AUGUST 2004

SALMON CREEK PROJECT

Draft Environmental Impact Statement

DOE/EIS-0346

Lead Agency
U.S. Dept of Energy, Bonneville Power Administration

Cooperating Agencies
U.S. Dept of Interior, Bureau of Reclamation
Confederated Tribes of the Colville Reservation
Okanogan Irrigation District

Salmon Creek Project

Draft Environmental Impact Statement
(DOE/EIS-0346)

Responsible Agency: Bonneville Power Administration (BPA), U.S. Department of Energy (DOE)

Cooperating Agencies: U.S. Department of Interior, Bureau of Reclamation, Confederated Tribes of the Colville Reservation, Okanogan Irrigation District.

County and State Involved: Okanogan County, Washington

Abstract: BPA proposes to fund activities that would restore sufficient water flows to Salmon Creek and rehabilitate its streambed as necessary to provide adequate passage for summer steelhead (*Oncorhynchus mykiss*) and possibly spring chinook (*O. tshawytscha*). Both steelhead and spring chinook are known to have historically occurred in Salmon Creek. However, habitat for these species in Salmon Creek was greatly affected in the early 1900s by the construction of two dams: Conconully Dam, constructed by the U.S. Bureau of Reclamation (BOR) on the upper reaches of Salmon Creek in 1910, and the Okanogan Irrigation District (OID) diversion dam on the lower reaches of Salmon Creek in 1916. Since these facilities were constructed, the lower 4.3 miles of Salmon Creek downstream from the OID diversion dam has been (and continues to be) typically dewatered under normal irrigation operations, except during high runoff years that result in uncontrolled spill at the reservoirs and diversion dam.

Three alternatives for restoring the flow of water in lower Salmon Creek are described and analyzed. Alternative 1 would construct a new pump station on the Okanogan River and use Okanogan River water for irrigation in place of Salmon Creek water and remove a gravel barrier at the mouth of Salmon Creek to aid fish passage. Alternative 2 would upgrade the existing Shellrock pump station to increase use of Okanogan River water for irrigation and also proposes to rehabilitate the stream channel in the lower 4.3 miles of Salmon Creek to improve fish passage. Alternative 3 would purchase water rights from irrigators and place the water in trust through the State of Washington to remain in Salmon Creek. All three of these alternatives also would upgrade the Salmon Lake Feeder Canal to increase water flow capability. Alternative 4 is the No Action Alternative.

Public comments are being accepted through October 19, 2004.

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You may submit your comment on-line at: www.bpa.gov/comment, or you may FAX a comment to 503-230-3285.

To receive additional copies of the Draft Environmental Impact Statement (DEIS), call BPA's document request line at 1-800-622-4520. You may access the Draft EIS on BPA's web site at http://www.efw.bpa.gov/cgi-bin/PSA/NEPA/SUMMARIES/SalmonCreek.

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SALMON CREEK PROJECT EIS

EXECUTIVE SUMMARY

The Bonneville Power Administration (BPA) proposes to fund activities that would restore sufficient water flows to Salmon Creek and rehabilitate its streambed as necessary to provide adequate passage for summer steelhead (*Oncorhynchus mykiss*) and possibly spring chinook (*O. tshawytscha*). The Upper Columbia River steelhead Evolutionarily Significant Unit (ESU) is listed as endangered under the Endangered Species Act (ESA). While an Upper Columbia River spring chinook ESU has also been listed, the Okanogan River and its tributaries were not included as part of this ESU because spring chinook are considered to be extirpated (locally extinct) from this watershed.

Both steelhead and spring chinook are known to have historically occurred in Salmon Creek. However, habitat for these species in Salmon Creek was greatly affected in the early 1900s by the construction of two dams: Conconully Dam, constructed by the U.S. Bureau of Reclamation (BOR) on the upper reaches of Salmon Creek in 1910, and the Okanogan Irrigation District (OID) diversion dam on the lower reaches of Salmon Creek in 1916. Since these facilities were constructed, the lower 4.3 miles of Salmon Creek downstream from the OID diversion dam has been (and continues to be) typically dewatered under normal irrigation operations, except during high runoff years that result in uncontrolled spill at the reservoirs and diversion dam. In addition, channel geometry, streambank stability, and riparian and aquatic habitat values of the lower 4.3 miles of Salmon Creek have been adversely affected in the last 80 years by a variety of conditions, including altered streamflow regimes, adjacent land uses that have altered vegetation and sediment production, and direct manipulation of streambanks and riparian vegetation.

These conditions have significantly degraded the lower 4.3 miles of Salmon Creek and deposited substantial sediments at the mouth of the creek, which has largely precluded fish migration into Salmon Creek from the Okanogan River. Summer steelhead now rarely use Salmon Creek, although this species is occasionally observed in the creek during high water years, and WDFW has been stocking the creek with steelhead hatchery smolts for several years.

UNDERLYING NEED FOR ACTION

The OID is the prime user of water in Salmon Creek for the irrigation of 5031 acres of agriculture land owned by its 617 members and has a keen interest in protecting its withdrawal water right in Salmon Creek. The District also recognizes that the listing of the Upper Columbia River ESU summer steelhead as endangered under the ESA by NOAA Fisheries created an obligation to comply with the ESA. The OID has a need to investigate opportunities to enhance or restore summer steelhead runs while retaining and protecting its existing water rights to assure viable District operations. The Colville Confederated Tribe's (CCT) interest in pursuing restoration of anadromous fish runs in the Okanogan and Columbia Rivers has given rise to a unique opportunity for the CCT and OID to pursue a joint study of this project. A cooperative approach will help to avoid expensive litigation over ESA compliance.

BPA's need for action arises primarily from its statutory obligations. BPA is responsible for protecting and conserving listed threatened and endangered species under the ESA of 1973, as amended. By funding a project that would increase endangered summer steelhead use of Salmon Creek, the proposed project would assist BPA in fulfilling its responsibilities under the ESA.

The proposed action also is needed to allow BPA to meet its obligations under the Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act) as managed by the Northwest Power and Conservation Council (Council). This project was proposed to the Council by a partnership between the CCT and OID. BPA's funding of this project would assist BPA in meeting its need to take the Council's program into account to the fullest extent practicable. In addition, the Northwest Power Act requires BPA to undertake its mitigation and enhancement responsibilities in a manner that provides "equitable treatment" for fish with the other purposes for which the system is operated.

BPA recognizes that a trust responsibility derives from the historical relationship between the Federal government and the Tribes as expressed in Treaties, statutes, Executive Orders, and Federal Indian case law. BPA and the CCT will work cooperatively to arrive at an understanding of how the trust responsibility applies to the proposed actions.

PURPOSES

BPA has identified the following purposes (i.e., goals or objectives) for the proposed action:

- Provide adequate passage in Salmon Creek for summer steelhead.
- Protect the ability of the OID to provide water delivery to its users.
- Maximize efficiency in water use.
- Achieve administrative efficiency and cost-effectiveness.
- Avoid or minimize adverse environmental impacts.
- Achieve local community and landowner acceptance and support.

AGENCY ROLES AND DECISIONS TO BE MADE

BPA would be a potential funding source for portions of the proposed project. BPA is acting as the lead agency under the National Environmental Policy Act (NEPA) for this Environmental Impact Statement (EIS). Once the final EIS (FEIS) is completed, BPA must decide whether or not to fund activities related to the proposed project. BPA has not decided on a preferred alternative at this time.

The U.S. Department of the Interior, Bureau of Reclamation (BOR) constructed and owns all of the water storage facilities in the Salmon Creek watershed. BOR is not a lead agency under NEPA for this EIS, but it could make a decision and issue its own Record of Decision (ROD) based on the FEIS for the project. BOR is a potential source of funding for portions of the project. BOR therefore is acting as a cooperating agency under NEPA.

The Washington State Department of Ecology (Ecology) is responsible for management of water rights within the State of Washington. If the need for a decision related to water rights results from the proposed project, Ecology would have to ensure that it meets the requirements of the Washington State Environmental Policy Act (SEPA).

The CCT, in cooperation with the OID, are sponsoring this project proposal. Both parties have contributed to the environmental analysis process and would be the primary organizations seeking funding to implement any decisions that are made. The OID would be the primary organization that would operate and maintain any new facilities integrated into the irrigation district infrastructure or implement any new actions affecting distribution of water within the district, but would not be responsible for any operations or maintenance costs over and above their current Okanogan River pumping budget associated with new facilities or actions.

SCOPING AND IDENTIFICATION OF ISSUES

For this project, the public scoping process began with a Notice of Intent to prepare a NEPA EIS that was published in the Federal Register on February 4, 2002. The close of the comment period was March 8, 2002. Several hundred public notice letters were mailed in early February 2002 to the people and organizations that may be interested or impacted by this project proposal.

Public and agency scoping meetings were held in Okanogan, Washington on February 21, 2002 and in Wenatchee, Washington on February 22, 2002. These were “open forum” meetings to encourage participation and dialogue with the attendees. Approximately 75 people attended the public scoping meeting on February 21, and 15-20 agency representatives attended the agency scoping meeting on February 22.

In addition to these scoping meetings, many informal meetings that included presentations and solicitation of issues and comments were held with local, state, and federal agencies, landowners, irrigators, and other members of the public. The majority of the public comments received were questions regarding water resources, impacts to the economy, and the need for the project. Some public comments were supportive, noting the potential for positive impacts to recreation and the economy if local labor pools are used to implement the project. Concerns were expressed with regard to the cost of the project and any increases in assessments for property owners and irrigators. Water rights and property rights were also major concerns.

Agency scoping comments also included water rights, and technical questions regarding the design and the process. Agencies such as Ecology, Washington Dept. of Fish and Wildlife (WDFW) and the Environmental Protection Agency (EPA) provided comments toward the project.

The Council sponsored two separate reviews of the project through its advisory panels. The issues raised by the Independent Scientific Review Panel, in its most recent review of the Salmon Creek Project for the Council in March 2002, were also raised during scoping and are addressed in this draft EIS (DEIS).

ALTERNATIVES

Three action alternatives were developed for the DEIS based upon three methods considered for improving fish passage: 1) increasing stream flows in lower Salmon Creek, 2) improving the lower Salmon Creek stream channel, and 3) improving the Salmon Lake feeder canal. Alternative 4 is the No Action alternative, under which BPA would not fund any activities related to the proposed project.

To increase stream flows, Alternatives 1 and 2 consider options that would allow the OID to use more water from the Okanogan River rather than Salmon Creek and thus allow flows[1] to be retained in Salmon Creek. Alternative 1 involves construction of a new pump station along the west bank of the Okanogan River to substitute Okanogan River water for Salmon Creek water used in irrigation. Alternative 2 evaluates upgrading the existing OID Shellrock pumping plant along the Okanogan River to allow the OID to withdraw more water from the Okanogan River. Under this alternative, OID would convert the Shellrock facility from supplementary use to serve as its primary source. Alternative 3 presents a proposal to purchase water rights from the Okanogan Irrigation District in order to maintain water in Salmon Creek.

To improve the lower Salmon Creek stream channel, Alternative 1 would remove the gravel bar at the mouth of the creek. Alternative 2 includes full rehabilitation of the lower 4.15 miles of Salmon Creek, with complete reconstruction of the channel along 0.25 miles.[2] Alternative 3 does not include channel rehabilitation.

All three action alternatives include improvements to the feeder canal and headgate that delivers water from the North Fork of Salmon Creek to Salmon Lake.

Alternative 1 is the preferred alternative of the OID and CCT. This alternative would implement the following actions to allow Salmon Creek streamflows to remain in the creek and improve anadromous fish passage:

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[1] Flow requirements for salmon and steelhead are expressed in cubic feet per second (cfs). Salmon engage in different activities in each season (e.g., spawning, rearing, wintering, and migration), and these life stages or activities require different amounts and timing of flows. Aggregating these flows over the course of a year yields a total volume of water (expressed in acre-feet) needed to meet life history requirements. The term “flow” is used in discussing the specific instream flow needed at a particular point in time (cfs), and “flow volume” is used in referring to the aggregate amount of water required.

[2] The proposed rehabilitation described under alternative 2 has been developed from initial concepts presented in the *Conceptual Rehabilitation Plan for Lower Salmon Creek, Washington* (ENTRIX 2002)

- ♦ Construction of a new 80 cfs pump station for the OID utilizing water from the Okanogan River, including construction of approximately 2 miles of new pipeline from the new pump station to the OID main canal.
- ♦ Replace the Salmon Lake feeder canal and headgate with a combination of buried pipeline and embedded pipeline in the canal to increase flow capability from 30 cfs to 90 cfs.
- ♦ Remove the alluvial fan at the mouth of Salmon Creek, which is impeding fish passage. Approximately 530 feet of the channel would be excavated. Excavation of the gravel and cobble deposits would require an excavator and/or backhoe within the dry channel and off road dump trucks to transport excavated sediment to an adjacent staging area.

Alternative 2 would implement the following actions to allow Salmon Creek streamflows to remain in the creek and improve anadromous fish passage:

- ♦ Upgrade the existing OID Shellrock pumping plant to allow more water to be pumped from the Okanogan River. There are options on the sizing of new pumps dependent on further design of the upgrade.
- ♦ Build a new pipeline from Shellrock to a sediment basin in the main canal to lessen the amount of sediment delivered in the water to Diversion 4 users.
- ♦ Replace the Salmon Lake feeder canal and headgate with a combination of buried pipeline and embedded pipeline in the canal to increase flow capability from 30 cfs to 90 cfs.
- ♦ Stream rehabilitation in the lower 4.3 miles of Salmon Creek, including a combination of site-specific treatment of eroding stream banks, constructing a low-flow channel, floodplain reconnection, and reestablishing riparian vegetation. Full channel rehabilitation would modify the lower channel shape and size and decrease the minimum streamflow required for adequate fish passage.

Alternative 3 would involve:

- ♦ Purchase 5100 acre-feet of OID water rights for Salmon Creek to allow the water that is subject to these rights to remain in Salmon Creek.
- ♦ Replace the Salmon Lake feeder canal and headgate with a combination of buried pipeline and embedded pipeline in the canal to increase flow capability from 30 cfs to 90 cfs.
- ♦ No rehabilitation of the lower 4.3 miles of Salmon Creek.

Alternative 4 is the No Action Alternative. Under the No Action Alternative:

- ♦ No flows would be provided for steelhead or chinook passage in lower Salmon Creek. The lower creek would continue to be dewatered in most years, and OID would continue to divert its irrigation water supply under existing water claims from its existing diversion dam at RM 4.3 on Salmon Creek, supplemented in dry years by pumping from the Okanogan River at Shellrock.

- The Lower Salmon Creek channel would not be rehabilitated and neither steelhead nor chinook salmon would be able to pass through the lower 4.3 miles of Salmon Creek in most years to reach the high quality habitat in middle reach of Salmon Creek. No additional infrastructure improvements, including the Salmon Lake feeder canal are expected to be undertaken.

All of the action alternatives would meet the primary goals of providing necessary stream flows for fish and protecting the irrigation district's ability to provide water to users. Alternative 1 would provide the most water for irrigation at approximately 16,165 acre-feet. Alternative 2 would provide 14,425 - 15,225 acre-feet, and Alternative 3 would provide 9,972 – 10,679 acre-feet. Although Alternative 1 is the OID and CCT's preferred alternative, they would like the size of the pump station to be re-evaluated to determine whether a smaller station at a smaller cost would provide the needed amount of water.

Alternatives 1 and 2 would exchange water from the Okanogan River for water to be left in Salmon Creek. This would decrease Okanogan River stream flows below the respective pump stations down to the confluence with Salmon Creek. Shellrock is located further upstream than the proposed location for the new pump. There would be slightly increased chance of not meeting WAC minimum flows in the Okanogan River, which could potentially impact some water rights holders in that stretch of the Okanogan River between the pump and the confluence with Salmon Creek.

The median lake levels in Conconully Reservoir and Salmon Lake would be higher in all three action-alternatives, with Alternative 1 providing the biggest boost to minimum and median lake levels. Alternative 2 would maintain the median level of the lakes at a higher level, but the minimum lake elevation would be lower between February and June. Alternative 3 would provide a slight boost in median and minimum lake levels.

Increased flows in lower Salmon Creek would provide a source of cool water entering the Okanogan River, providing refugia in the Okanogan River near the mouth of the creek for fish migrating upstream during the warm summer months. Alternative 2 provides the best passage and habitat for fish in the long term, largely due to the stream rehabilitation component.

Alternative 2 would create the highest amount of short-term environmental impact, mostly because of construction that would be needed for stream rehabilitation. Both alternatives 1 and 2 would require the construction of a pipeline, a sediment pond, and the feeder canal. Alternative 1 would have a larger construction footprint at the site of the pump station, however, the overall amount of ground disturbance would be highest for Alternative 2. Alternative 3 would have a relatively low amount of ground disturbance. The amount of potential impact to riparian vegetation and wetlands is highest in the short term for Alternative 2. However, in the long-term, Alternative 2 would end up with an increased amount of riparian vegetation and wetland areas if the rehabilitation were successful. Directly correlated with impacts to the ground and vegetation are impacts to wildlife, cultural resources, visual quality, and water quality.

Alternative 3 would have the least cost in the short term to meet desired goals for fish passage. However, the loss of revenue to the county would be over $4 million per year. Approximately 1,460 acres of farmland would revert back to non-irrigated uses. Alternatives 1 and 2 would require substantial investment to provide the needed water for fish passage, but would have no impact on county farmlands and revenues. It is not known what the cost would be of choosing the No Action Alternative, as there is an unknown cost associated with any future requirement to provide passage for endangered or threatened fish under the Endangered Species Act. There would be a requirement for the public sector to cover any additional costs associated with extra pumping needed for Alternatives 1, 2, or 3.

Tables 2-10 and 2-11 at the end of Chapter 2 provide a complete comparison of the potential impacts and mitigation measures of the various alternatives and the outcomes that each of the alternatives would have towards the stated purposes for this project.

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1.0 INTRODUCTION / PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

The Bonneville Power Administration (BPA) proposes provide some funding towards activities that would restore sufficient water flows to Salmon Creek and rehabilitate its streambed as necessary to provide adequate passage for summer steelhead (*Oncorhynchus mykiss*) and possibly spring chinook (*O. tshawytscha*). The Upper Columbia River steelhead Evolutionarily Significant Unit (ESU) is listed as endangered under the Endangered Species Act (ESA). While an Upper Columbia River spring chinook ESU has also been listed, the Okanogan River and its tributaries were not included as part of this ESU because spring chinook are considered to be extirpated (locally extinct) from this watershed.

Both steelhead and spring chinook are known to have historically occurred in Salmon Creek. However, habitat for these species in Salmon Creek was greatly affected in the early 1900s by the construction of two dams: Conconully Dam, constructed by the U.S. Bureau of Reclamation (BOR) on the upper reaches of Salmon Creek in 1910, and the Okanogan Irrigation District (OID) diversion dam on the lower reaches of Salmon Creek in 1916. Since these facilities were constructed, the lower 4.3 miles of Salmon Creek downstream from the OID diversion dam has been (and continues to be) typically dewatered under normal irrigation operations, except during high runoff years that result in uncontrolled spill at the reservoirs and diversion dam. In addition, channel geometry, streambank stability, and riparian and aquatic habitat values of the lower 4.3 miles of Salmon Creek have been adversely affected in the last 80 years by a variety of conditions, including altered streamflow regimes, adjacent land uses that have altered vegetation and sediment production, and direct manipulation of streambanks and riparian vegetation.

These conditions have significantly degraded the lower 4.3 miles of Salmon Creek and deposited substantial sediments at the mouth of the creek, which has largely precluded fish migration into Salmon Creek from the Okanogan River. Summer steelhead now rarely use Salmon Creek, although this species is occasionally observed in the creek during high water years, and WDFW has been stocking the creek with steelhead hatchery smolts for several years.

1.2 PURPOSE AND NEED FOR ACTION

1.2.1 UNDERLYING NEED FOR ACTION

The OID is the prime user of water in Salmon Creek for the irrigation of 5031 acres of agriculture land owned by its 617 members and has a keen interest in protecting its withdrawal water right in Salmon Creek. The District also recognizes that the listing of the Upper Columbia River ESU summer steelhead as endangered under the ESA by NOAA Fisheries created an obligation to comply with the ESA. The OID has a need to investigate opportunities to enhance or restore summer steelhead runs while retaining and protecting its existing water rights to assure viable District operations. The Colville Confederated Tribe's (CCT) interest in pursuing restoration of anadromous fish runs in the Okanogan and Columbia Rivers has given rise to a unique opportunity for the CCT and OID to pursue a joint study of this project. A cooperative approach will help to avoid expensive litigation over ESA compliance.

BPA's need for action arises primarily from its statutory obligations. BPA is responsible for protecting and conserving listed threatened and endangered species under the ESA of 1973, as amended. By funding a project that would increase endangered summer steelhead use of Salmon Creek, the proposed project would assist BPA in fulfilling its responsibilities under the ESA.

The proposed action also is needed to allow BPA to meet its obligations under the Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act). This Act places a responsibility on BPA to protect, mitigate, and enhance fish and wildlife affected by the development, operation, and management of Federal hydroelectric facilities on the Columbia River and its tributaries. Mitigating and enhancing anadromous fish populations and habitat are of particular importance. To accomplish this goal, the Northwest Power Act established the Northwest Power Planning Council, recently renamed the Northwest Power and Conservation Council (Council), and required the Council to develop and adopt a program for fish mitigation and enhancement. BPA is required to take this program and its recommended projects into account to the fullest extent practicable when exercising its responsibilities related to the hydroelectric system on the Columbia River and its tributaries. One of the projects recommended by the Council under its program is the Salmon Creek Project. The project was proposed to the Council by a partnership between the CCT and OID. BPA's funding of this project would assist BPA in meeting its need to take the Council's program into account to the fullest extent practicable.

In addition, the Northwest Power Act requires BPA to undertake its mitigation and enhancement responsibilities in a manner that provides "equitable treatment" for fish with the other purposes for which the system is operated. This obligation may coincide with, but is independent of, BPA's obligation to take the Council's program into account to the fullest extent practicable. Actions taken to increase instream flows and rehabilitate fish habitat in the lower reaches of Salmon Creek would allow the passage of summer steelhead and spring chinook and would increase the amount of spawning and rearing habitat available for use by species in the Okanogan River Basin. Thus, the project would assist BPA in fulfilling its equitable treatment mandate under the Northwest Power Act.

BPA recognizes that a trust responsibility derives from the historical relationship between the Federal government and the Tribes as expressed in Treaties, statutes, Executive Orders, and Federal Indian case law. BPA and the CCT will work cooperatively to arrive at an understanding of how the trust responsibility applies to the proposed actions.

BPA would not likely be the only source of funding for project activities. Funding would likely be needed from additional entities to implement any decision requiring multiple actions for the improvement of salmon habitat and access in the Salmon Creek basin.

1.2.2 PURPOSES

BPA has identified the following purposes (i.e., goals or objectives) for the proposed action:

- Provide adequate passage in Salmon Creek for summer steelhead.
- Protect the ability of the OID to provide water delivery to its users.
- Maximize efficiency in water use.
- Achieve administrative efficiency and cost-effectiveness.
- Avoid or minimize adverse environmental impacts.
- Achieve local community and landowner acceptance and support.

1.3 AGENCY ROLES AND DECISIONS TO BE MADE

1.3.1 BONNEVILLE POWER ADMINISTRATION (BPA)

Because BPA would be a primary potential funding source for portions of the proposed project, BPA is acting as the lead agency under the National Environmental Policy Act (NEPA) for this Environmental Impact Statement (EIS). Once the final EIS (FEIS) is completed, BPA must decide whether or not to fund activities related to the proposed project.

1.3.2 BUREAU OF RECLAMATION

The U.S. Department of the Interior, Bureau of Reclamation (BOR) constructed and owns all of the water storage facilities in the Salmon Creek watershed. BOR has the authority to undertake a feasibility study concerning water resource management opportunities in the Salmon Creek basin. BOR is not a lead agency under NEPA for this EIS, but it could make a decision and issue its own Record of Decision (ROD) based on the FEIS for the project. BOR may decide to fund a portion of this project. BOR therefore is acting as a cooperating agency under NEPA. BOR may adopt the analysis included in the FEIS in part or in whole, with or without modification or supplementation, to meet BOR's requirements for a feasibility study and associated NEPA compliance or for NEPA compliance on other activities carried out by BOR in the basin, such as modifications to the Salmon Lake Feeder Canal or upgrading OID's existing Shellrock pump station.

