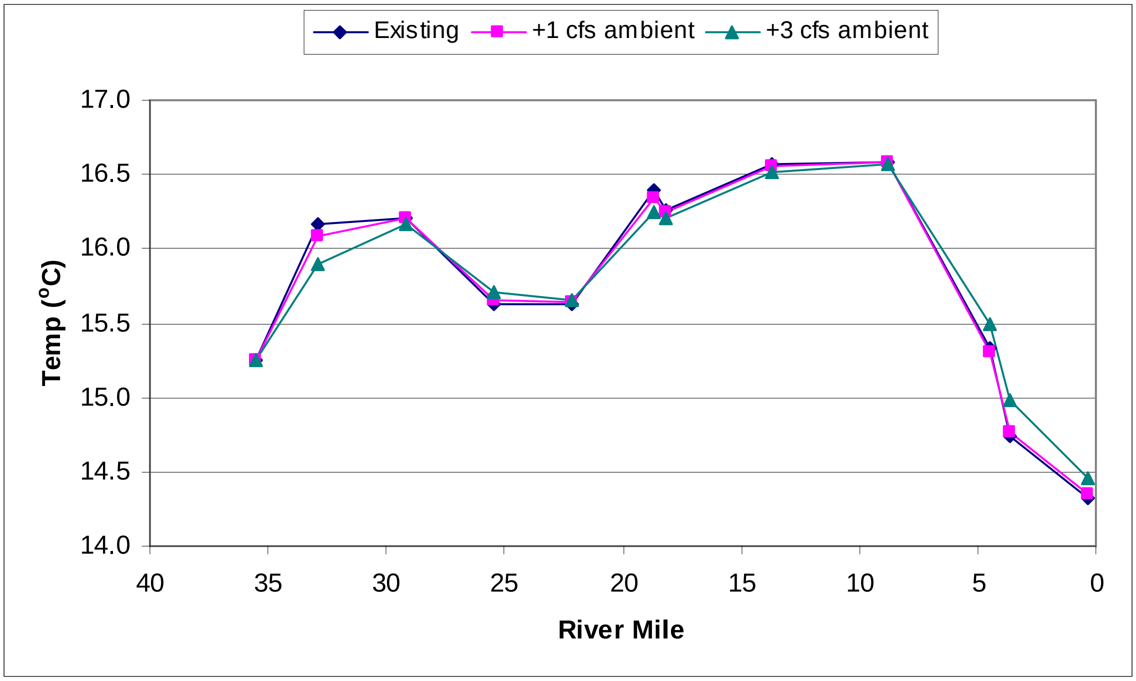


Figure 29. Longitudinal Temperature Comparison, Week 36 – simulated ambient inflow.

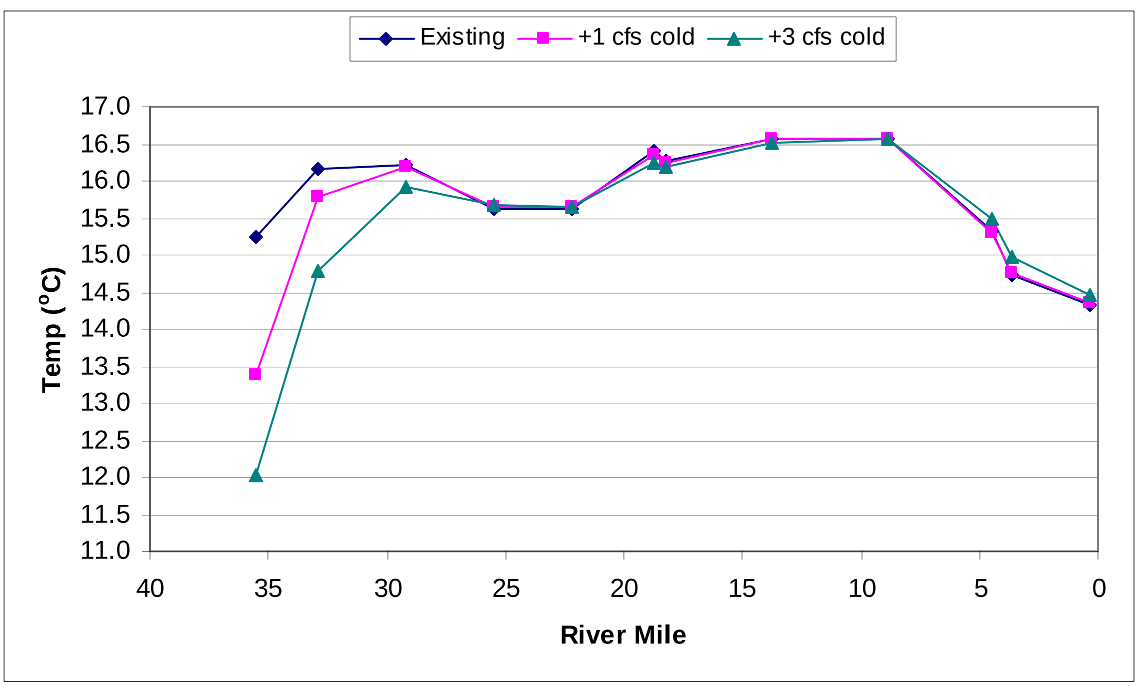


Figure 30. Longitudinal Temperature Comparison, Week 36 – simulated cold inflow.

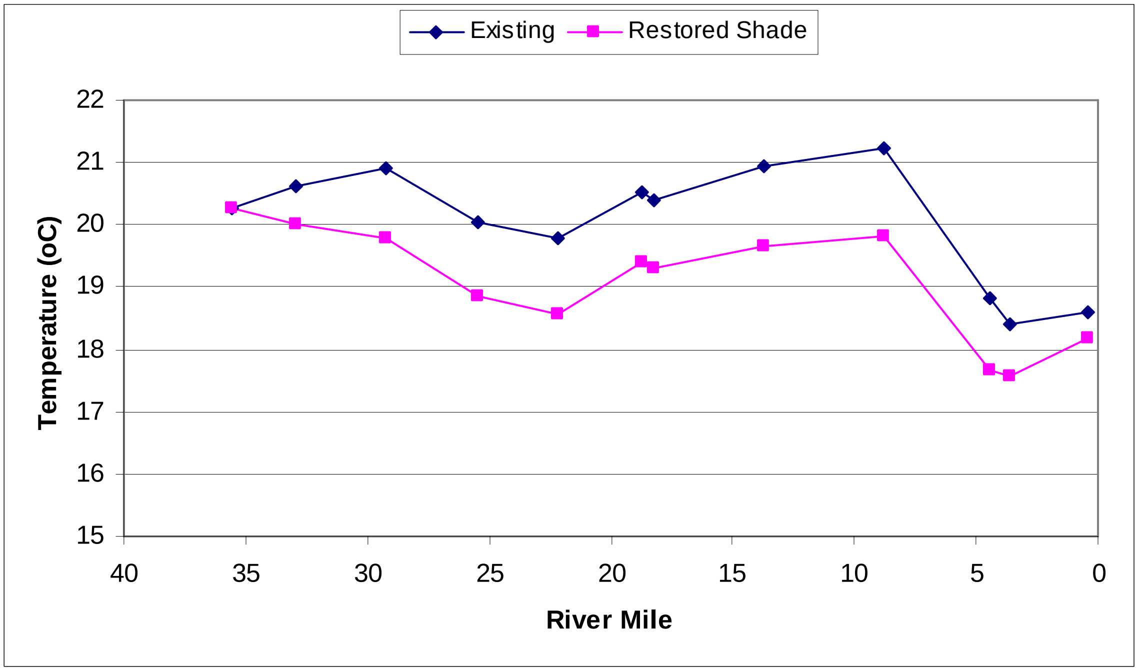


Figure 31. Mean Temperature Comparison, modeled existing conditions and restored shade, Week 24.

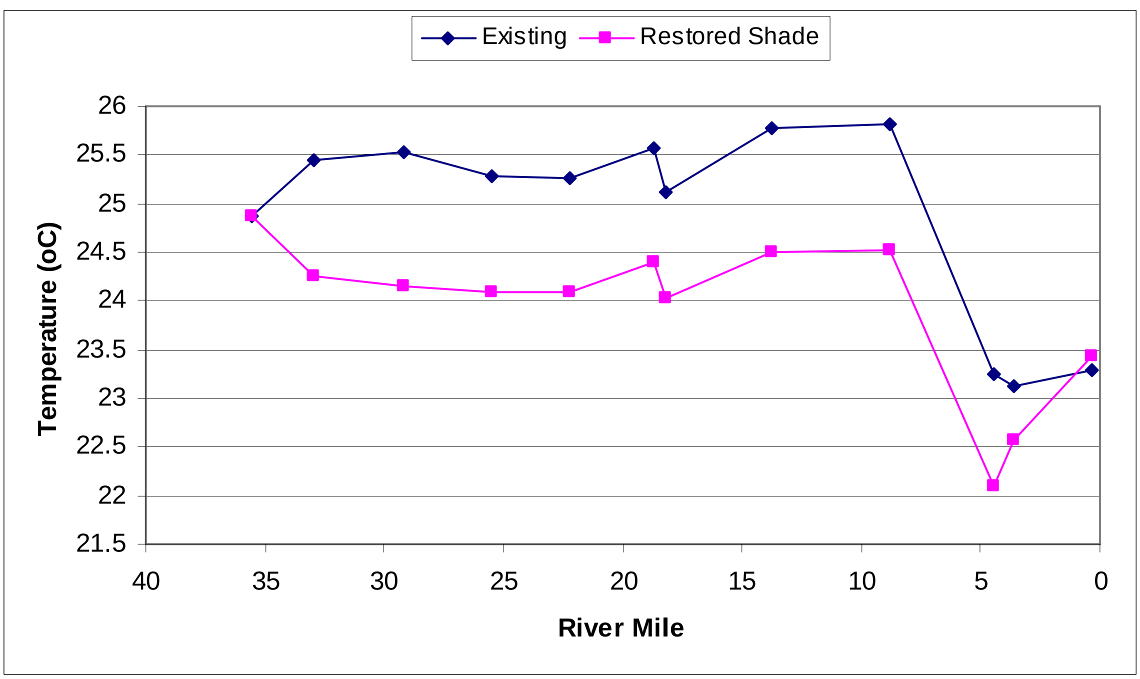


Figure 32. Mean Temperature Comparison, modeled existing conditions and restored shade, Week 28.

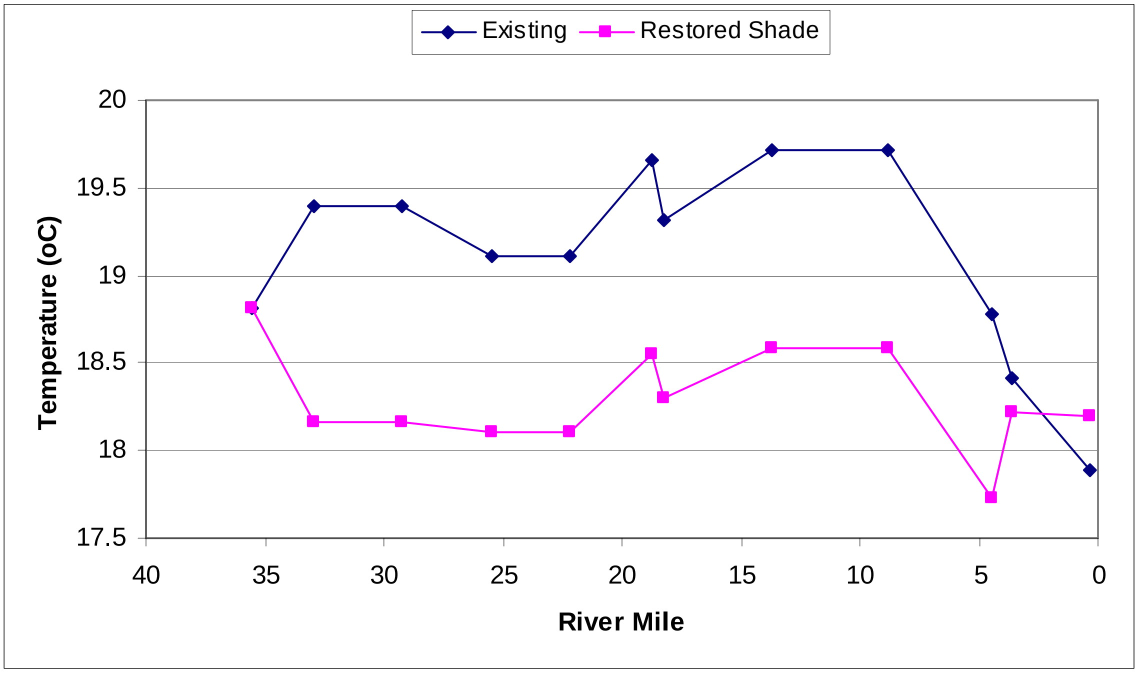


Figure 33. Mean Temperature Comparison, modeled existing conditions and restored shade, Week 32.

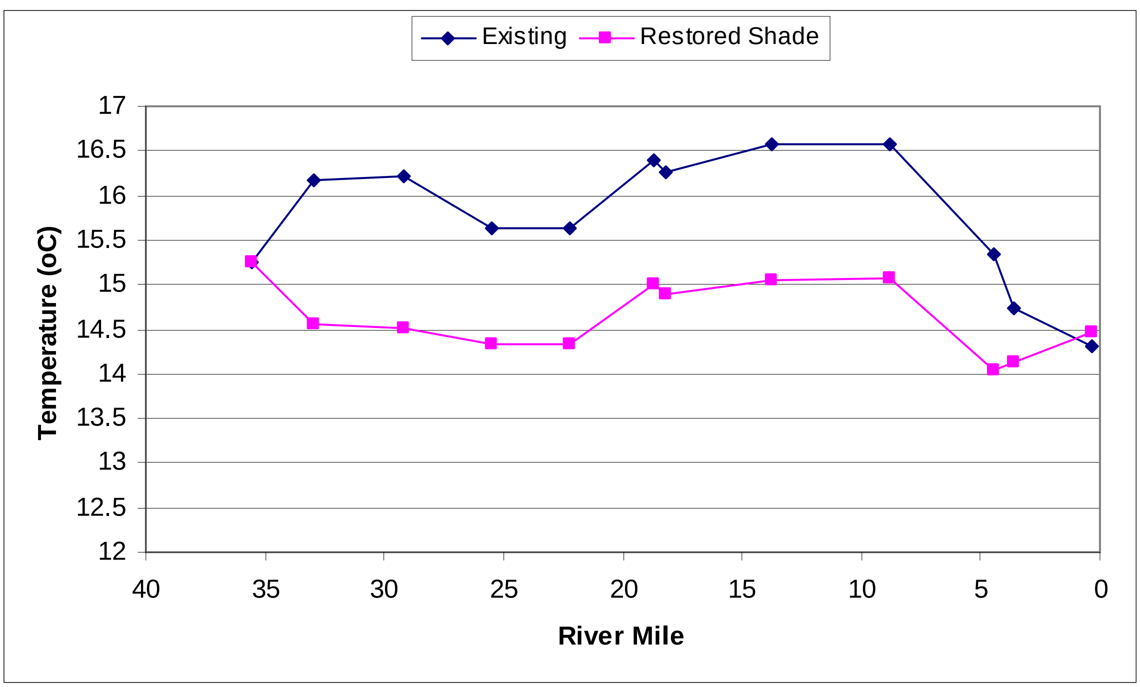


Figure 34. Mean Temperature Comparison, modeled existing conditions and restored shade, Week 36.

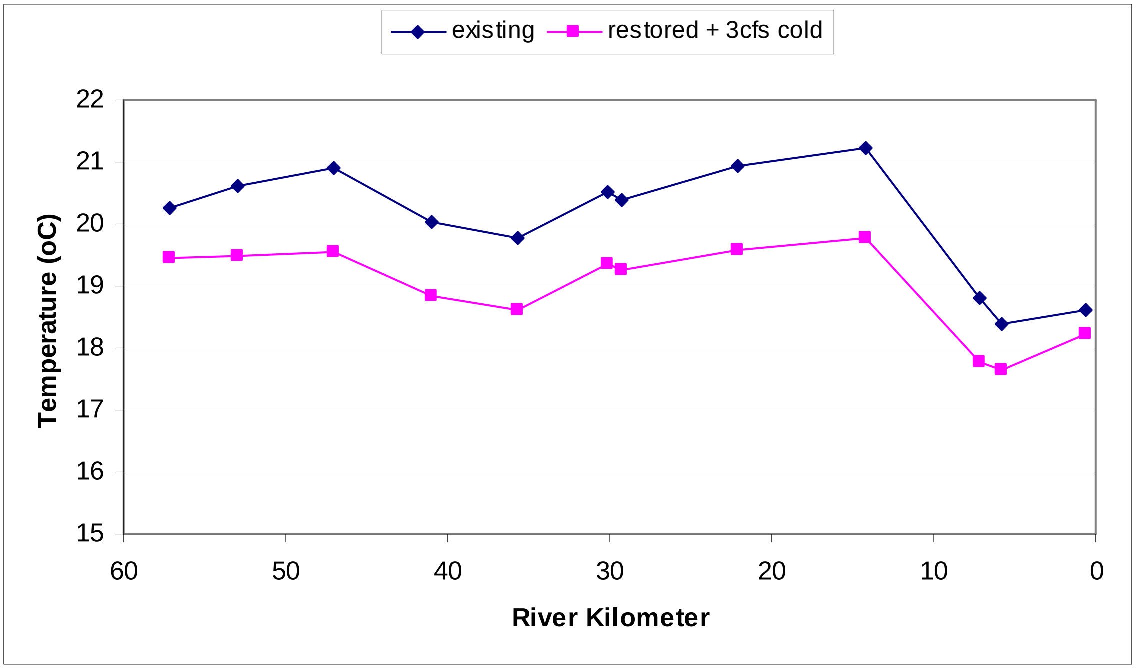


Figure 35. Mean temperature comparison, existing conditions and restored shade and flow, Week 24.

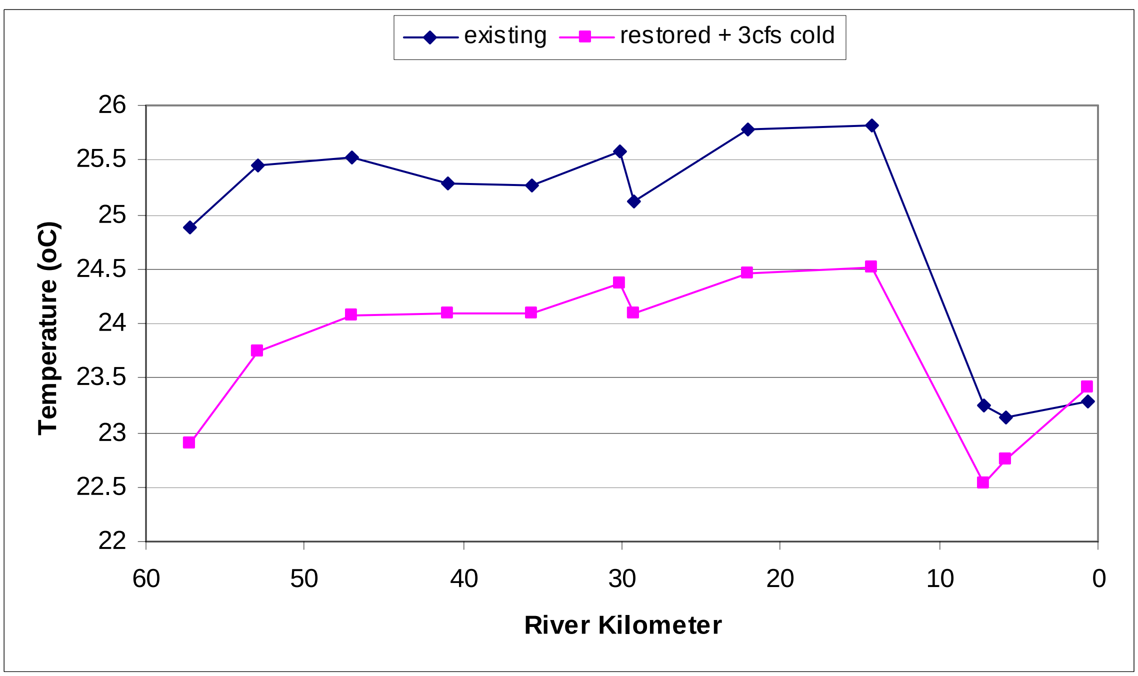


Figure 36. Mean temperature comparison, existing conditions and restored shade and flow, Week 28

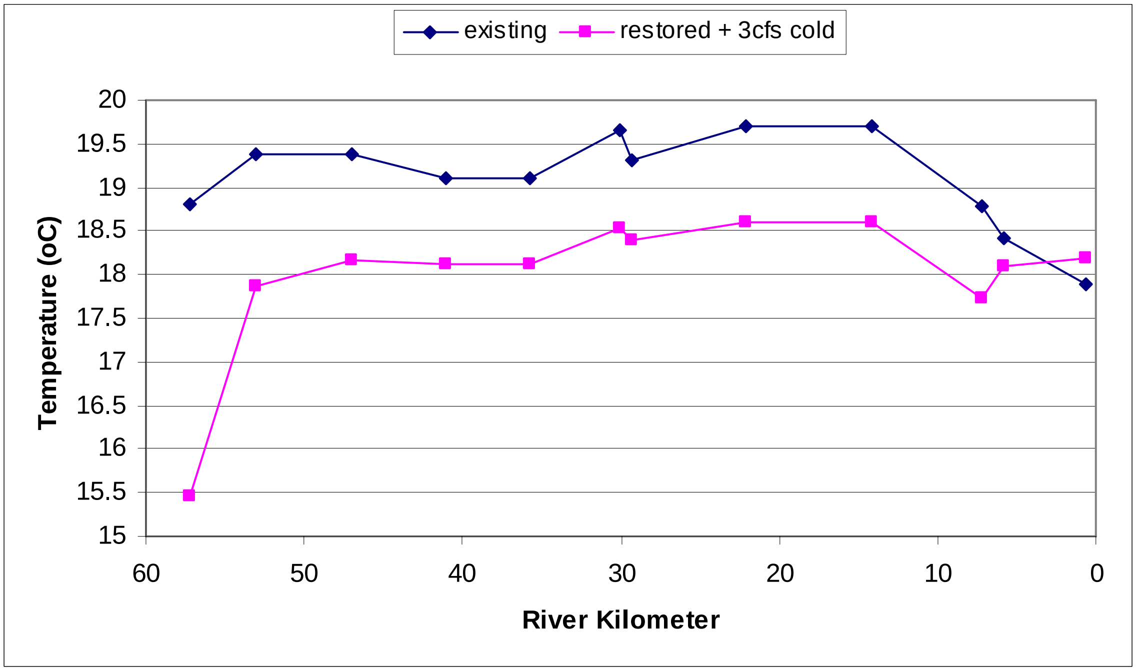


Figure 37. Mean temperature comparison, existing conditions and restored shade and flow, Week 32

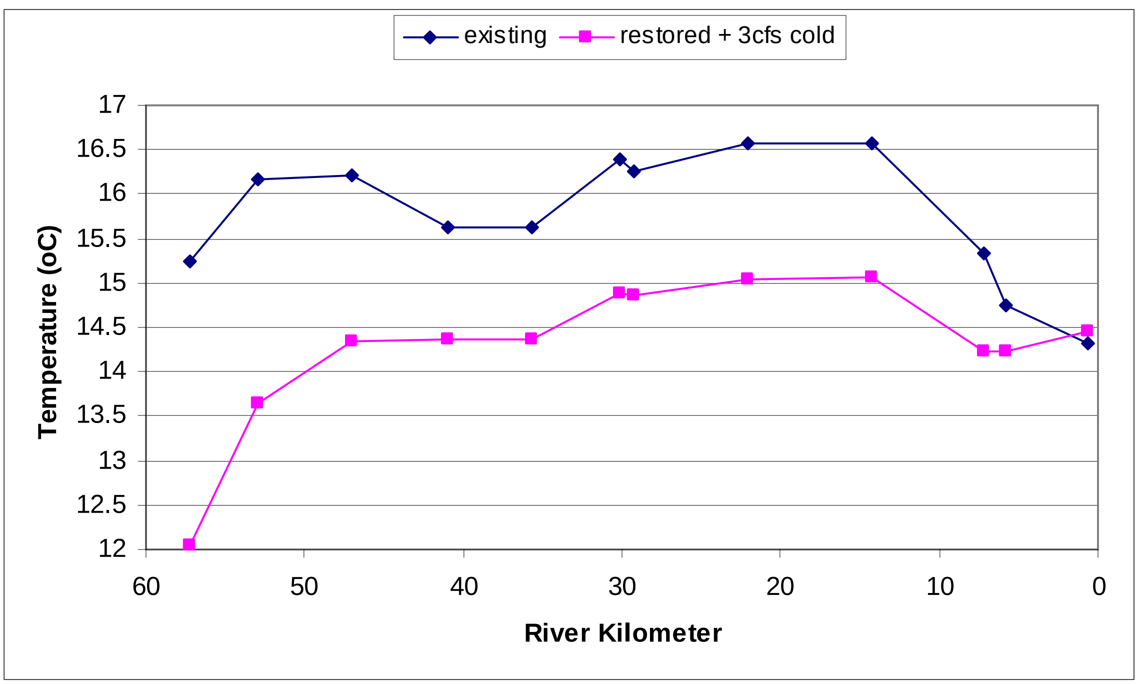


Figure 38. Mean temperature comparison, existing conditions and restored shade and flow, Week 36

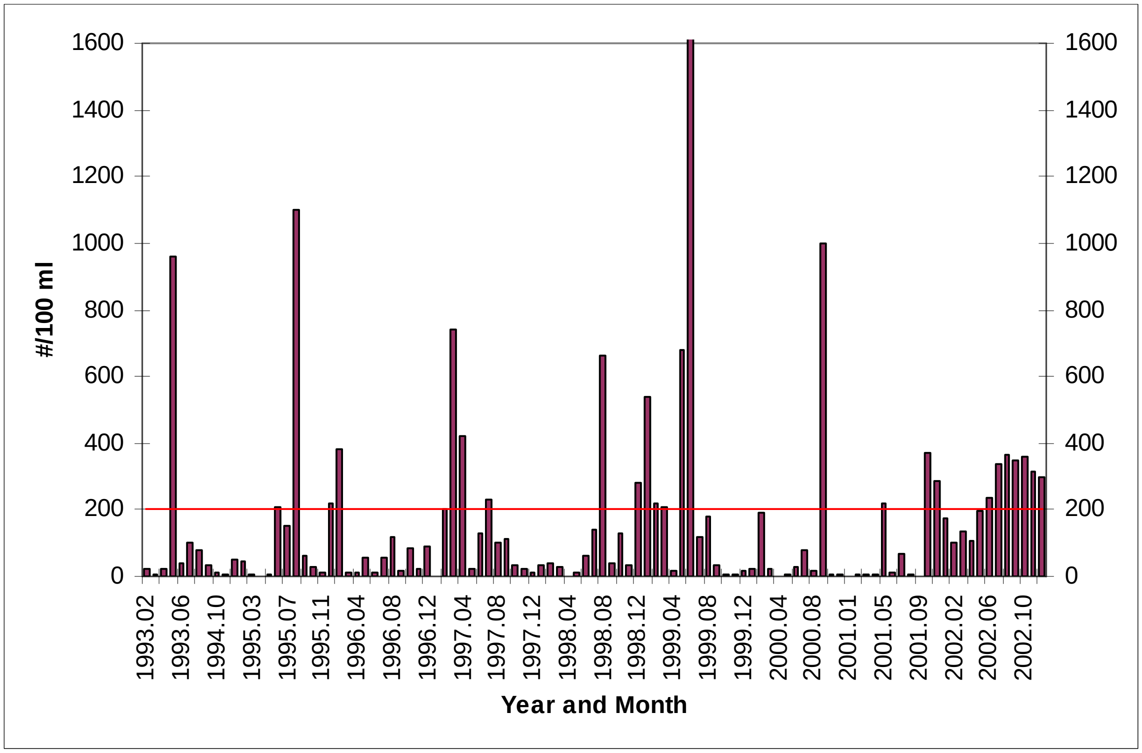


Figure 39a. Fecal coliform levels measured one day per month in Latah Creek near the mouth; 26 out of 103 measurements exceed maximum recommended level (DEQ data, 1993-2002).

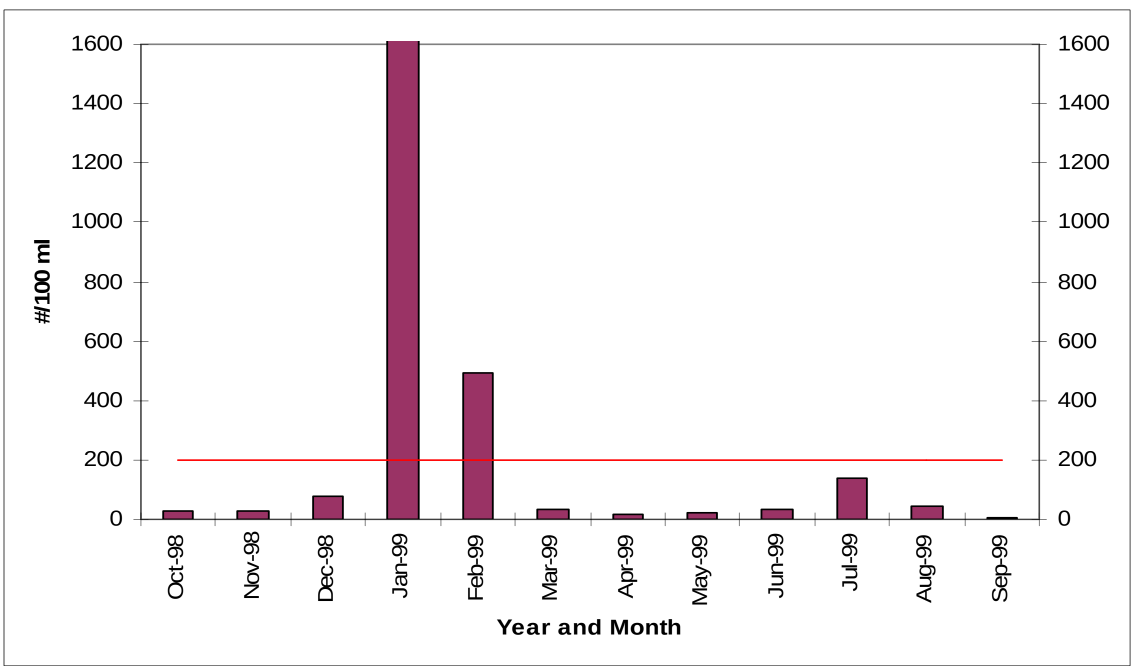


Figure 39b. Fecal coliform levels measured one day per month in Latah Creek near Bradshaw; 2 out of 12 measurements exceed maximum recommended level (DEQ data, 1998-1999).

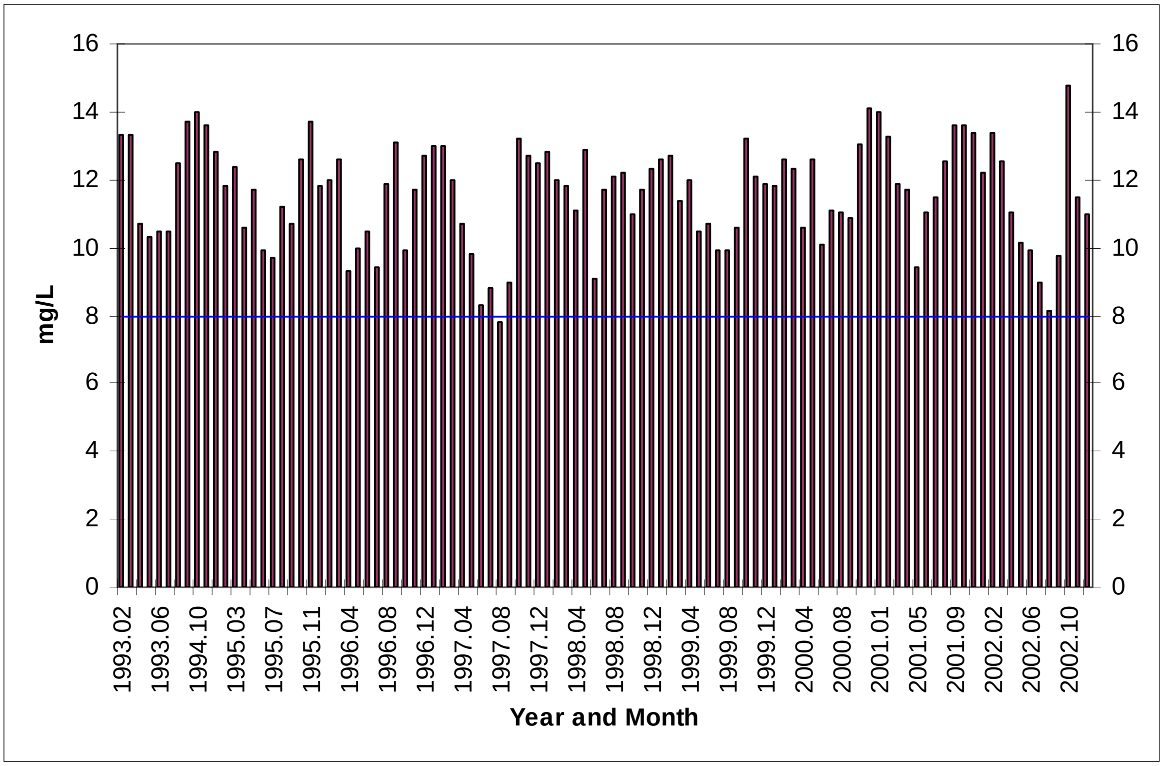


Figure 40a. Dissolved oxygen levels measured one day per month in Latah Creek near the mouth; 1 out of 103 measurements exceed minimum recommended level (DEQ data, 1993-2002).

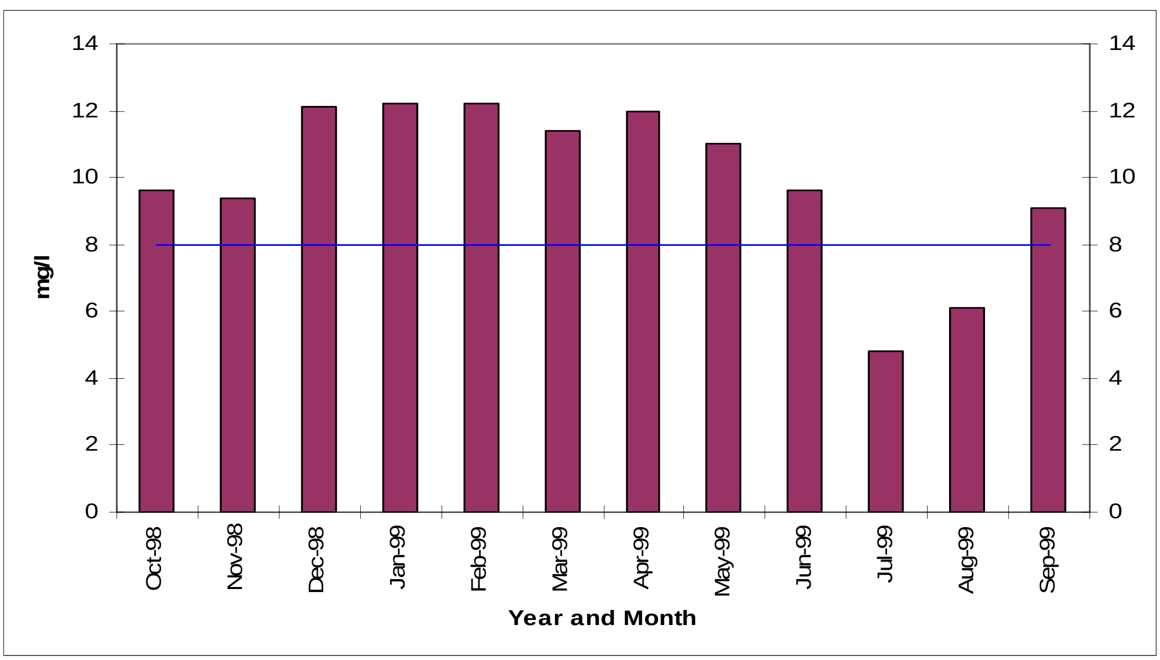


Figure 40b. Dissolved oxygen levels measured one day per month in Latah Creek near Bradshaw; 2 out of 12 measurements exceed minimum recommended level (DEQ data, 1998-1999).

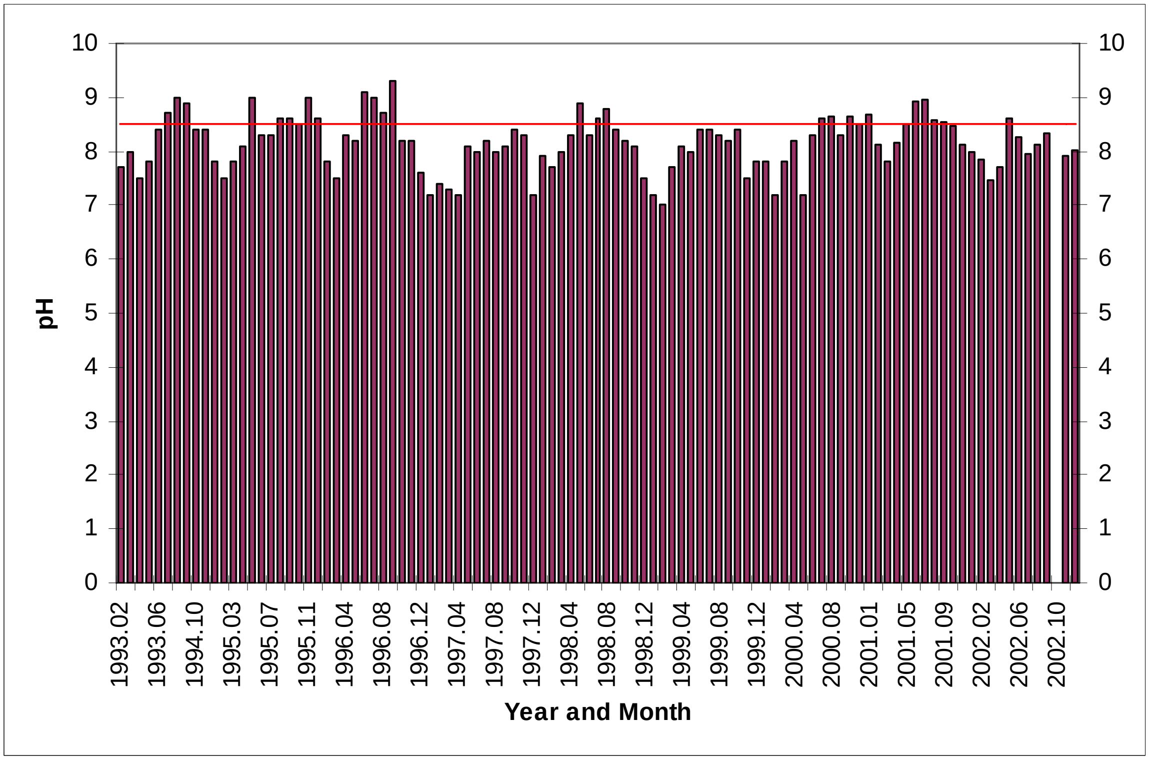


Figure 41a. PH levels measured one day per month in Latah Creek near the mouth; 25 of 103 measurements exceed maximum recommended level (DEQ data, 1993-2002).

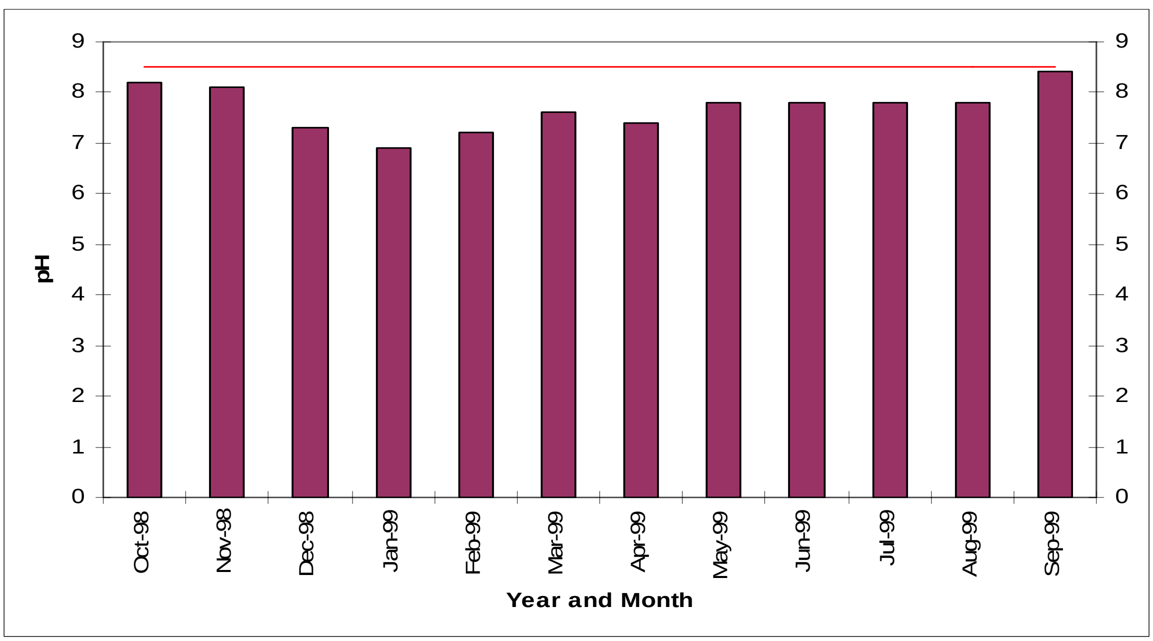


Figure 41b. PH levels measured one day per month in Latah Creek near Bradshaw; 0 of 12 measurements exceed maximum recommended level (DEQ data, 1998-1999).

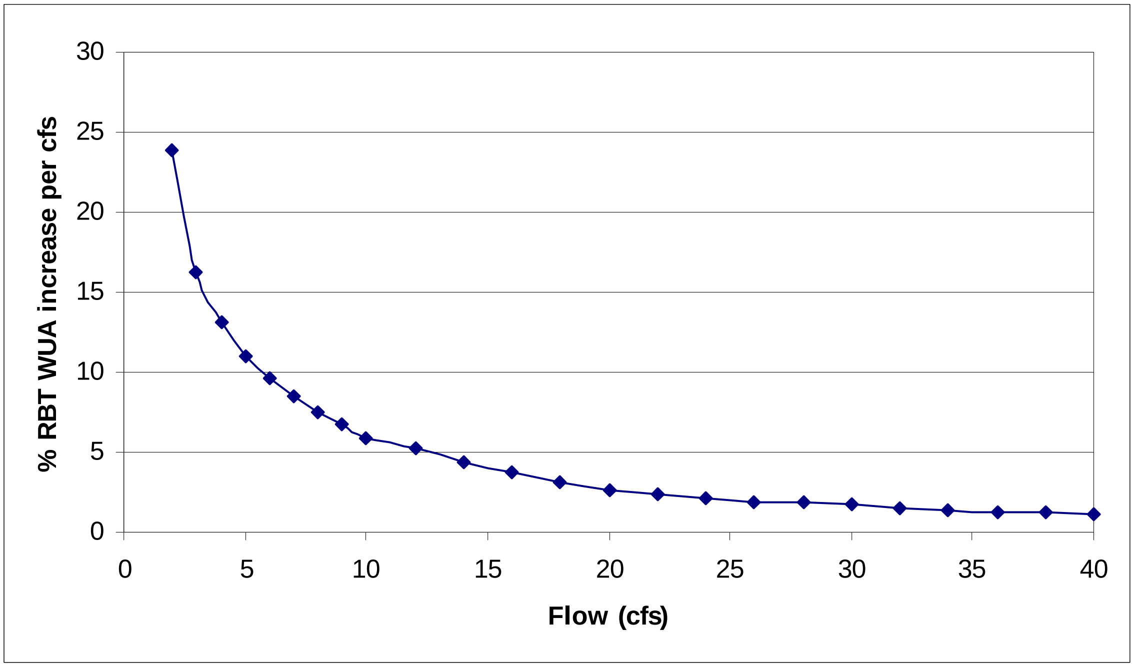


Figure 42. Percent rainbow trout WUA increase per 1 cfs, RM 35.4.

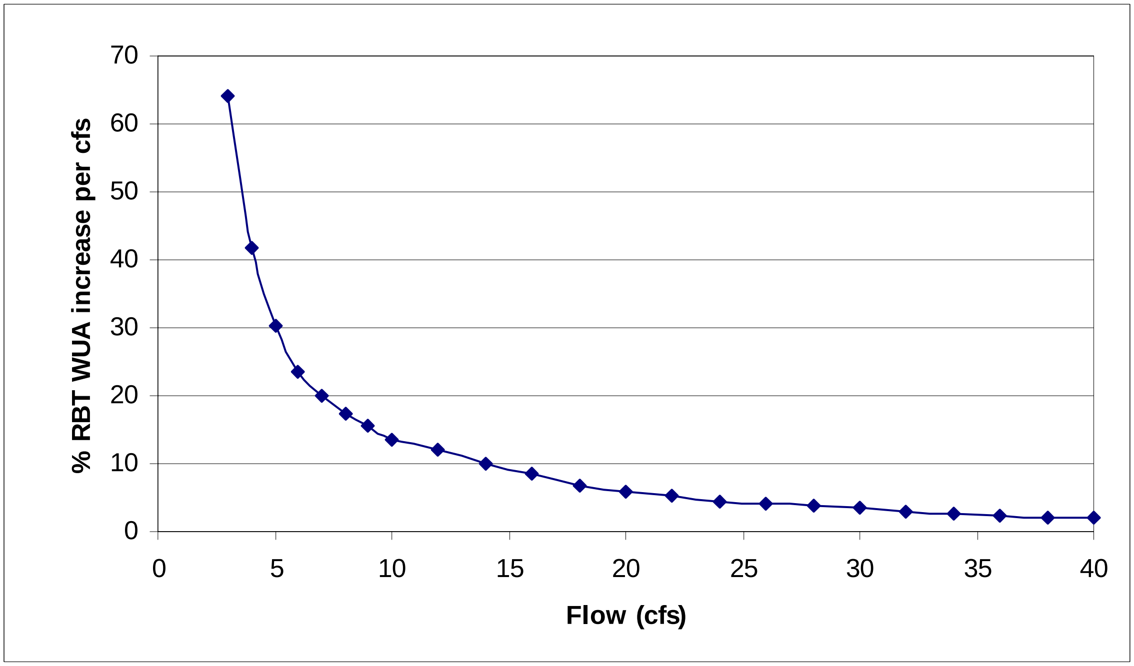


Figure 43. Percent rainbow trout WUA increase per 1 cfs, RM 29.2.

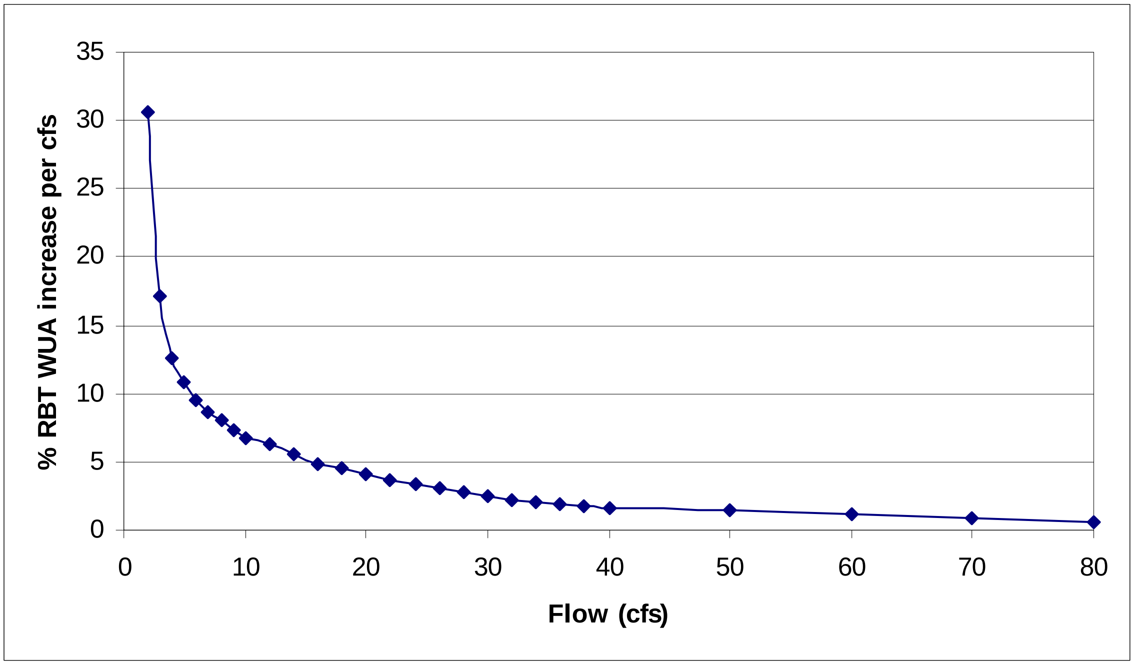


Figure 44. Percent rainbow trout WUA increase per 1 cfs, RM 2.5.

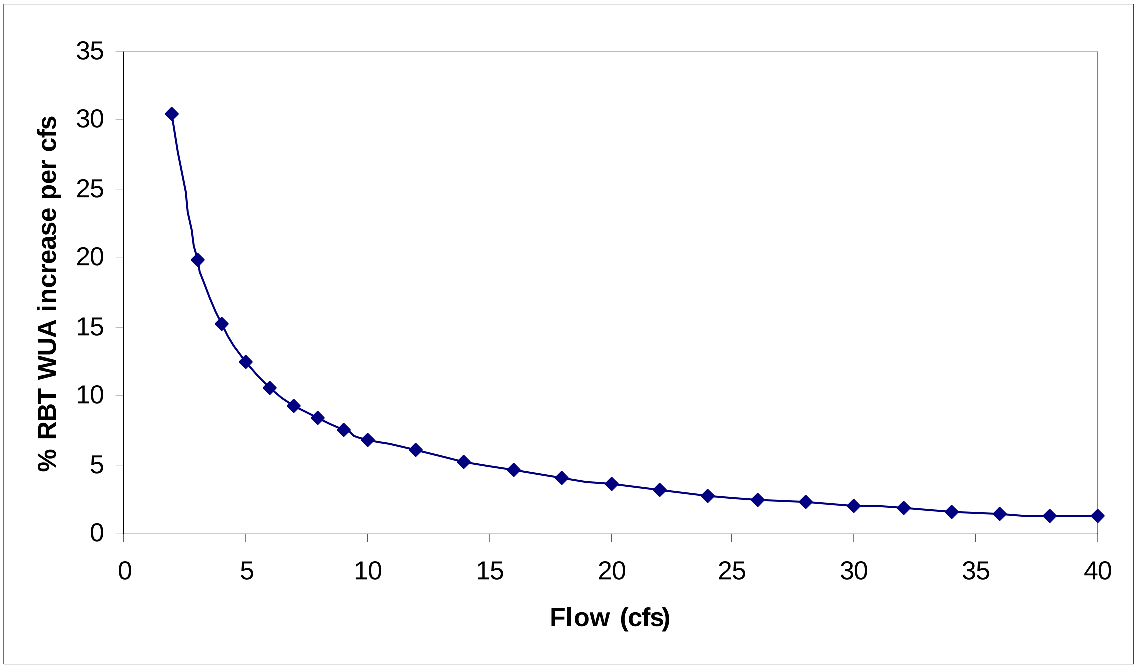


Figure 45. Percent rainbow trout WUA increase per 1 cfs, Rock Creek site.

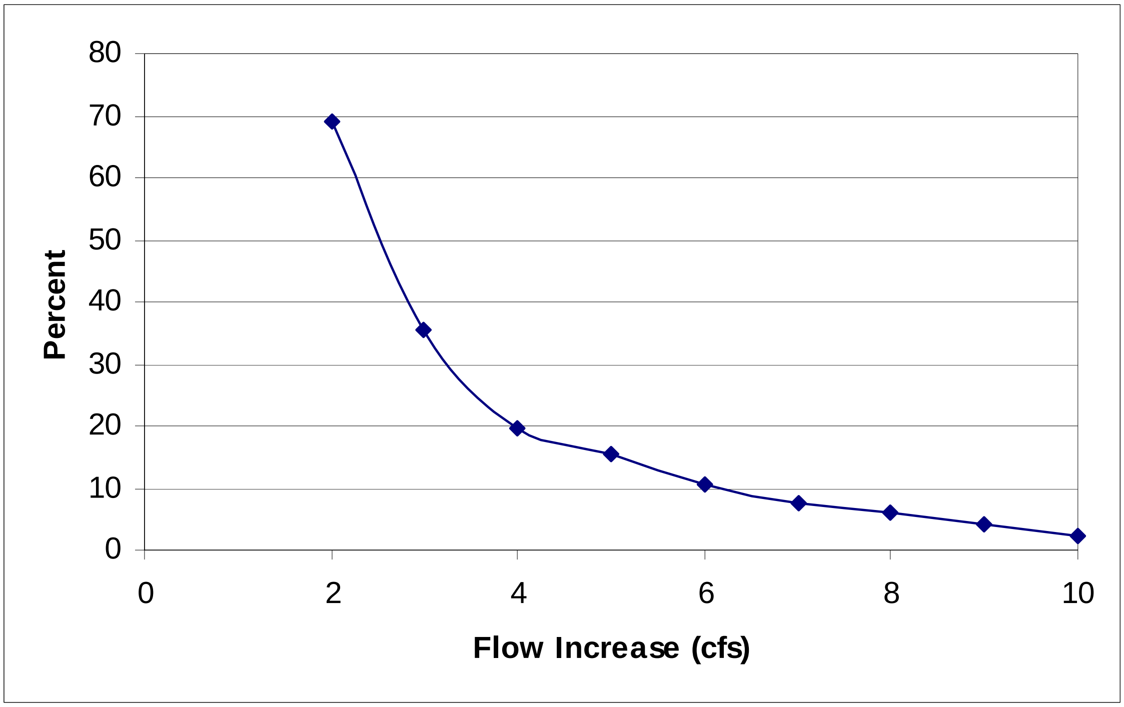


Figure 46. Percent rainbow trout WUA increase per 1 cfs, California Creek site.

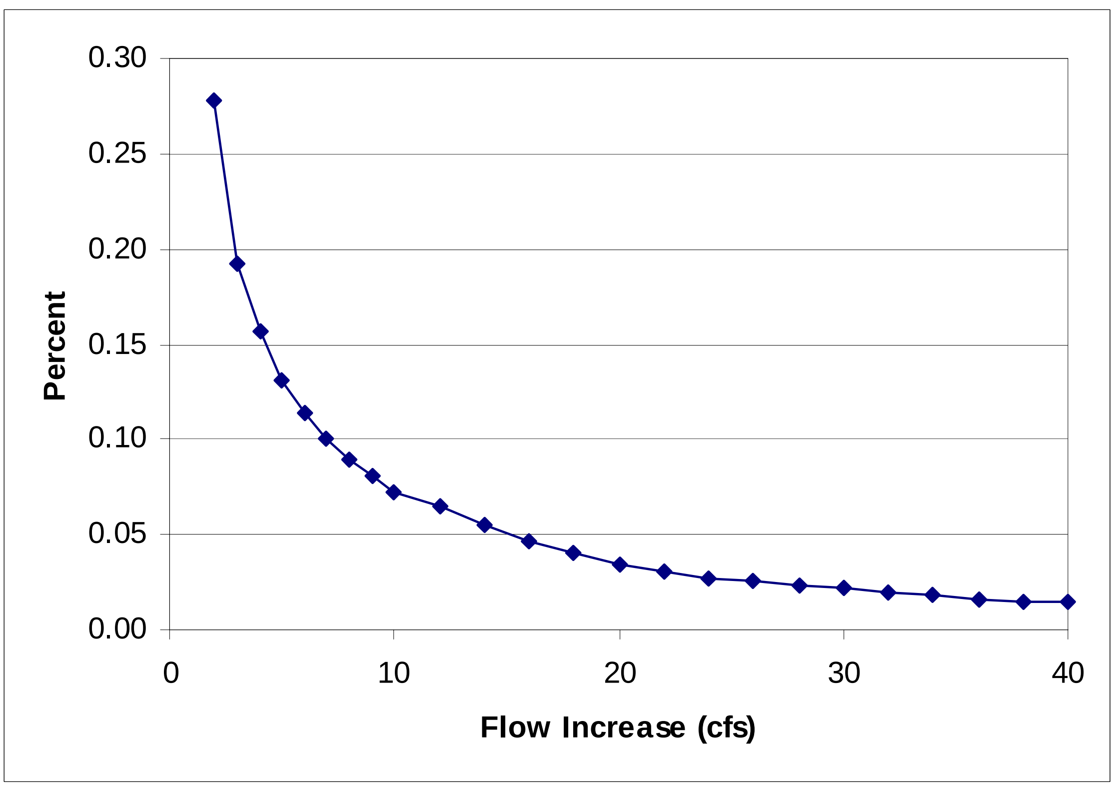


Figure 47. Percent rainbow trout WUA increase per 1 cfs, Latah Creek above Marshall Creek.

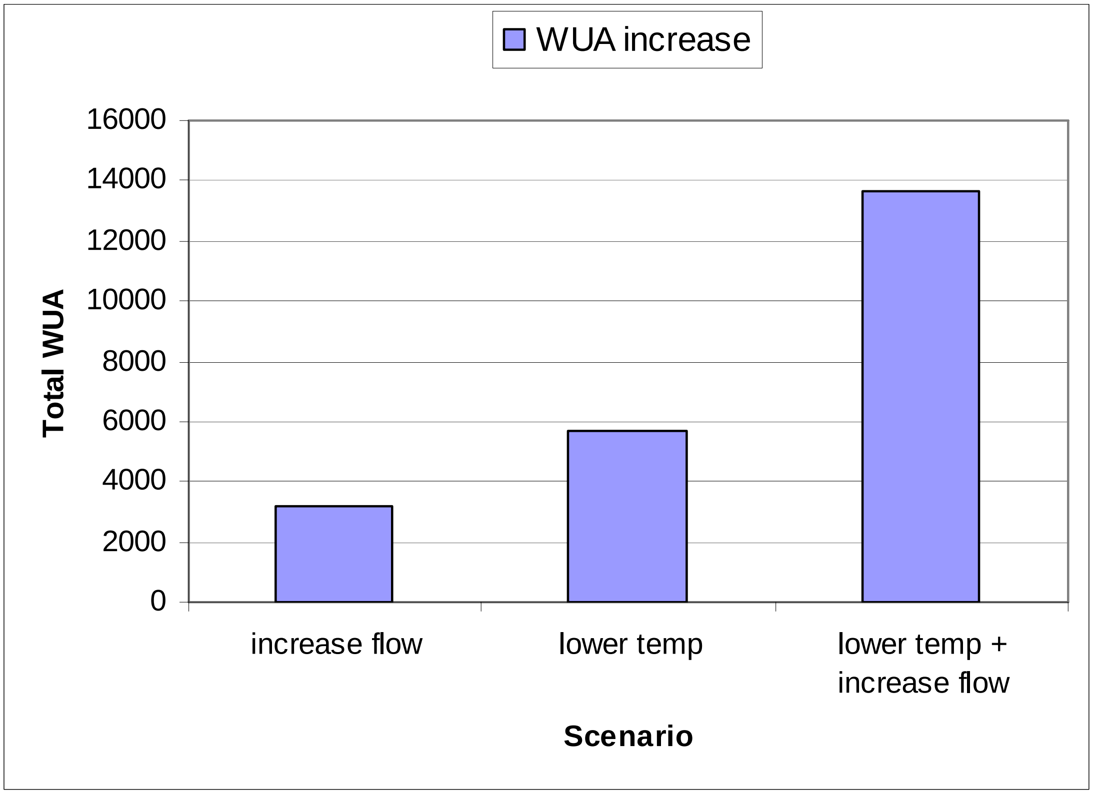


Figure 48. Example of WUA increase with improvements in flow and temperature individually, and combined (based on data from site at RM 29.2).

Common name	Latin name	Native/ Introduced	Comments
Rainbow trout	*Oncorhynchus mykiss*	Native	
Mountain whitefish	*Prosopium williamsoni*	Native	Not in historic collection data
Speckled dace	*Rhinychthys osculus*	Native	
Largescale sucker	*Catostomus macrocheilus*	Native	
Bridgelip sucker	*Catostomus columbianus*	Native	
Longnose sucker	*Catostomus catostomus*	Native	
Northern pikeminnow	*Ptychocheilus oregonensis*	Native	
Chiselmouth	*Achrocheilus alutaceus*	Native	
Redside shiner	*Richardsonius balteatus*	Native	
Torrent sculpin	*Cottus rhotheus*	Native	
Brown bullhead	*Ictalurus nebulosus*	Introduced	
Tench	*Tinca tinca*	Introduced	
Brook trout	*Salvelinus fontinalis*	Introduced	

Table 1. Fish Species in Latah Creek.

Habitat type	Description
Pool	Stream segment with reduced velocity and deeper water than surrounding areas
Riffle	Shallow rapids where water flowing over rough substrate produces surface agitation, but not standing waves
Run	Area of swiftly flowing water, without surface turbulence
SP	Step pool (pool downstream of a steep drop)
DP	Pool formed by a beaver dam

Table 2. Habitat types and characteristics classified according to W.T. Helm.

Stream	**Site**	**Distance from mouth (mi)**	**Habitat represented**
Latah Creek	Denny	35.4	Low gradient, open banks, little cover
	Keevy	29.2	Canyon, topographic shading, boulder cover
	Paintball	2.5	Downstream from groundwater inputs, altered banks, sandy substrate
Rock Creek	Dashiell	4.0	Wide channel, grazed, cobble substrate
California Cr	Elder Rd	3.8	Narrow, shaded channel, moderate gradient, cobble substrate

Table 3. PHABSIM site locations and characteristics.

	High flow (May)	**Mid flow (June)**	**Low flow (Sept)**
Headpin placement			
Benchmark survey			
Water surface elevations			
Velocities, all transects			
Site discharge			
Substrate			
Cover			

Table 4. PHABSIM field tasks completed at all sites, by month.

Code	**Description**
1	Clay-silt; organic
2	Sand
3	Fine gravel (0.1-0.3 inch diameter)
4	Medium gravel (0.3-1.25 inch)
5	Coarse gravel (1.25-2.5 inch)
6	Small cobble (2.5-5 inch)
7	Medium cobble (5-10 inch)
8	Cobble/Boulder (>10 inch)
9	Bedrock

Table 5. Substrate codes used in data collection and habitat modeling.

Stream	Site	Measured flows (cfs)			Modeled flow range (cfs)	
		low	mid	high	low	high
Latah Creek	Denny (RM 35.4)	1	11	42	1	40
	Keevy (RM 29.2)	1	11	43	1	40
	Paintball (RM 2.5)	7	39	85	1	80
Rock Creek	Dashiell	0.7	6	35	1	40
California Creek	Elder Rd	0.2	1.2	6	0.5	12

Table 6. Flow range modeled for habitat at each site.

Species	Sources
Rainbow trout	WDFW 2000; Smith and Aceituno 1987; Hardin-Davis et al. 1989
Mountain whitefish	Highwood River 1985
Speckled dace	Moyle & Baltz 1985; Dodge 1993
Largescale sucker	Twomey et al. 1984; Baltz and Moyle 1981
Redside shiner	Rodnick 1983

Table 7. Sources of information for habitat suitability curves.

File type	Inputs	Sources
Network files	river distances to all studied points	topo maps
Stream geometry	width, latitude, elevation	habitat mapping, topo maps
Meteorology	air temperature, wind speed, humidity, cloud cover	NOAA data, Spokane airport
Hydrology	Tributaries, other points (nodes) of flow change	USGS and SCCD gage data
	Discharge at every node	
	Water temperature at origin and validation points	SCCD temperature probes
Shade	topographic and vegetative shade estimates	habitat mapping, topo maps
Job control file	Options and calibration factors used	user discretion

Table 8. Input files used in the SNTEMP program.

River mi	Creek	Location	Stream flow estimate	Early-August flow (cfs)
35.4	Latah	Hays Rd	assumed same as Bradshaw gauge	1.41
32.9	Latah	Bradshaw Rd	SCCD gauge at Bradshaw	1.41
29.2	Latah	Keevy Rd	assumed same as Bradshaw gauge	1.41
22.2	Latah	Latah Rd	Bradshaw plus accretion*	2.29
20.2	Rock	near confluence	SCCD gauge in Rock Cr	0.74
18.7	Latah	Duncan	SCCD gauge at Duncan	3.03
18.3	California	near confluence	estimate from seepage run and IFIM studies	0.46
18.2	Latah	Valley Chapel Rd	sum of Duncan gauge and California Creek estimate	3.49
13.8	Latah	HV Golf Course	estimate for km 29.3, plus 1/3 of above-Marshall accretion estimate	4.55
8.8	Latah	Yellowstone Pipeline	estimate for km 22.2, plus 1/3 of above-Marshall accretion estimate	5.61
4.5	Latah	Qualchan Golf Course	estimate for km 14.2, plus 1/3 of above-Marshall accretion estimate	6.67
4.4	Marshall	near confluence	Marshall ungauged; assumed to be 100% of remaining inflow	3.39
3.6	Latah	Kampas Bridge	assumed same as USGS gage	10.06
0.4	Latah	Marne Bridge	assumed same as USGS gage	10.06
0	Latah	Mouth	USGS gage	10.06

Table 9. Flow estimates in the SNTEMP network; data and assumptions used
* accretion = Duncan flow - (Rock flow + Bradshaw flow).

Parameter	Data source
Latitude	Topographic maps
Elevation	Topographic maps
Average annual air temperature	Spokane airport meteorological station
Mean weekly air temperature	Spokane airport meteorological station
Mean weekly relative humidity	Spokane airport meteorological station
Mean weekly wind speed	Spokane airport meteorological station
Mean weekly solar radiation	Based on weather station data
Stream width	On-site measurements
Discharge, weekly, per site	SCCD and USGS gages
Mean water temp, per validation site	SCCD data loggers
Topographic shade	On-site measurements
Vegetative shade	On-site measurements
Dust coefficient	Default value
Ground reflectivity	Default value

Table 10. Data sources for SNTEMP inputs.