1.3.3 WASHINGTON DEPARTMENT OF ECOLOGY

The Washington State Department of Ecology (Ecology) is responsible for management of water rights within the State of Washington. If the need for a decision related to water rights results from the proposed project, Ecology would have to ensure that it meets the requirements of the Washington State Environmental Policy Act (SEPA). Either the OID or Ecology, acting as lead agency for the project under SEPA, must make a threshold determination under SEPA guidelines prior to adoption of a plan to proceed with the project or to issue a permit to authorize it. This NEPA EIS could be adopted by the SEPA lead agency as part of the State's environmental review if it determines that the NEPA EIS satisfies all or part of its responsibilities to prepare an EIS or other environmental document.

1.3.4 Colville Confederated Tribes (CCT) and Okanogan Irrigation District (OID)

The CCT, in cooperation with the OID, are sponsoring this project proposal. The CCT and OID are acting as cooperating agencies under NEPA for the EIS. Both parties have contributed to the environmental analysis process and would be the primary organizations seeking funding to implement any decisions that are made. The OID would be the primary organization that would operate and maintain any new facilities integrated into the irrigation district infrastructure or implement any new actions affecting distribution of water within the district, but would not be responsible for any operations or maintenance costs over and above its current budget for pumping Okanogan River water associated with new facilities or actions.

1.4 SCOPING AND IDENTIFICATION OF ISSUES

NEPA procedures require public scoping for an EIS. Scoping refers to a time early in the NEPA process when the public can help define the scope and significance of issues that should be considered in an EIS. While there are distinct points during preparation of an EIS that require public notification and input, public involvement is an on-going process.

For this project, the public scoping process began with a Notice of Intent to prepare a NEPA EIS that was published in the Federal Register on February 4, 2002. The close of the comment period was March 8, 2002.

A mailing list was developed consisting of landowners within 300 feet of Salmon Creek, landowners around Conconully or Salmon Lake, as well as others who expressed interest in the project. Several hundred public notices were mailed in early February 2002 to the people and organizations on this mailing list. A fact sheet that described the proposed project and related actions was included in the public mailings.

Public and agency scoping meetings were held in Okanogan, Washington on February 21, 2002 and in Wenatchee, Washington on February 22, 2002. These were “open forum” meetings to encourage participation and dialogue with the attendees. BPA mailed letters to the public and agencies, including a project map, comment form, and reply card inviting them to attend these scoping meetings. Ads were placed in the Omak Chronicle on February 13 and 20, and Wenatchee World on February 13 and 17. The ad was also used as a flyer that was distributed to residents in Conconully. In addition, residents of Conconully were telephoned to inform them of the public meeting. Approximately 75 people attended the public scoping meeting on February 21, and 15-20 agency representatives attended the agency scoping meeting on February 22.

In addition to these scoping meetings, many informal meetings that included presentations and solicitation of issues and comments were held with local, state, and federal agencies, landowners, irrigators, and other members of the public. A Rehabilitation Oversight Committee (ROC) was established to further provide opportunities for members of the public and agency representatives to be involved in the design of the rehabilitation of the stream. Meetings were held with the ROC on April 18, 2001; January 14, 2002; and March 21, 2002. Additional meetings have been held throughout the process.

Comments from the public scoping meetings in Okanogan and Wenatchee were recorded on flip charts. BPA also provided forms on which comments could be written and sent to BPA. Public notices that were mailed and advertised in newspapers provided persons to contact, telephone numbers, e-mail addresses, and mailing addresses. BPA compiled all of these comments and entered them into a database that was used to fine-tune alternatives and focus the analysis of environmental effects.

The majority of the public comments were questions regarding water resources, impacts to the economy, and the need for the project. Some public comments were supportive, noting the potential for positive impacts to recreation and the economy if local labor pools are used to implement the project. Concerns were expressed with regard to the cost of the project and any increases in assessments for property owners and irrigators. Water rights and property rights were major concerns.

Agency scoping comments also included water rights, and technical questions regarding the design and the process. Agencies such as Ecology, Washington Dept. of Fish and Wildlife (WDFW) and the Environmental Protection Agency (EPA) provided comments toward the project.

The Northwest Power Planning and Conservation Council (Council) sponsored two separate reviews of the project through its advisory panels. The issues raised by the Independent Scientific Review Panel, in its most recent review of the Salmon Creek Project for the Council in March 2002, were also raised during scoping and are addressed in this draft EIS (DEIS). A review by the Independent Economic Advisory Board for the Council also made some recommendations. The issues and recommendations raised by these reviews include:

- Temperatures in the Okanogan River exceed 80 degrees at times, which is unsuitable for salmon.
- The project needs a monitoring and evaluation plan.
- Concerned about the total cost needed for a return of an unspecified number of fish.
- Restoration of this stream would take an extensive effort and considerable resources.
- Efforts may be better directed towards summer/fall chinook, sockeye, or the recently reintroduced coho salmon that appear to be less habitat limited.
- A permanent water bank would improve the cost effectiveness of the project.

- Increased water supplies and water saved through improved efficiency should not be used to increase the amount of irrigated acreage in the OID.
- Detailed operations plan for Salmon Creek storage facilities should be developed and approved by OID, CCT, and the Council. Salmon Creek operations should be clearly defined for years when supplies are insufficient, such as in drought years.

2.0 DESCRIPTION OF THE ALTERNATIVES

2.1 OVERVIEW

This chapter describes the alternatives analyzed in detail in this EIS, as well as alternatives considered but eliminated from detailed study. All of the action alternatives meet the purpose and need for this project, and components of these alternatives could be funded by BPA. There are three methods considered in these alternatives for improving fish passage: 1) increasing stream flows in lower Salmon Creek, 2) improving the lower Salmon Creek stream channel, and 3) improving the Salmon Lake feeder canal. To increase stream flows, Alternatives 1 and 2 consider options that would allow the OID to use more water from the Okanogan River rather than Salmon Creek and thus allow flows[1] to be retained in Salmon Creek. Alternative 1 involves construction of a new pump station along the west bank of the Okanogan River to substitute Okanogan River water for Salmon Creek water used in irrigation. Alternative 2 evaluates upgrading the existing OID Shellrock pumping plant along the Okanogan River to allow the OID to withdraw more water from the Okanogan River. Under this alternative, OID would convert the Shellrock facility from supplementary use to serve as its primary source. Alternative 3 presents a proposal to purchase 5100 acre-feet of water rights from the Okanogan Irrigation District in order to maintain water in Salmon Creek. To improve the lower Salmon Creek stream channel, Alternative 1 would remove the gravel bar at the mouth of the creek. Alternative 2 includes full rehabilitation of the lower 4.15 miles of Salmon Creek, with complete reconstruction of the channel along 0.25 miles.[2] Alternative 3 does not include channel rehabilitation. All three action alternatives include improvements to the feeder canal that delivers water from the North Fork of Salmon Creek to Salmon Lake. Alternative 4 is the No Action alternative, under which BPA would not fund any activities related to the proposed project.

Sections 2.2 through **2.5** describe the alternatives considered in detail in this EIS. Alternatives considered but eliminated from detailed study are discussed in **Section 2.6**. **Section 2.7** provides a comparison of the alternatives.

2.2 ALTERNATIVE 1

Alternative 1 is supported by the OID and CCT as their preferred alternative. BPA has not identified its preferred alternative. Alternative 1 would implement the following actions to allow Salmon Creek streamflows to remain in the creek and improve anadromous fish passage:

- Construction of a new 80 cfs pump station for the OID on the Okanogan River,

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[1] Flow requirements for salmon and steelhead are expressed in cubic feet per second (cfs). Salmon engage in different activities in each season (e.g., spawning, rearing, wintering, and migration), and these life stages or activities require different amounts and timing of flows. Aggregating these flows over the course of a year yields a total volume of water (expressed in acre-feet) needed to meet life history requirements. The term "flow" is used in discussing the specific instream flow needed at a particular point in time (cfs), and "flow volume" is used in referring to the aggregate amount of water required.

[2] The proposed rehabilitation described under alternative 2 has been developed from initial concepts presented in the *Conceptual Rehabilitation Plan for Lower Salmon Creek, Washington* (ENTRIX 2002)

- Replace the Salmon Lake feeder canal and headgate,
- Remove the alluvial fan at the mouth of Salmon Creek.

2.2.1 OKANOGAN RIVER WATER EXCHANGE

Under Action Alternative 1, the OID would receive a portion of its water supply for irrigation use from a proposed new pump station on the Okanogan River. By diverting water from the Okanogan River rather than Salmon Creek, natural flows would be retained in Salmon Creek storage reservoirs and released to the creek as needed to provide passage and overwintering flows. The new pump station would consist of the following three facilities:

- An 80 cfs pump station located on the west bank of the Okanogan River, upstream of the confluence of Salmon Creek;
- A pipeline from the pump station to Diversion 2 on the OID main canal; and,
- A water filtration system located near Diversion 2 to remove sediment from the river water.

2.2.1.1 Pump Station

The new pump station would be located on the west bank of the Okanogan River about 1.25 miles upstream of its confluence with Salmon Creek, within the limits of the City of Okanogan (**Figure 2-1**). The pump house would contain pumps, motors, control centers, valves and related equipment. Removable roof hatches allow for repair and maintenance. This location requires noise abatement, and a concrete block pump house building would be designed to mitigate noise. The building would be climate-controlled with temperature-activated louvres for air circulation. It is assumed that the existing Shellrock pump station would be removed from service under this alternative.

A bathymetric survey of the Okanogan River bottom at this location indicates the presence of a sand bar on the outside bend of the river and a deep hole on the inside bend. Pump intakes would be located over the deep hole. Because State Route 215 runs adjacent to the river and confines the river channel at this location, the deep hole and sand bar are expected to remain in their present locations.

Preliminary geotechnical investigations (URS, 2002) led to a decision to locate the pump station away from the river bank to avoid potential conflicts with stream meander, erosion and sedimentation. The floor of the pump station would be placed above the elevation of the 100-year flood described on available Federal Emergency Management Agency (FEMA) maps. The bank would be shaped and protected from erosion by such methods as boulder and timber armoring or gabion baskets. The topographic survey indicates that the pump intakes can be submerged at this site. The City of Okanogan confirms that the site is properly zoned for use as a pump station and that easements and rights-of-way either exist or can be obtained.

Screens for the intake pipes would be placed in a part of the river channel with a relatively stable bottom. Mat gabions would be placed under the screens to prevent streambed erosion. Piles would be driven into the streambed in front of the screens to prevent damage from floating

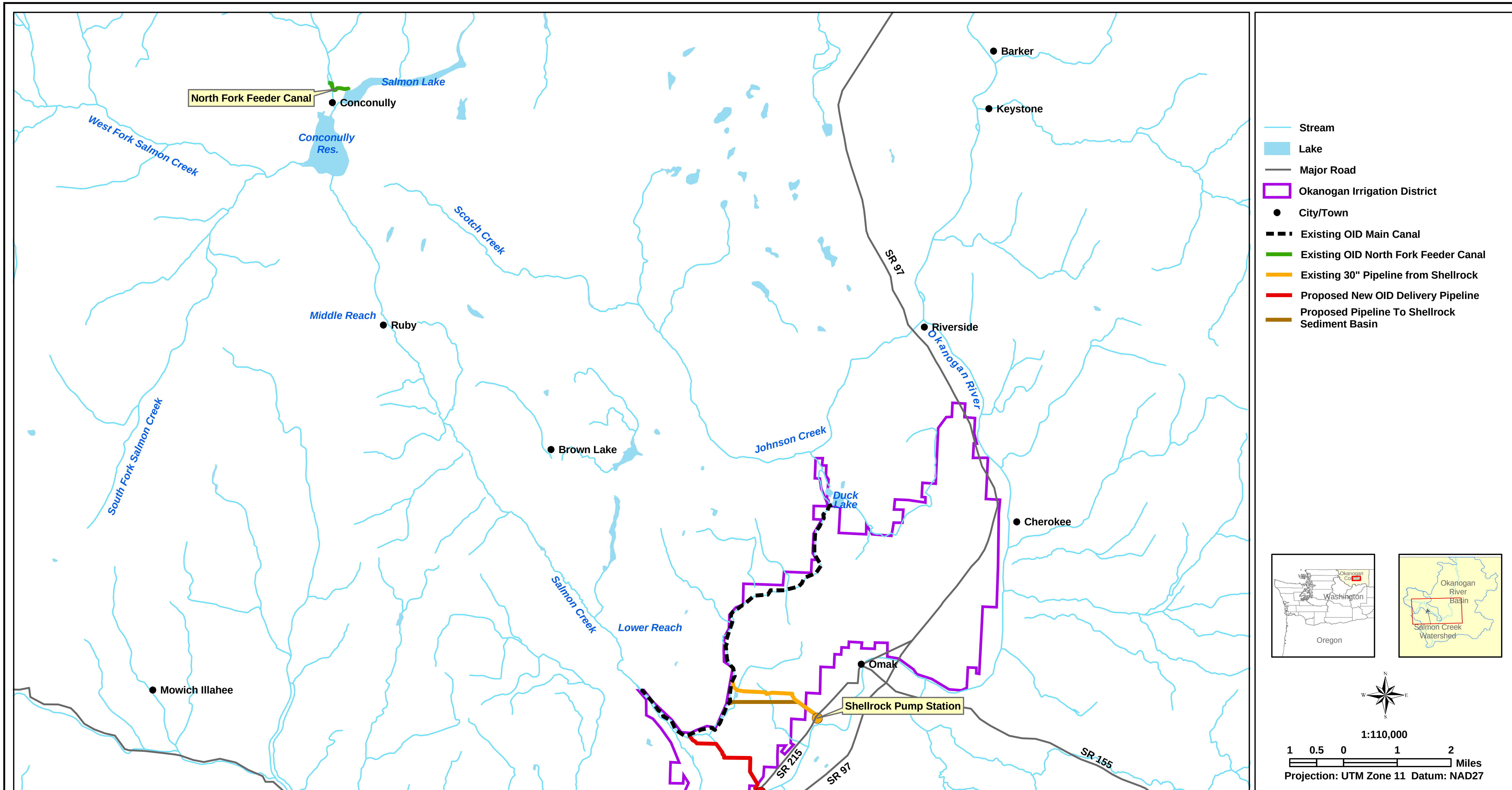

Figure 2-1
Regional Basemap

C:\GIS\entrix\SalmonCreek1\map\SCrk_RegionalBasemap04.mxd 5/24/2004 6:04:13 PM Mukhtyar debris. Activated wedge-wire drum screens were selected for the preliminary design because of their reliability, low maintenance, low capital cost, and proven effectiveness in properly screening juvenile and adult anadromous fish without damage. NOAA Fisheries screen criteria for the protection of anadromous fish were used for the selection of the screens (URS, 2002).

The intake manifold was designed to transfer water from the screens to vertical caissons in which vertical turbine pumps would be placed. The proposed intake structure consists of a four-foot vertical wall made of rock gabions through which the intake manifold protrudes. The cylindrical wedge-wire screens are mounted on the ends of the protruding manifold pipes.

It is estimated that 7,000 horsepower would be required to lift 80 cfs from the river to the OID main canal. The pump station design incorporates six 1,000 hp pumps (1,770 rpm operated from 4,160-volt electric motors) and two 500 hp pumps (1,770 rpm operated from 480 volt electric motors). Each pump would be placed in a vertical caisson connected to the river with a horizontal intake manifold and fish screens.

2.2.1.2 Pipeline

The proposed pipeline route (**Figure 2-1**) is approximately 10,630 feet (about 2.0 miles) long. It follows County roads and existing federal rights-of-way and easements over most of its length. The route crosses State Route 215 from the pump station site and proceeds over flat, undeveloped land. It then rises up a 25-percent grade to Pogue Flat, on the top of a 340 foot high slope. It continues north along Conconully Road and west on Glover Road to the Diversion 3 pump station, then crosses orchard land to terminate at Diversion 2. Approximately 85 percent of the route lies on Pogue Flat, which has a 1.5 percent grade.

The proposed pipeline would be a 48-inch diameter spiral welded steel pipe. A standard concrete outlet structure would allow water to flow from the pipeline into a sediment pond upstream of Diversion 2 and then into the OID main canal with minimal turbulence. Air vacuum release valves and drain valves along the pipeline would allow it to be emptied after the irrigation season and would provide an escape for trapped or entrained air during refilling and operation. The pipeline would be buried at least seven feet deep, with a one-foot layer of bedding material underneath and at least three feet of cover for frost resistance and pipeline protection. To accommodate this design, an eight-foot trench would be excavated.

2.2.1.3 Water Filtration System

Water samples taken from the Okanogan River at Malott (RM 17, approximately 10 miles downstream of the pump station site) show that during high flows the water is murky and has total suspended solids (TSS) levels that are too high for irrigation use.[3] The volume of sediment appears to be highest during May and June.

An airburst would be used to remove debris from the intake screens. Because scour velocity around intake screens is expected to be seasonally high, the accumulation of sediment at the screens is expected to be low. Periodic sediment removal would require mechanical methods such as backhoes, draglines, or suction pumps.

A sediment pond and a filtration system would be located near Diversion 2 on the OID main canal. The OID canal itself would also serve as a sediment basin. Secondary removal of larger remaining particles would be accomplished by self-cleaning filters located along the canal. Effluent from the backwash cycle at the filter stations would either be returned to the canal or captured in a dosing tank for return to the land by sprinklers.

2.2.1.4 Water Supply Operations

Under Action Alternative 1, the construction of the new pump station would help OID to satisfy its irrigation water requirement in part from the Okanogan River, leaving 5,100 acre-feet in Salmon Creek storage reservoirs to provide flows for fish passage and overwintering. This volume of water would be retained in Conconully Reservoir or Salmon Lake, to be released as needed for passage and overwintering flows. A water system model has been used to examine interactions between pumping, irrigation, instream flows, and storage (see **Section 3.1** and **Appendix C**). This alternative takes advantage of opportunities to pump early in the irrigation season when Okanogan River flows are high and releases water from storage in the late season low-flow periods. No operation of the existing Shellrock plant is assumed under this action alternative. This action alternative would be able to deliver water to 4,670 acres (all areas served by diversions 2-5), or 93 percent of OID lands. There would be no critical period shortages (deficit irrigation) under this alternative.

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[3] Monthly monitoring data collected by the Washington Department of Ecology at the Malott long-term monitoring station (approximately 15 miles downstream from Salmon Creek) show consistent sedimentation problems. Suspended solids data have been collected since 1978. Under most flow conditions, the Okanogan River has higher suspended sediment and total suspended solids (TSS) concentrations than Salmon Creek. In 1990, suspended solids ranged from 1 to over 400 mg/L, with the higher values typically in the 50 to 150 mg/L range (see Section 3.2 and Ecology 1995). Washington has no standard for TSS; the standard for turbidity in Class A waters reads "Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU." Data on background turbidity at this location were not available. As discussed in Section 3.2, the standard may be exceeded annually.

2.2.1.5 Water Rights

OID currently relies on Salmon Creek, Johnson Creek, Duck Lake, and the Okanogan River as sources of supply. Each source has some type of water right claim or certificate associated with it.

OID Salmon Creek water rights may be transferred from one surface source (Salmon Creek) to another (Okanogan River). There is no prohibition in state law against changing a water right from one surface water source to another so long as the two sources are related in some way (this condition is met by the fact that Salmon Creek is tributary to the Okanogan River). Action Alternative 1 would require transferring the point of diversion for at least 45 cfs of OID water rights from Salmon Creek to the Okanogan River, and would use up to the full 35 cfs of existing OID Okanogan River water rights to allow diversion at the new pump station site in the instantaneous and annual quantities required. The transfer of Salmon Creek water rights to a point of diversion on the Okanogan River would be accompanied by a determination by Ecology of an equivalent amount to be dedicated to instream flows in Salmon Creek. The expectation is that this water would be retained in storage for release to provide passage and overwintering flows.

The season, place and purpose of use would probably remain unchanged on the transferred water rights, however Ecology would review the validity of OID's water rights as part of the transfer process and this could change the amounts of the water rights. **Table 2-1** lists OID water rights. See **Section 2.3.1.6** for further discussion of the use of OID's existing Okanogan River water rights.

Water Right Changes

Ecology may consider changes to the following elements of an existing water right permit, certificate, or claim:

- Place of use
- Point of diversion or withdrawal
- Additional point(s) of diversion or withdrawal
- Purpose of use

Table 2-1. Okanogan Irrigation District Water Rights and Claims.

Certificate or Claim	Source	Priority	Instantaneous Quantity	Annual Quantity	Notes
Certificate #55	North Fork Salmon Creek	"not given" (filed April 6, 1926	all flows in excess of 1.33 cfs	not stated	"After Class 1 rights have been filled.," April 15 - Sept 30
Claim #88353	North Fork Salmon Creek, Conconully Reservoir	May, 1888	90 cfs	35,000 acre-feet	Storage and diversion, March 1- October 31
Claim #88354	West Fork Salmon Creek, Conconully Reservoir	May, 1888	90 cfs	35,000 acre-feet	Storage and diversion, March 1- October 31
Claim # (unknown)	Salmon Creek	May, 1888	8 cfs	2,920 acre-feet	Natural stream flow developing below Conconully dam
Claim #88352	Ophir Mining Claim Spring	1897	70 gpm	14 acre-feet	Continuous, domestic purpose
Adjudicated Certificate #75	Johnson Creek	1919	15 cfs	not stated	After Class 7 rights have been filled. (7.74 cfs)
Adjudicated Certificate Record No. XIX, page 16	Duck Lake	August 23, 1918	20.0 cfs (likely reduced to 10 cfs for non-use)	6,356 acre-feet	Supplemental to other OID rights
Orders DE 85-20, DE 95WR-C139	Duck Lake Ground Water Management Subarea	NA	10 cfs	2,700 acre-feet	Artificially stored groundwater
Certificate #384	Okanogan River	July 3, 1926	3.0 cfs	not stated	Change application in process
Certificate #357	Okanogan River	July 3, 1926	7.0 cfs	not stated	Change application in process
Certificate #466	Okanogan River	January 22, 1930	15 cfs	not stated	WDOE questions OID interest
Claim #089802	Okanogan River	1915	10 cfs	1,214 acre-feet	April-October, change in process

Certain aspects of a water right document[4] cannot be changed, such as increasing the withdrawal rate or annual quantity of water currently permitted. The change applicant may be an entirely different person than the one who originally applied for the water right (for example, some of OID's water rights were originally obtained by the Bureau of Reclamation).

Generally, a water user may only change the portion of a water right that has actually been put to beneficial use. In some cases, provisions clarifying when water can be used, based on availability, are added when changing a water right. Undeveloped portions of a water use described within a water right certificate (or claim) generally do not represent a water right and may not be changed or transferred. Water rights may be entirely, or partially, relinquished if the water has not been used for a period of five or more years. The process of quantifying the extent to which a water right is eligible for change is known as a "tentative determination of extent and validity." Ecology is required to make the tentative determination when it makes its recommendation on an application to change any water right under RCW 90.03.380.

Decisions on an application for a change of water right (commonly referred to as a change application) must pass the following legal test:

- The change, as requested, would not impair any existing rights or pending applications (this would include minimum instream flows established by rule).

Ecology considers the following factors when trying to determine a potential detriment or injury to existing rights:

- The change would not increase the instantaneous or annual quantity of water used.
- The water right is eligible to be changed, and has not been abandoned or relinquished for non-use.
- The source of water would not change (e.g., new wells must tap the same aquifer).
- The change would not expand the water right.
- The change would not increase the consumptive use of water.

Changing an existing water right does not change the original priority date. A priority date is the date assigned to a water right based on the date Ecology or a predecessor agency received the original water right application. In the case of vested rights (water rights that pre-date the state's water right laws), the priority date is when water was first put to beneficial use. This date determines the seniority of the water right within a watershed.

[4] Water right documents include certificates, permits, and claims. A permit is issued by the Department of Ecology when it approves a water right application. The permit allows water to be put to beneficial use within a certain period of time. When this has been accomplished a water right is said to be "perfected" and a certificate is issued allowing use to continue in perpetuity. Some water use preceded the State's water code; for such use, a "claim" may be filed (during periods when the claims registry was open) asserting the right to continue historical use. Some of OID's water rights are embodied in certificates or permits, others are claims.