Station	River mile	River km	Elevation (ft)	Elevation (m)	Lat (deg)	Lat (Rad)
HC @ Marne Bridge, Riverside Ave.	0.4	0.6	1730	527	47.65	0.83165
HC @ Kampas Bridge near Cheney Spokane Rd.	3.6	5.8	1780	543	47.63	0.83121
HC @ US 195, D/S of Qualchan Golf Course	4.5	7.2	1795	547	47.62	0.83107
HC @ Yellowstone Pipe Line	8.8	14.2	1830	558	47.58	0.83049
HC @ Hangman Valley Golf Course	13.8	22.2	1855	566	47.54	0.82976
HC @ Valley Chapel Rd.	18.2	29.3	1887	575	47.52	0.82932
HC @ Duncan	18.7	30.1	1896	578	47.51	0.82918
HC @ Latah Rd.	22.2	35.7	1945	593	47.47	0.82845
HC @ Keevy Rd. near Mt. Hope, WA	29.2	47.0	2195	669	47.42	0.82758
HC @ W. Bradshaw Rd. near Fairfield, WA	32.9	53.0	2295	700	47.38	0.82700
HC @ Hays Rd. near Waverly, WA	35.5	57.2	2325	709	47.36	0.82656
Tributaries						
Marshall Creek @ US 195	0.4	0.6	1820	555	47.62	0.83107
California Creek @ Elder Rd.	0.1	0.2	1975	602	47.52	0.82932
Rock Creek @ Valley Chapel Rd.	0.3	0.5	1915	584	47.49	0.82889

Table 11. Calibration locations for SNTEMP.

Site	Piezo-meter #	Transect location (ft)	Notes on locations	Notes on piezometer readings
Denny T-7 (09/03/02, pm)	1	45.25	1/4" gravel & silt	Not a good P. installation (vinyl tubing).
	2	43.2		Not a good P. installation (vinyl tubing).
	3	43.5		OK - P. made with stiff (HDPE) tubing. Falling head test.
	4	37.2		
	5	30	rock - abandon location.	
	6	27.7		
	7	19.3	with cobbles	
	8	6.2	edge of grass	
Keevy T-2 (9/03/02, pm)	1	54.1	rock	
	2	50.5	rock	
	3	46.8	rock	
	4	43.6		
	5	37.7	gravel & big rocks	P. installation failed due to bolt stuck in end of pipe.
	6	39.3	gravel and sand	Falling head too fast to measure.
	7		close to edge - too much rock	
	8	22.6		P. installation failed due to bent pipe.
Rock Creek T-4 (9/04/02, pm)	1	44.9	6" from south edge (flat bench)	
	2	37.3		
	3	15.6	beside north edge (steep bank)	
California Cr T-4	1	21.9	9" from south edge (cut bank)	Not a good seal - equilibrates quickly.
(9/04/02, pm)	2	11.8	5" from north edge (flat bank)	
	3	20.3	32" from south bank (try again)	
Paintball T-2 (9/05/02, am)	1	closest to west edge	hit obstruction & abandon location	
	2	49.8	26" from west edge	Not a good seal - equilibrates quickly
	3	47.2		
	4	40.8		Too loose - P. pulled right out (coarse sands).
	5	8	beside east edge (slower flow)	Some silt (fines) at this location. Falling head test.
	6	14.5		Failure - P. stuck in pipe end & didn't remain in streambed.
	7	15		

Table 12a. Piezometer data for Latah Creek.

Site	Piezo-meter #	Depth of bury beneath stream bed (in)	Depth of surface water (in)	Piezometer measurement below SW (in)
Denny T-7 (09/03/02, pm)	1	12	8	
	2	16.75	11	
	3	14.75	11	
	4	12.75	10.5	0.75
	5			
	6	19.75	9	2.25 – 3
	7	15.875	7.5 – 8	3
	8	18.75	15.25	2.5
Keevy T-2 (9/03/02, pm)	1			
	2			
	3			
	4	7.75	8	
	5	13.75	10.75	
	6	16.75	11.5	
	7			
	8	18.75		
Rock Creek T-4 (9/04/02, pm)	1	13.25	4.5	0.5
	2	13.75	8	0.5
	3	17.75	15	
California Cr T-4	1	16.75		
(9/04/02, pm)	2	17.75	3	1.5
	3	18.25	5	1
Paintball T-2 (9/05/02, am)	1			
	2	18.75	12	
	3	19.25	16	
	4	17.75	19.5	
	5	17.75	20	
	6	17.75	22.5	
	7	14.75	23	

Table 12b. Piezometer data for Latah Creek.

Creek	Site	Number of measurements	Average toe width (ft)	Recommended Flow (cfs)
Hangman	Denny (RM 35.4)	6	16.8	9.0
	Keevy (RM 29.2)	7	28.1	18.7
	Paintball (RM 2.5)	1	34.5	25.0
California		4	10.8	4.8
Rock	Dashiell	1	23.0	14.1

Table 13. Toe width results in Latah Creek.

Week	Airport (m/s)	SNTEMP (m/s)	Airport (mph)	SNTEMP (mph)
23	3.5	2.0	7.7	4.4
24	4.1	3.5	8.9	7.7
25	2.6	5.0	5.7	11.0
26	5.2	3.5	11.5	7.7
27	4.0	7.5	8.8	16.5
28	3.0	3.5	6.6	7.7
29	3.5	5.0	7.7	11.0
30	5.7	2.0	12.5	4.4
31	3.7	2.0	8.2	4.4
32	4.2	7.0	9.3	15.4
33	3.7	5.0	8.2	11.0
34	2.9	3.5	6.4	7.7
35	4.5	2.0	9.9	4.4
36	3.0	2.0	6.5	4.4
37	3.8	2.0	8.3	4.4
38	3.0	2.0	6.6	4.4

Table 14. Wind speed values measured at Spokane International Airport and used in stream temperature modeling.

River mile	number															
	23	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
32.9	-0.05	1.05	1.53	-0.72	1.42	-0.57	-1.17	0.56	0.46	0.96	-0.43	0.08	-0.18	0.91	-0.41	0.19
29.2	0.53	0.77	0.97	0.84	2.47	0.90	0.80	1.89	1.42	0.67	0.28	0.86	0.91	1.10	1.30	1.10
22.2	-0.41	-0.49	0.03	0.27	1.96	-0.16	-0.43	0.73	-0.35	-0.86	-1.51	-1.11	*	*	*	*
18.7	-0.31	-0.67	0.03	-0.36	1.41	-0.53	-0.96	0.50	-0.60	-0.59	-1.50	-0.61	-0.45	0.25	0.69	-0.22
18.2	0.43	-0.20	0.70	0.04	1.99	0.07	-0.38	0.47	-0.36	-0.43	-1.25	-0.12	-0.90	-0.61	-0.12	-0.95
13.8	-0.50	-0.02	0.00	0.62	1.33	0.23	-0.21	1.08	0.24	-0.59	-1.08	-0.04	-0.05	0.23	0.68	0.24
8.8	0.15	0.23	0.47	0.00	1.68	0.14	-0.33	0.77	0.12	-0.40	-1.29	-0.38	-1.11	-0.22	-0.23	-0.75
4.5	0.32	1.43	0.26	-0.73	0.05	-0.76	-0.22	0.48	0.73	1.02	1.11	0.68	0.58	0.51	0.86	-0.07
3.6	-0.97	-1.94	-1.86	-2.18	0.42	-1.02	-0.75	-0.74	-0.58	-0.08	-0.55	-0.47	-0.91	-0.30	-0.21	-0.81
0.4	-0.54	-0.89	-0.47	-0.41	1.93	0.35	0.08	0.11	-0.46	-0.56	-1.25	-0.56	-1.26	-0.49	-0.31	-0.83
Error by																
Average	-0.14	-0.07	0.17	-0.26	1.47	-0.13	-0.36	0.59	0.06	-0.09	-0.75	-0.17	-0.37	0.15	0.25	-0.23
Minimum	-0.97	-1.94	-1.86	-2.18	0.05	-1.02	-1.17	-0.74	-0.60	-0.86	-1.51	-1.11	-1.26	-0.61	-0.41	-0.95
Maximum	0.53	1.43	1.53	0.84	2.47	0.90	0.80	1.89	1.42	1.02	1.11	0.86	0.91	1.10	1.30	1.10
RMS**	0.482	0.952	0.880	0.852	1.624	0.572	0.634	0.864	0.630	0.671	1.109	0.593	0.766	0.563	0.612	0.645

Table 15a. SNTEMP prediction errors by site and week (* data not recovered for these sites; **Root Mean Square).

River mile	Average	Minimum	Maximum	RMS*
32.9	0.23	-1.17	1.53	0.805
29.2	1.05	0.28	2.47	1.169
22.2	-0.19	-1.51	1.96	0.769
18.7	-0.25	-1.50	1.41	0.718
18.2	-0.10	-1.25	1.99	0.750
13.8	0.13	-1.08	1.33	0.603
8.8	-0.07	-1.29	1.68	0.694
4.5	0.39	-0.76	1.43	0.716
3.6	-0.81	-2.18	0.42	1.052
0.4	-0.35	-1.26	1.93	0.805

Table 15b. SNTEMP prediction errors by site (*Root Mean Square).

Daily average flow (cfs)	Average number of days/year
500 - 1000	23.6
1000 - 2000	12.5
2000 - 5000	5.9

Table 16. Average number of days per year at flow ranges favorable for boating on Latah Creek (flow at USGS gauge; taken from 1949-2001 data).

Site	Level	Flow (cfs)	Exceedance % (June)	Exceedance % (July-Oct)
Below Marshall Cr, based on RM 2.5 data	Optimum	50	40%	<5%
	Minimum	15	90%	50%
	Critical	6	>95%	80%
Idaho border to Marshall Creek, based on RM 29.2 and 35.4	Optimum	26	25%	0%
	Minimum	15	55%	5%
	Critical	7	80%	20%

Table 17. Flow recommendations and percent exceedance in Hangman Creek, June-October.

Location	PHABSIM (optimal)	PHABSIM (min)	PHABSIM (critical)	Toe width	Tennant (min)	Tennant (good)
Latah Cr. below Marshall Cr.	50	15	6	25	24	72
Latah Cr. above Marshall Cr.	26	15	7	9-19	10	30
California Cr.	*	8	6	5	-	-
Rock Cr.	27	14	6	14	-	-

Table 18. Summer flow recommendations using different methods (units are flow at site in cfs; *flows above 10 cfs not simulated at this site).

Appendix M

Hydrology of the Hangman Creek Watershed

Hydrology of the Hangman Creek Watershed (WRIA 56), Washington and Idaho

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Hangman (Latah) Creek Planning Unit (WRIA 56)

and

Washington State Department of Ecology
1998 Legislature Engrossed Substitute House Bill 2514
(The Watershed Management Act) RCW 90.82
Grant # G0000101

June 2003

Executive Summary

Water resources inventory area (WRIA) 56 encompasses the Hangman (Latah) Creek watershed in Washington, with headwaters in Idaho. The basin covers 431,220 acres and contains approximately 222 miles of perennial streams. The headwaters in Idaho lie at an elevation of about 3,600 feet above mean sea level, and at its confluence with the Spokane River the elevation is 1,720 feet above mean sea level.

The geology varies considerably within the basin. The primary geological units include, from oldest to youngest: 1) crystalline basement rocks of meta-sedimentary and igneous plutonic origin that underlie the entire region and occur in the higher peaks, 2) widespread horizontally-bedded volcanic rocks consisting of basalt flows separated by laterally discontinuous sedimentary interbeds, and 3) unconsolidated surficial deposits consisting primarily of flood-deposited sand and gravel and the wind-deposited silts that comprise the rolling hills characteristic of the Palouse.

An unconfined aquifer exists in the sand and gravel deposits in the lower portion of WRIA 56, below the confluence of Rock and California Creek. The water table in this aquifer unit is strongly connected to, and is influenced by, the stage of flow in Hangman Creek. Groundwater discharge from the Hangman valley aquifer and into the lower Spokane aquifer is almost 13 cubic feet per second. However, the most prolific and important aquifer in WRIA 56 is contained within the Columbia River Basalts where multiply stacked confined or semi-confined aquifers are accessible through deep wells. Due to its limited recharge potential within WRIA 56, the basalt aquifer system may be impacted by increasing groundwater withdrawals into the future.

The climate in WRIA 56 is generally very warm and dry in the summer and cool and moist during the winter. Because of the large range in elevation in the watershed significant variation in precipitation occurs, from less than 16 inches/year in the lower part of the basin that is sub-arid, to more than 40 inches/year in the upper part that is sub-humid. Area-weighted calculations of evapotranspiration in the watershed, when compared to the areal distribution of precipitation, show that there is a moisture surplus of 173,882 acre feet per year. This excess water is free to either run off into surface streams, or to infiltrate into the ground to recharge shallow and/or deep aquifer systems.

Surface water appropriations in WRIA 56 have the potential to impact stream flows during the summer months, especially in the Lower Hangman and Marshall/Minnie Creek sub-basins. Groundwater mining is certainly a high potential, particularly in the Lower Hangman and Marshall/Minnie Creek sub-basins where water right allocations from groundwater greatly exceed the recharge rate. Allocated surface water rights are 3.9% of the total annual average stream flow in WRIA 56, while allocated surface water and groundwater rights are 19.7% of the average annual stream flow.

Introduction

The Hangman (Latah) Creek watershed, also known as WRIA (water resource inventory area) 56, is facing a future with numerous water-related issues. Increasing urbanization and changing land use practices is placing growing pressure on water development versus protection of stream flows and related stream and riparian habitat. The Spokane County Conservation District (SCCD) is the lead agency responsible for watershed planning, facilitated by a grant obtained through the Washington State Department of Ecology (grant number G0000101). This study and report are prepared in fulfillment of a contract between SCCD and Eastern Washington University. Walt Edelin and Rick Noll at SCCD were particularly instrumental in overseeing this technical work.

Purpose and Objectives

The primary purpose of this study is to review pertinent hydrologic and geologic literature and establish a general water balance for the Hangman (Latah) Creek watershed (WRIA 56). The study area includes all of the land within the watershed which spans two states and four counties: Spokane and Whitman Counties in Washington and Benewah and Kootenai Counties in Idaho.

The specific tasks/objectives in the scope of work are:

1. Delineation of watershed boundaries used for the water balance calculations
2. Determine groundwater flow within and leaving the basin
3. Estimate direct recharge from precipitation
4. Determine the impact of irrigation on groundwater recharge
5. Evaluate the potential for numerical modeling of the study area

Data Sources

Much of the information in this report is gleaned from numerous published sources and agency records. The primary data used in this study is attributed to:

SCCD	Spokane County Conservation District
NRCS	Natural Resources Conservation Service
USGS	U.S. Geological Survey
NOAA	National Oceanographic and Atmospheric Administration
IDWR	Idaho Department of Water Resources
WDOE	Washington Department of Ecology

General Basin/Watershed Description

The Hangman Creek drainage basin is located in eastern Washington and northern Idaho, and comprises 431,220 acres, with 64% (276,803 acres) in Washington and 36% (154,417 acres) in Idaho. Approximately 222 miles of perennial streams occupy the basin, with the largest tributaries to the mainstem being Rock Creek and California Creek (SCCD, 1994). The mainstem of Hangman Creek itself is tributary to the Spokane River with its confluence at the intersection of the Lower Spokane (WRIA 54) and Middle Spokane (WRIA 57) reaches.

The headwaters in Idaho lie at an elevation of about 3,600 feet above mean sea level, and at its confluence with the Spokane River the elevation is 1,720 feet above mean sea level. Along its course, Hangman Creek flows from mountainous topography, across rolling hills in the Palouse, then into deep and narrow basalt canyons, and ultimately into a broad alluviated valley as it joins the Spokane River (SCCD, 1994).

The basin contains a wide variety of land uses, including cropland, forest and range land in the upper part of the basin, to smaller residential parcels and intensely urbanized areas in the lower basin. The stream channel has undergone significant changes in historical times, including straightening and channelization, and the riparian areas are increasingly affected by encroaching roadways and other structures that require stream bank stabilization (SCCD, 1994).

The climate in WRIA 56 is generally very warm and dry in the summer and cool and moist during the winter. Because of the large range in elevation in the watershed significant variation in precipitation occurs, from less than 16 inches/year in the lower part of the basin that is sub-arid, to more than 40 inches/year in the upper part that is sub-humid (SCCD, 1994).

Sub-Basin Geology and Hydrogeology

In cooperation with the SCCD, the entire WRIA 56 watershed was divided into five smaller sub-watersheds/basins (Figure 1). These include the following, from largest in area to the smallest:

	Area (square miles)	Area (acres)
Upper Hangman	334.9	214,383
Rock Creek	179.0	114,589
California Creek	24.9	15,942
Lower Hangman	71.8	45,947
Marshall/Minnie Creek	63.1	40,359

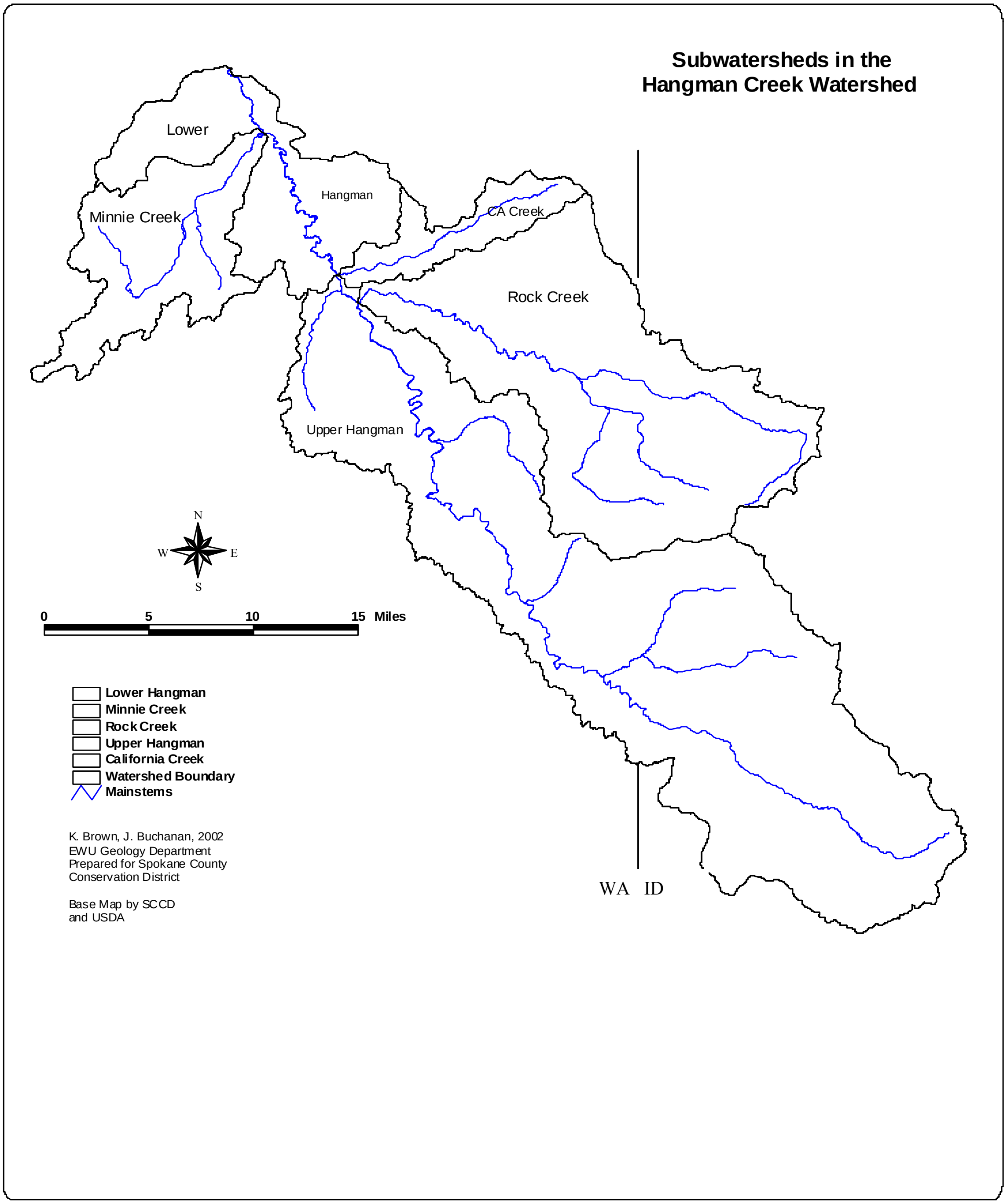

Figure 1. Map showing overall area of WRIA 56 including five sub-watersheds/basins.

Within the overall WRIA 56 basin, the geology varies considerably. There are several important geologic units that occur within the study area. The primary units are from oldest to youngest:

1) crystalline basement rocks of various compositions that underlie the entire region and core the numerous hills and steptoes (peaks surrounded by basalt lava),

2) widespread horizontally-bedded volcanic rocks consisting of basalt flows separated by laterally discontinuous sedimentary interbeds that form the relatively flat surfaces of the Columbia Plateau region, and

3) overlying unconsolidated surficial deposits consisting primarily of flood-deposited sand and gravel and the wind-deposited silts that comprise the rolling hills characteristic of the Palouse.

Crystalline Basement Rocks

The underlying basement rocks in WRIA 56 consist of several different types of rocks, most easily observed where they crop out in the higher peaks or where exposed in some stream canyons. Much of the basement consists of sedimentary rocks of the Precambrian age Belt Supergroup that have undergone low-grade metamorphism during intrusion by Mesozoic and Tertiary age quartz monzonite and granodiorite (granite) plutons (Griggs, 1976; Stoffel and others, 1991).

Depth to basement rock varies in the study area from zero to 1,555 feet or more. Drillers' logs of Cheney water wells 4 and 5 show that quartzite is encountered at 1,555 and 1,191 feet beneath the ground surface respectively. A water well three miles west of Cheney bottoms in granite at a depth of 516 feet beneath the ground surface. Where these rocks are exposed on the surface, they are usually deeply weathered and decomposed to a coarse sand and gravelly texture.

Columbia River Basalt and Latah Formation

The most ubiquitous rock in WRIA 56 is the Columbia River Basalt that was deposited during the Miocene (specifically, 12 to 17 million years ago). These rocks are the product of numerous volcanic eruptions of very fluid lavas in southeastern Washington and northeastern Oregon that flowed throughout the Columbia Plateau, resulting in deposits hundreds to thousands of feet in thickness that are regionally widespread (Swanson and others, 1975; Griggs, 1976). They are typically gray to black in color (red to orange when weathered) and vertically jointed and fractured.

A single basalt flow unit is typically several tens of feet in thickness, and exhibits a set of distinct morphologic elements that may sometimes be discerned in drillers' logs. The interior of a flow is typically dense, with vertical columnar jointing that developed during the cooling and crystallization of the flow. This section of the flow is termed the entablature if the columns are relatively thin, or termed the colonnade if the columns are well formed. A vesicular zone several feet thick usually develops on top of the flow as volatile gasses escape during cooling. In addition, the flow top may be weathered and rubbly (Mangan and others, 1986).

The basalts are multi-layered and contain interbeds consisting of semi-consolidated sand, silt and clay that reflect surficial deposition in streams and lakes during periods of quiescence between eruptions of basalt. These interbeds, known formally in this area as the Latah Formation, crop out in only a few locations due to their weak strength. Interbeds are usually less than ten feet in thickness and are laterally discontinuous. Basalt flows in the study area range in thickness from a few feet where they onlap the pre-Miocene steptoes to more than 1,500 feet in the deepest water well (Cheney well no. 4).

Stratigraphically, the Columbia River Basalts have been formally subdivided into different flow units (formations), and in WRIA 56 two recognized flows are present: the Wanapum and Grande Ronde Basalts (Drost and Whiteman, 1986). The Grande Ronde Basalts are older than the Wanapum Basalts and hence occur stratigraphically lower in the section. The contact between the two formations usually occurs between 2,100 and 2,200 feet in elevation in the Spokane area (Deobald and Buchanan, 1995).

Unconsolidated Surficial Sedimentary Deposits

The present surface above the Columbia River Basalts is covered by unconsolidated deposits consisting of thin soils of silt, sand and gravel. During the Pleistocene (0.01 to 1.6 million years ago) eastern Washington was periodically scoured by catastrophic outburst floods originating in northern Idaho due to the failure of glacial ice dams in the Clark Fork drainage. WRIA 56 was certainly affected by this extraordinary geologic event, as flood waters poured over the divide between Lake Coeur d'Alene and into Rock and California Creek.

Geologic mapping by Joseph (1990) and Stoffel and others (1991) shows these unconsolidated deposits exist in Hangman valley, and these deposits are in contact with similar ones in the lower Spokane valley. The sedimentary unit mapped in Hangman valley is described as consisting of glaciolacustrine (lake) and flood deposits containing silt and clay interbedded with coarser sand to gravel material (Joseph, 1990). Along Hangman Creek cyclic bedding between the coarse and fine sediments can be observed, and this pattern is speculated to exist in the subsurface but few well logs describe the stratigraphy in any detail. Recent work by Hamilton and others (2002) provides additional information on these deposits in the lower part of WRIA 56. This cyclic bedding is believed to be the product of periodic outburst floods from Glacial Lake Missoula entering the quiet waters of Glacial Lake Columbia that existed in the Spokane and Hangman valleys at the same time (Atwater, 1986; Molenaar, 1988). Since the energy of the floods was greater down the main Spokane valley, the finer-grained lake sediments there are mostly scoured away, leaving a coarser deposit of coarse sand and gravel. Nonetheless, these generally granular deposits exist in both valleys and are clearly contiguous with one another in map view.

Seismic reflection surveys performed during the delineation of wellhead capture areas for Fairchild Air Force Base (Buchanan and McMillan, 1997) fixes the third dimension of the aquifer geometry as it exists in Hangman and Marshall valleys. Both valleys appear to be trough-shaped and filled with 300 feet or more of sedimentary deposits sitting on top of competent bedrock at depth.

Also during the Pleistocene, finer-grained sediments blown by the wind from the glaciated terrain to the north, settled in the region resulting in the rolling hills typical of the Palouse. In many places these hills have been scoured by the outburst floods resulting in streamlined shapes when viewed from the air. The silts (eolian loess) comprising the Palouse hills range from a few tens of feet to no more than one hundred feet in thickness and are formally recognized by geologists as belonging to the Palouse Formation. This formation is best developed in the upper parts of WRIA 56, specifically in the upper Hangman and California Creek sub-basins.

Lastly, adjacent to the present-day river channels, these flood- and wind-laid sediments have been eroded and re-deposited as alluvium. The most notable occurrence of this alluvial material is in the lower part of WRIA 56, below the confluence of Rock and California Creek.

Aquifer Characteristics

An aquifer is defined as any geological material that stores and transmits groundwater in economic quantities. Several aquifers can be identified in WRIA 56 that are related to the geologic units identified in the preceding section, in fact, all lithologies contain groundwater to some degree. After examining nearly 800 water well records in the basin, Table 1 summarizes these major water-bearing units, and they are described in some detail below.

Unconsolidated Sand and Gravel Aquifer

A significant unconfined aquifer exists in the sand and gravel deposits in the lower portion of WRIA 56, below the confluence of Rock and California Creek. The water table in this aquifer unit is strongly connected to, and is influenced by, the stage of flow in Hangman Creek. The mainstem of Hangman Creek, below California Creek to its mouth, is an effluent (gaining) type stream based on this relationship with the adjacent groundwater system as observed by periodic groundwater level measurements in nearby wells during this study. Table 1 summarizes the characteristics of this important aquifer in WRIA 56.

Few water wells penetrate this aquifer unit through its entire thickness (Hamilton and others, 2002). Seismic reflection work along Meadowlane Road in the lower part of WRIA 56 (Buchanan and McMillan, 1997) suggests that the base of the alluvial aquifer in the center part of Hangman valley is about 1,400 feet MSL. This transect does not terminate against bedrock at either end so the cross-sectional area of the aquifer cannot be determined.

Table 1. Characteristics of major aquifer units in WRIA 56.

Aquifer unit	Host material	Aquifer type	Range in well depths minimum ft	Range in well depths maximum ft	Hydraulic conductivity ft/day	Typical range in well yields gpm
Basalt aquifer	Columbia River Basalts and Latah Formation (Miocene age) GW usually occurs in permeable interbeds and in vesicular zones.	confined to semi-confined	50	1,400	10^{-7} to 10^{2}	10s to 1,000s
Basement aquifer	pre-Miocene age crystalline rocks (various igneous and metamorphic rocks) GW usually occurs in fractures and in weathered zones.	confined to semi-confined	100	800	10^{-7} to 10	<10
Sand and gravel aquifer	unconsolidated sand and gravel (Pleistocene age)	unconfined	60	355	10^{-2} to 10^{3}	10s to 100s
Shallow water-bearing zones	unconsolidated soils above bedrock – not characterized in this study	perched	NA	NA	unknown	unknown

Notes:
Range in well depths derived from review of existing drillers' logs for water wells in the basin.
Hydraulic conductivity values from the technical literature.
Well yield range from drillers' logs.
Kh:Kv in basalt aquifers estimated to be 2,500:1 or greater.
Data sources: IDWR and WDOE

However, the saturated thickness in this part of the valley is more than 350 feet with the water table in the unconfined aquifer at about 1,820 feet MSL.

Another seismic transect along West 15th Avenue in the Vinegar Flats area and on the South Hill along West 14th Avenue provide a good, constrained cross-sectional view of the Hangman valley aquifer just before it connects to the western end of the Spokane aquifer (Buchanan and McMillan, 1997). The base of the alluvial aquifer resides at about 1,400 feet MSL, resulting in a saturated thickness of about 330 feet at its thickest part. The western edge of the aquifer terminates against basalt bedrock on the left (west) bank of Hangman Creek, while the eastern edge abuts a gradually rising weathered basalt bedrock surface up onto the South Hill. The water table lies at an elevation of 1,730 ft. MSL. This cross-section of the saturated area of the aquifer in this area is determined to be about 312,900 square feet.

The slope of the unconfined groundwater surface, or hydraulic gradient, in Hangman valley is closely related to the elevation of Hangman Creek as described above. Given this relationship, the hydraulic gradient in the Hangman valley aquifer is about 0.002, with a slope to the north. The groundwater flow rate can be calculated as being the product of hydraulic conductivity, hydraulic gradient, and cross-sectional area of the aquifer. Assuming a hydraulic conductivity of about 500 ft/day, and using the gradient and areas discussed above, calculations show that about 6.6 cubic feet per second of groundwater flow is moving from Marshall valley and into Hangman valley. Furthermore, about 12.7 cubic feet per second of groundwater throughflow is occurring from Hangman valley and into the lower Spokane valley at the confluence (Buchanan and McMillan). Therefore, since no physical barriers to groundwater flow have been discovered in the subsurface that would preclude the movement of groundwater from the Hangman valley aquifer and into the lower Spokane aquifer, almost 13 cubic feet per second of groundwater recharge is occurring from Hangman valley to the lower Spokane aquifer. This amount of groundwater discharge from WRIA 56 lies within the range described earlier by Bolke and Vaccaro (1981).

Elsewhere in WRIA 56, small, locally discontinuous unconfined and perched water-bearing strata exist in some locations in the variety of sediments that mantle the bedrock. Such zones occur in the riparian areas in the upper part of the watershed where some alluvium is present adjacent to the streams. Although these areas have potentially high porosity and permeability, the saturated thickness is typically less than ten feet and as such, these bodies of shallow groundwater respond immediately to periods of drought through rapid lowering of the water table. As a result, these shallow and perched water-bearing zones are not considered reliable for long term supplies of great quantities of groundwater, but may be sufficient for a domestic water supply. In addition, while the silts comprising the Palouse Formation retain significant amounts of infiltrated water, their permeabilities are usually very low, precluding them from definition as a viable aquifer. These small ground-water bearing zones are entirely uncharacterized in this study of WRIA 56.

Basement Rock Aquifer

Groundwater can also occur in the basement rocks where they are deeply weathered or jointed, or along the basalt/basement contact. Because of the crystalline nature of these rocks, quartzite and granite, porosity is usually low and permeability is limited as it is a function of the interconnectedness of the joints or the degree of weathering of the bedrock (Driscoll, 1986). At best, this aquifer may yield only several gallons of water per minute, and wells penetrating this aquifer will only yield water until the fractures in close proximity to the well are drained (Olson and others, 1975). Table 1 summarizes some of the characteristics of this aquifer in WRIA 56.

It is important to note that very few wells are developed in this aquifer in WRIA 56 due to its poor potential. It is surprising to note that Cheney water wells no. 4 and 5 are developed in the basement quartzite. Normally this lithology does not yield quantities of groundwater in sufficient quantities to municipal wells. With time yields may decrease to these wells as groundwater recharge to this deep hydrostratigraphic unit is limited. In fact the city has encountered a variety of problems in each of these wells that may be related to the quartzite aquifer.

Columbia River Basalt Aquifer

The most prolific and important aquifer in WRIA 56 is contained within the Columbia River Basalts. Since the basalt flows are generally multilayered, and many of the flows are interlayered with coarse sedimentary deposits of the Latah Formation, groundwater generally occurs in abundance in the porous vesicular zones between the flows or in the sedimentary interbeds thereby creating multiply stacked confined or semi-confined aquifers accessible through deep wells. Again, groundwater may also occur in abundance at the contact between the basalt and the underlying basement rock (quartzite and granite).

Most groundwater occurs within the vesicular zone that defines the top of a single basalt flow since it is usually quite permeable and porous; if the flow top was weathered prior to burial by the next succeeding flow, porosity and permeability may be further enhanced. Several statistics are offered below to indicate the great range of hydraulic properties one can encounter in basalt aquifers. The porosity of the vesicular zone in the basalts ranges from 10 to 50 percent. Transmissivity ranges from 100,000 to 40,000,000 gallons per day per foot (over the entire vertical saturated thickness of the aquifer), and hydraulic conductivity (permeability) ranges from 8,000 to 70,000 gallons per day per square foot making these rocks some of the most prolific, *and most variable and unpredictable*, aquifers (Fetter, 1994). The potential yield of groundwater from aquifers in the Columbia River Basalts ranges from 500 to 100,000 cubic meters per day (Driscoll, 1986). These water-yielding target zones account for less than six percent of the upper 1500 feet of the Columbia River basalts in eastern Washington (Newcomb, 1972). In fact, two water wells may be drilled to equal depth in the basalts within close proximity to one another, and as indicated in the range of hydraulic properties outlined above, may exhibit significantly different yields. Table 1 summarizes the important characteristics of this aquifer in WRIA 56.