As described above, Ecology would conduct a tentative determination of OID's Salmon Creek water claims in considering an application to transfer a portion of these rights to the Okanogan River. The tentative determination has the potential to lead to other changes, such as in the amount of water considered perfected under the claim and the rate of application of irrigation water per acre considered reasonable.

Ecology must consider detriment or injury to all other potentially affected water rights in approving a change. No impairment to other water rights is allowed. Minimum instream flow rights are among the rights that cannot be impaired, and these have been established by Ecology for the Okanogan River with a 1984 priority date.

Minimum Instream Flows

Alternative 1 assumes that pumping from the Okanogan River is unrestricted by minimum instream flows (this is also true for Action Alternative 2). Regulatory review of an application to change OID water rights would need to analyze whether OID Okanogan River water rights would be interruptible when minimum flows on the Okanogan River are not met. Ecology may waive the instream flow requirement only if it determines that it is in the "overriding public interest" to allow pumping from the river that conflicts with the minimum instream flow.[5] This would require further detailed environmental analysis during the permitting stage. Although pumping under these alternatives would reduce the flow of the Okanogan River whenever irrigation pumping exceeds Salmon Creek return flows, on an annual basis withdrawals should approximate return flows. The net effect would be to replace warmer, sediment-laden Okanogan River with cool, clear water from Salmon Creek. This tradeoff is the basis for the expectation that "overriding public interest" could be demonstrated for pumping at times when Okanogan River minimum flows are not met. Other scenarios under which minimum instream flows would not restrict pumping include:

- If other Okanogan River operations were curtailed when Okanogan River flows are below the minimum set by rule; and,
- If modeling during the permitting stage identifies operation scenarios that avoid conflicts during periods when minimum instream flows are not met on the Okanogan River.

Biological Opinion Regarding Downstream Flow Effects

Both alternatives that pump from the Okanogan River (Alternatives 1 and 2) will shift the timing of flows in the Okanogan and Columbia. Although water pumped for irrigation will be replaced

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[5] Regulatory review of proposed changes to OID water rights would be completed following this EIS if an application is submitted to the Washington Department of Ecology to change OID water rights. An impairment analysis would be conducted by Ecology to determine whether the change would affect any other water rights. The question of overriding public interest would be settled at that time, and could result in conditioning OID's Okanogan River water rights to be interruptible when minimum instream flows established by rule are not met on the Okanogan River. As part of that regulatory proceeding, Ecology also would determine the validity of the District's Okanogan River water certificates and will make a tentative determination regarding OID's Salmon Creek water claims. If water rights are found to be invalid or if recent use cannot be demonstrated to perfect the full water certificates or water claims, then OID may need to obtain new Okanogan River water rights. These water rights could be conditioned by Ecology to be interruptible when minimum flows are not met in the Okanogan River.

by flows released for fish passage and overwintering in Salmon Creek, the fish flows will occur in a different pattern than the irrigation pumping. Therefore, project operation could affect Columbia River flows at times when flow targets may not be met under the current Biological Opinion (BiOp).[6] The involved federal agencies will need to review these effects as part of a Biological Assessment to be conducted for the Salmon Creek project after NEPA review and selection of a preferred alternative. NOAA Fisheries will determine, in consultation with other federal agencies, whether the benefits to listed species offered by the Salmon Creek project offset the potential effects on the timing of flows in the Columbia River with regard to existing BiOp targets. The results of this determination may require the patterns of irrigation pumping and fish flow release schedules to be altered.

2.2.2 FEEDER CANAL UPGRADE

This component of Alternative 1 would involve repairing a deteriorated feeder canal that serves the Salmon Lake storage reservoir and to improve water management flexibility. Salmon Lake, the uppermost of the two storage reservoirs maintained by OID above the middle reach of Salmon Creek, is a storage reservoir with a storage capacity of 10,500 AF. It is situated in a small basin to the east of the North Fork of Salmon Creek and is filled by a feeder canal that delivers water from a diversion in North Fork Salmon Creek (**Figures 2-1 and 2-2**). Because Salmon Lake receives very little runoff from a small basin, the feeder canal is critical to filling this reservoir and to the ability to manage flows in Salmon Creek for fish. Salmon Lake releases water as controlled discharge to Conconully Reservoir.

The Salmon Lake feeder canal's size and condition constrain the flexibility of water management for Salmon Lake and the entire system. The feeder canal is approximately 3,715 feet (0.7 miles) in length, and was constructed in 1920. It is located northeast of the town of Conconully.

The feeder canal requires repair. Canal capacity is designed at about 90 cfs, but OID operates it at 30 cfs due to concerns regarding the potential instability of the slope along the alignment and debris that accumulates in the canal. The potential instability of the canal could affect the safety or property of those living below it if the canal failed or was overtopped by an accumulation of soil and vegetation debris in the canal.

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[6] The BiOp for the Federal Columbia River Power System (FCRPS) describes the U.S. Fish and Wildlife Service and NOAA Fisheries' determinations as to whether proposed actions will jeopardize species listed as threatened or endangered. The BiOp prepared for the FCRPS provides operating parameters for the U.S. Army Corps of Engineers (Corps), the Bureau of Reclamation (Bureau), and BPA in the operation of Federal dams on the Columbia River.

Figure 2-2 Existing Salmon Lake Feeder Canal

For approximately 40 percent of its length the canal passes near residences, some as close as 50 feet away. The toe of the slope in which the canal is built is adjacent to many back yards. Large cracks have been observed in the concrete lining of the canal (Dames & Moore, 1999; URS, 2002).

Salmon Creek Phase 1 and Phase 2 reports considered replacing the feeder canal with a buried pipeline along the canal alignment (Dames & Moore, 1999) or upgrading the existing canal and its inlet structure so that it can operate safely at its design capacity (URS, 2002). The Bureau of Reclamation (2003) completed a feasibility study for upgrading the feeder canal and developed preliminary construction cost estimates for a design with a 90 cfs capacity. Replacement of the canal with a pipe would help to control and prevent soil erosion. A pipeline would not be as susceptible to damage from soil slides along the upslope as the open channel. The pipeline would eliminate in-channel erosion and reduce water seeping into the down slope soils. It would protect public health by removing an open canal hazard in a residential area. Additionally, the pipeline would restore the capacity of the feeder canal to fill the Salmon Lake storage reservoir and thereby prevent its impairment.

BOR would replace approximately 3,700 feet of the open channel of the Salmon Lake Feeder Canal for the OID with high-density polyethylene (HDPE) black plastic pipe. BOR would install a 48-inch pipe along two-thirds of the canal, and a 42-inch pipe for the remaining one-third of the canal, with an approximate capacity of 90 cfs. Preliminary plans call for removing the existing canal and burying the pipe in the existing alignment for approximately 40% of its length. The next 35% of the length of the canal would have the pipeline bedded in the existing channel with soil cement and capped with shotcrete for protection from falling rock and vandalism of the pipe. The final 25% of the pipeline would leave the existing alignment and run in a straight line to the groin of the Salmon Lake Dam, where it would be completed with a energy dissipation device that would direct water about 200 feet upstream of the face of the dam. The last section of the existing canal alignment would be abandoned in place. The most probable design for the energy dissipation structure would be a concrete flume with multiple steps to reduce water speed and energy. Work at the inlet to the canal would include raising the level of the creek to allow for greater flow. This would be accomplished by placing rock weirs across the creek below the canal intake. It is estimated that about six such structures would be required in the 200 feet downstream of the intake. Some work may be required on the current culvert under the road such as an increase in the size of the pipe.

This action would save a small amount of water lost from canal leakage (estimated to be about 36 acre-feet per year), but more importantly, it would allow more flexible operations for fish and agriculture.

This component is included in all of the action alternatives.

2.2.3 SALMON CREEK MOUTH REHABILITATION

This alternative would involve rehabilitating the mouth of Salmon Creek by removing the coarse sediment that has accumulated that presents a barrier to fish passage (**Figure 2-3**). Approximately 530 feet of the channel would be excavated. Excavation of the gravel and cobble deposits would require an excavator and/or backhoe within the dry channel and off road dump trucks to transport excavated sediment to an adjacent staging area. A 110-horsepower screening plant would be temporarily sited on the staging area to sort sediment by particle size. A loader would be used to move and stockpile the sediment on-site. The active construction period is estimated to last about 3 weeks.

Pre-construction activities would include preparation of the staging area and screening plants, and clearing and grading of an access route into the channel. Erosion and sediment control fencing would be placed and maintained throughout construction to prevent releases of sediment and/or turbid water to the Okanogan River. An excavator will be used to reconfigure the low flow channel for fish passage and reshape the toe of banks. Upon completion of excavation, the coarsest materials that have been screened, sorted and stored would then be placed along the toe of the bank and within the channel to help define the low-flow fish passage channel. Vegetation would be planted along streambanks that have been disrupted by earth moving equipment during the construction phase. Re-vegetation areas would be supplied with seasonal temporary irrigation for 1-2 years until roots are able to utilize groundwater and the plants are established and can survive dry summer months.

While rehabilitation of the mouth is a key component of improving fish access from the Okanogan River to Salmon Creek, initial sediment removal may need to be followed by re-treatment periodically. Without rehabilitating the rest of the lower Salmon Creek stream channel, redeposition of gravel, cobble or fines near the mouth could occur as future high flow events transport material eroded upstream.

2.2.4 COSTS

2.2.4.1 Construction Cost Estimates

A detailed cost estimate for the pump station facilities prepared by URS (2002) totals $7.3 million dollars.

ENTRIX estimates that the cost for implementing the design approach described above for initial sediment removal would be $64,000, including construction and soft costs. This cost estimate does not include potential costs of future re-treatment, if needed to address erosion and sedimentation that could occur after future high flow events. The cost assumes that the channel work area will be dry and no dewatering or dewatering related water quality mitigations would be required. This cost also excludes cost associated with obtaining access to the adjacent potential staging area.

Figure 2-3. Area of Excavation of Coarse Sediment Deposition at Mouth of Salmon Creek.

Cost estimates for the feeder canal replacement range from $1.3 M to $2.3 M.

2.2.4.2 Operation Cost

Additional pumping costs (above the level of pumping required for the No Action Alternative) associated with Alternative 1 are estimated to be approximately $284,393 per year (see **Section 3.8.3**).

Potential re-treatment of the mouth rehabilitation could be required a couple of times over the life of the project, but if annualized, the cost would likely not exceed $4,000.

2.3 ALTERNATIVE 2

Alternative 2 would implement the following actions to allow Salmon Creek streamflows to remain in the creek and improve anadromous fish passage:

- Upgrade the existing OID Shellrock pumping plant to allow more water to be pumped from the Okanogan River,
- Build a new pipeline from Shellrock to a sediment basin in the main canal,
- Replace the Salmon Lake feeder canal and headgate,
- Stream rehabilitation in the lower 4.3 miles of Salmon Creek

2.3.1 UPGRADE SHELLROCK PUMPING PLANT

The OID operates the Shellrock pump station on the Okanogan River, 3.2 miles upstream of the confluence with Salmon Creek (**Figure 2-1**) (the rights-of-way for the pump house and pipeline are owned by the federal government). Shellrock is currently operated by OID as a supplemental supply, to meet irrigation demand during droughts when supply from Salmon Creek is inadequate. The station has a nominal capacity of 24 cubic feet per second (cfs), however OID owns water rights on the Okanogan River amounting to 35 cfs. Under this water supply action alternative, the Shellrock plant would be upgraded to take the full existing OID Okanogan River water rights as a supplementary source of water supply.

2.3.1.1 Existing Infrastructure and Operation

The Shellrock plant was commissioned in early 1978. It is an outdoor, reinforced concrete, wet-sump type pumping plant with four vertical turbine pumps. The pump station diverts water from the Okanogan River near the town of Okanogan, and pumps to the OID system and main canal, providing water to diversions 4 and 5 (which together serve approximately 78 percent of OID irrigated lands). The plant is typically operated during the irrigation season between April and October when needed to supplement flow from the Salmon Creek basin. The plant was designed to provide an output of 24 cfs with three equivalent pumps operating and a fourth pump as a backup. Often only two units are required to meet demand. During wet years, the pump station may not be used at all. Reviews of the Shellrock facility were conducted in October 2002 by the Montgomery Water Group (MWG) and in July 2003 by the BOR. The results of these reviews are summarized below; for a detailed description of the Shellrock facility, refer to BOR (2003).

The Shellrock plant service yard is relatively small and is constrained by Okoma Drive on the west, the Okanogan River on the east, and a private residence on the north. The pump motor deck is at elevation 841.18 feet, one foot above the recorded high-water elevation measured for the 100-year flood. The plant and discharge line were designed to deliver 25 cfs to the upper main canal. There are two gated openings on the river side of the structure and one gated opening about the same size on both the upstream and downstream sides of the structure.

The facility's fish screen was replaced in 2003 with a traveling water screen. The screen can be raised for maintenance by a manually operated hoist. The upstream and downstream side-gated openings produce a sweeping flow across the front of the fish screen.

Directly downstream from the concrete opening for the fish screen are located four vertical turbine pumps. Each pump has a 12-inch discharge line with check valve and butterfly valve that manifolds into a 30-inch main discharge line. Water is conveyed from the pump station to the OID Upper Main Canal via a cement mortar-lined, 30-inch diameter, ductile iron pipe, approximately 10,100 feet long. Diversion 4 laterals serving 925 acres are supplied from this pipeline prior to water reaching the main canal. The ground surface elevation where the main pipe ends at the canal is approximately 1,354 feet.

The Shellrock Pump Station currently experiences significant bedload and suspended sediment accumulation in the sump. Measured accumulation has been reported to be three feet or more. The sediment creates three major problems: (1) Volume of the sump is decreased, (2) sediment brought into the pumps causes damage to the impellers, bearings and seals, and (3) water being delivered to the consumers contains high sediment loads. Sediment may also deposit within the pipes and canals of the irrigation system, thus reducing system capacity. Currently water users on diversion 4 are filtering the sediment from the water at point of delivery, however at certain times of the year this process can require frequent (hourly) filter replacement.

It is likely that the current configuration of the plant is contributing to the sediment problem by creating hydraulic conditions that are conducive to sediment deposition. The Okanogan River tends to deposit sediment at the face of the plant's intakes. Velocities upstream and downstream of the intakes are very low, which create a depositional zone at the intakes. Also, the entrance into the sump is low with respect to the riverbed. Drawings of the current configuration show the floor of the sump at an elevation of 811.18 feet with a front sill rising one foot from the sump floor. This configuration encourages deposition of bedload material into the sump because of its low elevation with respect to the bed of the river.

OID reports that the existing intake for the Shellrock plant is located such that it is unable to obtain sufficient water for the full pumping capacity of the plant at extremely low Okanogan River levels. This was not evaluated by MWG in 2002, but Action Alternative 2 assumes that, as part of the upgrade, the intake would be relocated such that it does not constrain the plant from pumping at full capacity during any season.

BOR's review of the facility recommended the current overall system capacity should be limited to 23 cfs at low river water surface elevation 818.18 feet to meet fish agency criteria, and 24 cfs when the river level at the plant is above elevation 818.43 feet based on the following criteria:

- The plant and discharge system was designed to deliver 25 cfs to the Upper Main Canal [1].
- The existing transformer is too small for simultaneous operation of the four pumping units. Total rated discharge capacity with only three units running is approximately 25 cfs.
- The existing air tank borders on being on the small side for 25 cfs flow (a small negative pressure downsurge may occur at one high point location in the discharge pipeline).
- Using the NOAA Fisheries fish screen approach velocity criteria for fry-sized salmonids of 0.4 ft/s, and an assumed effective screen area of 58 ft^2 for the existing traveling screen at low river water surface elevation of 818.18 feet, the pumped flow from the existing plant should be limited to approximately 23 cfs. For a pumped flow of 24 cfs, an effective screen area of 60.0 ft^2 is required which equates to an approximate minimum river water surface elevation of 818.43 feet.
- Measured pump performance data provided by the Okanogan Irrigation District (OID) indicate an average pump capacity of only about 7.91 cfs (3,550 gpm) at a discharge pressure of 555 feet (240 psi). Single unit operation should produce about 9.47 cfs (4,250 gpm) depending on the river water surface elevation. This implies that unit pumping capacity is being reduced by additional head loss somewhere in the system (i.e., excessive impeller wear due to abrasive sediment erosion or cavitation, sediment in the plant or discharge line, or a combination of factors). Based on the measured pump performance, estimated current unit capacity is approximately 8.0 cfs, and the total capacity of the existing plant with three units operating is approximately 24 cfs.

2.3.1.2 Requirements to Upgrade to 35 cfs

The following modifications were identified that would improve system performance and increase system capacity to 35 cfs. Each is discussed in more detail below.

- Modify plant intake to reduce sediment load entering the sump.
- Modify plant to make it easier to remove accumulated sediment from sump.
- Increase fish screen area to permit 35 cfs at low river water elevation 818.18 feet.
- Modify or replace pumping units and motors to increase total capacity to 35 cfs.
- Replace power transformer to permit concurrent four-unit operation.
- Replace surge tank to protect existing discharge line during 35 cfs operation.
- Eliminate the delivery of sediment-laden water to diversion 4 water users.
- Identify a plan for backup pumping should one of the pumps fail.

Intake Modifications to Reduce Sediment in Sump

Two solutions were identified to reduce sediment in the sump. The first solution is to improve the hydraulic conditions at the face of the plant by constructing concrete wing walls at the upstream and downstream sides of the plant. The existing pump station intake projects out into the river and creates dead water, areas with low water velocities, and eddies around the intake. Construction of upstream and downstream wing walls that are flush with the front of the intake would prevent areas of low velocity and optimize conditions for a sweeping flow at the face of the plant.

The second solution is to modify the intake by raising the concrete sill of the gated openings as high as possible to reduce/prevent bedload from entering the intake. Bedload is the portion of sediment transported by the river, which maintains frequent contact with the bed by rolling, sliding or bouncing along the riverbed and is comprised of larger sized sediment. The maximum sill elevation is controlled by fish screen approach velocity criteria at low river water elevations. Sediment that is transported above the bed in suspension is referred to as suspended load. Although raising the sill would prevent or reduce bedload from entering the sump, suspended sediment would still enter it. Depending on sediment size and plant operation, the suspended sediment would be pumped through the pipeline, deposited within the pipeline, or deposited in the sump. Suspended sediment is smaller than bedload and should create fewer problems for the pumps and water users. It is possible that over time the bed of the river would aggrade to the new elevation of the sill. However, the sweeping flow anticipated at the face of the plant due to the construction of the wing walls is expected to prevent this from occurring.

The modified intake would also include silt barrier gates in front of the trashracks, similar to the existing installation, which should be lowered to prevent sediment and debris from entering the intake during non-pumping times. Past underwater examinations have reported that the existing silt barrier gates could not be fully lowered due to sediment and bedload deposits in front of the intake. The new plant intakes could be provided with an embedded spraybar in the silt barrier gate sills to keep sediment from building up below the gates and preventing their closure. Piping for the high pressure spray water would be similar to the spray water piping used for the traveling water screens and installation costs would be minor compared to other modification costs.

Plant Modifications to Facilitate Sediment Removal From Sump

Based on the existing siting and operation of the plant, it must be assumed that some sediment would be deposited in the sump and annual or bi-annual cleaning of the sump would be required. Past sediment removal operations using a dredge or cone-type separator have taken too long and cost too much.

The modified pump station would split the existing common sump shared by all four units into two separate sumps each with two units. Provisions for dewatering each side of the sump separately would be provided so that total plant shutdown is not required to maintain the sumps. Stoplogs and guides would allow dewatering and clean out of sediment within the sumps. It is assumed that the stoplogs would be stored in the yard and lowered into the guides with a mobile crane.

The current Reclamation design for upgrading Shellrock does not include a sedimentation pond to reduce turbidity in water delivery to irrigation, however it is assumed that a such a facility will be required in order to provide acceptable water quality.

Intake Modifications to Improve Fish Screening

The existing traveling fish screen for the Shellrock Pump Station provides sufficient screen area to meet NOAA Fisheries salmonid fry criteria for flows up to approximately 23 cfs at the assumed low water surface elevation of elevation 818.18 feet. Additional screening area would be required for the pump station flow to be increased to 35 cfs while maintaining the same criteria. The required effective screen(s) area for a flow of 35 cfs should be not less than 87.5 ft^2.

The two modified plant intakes would use the existing continuous belt traveling water screen in one bay and place a similar continuous belt traveling water screen in the other bay. The traveling screens would be positioned closer to the trashracks to eliminate the need for upstream and downstream gated openings to create required sweeping velocities across the screens. Moving the screens forward also would reduce the area downstream of the trashracks where fish may hold, and the close proximity may create hydraulic conditions that the fish would find undesirable, making it less likely that they would enter the intake.

The sill below the trashracks would be raised to elevation 813.58 feet, at or close to the same elevation as the top of the stainless steel drum located at the bottom of the traveling screens. With two screens, the concrete sill below the traveling screens can be raised to elevation 812.58 feet while still providing sufficient screening area to meet approach velocity criteria at the low water surface elevation of 818.18 feet. The existing concrete invert at the pumps would remain at elevation 811.18 feet. By having two independent screen/pump bays (each bay with one screen and two pumps), there should be better hydraulics leading to the pumps and also a better uniform flow through and across the screens. The upstream and downstream wing walls would also improve the sweeping flow at the face of the intake, which should benefit fish protection.

The existing continuous-belt traveling water screen is cleaned by high-pressure spray water. The spraybar is located just below the top drive roller and above the top of the upstream trashrack opening, which results in debris being sprayed off the screen directly into the upstream concrete wall above the trashracks. This arrangement can cause debris to be recycled between the trashracks and the screen and not carried away by the river. The modified intakes would position the spraybar for the traveling water screen(s) above the normal river water surface elevation of 821.18 feet, but below the top of the trashracks, elevation 824.18 feet. The debris then has a chance of being sprayed back through the trashracks where the river can carry it downstream and away from the screen(s). The upstream and downstream wing walls would also improve the sweeping flow at the face of the intake, which should improve debris removal.

The existing trashracks are welded to the embedded steel seat framework. As part of the modified intakes, new trashracks and embedded seats would be provided. The new trashracks would be similar to the existing racks, except they would be designed to be removable by bolting rather than welding the trashrack panels to the embedded seats. The trashracks and seats would also be designed to realign the upstream face of the trashbars to allow the new silt barrier gates to better carry their loadings into the trashracks and make them easier to clean.

The modified plant would be provided with monitoring equipment to measure three water surface elevations: 1) upstream of the trashracks; 2) between the trashracks and the traveling screens, and 3) downstream of the screens. This would allow OID to determine water level differentials across the trashracks and screens so they can assess rack and screen operation and cleaning requirements.

Modifications to Pumps, Motors, Piping and Valves

A major concern in upgrading the pump station to 35 cfs capacity using is the expected increase in pressure that the existing 30-inch ductile iron discharge pipeline would experience. An increase in head loss from the original design with increased flow directly relates to an increase in pressure in the pipeline, which affects its pressure carrying capability under the new operating conditions. BOR (2003, 2004) studied a range of system head losses to identify probable modifications to existing equipment.

There are three upgrading schemes to attain a total plant capacity of 35 cfs. The first two are based on four pumps operating simultaneously to provide the 35 cfs. With all four pumps operating, it would be necessary to increase the design capacity and adjust the associated design head of all four pumping units. In order to minimize unit modifications and reduce associated costs, existing equipment would be reused wherever possible or upgraded, where necessary. One option is based on reusing the existing 800-hp motors and the second on installing new 900-hp motors. The choice depends on the actual overall pumping head. Both of these options would include the purchase of one vertical-turbine pumping unit and a 900-hp motor and storage at an existing warehouse near the OID office to serve as a backup unit. The third upgrading scheme provides for installing four new pumps at the Shellrock Pump Station such that three pumps operating simultaneously could meet the 35 cfs design discharge and the fourth pump would serve as an on-site backup pump. Variable-speed pumps were not considered by BOR because of their anticipated costs and maintenance complexities.

Option 1 - Reuse Existing 800-hp Motors.