Water reaches the interflow zones and recharges the aquifers by either percolating downward through the vertical columnar jointing structures in the overlying basalt flows or by lateral groundwater inflow (Luzier and Burt, 1974). Vertical permeability is usually several orders of magnitude lower than that in the interflow zones so recharge through vertical infiltration is very slow. Most of the deep confined basalt aquifers on the Columbia Plateau are recharged almost entirely through lateral groundwater inflow or through vertical exchange.

Occurrence and movement of groundwater in the Wanapum and Grande Ronde hydrostratigraphic units has been described regionally by Drost and Whiteman (1986). Within WRIA 56, the Grande Ronde flow forms the deepest hydrostratigraphic unit in the basalts and probably receives most of its recharge via the overlying Wanapum Formation. Aquifers in the Grande Ronde unit are mostly confined. The uppermost significant water-bearing basalt aquifer in WRIA 56 is the Wanapum flow, and in many places in the watershed this flow crops out on the land surface or is covered by a thin veneer of soil, alluvium, or the Palouse Formation. Recharge to this unit comes primarily from direct precipitation and infiltration on weathered outcrop surfaces. It is groundwater in the Wanapum hydrostratigraphic unit that is responsible for flow to the small springs that occur naturally in the surrounding area. The hydraulic gradient in both basalt hydrostratigraphic units controls the direction of groundwater flow, and is shown in Figure 2. Generally, groundwater flow is toward the main Hangman Creek valley, though it does not discharge to the stream itself. The groundwater surface is graded toward the main stream valleys in WRIA 56, though the groundwater surface lies beneath the streams at a depth of more than 80 feet in the upper part of the watershed (above the confluence of California Creek). Because of this relationship, Hangman Creek appears to be a losing (influent) stream in the Upper Hangman sub-basin. It is believed that the groundwater in the basalt system is discharging to an underlying structure, either a suspected fault (Hamilton and others, 2002) or a buried linear structure (lineament), that in turn may convey the groundwater to deeper strata or towards the north-northwest where it may eventually discharge into the alluvial reach in the lower Hangman sub-basin.

A projected longitudinal profile of the mainstem of Hangman Creek (Figure 3), and the underlying groundwater surface in the adjacent aquifers, shows this separation in the upper part of the watershed. Below Rock Creek, the groundwater surface lies at an elevation above the stream, and this is where numerous springs discharge from the basalts and sustain low flows in Hangman Creek during the dry summer season. Further down valley, the groundwater surface in the sand and gravel aquifer is strongly coupled to the stream stage as discussed previously. This effluent reach is also depicted in Figure 3.

Due to its limited recharge potential within WRIA 56, the basalt aquifer system may be impacted by increasing groundwater withdrawals into the future. In a subsequent section on water use within WRIA 56, it is clear that most irrigation in the basin is derived from groundwater sources in the basalt aquifers. Well interference (a pumping well affects water levels in another nearby well) and groundwater level decline are potential problems given this scenario.

Groundwater level monitoring of this important aquifer system is of paramount importance, and will require periodic measurements of existing wells, and perhaps the installation of dedicated monitoring wells. Fortunately, groundwater withdrawals from the basalt aquifer system in the upper parts of WRIA 56 will have minimal impacts on stream flow as best as this study can determine at this time.

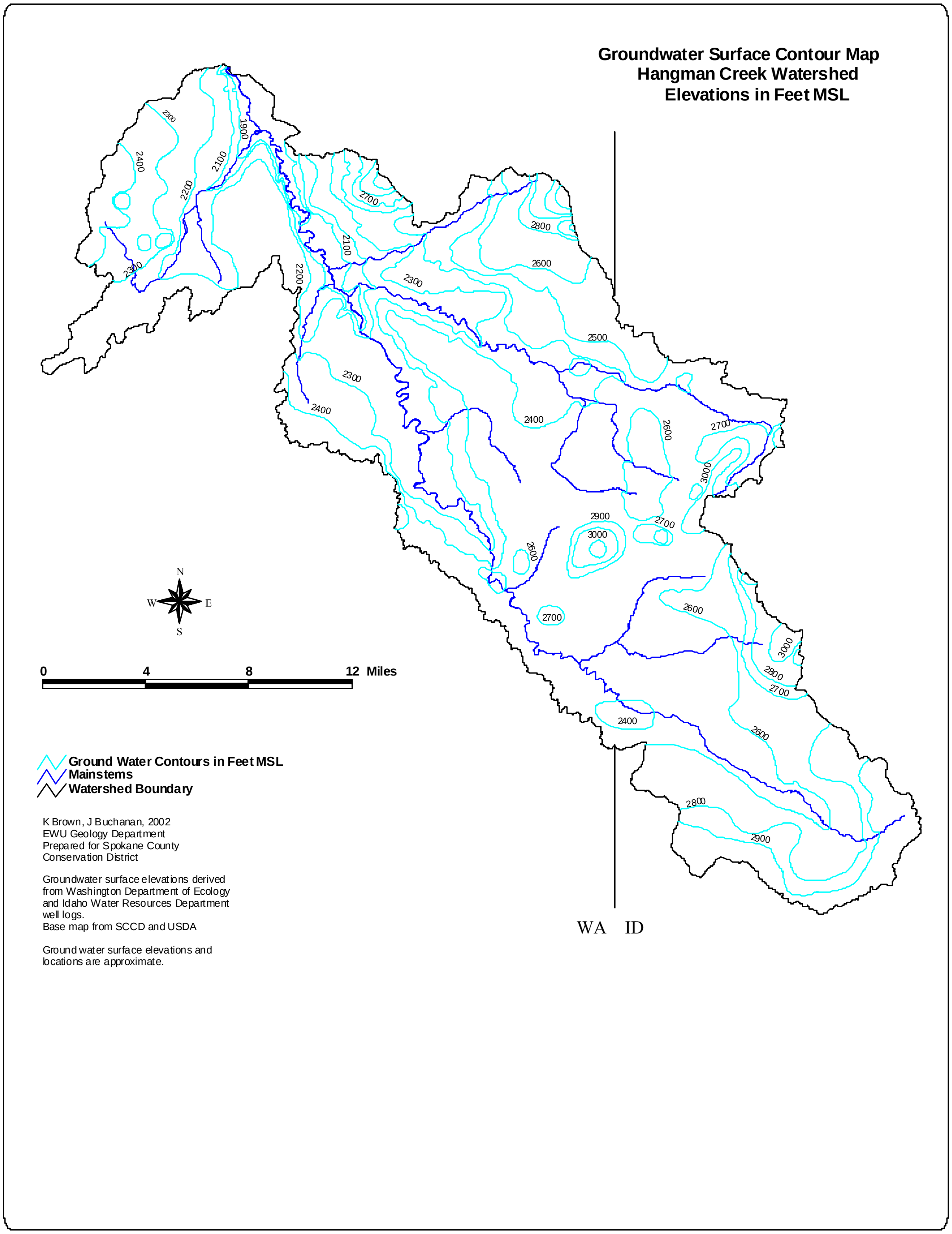

Figure 2. Map showing the groundwater surface in WRIA 56 based on review of about 800 water well records from IDWR and WDOE.

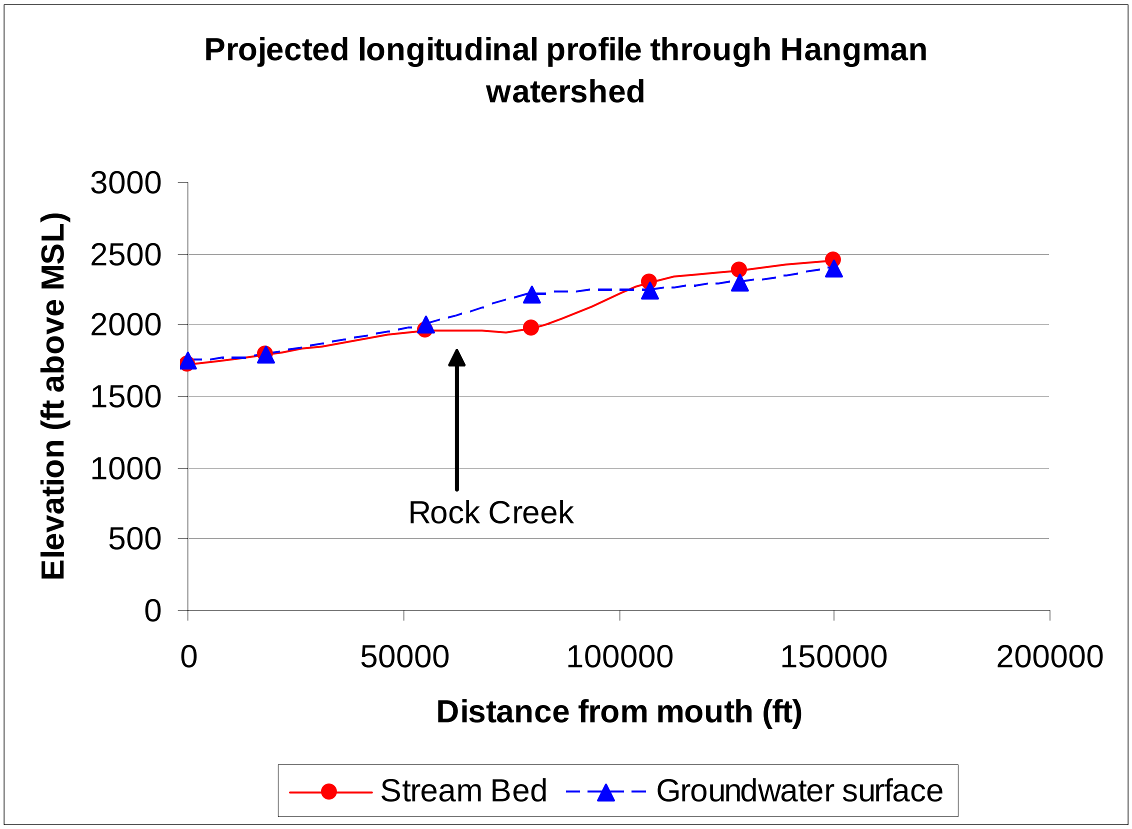

Figure 3. Projected longitudinal profile showing losing stream reach in the Upper Hangman sub-basin and the gaining reach below Rock Creek in the Lower Hangman sub-basin.

Precipitation and Evapotranspiration

Precipitation

The climate in WRIA 56 is generally very warm and dry in the summer and cool and moist during the winter. Because of the large range in elevation in the watershed significant variation in precipitation occurs, from less than 16 inches/year in the lower part of the basin that is sub-arid, to more than 40 inches/year in the upper part that is sub-humid. The "Hangman Creek Watershed Management Plan" (SCCD, 1994) includes a brief summary of the climate conditions in WRIA 56 and includes a basic isohyetal map.

Five meteorological stations exist in and around the periphery of WRIA 56. These are listed in the table that follows:

Summary of meteorological stations in and around WRIA 56

Name	Station ID	Period of Record
Spokane WSO Airport, Washington	457938	1/1/1890 to present
Rosalia, Washington	457180	6/1/1948 to present
Tekoa, Washington	458348	6/1/1948 to 9/30/1980
Plummer 3 WSW, Idaho	107188	2/1/1950 to 8/31/2000
Potlatch 3 NNE, Idaho	107301	3/1/1915 to present

Unfortunately, these stations are not spatially distributed in a meaningful manner, and their periods of record are somewhat incomplete, to provide comprehensive climate data in regards to a new analysis of the distribution of precipitation within the watershed.

Fortunately, the Spokane NRCS office has PRISM (Parameter-Elevation Regressions on Independent Slopes Model) coverage in GIS format for WRIA 56. This dataset uses point data and Digital Elevation Models (DEMs) to derive spatial variations in climatic parameters. The data sources include NOAA sites, SNOTEL sites and selected state sites. PRISM data is considered high quality data by most researchers.

In Figure 4, the PRISM data clearly show the gradient in precipitation that is influenced by topographic elevation in the watershed. Annual precipitation ranges from more than 40 inches per year in the upland areas in the southern portion of WRIA 56, to 16 inches or less in the lower elevation areas near Cheney. It is difficult to confirm the adequacy of the PRISM model for precipitation in WRIA 56 given the dearth of data from meteorological stations in the watershed. For purposes of this study, the PRISM data shown in Figure 4 is used to calculate the effective uniform depth (EUD) of precipitation by the isohyetal method (Fetter, 1990) in WRIA 56 and its sub-basins.

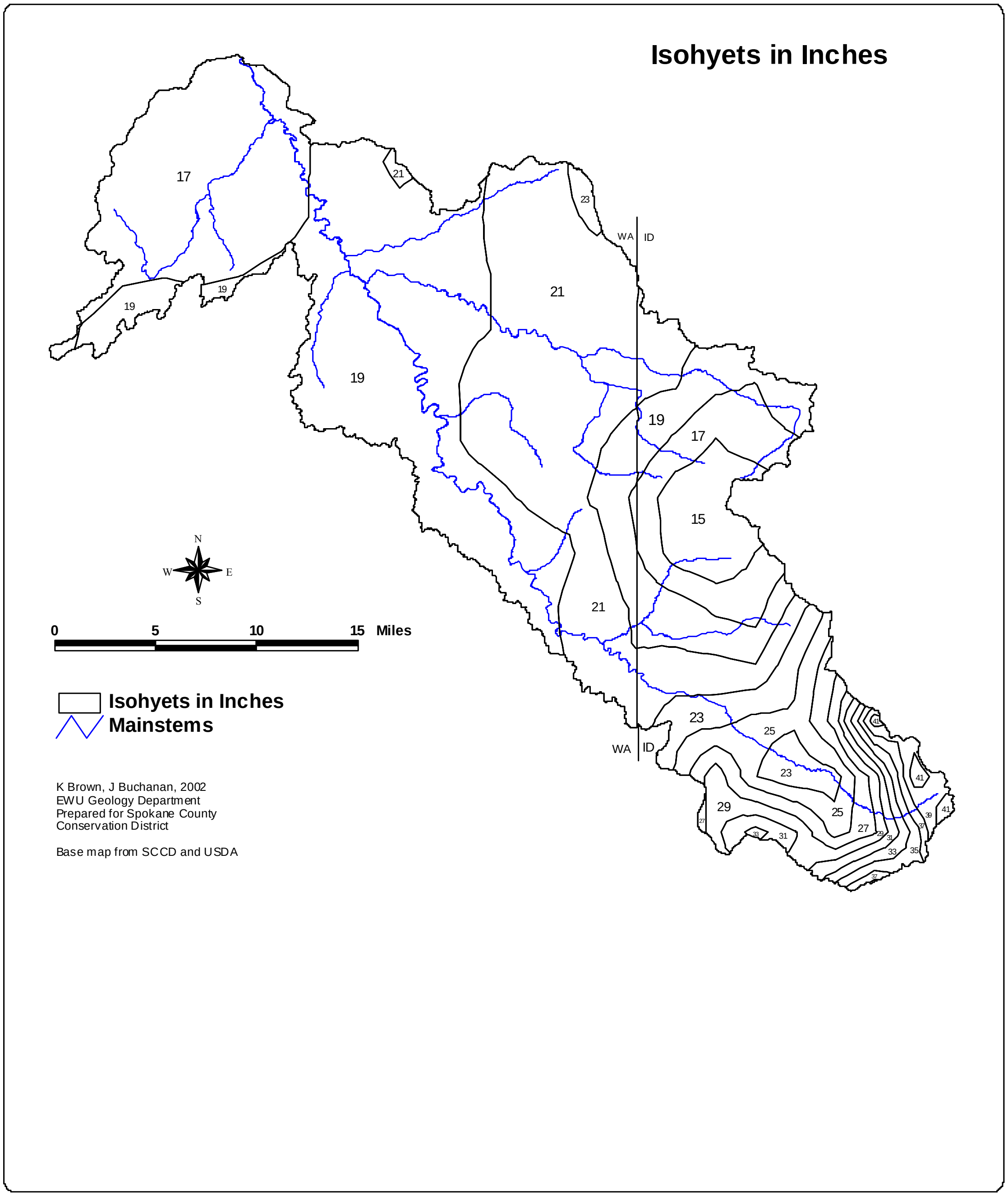

Figure 4. Isohyetal map of annual precipitation for WRIA 56 generated with PRISM data.

Evapotranspiration

Evapotranspiration (ET) is difficult to measure directly, and is similarly difficult to estimate on a basin-wide scale. Excellent evaporation data exists at Spokane Airport WSO where an evaporation pan shows an annual average evaporation of 47.02 inches.

Additional ET data for various types of common vegetation in the western U.S. that are also found in WRIA 56 has been gathered from Van der Leeden and others (1990). These data are listed in Table 2.

Table 2. Estimated evapotranspiration (ET) rates for types of vegetation in WRIA 56.

Land use code	Description	Average annual ET (inches)
Water		
11	open water	47
12	perennial ice/snow	na
Developed		
21	low intensity residential	20
22	high intensity residential	22
23	commercial/industrial	16
Barren		
31	rock/sand/clay	0
32	quarries	na
33	transitional	0
Forested Upland		
41	deciduous forest	23
42	evergreen forest	17
43	mixed forest	20
Shrubland		
51	shrubland	11
Non-Natural Woody		
61	orchards/vineyards	na
Herbaceous Upland		
71	grasslands	11
Herbaceous Planted		
81	pasture/hay	28
82	row crops	26
83	small grains	16
84	fallow	11
85	urban/recreational	na
Wetlands		
91	woody	40
92	emergent herbaceous	40

Notes:
Land use categories from National Land Cover Class Definitions
ET values from The Water Encyclopedia, 1990
na = not applicable in WRIA 56

In order to estimate an ET budget for WRIA 56 and its sub-basins, an additional GIS land use coverage map was acquired from the Spokane NRCS office (Figure 5) and the values in Table 2 applied in an area-weighted manner to the associated land coverages. The related spreadsheets for each sub-basin are provided in Appendix A of this report. The net result is an overall estimate of ET for the entire WRIA 56 basin and each of its sub-basins, very similar to the methodology employed in the Theissen weighted-polygon method of determining the effective uniform depth of precipitation (Fetter, 1990).

Table 3 provides a summary of climate data for WRIA 56, including the estimated effective uniform depth of precipitation (EUD) calculated by the isohyetal method from Figure 4 and the estimated evapotranspiration from Table 2 and Figure 5.

Table 3. Summary of estimated annual precipitation and evapotranspiration for sub-basins in WRIA 56.

	Estimated precipitation inches	Estimated evapotranspiration inches	Moisture surplus inches (acre-feet)
Upper Hangman	22.3	15.9	6.4 (114,338)
Rock Creek	19.6	15.4	4.2 (40,106)
California Creek	19.9	15.8	4.1 (5,447)
Lower Hangman	17.8	15.2	2.6 (9,955)
Marshall/Minnie Creek	17.4	16.2	1.2 (4,036)

Table 3 shows that there is, on average, an annual moisture surplus in WRIA 56. Note that the moisture surplus is greatest in those sub-basins that extend to the upland areas that receive more annual precipitation than those that are found in the lower semi-arid portions of the watershed. This surplus moisture is free to either run off into surface streams, or to infiltrate into the ground to recharge shallow and/or deep aquifer systems. In sum, based on the numbers in Table 3, the average annual moisture surplus in WRIA 56 is about 173,882 acre feet per year (af/yr).

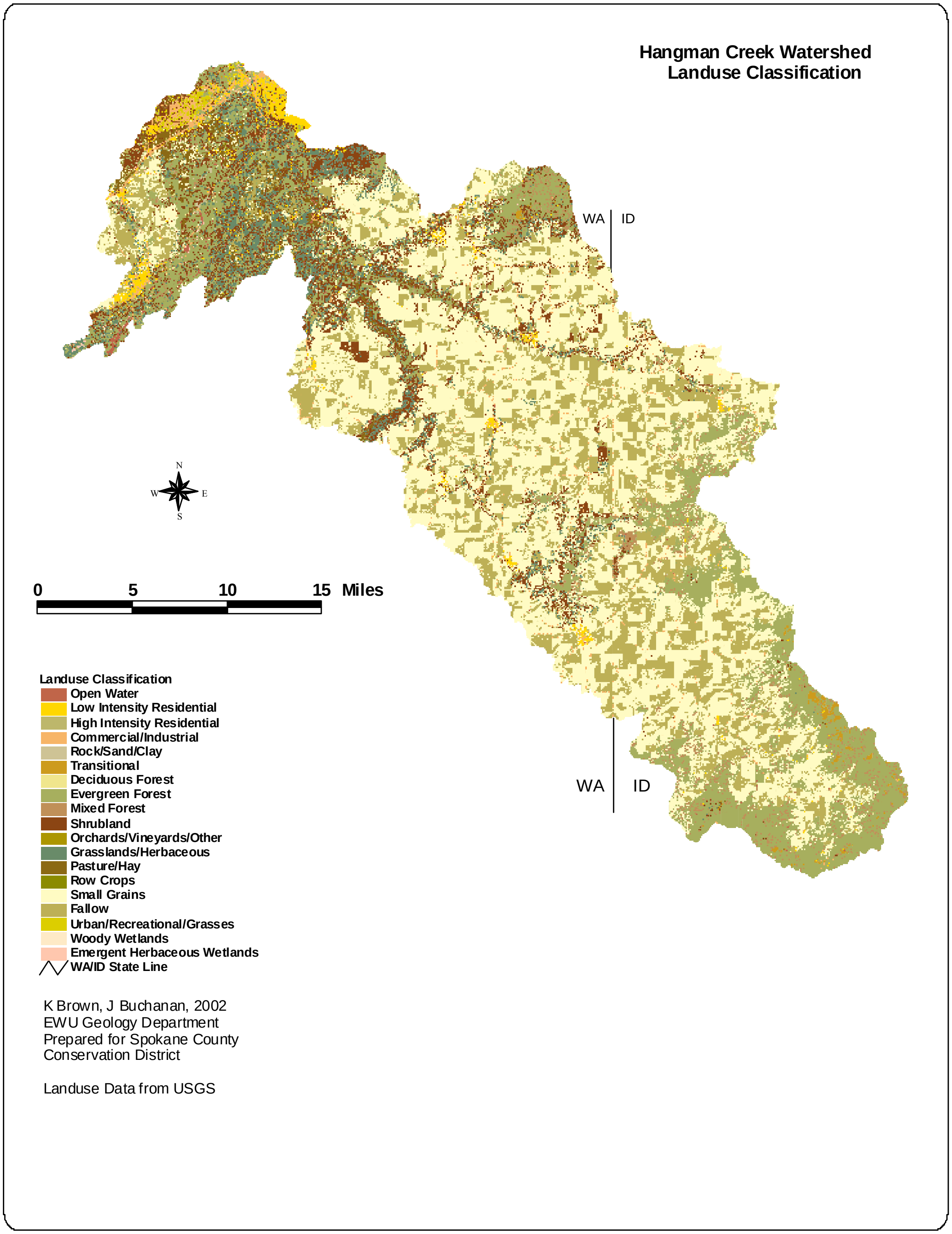

Figure 5. Land use coverage in WRIA 56 from Spokane NRCS office (1994 data).

Overall Water Balance

The discussion in the preceding section of this report indicates that there is a moisture surplus in WRIA 56 due to the difference in precipitation and evapotranspiration in the basin as shown in Table 3. During the average year the moisture surplus amounts to approximately 173,882 acre feet (af) for all sub-basins in WRIA 56 combined.

Note that in Table 3, the volume of water lost from precipitation by evapotranspiration (about 6.4 inches annually) from the Upper Hangman sub-basin is 71.3% of the precipitation total, leaving about 28.7% of the remaining moisture surplus available for runoff or infiltration to the ground. These numbers compare favorably with the earlier work by Ko and others (1974) in this specific part of the watershed despite an entirely independent study.

A technical study performed in the Idaho portion of the Hangman Creek drainage basin by Ko and others (1974) reports a simple mass balance for their limited study area. Their upper basin study showed that about 24.3% of precipitation flows from the basin as runoff, and about 74.2% returns to the atmosphere as evapotranspiration. They concluded that only about 1.5% of the moisture infiltrates as recharge to aquifer units in the area corresponding to the Upper Hangman sub-basin in this study.

Furthermore, recent work in the Colville watershed (WRIA 59) also yielded similar results (Kahle and others, 2002). Their study concluded that the “predominant fate of precipitation in the basin (83%) is evapotranspiration, a combination of evaporation from open bodies of water, evaporation from soil surfaces, and transpiration from the soil by plants.” They go on to further infer that groundwater flow comprises only about 1% of precipitation in their overall water budget.

Therefore, it appears that the soil moisture surplus calculated for WRIA 56 is entirely consistent with these two previous studies in eastern Washington and northern Idaho. That is, the vast majority of precipitation falling in the basin is lost to evapotranspiration with a significant portion of the remaining surplus going to runoff. Both other studies (Ko and others, 1974; Kahle and others, 2002) concluded that only a minimal amount (1 to 1.5% of precipitation) goes to groundwater.

Another independent check on the water balance determined by this study can be made by examining the available gaging data for the mainstem of WRIA 56. The historical record at the gaging station, located very close to the basin mouth (Hangman Creek at Spokane, Washington, USGS number 12424000,) shows a long-term mean annual discharge from the basin of about 242.56 cubic feet per second (cfs) for the period of 1949-2000. This discharge rate converts to 175,608 af/yr and compares surprisingly well with the moisture surplus estimate made in the previous section of this report of 172,143 af/yr (agreement within 1.9%).

Table 4 is a summary of the comprehensive water balance for WRIA 56 that presents two different proportions of runoff and infiltration of the remaining moisture surplus: that is, either 99% of the moisture surplus goes to runoff leaving 1% to infiltrate (similar to Ko and others (1974) and Kahle and others (2002)) or 95% goes to runoff with 5% going to infiltration if one would prefer to accept a higher value for infiltration. Not surprisingly, it is the proportion of 99% runoff and 1% infiltration that yields the results closest to the two other similar studies. Additionally, the 99% runoff scenario results in a discharge volume that corresponds with the long-term average annual flow from the basin as measured at the U.S.G.S. gaging station at the mount of WRIA 56.

In summary, the overall water balance determined in this study for WRIA 56 appears reasonable, based on close agreement with the conclusions made in two other independent watershed studies in the region, and on the cross-check with long-term gaging data for WRIA 56 itself. About 172,143 af/yr of surface water runs off the entire basin, and only about 1,738 af/yr goes to infiltration.

Water Rights

Recorded Water Allocations

The WDOE tracks groundwater and surface water allocations and/or water rights information through their Water Right Tracking System (WRATS) system, and an abstracted version termed “WRTS-On-A-Bun.” The latter database was utilized in this analysis of water allocation in WRIA 56, with the database current as of September 5, 2002.

The IDWR maintains an on-line database that is Web-accessible for similar access to water rights information for that portion of the Hangman watershed that exists in Idaho. The Coeur d’Alene Tribe had no meaningful records for groundwater or surface water allocation on their lands. In total, 2,928 records were found for WRIA 56 in the WDOE database, while 111 records were found for the Idaho portion of the watershed in the IDWR database.

Unfortunately, with all of these databases, the records are not necessarily complete and may contain omissions and/or errors made when transcribing paper records into a digital format. Also, they may not reflect the most up-to-date information at any moment in time. Most importantly, some water allocations may not be used at present, and some may have been abandoned entirely.

In this study, these databases were queried for the type of registration (claim, application, permit or certificate), the point of use or diversion, the purpose of use, and the allocation amount. For a thorough review of water rights registration and pertinent state laws and rules, the reader may want to visit related Web sites at WDOE and IDWR; such a discussion is beyond the scope of this report and is not included here.

During the analysis of the available data several assumptions had to be made, particularly if an allocation amount was not indicated in the records, in order to estimate an annual quantity of water use. In consultation with John Covert at WDOE in Spokane, water used by a single domestic unit is equivalent to 1 af/yr. Wells that fall under the domestic exemption, that is, use less than 5,000 gallons per day, were ignored and are not included in the registry.

Table 4. Summary of water balance for WRIA 56.

Sub-watershed	Basin Area	EUD	Estimated	Moisture surplus	Runoff	Runoff	Infiltration
	acres	Precipitation	ET	inches	acre-feet	feet	acre-feet
	(mi^2)	inches	inches	(acre-feet)	99%	99%	1%
					95%	95%	5%
Upper Hangman	214,383	22.3	15.9	6.4	113,194	0.53	1,143
	(334.9)			(114,338)	108,621	0.51	5,717
Rock Creek	114,589	19.6	15.4	4.2	39,705	0.35	401
	(179.0)			(40,106)	38,101	0.33	2,005
California Creek	15,942	19.9	15.8	4.1	5,392	0.34	54
	(24.9)			(5,447)	5,175	0.32	272
Lower Hangman	45,947	17.8	15.2	2.6	9,856	0.21	100
	(71.8)			(9,955)	9,457	0.21	498
Marshall/Minnie Creek	40,359	17.4	16.2	1.2	3,996	0.10	40
	(63.1)			(4,036)	3,834	0.10	202
Total	431,220	--	--	18.5	172,143	1.53	1,738
	(673.7)			(173,882)	165,188	1.47	8,694

EUD = effective uniform depth of precipitation calculated using the isohyetal method on PRISM data.

Estimated ET = evapotranspiration based on weighted values for various land uses within the watershed shown on GIS.

Runoff = water available for flow to streams and shallow (perched) aquifers.

Infiltration = water percolating to deep aquifers.

In order to calculate an annual allocation for a water well with a specified irrigation use, and where no amount was given in the water rights database, each acre under irrigation uses 3 af/yr and is 100% consumptive.

Table 5 presents an estimate of the total water right quantities for WRIA 56 and its sub-basins as recorded in the WDOE and IDWR databases, and using the assumptions listed above to calculate an annual water quantity that has been recorded for use.

Table 5. Water rights (claims/permits/certificates) in annual acre feet for WRIA 56.

	Groundwater	Surface	Springs	Totals
	ac-ft and %	ac-ft and %	ac-ft and %	ac-ft
Upper Hangman	3,659	1,353	234	5,246
	69.7%	25.8%	4.5%	
Rock Creek	3,430	14	9	3,453
	99.3%	0.4%	0.3%	
California Creek	539	5	151	695
	77.6%	0.7%	21.7%	
Marshall/Minnie Creek	10,805	1,756	487	13,048
	82.8%	13.5%	3.7%	
Lower Hangman	8,863	2,445	228	11,536
	76.8%	21.2%	2.0%	
Totals	27,296	5,573	1,109	33,978
	80.3%	16.4%	3.3%	(0.95 inches)
All data from WRATS/WOB and IDWR				

Furthermore, Figures 6, 7 and 8 show the spatial distribution of water right allocations in WRIA 56 for surface water, groundwater, and springs, respectively. Not surprisingly, surface water rights correspond to locations adjacent to the main stream channels, as shown in Figure 6. Groundwater rights, however, are distributed more widely, and are most prevalent in the Lower Hangman and Marshall/Minnie Creek sub-basins as shown on Figure 7. There are a few water right allocations on springs, and their locations can be seen in Figure 9.

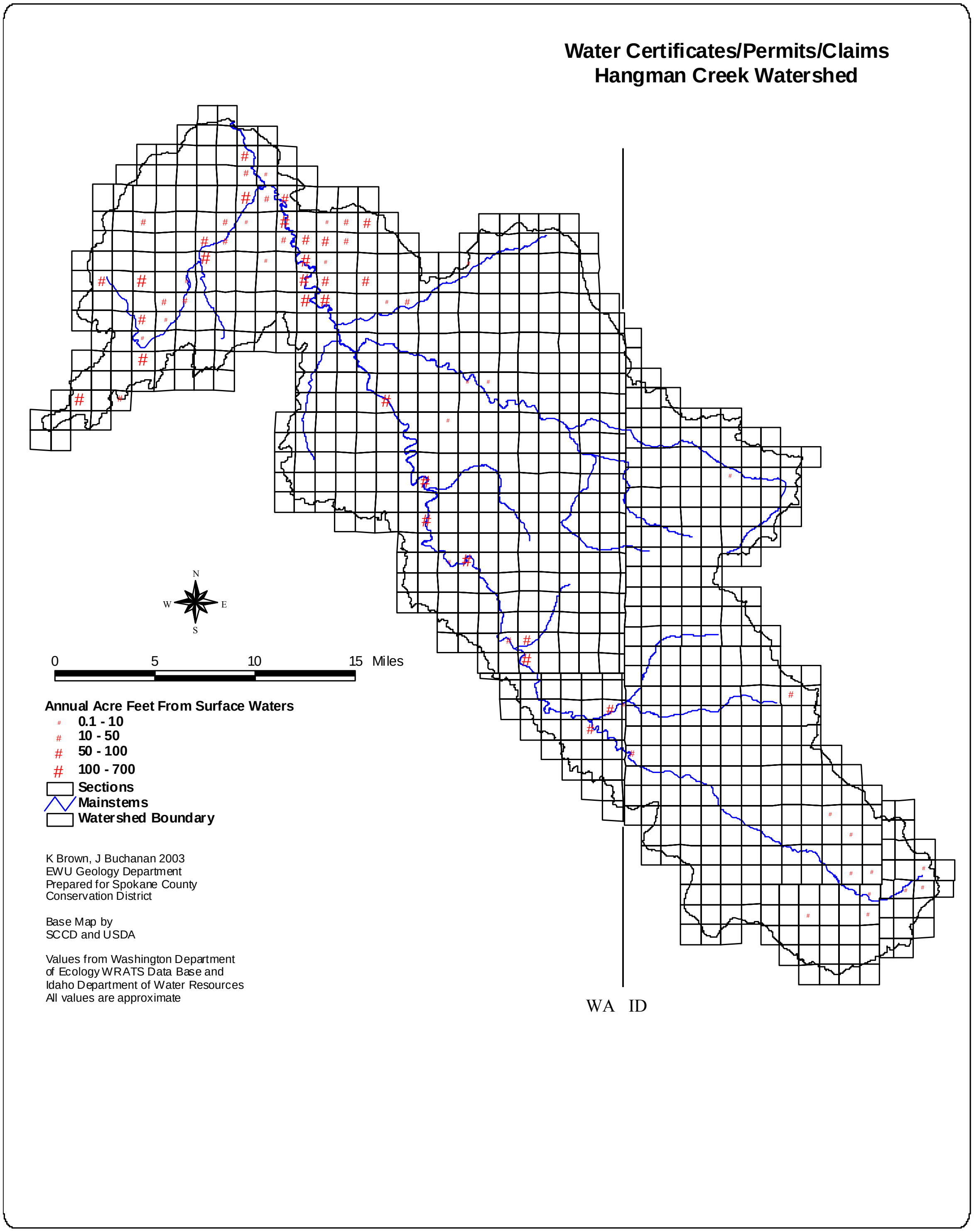

Figure 6. Summary of surface water rights in WRIA 56 from WDOE and IDWR records.