It appears the capacity of the existing pumps can be upgraded by changing the impeller diameter for the existing bowl assemblies to achieve the required pumping flow capacity and head. For this option, only the pump impellers would have to be redesigned and replaced; the bowl assemblies could be reused. The first stage or bottom impeller would be replaced with an impeller designed for low-NPSHR (Net Positive Suction Head Required) design. The remaining four impellers would be redesigned to match the new flow capacity and operating head requirements.

This option would require the purchase and storage of an off-site backup pump. The pump would have a rated capacity of 9.35 cfs (4,200 gpm) at a total dynamic head (TDH) of 628 feet. A 15-ton mobile crane would be included to permit easy replacement of the failed pumping unit. The mobile crane would be sized to remove the motor first, then the complete pump and column.

Option 2 – Replace Existing Motors with New 900-hp Motors.

Should the actual head loss in the system be determined to be higher than can be accommodated by the existing pumps, larger impellers for the existing 5 bowl assemblies would be required to provide the nominal 35 cfs capacity. The impellers would be designed similar to Option 1, but new 900-hp motors would be needed to provide the required flow at this higher system head. Keeping the motor upgrade to 900 hp enables reuse of the existing stainless steel line shaft size, which would be cut to length and re-threaded depending on its condition. Alternatively, the line shaft section between the top impeller/bowl assembly and motor shaft coupling could be replaced in its entirety along with new line shaft sleeves and bearings.

Evaluation of the required pump setting from pump manufacturer’s data indicates there should be sufficient submergence for the new units when operating at a minimum river water surface elevation of 818.18 feet based on current intake design recommendations. It is recommended that the pump bell diameters be increased in order to reduce the velocity of the water entering the pump bowls over the expected range of pump flows, including runout of the pump when only single-pump operation occurs. Surface generated vortices reducing pump output capacity should not be an issue affecting pump performance at lower bell velocities. The current spacing of the units allows for adequate clearance between individual units and the adjacent sump walls using the larger diameter bells.

A special first stage impeller would be installed in the bottom or first bowl assembly. An impeller designed for the new flow and head conditions should be specified for the first stage to ensure that negative pressure does not exist, which can cause cavitation of the pump impeller, and to provide good flow characteristics into the remaining impellers in-line above it. The existing unit wafer check and butterfly valves are sufficient for the pressure that the new pumps would be putting out. Assuming that the manifold pipeline is schedule 30 carbon steel pipe or better, there would be a more-than-sufficient safety factor for the estimated higher operating pressure of the new pumps. It appears that the existing 4-inch and 2-inch air valves on the unit and manifold piping are sufficient for operation at the higher head of the new pumps. The valves would be replaced with higher pressure class air valves should the design head of the new units be found to exceed the pressure limits of the existing valves.

This option would require the purchase and storage of an off-site backup pump and crane as described in option 1.

Option 3 - Three Unit Pumping Plant Option

The existing four pumps and motors would be replaced with four units sized so three pumps operating simultaneously could meet the 35 cfs design discharge, and the fourth pump could function as a backup unit. The motors would have to be rated 1,250 hp if additional head loss in the existing pipeline at the new condition of 35 cfs (36.75 cfs with 5% wear factor) results in a total pumping head requirement greater than about 600 feet. If the pump tests recommended in **Section 2.3.1.4** determine that the actual head loss in the existing pipeline system is significantly lower than 600 feet, four motors with smaller horsepower ratings could be supplied to meet the rated operating conditions. The entire motor deck slab would be removed and replaced to accommodate the new pumps and motors.

Consideration was given to re-spacing the existing units and adding a fifth unit but it was determined that the existing sump is not wide enough to adequately accommodate 5 pumping units and still provide sufficient spacing between the units for performing maintenance activities. If the existing sump were enlarged approximately three feet, then up to 5 units (or 4 units + 1 spare) could be utilized to provide the 35 cfs pumping plant capacity required. However, the cost of expanding the sump appeared prohibitive so the 3 units + 1 spare option was developed.

Replacement of Power Transformer

The existing transformer is too small for simultaneous operation of the four pumping units. The existing transformer is rated at 2,500 kVA with secondary full-load current of 346 amperes at 4,160 volts. Each of the existing motors has a full-load current rating of 100 amperes for a total load of 400 amperes. The power transformer would be replaced with a new 3,750 kVA oil-filled transformer with suitable oil-containment provisions.

Replacement of Surge Tank

Assuming that the current maximum capacity of 25 cfs is delivered to the OID upper main canal, the velocity in the main pipeline would be about 4.83 ft/second. This velocity is within the typical range of velocities for pipelines. A change to 35 cfs would increase the pipeline velocity to 6.76 ft/second, still within the range of acceptable velocities for cement-mortar lined ductile iron pipe.

An important safety feature of the discharge line is the air tank located in the plant yard. Available information indicates that the air tank is a horizontal pressure vessel of minimum 2,500-gallon capacity. In the event of a power loss with all pumps operating, the air tank dampens the hydraulic shock for both down- and upsurge conditions. Downsurge occurs when the supply of water is suddenly cut off. Water momentum would tend to keep the pipeline flowing with water supplied from the air tank to the pipeline. Upsurge happens when the water starts to flow back toward the pump station and suddenly slams against the check valve. Air in the air tank dampens this upsurge.

An analysis of the potential effects of a power loss with water in the pipeline shows that at a flow of 35 cfs (and using the existing air tank), the downsurge at one high point in the discharge pipeline would be unacceptably low and there is a danger of "column separation." During column separation, the negative pressure creates a vacuum and the water column temporarily separates. When the column comes back together, the resultant internal pressure increase could exceed the rated pressure of the installed pipe, resulting in a pipe failure.

To protect the existing pipeline from excessive negative pressures, the existing air tank needs to be at least 2.5 times larger if the pumped flow is increased to 35 cfs. A larger standard size would be about 7,500-gallon (1,000 cu ft) capacity and the pressure rating would be the same as the existing tank. Air release and air filling settings would be about the same proportion as the existing tank.

Construction of a Sediment Basin

Water furnished from the Okanogan River contains high sediment loads that create problems at the Shellrock Pump Station and delivery points. There are proposed modifications at Shellrock Pump Station to reduce sediment accumulation problems in the sump, however to adequately address the sediment problems currently being experienced by the water district and water users, a sediment basin should be incorporated into the delivery system to remove suspended sediment.

The proposed action is to widen a portion of the Upper Main Canal to create a continuous flow-through sedimentation basin to settle out coarse sands after pumping but before delivery. The existing pipeline would be terminated via a blind flange below the lowest sub-lateral. At this point, a new pipeline would be constructed about 1,000 feet to the south of the existing line to convey river water to the sedimentation basin for cleanup (See Figure 2-1). After settling out particles, water would continue down the Upper Main Canal to Diversion 4 where gravity would furnish sufficient pressure to supply the deliveries on the existing main transmission pipeline between the canal and pump station in the same manner as present. No significant operational changes would be needed at the pump station or deliveries. That is, when delivery water is needed through pumping, only the route of the flow changes.

The Upper Main Canal sedimentation basin would be lined with a 6-inch reinforced concrete lining. An access ramp would allow motorized equipment to enter the basin during the off-season and remove sediment accumulations. Space for accumulation of sediment sludge is furnished by a 4-foot dropped canal invert. Transitions at each end of the basin bring it back to conformance with the existing canal invert and side slopes. Major items for the basin construction will be excavation, embankment construction, lining placement, and construction of a 30-inch diameter pipe inlet with safety racks. During final design, basin alternatives that would permit basin operation to continue during sediment removal operations (split basin), and use of existing OID equipment (trackhoe) to remove sediment accumulations could be considered. However, these features are not included in this proposed action.

2.3.1.3 Construction Considerations

Construction of the plant modifications assume that work could be accomplished during one irrigation season when the Shellrock plant is not needed and the maximum river water surface during construction is at or below elevation 822.0 feet. Modifications to the plant would require that it be dewatered. An earthen cofferdam with a sheetpile cutoff wall would be needed to channel river flows away from the plant during construction. Once the area between the cofferdam and plant is dewatered, the sediment deposits both inside and upstream of the plant would be removed.

Modification of the existing intakes would require removal of the upstream 11.75 feet of the plant to elevation 811.18 feet. It is assumed that diamond wire concrete cutting methods would be used to remove the concrete and provide sound concrete surfaces to attach the new concrete features. The concrete fillets in the existing sump would be removed by common chipping methods. Once demolition is complete, new reinforced concrete sump walls and motor deck slab would be placed. Reinforced concrete upstream and downstream wing walls would also be placed and backfilled with free-draining material.

After plant sump modifications are complete, the sheetpile cutoff wall and cofferdam would be removed and the cofferdam access ramp reclaimed.

2.3.1.4 Future Investigations and Studies

Further investigation would be required if modifications to the plant are to be implemented. These include:

- Conduct pump tests to confirm existing unit operation, flows and head loss through the system.
- Conduct a more detailed hydraulic study of the discharge line, including all turnouts and valve timing information to properly size the surge tank.
- Conduct a condition assessment of the existing pipeline and perform a detailed analysis of the maximum allowable pressure the existing pipeline can withstand.
- Determine as-built dimensions and elevations of the existing plant and equipment to verify that the plant was constructed in accordance with contract documents. Data developed during the 1996 topographic survey of the site indicate that the motor deck may be slightly lower than its design elevation (elevation 840.78 feet versus elevation 841.18 feet).
- Verify material and thickness of manifold piping.
- Assemble and analyze historical river data to verify appropriate minimum operating, normal operating, maximum operating, and 100-year river flood elevations. Develop a flood frequency curve.
- Conduct sediment sampling to identify gradation of sediment currently being deposited in the sumps. Also determine maximum particle size that can be pumped with nominal additional filtering from water users.
- Obtain geologic foundation data for the proposed cofferdam including soil sampling and determination of top of rock. Investigate dike material sources as well as alternatives to the earthen dam with sheetpile wall cutoff.
- Consider constructing and operating a physical model to better assess hydraulics around the modified intakes with regard to fish protection and sediment deposition.
- Compare benefits of locating stoplog guides downstream of the traveling screens (as proposed), upstream of the trashracks, or between the trashracks and the fish screens.
- Consider alternate impeller and bowl materials to improve resistance to sediment abrasion.

- Frequent four-unit operation of the outdoor plant may create noise levels that adversely impact the private residence located directly north of the plant. The current property owner has constructed a sound barrier using old tires between the plant and his residence. Consideration should be given to installing additional sound dampening features or enclosing the pump station.
- Verify with NOAA Fisheries that the modified intake meets their juvenile fish criteria or is an acceptable variance. Obtain variance if needed.

2.3.1.5 Water Supply Operations

Under Action Alternative 2, OID would satisfy its irrigation water requirement in part from the Okanogan River, leaving 5,100 acre-feet in Salmon Creek storage reservoirs to provide flows for steelhead and (with rehabilitation) chinook passage and overwintering. This volume of water would be retained in Conconully Reservoir or Salmon Lake, to be released as needed for passage and overwintering flows. A water system model has been used to examine interactions between pumping, irrigation, instream flows, and storage (see **Section 3.1** and **Appendix C**). At times when the District's water demand exceeds the instantaneous capacity of the Shellrock pumps, other sources (Salmon Creek, Duck Lake) would need to be accessed to supplement pumping from the Okanogan River. This action alternative would be able to deliver water to 3,927 acres (all areas served by diversions 4 and 5), or 78 percent of OID lands.

There would be critical period shortages (deficit irrigation) under this alternative. A critical period is defined as the sequence of years with the lowest runoff in the 99-year period of record used for water model simulation (1904-2002, inclusive). For a water supply source to be considered firm, it must provide a dependable supply of water during all in this period. The critical period includes 12 straight years (1922 to 1933 of below median runoff) and 10 years (1924 to 1934) when storage in Conconully and Salmon Lake reservoirs did not reach full capacity. It includes the three driest years on record (1929-1931), when aggregate runoff for the three-year period was 7,050 AF, or less than a third of the mean annual runoff of the creek.

Model results indicate that Alternative 2 would not meet firm supply requirements if this critical period were repeated. **Table 2-2** shows critical period shortages for Alternative 2 under conditions of weather and storage that existed from 1928-1933. Shortages were modeled to occur in one- to five-month periods in the four consecutive years from 1930-1933. The annual shortage was highest during 1931, the driest year. Shortages began as early as June (1932 and 1933) and lasted as late as October (1930-1932). A total of 14 months over four years were water-short. In eight months of the 1930-1933 period, shortages approached or exceeded 20 percent of OID monthly demand, and during October for three years shortages exceeded 25 percent and approached 30 percent. August shortages averaged 20 percent over the 1930-1932 period, and October shortages averaged 28 percent. In all other months and years, shortages were less than 10 percent of OID monthly demand. Depending on how one defines "critical

Table 2-2. Salmon Creek Critical Period Shortage v. OID Monthly Demand. Alternative 2: Upgrade Shellrock Pump Station.

Month	1928	1929	1930	1931	1932	1933
Critical Period Shortages (ac-ft)						
Jan	0	0	0	0	0	0
Feb	0	0	0	0	0	0
Mar	0	0	0	0	0	0
Apr	0	0	0	0	0	0
May	0	0	0	0	0	0
Jun	0	0	0	134	80	114
Jul	0	0	0	614	469	0
Aug	0	0	614	614	607	0
Sep	0	0	178	212	126	0
Oct	0	0	113	124	96	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Annual Total	**0**	**0**	**905**	**1698**	**1379**	**114**
Total OID Monthly Demand						
Jan	0	0	0	0	0	0
Feb	0	0	0	0	0	0
Mar	26	23	24	25	23	24
Apr	535	535	535	535	535	535
May	2072	2056	2056	2084	2142	2148
Jun	2340	2246	2282	2287	2201	2235
Jul	3220	2729	2943	2987	2735	2901
Aug	3377	2866	3044	3140	2884	3059
Sep	2474	2326	2382	2405	2298	2353
Oct	447	399	417	419	372	390
Nov	52	51	51	46	35	35
Dec	6	5	5	5	5	5
Annual Total	**14550**	**13236**	**13740**	**13935**	**13231**	**13686**
% of Total OID Monthly Demand						
Jan	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Feb	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mar	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Apr	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
May	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jun	0.0%	0.0%	0.0%	5.9%	3.6%	5.1%
Jul	0.0%	0.0%	0.0%	20.5%	17.2%	0.0%
Aug	0.0%	0.0%	20.2%	19.5%	21.0%	0.0%
Sep	0.0%	0.0%	7.5%	8.8%	5.5%	0.0%
Oct	0.0%	0.0%	27.2%	29.7%	25.9%	0.0%
Nov	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dec	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Annual Total	**0.0%**	**0.0%**	**6.6%**	**12.2%**	**10.4%**	**0.8%**

1928 was first year of drought - see annual runoff running mean plot period" (e.g., with reference to runoff below median, storage less than full, or the level of multiyear running mean total runoff) this alternative began to experience shortages in the third, sixth, or eighth year of the critical period drought. If a pump or motor were to fail, the District could experience a short-term immediate water loss with either of the off-site backup pump options. Extended down time could affect irrigation delivery and yield. Option 3, with the backup pump on-site, would operate similar to the way the system is currently operated should one of the pumps fail.

2.3.1.6 Water Rights

This alternative would not rely upon the transfer of District water rights from Salmon Creek, but would make use of existing OID Okanogan River water rights. It is reasonable for OID to increase the frequency of its Okanogan River pumping, within the limitations of its existing rights, if compelled to do so by the requirements of the ESA to address Salmon Creek fisheries (pers. comm., Bob Barwin, Department of Ecology).

Table 2-3 lists the Okanogan River water rights owned by the OID. The four rights total 35 cfs in instantaneous quantity. Annual quantities are stated for only one of the rights (1,214 AF).

Table 2-3: Okanogan Irrigation District Okanogan River Water Rights.

Certificate or Claim	Priority	Instantaneous Quantity	Annual Quantity
Certificate #384	July 3, 1926	3 cfs	Not stated
Certificate #357	July 3, 1926	7 cfs	Not stated
Certificate #466	January 22, 1930	15 cfs	Not stated
Claim #089802	1915	10 cfs	1,214 acre-feet

OID's existing Okanogan River water rights probably can be used for irrigation supply in lieu of Salmon Creek diversions. Changes to the points of diversion and, potentially, the places of use would be necessary. The histories of use of the certificates and claim listed in the table are somewhat complicated. Some rights relate to pump stations that are not located at the Shellrock site. These rights would require a relatively extensive evaluation of the history of use between the 1920s and 1970s (when Shellrock was constructed) in order to quantify the extent of use and annual quantity they represent.

Since the level of pumping at a given moment from the Okanogan River would very likely not match the level of flow returning to the river from Salmon Creek at the same moment, Okanogan River flows probably would be reduced at times under this action alternative. As discussed above (**Section 2.2.1.5**), it is assumed that pumping would not be constrained by minimum flow requirements on the Okanogan River, although regulatory review of an application to change OID water rights does have the potential of conditioning OID Okanogan River water rights to be interruptible when minimum flows are not met. If Ecology, in its determination of extent and validity, finds that OID's existing Okanogan River water rights are not sufficient to obtain 35 cfs, then the increment between their existing Okanogan River rights and 35 cfs would be subject to restrictions at times when minimum instream flows are not met. Ecology estimates that this would restrict pumping during August and September about one year in four.

2.3.2 FEEDER CANAL UPGRADE

Under this alternative, improvements to the feeder canal that delivers water from the North Fork of Salmon Creek to Salmon Lake would be the same as described for Alternative 1 (see **Section 2.2.2**).

2.3.3 LOWER SALMON CREEK FULL CHANNEL REHABILITATION

Full rehabilitation of the lower reach of Salmon Creek would be intended to facilitate fish passage by reestablishing more natural hydrologic and geomorphic stream processes in the channel downstream of the OID diversion dam. Efforts to increase streamflow and rehabilitate fish habitat in lower Salmon Creek would allow the passage of spring run chinook salmon and summer run steelhead to the middle reach, thereby increasing the amount of spawning and rearing habitat available to these species in the U.S. portion of the Okanogan River Basin.

Above the OID diversion, Salmon Creek is somewhat impaired but overall it is well defined and relatively stable. Site-specific stream bank treatment and voluntary changes in stream corridor land use have been recommended (NRCS, 1999; ENTRIX, Inc., 2002). The Natural Resources Conservation Service (NRCS) is leading stream rehabilitation efforts in the middle reach of Salmon Creek above the OID diversion, primarily using established programs for working with individual landowners.

This alternative includes various rehabilitation treatments that would be implemented in the lower 4.15 miles of Salmon Creek to enable fish access up to the middle reach. At many locations, a combination of site-specific treatment of eroding stream banks, constructing a low-flow channel, floodplain reconnection, and reestablishing riparian vegetation would sufficiently enhance channel and habitat conditions. Full channel rehabilitation would modify the lower channel shape and size and decrease the minimum streamflow required for adequate fish passage. This would reduce the total volume of water needed for fish passage and/or allow greater flow management flexibility.

2.3.3.1 Rehabilitation Recommendations

A *Conceptual Rehabilitation Plan for Lower Salmon Creek* has been developed to describe ways to improve local channel and habitat conditions (ENTRIX 2002), and preliminary design is progressing in parallel with the environmental review. Lower Salmon Creek has been split into four segments based on distinguishing characteristics, notably land use and channel condition (**Figure 2-4**), and each segments has different rehabilitation needs. At many locations, site-specific cut and fill of eroding streambanks would be used to reduce bank heights and angles, and in some select locations, reestablish a floodplain connection with the channel. Treatments will also include geo-technical and bio-stabilization bank strengthening measures, such as rock armoring of streambanks, construction of hard toe structures, geo-textile fabrics and

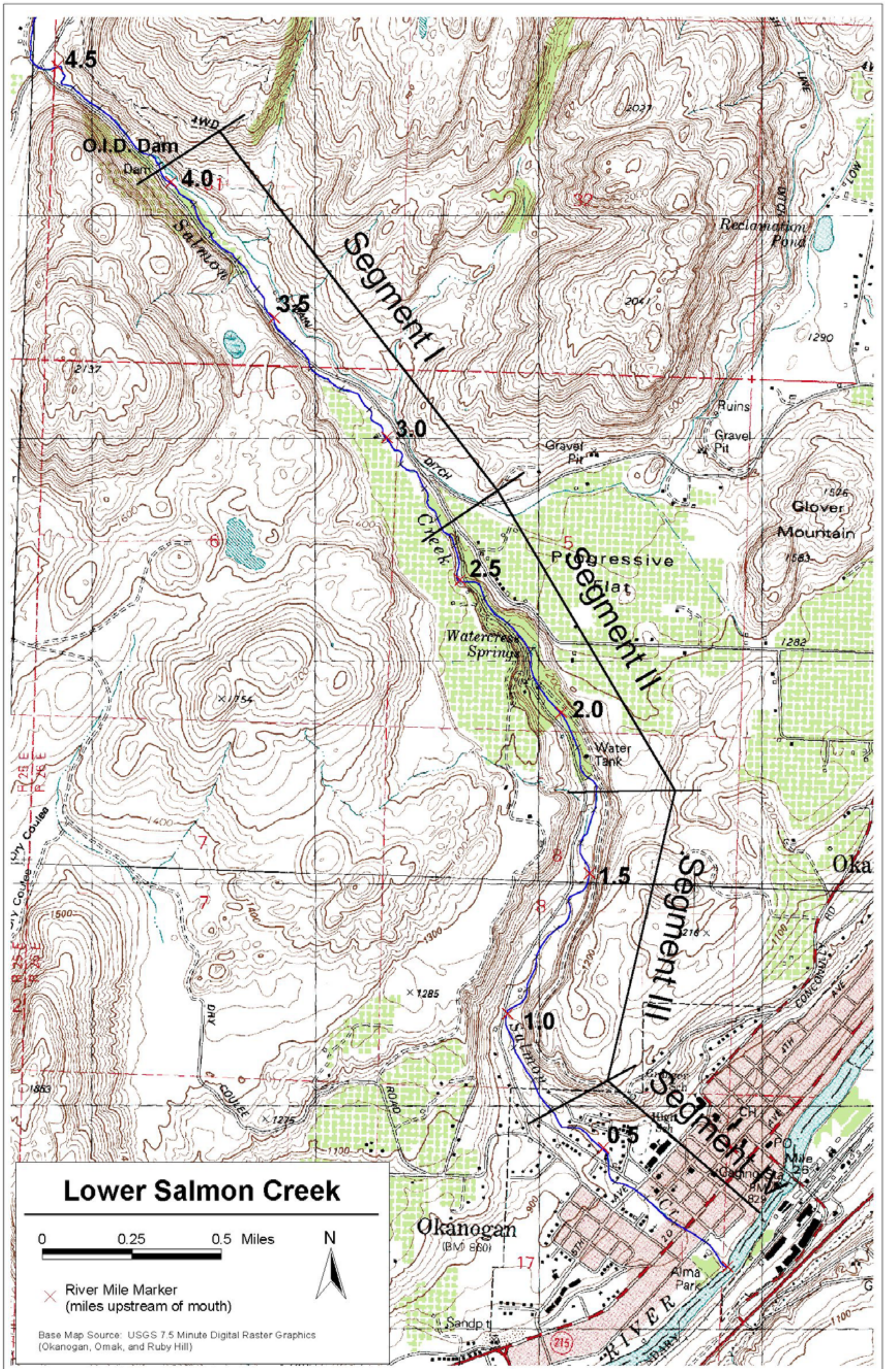


Figure 2-4. Lower Salmon Creek Segments.

revegetation, and land use management measures (e.g., livestock management, cultivation buffers). Complete reconstruction of both the streambed and streambanks is recommended in a portion of lower Salmon Creek, which can include realigning channel and modifying streambed features and local gradient. Channel design would reconfigure the bed geometry and substrate material in many places to diversify hydraulics and create resting areas and cover for migrating fish.

Under its existing condition, sand and gravel in the streambed surface of the lower 2 miles of Salmon Creek is minimal. Sand and gravel is mostly found beneath the coarse surface deposits of cobble and boulder, or infrequently, as small bars. Reconfiguring the channel to be more asymmetrical, and reducing peak flows by increasing floodplain storage, may increase the amount of sand and gravel stored in bars and floodplain features. However, a combination of steep channel gradients, and the fact that much of the channel will remain somewhat incised, means the dominant bed composition of the rehabilitated channel will still be dominated by cobble, with local areas of sand and gravel.

Table 2-4 describes the levels of treatment types that would be implemented in the full rehabilitation of lower Salmon Creek. The treatment types range from management-only (channel preservation) to full channel reconstruction. The treatment type that is applied to a particular section of the river depends on the existing channel conditions that are impeding fish passage riparian land use constraints and the expected long-term stability of the channel. For example, reaches designated for preservation already have adequate low-flow depths and suitable bed and bank stability to enable fish passage. In some reaches, recontouring the top of the bank/levee would provide floodwater storage areas for peak flows and reduce high flow stress on existing in-channel conditions. For other reaches, though, the channel is incising, the banks are unstable and eroding, and without preventative action, the channel will continue widening and flow depths for fish passage will remain minimal or inadequate. In reaches such as these, geo-technical (e.g. placement of large angular rocks at the bank toe, construction of rock walls) and/or bio-stabilization (e.g. grassy mats, willow staking, or other vegetation plantings) treatments will be implemented to stabilize the channel and prevent further degradation. The highest level of treatment, full channel reconstruction, is recommended for a couple of short reaches that are severely degraded and incised, overwidened, unvegetated, and have highly unstable banks. Full reconstruction of these channel sections will help ensure that long-term, low maintenance fish passage is met. All of the bank stabilization, flood plain reconstruction, and channel reconstruction efforts will work together to decrease sources of future channel instability and sediment to lower areas. Selection of the treatment type must also consider riparian land uses that may affect which treatments are suitable for a particular reach. This is especially important in treatments that call for reestablishing a floodplain connection, since this treatment is only viable where adjacent land use and landowner consent permits. All of the bank stabilization, flood plain reconnection, and channel reconstruction efforts work together to decrease sources of future channel instability and sediment to downstream areas. **Table 2-5** summarizes the amount of each type of treatment proposed by stream segment.

Table 2-4. Treatment Types to be Implemented in the Rehabilitation of Salmon Creek.

Treatment Type	Description of Recommended Treatment Activities/Features
Channel preservation	No direct action. Preservation of existing channel alignment, bank conditions, in-channel habitat, and floodplain areas.
Top of bank/levee recontouring	Locally remove artificially raised top of banks/levees to reestablish the channel's floodplain connection where consistent with adjacent landowner needs. No change to channel alignment or in-channel habitat. Assumes no net impact or export of material.
Bank protection	Use geo-technical and/or bio-stabilization materials to protect banks from erosive high flows. No change to channel alignment, in-channel habitat, or floodplain connection.
Bank protection and bed improvements	Use geo-technical and/or bio-stabilization materials to protect banks from erosive high flows and constrict low flow channel width. Use excavator to reconfigure bed geometry to create a low-flow channel for fish passage. No change to channel alignment or floodplain connection.
Bank, bed, and floodplain modification	Use geo-technical and/or bio-stabilization materials to protect banks from erosive high flows and constrict low flow channel width. Use excavator to reconfigure bed geometry to create a low-flow channel for fish passage. Use local cut and fill to contour portions of leveed or terraced banks to reestablish the channel's floodplain connection. No change to channel alignment.
Full channel reconstruction	Use geo-technical and/or bio-stabilization materials to protect banks from erosive high flows and constrict low flow channel width. Use excavator to construct a new channel along a new alignment, reduce channel width, and define a low-flow channel for fish passage. Use local cut and fill to contour leveed or terraced banks and construct a connected floodplain.

Note: Geo-technical includes actions such as placement of large, angular rock at the toe of banks, construction of rock walls, and geo-textiles.

Bio-stabilization includes re-vegetating with treatments such as plant staking and vegetation mats.

Segment 1

Segment 1 is 1.45 miles long and has a valley gradient of 0.8 percent. This segment provides pool/riffle habitat and adequate fish passage with streamflows of at least 10 to 15 cfs under existing conditions. This segment has high potential for reestablishing floodplain connection and providing floodwater storage areas that will attenuate peak flows downstream. About a third (0.55 miles) of Segment 1 has a well vegetated and stable channel that should be preserved (**Figure 2-5**). Between RM 3.9 and 3.3, the channel planform appears to have been straightened, but the riparian corridor is well vegetated. The recontouring of leveed banks in a portion of this reach would re-establish overbank flood processes and functions, and reduce high flow stress on the existing bed and banks. About 0.25 miles of this reach are recommended to have bank, bed, and floodplain modifications in areas that are incised or have experienced prior flood damage. All work in this segment is along private parcels and would require landowner support.

Segment 2

Segment 2 is 0.95 miles long with a steep upstream portion (3.6 percent) that is confined in a narrow valley. Rehabilitation of this segment would primarily feature preservation, but includes an area recommended for bank protection (**Figure 2-6**). Between RM 2.7 and RM 2.45, a bio-engineered hard toe structure for stream bank stabilization would limit sediment input, and

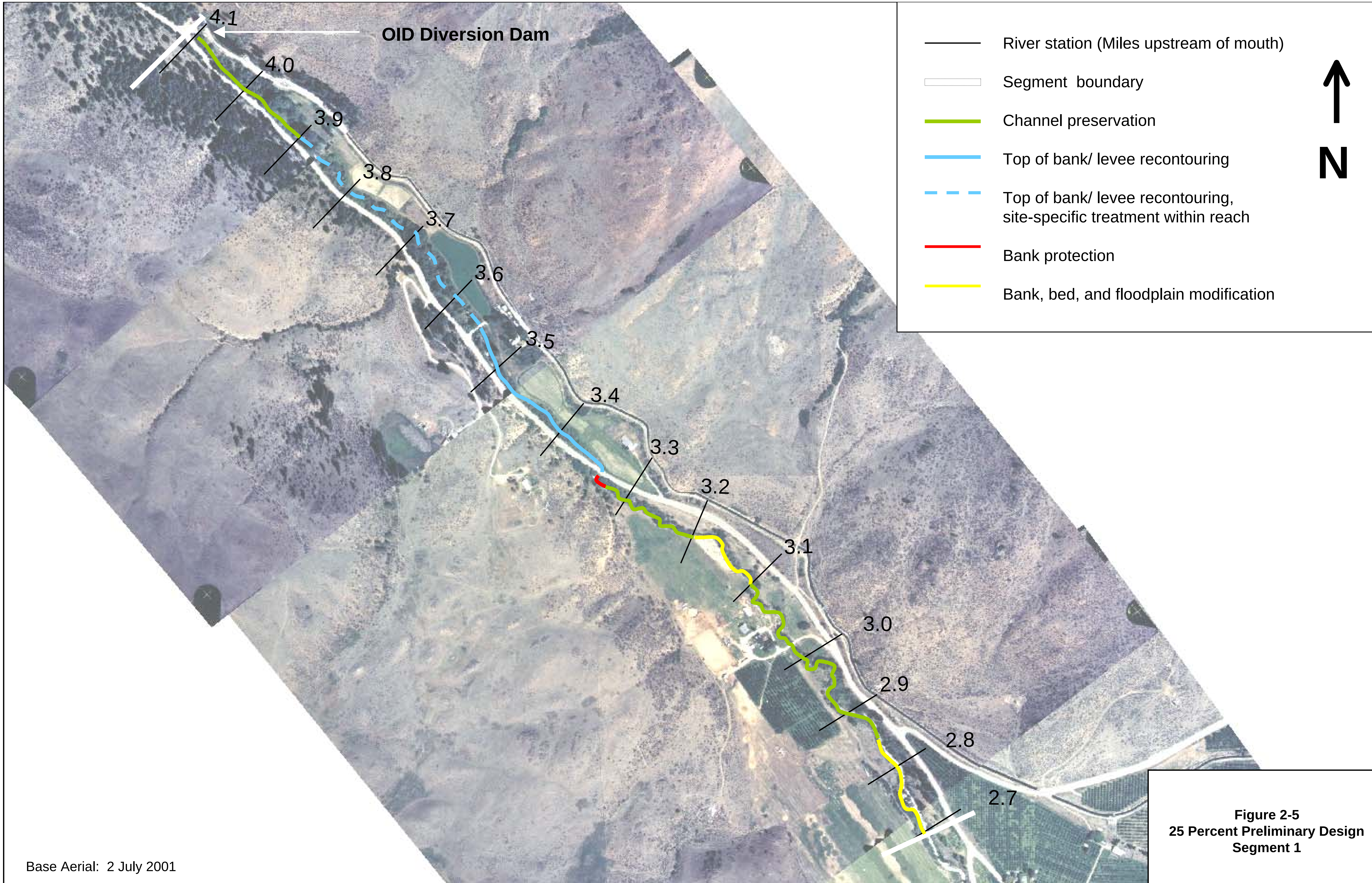
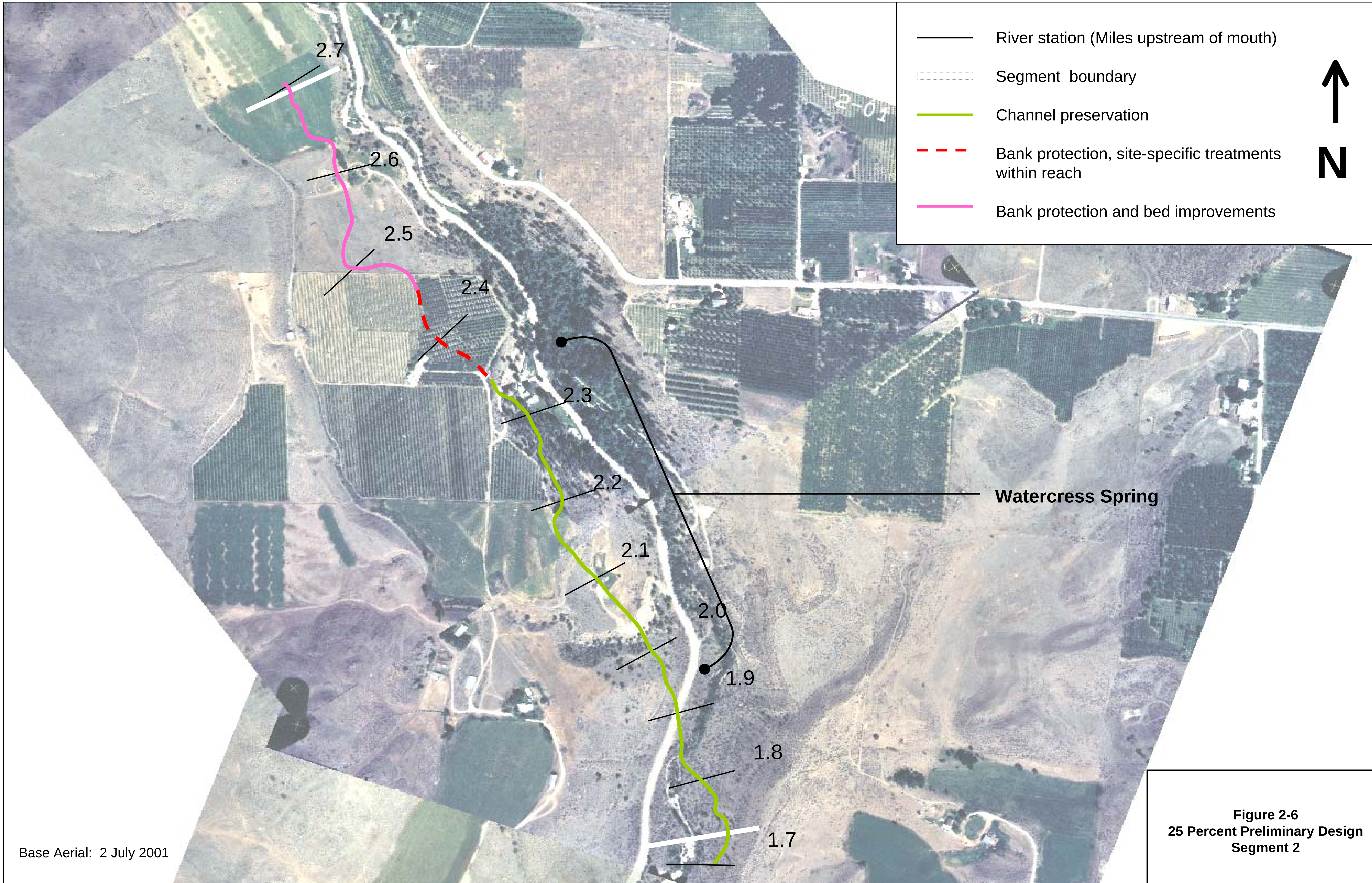


Figure 2-5
25 Percent Preliminary Design
Segment 1


River station (Miles upstream of mouth)
Segment boundary
Channel preservation
Bank protection, site-specific treatments within reach
Bank protection and bed improvements
N
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
Watercress Spring
Base Aerial: 2 July 2001
Figure 2-6
25 Percent Preliminary Design
Segment 2

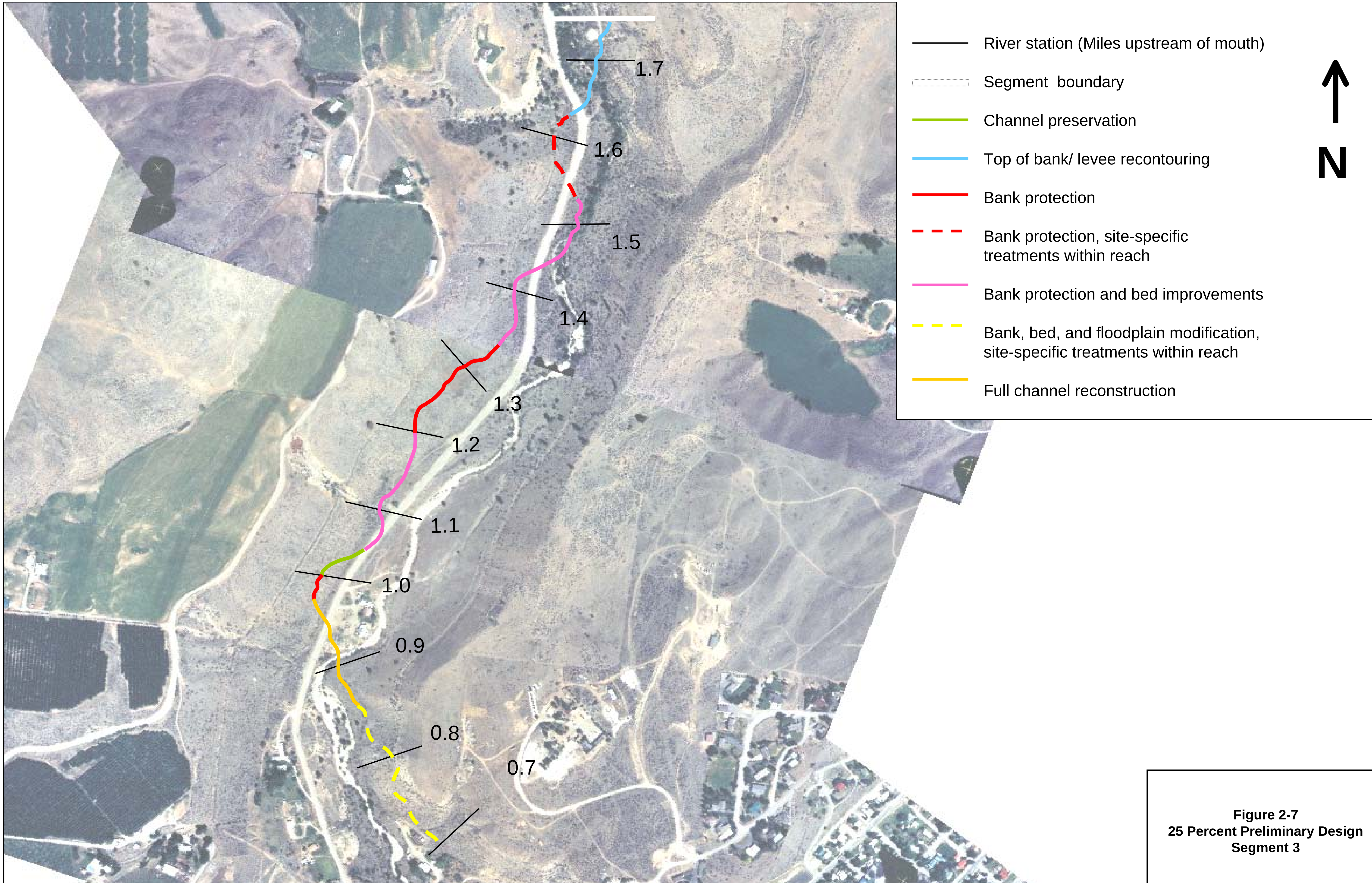


Figure 2-7
25 Percent Preliminary Design
Segment 3

Base Aerial: 2 July 2001

Figure 2-8
25 Percent Preliminary Design
Segment 4

reconfiguration of the bed would improve fish passage. The downstream two-thirds of this segment would be preserved in its existing condition. The Watercress Springs area (RM 2.4 to 2.0) has the potential benefit of providing excellent winter habitat and water to irrigate newly planted riparian vegetation. All work in this segment would require landowner support.

Segment 3

Segment 3 is 1.05 miles long and has a steep slope (3.8 percent) and a broad valley floor. Only about 0.05 miles of this segment would be preserved in its existing condition (**Figure 2-7**). The remainder of the segment lacks well-vegetated banks and is experiencing streambank failure that is recommended for treatment. A knickpoint (i.e. an abrupt change in channel bed elevation and gradient) near RM 1.6 is evidence of the continued upstream advance of channel incision. This channel instability causes abandonment of the floodplain and a wide, shallow, or braided channel with lateral and transverse bars that impede fish passage. Bank stabilization to regulate sediment supply and streambed modification to define a low-flow channel would improve fish passage. About 0.25 miles of channel (RM 1.35-1.25 and RM 0.95-0.85) will require full channel reconstruction to provide streambank stability, create a low-flow channel, and reestablish floodplain connection with the channel. Segment 3 also contains the former city dumpsite. Refuse from the dump is evident in the banks along Salmon Creek (RM 1.1 to 1.2). The rehabilitation design would include plans to stabilize and armor the banks along the dumpsite so that refuse is no longer exposed and the possibility of future streambank erosion is prevented. The alignment of the creek through the dumpsite would be stabilized so that the channel would not erode into the dumpsite in the future.

Segment 4

Segment 4 is 0.7 miles long, has an average gradient of 2.4 percent, and a low channel sinuosity that reflects land use encroachment on the stream. Many private properties require protection from high flows and bank erosion (**Figure 2-8**). Downstream of Fifth Avenue (RM 0.35), the channel shape is a trapezoidal design with riprap bank protection from a prior U.S. Army Corps of Engineers project. Urban constraints and maintenance of flood protection limit use of treatment options. About one-third of the segment, in the uppermost portion, would be preserved in its existing condition. Much of the reach would require maintenance of existing rip-rap and additional bank strengthening to arrest active bank erosion. A low-flow channel would also have to be defined throughout portions of the segment, and some vegetation planting will be necessary. As previously described under Action Alternative 1, the large coarse sediment deposit at the mouth of Salmon Creek would have to be excavated. Excavation would be a one-time event if the full rehabilitation program is implemented, since the rehabilitation in segments 1, 2, and 3 will decrease the sediment inputs during floods and reduce the likelihood of new gravel accumulations near the mouth.

2.3.3.2 Rehabilitation Implementation

The preliminary design does not make a final determination of these treatments. However, it does provide estimated locations and extent of various treatment types that would be refined through subsequent design steps following environmental review.

Specific rehabilitation efforts can be independently undertaken in Segment 1 (upstream of Danker cutoff at RM 2.75) without regard for other project timing. Actions to restore channel stability in these portions of the stream can occur in any sequence that opportunity provides.

However, in segments 2, 3, and 4, particularly downstream of Watercress Springs, channel rehabilitation actions would proceed sequentially in the downstream direction, and would comply with a well-integrated design. Rehabilitation actions would affect flow conveyance, sediment supply and sediment transport capacity within the stream. Improper project implementation could undermine the integrity of other site designs within the channel.

2.3.3.3 Construction Activity

Channel construction would take between 1 to 3 construction seasons[7] to complete and would involve several construction phases, including:

1. Obtaining access agreements to begin survey and construction staking
2. Stockpiling of construction materials and equipment
3. Diversion of water from the channel, if necessary
4. Excavation, fill, and reconfiguration of streambed and streambanks
5. Upland and out-of-channel construction
6. Habitat placement construction
7. Planting
8. Cleanup

Instream rehabilitation would be performed in a dry stream channel to reduce short-term impacts to water quality and to minimize costs. A construction schedule would be implemented so that the different construction phases would be coordinated with the wet and dry seasons and to avoid impacts to any migrating fish in the channel. Any construction that occurs during the wet season would require water diversion. To divert the water, a dam would be created and water diverted around the site by pumping through screened pipes. The proper authorities would be notified

[7] Based on the existing hydrologic information, high flows occur during May and June. In-channel construction would not occur during these two months, leaving a construction season of about 10 months per year.

and permits obtained if water diversion is necessary. Fish passage flow regimes should be implemented after completion of channel rehabilitation. Premature streamflow releases may alter design constraints, and would not benefit fish passage.

Construction monitors for biological and archeological finds would be on site for all construction phases to ensure that in the event of uncovering a significant find, construction activity would be halted until the issue is properly handled.

Rehabilitation work would require staging areas at various locations outside the active channel on level ground for storage of equipment, supplies, and stockpiling of material. Materials excavated from one site may be reused in other areas within the lower Salmon Creek project area requiring fill materials. Additional materials may also be needed from off-site sources. Thus, areas to stage and process rock and other substrate materials (e.g., wood, gravel, boulders, plantings, etc.) would be necessary. Considerations for such areas would include haul distance from source and site, heavy equipment, and sufficient space to move, sort and store materials. Preliminary examinations of the work area suggest that sufficient space is available within the plan area. Specific sites would be identified as part of more detailed project design.

Fuels, solvents, and lubricants used by construction machinery would be temporarily stored at the project area. Since the potential exists for exposure due to spillage or leakage, appropriate measures would be taken to limit exposure and prevent groundwater or stream contamination.

Access to project areas would be obtained prior to construction through correspondence and agreement with public and private property owners. Over the length of the project, access may be needed for construction clean-up, vegetation watering, and personal site visits for monitoring purposes. Heavy equipment access to rehabilitation sites is readily available. The portions of the channel proposed for major rehabilitation are accessible directly from the public road west of Salmon Creek. Access within the city of Okanogan may occur at bridge crossings, dead end streets, or other nearby access points. Most of the channel rehabilitation within the city limits would be targeted to specific sites, where access requirements may be on a point-by-point basis. Specific details of site access would be included in the final design.

Traffic in the project area would increase as heavy machinery exits and enters staging areas and access points. Traffic would also increase outside of the project area due to trucks hauling soil, rock, and vegetation to and from the site. Proper signage and traffic control would be enforced for the duration of the project, and the proper authorities would be notified in advance about the projected increase in traffic volume.

Revegetation and Watering

Reestablishing a healthy riparian vegetation corridor in lower Salmon Creek is critical to arresting bank erosion and maintaining channel stability that will allow for successful fish passage. As a result of years of channel dewatering and land use activities that have contributed to channel incision and a lowering of the water table, there has been a dramatic reduction in riparian vegetation along the streambanks. In some reaches, the riparian vegetation has been eliminated all together. Loss of riparian vegetation is a negative feedback on channel stability and is a major factor that causes streambanks to become more prone to erosion. This is particularly true in lower Salmon Creek, where the streambanks are composed of a coarse mixture of unconsolidated sediment that gain much of their cohesive strength from root binding.

Although Action Alternative 2 supplies more water to lower Salmon Creek than under existing conditions, there may still be times in the months of July, August, and September where there is no flow in the channel. However, because lower Salmon Creek would have more water in the channel throughout the year than under the No Action Alternative, it is expected that the groundwater table will rise. Additionally, the stream rehabilitation will reduce bank heights in several reaches, which will bring the elevation of the riparian vegetation closer to groundwater levels. New vegetation native to eastern Washington and adapted to riparian zones will likely have to be planted, rather than seeded, and watered regularly for 3 to 5 years until the plants are established. A combination of direct watering from a water truck and an irrigation system will be used to water the newly establishing vegetation. Irrigation systems will have to be constructed in some reaches, and plants would benefit from watering at progressively lower elevations in the soil profile to promote deep root development and enable the plants to utilize groundwater during the dry months. Plant growth would also benefit substantially if the flow ramping rates were tailored for a gradual rise and fall of the monthly hydrograph to allow plants to adjust to the changing water levels. Riparian land uses, notably grazing, will have to be controlled to protect the vegetation.