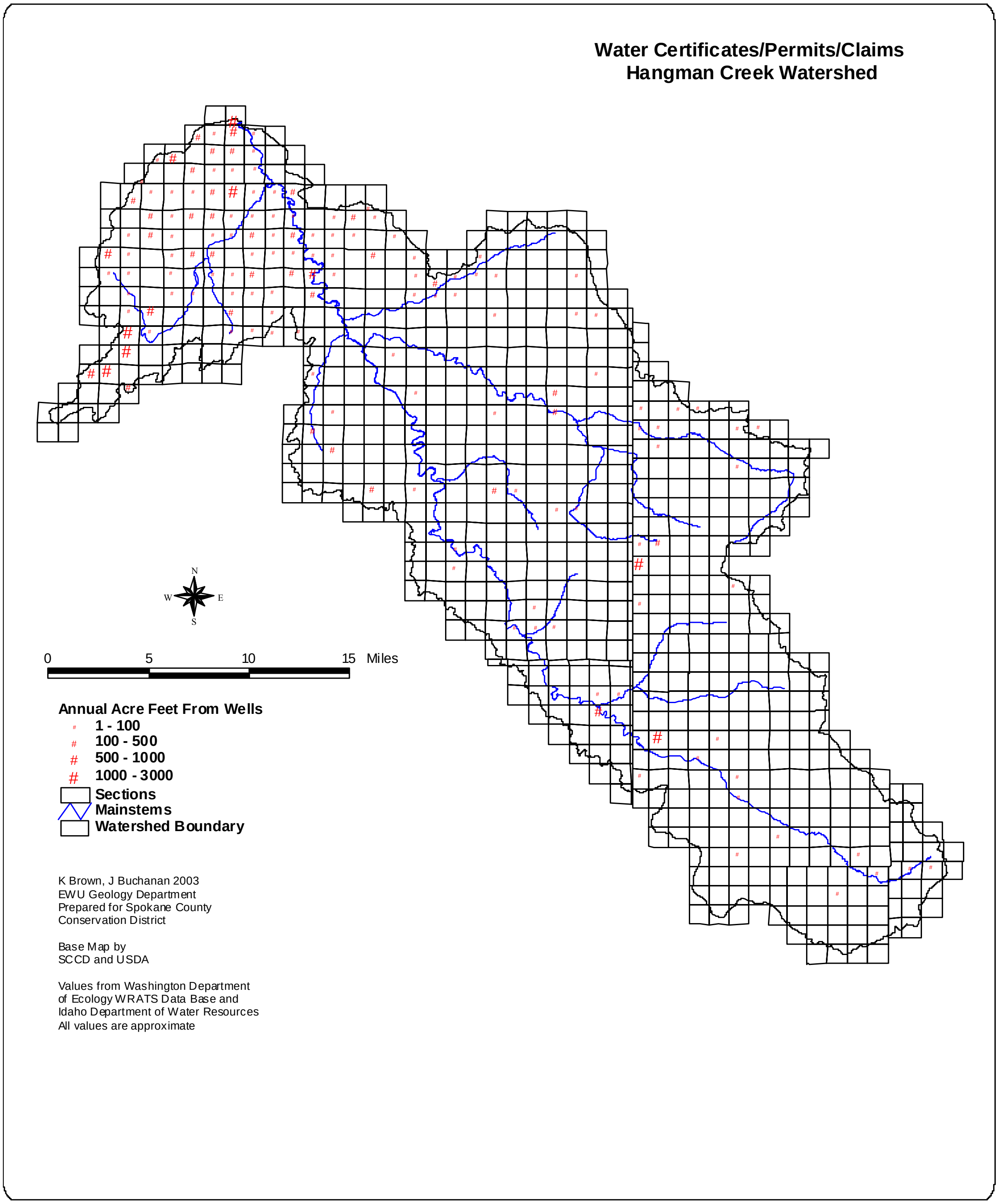

Figure 7. Summary of groundwater rights in WRIA 56 based on WDOE and IDWR records.

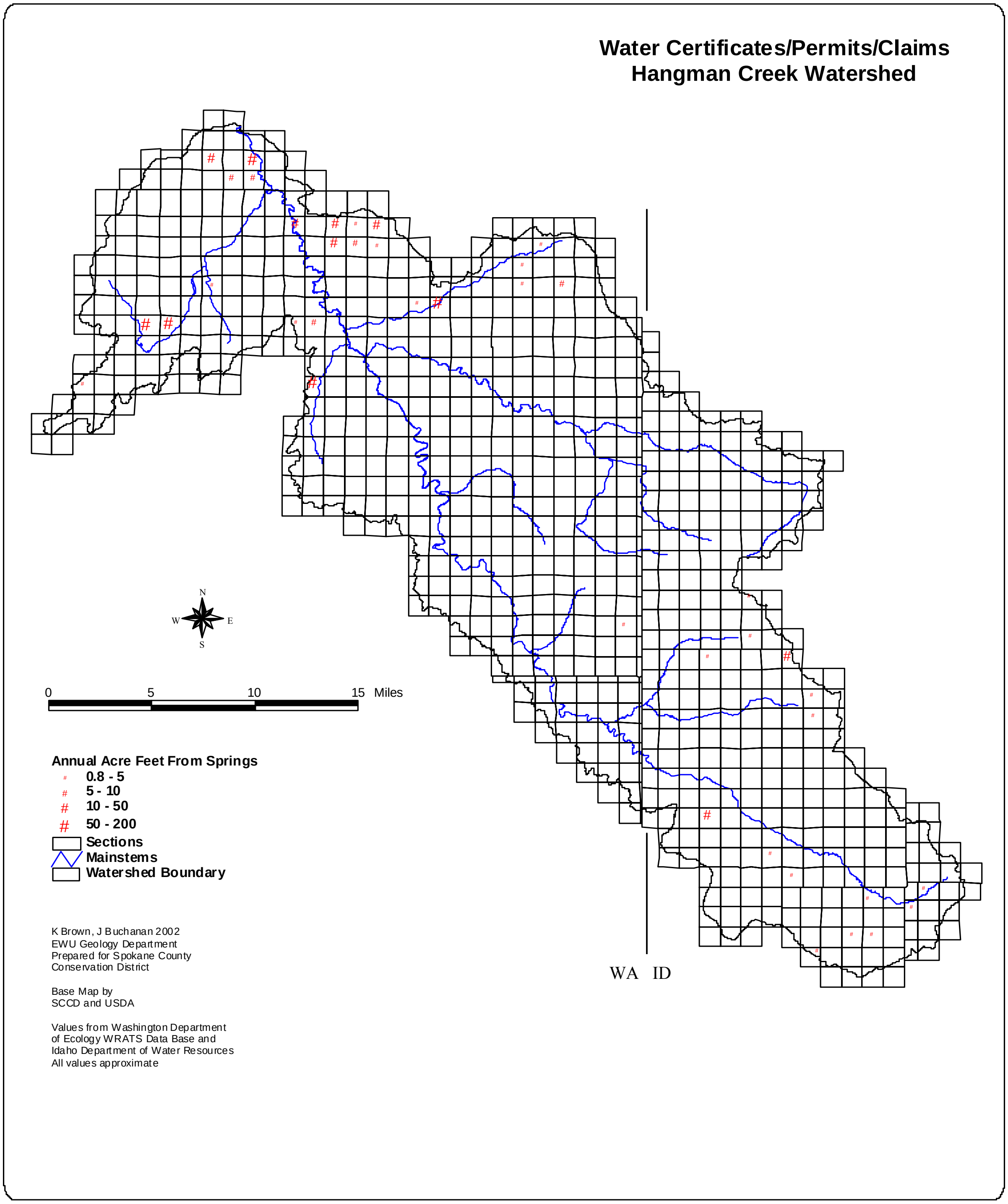

Figure 8. Summary of water rights from springs in WRIA 56 from WDOE and IDWR records.

Table 5 shows very clearly that groundwater allocations are the overwhelming source of water rights in WRIA 56, accounting for about 80% of all water use in the watershed. About 16% of water use is derived from water rights on surface water, and only 3% are associated with allocations on water flow from springs. In all, the total estimated volume of allocated water as recorded on "paper" is estimated to be about 33,978 acre feet annually in WRIA 56, the equivalent to 0.95 inches of precipitation across the entire watershed.

Estimated Actual Use

The actual water used by agricultural application is often quite different from the "paper" allocation, which almost always tends to be greater in quantity. Table 6 shows that the "paper" allocation for a specified irrigation use in WRIA 56 is 13,857 af based on the WRATS and IDWR databases.

GIS coverage for land use (Figure 5) was queried to assess the total amount of potential irrigated acreage in WRIA 56, and the results are listed in Table 6 by sub-basin. In total, 6,174 acres are potentially subject to irrigation in WRIA 56. No other better authoritative estimate of irrigated cropland was found, and no estimate is given in the Management Plan (SCCD, 1994). It is the opinion of the SCCD staff, however, that the estimate for irrigated land used here is probably high.

The crop irrigation requirement (CIR) is the amount of water actually used by a crop for growth, in addition to natural precipitation. This represents a theoretical maximum water use by plants, and it is entirely consumptive. In studies of WRIA 55 and 57, Golder Associates Inc. (2001) calculated the CIR to be 1.6 feet annually for the Little Spokane and Middle Spokane watersheds (for a mix of wheat, alfalfa/hay, and barley), and that number is used in this study.

The volume of water necessary for crop growth is the product of the CIR and the area of the irrigated land. For WRIA 56, the sum total of water actually used for watering the potentially irrigated land area within each sub-basin is 9,910 af/yr (Table 6,) a figure that is about 72% of the total "paper" rights listing irrigation as a specified use (13,857 af).

Evaluation of Water Rights Compared to Overall Water Balance

Total annual runoff as determined in the overall water balance is 172,143 af/yr (99% runoff scenario) to 165,188 af/yr (95% scenario) (Table 4). The total surface water allocation in WRIA 56 (both surface water and from springs) amounts to 6,682 af/yr (Table 5). Table 7 shows that surface water allocations are indeed a small proportion of the runoff volume for each sub-basin, and comprises nearly 4% of the total annual runoff from WRIA 56 as a whole.

Table 6. Summary of irrigation "paper" allocations and actual water use in WRIA 56.

Sub-watershed	Basin Area acres	Irrigated Area acres	CIR af/yr	All "Paper" Water Rights af/yr	"Paper" Rights for Irrigation af/yr	Non-Irrigation or Other Use af/yr
Upper Hangman	214,383	922	1,475	5,246	994	4,252
Rock Creek	114,589	419	670	3,453	130	3,323
California Creek	15,942	232	371	695	471	224
Lower Hangman	45,947	3,180	5,088	11,536	6,851	4,685
Marshall Creek	40,359	1,441	2,306	13,048	5,412	7,636
Totals	431,220	6,194	9,910	33,978	13,857	20,121

Notes:

Irrigated area by sub-basin from GIS database (NRCS, 1994)

All "Paper" water rights from WRATS/IDWR

"Paper" rights for irrigation is sum of water rights for specified irrigation use
CIR = estimate of actual irrigation based on crop irrigation requirement
(CIR) of 1.6 feet /acre/year (Golder, 2001)

Table 7. Surface water appropriations (surface water and springs) compared to annual runoff volume for WRIA 56.

SURFACE WATER APPROPRIATION (surface water + springs)							
Sub-watershed		Basin Area	Irrigated Area	Annual SW rights	Annual SW Rights	Annual Runoff	Annual SW Rights
		acres	acres	acre-feet	in inches	acre-feet	as % of runoff
						99% scenario	99% scenario
						95% scenario	95% scenario
Upper Hangman		214,383	922	1,587	0.0888	113,194	1.40
						108,621	1.46
Rock Creek		114,589	419	23	0.0024	39,705	0.06
						38,101	0.06
California Creek		15,942	232	156	0.1174	5,392	2.89
						5,175	3.01
Lower Hangman		45,947	3,180	2,673	0.6981	9,856	27.12
						9,457	28.26
Marshall Creek		40,359	1,441	2,243	0.6669	3,996	56.14
						3,834	58.50
Totals		431,220	6,194	6,682	1.57	172,143	--
						165,188	--

Notes:
Annual runoff (99% and 95% scenarios) from Table 4.
Irrigated area by sub-basin from GIS database (NRCS, 1994)

Table 8. Groundwater appropriations compared to annual infiltration volume for WRIA 56.

GROUNDWATER APPROPRIATION							
Sub-watershed		Basin Area	Irrigated Area	Annual GW rights	Annual GW rights	Annual infiltration	Annual GW rights as
		acres	acres	acre feet	in inches	acre-feet	% of infiltration
						1% scenario	1% scenario
						5% scenario	5% scenario
Upper Hangman		214,383	922	3,659	0.20	1,143	320
						5,717	64
Rock Creek		114,589	419	3,430	0.36	401	855
						2,005	171
California Creek		15,942	232	539	0.41	54	998
						272	198
Lower Hangman		45,947	3,180	8,863	2.31	100	8,863
						498	1,780
Marshall Creek		40,359	1,441	10,805	3.21	40	27,013
						202	5,349
Totals		431,220	6,194	27,296	6.49	1,738	--
						8,694	--

Notes:
Annual infiltration (1% and 5% scenarios) from Table 4.
Irrigated area by sub-basin from GIS database (NRCS, 1994)

However, in the Lower Hangman and the Marshall/Minnie Creek sub-basins, the allocations approach 27% and 56%, respectively, of the estimated runoff volumes from those basins (Table 7). This would suggest that water extraction via surface water rights in these two sub-basins has significant potential of affecting stream flows, particularly in the summer months when streams are low and the water use and irrigation season is peaking.

Table 5 shows very clearly that groundwater allocations are the overwhelming source of water rights in WRIA 56, accounting for about 80% of all water use in the watershed, or 27,296 af/yr. Recall that the volume of infiltration in the basin is between 1,738 af/yr (1% infiltration scenario) to 8,694 af/yr (5% scenario) (Table 4) based on the overall water balance determined by this study. It is clear that the amount of groundwater that is allocated for use is far greater than that volume of infiltrating moisture that potentially goes to aquifer recharge in the basin (Table 8).

Table 8 also shows that this trend is true for all of the sub-basins in WRIA 56, where each is potentially using groundwater at a rate that exceeds recharge. Such activity is likely to drive groundwater levels lower through time, in a condition sometimes known as "groundwater mining." This situation occurs when discharge of groundwater from an aquifer system exceeds the recharge amount to the system. This is especially true in the Marshall/Minnie Creek and Lower Hangman sub-basins, however, in the Rock Creek, California Creek and Upper Hangman sub-basins, this condition is not as significant.

Unfortunately there are no monitoring wells in WRIA 56 to assess long-term trends in groundwater levels, and no data is available from any identified source. However, wells developed in basalt aquifers in Lincoln County and in Medical Lake show declining trends in the elevation of the groundwater surface through time (Olson, T.M and J.J. Covert, 1994; Deobald and Buchanan, 1995). In addition, groundwater levels in the Pullman-Moscow basin (WRIA 34) have been declining for decades in an aquifer system similar to that in the Hangman watershed (Lum and others, 1990).

The center column in Table 8 (Annual GW Rights in inches) indicates a sense of the amount of annual groundwater decline, in each sub-basin, that may be expected into the future. The value in that column, when divided by the specific yield of the aquifer, results in the annual decline in the groundwater level to be expected in a well. For example, if one assumes a 25% specific yield for a basalt aquifer in the Marshall/Minnie Creek sub-basin, dividing 3.21 inches by 0.25 equals about one foot of groundwater decline, an amount that matches closely the amount of head loss in wells in the Medical Lake area adjacent to that sub-basin.

In sum, surface water appropriations in WRIA 56 have the potential to impact stream flows during the summer months, especially in the Lower Hangman and Marshall/Minnie Creek sub-basins. Groundwater mining is certainly a high potential, particularly in the Lower Hangman and Marshall/Minnie Creek sub-basins where water right allocations from groundwater greatly exceed the recharge rate. Allocated surface water rights are 3.9% of the total annual average stream flow in WRIA 56, while allocated surface water and groundwater rights are 19.7% of the average annual stream flow.

Evaluation of Potential for Numerical Modeling

Software exists today that enables scientists and land managers to simulate the hydrologic cycle, and its component parts, within an entire watershed. A well implemented watershed model can be used to identify the important data needs within a basin and guide future research, as well as serve as a predictive tool to anticipate potential impacts in the basin under various land use scenarios.

Watershed modeling software exists in the public domain (free) and is available from the U.S. Geological Survey, the Environmental Protection Agency, or the U.S. Army Corps of Engineers, or it is commercially available for a licensing fee. All modeling software requires comprehensive datasets representing information for each component of the hydrologic and physical system, at the appropriate resolution, in the proper format, and usually as a time series to enable transient simulations. Table 9 lists a subset of fundamental model data requirements, but it is not an exhaustive list.

Numerical modeling is typically very expensive and highly time consuming. Commercial software tends to cost several thousand dollars to license, and that fee does not include the added costs for training personnel to use the software, the time devoted to data entry, and the time for model calibration/verification and subsequent execution.

The latter aspect of modeling is typically underappreciated. All numerical models have to be calibrated and verified against field data to demonstrate their accuracy, prior to using the model as a tool to predict various scenarios and outcomes. In order to achieve this important goal, datasets have to span years of time (typically a minimum of 3 to 10 years) so that the model can be calibrated using one subset of the temporal data, and then verified against a second (separate) interval of time.

It is important that before any attempt is made to construct a watershed model of WRIA 56 there should be a consensus among all those involved in the planning process to clearly and specifically identify the primary purpose and objectives of the undertaking. The selection of the actual modeling code or software will depend on the expectations established by the planning process.

Numerous public domain codes exist for simple runoff and infiltration modeling. A brief review of some of these is provided in Appendix B. The models described there are not to be applied to an entire watershed, but rather to determine field values of runoff or infiltration on a local scale given the proper inputs. These models are free, are somewhat simple to operate, and can be instructive in understanding the hydrologic processes at work in various parts of a watershed.

However, more robust applications are required for full numerical modeling of a watershed system. The tool of choice being utilized for WRIA 55 and 57 is MIKE SHE, a very comprehensive code that can simulate all components of the hydrologic cycle (Golder Associates Inc., 2001). It appears the implementation for those basins will be achieved given

Table 9. Basic data requirements for watershed modeling (from Golder, 2001).

Watershed Geometry

- Boundaries of the watershed and all stream segments in a coordinate system
- Digital elevation model (DEM) of the watershed
- Specific site locations of all data, for example, locations of stream gages, water wells, stream withdrawals, etc.

Groundwater

- Aquifer/aquitard properties – hydraulic conductivity, storativity, specific yield, etc
- Locations of groundwater withdrawal or recharge
- Locations of water wells or monitoring wells

Soils

- Soil characteristics – profile information from land surface to groundwater surface
- Distribution of soil types
- Physical properties of soils – water content, saturated hydraulic conductivity, etc.

Runoff and Overland Flow

- Land use coverage
- DEM data for slope/length information
- Meteorologic data – station data or PRISM data
- Storage sites on surface
- Runoff coefficients
- Flood maps

Channel Flow

- Surveyed river transects
- Manning's n – channel roughness coefficient
- Specific locations for gaining/losing reaches – interaction with groundwater
- Specific locations for control structures, water input or abstraction, etc.

Snowmelt

- Climate data
- Temperature data
- Degree-day coefficients

Evapotranspiration

- Pan evaporation data
- Land use and vegetation cover – usually imported from GIS coverage

the outstanding set of spatially and temporally distributed data that is available for model input, and the availability of qualified consultants to design and implement the working model. However, for WRIA 56, using that code would not necessarily yield equally reliable results, especially given the limited quantity of data that exists for the Hangman Creek watershed.

Modeling could ultimately be helpful in future water resource management in WRIA 56. A model development project would take at least a year or more in time to formulate the model framework and to calibrate against field data, provided that a comprehensive dataset already exists. The first objective of such a project would be to build the model to represent the hydrologic system as it exists today in the watershed. Once constructed, calibrated and validated, the model may be applied to helping choose among different management schemes as a solution to a particular problem.

For example, a working watershed model could explore the potential of gradually increasing groundwater pumping in the select parts of the basin, and to predict whether it may eventually have an impact on stream flows. Similarly, a well constructed model could aid in further refinement of the water balance of the watershed, and provide insight to WDOE as it processes water right applications for WRIA 56 into the future. The model may also be used as a guide to further research, for example, in understanding the coupling of various stream reaches with the underlying groundwater system. Short-term and long-term climatic cycles could also be simulated as more information becomes available in the Pacific Northwest region, with simulated stream hydrographs as the model output. Lastly, historical conditions in the watershed could be simulated in the model, prior to major land use modifications, in order to contrast the present day hydrology with that of the past.

No attempts have been made at modeling WRIA 56 to this date, and such an attempt may have to wait at least several more years so that additional field data can be gathered. Recommendations for additional studies, most of which would assist in model development, are presented in the next section of this report.

Future Data Needs

This study has identified the following as primary data needs in order to better understand the hydrologic system in WRIA 56. In addition, these would be prerequisite to any reasonable attempt at constructing a numerical model of the watershed system.

First, there is no groundwater assessment or monitoring system in place at all in WRIA 56. Groundwater monitoring wells in select locations, in select aquifer units, should be installed, and coupled to a long-term monitoring program. Autonomous data-loggers are available at modest cost that can record water levels, temperature, and water chemistry parameters. Some select existing wells may be utilized in the near term to begin to gather data on groundwater level fluctuations through time.

Second, a special subset of groundwater monitoring wells should be installed close to the stream in the Upper Hangman sub-basin in order to better understand the relationship there between surface and groundwater. Influent reaches of the stream should be identified in this area, with two or more monitoring wells installed in an array perpendicular to the stream course. Additional wells should be installed at different depths to better understand the vertical gradients in the groundwater system immediately adjacent to the stream.

Third, similar groundwater monitoring of water levels and river stage in the alluvial aquifer adjacent to Hangman Creek below the confluence of Rock Creek should also occur. An accurate survey of the elevation of the wellheads should be made in this area as the hydraulic gradients are likely to be very small.

Fourth, the SCCD has established five stream gages in the basin and three years of data have been gathered to date. These gages should be maintained long-term, and data gathering efforts continued as long as funding permits. Additional seepage runs on the mainstem of Hangman Creek and select tributaries should be continued in successive years to augment the existing data set.

Fifth, a very important field survey to identify and verify the specific locations of all irrigators in WRIA 56 should be undertaken. Both surface water and groundwater diversions should be investigated, and the amounts of withdrawal and the acreage under irrigation should be gathered. The existing water rights databases are often incomplete and may contain erroneous data.

Sixth, water use is likely occurring on Tribal Lands in the upper watershed. However, as best as this study could determine, much of this use is entirely undocumented. Watershed planners and managers should encourage better record keeping by the Coeur d'Alene Tribe.

Summary and Conclusions

Water resources inventory area (WRIA) 56 encompasses the Hangman (Latah) Creek watershed in Washington, with headwaters in Idaho. The basin covers 431,220 acres and contains approximately 222 miles of perennial streams. The headwaters in Idaho lie at an elevation of about 3,600 feet above mean sea level, and at its confluence with the Spokane River the elevation is 1,720 feet above mean sea level.

The geology varies considerably within the basin. The primary geological units include, from oldest to youngest: 1) crystalline basement rocks of meta-sedimentary and igneous plutonic origin that underlie the entire region and occur in the higher peaks, 2) widespread horizontally-bedded volcanic rocks consisting of basalt flows separated by laterally discontinuous sedimentary interbeds, and 3) unconsolidated surficial deposits consisting primarily of flood-deposited sand and gravel and the wind-deposited silts that comprise the rolling hills characteristic of the Palouse.

An unconfined aquifer exists in the sand and gravel deposits in the lower portion of WRIA 56, below the confluence of Rock and California Creek. The water table in this aquifer unit is strongly connected to, and is influenced by, the stage of flow in Hangman Creek. Groundwater discharge from the Hangman valley aquifer and into the lower Spokane aquifer is almost 13 cubic feet per second. However, the most prolific and important aquifer in WRIA 56 is contained within the Columbia River Basalts where multiply stacked confined or semi-confined aquifers are accessible through deep wells. Due to its limited recharge potential within WRIA 56, the basalt aquifer system may be impacted by increasing groundwater withdrawals into the future.

The climate in WRIA 56 is generally very warm and dry in the summer and cool and moist during the winter. Because of the large range in elevation in the watershed significant variation in precipitation occurs, from less than 16 inches/year in the lower part of the basin that is sub-arid, to more than 40 inches/year in the upper part that is sub-humid. Area-weighted calculations of evapotranspiration in the watershed, when compared to the areal distribution of precipitation, show that there is a moisture surplus of 173,882 acre feet per year. This excess water is free to either run off into surface streams, or to infiltrate into the ground to recharge shallow and/or deep aquifer systems.

Surface water appropriations in WRIA 56 have the potential to impact stream flows during the summer months, especially in the Lower Hangman and Marshall/Minnie Creek sub-basins. Groundwater mining is certainly a high potential, particularly in the Lower Hangman and Marshall/Minnie Creek sub-basins where water right allocations from groundwater greatly exceed the recharge rate. Allocated surface water rights are 3.9% of the total annual average stream flow in WRIA 56, while allocated surface water and groundwater rights are 19.7% of the average annual stream flow.

Numerical modeling could ultimately be helpful in future water resource management in WRIA 56. A model development project would take at least two years or more in time to formulate the model framework and to calibrate against field data, provided that a comprehensive dataset already exists. The first objective of such a project would be to build the model to represent the hydrologic system as it exists today in the watershed. Once constructed, calibrated and validated, the model may be applied to helping choose among different management schemes as a solution to a particular problem.

For example, a working watershed model could explore the potential of gradually increasing groundwater pumping in the select parts of the basin, and to predict whether it may eventually have an impact on stream flows. Similarly, a well constructed model could aid in further refinement of the water balance of the watershed, and provide insight to WDOE as it processes water right applications for WRIA 56 into the future. The model may also be used as a guide to further research, for example, in understanding the coupling of various stream reaches with the underlying groundwater system. Short-term and long-term climatic cycles could also be simulated as more information becomes available in the Pacific Northwest region, with simulated stream hydrographs as the model output. Lastly, historical conditions in the watershed could be simulated in the model, prior to major land use modifications, in order to contrast the present day hydrology with that of the past.

No attempts have been made at modeling WRIA 56 to this date, and such an attempt may have to wait at least several more years so that additional field data can be gathered.

This study has identified the following as primary data needs in order to better understand the hydrologic system in WRIA 56. Groundwater monitoring wells in select locations, in select aquifer units, spatially distributed around the basin should be installed, and coupled to a long-term monitoring program. Additional groundwater monitoring wells should be installed close to the stream in the Upper Hangman sub-basin in order to better understand the relationship there between surface and groundwater, which is fundamentally influent (losing). Similar groundwater monitoring of water levels and river stage in the alluvial aquifer adjacent to Hangman Creek below the confluence of Rock Creek should also occur in this reach that is dominantly effluent (gaining).

Additional stream gages should be established at the mouths of the major sub-basins identified in this study to better understand their hydrologic behavior, particularly if numerical modeling is going to be seriously considered. Additional seepage runs on the mainstem of Hangman Creek and select tributaries should be continued in successive years to augment the existing data set already gathered by SCCD and other consultants.

Examination of the water right databases in Washington and Idaho showed that many records are incomplete or may contain erroneous data on water use in the basin. It is very important that a detailed field survey be performed in order to identify and verify the specific locations of all irrigators in WRIA 56. Both surface water and groundwater diversions should be investigated, and the amounts of withdrawal and the acreage under irrigation should be gathered.