There is no guarantee that riparian vegetation will reestablish with stream rehabilitation and the water supply alternatives, since factors such as droughts cannot be predicted nor controlled by the Project. However, a stream rehabilitation that reduces the distance between vegetation's roots and groundwater levels, combined with a strategic watering and flow release schedule, can result in successful reestablishment of riparian vegetation that can persist through seasonal patterns when there is no flow in the channel.

2.3.4 COSTS

2.3.4.1 Construction Cost Estimates

Two field cost estimates were prepared for the plant and system modifications needed to upgrade the Shellrock plant to 35 cfs capacity. Option 1 assumes reuse of the existing 800-hp motors and Option 2 would include replacement of the existing motors with new 900-hp motors. The cost estimate for Option 1 is $1,755,000. The cost estimate for Option 2 is $2,600,000. Both estimates include 10 percent for unlisted items, 20 percent for contingencies, and 30 percent for additional site investigation, environmental studies, and construction management. All costs are based on calendar year 2003 unit prices.

The costs for fully rehabilitating the lower 4.15 miles of Salmon Creek to enable fish passage to the middle reach are outlined in **Table 2-5**. At the preliminary design stage, it is estimated that the total construction cost would be 1.25 million dollars. The associated soft costs and a 25% contingency estimate increases the total implementation cost to 2.35 million dollars. As indicated in **Table 2-4**, some reaches would only require the selected treatment type at site-

Table 2-5. Estimated Costs to Fully Rehabilitate Lower Salmon Creek to Enable Fish Passage to the Middle Reach.

	Upstream River Station (mi)	Downstream River Station (mi)	Reach Length (mi)	Treatment Length of Reach[a] (mi)	Treatment Type	Cost ($)
Segment 1	4.10	3.90	0.20	0.20	Channel preservation	$0
	3.90	3.55	0.35	0.18	Site-specific top of bank/levee bank recontouring	$12,012
	3.55	3.35	0.20	0.20	Top of bank/levee recontouring	$13,728
	3.35	3.30	0.05	0.05	Bank protection	$9,768
	3.30	3.20	0.10	0.10	Channel preservation	$0
	3.20	3.10	0.10	0.10	Bank, bed, and floodplain modification	$86,592
	3.10	2.85	0.25	0.25	Channel preservation	$0
	2.85	2.70	0.15	0.15	Bank, bed, and floodplain modification	$129,888
					Segment Subtotal $	$251,988
Segment 2	2.70	2.45	0.25	0.25	Bank protection and bed improvements	$124,080
	2.45	2.35	0.10	0.05	Site-specific bank protection	$9,768
	2.35	1.95	0.40	0.40	Channel preservation	$0
	1.95	1.75	0.20	0.20	Channel preservation	$0
					Segment Subtotal $	$133,848
Segment 3	1.75	1.65	0.10	0.10	Top of bank/levee recontouring	$6,864
	1.65	1.55	0.10	0.05	Site-specific bank protection	$9,768
	1.55	1.35	0.20	0.20	Bank protection and bed improvements	$99,264
	1.35	1.20	0.15	0.15	Full channel reconstruction	$174,240
	1.20	1.05	0.15	0.15	Bank protection and bed improvements	$74,448
	1.05	1.00	0.05	0.05	Channel preservation	$0
	1.00	0.95	0.05	0.05	Bank protection	$9,768
	0.95	0.85	0.10	0.10	Full channel reconstruction	$116,160
	0.85	0.70	0.15	0.08	Site-specific bank, bed, and floodplain modification	$64,944
					Segment Subtotal $	$555,456
Segment 4	0.70	0.45	0.25	0.25	Channel preservation	$0
	0.45	0.35	0.10	0.10	Bank protection and bed improvements	$49,632
	0.35	0.10	0.25	0.13	Site-specific bank protection and bed improvements	$62,040
	0.10	0.00	0.10	0.10	Bank protection and bed improvements, and remove coarse sediment at mouth	$83,427
					Segment Subtotal $	$195,099
					Installation of irrigation system	$10,000
					Vegetation watering for first 3 years[b]	$105,000
					Construction Costs Total $	$1,251,391
					Soft Costs	
					Temporary facilities, administration, project management, project closeout @ 5%	$62,570
					Design, Permitting, and Construction Management @ 35%	$437,987
					Mobilization/demobilization @ 10%	$125,139
					Soft Costs Total $	$625,696
					Contingency Costs @ 25%	$469,272
					Total $	**$2,346,358**

a Treatment lengths for reaches specified as "site-specific" are estimated at half the reache's total length. Otherwise, the treatment is applied to the entire reach.

b Watering may be necessary for up to 5 years to get plants established depending on streamflow and precipitation.

specific locations within the reach. In areas of site-specific treatment, it has been assumed that the treatment length is 50 percent of the total reach length. Rehabilitation costs in these reaches will vary depending on the actual length of channel treated, and will be refined at a further stage in the design process. This cost estimate does not include funds for mitigation, temporary landowner access permits to the site or staging areas, or property acquisition.

Cost estimates for the feeder canal replacement range from $1.3 M to $2.3 M.

2.3.4.2 Operation Cost

Based on data provided by OID, the variable cost (energy and O&M) of operating the Shellrock plant averaged $40.19 per acre-foot pumped in 2001 and 2002. Additional pumping costs (above the level of pumping required for the No Action Alternative) associated with this alternative are estimated to be approximately $200,000 per year (see **Section 3.8**).

2.4 ALTERNATIVE 3

This alternative would involve:

- Purchase of 5100 acre-feet of OID water rights for Salmon Creek to allow the water that is subject to these rights to remain in Salmon Creek.
- Replace the Salmon Lake feeder canal and headgate.
- No rehabilitation of the lower 4.3 miles of Salmon Creek.

2.4.1 INFRASTRUCTURE

No infrastructural components are included in this Action Alternative. Water obtained through water rights purchase would be stored in existing reservoirs (Conconully Reservoir and Salmon Lake) and released to Salmon Creek using controls already in place.

2.4.2 WATER SUPPLY OPERATIONS

Water rights purchased under Alternative 3 would be retained in storage in Conconully Reservoir or Salmon Lake and would be released as needed to provide passage flows. OID operations would continue using its Salmon Creek and Okanogan River sources to supply a reduced irrigated acreage. Water would be used for passage and overwintering flows. As compared to the No Action Alternative, pumping increases under Alternative 3. This is because the No Action Alternative has no instream flow demands, so Salmon Creek supplies 78 percent of the irrigation water demand while Shellrock supplies only 15 percent (with the other 7 percent coming from Duck Lake). Under Alternative 3, instream flow demands reduce the proportion of the irrigation requirement that can be supplied from Salmon Creek to 41-51 percent of the OID water demand. Shellrock makes up the difference, supplying 44-51 percent of irrigation demand (with another 5-8 percent coming from Duck Lake). Thus, even though the total demand is reduced (i.e., from 15,745 AF to an average of 10,325 AF), pumping from Shellrock must increase (i.e., from 2,414 to an average of 4,882 AF) to make up for the reduced availability of Salmon Creek water.

There would be critical period shortages (deficit irrigation) under this alternative. **Table 2-6** shows critical period shortages for Alternative 3 under conditions of weather and storage that existed from 1928-1933. Shortages occurred in the model in two- to three-month periods in two consecutive years (1931-1932). The annual shortage was highest during 1931, the driest year of the two years that were water-short. In one month (October 1931) shortages reached 20 percent of OID monthly demand. Depending on how one defines "critical period" (e.g., with reference to runoff below median, storage less than full, or the level of multiyear running mean total runoff) this alternative began to experience shortages in the fourth, seventh or ninth year of the critical period drought.

2.4.3 WATER RIGHTS

Under this action alternative, sufficient water rights would be purchased from OID to provide the 5,100 AF of water required for passage flows. This amount of water would require retiring from irrigation about 1,470 acres, or about 30 percent of District lands. This action alternative does not assume that OID develops other sources of water to replace the water rights it sells to provide passage flows.

If public funds are used to acquire the water rights for permanent transfer to instream flow purposes, Washington law requires that they be held by the State in the State Water Trust Program (managed by Ecology). Application was made to place water temporarily leased from OID members in 2000 through 2002 into trust. Holding instream water rights in the trust program protects instream flows as a water right, preventing other applicants from seeking permits and junior water right holders from taking the acquired water out of stream. It also provides a basis for enforcement action against a party that infringes the right. In cases of temporary acquisition, such as through a lease, the transferor can protect itself from relinquishment of the water right only by placing the transferred water into the trust program.

Ecology may reduce the gross amount of water offered to the trust based on return flows, using a "net water savings" analysis. This analysis requires determination that "reasonably efficient practices" have been employed in the use of the irrigation water right. For the purposes of EIS analysis it is assumed that District water use rises to the standard of reasonably efficient use and the full diversion quantity is transferrable (there are no return flows to Salmon Creek below the irrigation diversion dam). The stream reach for which the instream flow right would be protected is limited to the "affected reach" as defined in Ecology's guidelines; this would be the lower 4.3 mile reach of Salmon Creek. Finally the quantity which could be transferred to a trust water right would be limited or conditioned to avoid impairment to other rights.

Alternative 3 would require negotiation of a water right purchase agreement with the District and its members and changing the purpose of a portion of OID's Salmon Creek water rights from irrigation to instream flow. The season, place and purpose of use would all be changed on the transferred water rights. In addition, Ecology would conduct a tentative determination of the extent and validity of the water rights, and this could change the amounts of the water rights. As

Table 2-6. Salmon Creek Critical Period Shortage v. OID Monthly Demand. Alternative 3: Water Rights Purchase.

Month	1928	1929	1930	1931	1932	1933
Critical Period Shortages (ac-ft)						
Jan	0	0	0	0	0	0
Feb	0	0	0	0	0	0
Mar	0	0	0	0	0	0
Apr	0	0	0	0	0	0
May	0	0	0	0	0	0
Jun	0	0	0	0	0	0
Jul	0	0	0	307	0	0
Aug	0	0	0	307	224	0
Sep	0	0	0	0	0	0
Oct	0	0	0	60	41	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	
Annual Total	**0**	**0**	**0**	**674**	**266**	**0**
Total OID Monthly Demand						
Jan	0	0	0	0	0	0
Feb	0	0	0	0	0	0
Mar	18	16	17	17	16	17
Apr	416	416	362	357	354	354
May	1518	1501	1469	1461	1413	1408
Jun	1575	1575	1575	1559	1527	1527
Jul	2092	1877	1959	1991	1835	1914
Aug	2180	1917	2018	2065	1888	1985
Sep	1610	1610	1610	1599	1578	1578
Oct	322	289	301	299	262	274
Nov	48	47	48	43	31	32
Dec	4	3	4	4	3	4
Annual Total	**9783**	**9251**	**9362**	**9395**	**8908**	**9092**
% of Total OID Monthly Demand						
Jan	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Feb	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mar	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Apr	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
May	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jun	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jul	0.0%	0.0%	0.0%	15.4%	0.0%	0.0%
Aug	0.0%	0.0%	0.0%	14.9%	11.9%	0.0%
Sep	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Oct	0.0%	0.0%	0.0%	20.1%	15.7%	0.0%
Nov	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dec	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Annual Total	**0.0%**	**0.0%**	**0.0%**	**7.2%**	**3.0%**	**0.0%**

1928 was first year of drought - see annual runoff running mean plot part of Ecology's tentative determination or as a part of the negotiated agreement, the purchased water rights would need to be safeguarded to satisfy the action agency that flow volumes purchased for fish passage would not be reduced by the use of any remaining water rights or claims. A trust water right retains the same priority date as the water right from which it originated, but the trust right shall be deemed to be inferior in priority unless otherwise specified by an agreement between the state and the party holding the original right. Because the object of this proposal is to secure water for fish in Salmon Creek, it follows that the irrigation portion of the right would (as a matter choice, not a requirement of water law) be subordinated.

This action alternative assumes that the remaining OID Salmon Creek water rights would be subordinated to the purchased water rights.[8] The purchased water rights would be senior to other Salmon Creek water rights that could affect flow objectives. As the oldest existing non-OID water claims on Salmon Creek date from 1890 and OID water claims date from 1888, the water rights purchased under Action Alternative 3 should be the most senior water rights on the creek.[9]

This alternative would require negotiation of a water right purchase agreement with the District and its members. Individual OID irrigators may not make independent arrangements to sell water appurtenant to their lands, as OID holds all water rights and claims in trust for its members.[10] However, OID can take land out from under assessment and sell water rights in amounts freed up by cessation of irrigation on that land. For example, in 1999 the OID Board passed a resolution to establish a Conservation Water Bank to allow its members to lease water on an annual basis. Members who wish to forego irrigation in a given season are allowed to register their allocation for transfer to the bank.

OID expressed concerns that several kinds of costs would occur and would need to be compensated in a water purchase scenario. These include direct payments to the grower who would be surrendering water; O&M payments to OID to avoid spreading fixed costs across fewer members; and offsets to the County for loss of tax base. Given that these concerns are addressed the OID Board indicated that it would be willing to consider negotiation of a water right purchase.

Analysis of this alternative does not attempt to predict final actual cost and sales of water rights, but works through water right purchase scenarios. The scenarios include:

Broadcast offer to purchase, allowing members to participate regardless of their location within the District. (Participation may need to be limited to a percentage of acreage as necessary to

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[8] If the purchased water rights were junior to the other OID rights, OID could take the entire flow of the creek during dry years by exercising its water claims (which would exceed the creek flow during low flow seasons even after sale of a portion of the OID water rights, unless the total OID water rights were reduced by Ecology collateral to the transaction).

[9] It is possible that Ecology could ask for an adjudication if relative priority among claimants to Salmon Creek water became an issue. This could be avoided by an agreement among claimants.

[10] During an October 3, 2002 conference call with Ecology, Ecology addressed the question of whether the OID water rights are actually owned by the district or by its members (pers. comm. Bob Barwin). Recent case law cited by Ecology suggests that while the district may hold the rights in trust for its members, the water rights are actually owned by the members.

allow equal opportunity to participate to all members, however this limitation would apply only if members offer more water than needed for instream flows).

The water right buyer would be required to pay the annual assessment charge to OID for as long it holds the water right. This addresses the district's concern regarding cost of service impacts to remaining district lands.

The water right purchase itself could be handled through BPA's water rights acquisition program. This program requires that the action alternative: (1) Take account of return flows in calculating the actual instream flow volume that would transfer with a water right acquisition, and (2) complete a valuation or appraisal of the water right(s).

Under this program, it would be necessary for a "qualified local entity" under the BPA Columbia Basin Water Transactions Program (CBWTP) to prepare an application or proposal for the transaction (the CBWTP reviews and funds such proposals). [11]

2.4.4 Feeder Canal Upgrade

Under this alternative, improvements to the feeder canal that delivers water from the North Fork of Salmon Creek to Salmon Lake would be the same as described for Action Alternative 1 (see **Section 2.2.2**).

2.4.5 Lower Salmon Creek Stream Rehabilitation

Under Action Alternative 3, no stream rehabilitation would occur.

2.4.6 Cost

2.4.6.1 Water Right Acquisition Cost

A water purchase price is not determined in this analysis for permanently transferred water. However, the decline in net income estimated by the Agricultural Production Model represents the estimated *minimum* level of payment that would be required to leave irrigators with net incomes equal to that which would have been earned through irrigated crop production. A premium above this amount is typically required to bid water away from irrigators. The level of premium depends upon specific water supply and demand factors that were not analyzed in this study. The decline in net income associated with the water right purchase alternative estimated in **Section 3.8** is approximately $250,000 per year. The capitalized cost of annual payments to the OID and decline of net income associated with this alternative would total $5.9 million (see **Section 3.8.3**). There would be an estimated total revenue loss to the local economy of approximately $4.1 million and a loss of approximately 118 jobs.

[11] The actual proposal or application would occur after the EIS ROD and only if BPA decided to pursue this alternative.

2.4.6.2 Operation Cost

Additional pumping costs (above the level of pumping required for the No Action Alternative) associated with this alternative are estimated to be approximately $100,000 per year (see **Section 3.8**). (This assumes that the variable cost [energy and O&M] of operating the new pumping plant are equivalent to the variable costs for the Shellrock plant noted above.)

2.5 NO-ACTION ALTERNATIVE

Under the No Action Alternative, no flows would be provided for steelhead or chinook passage in lower Salmon Creek. The lower creek would continue to be dewatered in most years, and OID would continue to divert its irrigation water supply under existing water claims from its existing diversion dam at RM 4.3 on Salmon Creek, supplemented in dry years by pumping from the Okanogan River at Shellrock. The District would continue to operate with its existing water sources and reservoir storage facilities, and there would be no critical period shortages. The Lower Salmon Creek channel would not be rehabilitated and neither steelhead nor chinook salmon would be able to pass through the lower 4.3 miles of Salmon Creek in most years to reach the high quality habitat in middle reach of Salmon Creek. No additional infrastructure improvements, including the North Fork Salmon Creek feeder canal are expected to be undertaken.

The No Action alternative could seriously impact the Okanogan Irrigation District and rural economy of the region. Under such an alternative, the District's water diversions, which have supported an irrigation economy for the Okanogan area for more than 80 years, would be subject to enforcement under the Endangered Species Act as the Okanogan Basin is listed as "critical habitat" by NMFS for summer steelhead. Enforcement could result in federal reallocation of water to instream flows, without the benefits of planning and investment to offset what certainly would be very significant social and economic effects for the region.

In 1998, OID developed a Draft Conservation Plan detailing some of its conservation efforts to-date. The OID conservation program includes both District-wide and on-farm elements. Most of the District-wide conservation program has been implemented. On-farm conservation represents most future conservation potential in the District, but attempts to engage OID members in implementing on-farm conservation measures have resulted in very limited participation. The on-farm program conservation program has been discontinued and there are no current plans to restart it. Implementation of the existing conservation plan is considered part of the No Action Alternative.

Under the No Action Alternative, OID's existing water supply sources would be adequate to provide a firm supply of water to the irrigation system[12], assuming maximum pumping from the Shellrock plant throughout the irrigation season. It is assumed that:

[12] Firm water supply is further discussed and defined in Appendix A.

- the monthly distribution of canal spill continues to follow current OID practices;
- annual OID crop water requirements are slightly reduced to reflect the predicted needs over the next 5 years rather than the crop water requirements that have occurred over the last 16 years;
- Duck Lake pumping follows the strategy outlined in **Appendix A**;
- maximum pumping from Shellrock occurs when storage reaches a critical level of 9,500 ac-ft; and
- maximum pumping from Duck Lake and Shellrock may occur at any time.

These assumptions maximize the current OID practices and reflect potential management strategies to conserve water for a critical drought period.

A Trust Water Agreement (TWA) may be negotiated between Ecology and OID following the precedent set on the Dungeness River by the Sequim-Dungeness Valley Agricultural Water Users Association. A TWA could include a commitment by OID to a conservation program together with provisions for transferring water that can be documented to be conserved under their Comprehensive Water Conservation Program into trust. Trust water may be allocated to instream flows and to a reserve for future irrigation.[13]

For the No Action Alternative, the water system model predicts a firm yield of 448 ac-ft of flow over the Salmon Creek diversion dam and 354 ac-ft at the mouth of Salmon Creek. Average annual flow over the weir is estimated at 10,501 ac-ft/yr. The predicted average combined storage for the modeling period was 19,178 ac-ft/yr, with a minimum annual storage volume of 1,748 ac-ft. Predicted average annual total OID demand from the water supply system is 15,745 ac-ft/yr, with an overall district efficiency of 70%. Under this alternative, Salmon Creek supplies about 78% of total OID irrigation water supply (12,229 ac-ft/yr), Shellrock 15% (2,414 ac-ft/yr) and Duck Lake 7% (1,101 ac-ft/yr). Predicted average annual efficiencies for on-farm and delivery are 77% and 91%, respectively.

2.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Several types of alternatives were considered in the development of this EIS, including:

- Flow alternatives
- Water supply alternatives
- Stream rehabilitation design alternatives

[13] In the case of the Dungeness River, the Trust Water Agreement allocates two-thirds of conserved water to instream flows and reserves one-third for future irrigation up to a maximum irrigated acreage specified in the agreement.

2.6.1 FLOWS

In order to define water supply alternatives, an initial range of potential flow volumes that might be restored to Salmon Creek was considered (**Table 2-7**). Both passage and base flows[14,15] in the lower creek were initially evaluated, but alternatives that provided the (larger) base flows were eliminated from consideration since these flows are not required to meet the purpose and need for the project. It was decided to evaluate one flow volume for the provision of passage flows (5,100 AF), as described further below. The other flows initially considered were eliminated from further consideration

Table 2-7. Initial Range of Flow Volumes Considered for Action Alternatives.

Volume (acre-feet)	Stream Rehabilitation Required?	Benefits
2,300	Yes	Steelhead passage (adult and juvenile) and overwintering
3,460	No	Steelhead passage (adult and juvenile) and overwintering
5,100	(a) Yes (b) No	(a) Steelhead and chinook passage (adult and juvenile) and overwintering (b) Steelhead passage (adult and juvenile) and overwintering
8,700	No	Steelhead and chinook passage (adult and juvenile) and overwintering
10,000	Yes	Steelhead and chinook passage (adult and juvenile) and overwintering, lower Salmon Creek base flows
13,600	No	Steelhead and chinook passage (adult and juvenile) and overwintering, lower Salmon Creek base flows

The 5,100 AF flow volume was chosen because it is the lowest flow volume that can meet the purpose and need for the project for both species of fish (steelhead and chinook salmon), and because it provides benefits both with and without stream rehabilitation. This flow volume provides passage flows for steelhead without stream rehabilitation, and passage flows for both steelhead and chinook with stream rehabilitation. It represents a flow volume that can be achieved by a reasonable range of water supply action alternatives (whereas higher flow volumes could only be provided by few alternatives).

It is important to recognize that 5,100 AF roughly represents the center of a range of flow volumes that could potentially provide the fish benefits analyzed in this EIS. This flow volume has been selected for EIS analysis as a good approximation of the flows that meet the action objectives. It is not intended to indicate that these flows meet the minimum requirements of all lifestages under all circumstances of weather and water system operations and in all reaches of Salmon Creek. Conversely, the selection of the 5,100 AF flow volume target should not be read

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14 *Passage flows* provide water in lower Salmon Creek to allow up-migration of steelhead and Chinook adults to spawn and out-migration of steelhead and Chinook smolts. The 3,300 AF flow provides passage flows sufficient only for steelhead, and the 5,100 AF flow provides passage flows only for steelhead if no stream rehabilitation is done. The other flows (5,100 AF with stream rehabilitation and the higher flows described in Table 2-1 provide passage flows for both steelhead and Chinook). *Base flows* provide sufficient water for survival of salmonids year-round in lower Salmon Creek. Only the 10,000 AF and 13,600 AF flow volumes would provide base flows. *Overwintering flows* provide water for fish survival over the winter in the middle reach of Salmon Creek (above the diversion dam).

15 All the flow alternatives considered the provision of overwintering flows for salmonids in the middle reach of Salmon Creek.

as indicating that this amount of water would be needed under all circumstances for all species and lifestages. It is a representative number chosen for EIS analysis. In some circumstances, weather and water system operations lead to water model results that show more than 5,100 AF of water in Lower Salmon Creek. In other circumstances, weather, operations and fish requirements of some scenarios analyzed result in the 5,100 AF supplied to Lower Salmon Creek not meeting fish flow requirements at times. Further detail is provided in **Section 3.5** regarding the monthly flow requirements for steelhead without stream rehabilitation, and for steelhead and chinook with stream rehabilitation.