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APPENDICES

Appendix A. Land use by sub-basin spreadsheets

Appendix B. Review of runoff and infiltration models

Appendix A. Land use spreadsheets for each sub-basin

Marshall/Minnie Creek Sub-basin: land use (acreage and percent) by precipitation range (inches)						
Precipitation (isohyet zone)	17	19		Precipitation	17	19
Land use category (see Table 2)				Land use %		
11	315.15	406.22		11	0.95	5.72
21	1129.11	311.57		21	3.39	4.39
22	13.65	10.06		22	0.04	0.14
23	663.06	208.78		23	1.99	2.94
31	226.46	30.69		31	0.68	0.43
33	36.66	46.71		33	0.11	0.66
41	91.70	29.21		41	0.28	0.41
42	10253.76	3180.46		42	30.83	44.80
43	367.59	111.95		43	1.11	1.58
51	4777.29	1347.68		51	14.36	18.98
71	4043.45	1192.85		71	12.16	16.80
81	1686.06	83.17		81	5.07	1.17
82	2.64	0.96		82	0.01	0.01
83	4750.49	52.01		83	14.28	0.73
84	4745.02	32.31		84	14.27	0.46
85	0.96	4.07		85	0.00	0.06
91	26.41	27.32		91	0.08	0.38
92	132.60	23.73		92	0.40	0.33
Total acres	33262.04	7099.73	40361.77		100	100

Appendix A. Land use spreadsheets for each sub-basin (continued)

Lower Hangman Sub-basin: land use (acreage and percent) by precipitation range (inches)								
Precipitation (isohyet zone)	17	19	21		Precipitation	17	19	21
Land use category (see Table 2)					Land use %			
11	76.47	43.61	0.24		11.00	0.27	0.27	0.03
21	3000.45	180.23	0.24		21.00	10.56	1.10	0.03
23	2361.65	126.27	0.96		23.00	8.31	0.77	0.12
31	15.58	13.35	0.00		31.00	0.05	0.08	0.00
33	74.75	0.15	0.00		33.00	0.26	0.00	0.00
41	87.85	4.08	0.00		41.00	0.31	0.02	0.00
42	5413.73	2110.10	306.30		42.00	19.05	12.83	39.39
43	148.85	81.26	36.00		43.00	0.52	0.49	4.63
51	5424.84	4261.34	100.06		51.00	19.09	25.92	12.87
71	4062.83	3080.22	97.60		71.00	14.30	18.74	12.55
81	3178.92	428.88	0.00		81.00	11.19	2.61	0.00
82	18.45	6.75	0.00		82.00	0.06	0.04	0.00
83	1454.39	4701.69	227.04		83.00	5.12	28.60	29.20
84	1822.79	1399.20	8.38		84.00	6.41	8.51	1.08
91	1220.10	1.68	0.72		91.00	4.29	0.01	0.09
92	58.97	1.65	0.00		92.00	0.21	0.01	0.00
Total acres	28420.61	16440.43	777.54	45638.58	Total	100.00	100.00	100.00

Appendix A. Land use spreadsheets for each sub-basin (continued)

California Creek Sub-basin: land use (acreage and percent) by precipitation range (inches)								
Precipitation (isohyet zone)	19	21	23		Precipitation	19	21	23
Land use category (see Table 2)					Land use %			
11	10.54	7.43	0.96		11	0.12	0.11	0.23
21	194.50	37.38	0.00		21	2.17	0.57	0.00
23	94.19	20.74	0.01		23	1.05	0.32	0.00
31	0.96	1.20	0.00		31	0.01	0.02	0.00
33	0.00	1.28	0.98		33	0.00	0.02	0.24
41	0.48	0.24	0.00		41	0.01	0.00	0.00
42	502.53	2340.32	327.01		42	5.61	35.62	79.84
43	25.40	317.29	58.33		43	0.28	4.83	14.24
51	1479.13	593.18	21.49		51	16.50	9.03	5.25
71	620.54	205.90	0.78		71	6.92	3.13	0.19
81	2.64	0.01	0.00		81	0.03	0.00	0.00
83	4159.51	2257.84	0.00		83	46.41	34.36	0.00
84	1870.10	780.18	0.00		84	20.87	11.87	0.00
91	1.94	3.84	0.00		91	0.02	0.06	0.00
92	0.00	4.07	0.00		92	0.00	0.06	0.00
Total acres	8962.45	6570.89	409.56	15942.90		100.00	100.00	100.00

Appendix A. Land use spreadsheets for each sub-basin (continued)

Rock Creek Sub-Basin: land use (acreage and percent) by precipitation range (inches)												
Precipitation (isohyet zone)	15	17	19	21	23		Precipitation	15	17	19	21	23
Land use category (see Table 2)							Land use %					
11	3.84	5.27	19.71	26.77	0.00		11	0.05	0.04	0.06	0.05	0.00
21	2.30	119.29	35.64	253.45	9.38		21	0.03	0.88	0.10	0.44	0.61
23	53.15	108.39	293.11	672.35	0.80		23	0.76	0.80	0.85	1.16	0.05
31	0.24	0.00	1.92	2.16	0.00		31	0.00	0.00	0.01	0.00	0.00
33	0.00	0.00	0.00	110.11	21.72		33	0.00	0.00	0.00	0.19	1.42
41	0.48	1.92	3.36	10.37	0.00		41	0.01	0.01	0.01	0.02	0.00
42	2135.15	2013.48	1799.10	2455.45	951.26		42	30.56	14.81	5.24	4.22	62.32
43	407.62	313.78	321.82	614.37	202.15		43	5.83	2.31	0.94	1.06	13.24
51	14.65	77.10	2449.40	3798.54	226.50		51	0.21	0.57	7.14	6.53	14.84
71	0.62	33.67	675.61	1081.66	81.59		71	0.01	0.25	1.97	1.86	5.35
81	0.00	0.00	209.36	11.26	3.84		81	0.00	0.00	0.61	0.02	0.25
82	0.00	0.00	0.00	0.00	0.00		82	0.00	0.00	0.00	0.00	0.00
83	2879.64	7002.95	20276.39	36763.09	29.07		83	41.22	51.50	59.08	63.21	1.90
84	1489.07	3921.27	8229.58	12350.16	0.00		84	21.31	28.84	23.98	21.23	0.00
91	0.00	0.00	6.71	11.27	0.00		91	0.00	0.00	0.02	0.02	0.00
92	0.00	0.00	0.00	0.24	0.00		92	0.00	0.00	0.00	0.00	0.00
Total	6986.75	13597.12	34321.70	58161.24	1526.29	114593.10	Total	100.00	100.00	100.00	100.00	100.00

Upper Hangman Sub-Basin: land use (acreage and percent) by precipitation range (inches)															
Precipitation (isohyet zone)	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
Land use (see Table 2)															
11	12.47	6.23	56.21	6.59	6.47	6.23	6.64	7.98	5.75	0.96	5.27	1.68	4.79	0.72	0.00
21	29.37	14.16	296.58	372.95	17.33	76.29	30.33	27.05	17.03	19.99	12.74	8.77	0.17	0.00	0.00
23	128.46	72.61	833.12	588.80	91.54	92.30	32.89	14.43	4.19	6.67	4.38	8.56	7.67	0.00	0.00
31	8.87	20.37	3.92	2.88	0.24	0.72	0.24	0.96	0.48	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00	0.00	38.22	12.27	61.55	120.53	112.68	231.64	194.14	257.94	123.19	0.00
41	0.72	0.00	12.23	11.98	2.16	1.79	3.25	7.64	3.14	0.96	1.87	0.91	0.81	0.48	0.00
42	2416.55	3275.29	2820.13	1583.02	2068.75	3524.85	3730.46	6013.01	4079.50	2489.87	2909.67	2103.22	3000.03	1125.03	1.02
43	443.03	498.61	209.04	328.85	324.62	528.63	531.97	714.30	306.54	197.19	274.29	210.89	335.98	99.86	0.00
51	22.44	134.12	7025.02	1689.77	11.51	11.45	26.35	18.91	46.16	3.81	5.90	0.34	0.96	0.00	0.00
71	3.22	81.75	3008.96	635.10	0.00	0.00	0.72	3.21	14.76	0.24	2.16	0.00	0.00	0.00	0.00
81	0.00	0.00	768.61	0.00	0.00	0.00	1.92	5.96	6.08	0.00	4.07	0.00	0.96	0.00	0.00
82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	3303.89	3700.53	44208.64	27028.02	8861.58	8056.74	4238.72	2430.45	851.14	505.01	248.55	104.19	44.31	0.00	0.00
84	2758.10	1979.14	18982.50	13253.99	3787.75	3601.62	1365.43	485.04	354.38	227.57	54.49	77.16	4.51	0.00	0.00
91	0.00	0.00	10.05	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	0.24	0.00	2.16	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	9127.34	9782.81	78237.15	45502.18	15171.94	15939.32	9981.17	9790.48	5809.68	3564.94	3755.04	2709.85	3658.13	1349.27	1.02

Precipitation (isohyet zone)	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
Land use %															
11	0.14	0.06	0.07	0.01	0.04	0.04	0.07	0.08	0.10	0.03	0.14	0.06	0.13	0.05	0.00
21	0.32	0.14	0.38	0.82	0.11	0.48	0.30	0.28	0.29	0.56	0.34	0.32	0.00	0.00	0.00
23	1.41	0.74	1.06	1.29	0.60	0.58	0.33	0.15	0.07	0.19	0.12	0.32	0.21	0.00	0.00
31	0.10	0.21	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00	0.00	0.24	0.12	0.63	2.07	3.16	6.17	7.16	7.05	9.13	0.00
41	0.01	0.00	0.02	0.03	0.01	0.01	0.03	0.08	0.05	0.03	0.05	0.03	0.02	0.04	0.00
42	26.48	33.48	3.60	3.48	13.64	22.11	37.38	61.42	70.22	69.84	77.49	77.61	82.01	83.38	100.00
43	4.85	5.10	0.27	0.72	2.14	3.32	5.33	7.30	5.28	5.53	7.30	7.78	9.18	7.40	0.00
51	0.25	1.37	8.98	3.71	0.08	0.07	0.26	0.19	0.79	0.11	0.16	0.01	0.03	0.00	0.00
71	0.04	0.84	3.85	1.40	0.00	0.00	0.01	0.03	0.25	0.01	0.06	0.00	0.00	0.00	0.00
81	0.00	0.00	0.98	0.00	0.00	0.00	0.02	0.06	0.10	0.00	0.11	0.00	0.03	0.00	0.00
82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	36.20	37.83	56.51	59.40	58.41	50.55	42.47	24.82	14.65	14.17	6.62	3.84	1.21	0.00	0.00
84	30.22	20.23	24.26	29.13	24.97	22.60	13.68	4.95	6.10	6.38	1.45	2.85	0.12	0.00	0.00
91	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Appendix B. Review of runoff and infiltration models

Basic Runoff Model Summary

Runoff models differ mainly in the methods used to generate runoff and to route it through a basin. They also differ in the control options available, data handling, and user interface, but these differences generally have little or no effect on how the model computes runoff (Zarriello, 1998). The most utilized models (Table 10) calculate runoff (excess precipitation) by one of the following:

(1) SCS (Soil Conservation District) curve number,
(2) Horton's equation, or
(3) continuous soil moisture accounting.

The SCS curve number is the most widely used method because of its relative simplicity; it defines the watershed storage and is determined for a watershed or sub-watershed predominantly from the types of soils, vegetative cover, and land-use characteristics (Soil Conservation Service, 1986). Horton's equation assumes that the soil infiltration rate decreases exponentially as a function of time since the storm began. Some models account for soil-moisture storage and infiltration using either the Green-Ampt or Phillips equation (see separate summary of infiltration models), or a variation thereof. The PSRM model uses the SCS curve number for determining soil infiltration, but uses soil moisture accounting to determine available storage. These models are either continuous or quasi-continuous (soil-moisture accounting is continuous, but routing is only performed only for a specified storm period). Continuous meteorologic data must be available for best results rather than estimating initial starting conditions for each storm event. Soil moisture accounting and infiltration procedures generally are more data-intensive than the SCS curve and Horton methods, and require a number of parameters corresponding to physical soil-water storage and infiltration characteristics.

Once excess precipitation is determined, surface runoff is calculated for overland flow and channel flow by one of the following methods:

(1) unit hydrograph,
(2) SCS triangular unit hydrograph, or
(3) by solving equations for flow.

The unit-hydrograph procedure derives a hydrograph by assuming a specific shape that represents land-use, soil, and geometric characteristics of the watershed, and techniques are available to derive the unit hydrograph from observed rainfall-runoff data. The SCS triangular unit hydrograph is an approximation of a nonlinear runoff distribution that is assumed to be constant in a unit hydrograph method. A number of methods exist for solving equations for flow. The Muskingum method is used for channel routing by determination of a wedge-shaped channel storage in relation to inflow and outflow channel volume. Overland flow and channel routing is performed in some models by kinematic wave to solve the continuity equation for flow or by diffusive wave, which includes an additional pressure-

Table 10. Comparison of runoff models.

Model Name	Authors	Simulation Type	Runoff Generation	Overland Flow	Channel Flow
CASC2D Cascade 2-D	Julian and Saghafian, 1991	event	soil moisture accounting	cascade	diffusive wave
CUHP Colorado Unit Hydrograph Procedure	Urban Drainage Flood Control District, 1984	event	Horton	unit hydrograph	unit hydrograph
DR3M Distributed Rainfall Routing Runoff Model	Alley and Smith, 1982	quasi-continuous	soil moisture accounting	kinematic wave	kinematic wave
HEC-1 Hydrologic Engineering Ctr.	Hydrologic Engineering Center, 1990	event	SCS curve number	unit hydrograph	Muskingum
HSPF Hydrologic Simulation Program Fortran	Bicknell and others, 1993	continuous	soil moisture accounting	kinematic wave	kinematic wave
PRSM Penn State Runoff Model	Aron and others, 1996	quasi-continuous	SCS curve number	cascade	kinematic wave
SWMM Storm Water Management	Model Huber and Dickenson, 1988	event	Horton	kinematic wave	kinematic wave
TR20 Technical Release No. 20	Soil Conservation Service, 1983	event	SCS curve number	SCS unit hydrograph	SCS unit hydrograph

differential term (Miller, 1984). The cascade method is a two-dimensional kinematic wave approximation for routing overland flow (Julien and others, 1995). Models that use the kinematic or diffusive wave routing differ by how overland flow and channel characteristics are specified.

In an uncalibrated test application for a watershed in Colorado, models based on the SCS curve number (HEC-1 and TR20) for generating runoff generally had the poorest fit. HEC-1 simulations substantially overpredicted peak flows, and TR20 simulations substantially underpredicted peak flows; this may indicate the sensitivity of the simulations to user judgment of the SCS curve number (Zarriello, 1998). A comparison of runoff simulation techniques in west-central Florida indicated a somewhat less, but comparable error, in simulated peak-flows and storm volumes for TR20 and HEC-1 simulations (Trommer and others, 1996). In that study, average uncalibrated-model peak-flow and storm-volume error averaged 45 and 43 percent, respectively, for TR20 simulations and 105 and 27 percent, respectively, for HEC-1 simulations.

Basic Infiltration Model Summary

The Environmental Protection Agency presents information on six infiltration models for which they provide the model code in MathCad. A comprehensive web site is available at the following URL: http://www.epa.gov/ada/csmos/ninflmod.html. Brief descriptions of each are provided below.

Description of the SCS (Soil Conservation Service) Model

The SCS Model is an empirically developed approach to the water infiltration process. It has been developed by first finding a mathematical function whose shape as a function of time matches the observed features of the infiltration rate. In semi-empirical models, most physical processes are represented by commonly accepted and simplistic conceptual methods rather than by equations derived from fundamental physical principles. The commonly used semi-empirical infiltration model in the fields of soil physics and hydrology is the SCS Model.

Description of the Philip's Two-Term Model

The Philip's Two-Term model (PHILIP2T) is a truncated power series solution developed by Philips (1957). During the initial stages of infiltration, i.e., when t (time) is very small, the first term of the model/equation dominates the process. In this stage, the vertical infiltration proceeds at almost the same rate as absorption, or horizontal infiltration. In this stage of infiltration the gravity component, represented by the second term of the model/equation, is negligible. As infiltration continues, the second term becomes progressively more important until it dominates the infiltration process. Philips (1957) suggested the use of the two-term model in applied hydrology when t is not too large.

Description of the Layered Green-Ampt Model

The Green-Ampt Model has been modified in this application to calculate water infiltration into non-uniform soils by several researchers (Bouwer, 1969; Fok, 1970; Moore, 1981; Ahuja and Ross, 1983). The implementation for layered systems (GALAYER) was developed by Flerchinger et al. (1989). Specifically, the model could be utilized for the determination of water infiltration over time in vertically heterogeneous soils.

Description of the Explicit Green-Ampt Model

The initial Green-Ampt model was the first physically-based model/equation describing the infiltration of water into soil. It has been the subject of considerable developments in soil physics and hydrology owing to its simplicity and satisfactory performance for a great variety of water infiltration problems. This model yields cumulative infiltration and the infiltration rate as an implicit function of time (i.e., given a value of time (t), values of the cumulative infiltration (I) and the infiltration rate (q) can be directly obtained. The Explicit Green-Ampt model was developed by Salvucci and Entekhabi (1994), which provides a straightforward and accurate estimation of infiltration for any given time. This formulation supposedly yields an error of less than 2% at all times when compared to the exact values resulting from the Implicit Green-Ampt Model.

Description of the Constant Flux Green-Ampt Model

For the constant flux Green-Ampt model, two formulations are required, one for the condition that the application rate (r) is less than the saturated hydraulic conductivity (Ks), and one for the condition that the application rate is greater than the saturated hydraulic conductivity. When r<Ks, the infiltration rate (q) is always equal to the surface application rate (r), and the surface never becomes saturated. When r>Ks , the surface becomes saturated at the time of the initial application (t0).

Description of the Infiltration/Exfiltration Model

The vertical movement of water in the soil profile from the surface to water table is a dynamic condition, and can be conceptualized as being composed of basically two predominant processes: 1) infiltration and 2) exfiltration. Exfiltration can be envisioned as the processes dominating during drying periods, and water released during this period can be thought of as being released through evaporation to the atmosphere. The model (INFEXF) selected for this project is a formulation of the Philips model developed by Eagleson (1978) to account for water infiltration during the wetting season and exfiltration during the drying season. Infiltration and exfiltration as described in this application assumes the soil medium to be effectively semi-infinite and the internal soil water content at the beginning of each storm event and inter-storm period is assumed to be uniform at its' long-term and space-time average. The exfiltration equation is modified for the presence of natural vegetation through the approximate introduction of a distributed sink representing the moisture extraction by plant roots. Two scenarios are presented in the accompanying worksheet applications: 1) demonstrates water infiltration during the rainy season and 2) exfiltration during the drying season.

HELP Model Summary

In addition, a simple model that is also in the public domain and provided by the U.S. Army Corp of Engineers is the Hydrologic Evaluation of Landfill Performance (HELP) Model. This model can be used to evaluate infiltration and runoff from small parcels of land, and is not necessarily strictly limited to landfill evaluation. Their web site provides access to the free model code at: http://www.wes.army.mil/el/elmodels/helpinfo.html.

Landfill systems including various combinations of vegetation, cover soils, waste cells, lateral drain layers, low permeability barrier soils, and synthetic geomembrane liners may be modeled. The program facilitates rapid estimation of the daily, monthly, annual, and average annual amounts of runoff, evapotranspiration, drainage, leachate collection, and liner leakage that may result from the operation of a wide variety of landfill designs.

The primary purpose of the model is to assist in the comparison of design alternatives as judged by their water balances. The model is sufficiently sophisticated to consider all of the principal design parameters including vegetation, soil types, geosynthetic materials, initial moisture conditions, thicknesses, slopes, and drain spacing as well as climate effects. Local consultants in the Spokane area have used this model to predict runoff and groundwater levels due to storm events and the routing of storm water runoff into grassy swales.

Version 3 of the Hydrologic Evaluation of Landfill Performance (HELP) model is a user-friendly computer program that computes estimates of water balances for municipal landfills. The model accepts weather and soil data and uses solution techniques that account for the effects of surface storage, snowmelt, frozen soil, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane, or composite liners.

Climate data requirements: General evapotranspiration data and daily values of precipitation, temperature, and solar radiation. The HELP model has a default evapotranspiration database for 183 U.S. cities, containing data for latitude, evaporative zone depths, leaf area indices, growing season, average wind speed, and average quarterly relative humidities. A default precipitation database is included, containing 5 years of daily values for 102 cities throughout the United States. The model also has a synthetic weather generator with coefficients for 139 cities for daily precipitation data generation and for 183 cities for daily temperature and solar radiation data generation. The user interface also contains a number of utility routines to import weather data from other databases.

Soil data requirements: Porosity, field capacity, wilting point, initial moisture content, and saturated hydraulic conductivity of up to 20 layers of materials. The model contains a default soil database of characteristics for 42 types of materials (soils, waste, and geosynthetics). Design data requirements include the AMC-II runoff curve number for the site, a description of the vegetation, a description of the function of each layer of material, the thickness of each layer, the slope at the base of each drainage layer, the spacing between drainage collectors in each drain system, a description of leakage potential of each geomembrane liner, and a description of the leachate recirculation, if used. As evident by the data requirements, the model permits an evaluation of detailed designs and a sensitivity analysis of design components and climatological variables.

Appendix N

Golder Storage Report/Reforestation Memo

Note: The Golder Storage Report is attached as a separate document.

TECHNICAL MEMORANDUM

TO:	Spokane County Conservation District and WRIA 56 Planning Unit	**DATE:**	November 5, 2004
FR:	Golder Associates Inc.	**OUR REF:**	043-1155-001
RE:	WEPP Reforestation Analysis		

Reforestation Alternative

Reforestation of the Hangman Creek Watershed (WRIA 56) is being considered as a storage option for augmenting streamflow during summer, low flow periods. The analysis of the reforestation alternative makes use of the U.S. Department of Agriculture Water Erosion Prediction Project (WEPP) hillslope model to determine the changes in runoff through reforestation of representative sub-basin areas. The WEPP hillslope model incorporates climate, hillslope, soil, and land use information to simulate daily water balance parameters such as runoff, soil evaporation, plant transpiration, deep percolation, and lateral subsurface flow. The model does not include a runoff routing component and is not capable of modeling subsurface flow.

We explore model simulations of eight representative hillslopes for the purpose of:

- determining if changes from current landcover to historic forest cover affect runoff,
- determining if it is possible to achieve an equivalent of 3 cfs additional streamflow in Hangman Creek through reforestation, and
- determining which sub-basins exhibit greater runoff benefit from reforestation.

Benefits

Forested lands can experience lower surface temperatures due to decreased convective heat transfer from the ground and decreased net radiation, which can cause delayed snowmelt. The Hangman Creek basin experiences an average 19 inches of snowfall in January (Golder Associates, 2004) and often experiences temperatures near freezing, resulting in frequent snow accumulation and melt events. Reforestation of agricultural land could benefit the Hangman Creek watershed by decreasing surface temperatures enough to maintain snow depth and delay snowmelt. This effect could result in increased streamflow later in the season than would normally occur, thereby augmenting potentially low streamflow However, forested lands may also negatively affect runoff as they typically experience greater evapotranspiration, infiltration, and depression storage than do agricultural lands, given identical hillslope characteristics (Maidment, 1993).

Identification of Representative Hillslopes

Representative hillslopes were developed using Geographic Information Systems (GIS) analysis. Digital maps of soils, current land cover, topography, and historical land cover were used to characterize each sub-basin and hillslope. A historic forest vegetation layer developed by the Spokane County Soil Conservation District was used to locate areas of historic forest cover. Only areas that were historically covered by forest, including cottonwood, ponderosa pine forest, or evergreen forest, and now used for agriculture, were considered for potential reforestation analysis. At least one representative hillslope was identified for modeling purposes in each of five sub-basins identified by Buchanan (2002). These sub-basins include Minnie Creek, Lower Hangman Creek, California Creek, Rock Creek, and Upper Hangman Creek. Figure 1 shows the location of each sub-basin. For three of the sub-basins, more than one hillslope type was representative of the area. As a result, a total of eight representative hillslopes were analyzed. The eight representative hillslopes range in elevation, slope angle, soil type, and land cover type. The locations of the hillslopes were chosen to ensure a range of characteristics. Table 1 summarizes the characteristics for each hillslope by sub-basin.

Model Development

The WEPP model, developed by the U.S. Department of Agriculture, is a continuous simulation physically based soil erosion prediction model. The WEPP hillslope model was used to evaluate the effects of returning agricultural lands in the Hangman Creek watershed to mature forest. Two scenarios were simulated for each representative hillslope, one with the current land cover classification and one with mature forest. This section describes the WEPP model, including model assumptions that might impact model results, and discusses the methods used for model simulation.

Background and Modeling Methods

The WEPP hillslope model contains several components and predicts snow depth and density, runoff, plant transpiration, soil evaporation, deep percolation, and lateral subsurface flow, among other parameters, which provide the context for evaluation of runoff changes due to reforestation. The hillslope model is best suited for hillslopes less than 100m in length; however, it is advantageous for this exploratory analysis because of its ease of use and the limited number of required inputs. The model generates daily climate using statistical methods that incorporate available gage data. The user provides soil, vegetation, and topographic information. The water balance model contains several components, including an evapotranspiration model based on Ritchie (1972), a snowmelt model first developed by the Army Corps of Engineers (1956,1960) then modified by Hendrick et al. (1971) and Savabi et al. (1995), and an infiltration model based on a modified version of the Green Ampt equation. Overland flow is simulated using an analytical solution to the kinematic wave equations. The model simulates the water balance using the above mentioned models for every combination of soil type and land cover type on the hillslope.

Two model simulations (current land cover and reforestation of historic forest) were performed for each of the eight representative hillslopes. Simulations were run for a 30 year period and daily output was processed to produce one year of daily averages for several parameters, including runoff, soil evaporation, plant transpiration, deep percolation, lateral subsurface flow, snow depth, and melt water. Calibration of the model was not performed because the model has been well calibrated for northern Idaho and northeastern Washington. Specific input parameters for soil and land cover types are provided and analysis to verify their accuracy in the Hangman Creek watershed was not conducted. Land cover and soil types were chosen to best correspond with actual sub-basin types. For example, if the actual soil type on a hillslope was a composite of several types, the most dominant type was chosen for modeling. Land cover types were also chosen to best correspond to documented land cover. For example, if the current land cover was classified as small grains, winter wheat was used for modeling.

Water balance components including runoff, plant transpiration, soil evaporation, and deep percolation were calculated and compared for each of the eight representative hillslopes to provide an understanding of their relative importance by sub-basin. It is important to note that detailed sub-surface hydrology routing cannot be performed with the WEPP model. Thus, the changes in runoff relate to changes in surface runoff only as a result of snowmelt and precipitation events. In addition, the hillslope model does not route runoff into a channel, thus changes in runoff represent only the total amount of water running off the hillslope.

Daily average depths in millimeters were calculated for each component over the 30 year simulation period for each of the eight representative hillslopes. Positive values indicate that the resulting daily average is greater as a result of reforestation, while negative values indicate a decrease as a result of reforestation. Runoff results are also presented in terms of monthly changes in volume in acre-feet (AF) and changes in rates of surface runoff in cubic feet per second (cfs). Surface runoff rates correspond to the total volume of runoff and may not directly translate into streamflow due to routing effects.

Modeling Results and Analysis

Model results indicate that reforestation decreases surface runoff during most of the year, especially during summer months when evapotranspiration, or water consumed by plants through evaporation and transpiration, is high. Isolated periods of increased surface runoff do occur in most sub-basins in late winter, early spring as snowmelt is slightly delayed. Surface runoff in the Rock Creek sub-basin also increases during the spring snowmelt period of May and June, according to model results. This effect may be caused by delayed snowmelt due to cooling by mature forest. It should be reiterated however that because the WEPP hillslope model is unable to simulate subsurface flow, the model is driven by precipitation events, which limits the source of increased runoff during low flow periods predominantly to delayed snowmelt and rain events. Due to limitations of the model's capacity to deal with subsurface flow, details of the return of groundwater to the stream through reforestation are not known. The following sections further evaluate impacts of reforestation on surface runoff and other water balance parameters for each sub-basin.

Runoff

Streamflow augmentation in the Hangman Creek watershed is most desirable during the low flow period from April-September. Changes in monthly rates and volumes of runoff for each sub-basin are shown in Table 2. As a result of reforestation, only Rock Creek shows potential for increased runoff during the period of interest, and only during spring months of May and June. Runoff increases are approximately 3.3 cfs for May and 4 cfs for June due to reforestation of 67,580 acres in Rock Creek sub-basin. Results, however, indicate a general decrease in runoff in mid to late summer in the Rock Creek sub-basin by up to 3 cfs in August due to higher evapotranspiration rates. The Upper Hangman sub-basin, in comparison, has a loss of runoff by as much as 12-13 cfs in August through reforestation.

Water Balance

Results for all scenarios show significant increases in plant transpiration due to reforestation, largely during the spring and early summer months. In addition, soil evaporation generally decreases as a result of reforestation, because latent heat transfer and convective heat transfer are greater for agricultural land than they are for forested land (Maidment, 1993). Changes in water balances for each representative hillslope are described in more detail below.

Minnie Creek and Lower Hangman Creek

Throughout the year in the Minnie Creek and Lower Hangman sub-basins, there is little change in runoff between the forested condition and current land use condition, which suggests that runoff does not change significantly due to reforestation in these regions (Figures 2-4). Both the Minnie Creek sub-basin and Lower Hangman sub-basin appear to have a number of days of higher daily average runoff due to reforestation in late winter periods. However, this does not carry through to the low flow target period for streamflow augmentation.

Results show that plant transpiration in these sub-basins increases by approximately 200% during spring and summer months due to reforestation. This large loss of water during the spring and summer comes mainly from the model's simulated soil water content, because much of the calculated runoff comes from precipitation events. Daily average deep percolation generally decreases due to reforestation for most of the winter. Deep percolation is water that infiltrates below the subsurface and is essentially lost from the modeled system. Overall decreases in deep percolation may be attributed to decreased lateral movement of water due to trees. Deep percolation increases later n late winter and early spring. The transition from decreased to increased deep percolation may be attributed to later timing of ground surface thawing and snowmelt.

The Minnie Creek sub-basin is characterized as having moderate rates of infiltration, while the Lower Hangman sub-basin is characterized by high infiltration (Golder Associates 2004, Figure 17). Moderate to high infiltration rates make it possible for snowmelt to infiltrate and/or become lost to deep percolation and not translate into runoff. Also, reforestation delays snowmelt by several days and may contribute to an initial decrease in deep percolation followed by greater deep percolation, corresponding to the timing of snowmelt.

Reforestation also appears to cause a decrease in daily average soil evaporation overall. Soil evaporation includes water that is sublimated from the snowpack. During the low flow period, even though less water is lost to deep percolation and soil evaporation as a result of reforestation, increases in plant transpiration prevent increases in daily average runoff.

California Creek

The California Creek scenario shows little change in runoff due to reforestation during the flow period proposed for streamflow augmentation (Figure 5). Changes in plant transpiration, deep percolation and soil evaporation in the California Creek sub-basin exhibit similar trends as Minnie Creek and Lower Hangman Creek, however the magnitude of the changes are less significant. Reforestation causes a 150% increase in average plant transpiration, a smaller increase than seen in results from the Minnie Creek and Lower Hangman Creek scenarios. California Creek is characterized by moderate infiltration rates as opposed to moderate to high infiltration rates of the above-mentioned sub-basins, which may contribute to less significant changes in deep percolation.

Rock Creek

The Rock Creek sub-basin is characterized by two different slope types. Reforestation causes an overall reduction in daily average runoff over the 30 year simulation period, but also causes increases in runoff at times during the late spring that may augment streamflow above the 3 cfs target increase.

Approximately 60 % of the reforestable area of the Rock Creek sub-basin is characterized by the Rock Creek (a) hillslope and 40 % is characterized by hillslope (b). A comparison of total monthly runoff from the combined (a) and (b) hillslopes indicate that runoff increases occur in

May and June under the reforestation scenario (Figure 6, 7). Increased runoff in May could be the result of delayed snowmelt due to decreased convective heat transfer in forested areas. A comparison of simulated snow water equivalent (SWE), the liquid content in the snow pack, for hillslope (a) shows that SWE decreases in the beginning of the year, but increases slightly in April and May as a result of reforestation (Figure 8). The increase in June runoff may be attributed to delayed snowmelt and the resulting higher simulated SWE in March, April, and May in the forested scenario (Figure 9).

A total of approximately 3.3 cfs increase in runoff can be found through May and an approximately 4 cfs increase in runoff through June in the Rock Creek sub-basin. This increase of runoff is total volume from the hillslope without consideration of routing, thus the precise amount of cfs that will route to the stream channel cannot be determined.

Transpiration during late winter and early spring by the mature trees is less than transpiration by the current vegetation. Later in the spring and through summer, however, historic vegetation transpires more than the current vegetation types. As a result of this higher transpiration later during the summer, decreased runoffs in the Rock Creek basin up to approximately 3 cfs in August occurred as a result of re-forestation. Soil evaporation is largely decreased due to reforestation. Reforestation causes decreased deep percolation during much of the year, with the greatest difference occurring during mid- to late winter. Decreased deep percolation indicates less water percolating below the root zone.

Upper Hangman Creek

The Upper Hangman Creek sub-basin has two representative hillslopes. While runoff in this sub-basin increases during winter periods, the reforestation scenarios show decreased runoff occurs during the flow period proposed for streamflow augmentation (Figure 10,11). Upper Hangman Creek is characterized by low infiltration rates. It is likely that snowmelt results in rapid runoff in this basin as a result of the low infiltration of the soils. As a result, any changes in timing of runoff due to snowmelt runoff are very limited in this sub-basin and still occur primarily during winter months under reforestation.

The reforested scenarios for this sub-basin result in increased average plant transpiration 2 to 3 times that of the current land use scenarios during summer months. In addition, an overall decrease in deep percolation occurs, with more significant decreases occurring mid-winter. Soil evaporation decreased overall in the fully forested scenarios, with more significant decreases occurring mid-winter and mid-summer, but did not compensate for higher losses in transpiration.

Reforestation Costs

There are several factors that must be considered in reforestation costs such as site preparation, desired vegetation type and availability, as well as planting labor and maintenance.

According to historic vegetation maps developed by Spokane County Conservation District, the three historic land cover types that could be revegetated in the Hangman basin are evergreen forest, open ponderosa pine, and cottonwood. Species selection should not be finalized without a full site assessment and consideration of objectives by a forester or other management professional familiar with the area. The Hangman Valley area approaching Spokane, Washington, would only support ponderosa pine on many sites, and a mix of ponderosa pine and Douglas-fir on others (Ron Mahoney personal communication, October 13, 2004). It is too dry for white pine, and likely also for W. larch (Ron Mahoney pers. comm.). The upper watershed, especially in the agricultural areas, will only support ponderosa pine (Gerry Green, personal communication, October 18, 2004). Douglas fir and grand fir may grow, but would likely not persist in those areas.

Nursery grown seedlings can vary in price depending on type, size and source. The University of Idaho Nursery as well as local wholesale and retail providers, base prices mainly on plug size and number ordered. Assuming locally adapted seed is available, a one year old, container grown conifer seedling of 5.5 cu in plug (root) volume (90 ml), which is a typical size for the average reforestation site, costs $0.28 each if over 500 are ordered from the University of Idaho Forest Research Nursery (Dave Wenny, personal communication, October 14, 2004). They also provide a larger one-year old seedling (20 cu in (340 ml) plug volume) for $1.75 each designed for harsh sites). Cottonwoods and other hardwoods have increased costs. Table 3 details pricing from two local sources.

A clearcut artificially regenerated may take 300 – 400 seedlings per acre depending upon stock size (Dave Wenny pers. comm.). Interplanting or reliance on natural regeneration for partial stocking of some species would call for fewer seedlings, perhaps 150 – 200, per acre (Dave Wenny pers. comm.).

Site preparation costs vary a great deal with site, objectives, and constraints. Site preparation involves assessing the condition of the site including present vegetation, soil type, aspect, as well as types of animals present that may damage trees. Is there a great deal of slash that must be removed or merely minor duff reduction? Can it be done by hand, mechanical equipment, fire, or herbicide? Are there leave trees or advanced regeneration to be protected? Several hundred dollars per acre is common.

Planting costs vary from 25-45 cents per seedling or $1000 to $2000 per acre depending on site conditions, size of seedling, spacing, and availability of planting crews (Atkinson and Fitzgerald 2002). Dave Wenny with the University of Idaho indicated that planting costs would vary ($0.15 - $0.20 per seedling for 5.5 cu in seedlings), depending upon site acreage, planter's access, planting season, degree of microsite preparation required, and stock size.

Total revegetation costs including seedlings and labor are estimated at $500 to $2500 per acre, based on 400 seedlings per acre. Table 4 illustrates the wide range of total costs per acre by historic vegetation type in the Hangmen watershed. Other factors to consider in costs include current land use, wildlife presence, and seedling protection measures necessary. Maintenance may be required after planting to ensure continued survival and growth. These could significantly add to regeneration costs.

Summary

Increased transpiration by trees makes reforestation in the Hangman Creek watershed for purposes of increasing stream flow during summer months generally undesirable. Rock Creek is the only sub-basin that shows promise for reforestation as a means of streamflow augmentation. Increased runoff of 3 and 4 cfs a day occurs during the May and June time periods respectively in the Rock Creek sub-basin primarily due to delays in snowmelt runoff. However, in the same sub-basin decreased runoff of up to 3 cfs per day occurs in August as a result of increased plant transpiration. Reforestation of the 67,500 historically forested acres in the Rock Creek sub-basin to obtain increased flows during the May (3.3 cfs) and June (4 cfs) time period would cost an estimated $33,750,000 to $168,750,000. Further analysis of this alternative using a more complex watershed model with subsurface hydrology and stream routing may provide additional insight into this scenario if desired.