Table 2-7 lists the flow volumes initially considered, identifies whether there would be a need to rehabilitate the stream to meet the purpose and need at that flow, and the benefits to fish that would result if that flow volume were provided. Two options ("a" and "b") are described for the 5,100 AF flow volume. This flow volume would provide different benefits depending upon whether or not the lower stream channel is rehabilitated. Without stream rehabilitation, the 5,100 AF flow volume would provide passage only for steelhead. With rehabilitation, it would provide passage for both steelhead and chinook. During spring 2003 flow releases of 25 cfs were adequate for adult steelhead migration in the lower reach of Salmon Creek. Assuming that flows would need to be provided for adult up-migration, juvenile out-migration, and overwintering above the diversion dam, it is estimated that flows would be need for about 70 days. At 25 cfs, the spring 2003 results suggest that flow volumes as low as 3,500 AF could be sufficient to meet steelhead requirements and without stream rehabilitation. With stream rehabilitation, assuming a flow of about 16 cfs could provide adequate steelhead passage, the provision of 70 days of flows would require as little as 2,300 AF (pers. comm. Chris Fisher, Colville Confederated Tribes, May 5, 2003). Provision of these lower flow volumes could be considered to implement a project targeted only on steelhead.

2.6.2 OTHER WATER SUPPLY ALTERNATIVES CONSIDERED

2.6.2.1 Screening of Water Supply Alternatives

A large list of water supply action alternatives was initially screened in 1999 (Dames & Moore, 1999). These alternatives are described briefly below and in **Appendix A**. Based on the screening, the following alternatives were carried forward for further analysis and EIS consideration:

- Okanogan River Water Exchange
- Upgrade Shellrock Pumping Plant
- Okanogan Irrigation District Water Right Purchase
- Raise Salmon Lake Dam
- Diversion 5 Reregulating Reservoir
- Replace North Fork Salmon Creek Feeder Canal and Headworks
- Okanogan Irrigation District Water Leasing
- Okanogan Irrigation District Water Conservation (District-wide and On-farm)

Some of these alternatives have been retained as action alternatives and some have been eliminated from further consideration. Each was analyzed to determine if it could provide for the range of flows under consideration. For each flow volume, those action alternatives capable of supplying the flow are identified in **Table 2-8**.

Table 2-8. Water Supply Action Alternatives Capable of Meeting Initial Range of Flows.

Flow Volume (acre-feet)	Alternatives Capable of Providing Flow	Notes
13,600	Alternative 1	Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.
10,000	Alternative 1	Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.
8,700	Alternative 1	Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.
5,100	Alternative 1, 2 or 3	OID irrigators would not receive 100 percent of modeled crop water requirements during a few months of a sustained critical drought under the Shellrock upgrade. Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.
3,300	Alternative 1, 2 or 3	OID irrigators would not receive 100 percent of modeled crop water requirements during a few months of a sustained critical drought under the Shellrock upgrade. Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.

These considerations of the initial range of flow volumes and water supply alternatives helped narrow a wide range of possible actions into the range of action alternatives that are presented for detailed consideration in this EIS.

Only three of the water supply action alternatives that had been carried forward from the 1999 screening exercise are considered capable of providing the 5,100 AF flow. These are the Okanogan River water exchange, Shellrock upgrade, and water purchase alternatives. The North Fork Salmon Creek feeder canal is incorporated as an element that can augment flows in all the alternatives. Three alternatives were considered further into the NEPA process but were eventually eliminated (raise Salmon Lake dam, Diversion 5 reregulating reservoir, and water leasing) and are briefly described below. One (water conservation) is an element of the No Action Alternative.

2.6.2.2 Water Supply Alternatives Previously Eliminated from Consideration

In an earlier stage of planning for the Salmon Creek project, twenty-four alternatives were identified, critically reviewed, and characterized as potential sources of water to provide instream flows in Salmon Creek while preserving irrigation deliveries (Dames & Moore, 1999). The alternatives were grouped into six categories as follows (those which have been carried forward in this EIS are identified with bold italics):

WATER CONSERVATION ALTERNATIVES

- District-wide Agricultural Water Conservation
- OID Totally Pressurized Water Delivery System
- Non-Agricultural Water Conservation Purchase and Transfer

WATER EXCHANGE ALTERNATIVES

City of Okanogan Water Exchange

- Reclaimed Water
- Watercress Springs Water Claim

Okanogan River Water Exchange

- Alternative Points of Diversion

Upstream Okanogan River (add new point of diversion for existing OID Okanogan River water rights)

Shellrock pumps (increase use of existing OID Okanogan River water rights)

- Alternative Water Right Actions

    Convert existing Okanogan River emergency water rights to base supply

    Acquire new Okanogan River rights

- Alternative Water Amounts

    Full irrigation service (ca. 80 cfs)

    Fish flow only (ca. 20 cfs)

    Confluence of Salmon Creek and Okanogan River (add new point of diversion for existing OID Salmon Creek water rights and claims)

Salmon Creek/Watercress Springs Water Right Claimants

WATER MANAGEMENT ALTERNATIVES

- Duck Lake Water Management
- OID Diversion 5 Reregulation
- On-Farm Water Management

WATER MARKETING ALTERNATIVES

- OID Member Irrigators Water Bank
- Purchase Groundwater Stored at Duck Lake
- Purvey to City of Omak (involve City in financing new storage)

WATER RIGHTS ALTERNATIVES

- Duck Lake Water Association
- North Fork Salmon Creek water right owners
- Okanogan County

WATER STORAGE ALTERNATIVES

- Aquifer Storage and Recovery
- Brown Lake
- CCT Reservation
- Green Lake
- Interbasin Transfer

    Fish Lake

    Johnson Creek

    Scotch Creek
- Raise Salmon Lake Dam and Replace Feeder Canal
- Scotch Basin
- West Fork Salmon Creek

The review considered both potential benefits to instream flows for salmon restoration and potential effects on the OID water system, water rights, and member irrigators (including the potential for alternatives to promote a net loss of irrigable land). The review also considered the compatibility of alternative water supply opportunities with one another in developing a planning level program. The review considered ways to:

- Improve OID water system infrastructure or operations;
- Creatively use water rights, including new points of diversion;
- Obtain new or supplemental water rights;
- Create incentives for water conservation;
- Use groundwater in conjunction with surface water supplies;
- Engage in water marketing, including leases, buy-backs, and purchases;

- Purchase water conservation outside of the OID.

Results are presented in Dames & Moore (1999), together with overview matrices of the water supply alternatives. An overall summary matrix (**Appendix A**) compares the range of alternatives with one another. The alternative matrices are organized by the following characteristics:

- Source of water, point of withdrawal/diversion, purpose and place of use;
- Potential water amount and timing;
- Cost and schedule;
- Engineering feasibility;
- Regulatory requirements;
- Environmental impacts and benefits.

These alternatives were described at a conceptual "planning level." The purpose was to characterize a range of alternatives sufficiently for comparison with one another, to allow selection of alternatives for further study and more detailed design and to identify fatal flaws and eliminate flawed alternatives. When fatal flaws were identified, no further work was conducted on an alternative; thus, the review sometimes went no further than to document a fatal flaw.

Three of the water supply action alternatives that had been carried forward for EIS consideration were subsequently eliminated. These alternatives are: raise Salmon Lake dam, Diversion 5 reregulating reservoir, and OID water leasing. In addition, several pump station sites and pipeline routes for the Okanogan River water exchange action alternative were considered and eliminated. The rationale for rejecting these alternatives for detailed analysis in this EIS is provided in the following sections.

2.6.2.3 Raise Salmon Lake Dam

Existing mapping was used to evaluate the inundation zone of Salmon Lake with a two-foot raise in elevation. As-built drawings were examined showing the location of the existing lakeshore sewer lines from the City of Conconully, as compared to the inundation zone. Analysis of impacts to physical structures and sewer infrastructure resulting from a two-foot increase in the level of Salmon Lake was based on an increase in the high water line from 2,318.5 feet to an elevation of 2,320.5 feet.[16] Data on structures and sewer system locations were gathered from plans prepared by RW Beck & Associates in 1990 for the construction of a sewer system to serve cabins along the lake[17.]

[16] - elevation figures provided by Tom Sullivan, OID Manager.
[17] - "as-built" plans provided by Lee Moore, Conconully Public Works Director and Okanogan County Public Works Department.

Sewer system: It appears that approximately 550 feet of 3-inch sewer line and eight septic tanks fall within or only slightly above the area that would be impacted by the rise in water. An additional 1,500 or more feet is within a few feet of the high-water line and could be affected at depth. The depth at which the sewer line is buried is not shown on the as-built plans. Depending on depth, more line could be affected. Not all of these septic tanks could be simply moved elsewhere on the property, as they collect and pump effluent from several residences.

Docks: All 35 docks along the upper lake fall below the 2,320.5 elevation. It appears that most of the docks would require some modification and/or reconstruction to accommodate the proposed increase in high water line. Further analysis and site visits would be required to determine the extent of modification/reconstruction necessary.

Cabins: It appears that twelve cabins would be affected by the proposed increase in lake elevation. A few have a small corner that protrudes below the proposed high water line, while others have greater area below the 2,320.5-foot line. Six cabins could be moved, while the remaining cabins (numbers 10, 30, 35, 40, 41, & 49) would face serious constraints due to topography and location of the main road. Along with the cabins, approximately five outbuildings would also be impacted. (Note: all cabins are situated on leased property and all leases are up for renewal in 2003.)

Other: The public boat ramp would be submerged. From the map drawings, up to 24 dry well locations could be impacted. Field reconnaissance indicates that at least six of these would be inundated and an additional six very likely to be affected, with the balance impacted depending on the depth of the well. In addition a couple of irrigation lines and one pump line would be submerged.

Based on this review, it was decided to eliminate this alternative from further consideration. The alternative was eliminated in order not to disrupt lakeshore cabin owners. Also, with the present leases in place and shoreline policy, the alternative would create a permitting challenge in addition to the impact and engineering challenges from the dam raise. It would create long-term operational problems beyond immediate impacts. However, if the BOR were to eliminate lakeshore leases at some future time, this alternative could be reevaluated.

2.6.2.4 Diversion 5 Reregulating Reservoir

This alternative was eliminated from consideration because its expected firm yield is small relative to its cost. During Phase 1, Dames & Moore 1999 estimated a firm yield of 500 AF from a 100 AF reregulating reservoir. A recent engineering report (URS, 2002) estimated a total cost of $1.6 million for a 100 AF reservoir.

2.6.2.5 OID Water Leasing

Water leasing from OID member irrigators began to be implemented in the 2000 irrigation season with funding from BPA to provide water for interim Salmon Creek flows until a more comprehensive water supply program can be implemented. **Table 2-9** documents the number of acres participating in the lease program each year and the total acre-feet of water leased.

Table 2-9. OID Water Leasing History.

Year	Number of acres	Acre-Feet
2000	322	966
2001	573	1,719
2002	624	1,873

The OID Board voted at their March 2003 meeting not to enter into water leasing during the 2003 irrigation season, as this is the third consecutive year of drought. The Board was concerned that the District may have to ration water. Under law, the District must provide water to their membership before excess water can be distributed elsewhere. These circumstances illustrate the uncertainty in relying upon a water-leasing alternative for long-term flows. Due to this uncertainty, this alternative was eliminated from further consideration in the EIS.

2.6.2.6 Okanogan River Water Exchange Alternative Pump Station Sites and Pipeline Routes

Criteria used by URS (002) for pump station site selection included:

- stable river channel at the location of the pump station
- river depth adequate for intake structures and fish screens
- support a cost-effective route from the river to the irrigation canal
- minimize distance from Salmon Creek confluence to reduce water right and fish impacts in the Okanogan River
- easements and rights-of-way available, and zoning to allow proposed use
- adequate source for electric power supply nearby
- site accessibility for maintenance
- soils suitability for foundation
- located above an elevation that could be impacted by river flooding
- avoid adverse impacts to residential areas

Based on these criteria, two general site areas were selected (URS, 2002) as candidates for further evaluation. Both are on the west bank of the Okanogan River, within the city limits of Okanogan:

- Site 1 is at the confluence of Salmon Creek and the Okanogan River. This site was found to be infeasible during Phase 1 due to the disruption it would create to residential areas and city streets during the installation of a pipeline to serve it.

- Site 2 consists of two potential locations, one of which is the preferred location (2A) and the other (2B) a site that was eliminated from consideration. Site 2A was considered to better meet the criteria listed in the URS report, and on that basis Site 2B was eliminated from consideration.

The engineering report (URS, 2002) also specified criteria for the pipeline:

- pipeline outlet near to the uppermost end of the irrigation canal to reduce need for canal modifications
- bedding materials for pipeline construction available nearby
- as short a length of pipeline as possible
- alignment within existing easements and rights-of-way
- soils suitable for trenching with conventional equipment

Based on these criteria, two possible routes were identified: Route A and Route B. Route A is approximately 9,680 feet (1.8 miles) long. It would be relatively direct but would encroach on private lands and traverse orchards and land that have development potential. Easements and rights-of-way do not exist for this route. For these reasons, as well as cost and technical feasibility, Route A was eliminated from consideration. Route B is the proposed route described in **Section 2.2.1.2**. Although slightly longer, Route B was preferred because it follows county roads and existing OID rights-of-way and easements for most of its length. Route B would minimize impacts on private lands and orchards, and is more cost-effective and technically feasible as well.

2.6.2.7 Other Water Purchase Alternatives Considered

An alternative to limit participation in offering water rights for sale to a particular OID diversion was considered, but was eliminated based on a decision by the OID Board.

2.6.3 Other Stream Rehabilitation Design Alternatives Considered

No other stream rehabilitation design alternatives were developed in conceptual or engineering detail. Engineering constraints to rebuild the existing stream channel in its present condition required that the low end of the design provide salmonid passage at low flows, and the high end of the design be capable of passing flood flows with channel stability. A design for base flows was considered but was not significantly different from the design required for passage flows due to these engineering constraints. An alternative was considered to bring in heavy equipment and deepen the channel at local passage impediments without full channel reconstruction, but was eliminated because this work would need to be repeated after each high flow event (i.e., this was considered ongoing maintenance rather than a design solution).

2.7 COMPARISON OF ALTERNATIVES

Table 2-10. Estimated Outcome of Each Alternative Towards Select Goals and Objectives .

	Alternative 1 New 80 cfs Pump + Alluvial Fan Removal + Feeder Canal Upgrade	Alternative 2 Shellrock Upgrade + Full Rehabilitation of Creek + Feeder Canal Upgrade	Alternative 3 Water Purchase + No Creek Rehabilitation + Feeder Canal Upgrade	Alternative 4 No Action
Passage for steelhead	Yes, in normal and wet years w/ careful mgt. of small deficits.	Yes	Yes, except for driest years	Only in wet years
Passage for Chinook	Only in wet years	Yes, except in driest years	Only in wet years	No
Water delivered for irrigation (acre-feet)	16,165-16,167	14,425-15,225	9,972-10,679	15,745
Source of water for irrigation	33-35% Salmon Creek 8-9% Duck Lake 56-59% Okanogan River	41-46% Salmon Creek 47-52% Shellrock 7% Duck Lake	41-51% Salmon Creek 44-51% Shellrock 5-8% Duck Lake	78% Salmon Creek 15% Shellrock 7% Duck Lake
Okanogan Irrigation District efficiency[18]	89%	92-93%	93%	91%
Conconully Reservoir elevations (feet)	Median 2285 – 2286 Minimum 2246 - 2277	Median 2284 – 2285 Minimum 2242 - 2245	Median 2284 – 2285 Minimum 2243 - 2252	Median 2273 Minimum 2246
Salmon Lake elevations (feet)	Median 2315 – 2316 Minimum 2284 - 2298	Median 2314 – 2315 Minimum 2276 - 2277	Median 2314 – 2315 Minimum 2277 - 2285	Median 2314 Minimum 2282
Cost to implement water supply only ($US)	$7.3 million	$9.3 million - $10.3 million	$5.9 million	$0
Cost of stream channel rehabilitation	$64,400	$2,346,358	$0	$0
Annual increase in pumping cost (over No Action Alternative), including O&M ($US)	+$284,393	+$202,062	+$107,620	NA
Regional economic impacts ($US)	$0	$0	-$4.1 million	$0[19]

[18] *District efficiency* (the efficiency of the overall water delivery system) is defined by the ratio of water delivery to water supply.
[19] There will likely be costs associated with ESA enforcement actions that are not predictable at this time.

Table 2-11 Summary of Potential Impacts and Mitigation Measures by Alternative.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUANTITY IMPACTS *Salmon Creek Streamflow*	Reduces unnaturally high summer flows in the middle reach of Salmon Creek and establishes winter base flows in the lower and middle reaches. Re-establishes seasonal fish migration flows. Upgrade of the feeder canal would increase the operational flexibility of Salmon Lake. The feeder canal upgrade would also increase the maximum rate of diversion by 60 cfs, potentially decreasing flows in a short reach (4500 feet) of North Fork Salmon Creek, between the feeder canal intake and the upstream end of Conconully Reservoir. Stream rehabilitation would increase flow depths under low to moderate flow magnitudes at the mouth of Salmon Creek.	Reduces unnaturally high summer flows in the middle reach of Salmon Creek and establishes winter base flows in the lower and middle reaches. Re-establishes seasonal fish migration flows. Upgrade of the feeder canal would increase the operational flexibility of Salmon Lake. The feeder canal upgrade would also increase the maximum rate of diversion by 60 cfs, potentially decreasing flows in a short reach (4500 feet) of North Fork Salmon Creek, between the feeder canal intake and the upstream end of Conconully Reservoir. Stream rehabilitation would increase flow depths under low to moderate flow magnitudes and enhance the ability to manage flow regimes in lower reach.	Reduces unnaturally high summer flows in the middle reach of Salmon Creek and establishes winter base flows in the lower and middle reaches. Re-establishes seasonal fish migration flows. Upgrade of the feeder canal would increase the operational flexibility of Salmon Lake. The feeder canal upgrade would also increase the maximum rate of diversion by 60 cfs, potentially decreasing flows in a short reach (4500 feet) of North Fork Salmon Creek, between the feeder canal intake and the upstream end of Conconully Reservoir.	Upper reach unregulated. High summer flows would continue in the middle reach, Lower reach would continue to be dewatered in most months.
Okanogan River	Decreases streamflow in the Okanogan River from the new pump station to Salmon Creek (1.25 miles) by up to 60 cfs. The frequency of WAC minimum flow violations is very slightly increased in dry years.	The average monthly percentage of the Okanogan River that would be pumped would increase over all water year types. However, the increased percentage would not be of a magnitude or seasonality that adversely affects stream flow in the Okanogan River. Results in a small decrease in streamflow in the Okanogan River from Shellrock to Salmon Creek (3.2 miles).	The number of months with flow below WAC minimums under various water year types would remain identical to the No Action Alternative. Salmon Creek inflow to the Okanogan River would increase.	Higher percentage pumped when compared to District patterns since1987. Salmon Creek inflow would continue to contribute 0.1 to 0.2% to Okanogan River flows in dry and below normal years.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUANTITY IMPACTS (cont)		The frequency of WAC minimum flow violations in the Okanogan River is not increased.		
Flooding	The feeder canal upgrade would likely reduce potential flood hazards to persons and property adjacent to the quarter-mile long diverted reach.	The rehabilitated channel would be designed to pass the base flood (100-year flood). The recontouring of channel bed and banks would be designed to increase the frequency of overbank flow and floodwater retention, where valley width is adequate. The feeder canal upgrade would likely reduce potential flood hazards to persons and property adjacent to the quarter-mile long diverted reach.	The feeder canal upgrade would likely reduce potential flood hazards to persons and property adjacent to the quarter-mile long diverted reach.	No Change
Reservoir Levels	Median Salmon Lake elevations higher. Reduces seasonal fluctuations. Minimum Salmon Lake elevations increase in all months. Median monthly Conconully Reservoir water surface elevations increase by 10-20 feet from August through April. Minimum lake levels are increased when flows are provided for steelhead only, but decrease from January to July if flows are provided for steelhead and Chinook. Lake levels could be positively affected by increased flexibility afforded to the management of irrigation water supply through the upgrade of the feeder canal.	Median Salmon Lake elevations higher. Reduces seasonal fluctuations. Minimum Salmon Lake elevations decrease by 8 to 12 feet in February through June. Median monthly Conconully Reservoir water surface elevations increase or remain the same in all months. Lake levels could be positively affected by increased flexibility afforded to the management of irrigation water supply through the upgrade of the feeder canal.	Small changes in median Salmon Lake elevations. Reduces seasonal fluctuations. Minimum Salmon Lake elevations increase in most months for "steelhead only" flow regimes but decrease up to 6 feet when flows are also provided for Chinook. Conconully Reservoir water surface elevations increase by 5-10 feet from August through April. Minimum lake levels are generally decreased (up to 8 feet) in most months, although when flows are provided for steelhead only, lake levels increase up to 10 feet from August through March. Lake levels could be somewhat affected by increased flexibility afforded to the management of irrigation water supply through the upgrade of the feeder canal.	No Change