References

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Appendix O

Responsiveness Summary

All comments below are either from the two public meetings (questionnaire) held on November 11th, 2004 in Fairfield, WA, November 16th, 2004 at St. Stephen's Church in Spokane, WA or were received during the open comment period (November 11th, 2004 through December 22nd, 2004).

Comment Number	Comments	Name/Agency	Action Required	Revision or change to document
	Comments from Public in response to Questionnaire			
	1. Do you have any comments regarding the Hangman (Latah) Creek In stream Flow Study?			
1	They need to just forget it all together.	Anonymous	noted	None required
2	I do not know of a person in our area who does not at least enjoy living in the Hangman Valley. However, to change the creek for no valid reason, to try to fix something which isn't yet anyway is foolish. I have lived by the creek 58 years. The characteristics are generally the same.	Carol Wildman	noted	None required

	2. Do you have any comments and or suggestions regarding the multi-purpose storage analysis?			
3	Too costly, leave us alone, leave it alone.	Anonymous	noted	None required
4	Leave alone. Don't try to have man play with water level, then we will have problems.	Fred Wildman	noted	None required
5	To costly, leave us (rural) alone!	Anonymous	noted	None required
6	Please do not mess with nature- it never leads to long term benefits.	Carol Wildman	noted	None required

	3.Do you have any comments regarding the Draft watershed Plan and associated recommended actions that you would like to share?			
7	Leave it as it is! It is arbitrary junk science.	Anonymous	noted	None required
8	Too much government. It it's about control of property and water rights! Also insures many government jobs- when you control (stagnate) a society, the industrious citizen will become a government slave!	Anonymous	noted	None required

9	Weed Control. Keep main channel open, to avoid side channels and eroding of banks.	Fred Wildman	noted	The Planning Unit is aware of weed issues and streambank erosion.
10	There were losses in animal population from the 50's through the 70's. Farming practices and chemical use are improving. The turtles are back. Last year in casual observation I saw 4. This year I saw some and even noticed one making a nest along the bank! Things are good!	Carol Wildman	noted	None required
11	This is a government job set up by government to increase the government and to spend money the government doesn't have. And create more government jobs for more people so more and more can work for the government.	Anonymous	noted	None required
12	Too much government its about take over of our property and water rights. We are over seas in a war, now we have 2 wars to try and keep our rights.	Anonymous	noted	The Planning Unit does not intend or condone the loss of property or water rights.
13	One of my chief concerns is the application for a zone change from general agriculture to mining in the flat west and above Hangman Creek and east of Route 195 just south of the intersection of Paradise Road and Route 195. This is above hangman creek and is part of the watershed. The excavation, blasting, rock crushing, asphalt batching diesel leaking alteration of surface and sub-surface drainage, and multiple opportunities for particulate and chemical contamination of water flowing into Hangman Creek and area wells is formidable. Mitigation is not possible in light of the geology of this area. This is a crucial factor to consider and impacts on every facet of the planning for and protection of the Hangman Creek watershed.	Chadwick F. Baxter, M.D.	noted	The Planning Unit has addressed such issues under the Habitat and Land Use section. Water quality and quantity issues are paramount to the plan.

	5. What categories of recommended actions in the Draft Watershed Plan do you feel should be the highest priority?			
14	Water Rights and Claims.	Fred Wildman	noted	Reviewed
15	Future Growth/Management.	Carol Wildman	noted	Reviewed
16	Water Conservation, Habitat and Land Use, Fisheries.	John Klekas	noted	Reviewed
17	Water Conservation, Instream Flow needs for Hangman, Future Growth Management, Habitat and Land Use, Strategies for Base Flow Augmentation, Strategies for Water Quality	Chadwick F. Baxter, M.D.	noted	Reviewed
	General Comments Received			
18	Throughout the document replace "Watershed Management Act" with "Watershed Planning Act."	State Caucus	make change	Correction made throughout document
19	Throughout the document replace "Washington State Department of Fish and Wildlife" with "Washington Department of Fish and Wildlife."	State Caucus	make change	Correction made throughout document
20	Cover page, change date from "September 2004" to "November 2004."	State Caucus	make change	Correction made to cover page
21	Cover page, delete "ESHB."	State Caucus	make change	Correction made to cover page
22	Page ii, Acknowledgements, change "Hal Beecher, Washington State Department of Fish and Wildlife" to "Hal Beecher, Ph.D., Washington Department of Fish and Wildlife."	State Caucus	make change	Correction made to Acknowledgements page
23	Page ii, Acknowledgements, add acknowledgements for *Hangman Creek Water Resources Management Plan.*	State Caucus	make change	Acknowledgments section was added
24	Page ii, Executive Summary, second paragraph, insert "lead agency and" before "facilitation" and make "role" plural.	State Caucus	make change	Correction made

25	Page 87, third paragraph, non-point sources were limited to erosion. It seems some indication of other non-point water quality issues could have been included from observations of potential runoff from livestock operations or roads near streams.	State Caucus	add or remove language	Language could not be added or removed from this section. The observations were made specifically to each reach. To add more would be speculative.
26	Pages 89 and 90, Section 4.6, it would be helpful to have reasons why the locations in the bullets are recommended for future monitoring. The second bullet does this but the others do not.	State Caucus	add or remove language	Reasons were removed. Additional information is available from the SCCD.
27	Page 90, second paragraph, the case for a Use Attainability Analysis (UAA) has not been made. A Use Attainability Analysis is not conducted for specific parameters (e.g., dissolved oxygen and temperature), it is conducted for uses. In other words, does the use exist and can the use be attained? Removing uses assigned to a water body may change the applicable standards. A UAA is not performed because the stream doesn't meet standards and hasn't for a long time. In most cases a Total Maximum Daily Load (TMDL) can determine natural conditions and if a parameter is found to have natural conditions above the standard then the natural conditions become the standard. According to Table 51 a lot more of the watershed was forested historically then what exists today. This change in land cover could affect both dissolved oxygen and temperature. In addition one of the efforts of the watershed planning process is to keep water in the streams and augment seasonal low flows. If this is successful these flow dependant parameters may improve and help restore the uses. It seems premature to recommend a UAA before the activities identified in the watershed plan and the TMDL plan	State Caucus	revise	This section was revised to state that a UAA was a possibility in the future and that the planning unit may or may not support one pending the outcome of the current TMDL process.

	have had an opportunity to restore the beneficial uses of the stream.			
28	Page 91, Phase III, outlining implementation funding is part of the current TMDL grant awarded to the Spokane County Conservation District. Funding resources are a required part of the Detailed Implementation Plan (task 8 of the grant). The funding sources do not need to be secured but potential sources do need to be outlined in the plan.	State Caucus	noted	None required
29	Page 93, New Dams Section, the planning unit should be aware that as required by law under Chapter 77.55.060 RCW, "dam[s] or other obstructions...shall be provided with a durable and efficient fishway..." The cost of constructing and maintaining fish ladders can be expensive. For example, cost for constructing a fish ladder at the 19' high Cedar Creek Dam in Pend Oreille County has been estimated at $50,000 to $250,000 (MWH 2002). This does not include maintenance. Cost estimates provided in the report should reflect the potential expense of providing fish passage.	State Caucus	noted	None required. The planning unit is aware of expenses associated with dam construction and associated fishway.
30	Page 115, R1.a and Strategy 1, Ecology is required to allocate water in accordance with state law. Washington State water law does not necessarily allow for allocating water rights in the manner recommended. In addition, this recommendation and strategy might result in impairing or diminishing existing water rights. This recommendation and strategy would appear to violate Chapter 90.82.120 (1) (a) and (b) RCW. The technical assessment of water quantity in WRIA 56 did not project that the municipalities would have a water need that their water rights would not meet through the year 2020. Ecology	State Caucus	make change	Recommendation and strategy was deleted

	suggests deleting the recommendation and strategy, unless revisions addressing a validated need are agreed upon.			
31	Page 115, R1.b and Strategy 1, Ecology supports this recommendation and strategy. The costs for this type of work varies greatly, therefore the range identified is significantly underestimated. The state agencies would rank the strategy as H, and estimate initiating upon plan approval at a cost ranging between $2,000 and $50,000 for revision of Table XX in the Executive Summary.	State Caucus	make change	Changes to priority and costs were made
32	Page 116, R2.a and Strategy 1, Ecology does not necessarily agree there are two (or only two) separate and distinct sub-basins in this WRIA for purposes of water regulation on the basis of ground water behavior. In fact it may be several, and they may not coincide with surface water drainages. Ecology does not commit to implementing this recommendation and strategy at this time.	State Caucus	revise	Recommendation and strategy were revised to reflect potential for multiple basin management
33	Page 116, R2.c and Strategy 1, Regulation of domestic exempt wells presents some significant practical and political issues. Cost of this effort is significantly underestimated. Ecology would rank the strategy as M, and estimate initiating in the 2007-2011 timeframe at a cost ranging between $5,000 and $100,000 for revision of Table XX in the Executive Summary.	State Caucus	revise	The word “new” was added to recommendation and strategy 1. Costs were changed
34	Page 117, R.3.a, Ecology is bound to allocate water rights according to the process in Washington water law. Water right issuance is prioritized "first in time, first in right," not in the fashion proposed. Ecology does not commit to implement this recommendation as stated.	State Caucus	noted	The planning unit realizes the statute of Ecology, but wanted to document the priority for perhaps other purposes in the future.

35	Page 118, R4.a and Strategy 1, if the watershed team coordinates a meeting with water purveyors, Department of Health (DOH) would provide information on regional conservation programs. The DOH would rank the strategy as M for revision of Table XX in the Executive Summary.	State Caucus	noted	Change made to priority ranking
36	Page 118, R4.b and Strategy 1, DOH can assist with identifying funding sources for water systems. The DOH would rank the strategy as M for revision of Table XX in the Executive Summary.	State Caucus	noted	Change made to priority ranking
37	Page 118, R4.c, The terminology in parenthesis should be "systems who are not municipal water suppliers."	State Caucus	make change	Change made to document
38	Page 119, R4.g and Strategy 1, DOH can provide information when requested on where educational conservation materials can be found. At this time due to limitations in funding and personnel, DOH cannot commit to any larger role.	State Caucus	revise	Commitments at this time have not been made. DOH will not be burdened with additional work. Coordination will be approached at a later date.
39	Page 121, R6.a and Strategy 1, please specify the additional resources that should be devoted. Is this a request for a water master in WRIA 56? Ecology does not currently have the funding for such a position. Based on the situation in WRIA 56, it is estimated that approximately 0.5 of a Full Time Equivalent might be needed to perform such duties. Ecology would rank the existing strategy as M, and estimate initiating in the 2007-2011 timeframe at a cost ranging between $30,000 and $80,000 for revision of Table XX in the Executive Summary.	State Caucus	noted	This recommendation was revised and the strategy removed. The planning unit will address this more specifically during the detailed implementation plan.
40	Page 122; Issue Statement 7; Recommendations R7.a, R7.b, and R7.c; and their strategies are not represented in Table XX in the Executive Summary. Also, the recommendations and strategies do not reflect the information in the Draft	State Caucus	revise	At the time, the Multipurpose Storage report was not complete. These recommendations are now in the document.

	Recommendation Matrix dated November 8, 2004.			
41	Draft Recommendation Matrix dated November 8, 2004, R7.a and Strategy 1, recommend the language be changed to "If a high level of unaccounted water is found, actions should be taken to reduce the unaccounted for water." This is first because that if the unaccounted for water levels in these small towns is low, there is no need to address it. Second, leak detection is not the only action water systems can or should take when their unaccounted for water is high. Some times the issue can be solved by calibrating or replacing meters, changing how data is collected, and other actions.	State Caucus	make change	The words "if necessary" were added to the strategy
42	Draft Recommendation Matrix dated November 8, 2004, R7.b, Strategy 1, assuming this new well is a new allocation of water in WRIA 56, then a water right would be needed. An applicant needs to be identified. Ecology would rank the strategy as L, and estimate initiating in the 2011+ timeframe at a cost ranging between $50,000 and $250,000.	State Caucus	noted	Change was made to priority ranking, costs, and timeline. Additional language was added to Recommendation section to discuss the need for an applicant and new water right.
43	Draft Recommendation Matrix dated November 8, 2004, R7.b, Strategy 5, Ecology would rank the strategy as M, and estimate initiating in the 2011+ timeframe.	State Caucus	noted	Change was made to priority ranking and timeline
44	Draft Recommendation Matrix dated November 8, 2004, R7.b, Strategy 6, the state agencies would rank the strategy as L, and estimate initiating in the 2011+ timeframe. This input should not be viewed as a commitment.	State Caucus	make change	Change was made to priority ranking and timeline

45	Page 123, R8.a and Strategy 1, while it is important for the WIT to participate in the Spokane/Lake Spokane Dissolved Oxygen TMDL process it is equally or more important to have their participation in the Hangman Watershed TMDL process. This separate TMDL is not included in the recommendations but it appears to be referred to in other recommendations (i.e., R8.d and R8.e). It seems that the two TMDL processes have been lumped together which could create confusion. Ecology would rank the strategy as M for the Spokane TMDL and H for the Hangman TMDL with initiation per plan approval.	State Caucus	Make change	The TMDL processes were split into different recommendations and strategies. Changes were made to priority rankings.
46	Page 124, R8.f and Strategy 1, Ecology ranks the strategy as H with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	Make change	Change was made to priority ranking
47	Page 124, R8.g and Strategy 1, Ecology ranks the strategy as H with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	Make change	Change was made to priority ranking
48	Page 124, R8.h and Strategy 1, Ecology ranks the strategy as H with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	Make change	Change was made to priority ranking
49	Page 126, R10.b and Strategy 1, free technical assistance for developing wellhead protection plans is available for small communities from Evergreen Rural Water of Washington (www.erwow.org).	State Caucus	Add language	This note was added to the plan.
50	Page 127, R11.c and Strategy 1, Ecology is currently and will continue to provide technical assistance for amendment of local Shoreline Master Programs contingent upon funding and staff resources. Ecology ranks the strategy as H with initiation per plan	State Caucus	Make change	Change made to priority ranking.

	approval for revision of Table XX in the Executive Summary.			
51	Pages 127 and 128, R11.e and Strategy 1, the strategy doesn't indicate who would work with appropriate landowners. It seems that this would obligate city and county planning to perform this recommendation and the education.	State Caucus	revise	Changed shall to should
52	Page 128, R11.f and Strategy 1, Ecology is currently and will continue to provide technical assistance contingent upon funding and staff resources. Ecology ranks the strategy as M with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	noted	Change made to priority ranking
53	Page 128, R11.j and Strategy 1, Ecology is currently and will continue to work with local jurisdictions on flood issues contingent upon funding and staff resources. Ecology supports the strategy language found in the Draft Recommendation Matrix dated November 8, 2004. Ecology ranks the strategy as M with initiation in the 2005 - 2006 timeframe for revision of Table XX in the Executive Summary.	State Caucus	noted	Change was made to priority ranking and timeline
54	Page 128, R11.l and Strategy 1, should include "Department of Ecology and other entities" in this strategy as they have riparian/water quality education efforts that should be part of this coordination. An overall coordination of all the efforts would be beneficial. Ecology ranks the strategy as H with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	make change	Change was made to priority ranking and timeline
55	Page 129, R11.n and Strategy 1, include Ecology as an entity to coordinate with for funding, permitting, etc. Ecology ranks the strategy as H with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	noted	Change was made to priority ranking and timeline

56	Page 129, R11.o and Strategy 1, Washington Department of Fish and Wildlife (WDFW) supports this strategy contingent upon funding and staff resources. The WDFW ranks the strategy as M with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	noted	Change was made to priority ranking and timeline
57	Page 130, R12.a through c, WDFW supports these strategies contingent upon funding and staff resources. The WDFW ranks the strategy as H with initiation per plan approval for revision of Table XX in the Executive Summary.	State Caucus	noted	Change was made to priority ranking and timeline
58	Page 130, Section 6.5, Issue 13 addresses minimum Instream flows, while Issue 13 of the Draft Recommendation Matrix dated November 8, 2004 addresses the implementation process. Please resolve difference, and, if the minimum instream flow section is to remain, confirm with the planning unit.	State Caucus	revise	Changes made
59	Draft Recommendation Matrix dated November 8, 2004, R13.b, change "entity" to "agency."	State Caucus	make change	Correction made
60	Page 132, Section 7.0, complete the implementation strategy and submit to the planning unit for review and approval.	State Caucus	make change	Implementation strategy completed
61	R2b Comment: What about the Cities Comp Plans? Should the City Comp Plan also amended for these issues? (see further comments from Bill Rickard, below)	City of Spokane Planning Dept. (Leroy Eadie)	review	GMA wording added
62	R2.b strategy 1-This process should be wrapped into the Countywide Planning Policy (CWPP) Land Capacity Analysis conducted by jurisdictions every 5 years. May want to review CWPPs to determine if this task is already required.	City of Spokane Planning Dept. (Leroy Eadie)	review	No change

63	R11.b -This is good but would have to be timely - there is a 14 day comment period per application.	City of Spokane Planning Dept. (Leroy Eadie)	noted	No change
63	R11.c -The SMPs only have jurisdiction of 200' from the ordinary high water mark by state law. The Riparian Area Setbacks in our Fish & Wildlife Habitat Conservation Area Ordinance restrict development in the 100 yr. flood plain in some areas along the Spokane and Latah Creek. That is to say that this is more specifically a critical areas ordinance issue. (see additional comments fr. Bil Rickard, below)	City of Spokane Planning Dept. (Leroy Eadie)	review	Noted
65	R11.e- see comment for R11. C.; riparian buffers are required by the Critical Area standard of the Growth Managment Act - not really SMPs	City of Spokane Planning Dept. (Leroy Eadie)	review	Noted
66	R11.j-FEMA Maps would eventually have to be amended for this to be implemented.	City of Spokane Planning Dept. (Leroy Eadie)	review	Noted
67	R2.c- Although this specifically mentions "Policies", this would appear to require a change in state law. If that is not the case, more specificity would be needed. (see additional comments from Bill Rickard, below)	City of Spokane Water Department (Harry McLean)	review	Noted
68	R4.d-This needs clarification as it would seem that not holding water rights in the watershed would not be possible.	City of Spokane Water Department (Harry McLean)	review	Change made to “options for keeping current water rights and place of use”
69	R4.g-The Water Department would be interested in committing staff and funds to this element, but only as part of a larger regional effort (i.e. WRIA 55/57 and WRIA 54) and the funding would only be a portion of the funding total already committed to WRIA 55/57)	City of Spokane Water Department (Harry McLean)	noted	Noted

70	R4.h- The Water Department and/or the Wastewater Management Department are not incline to commit resources to these elements at this time. The City is currently implementing a conservation rate structure and has pending conservation education activities. The need for further activities is unknown at this time.	City of Spokane Water Department (Harry McLean)	review	Noted. City of Spokane removed from potential stakeholder column
70	R10.a- The Water Department and/or in conjunction with the Spokane Aquifer Joint Board may be interested in offering limited (staff only) technical assistance.	City of Spokane Water Department (Harry McLean)	noted	Noted
72	R11.m- The Water Department may be interested in a limited (staff and limited equipment-no funding) participation in this strategy for the purpose of safeguarding the pipe crossings over and/or under Hangman Cr.	City of Spokane Water Department (Harry McLean)	noted	Noted
73	R2.b- Allowance should be given for permitted withdrawels and/or for water from outside the watershed	City of Spokane, Environmental Programs (Bill Rickard)	noted	Recommendation was revised.
74	R2.c- Harry McLean commented that this (aside from any land use question) may need a change in state law. Lloyd Brewer thought that Counties may already have the authority to limit domestic exempt well withdrawels, but may need to justify the action relative to a superior water right.	City of Spokane, Environmental Programs (Bill Rickard)	review	Recommendation was revised
75	R4.d- The recommendation should be eliminated. The idea of "holding" water rights implies that they can otherwise "go" somewhere. As they only apply to the use of water and the decision-making is oriented for water availability, this doesn't apply. Or perhaps the intent is otherwise.	City of Spokane, Environmental Programs (Bill Rickard)	review	Recommendation was revised
76	R11.a strategy 1- This implies that the Planning Unit wants to be a regulatory agency. Is this the intent? I suspect not. The WIT as it seems to be currently envisioned would recommend changes to regulations and those agencies mandated to implement those regulations would review SEPA documents. This recommendation should be eliminated.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Noted. No change.

77	R11.c strategy 1- The recommendation calls for changes to regulatory elements, but there is no strategy for taking this action. The WIT "should" make recommendations to land-use authorities for Critical Areas ordinances to be changed to reflect these concerns. Technical assistance is not needed for this recommendation, unless it is used by land-use authorities.	City of Spokane, Environmental Programs (Bill Rickard)	review	Language added to recommendation
78	R11.e strategy1- The recommendation uses the term "shall", but the Strategy is for "inform and eduate". There is not strategy for implementing the "shall". Either 1) a strategy be included with recommendations for regulations that require BMPs and riparian buffers, or 2) change the term "shall" to "should".	City of Spokane, Environmental Programs (Bill Rickard)	make change	Changed shall to should.
79	R12.a- The second line "An action plan…." should be changed to "A feasibility plan to identify the benefits of removal of these barriers and a action plan of remove identified barriers should be developed." It has recently come to my attention that fish barrier removal is not always regarded as a good thing by WDFW.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Recommendation was revised. Additional strategy was added.
80	R12.a strategy 1- The Strategy should read "An action plan should be developed to identify, map and evaluate potential fish barriers. Further action for identified fish barriers should identified."	City of Spokane, Environmental Programs (Bill Rickard)	make change	Combined with last comment and addressed
81	R13.b- Replace this recommendation with the following; At such time as a Memorandum of Agreement between the Initiating Agencies is complete, a lead entity should be identified to develop the Phase IV grant application and assume administrative responsibility for the grant.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made
82	R13.b strategy 1- Replace this recommendation with the following: The Spokane County Conservation District should be tentatively identified as the lead entity for plan implementation until such time as the Memorandum of Agreement formalizes this position.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made
83	R13.b strategy 2- Replace this recommendation with the following: At such time as the Memorandum of Agreement between the Initiating Agencies is complete, the lead agency shall develop and submit the Phase IV grant application to the Washington State Department of Ecology.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made

84	R13.c- Replace this recommendation with the following: The current planning unit, shall continue for no longer than initial year of Phase IV, to develop the Detail Implementation Plan.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made
85	R13.c- strategy 1- Replace this strategy with the following: The current Planning Unit shall continue for no longer than the initial one year for Phase IV Implementation, under the current Operating Procedures, until such time as a completed MOA for Phase IV specifies otherwise.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made
86	R13.d- Replace the term "shall" with the term "should"	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made
87	R13.d strategy 1- Replace this strategy with the following: A Detail Implementation Strategy should be developed for this watershed. This plan may include milestones, timelines, funding mechanisms, and obligations of local stateholders.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made
88	R13.d- strategy 2- Eliminate this strategy. This potential element may or may not be a function of the MOA and/or the detailed implementation plan.	City of Spokane, Environmental Programs (Bill Rickard)	make change	Change made

Appendix P

WRIA 56 EIS Alternative References

All EIS Alternative References are from The Washington State Department of Ecology's *Draft Environmental Impact Statement for Watershed Planning Under Chapter 90.82 RCW, March 2003.* Shorelands and Environmental Assistance Program. Ecology Publication # 03-06-013.

Recommendations and Strategies	Alternative Reference
ISSUE 1: PROJECTED FUTURE GROWTH **According to current data collection efforts and reports, some municipal water systems may not have enough water to meet projected future growth.**	
R1.a. Evaluate the potential to purchase or lease, valid current water rights for municipal supply.	**WP-7**
Strategy Research and develop a mechanism for this process.	**WP-7**
R1.b. Reclamation, conservation and reuse strategies shall be encouraged to increase water available for beneficial uses in the watershed.	**WP-5**
Strategy Further investigate opportunities.	**WP-5**
ISSUE 2: GROWTH MANAGEMENT **Projected growth over the next 20 years could have severe impacts on the water resources in the basin. Growth should be managed to minimize impacts**	
R2.a. Separate watershed management units may be identified and managed differently for water rights if future studies indicate a disparity between sub-basins and their groundwater/surface water relationships.	**WP-18**
Strategy Identify funding sources and develop studies to better understand groundwater/surface water interactions within the sub-basins of the watershed.	**WP-18**
R2.b. All proposed changes in GMA Comprehensive Plans, that affect housing density and require new withdrawals and/or the issuance of new water rights from the watershed should be strongly dependent on water availability.	**WP-16**
Strategy Further development of water availability information is required to assist local jurisdictions with future land use planning.	**WP-16**
Strategy: Local jurisdictions should develop a better understanding of the aquifer and water availability before conducting land use planning in the basin.	**WP-16**
Strategy: Request Counties, Cities, and/or Regional Health Districts to evaluate the quantity of water necessary (currently 1 gallon per minute), from a domestic exempt well before a building permit is issued.	**WP-16**
R2.c. Land use regulators should utilize water availability estimates described in the Watershed Management Plan. Minimum parcel size should be based on sub-basin estimates in areas where exempt wells will be the main source of domestic water.	**WP-16**
Strategy: All new domestic exempt wells should be regulated by any future Minimum Instream Flow Ruling developed by Ecology.	**WP-16**
Strategy: Policies that will limit the maximum daily withdrawals of domestic exempt wells to less than 5000 gallons per day should be investigated.	**WP-16**
Strategy: Request Counties, Cities, and/or Regional Health Districts to evaluate the quantity of water necessary (currently 1 gallon per minute,), from a domestic exempt well before a building permit is issued.	**WP-16**

ISSUE 3: PRIORITIES OF FUTURE WATER ALLOCATION **It is important to ensure adequate water supplies for instream and out-of-stream uses within the basin. Priorities need to be set for the watershed.**	
R3.a. Future allocation of water rights should be apportioned accordingly. **1. Municipal** **2. Domestic (group, domestic exempt)** **3. Stock water (requiring less than 5,000 gallons per day for ranging cattle)** **4. Light Industrial** **5. Commercial (retail, commercial livestock)** **6. Stock water (requiring greater than 5,000 gallons per day)** **7. Agriculture (irrigated)** **8. Heavy Industrial**	**N/A**
R3.b. Initiate a watershed based negotiation to achieve a cooperative agreement to address cross state line availability of water (both surface and groundwater).	**N/A**
Strategy: A process should be initiated to develop collaboration between appropriate multi-state stakeholders and agencies.	**N/A**
ISSUE 4: WATER CONSERVATION, RECLAMATION, AND RE-USE **The Planning Unit recognizes that the watershed may be fully allocated. Water savings will occur from implementing water conservation measures. Communities may want to consider instituting a plan to prevent shortages in the future.**	
R4.a Work with water purveyors to implement conservation programs required by the new Municipal Water Law.	**WP-1**
Strategy: A coordinated effort should be initiated between the State Department of Health and the water purveyors. A process should be facilitated to convene local purveyors to develop coordinated conservation provisions. These can take the form of individual plans.	**WP-1**
Strategy: Assess the need for additional conservation measures in the basin (aside from Municipal Water Law)	**WP-1, WP-4**
R4.b. Identify funding sources for small town infrastructure upgrades (*i.e.* leak detection, repair, storage, metering).	**WP-1**
Strategy: Funding sources should be identified.	**WP-1**
R4.c. Develop new legislation to prevent water saved by improved irrigation efficiency or conservation from being subject to relinquishment (systems who are not municipal water suppliers).	**WP-7, 8**
Strategy: Appropriate legislation should be drafted and submitted.	**WP-7, 8**
R4.d. Options for keeping current water rights and place of use in the watershed should be explored.	**WP-7, 8**
Strategy: Further investigation is needed to develop alternatives	**WP-7, 8**
R4.e. Funding should be requested from the Legislature to purchase or lease saved water (from R4.d.).	**WP-7, 8**
Strategy: A formal request should be developed and submitted to the Legislature.	**WP-7, 8**

R4.f. The potential to utilize the Conservation Futures Program for purchasing water rights should be explored.	**WP-8**
Strategy: The Conservation Futures Program should be explored to investigate this opportunity.	**WP-8**
R4.g. A coordinated water conservation education/information program should be developed and implemented. This program may be coordinated with a larger regional effort.	**N/A**
Strategy: A program should be developed. This program may also be developed in coordination with a larger regional program.	**N/A**
R4.h. Encourage the use of water conserving programs, actions, and technology (*i.e.* xeriscaping, low flow toilets and shower heads) for domestic (group, domestic exempt), light industrial, heavy industrial, commercial, agriculture, irrigation, and municipal uses.	**WP-1, 2, 3, 4, 5**
Strategy: This program should be developed and coordinated with appropriate agencies and departments.	**WP-1, 2, 3, 4, 5**
R4.i. A watershed drought management plan should be developed. This plan will initiate specific actions to be taken to conserve and preserve water in the basin.	**WP-1, 2, 3, 4, 5**
Strategy: A plan should be developed. This plan may be coordinated with a larger regional effort.	**WP-1, 2, 3, 4, 5**
ISSUE 5: GROUNDWATER/SURFACE WATER INTERACTIONS **Groundwater withdrawals from the deep basalt aquifer system in the upper basin do not have an immediate, direct impact on stream flows in the upper basin (Buchanan 2003). However, groundwater withdrawal in the upper basin may indeed have an impact on surface water flows in the lower basin, but it may be delayed by many years or decades. Furthermore, the impact may be so small that it would not be measurable in the lower basin.**	
R5.a. The groundwater connections between sub-basins should be studied and better defined.	**WP-18**
Strategy: A scope of work should be developed and funding for this study should be identified.	**WP-18**
R5.b. Groundwater levels need to be monitored to determine if aquifer mining is occurring within the basin.	**WP-18**
Strategy: A scope of work should be developed and funding for this study should be identified.	**WP-18**
R5.c. A study should be conducted to evaluate whether groundwater from adjoining watersheds is being utilized by municipalities on the edge of watershed (Tekoa, Cheney, Spangle). The addition of a dedicated monitoring station (well) should be established.	**WP-18**
Strategy: A scope of work should be developed and funding for this study should be identified.	**WP-18**
R5.d. A new permanent gaging station should be developed between the upper and lower watershed. This will help determine water interchange rates, instream flow levels (regulatory and recreational)	**WP-18**
Strategy: A real time gaging station should be established and maintained. Funding for the station should be identified to help support this.	**WP-18**

R5.e. Encourage the establishment of a new permanent gaging station near the stateline.	**WP-18**
Strategy: This station should be established and maintained. This station may be implemented through joint entities/stakeholders.	**WP-18**
ISSUE 6: ACTUAL WATER USE/ALLOCATION IN THE BASIN **The total certificated water rights in the basin are approximately 48 cfs. However, the actual use in the basin is not known.**	
R6.a. Determine the need for addressing compliance and enforcement of water rights and claims. Required resources should be identified.	**WP-13, 14, 15**
Strategy: The Watershed Implementation Team should determine the need and requirements for compliance and enforcement issues.	**WP-13, 14, 15**
R6.b. Determine the need and support for adjudication in the watershed. If supported, the appropriate sub-basins should be prioritized for adjudication.	**WP-12**
Strategy: The Watershed Implementation Team should determine the need and support for adjudication and then prioritize sub-basins as needed.	**WP-12**
R6.c. If appropriate, a petition should be filed with the State of Washington for general adjudication of water rights in the basin.	**WP-12**
Strategy: File a petition (if necessary).	**WP-12**
MULTIPURPOSE STORAGE	
ISSUE 7: STREAMFLOW AUGMENTATION AND STORAGE **The Hangman Creek Watershed is routinely impacted by low flows during the critical summer months of July through September. Improvements in storage and augmentation may prove to be beneficial to communities and stream flow levels.**	
R7.a. The Cities and Towns of Spangle, Rockford, Tekoa, and Latah should evaluate and investigate the causes for unaccounted water in their Public Water Systems. If high levels are found, actions should be taken to reduce the unaccounted for water.	**WP-1**
Strategy: If necessary, a leak detection program should be developed for these towns.	**WP-1**
R7.b. A streamflow augmentation program should be developed and implemented for Hangman Creek.	**WP-10**
Strategy: New and existing wells should be drilled and/or pumped to augment the streamflow with groundwater. This water may be purchased or leased.	**WP-10**
Strategy: Water rights should be purchased or leased from The City of Tekoa to augment streamflows.	**WP-7**
Strategy: Develop a system to utilize inchoate water rights, on a temporary basis, from appropriate cities and towns within the watershed.	**WP-7**
Strategy: Historic and current wetland sites should be acquired and restored.	**WP-53**
Strategy: Catchment basins should be built to capture and store water.	**WP-21**

Strategy: Balancing basins should be built to capture and store runoff during peak periods.	**WP-21**
Strategy: Dams should be built in the upper watershed to capture and store water.	**WP-21**
Strategy: Beaver ponds should be encouraged and protected throughout non-developed portions of the watershed.	**N/A**
Strategy: An education program on storage activities and benefits should be regionally coordinated and implemented. Funding should be identified.	**N/A**
Strategy: A cost-share program for snow fencing should be developed and maintained.	**N/A**
Strategy: Living and constructed snow fencing should be encouraged and supported throughout the watershed.	**N/A**
Strategy: Vegetated buffer strips should be encouraged and implemented throughout the watershed.	**WP-47**
Strategy: No-till/Direct Seed tillage operations should be encouraged throughout the watershed.	**WP-3**
Strategy: A No-till/Direct Seed Demonstration Program should be initiated and funded.	**WP-3**
Strategy: The Rock Creek sub-watershed should be targeted for reforestation efforts.	**WP-53**
R7.c. Encourage change of source for water rights from surface to ground water where feasible. Additional incentives may help involvement.	**WP-7**
Strategy: This option should be further explored..	**WP-7**
WATER QUALITY	
ISSUE 8: WATER QUALITY (FLOW RELATED) PARAMETERS **Hangman Creek is listed on the 1998 303(d) List of impaired water bodies for four flow related parameters (fecal coliform, pH, dissolved oxygen, and temperature).**	
R8.a. Participate in Lake Spokane D.O. TMDL process related to point and non-point sources in the Hangman Creek watershed.	**WP-38**
Strategy: The Watershed Implementation Team should participate in the Lake Spokane TMDL process	**WP-38**
R8.b. Participate in the Hangman Creek TMDL project.	**WP-38**
Strategy: The Watershed Implementation Team should participate in the Hangman Creek TMDL process	**WP-38**
R8.c. The information (data) gaps for short and long-term water quality needs should be evaluated.	**N/A**
Strategy: Information (data) gaps and needs should be evaluated. An action plan should be developed.	**N/A**
R8.d. The long-term trends of sediment loads should be evaluated.	**WP-52**
Strategy: A coordinated effort should be organized to evaluate trends.	**WP-52**
R8.e. The stream gaging operation throughout watershed should be maintained to assist with the TMDL study. The stations will assist in the determination of pollutant load allocations.	**WP-18**

Strategy: The gaging stations should be maintained	**WP-18**
R8.f. The installation of additional gaging stations to monitor the effects of BMP implementation should be supported. These BMPs should be recommended through the TMDL process.	**WP-18**
Strategy: Additional gages should be established (if necessary)	**WP-18**
R8.g. Stock watering impacts to surface waters should be minimized throughout the watershed.	**WP-34**
Strategy: An action plan should be developed to minimize livestock impacts. This effort should be coordinated with appropriate agencies	**WP-34**
R8. h. Incentives should be developed to encourage off creek watering systems for livestock.	**WP-34**
Strategy: A coordinated effort to develop incentives for off creek watering systems should be organized. This effort should be coordinated with appropriate agencies.	**WP-34**
R8.i. Incentives should be developed to improve riparian zones.	**WP-47**
Strategy: An action plan to improve riparian zones should be developed. This effort should be coordinated with appropriate agencies.	**WP-47**
ISSUE 9: SEPTIC SYSTEMS **Septic systems that are failing, improperly maintained or non-functioning can provide contaminants to surface and ground water.**	
R9.a. An education/information program should be initiated for septic system construction, care and maintenance.	**N/A**
Strategy: A program should be initiated and supported.	**N/A**
R9.b. A septic maintenance program should be established. Inspections should take place every three years. Septic system pumping should occur every six years.	**N/A**
Strategy: A program should be initiated and maintained	**N/A**
R9.c. Incentives should be developed for replacement and/or upgrades of substandard septic systems.	**N/A**
Strategy: A coordinated effort to develop incentives should be organized.	**N/A**
ISSUE 10: WELLHEAD PROTECTION **Wellhead protection is lacking in the smaller communities throughout the watershed.**	
R10.a. The needs for wellhead protection in smaller communities should be identified.	**N/A**
Strategy: The needs should be identified. An action plan should be developed	**N/A**
R10.b. Potential funding sources for wellhead protection in smaller communities should be identified.	**N/A**
Strategy: Potential funding sources should be identified	**N/A**
R10.c. The impacts of storm water handling in smaller communities should be identified.	**WP-40**

Strategy: Impacts of storm water handling should be identified. An action plan should be developed.	**WP-40**
R10. d. Identify potential funding sources for storm water system plans with wellhead protection program.	**WP-40**
Strategy: Potential funding sources should be identified	**WP-40**
HABITAT AND LAND USE	
ISSUE 11: LAND USE PLANNING, SHORELINES, AND DEVELOPMENT **The types and extents of land uses appropriate for the watershed should be compatible with the Watershed Management Plan's goals. These plans include both water quantity and water quality issues (future TMDL Plan). Riparian area and flood plain encroachment continues to occur throughout the basin (rural and urban).**	
R11.a. All development and construction proposals within the watershed should have a SEPA review and be reviewed by the Watershed Implementation Team for compatibility with the watershed management plan.	**N/A**
Strategy: The Watershed Implementation Team should request to be on review lists of all relevant agencies.	**N/A**
R11.b. All County and City Land Use Planning intended for WRIA 56 should be reviewed/coordinated with the Watershed Implementation Team for compatibility with the watershed management plan.	**N/A**
Strategy: A coordinated effort should be made with local planning departments to review land use planning proposals within the basin.	**N/A**
R11.c. The local Shoreline Management Plans and/or Critical Areas Ordinance should include a restriction on commercial, residential, and industrial development along streams, within the 100-year flood plain, and the associated channel migration belts.	**WP-49**
Strategy: The Spokane County Conservation District, the local jurisdictions, and Ecology should provide technical assistance to the extent possible.	**WP-49**
Strategy: The Watershed Implementation Team should make recommendations to land-use authorities for Shoreline Management Plans and Critical Area Ordinances.	**WP-49**
R11.d. If new commercial, residential, and industrial development within the 100-year flood plain occurs, then mitigation should be required for fish and wildlife impacts.	**WP-49**
Strategy: A coordinated effort should be made to review policies and provide comments.	**WP-49**
R11.e. All streamside/shoreline land uses (eg. Agricultural, urban, residential) subject to the jurisdiction of local regulations should implement Best Management Practices and establish appropriate riparian buffers to protect streamside habitat and water quality.	**WP-49**
Strategy: Work with appropriate landowners to inform and educate.	**WP-49**
R11.f. Technical assistance should be available for landowner consultation	**N/A**
Strategy: Technical assistance should be available through various sources	**N/A**

R11.g. Shoreline Management Plan regulations and Critical Area Ordinances should be enforced to the extent possible.	**WP-54**
Strategy: All local jurisdictions required to regulate shorelines should maintain adequate staffing for enforcement.	**WP-49**
R11.h. Greenbelts or conservancy corridors should be established to improve and enhance fish and wildlife habitat.	**WP-53**
Strategy: Applications should be coordinated, developed, and submitted to the Spokane County Conservation Futures Program.	**WP-53**
R11.i. A complete channel migration zone delineation project should be funded within the watershed and should be considered in future land use regulations.	**N/A**
Strategy: A scope of work should be developed. Funding sources should be identified.	**N/A**
R11.j. The current delineation of the 100-year FEMA flood plain designations should be reassessed. New boundaries should be determined by a professional engineer.	**WP-51**
Strategy: A coordinated action plan should be developed and submitted to FEMA.	**WP-51**
R11.k. Conduct feasibility study of a land acquisition/relocation program for structures within the 100-year flood plain.	**WP-53**
Strategy: A scope of work should be developed. Funding sources should be identified	**WP-53**
R11.l. Develop and maintain public awareness and education programs for riparian area function, benefits, and flood plain encroachment (This should be inclusive of residents, developers, and a broad range of stakeholders).	**N/A**
Strategy: A coordinated program should be developed. This program should be maintained over the long-term. Funding should be identified.	**N/A**
R11.m. The local jurisdictions should develop a coordinated flood response plan in conjunction with a flood warning system.	**WP-51**
Strategy: A plan should be developed and coordinated with local jurisdictions.	**WP-51**
R11.n. Establish a riparian restoration program for the watershed.	**WP-47**
Strategy: A program should be coordinated, developed and implemented. Funding sources should be identified. This program should be maintained.	**WP-47**
R11.o. Identify high priority riparian habitat to submit for consideration in the Spokane County Conservation Futures Program.	**WP-53**
Strategy: A process to determine high priority habitats should be developed. Priority habitats should be identified. An application should be developed and submitted to the Conservation Futures Program.	**WP-53**
R11.p. Coordinate and continue Riparian Buffer Cost-Share/and or loan programs.	**WP-47**
Strategy: The program should be coordinated and maintained. Funding should be identified.	**WP-47**

ISSUE 12: FISHERIES HABITAT **Fisheries within the Hangman watershed are stressed due to poor habitat, water quality and low water quantity issues.**	
R12.a. Fish barriers should be identified and mapped within the mainstem and tributaries. A feasibility plan to identify the benefits of removal of these barriers and an action plan to remove identified barriers should be developed.	**WP-45**
Strategy: An action plan should be developed to identify, map, and evaluate potential fish barriers.	**WP-45**
Strategy: Further action for identified fish barriers should be developed.	**WP-45**
R12.b. Conduct Proper Function Condition Assessment (PFC) on the remaining tributaries in the Hangman Creek Watershed.	**N/A**
Strategy: An action plan should be developed and coordinated. Funding sources should be identified.	**N/A**
R12.c. Evaluate whether the current hydrology is capable of supporting flows required for returning migratory salmonids.	**N/A**
Strategy: A body of hydrological information should be developed, analyzed, and reviewed.	**N/A**
PHASE IV PLAN IMPLEMENTATION	
ISSUE 13: IMPLEMENTATION PROCESS **The success of the Hangman Creek Watershed Plan depends upon the formation of a Watershed implementation Team, local acceptance of the plan, and participation of local and stakeholders, and coordination of regional efforts.**	
R13.a. An Implementation Plan MOA shall be developed between local governmental agencies and other required stakeholders.	**N/A**
Strategy: The Spokane County Conservation District shall undertake the development and completion of an Implementation Plan MOA.	**N/A**
R13.b. At such time as a Memorandum of Agreement between the Initiating Agencies is complete, a lead agency should be identified to develop the Phase IV grant application and assume administrative responsibility for the grant.	**N/A**
Strategy: The Spokane County Conservation District should be tentatively identified as the lead agency for plan implementation until such time as the Memorandum of Agreement formalizes this position.	**N/A**
Strategy: At such time as the Memorandum of Agreement between the Initiating Agencies is complete, the lead agency shall develop and submit the Phase IV grant application to the Washington State Department of Ecology.	**N/A**
R13.c. The current planning unit shall continue for no longer than one year under the current Operating Procedures or until such time as a completed MOA for Phase IV specifies otherwise.	**N/A**
R13.d. A Detailed Implementation Plan should be developed.	**N/A**

Strategy: A Detailed Implementation Strategy shall be developed for this watershed. The plan may include milestones, timelines, funding mechanisms, and obligations of local stakeholders.	**N/A**

Appendix Q

SEPA Review Process

SEPA Review Process

The Hangman (Latah) Creek Water Resources Management Plan has satisfied the State Environmental Policy Act (SEPA). A transmittal letter and the SEPA checklist were completed, reviewed by the Planning Unit, and submitted to the following distribution list (66 recipients). The checklists were mailed on July 8, 2005. A three-week review period was given (July 11 – July 29). All comments were to be received by 5:00 p.m. on July 29th 2005

Distribution List

1. Spokane County Division of Building and Planning
2. Neighborhood Alliance of Spokane County
3. City of Spokane
4. City of Spokane Neighborhood Services
5. Spokane County Health District
6. Joint Aquifer Protection Board
7. Coeur d'Alene Tribe
8. Spokane Tribe of Indians
9. City of Cheney,
10. Town of Waverly
11. City of Tekoa
12. Town of Latah
13. Town of Rockford
14. Town of Spangle
15. Town of Fairfield
16. Hangman Creek Chamber of Commerce
17. Whitman County Planning Department
18. Washington State Department of Ecology
19. Washington State Department of Fish and Wildlife
20. U.S. Army Corp of Engineers
21. U.S. Dept. of Agriculture, NRCS
22. Washington State Department of Natural Resources
23. Washington State Department of Health
24. Washington State Department of Transportation
25. Spokane County Air Pollution
26. Spokane County Housing and Community Development
27. AVISTA
28. Chevron Pipeline Company
29. Comcast Cable Services
30. Qwest Communications
31. Spokane Transit Authority
32. Water Management of Spokane
33. Yellowstone Pipeline Company
34. North Spokane Library
35. Valley Library
36. Main City Library
37. Fire District No. 2, No. 3, No. 8, No. 10, No. 11, No. 12
38. Four Lakes Water District
39. Spokane Fire Department

40. Cheney School District
41. Spokane Public School District # 81
42. Freeman School District
43. Liberty School District
44. Historic Preservation Office

Additionally, the following SEPA notice was posted in several local newspapers. SEPA checklists, final documents, and other information were available at the Spokane Conservation District.

Publications and Dates Posted (All dates are 2005)

Spokesman Review:	July 17, July 20, July 24
Colfax Gazette:	July 14, July 21
North Palouse Journal:	July 14, July 21
St. Maries Gazette:	July 14, July 21

Public Notice

The WRIA 56 Planning Unit has made a Determination of Significance on the following non-project proposal: The Hangman (Latah) Creek Water Resources Management Plan.

The lead agency (Spokane County Conservation District) has determined this proposal is likely to have a significant adverse impact on the environment. An Environmental Impact Statement (EIS) is required under RCW 43.21C.030(2)© and will be prepared. An EIS checklist and/or other materials indicating likely environmental impacts is available for review.

The lead agency has identified the following areas for discussion in the EIS: In 2003, the WA Department of Ecology developed and submitted a Final Environmental Impact Statement (EIS) for Watershed Planning under Chapter 90.82 RCW (Publication # 03-06-013). The Hangman (Latah) Creek Watershed Planning Unit has agreed to the "Adoption and Determination of Significance (DS) option. This option proposes that Ecology's statewide nonproject document generally addresses probable significant adverse impacts associated with watershed planning under provisions of Chapter 90.82 RCW. The EIS fulfills the SEPA environmental review requirements for actions that may be needed to adopt the plan, including instream flows. Specific recommended actions of individual plans may require project-level, or non-project SEPA review prior to implementation.

Agency, affected tribes, and members of the public are invited to comment on the scope of the EIS. You may comment on alternatives, mitigation measures, probable significant adverse impacts and licenses or other approvals that may be required. The method and deadline for giving us your comments is:

Responsible official Walter J. Edelen
Position/title Water Resources Program Manager Phone (509) 535-7274
Address 210 N. Havana, Spokane, WA 99202

You may appeal this determination of significance no later than July 29, 2005 at 5:00 p.m.by written Statement of Appeal. You should be prepared to make specific factual objections. Contact Walt Edelen to read or ask about the procedures for SEPA appeals.

Spokane County Conservation District
Bringing People and Resources Together

210 N. Havana - Spokane, WA 99202 - Phone (509) 535-7274 - Fax (509) 535-7410
http://www.sccd.org

July 8, 2005

Dear Stakeholder:

The Hangman Creek Watershed Planning Unit is pleased to submit for your consideration and approval the *Hangman Creek Water Resources Management Plan* (Plan). Enclosed are three hard copies of the Plan for each Board of Commissioners. This Plan approved by the planning unit on May 19, 2005 encompasses approximately four years of effort by the planning unit and roughly $800,000 of state funding invested toward studying and planning how to better manage the water resources in our watershed. Included in this Plan is compliance with the State Environmental Policy Act.

Please feel free to contact the planning unit or lead agency with any questions or concerns related to the Plan.

Sincerely,

Walter J. Edelen
Water Resources Program Manager

CC: R.E. Baden, Executive Director, Spokane Conservation District
Spokane Conservation District Board of Supervisors
WRIA 56 Planning Unit Members

SPOKANE ENVIRONMENTAL ORDINANCE
(WAC 197-11-980) Section 11.10.230(4)
Determination of Significance and Scoping Notice (DS)

DETERMINATION OF SIGNIFICANCE
AND REQUEST FOR COMMENTS ON SCOPE OF EIS

Description of proposal The Hangman (Latah) Creek Water Resources Management Plan was developed to evaluate and provide recommendations for water use within the basin.

Proponent Spokane County Conservation District

Location of proposal The Hangman (Latah) Creek Watershed (WRIA 56) within Spokane County, WA.

Lead agency Spokane County Conservation District

EIS required. The lead agency has determined this proposal is likely to have a significant adverse impact on the environment. An Environmental Impact Statement (EIS) is required under RCW 43.21C.030(2)(c) and will be prepared. An environmental checklist or other materials indicating likely environmental impacts can be reviewed at our offices.
The lead agency has identified the following areas for discussion in the EIS.

In 2003, Ecology developed and submitted a Final Environmental Impact Statement (EIS) for Watershed Planning under Chapter 90.82 RCW (Publication # 03-06-013). The Hangman (Latah) Creek Watershed Planning Unit has agreed to the "Adoption and Determination of Significance (DS) option. This option proposes that Ecology's statewide nonproject document generally addresses probable significant adverse impacts associated with watershed planning under provisions of Chapter 90.82 RCW. The EIS fulfills the SEPA environmental review requirements for actions that may be needed to adopt the plan, including instream flows. Specific recommended actions of individual plans may require project-level, or non-project SEPA review prior to implementation.

Scoping. Agency, affected tribes and members of the public are invited to comment on the scope of the EIS. You may comment on alternatives, mitigation measures, probable significant adverse impacts and licenses or other approvals that may be required. The method and deadline for giving us your comments is:

Responsible official Walter J. Edelen
Position/title Water Resources Program Manager Phone (509) 535-7274
Address 210 N. Havana, Spokane, WA 99202

Date: July 8, 2005 Signature ______________________________

You may appeal this determination of significance to (name) Walter J. Edelen
at (location) Spokane County Conservation District, 210 N. Havana, Spokane, WA 99202
no later than (date) No later than July 29, 2005 at 5:00 p.m.
by (method) Written Statement of Appeal

You should be prepared to make specific factual objections.

Contact Walt Edelen to read or ask about the procedures for SEPA appeals.

WAC 197-11-960 Environmental checklist.

ENVIRONMENTAL CHECKLIST

Purpose of checklist:

The State Environmental Policy Act (SEPA), chapter 43.21C RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the agency identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the agency decide whether an EIS is required.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Governmental agencies use this checklist to determine whether the environmental impacts of your proposal are significant, requiring preparation of an EIS. Answer the questions briefly, with the most precise information known, or give the best description you can.

You must answer each question accurately and carefully, to the best of your knowledge. In most cases, you should be able to answer the questions from your own observations or project plans without the need to hire experts. If you really do not know the answer, or if a question does not apply to your proposal, write "do not know" or "does not apply." Complete answers to the questions now may avoid unnecessary delays later.

Some questions ask about governmental regulations, such as zoning, shoreline, and landmark designations. Answer these questions if you can. If you have problems, the governmental agencies can assist you.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Use of checklist for nonproject proposals:

Complete this checklist for nonproject proposals, even though questions may be answered "does not apply." IN ADDITION, complete the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D).

For nonproject actions, the references in the checklist to the words "project," "applicant," and "property or site" should be read as "proposal," "proposer," and "affected geographic area," respectively.

A. BACKGROUND

1. Name of proposed project, if applicable:

The Hangman (Latah) Creek Water Resources Management Plan (WRIA 56)

2. Name of applicant:

WRIA 56 Watershed Planning Unit (Hangman Creek)

3. Address and phone number of applicant and contact person:

Lead Agency – Spokane County Conservation District

Contact Person: Walt Edelen

Spokane County Conservation District

210 Havana, Spokane WA, 99202

Phone: (509) 535-7274

Fax (509) 535-7410

Email: walt-edelen@sccd.org

4. Date checklist prepared: 6/01/05

5. Agency requesting checklist: Spokane County Public Works Department, Division of Utilities

6. Proposed timing or schedule (including phasing, if applicable):

The WRIA 56 Watershed Management Plan contains recommendations and a proposed schedule for implementation of water resource-related projects and initiatives (referred to as "recommended actions") within Spokane and Whitman County. As part of the implementation phase of the watershed planning effort, an additional 1-year of project planning will be conducted, following Plan approval, before a revised implementation schedule is prepared. Approval of the Plan by Spokane and Whitman County is expected to occur in June 2005. Implementation of the "recommended actions" is expected to occur over the next 10 years.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

Yes, as previously stated, an additional year of implementation planning will be conducted, following Plan approval. Implementation of the "recommended actions" is expected to occur over the next 10 years. Activities identified for implementation by various participating agencies will be reviewed for SEPA compliance at the time of implementation planning specific to the "recommended action".

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

The WA State Department of Ecology has prepared the following publication, "*Environmental Impact Statement for Watershed Planning under Chapter 90.82 RCW*" (publication # 03-06-013), for watershed planning. The document evaluates the impacts of and identifies mitigation measures for various types or classes of recommended actions that may be included in watershed plans. Although the recommendations in the Ecology document are generic, many of them apply directly to the WRIA 56 planning document's recommendations. Additionally, SEPA reviews will be completed before individual activities, related to the recommendations, are conducted.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.
No

10. List any government approvals or permits that will be needed for your proposal, if known.

The Spokane and Whitman County Commissioners are required to adopt the watershed plan for WRIA 56.

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The expectation of the WRIA 56 Planning Unit is to implement the various "recommended actions" of the Plan. Specific projects have been envisioned in the Plan and strategies for implementation of those projects will be developed in the initial year following approval.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The Plan pertains to the areas described as the Hangman Creek Watershed (WRIA 56) in Spokane and Whitman Counties.

13. Does the proposed action lie within the Aquifer Sensitive Area (ASA)? The City of Spokane, Spokane Valley or Liberty Lake?

Yes. According to Spokane County's Aquifer Sensitivity Map, a majority of Hangman Creek is considered to be either moderate or high susceptibility. The upland portions of the watershed vary from low to moderate susceptibility.

14. The following questions supplement Part A.

a. Critical Aquifer Recharge Area (CARA) / Aquifer Sensitive Area (ASA).

(1) Describe any systems, other than those designed for the disposal of sanitary waste installed for the purpose of discharging fluids below the ground surface (includes systems such as those for the disposal of stormwater or drainage from floor drains). Describe the type of system, the amount of material to be disposed of through the system and the types of material likely to be disposed of (including materials which may enter the system inadvertently through spills or as a result of firefighting activities).

There are recommendations in the plan that pertain to stormwater management.

(2) Will any chemicals (especially organic solvents or petroleum fuels) be stored in aboveground or underground storage tanks? If so, what types and quantities of material will be stored?

Does not apply.

(3) What protective measures will be taken to insure that leaks or spills of any chemicals stored or used on site will not be allowed to percolate to groundwater. This includes measures to keep chemicals out of disposal systems.

Does not apply.

(4) Will any chemicals be stored, handled or used on the site in a location where a spill or leak will drain to surface or groundwater or to a stormwater disposal system discharging to surface groundwater?

There are recommendations in the plan that pertain to stormwater management.

b. Stormwater.

(1) What are the depths on the site or groundwater and to bedrock (if known)?

Does not apply.

(2) Will stormwater be discharged into the ground? If so, describe any potential impacts.

There are recommendations in the plan that pertain to stormwater management.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other

The area covered by the Plan is large and encompasses a wide range of terrains, slopes, soils, and bodies of surface water. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific "recommended actions", as required.

b. What is the steepest slope on the site (approximate percent slope)?

See 1.a.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

See 1.a.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

See 1.a.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

Does not apply.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Does not apply.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Does not apply.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

Does not apply.

2. Air

a. **What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.**

Does not apply.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

Does not apply.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Does not apply.

3. Water

a. Surface:

(1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

Yes, the area covered by the Plan is large and encompasses a wide range of terrains, slopes, soils, and bodies of surface water. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific "recommended actions", as required.

(2) Will the project require any work over, in, adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

Potentially, see 3.a.1

(3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

See 3.a.1

(4) Will the proposal require surface water withdrawals or diversions? Give general descriptions, purpose, and approximate quantities if known.

See 3.a.1

(5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

See 3.a.1

(6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

Does not apply.

b. Ground:

(1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.

There is potential for this in the plan. The Plan includes a wide range of options to augment stream flows and/or recharge the aquifers in the area. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific "recommended actions", as required.

(2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following applicable), or the number of animals or humans the system(s) are expected to serve.

Does not apply.

c. Water Runoff (including storm water):

(1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

There are recommendations in the plan that pertain to stormwater management.

(2) Could waste materials enter into ground or surface waters? If so, generally describe.

Does not apply.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

Does not apply.

4. Plants

a. Check or circle types of vegetation found on the site:

_x_ deciduous tree: alder, maple, aspen, other
_x_ evergreen tree: fir, cedar, pine, other
_x_ shrubs
_x_ grass
_x_ pasture
_x_ crop or grain
_x_ wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other
_x_ water plants: water lily, eelgrass, milfoil, other
_x_ other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Does not apply.

c. List threatened or endangered species known to be on or near the site.

Water howellia (*Howellia aquatilis*) has been listed in the watershed (habitat range). However, no known occurrences have been documented.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

There are recommendations in the plan that pertain to riparian management and vegetation enhancement.

5. Animals

a. Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

The project area includes all animals listed below.

birds: hawks, herons, eagles, songbirds, other
mammals: deer, elk, bear, beaver, moose, squirrel, other
fish: trout, whitefish, carp, other

b. List any threatened or endangered species known to be on or near the site.

The WRIA 56 watershed includes, but may not be limited to, the following endangered and threatened species: Bald Eagle, Peregrine Falcon.

c. Is the site part of a migration route? If so, explain.

Portions of the Hangman Creek riparian corridor may function as migration routes and hunting grounds.

d. Proposed measures to preserve or enhance wildlife, if any:

Implementation of various “recommended actions” in the Plan will create mechanisms to manage and conserve water resources in the region, thus creating additional habitat for fish and other aquatic biota, and enhancing habitat in existing wetlands and shoreline environments.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Does not apply.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

Does not apply.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Does not apply.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

Does not apply.

(1) Describe special emergency services that might be required.

Does not apply

(2) Proposed measures to reduce or control environmental health hazards, if any:

b. Noise

Does not apply.

(1) What types of noise exist in the area which may affect your project (for example, traffic, equipment, operation, other)?

(2) What types and levels of noise would be created by or associated with the project on a short-term or long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

(3) Proposed measures to reduce or control noise impacts, if any:

8. Land and Shoreline Use

The project area includes all land in Hangman Creek watershed. The Plan includes a wide range of options that may impact zoning and land use in the watersheds, including shorelines. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific "recommended actions", as required.

a. What is the current use of the site and adjacent properties?

Does not apply.

b. Has the site been used for agriculture? If so, describe.

Yes, the watershed contains over 260,000 acres of dryland agricultural crop production.

c. Describe any structures on the site.

Does not apply.

d. Will any structures be demolished? If so, what?

Does not apply.

e. What is the current zoning classification of the site?

Does not apply.

f. What is the current comprehensive plan designation of the site?

This is a programmatic non-project proposal

g. If applicable, what is the current shoreline master program designation of the site?

This is a programmatic non-project proposal

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

The lower portions of Hangman Creek do include hazardous and sensitive sites (Latah Formation) that are easily erodible. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific "recommended actions", as required.

i. Approximately how many people would reside or work in the completed project?

Does not apply.

j. Approximately how many people would the completed project displace?

Does not apply.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Does not apply.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

Does not apply.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.
Does not apply.

c. Proposed measures to reduce or control housing impacts, if any:

Does not apply.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

Does not apply.

b. What views in the immediate vicinity would be altered or obstructed?

Does not apply.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Does not apply.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Does not apply.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Does not apply.

c. What existing off-site sources of light or glare may affect your proposal?

Does not apply.

d. Proposed measures to reduce or control light and glare impacts, if any:

Does not apply.

12. Recreation

The Hangman Creek watershed provides a wide variety of recreational opportunities including fishing, boating, swimming, and hiking. The Plan is not likely to significantly impact those activities. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific "recommended actions", as required.

a. What designated and informal recreational opportunities are in the immediate vicinity?

Kayaking, canoeing, fishing, hiking, hunting, swimming, wading, bird watching

b. Would the proposed project displace any existing recreational uses? If so, describe.

No

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Does not apply.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

None Known. Separate Environmental Checklists, with detailed environmental information, will be prepared for specific “recommended actions”, as required.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

The Washington State Archaeological database (ARCHNET) has revealed several archaeological or historical sites within the Hangman Creek watershed. These sites are recorded closer to the City of Spokane, but other sites may exist within the watershed. These cultural and archaeological areas are not available to the general public. If a site is suspected to contain artifacts, appropriate actions will be taken.

c. Proposed measures to reduce or control impacts, if any:

Does not apply.

14. Transportation

No impacts to transportation networks are anticipated. Separate Environmental Checklists, with detailed information, will be prepared for specific “recommended actions”, as required.

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

Does not apply.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

Does not apply.

c. How many parking spaces would the completed project have? How many would the project eliminate?

Does not apply.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

Does not apply.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

Does not apply.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Does not apply.

g. Proposed measures to reduce or control transportation impacts, if any:

Does not apply.

15. Public Services

a. Would the project result in an increased need for public services (for example, fire protection, police protection, health care, schools, other)? If so, generally describe.

When implemented, recommended actions in the Plan could affect the need for public services. Some elements of the Plan could result in additional staff needed for water conservation/education programs. Conversely, other elements of the Plan could result in a reduction of need for public services (automation of sprinkler systems in parks, for instance). Separate Environmental Checklists, with detailed information, will be prepared for specific "recommended actions", as required.

b. Proposed measures to reduce or control direct impacts on public services, if any.

Does not apply.

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other, all.

Does not apply. This is a non-project action.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity, which might be needed.

Does not apply.

C. Signature

I, the undersigned, swear under the penalty of perjury that the above responses are made truthfully and to the best of my knowledge. I also understand that, should there be any willful misrepresentation or willful lack of full disclosure on my part, the agency may withdraw any determination of nonsignificance that it might issue in reliance upon this checklist.

Date: ______________________ **Signature:__________________________**

Proponent: **Name** ____
Address ____
Phone ____

SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS

(Do not use this sheet for project actions)

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment.

When answering these questions, be aware of the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

1. How would the proposal be likely to increase discharge to water, emission to air, production, storage, or release of toxic or hazardous substances; or production of noise?

Implementation of the Plan is not likely to increase noise or increase discharges of toxic or hazardous substances to the environment.

Proposed measures to avoid or reduce such increases are:

Does not apply.

2. How would the proposal be likely to affect plants, animals, fish, or marine life?

Implementation of various "recommended actions" in the Plan will create mechanisms to manage and conserve water resources in the region, thus creating additional habitat for fish and other aquatic biota, and enhancing existing habitat in wetlands and shoreline environments.

Proposed measures to protect or conserve plants, animals, fish, or marine life are:

Implementation of various "recommended actions" in the Plan will create mechanisms to manage and conserve water resources in the region, thus creating additional habitat for fish and other aquatic biota, and enhancing habitat in existing wetlands and shoreline environments.

3. How would the proposal be likely to deplete energy or natural resources?

Implementation of various "recommended actions" in the Plan will have the potential to increase the availability of water resources in the region. Implementation of instream flow recommendations in the Hangman Creek watershed would not deplete energy or natural resources.

Proposed measures to protect or conserve energy and natural resources are:

The Plan identifies numerous "recommended actions" to be evaluated for the conservation of water resources in the region.

4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

Implementation of various "recommended actions" in the Plan will create mechanisms to manage and conserve water resources in the watershed. These actions will positively affect environmentally sensitive areas.

Proposed measures to protect such resources or to avoid or reduce impacts are:

The Plan identifies numerous "recommended actions" to be evaluated for the protection and enhancement of wetlands and other environmentally sensitive areas related to the watersheds.

5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

Implementation of various “recommended actions” will provide information with which to make appropriate land use and zoning policy decisions regarding developments outside of existing public water service areas, and could result in changes to existing plans and ordinances.

Proposed measures to avoid or reduce shoreline and land use impacts are:

The Plan identifies numerous “recommended actions” to be evaluated for the protection and enhancement of wetlands and other environmentally sensitive areas related to the watersheds.

6. How would the proposal be likely to increase demands on transportation or public services and utilities?

No impacts to transportation networks are anticipated. When implemented, “recommended actions” in the Plan could affect the need for public services. Some elements of the Plan could result in additional public services staff needed for water conservation/education programs. Conversely, other elements of the Plan could result in a reduction of need for public services (automation of sprinkler systems in parks, for instance).

Proposed measures to reduce or respond to such demands(s) are:

See above.

Identify, if possible, whether the proposal may conflict with local, State, or Federal laws or requirements for the protection of the environment.

In accordance with RCW Chapter 90.82, watershed management plans (Plan) may not conflict with local, State, or Federal laws or requirements for the protection of the environment.

FOR STAFF USE ONLY

Staff Member(s) Reviewing Checklist: ____

Based on this staff review of the environmental checklist and other pertinent information, the staff:

☐ Concludes that there are no probable significant adverse impacts and recommends a Determination of Nonsignificance.

☐ Concludes that probable significant adverse environmental impacts do exist for the current proposal and recommends a Mitigated Determination of Nonsignificance with conditions.

☐ Concludes that there are probable significant adverse environmental impacts and recommends a Determination of Significance.

SEPA Responses

One response was submitted from the Spokane Tribe of Indians via email. No others were received. The response was positive in nature and did not require an answer. Specific recommended actions of individual plans may require project-level, or non-project SEPA review prior to implementation.

Response # 1

August 1, 2005

Walter Edelen
Water Resources Program Manager

RE: Hangman Creek Watershed Planning Unit

Mr. Edelen:

Thank you for inviting the Spokane Tribe of Indians to review and comment on the SEPA checklist.

We have received the application material for the project area,

The Spokane Tribe of Indians does express interest in projects that impacts cultural resources and traditional Cultural properties (TCP).

After reviewing our information, our office has a high concern on any earth- disturbing activities in hangman Creek watershed.

Should additional information become available our assessment may be revised.

Our tribe considers this a positive action that will assist us in protecting our shared heritage.

If questions arise, contact my office at (509) 258 – 4315.

Sincerely,

Randy Abrahamson
Tribal Historic Preservation Officer.
Spokane Tribe of Indians
P.O. Box 100 Wellpinit WA. 99040