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUANTITY IMPACTS *Groundwater*	May create localized seasonal groundwater drawdown in close proximity to the new pump station. Worst case decreases in potential groundwater recharge to this reach of the Okanogan River valley aquifer range from about 1,500 AF to 2,000 AF. Along reservoir margins, increased recharge volumes and reduced fluctuations in local groundwater gradients would be a substantial benefit. Groundwater levels and recharge along the middle reach of Salmon Creek would likely experience a seasonal shift with changing flow regimes. In Lower Salmon Creek, groundwater recharge and levels would increase. No substantial impacts to the Duck Lake aquifer groundwater levels or recharge.	Groundwater recharge along the Okanogan River Valley aquifer could decrease slightly in the vicinity of Shellrock and down gradient towards the mouth of Salmon Creek, at least during dry years or below normal years, although it is unlikely. During dry years, groundwater levels around Salmon Lake will be depressed throughout the year relative to the No Action Alternative. Groundwater levels and recharge along the middle reach of Salmon Creek would likely experience a seasonal shift with changing flow regimes. In Lower Salmon Creek, groundwater recharge and levels would increase. Channel rehabilitation design contains several elements intended to produce increased recharge within the riparian corridor. Duck Lake pumping is maximized under this alternative, but the minimum lake level established by the Department of Ecology is respected.	Groundwater recharge and levels along the Okanogan River Valley aquifer could decrease slightly in the vicinity of Shellrock and down gradient towards the mouth of Salmon Creek, at least during dry years or below normal years, although unlikely. Along reservoir margins, increased recharge volumes and reduced fluctuations in local groundwater gradients would be a substantial benefit. Groundwater levels and recharge along the middle reach of Salmon Creek would likely experience a seasonal shift with changing flow regimes. In Lower Salmon Creek, groundwater recharge and levels would increase. No substantial impacts to the Duck Lake aquifer groundwater levels or recharge.	No Change
Water Supply for Irrigation	Slight improvement in flexibility and storage in Salmon Lake for use downstream. Decreased losses in available water. No critical period shortage would occur under this alternative.	When instream flows are provided for both steelhead and Chinook, a small critical period shortage would occur when conditions are similar to the early 1930's drought period. The shortage is modeled to persist for four years, with a peak critical storage deficit of 1678 acre-feet per year.	When instream flows are provided for both steelhead and Chinook, a small critical period shortage would occur when conditions are similar to the early 1930's drought period. The shortage is modeled to persist for two years, with a peak critical storage deficit of 674 acre-feet per year. Reduces the total acres of irrigated farmland by 1,470 acres.	No change from current use.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUANTITY MITIGATION	*Streamflow:* Any possible mitigation measures for dry year impacts would induce additional adverse effects on either OID water supply or fish instream flow needs. Therefore, no mitigation measures are available. *Reservoir Levels:* None. *Flooding:* The reservoir management component of the Stream Management Plan should incorporate a flood storage rule. *Groundwater:* Any drawdown effects on ground water supply at existing wells would be compensated by deepening existing wells and/or by subsidizing the incremental increase in pumping costs. *Water Supply for Irrigation:* Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.	*Streamflow:* None. *Reservoir Levels:* None. *Flooding:* The reservoir management component of the Stream Management Plan should incorporate a flood storage rule. *Groundwater:* None. Pre- and post-construction monitoring of Salmon Creek rehabilitation area. *Water Supply for Irrigation:* Some mitigation payments to OID irrigators during later years of a sustained critical drought may be required. Some purchase of OID water rights or drought year lease of water may be required to assure water availability and reliable irrigation supply during a drought if Okanogan River minimum flows are not met.	*Streamflow:* None. *Reservoir Levels:* None. *Flooding:* The reservoir management component of the Stream Management Plan should incorporate a flood storage rule. *Groundwater:* None. *Water Supply for Irrigation:* None.	None proposed.
WATER QUALITY IMPACTS *Erosion and Sedimentation*	Short-term erosion and sedimentation impacts could occur during construction activities for the new pump station, intake structures in the Okanogan River, Salmon Lake feeder canal, the North Fork of Salmon Creek below the headworks, and potentially the pipeline from the new pump station. Construction activities at the mouth of Salmon Creek would contribute sediment to the Okanogan River.	Short-term construction impacts may occur during relocation and reconstruction of the intake structures. Increased flows in Lower Salmon Creek would not be high enough to transport much sediment. Bank stabilization, erosion and sedimentation controls, riparian habitat improvements, and channel design in lower Salmon Creek would reduce loadings of sediment and concentrations of suspended sediment during high flow events.	No significant impacts to erosion and sedimentation. Increased flows in Lower Salmon Creek would not be high enough to transport much sediment even if the stream is not rehabilitated.	Channel incision followed by bank erosion would most likely spread upstream. Streambanks at the knickpoint in Watercress Springs could continue to degrade toward the highly unstable and eroding condition of the banks farther downstream. Streambanks would become taller, steeper, have less vegetation, and slough fine material into the channel.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUALITY IMPACTS (CONT)	Increased flows in Lower Salmon Creek would not be high enough to transport much sediment.	Short-term erosion and sedimentation could occur during construction activities associated with stream rehabilitation of Salmon Creek.		Further downstream, bank erosion and channel widening may occur. High flows would continue to transport fine sediment, the remaining coarse material would collapse to the bank toe and vegetation would be uprooted.
Water Temperature	The addition of water to Lower Salmon Creek will have generally positive effects on water quality in the creek. Decreased flows in the Okanogan River may have minor impacts on water temperature in the affected reach. Return flows of cool, clean water at the mouth of Salmon Creek would offset any impacts in the affected reach and could provide a thermal refugia near the mouth of the creek.	The addition of water to Lower Salmon Creek will have generally positive effects on water quality. Riparian habitat improvements would shade Lower Salmon Creek, improving water temperatures. Cool water released into the lower creek and other rehabilitation design features would have a positive effect on stream temperatures. Decreased flows in the Okanogan River may have minor impacts on water temperature in the affected reach. Return flows of cool, clean water at the mouth of Salmon Creek would offset any impacts in the affected reach and could provide a thermal refugia near the mouth of the creek.	The addition of water to Lower Salmon Creek will have generally positive effects on water quality in the creek. Return flows of cool, clean water at the mouth of Salmon Creek would have a beneficial impact on the Okanogan River and could provide a thermal refugia near the mouth of the creek.	Existing high stream temperatures would continue unabated and could increase if the stream continues to degrade.
WATER QUALITY MITIGATION	Standard construction BMPs for all construction components would include: • Delineating and preparing appropriate work zones, including staging and access areas • Proper siting of equipment, and chemical storage areas away from surface waters • Minimize slope disturbance from roads	Standard construction BMPs listed in Alternative 1 would be required for all construction components. Additional mitigation for this alternative includes: • A water filtration system, including a sediment pond, would be installed to remove solids from irrigation water. Pump intakes would be located over a deep hole	Standard construction BMPs listed in Alternative 1 would be required for the feeder canal construction.	None proposed.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUALITY MITIGATION (CONT)	• Construct roadways with low gradients • Ensure that storm water runoff from roads drains to outlets • Physically screen areas to remain undisturbed • Install erosion and sediment control measures during site preparation • Use silt fences, straw bales, sediment ponds, and other BMPs • Avoid sensitive wetland and riparian areas • Inspect construction site during or immediately after a rain event • Stockpile erosion and sediment control equipment The proposed new pump house station would be located away from the river bank and above the 100-year flood elevation. Additional mitigation for the pump station component includes: • A water filtration system, including a sediment pond, would be installed to remove solids from irrigation water. • Pump intakes would be located over a deep hole on the inside bend of the river to help minimize impacts and disturbances to the bed during construction and operation. • The bank would be shaped and protected from erosion by use of boulder and timber armoring and/or gabion baskets. • Screens for the intake pipes would be placed in a part of the river	on the inside bend of the river to help minimize impacts and disturbances to the bed during construction and operation. • The bank would be shaped and protected from erosion by use of boulder and timber armoring and/or gabion baskets. • Screens for the intake pipes would be placed in a part of the river channel with a relatively stable bed. • Mat gabions would be secured under the screens to prevent streambed erosion. Additional mitigation for stream rehab component includes: • Minimize crossing of stream • Use bridges as much as possible • Steam clean vehicles and equipment offsite regularly • Check for anti-freeze leaks and make any needed repairs • Use adequate slopes, bank stabilization, and revegetation methods to minimize erosion.		

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WATER QUALITY MITIGATION (CONT)	channel with a relatively stable bed. • Mat gabions would be secured under the screens to prevent streambed erosion. Additional mitigation for stream rehab component includes: • Steam clean vehicles and equipment offsite regularly • Check for anti-freeze leaks and make any needed repairs • Use adequate slopes, bank stabilization, and revegetation methods to minimize erosion.			
WETLANDS AND VEGETATION IMPACTS	Construction of the new pump station would result in the permanent loss of riparian vegetation, primarily white alder and cottonwood, at the proposed site. Construction of the pipeline would result in temporary loss of upland vegetation, primarily cheatgrass grassland, in Omak and in an abandoned orchard near the main canal. This impact is expected to be less than significant. Construction of the water filtration system and sediment pond would result in the permanent loss of upland vegetation near Diversion 2. This impact is expected to be less than significant. The feeder canal upgrade would result in temporary disturbance of vegetation along the canal route during removal of existing canal and construction of the proposed pipeline. Channel construction activities would be limited to late summer and	The feeder canal upgrade would result in temporary disturbance of vegetation along the canal route during removal of existing canal and construction of the proposed pipeline. Riparian habitat would be re-established in Lower Salmon Creek. Channel construction activities would be limited to late summer and early fall to minimize impacts to migratory fish. Construction at the Shellrock pump station would result in temporary impacts to riparian vegetation. Construction of the pipeline would result in temporary loss of upland vegetation in Omak and could temporarily impact orchards. The pipeline also would impact two small wetland areas. Direct impacts to sensitive species that occur in wetland or riparian areas could result from this alternative.	The feeder canal upgrade would result in temporary disturbance of vegetation along the canal route during removal of existing canal and construction of the proposed pipeline. Direct impacts to sensitive species that occur in wetland or riparian areas could result from this alternative, although less than Alternatives 1 and 2.	Stream incision and bank erosion downstream of Watercress Springs is likely to continue. Uncontrolled bank erosion could reduce the extent of riparian vegetation along lower Salmon Creek, or result in a change in species composition. Loss of riparian habitat would continue unabated and could worsen.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WETLANDS AND VEGETATION IMPACTS (CONT)	early fall to minimize impacts to migratory fish. Construction may result in temporary impacts to riparian vegetation. Direct impacts to sensitive species that occur in wetland or riparian areas could result from this alternative.	Construction of the sediment pond would result in the permanent loss of upland vegetation near the main canal. This impact is expected to be less than significant.		
WETLANDS AND VEGETATION MITIGATION	A special status plant survey would be conducted to locate any plant populations within the feeder canal construction corridor. Areas within the construction corridor containing special-status plant species, if found, would be fenced off so that construction equipment could avoid impacts to such species to the extent compatible with project goals. To ensure no transport of disturbed materials from upland sites into waterways, straw bales and silt fences would be placed downslope of upland grading locations prior to construction activities. Construction equipment and staging areas would be located to avoid impacts to wetland buffer areas and large, well-established vegetation, as well as to avoid priority habitats such as wetlands, riparian areas, shrub-steppe, and native grasslands.	A special status plant survey would be conducted to locate any plant populations within the feeder canal construction corridor. Areas within the construction corridor containing special-status plant species, if found, would be fenced off so that construction equipment could avoid impacts to such species to the extent compatible with project goals. To ensure no transport of disturbed materials from upland sites into waterways, straw bales and silt fences would be placed downslope of upland grading locations prior to construction activities. Best Management Practices (BMPs) for stream channel construction would be implemented during construction of the stream rehabilitation alternative to minimize impacts to riparian vegetation. Construction equipment and staging areas would be located to avoid impacts to wetland buffer areas and large, well-established vegetation, as well as to avoid priority habitats such as wetlands, riparian areas, shrub-steppe, and native grasslands.	A special status plant survey would be conducted to locate any plant populations within the feeder canal construction corridor. Areas within the construction corridor containing special-status plant species, if found, would be fenced off so that construction equipment could avoid impacts to such species to the extent compatible with project goals. To ensure no transport of disturbed materials from upland sites into waterways, straw bales and silt fences would be placed downslope of upland grading locations prior to construction activities. Construction equipment and staging areas would be located to avoid impacts to wetland buffer areas and large, well-established vegetation, as well as to avoid priority habitats such as wetlands, riparian areas, shrub-steppe, and native grasslands.	None proposed.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WILDLIFE IMPACTS	Riparian habitat would be re-established in Lower Salmon Creek slowly through time, benefiting rare, sensitive, and listed wildlife species. Construction of the new pump station would result in the permanent loss of riparian habitat, primarily white alder and cottonwood. Construction would result in direct impacts to wildlife species present in the project area. Construction of the pipeline would result in temporary loss of upland habitat, primarily cheatgrass grassland, in Omak and in an abandoned orchard near the main canal. Temporary disturbance of wildlife habitat along the canal route during removal of the existing canal and installation of the proposed pipeline may occur. Animals present in the construction zone, or that stray into it, could be impacted during construction activities.	Riparian habitat would be re-established more quickly in Lower Salmon Creek, benefiting rare, sensitive, and listed wildlife species. Construction activities in lower Salmon Creek would result in temporary impacts to riparian habitat, but is offset by the resulting enhancement of riparian habitat. Construction of the pipeline would result in temporary loss of upland habitat and impact two small wetlands in Omak. Construction would result in direct impacts to wildlife species present in the project area. Temporary disturbance of wildlife habitat along the canal route during removal of the existing canal and installation of the proposed pipeline may occur. Animals present in the construction zone, or that stray into it, could be impacted during construction activities.	Riparian habitat would be re-established slowly through time in Lower Salmon Creek, benefiting rare, sensitive, and listed wildlife species. Temporary disturbance of wildlife habitat along the canal route during removal of the existing canal and installation of the proposed pipeline may occur. Animals present in the construction zone, or that stray into it, could be impacted during construction activities.	Stream incision and bank erosion downstream of Watercress Springs is likely to occur. Uncontrolled bank erosion could reduce the extent of riparian habitat along lower Salmon Creek, or result in a loss of riparian wildlife populations or in a change of riparian species composition.
WILDLIFE MITIGATION	Prior to construction a qualified biologist would conduct site-specific surveys to evaluate the potential for special status wildlife to occur within the construction corridors. Any areas within the construction corridor that are occupied by special status species would be fenced off so that construction equipment can avoid impacts to the species.	Prior to construction a qualified biologist would conduct site-specific surveys to evaluate the potential for special status wildlife to occur within the construction corridors. Any areas within the construction corridor that are occupied by special status species would be fenced off so that construction equipment can avoid impacts to the species.	Prior to construction a qualified biologist would conduct site-specific surveys to evaluate the potential for special status wildlife to occur within the construction corridors. Any areas within the construction corridor that are occupied by special status species would be fenced off so that construction equipment can avoid impacts to the species.	None proposed.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
WILDLIFE MITIGATION (CONT)	Sensitive habitats in the Project area that could potentially be impacted would also be fenced for avoidance. Timing of construction or maintenance operation would be adjusted to avoid or minimize disturbances to special status species. A qualified biologist would conduct surveys to locate any active migratory bird nests prior to vegetation removal for construction during the breeding season. Fence off areas within the construction corridor containing active nests. Removal of that vegetation containing active nests would be postponed until after the nesting season. BMPs would be implemented to minimize sediment and pollution during construction activities.	Sensitive habitats in the Project area that could potentially be impacted would also be fenced for avoidance. Timing of construction or maintenance operation would be adjusted to avoid or minimize disturbances to special status species. A qualified biologist would conduct surveys to locate any active migratory bird nests prior to vegetation removal for construction during the breeding season. Fence off areas within the construction corridor containing active nests. Removal of that vegetation containing active nests would be postponed until after the nesting season. BMPs would be implemented to minimize sediment and pollution during construction activities.	Sensitive habitats in the Project area that could potentially be impacted would also be fenced for avoidance. Timing of construction or maintenance operation would be adjusted to avoid or minimize disturbances to special status species. A qualified biologist would conduct surveys to locate any active migratory bird nests prior to vegetation removal for construction during the breeding season. Fence off areas within the construction corridor containing active nests. Removal of that vegetation containing active nests would be postponed until after the nesting season. BMPs would be implemented to minimize sediment and pollution during construction activities.	
FISHERIES IMPACTS *Okanogan River*	Construction design and techniques should minimize impacts. Facility may provide habitat for warm water predators. Temporary increases in TSS and sediment from construction. Increased water withdrawals may have minor impact on flows, levels, and temperature for 1.3 miles to confluence with Salmon Creek. Downstream of confluence, cooler Salmon Creek water will significantly improve river water quality, thermal conditions, and ability to withstand dry year impacts.	Temporary increases in TSS and sediments from construction. Potential improved habitat associated with deeper intake channel. Increased pumping capabilities may intensify withdrawals but reduce length of pumping periods, improving ability to time pumping more favorably for fisheries. Downstream of confluence, cooler Salmon Creek water will significantly improve river water quality, thermal conditions, and ability to withstand dry year impacts.	No construction impacts. Increased water withdrawals may have minor impact on flows, levels, and temperature for 1.3 miles to confluence with Salmon Creek. Downstream of confluence, cooler Salmon Creek water will significantly improve river water quality, thermal conditions, and ability to withstand dry year impacts. Absent stream rehabilitation, restored flows through Salmon Creek could result in undesirable delivery of increased sediment to the river.	Current irrigation pumping would continue to endanger fish at the intake and at the screen. Instream flow violations would persist. There would be no improvements to water quantity or quality downstream of the confluence with Salmon Creek. Alluvial bar at confluence will continue to prevent improved habitat and to constitute a passage barrier.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
FISHERIES IMPACTS (CONT) *Okanogan River*	Some site-specific habitat loss. Reduced sediments and increased flows from restored Salmon Creek would improve habitat, water quality (especially temperature), and water quantity in the Okanogan River, especially from the confluence downstream.	Some potential site-specific habitat loss. Reduced sediments over the long term, and increased flows from restored Salmon Creek would improve habitat, water quality (especially temperature), and water quantity in the Okanogan River, especially from the confluence downstream.		
Lower Reach Salmon Creek	Temporary increases in TSS and sediment from construction at mouth of Salmon Creek. Removal of substrate bar at confluence could improve habitat and migration routes. Flows restored to levels supportive of seasonal fish migration, including adequate winter base flow. Associated benefits of improved water quality, reduced temperature, and habitat improvement. Chinook and steelhead may out-compete kokanee and small trout. Absent stream rehabilitation, restored flows through Salmon Creek could result in a low amount of undesirable delivery of increased sediment to the river.	Temporary increases in TSS and sediment from rehab construction. Reduced channel erosion, increased shade, expanded habitat, increased flows (especially during low flow periods), and improved water quality, including thermal benefits. Chinook and steelhead may out-compete kokanee and small trout. Flows restored to levels supportive of seasonal fish migration, including adequate winter base flow with associated benefits of improved water quality, reduced temperature, and habitat improvement. Increased flows through lower reach will improve habitat, water quantity, and water quality (especially temperature).	No construction impacts. Flows restored to levels supportive of seasonal fish migration, including adequate winter base flow. Associated benefits of improved water quality, reduced temperature, and habitat improvement. Absent stream rehabilitation, restored flows through Salmon Creek could result in a low amount of undesirable delivery of increased sediment to the river. Chinook and steelhead may out-compete kokanee and small trout.	Streamflows would remain low, nearing zero in most months. This represents a loss of 4.3 miles of potential habitat. Flows would be inadequate for supporting migration or spawning of steelhead or chinook.
Middle Reach Salmon Creek	No construction impacts. Reduction of unnaturally high summer flows and restoration of winter base flows. Significant improvement to anadromous passage and habitat for all stocks and stages. Resident fish benefit from expanded habitat.	No construction impacts. Reduction of unnaturally high summer flows and restoration of winter base flows. Significant improvement to anadromous passage and habitat for all stocks and stages. Resident fish benefit from expanded habitat.	No construction involved. Reduction of unnaturally high summer flows and restoration of winter base flows. Significant improvement to anadromous passage and habitat for all stocks and stages. Resident fish benefit from expanded habitat.	Flows would continue to be unnaturally high in summer and low in winter. Minimum flows not met for November – April, significantly reducing migration and spawning potential for adults and outmigration for smolts.

	Alternative 1 New Pump Station	Alternative 2 Upgrade Shellrock	Alternative 3 Purchase Water Rights	Alternative 4 No Action
FISHERIES IMPACTS (CONT)	Water quality benefits including thermal, dissolved oxygen, and sediment. Improved feeder canal may provide some ability to control reservoir storage and provide improved flows downstream with associated benefits to stocking programs, water quality, and habitat.	Water quality benefits including thermal, dissolved oxygen, and sediment. Improved feeder canal may provide some ability to control reservoir storage and provide improved flows downstream with associated benefits to stocking programs, water quality, and habitat.	Water quality benefits including thermal, dissolved oxygen, and sediment. Improved feeder canal may provide some ability to control reservoir storage and provide improved flows downstream with associated benefits to stocking programs, water quality, and habitat.	
Upper Reach Salmon Creek	Short-term, localized increases in TSS and solids from construction in North Fork down to Conconully Reservoir. Potential long-term loss of habitat at canal entrance. Potential streamflow decrease for portion of North Fork at various times throughout the year, resulting in habitat loss, and some migratory limitations. <u>North, West, South Forks</u> Kokanee and resident rainbow trout spawning may be further limited.	Short-term, localized increases in TSS and solids from construction in North Fork down to Conconully Reservoir. Potential long-term loss of habitat at canal entrance. Potential streamflow decrease for portion of North Fork at various times throughout the year, resulting in habitat loss, and some migratory limitations. <u>North, West, South Forks</u> Kokanee and resident rainbow trout spawning may be further limited.	Short-term, localized increases in TSS and solids from construction in North Fork down to Conconully Reservoir. Potential long-term loss of habitat at canal entrance. Potential streamflow decrease for portion of North Fork at various times throughout the year, resulting in habitat loss, and some migratory limitations. <u>North, West, South Forks</u> Kokanee and resident rainbow trout spawning may be further limited.	Reach would continue as naturally-flowing, unregulated stream. Fish production would remain unchanged.
Reservoirs	Greater water supply to reservoirs would enable improved water management of reservoir levels with associated benefits of increased habitat for resident and anadromous stocks, reduced water temperatures (favoring salmonids over warm water species), decreased algae, and increased dissolved oxygen levels. Stocking levels of steelhead trout may be able to be reduced.	Greater water supply to reservoirs would enable improved water management of reservoir levels with associated benefits of increased habitat, reduced water temperatures (favoring salmonids over warm water species), decreased algae, and increased dissolved oxygen levels. Stocking levels of steelhead trout may be able to be reduced	Greater water supply to reservoirs would enable improved water management of reservoir levels with associated benefits of increased habitat, reduced water temperatures (favoring salmonids over warm water species), decreased algae, and increased dissolved oxygen levels. Stocking levels of steelhead trout may be able to be reduced	Surface elevations would continue to fluctuate, resulting in continued impairment of reservoir fisheries. Stocking efforts would likely need to be continued indefinitely.

FISHERIES MITIGATION	*Construction Mitigation* • Have emergency spill containment kits available to contain and remove accidentally spilled fuels, hydraulic fluids, etc. immediately. • All equipment refueling and fuel storage would not occur within 100 ft. of any surface water. • Disposal of waste materials and washing of equipment would not occur within 100 ft. of any watercourse, ravine, drainage ditch, etc. • A spill prevention, control and countermeasures plan (SPCC) would be developed prior to the start of construction. • Construction of steep, straight roads, which could result in concentration of runoff and channelization, would be avoided. • Access roads and pipelines would be sited to avoid water bodies and riparian areas. When in close proximity, sedimentation control structures would be put in place prior to beginning work. • All construction access roads, staging areas, and any other disturbed upland or riparian vegetated area would be revegetated following construction. • Pump intake devices would be located in areas of river where disturbance to the streambed and stream bank are minimized. They would also be located on mat gabions to help prevent disturbance.	*Construction Mitigation* • Have emergency spill containment kits available to contain and remove accidentally spilled fuels, hydraulic fluids, etc. immediately. • All equipment refueling and fuel storage would not occur within 100 ft. of any surface water. . • Disposal of waste materials and washing of equipment would not occur within 100 ft. of any watercourse, ravine, drainage ditch, etc. • A spill prevention, control and countermeasures plan (SPCC) would be developed prior to the start of construction. • Construction of steep, straight roads, which could result in concentration of runoff and channelization, would be avoided. • Access roads and pipelines would be sited to avoid water bodies and riparian areas. When in close proximity, sedimentation control structures would be put in place prior to beginning work. • All construction access roads, staging areas, and any other disturbed upland or riparian vegetated area would be revegetated following construction. • Pump intake devices would be located in areas of river where disturbance to the streambed and stream bank are minimized. They would also be located on mat gabions to help prevent disturbance.	*Construction Mitigation* • Have emergency spill containment kits available to contain and remove accidentally spilled fuels, hydraulic fluids, etc. immediately. • All equipment refueling and fuel storage would not occur within 100 ft. of any surface water. • Disposal of waste materials and washing of equipment would not occur within 100 ft. of any watercourse, ravine, drainage ditch, etc. • A spill prevention, control and countermeasures plan (SPCC) would be developed prior to the start of construction. • Construction of steep, straight roads, which could result in concentration of runoff and channelization, would be avoided. • Access roads and pipelines would be sited to avoid water bodies and riparian areas. When in close proximity, sedimentation control structures would be put in place prior to beginning work. • All construction access roads, staging areas, and any other disturbed upland or riparian vegetated area would be revegetated following construction. • To the greatest extent possible, construction activities would be timed around periods of lowest fish use and instream flows.	*Construction Mitigation* None

FISHERIES MITIGATION (CONT)	• To the greatest extent possible, construction activities would be timed around periods of lowest fish use and instream flows. *Operational Mitigation* • A water filtration system would be constructed to mitigate for water being used from the Okanogan River with a high total suspended solid concentration. • Pump intake and diversion canal fish screens would be designed in accordance with NOAA Fisheries specifications and utilized to prevent fish from entering pumping structures or irrigation canals and to prevent injury. • Pilings would be driven into the streambed in front of fish screens to prevent damage by floating debris, maintaining functionality of fish screens. • Pump intake structures would be located in locations where they would have the least impact when in operation. • The Okanogan Irrigation District Comprehensive Water Conservation Program would be implemented to conserve water and prevent excess irrigation runoff. • Pump station would be located away from the riverbank and above the elevation of the 100-year floodplain. • Streambanks along Project structures would be protected from erosion using methods such as boulder and timber armoring or rock gabions.	• To the greatest extent possible, construction activities would be timed around periods of lowest fish use and instream flows. *Operational Mitigation* • A water filtration system would be constructed to mitigate for water being used from the Okanogan River with a high total suspended solid concentration. • Pump intake and diversion canal fish screens would be designed in accordance with NOAA Fisheries specifications and utilized to prevent fish from entering pumping structures or irrigation canals and to prevent injury. • Pilings would be driven into the streambed in front of fish screens to prevent damage by floating debris, maintaining functionality of fish screens. • Pump intake structures would be located in locations where they would have the least impact when in operation. • The Okanogan Irrigation District Comprehensive Water Conservation Program would be implemented to conserve water and prevent excess irrigation runoff. • Streambanks along Project structures would be protected from erosion using methods such as boulder and timber armoring or rock gabions. • Work with landowners adjacent to the mainstem Okanogan River and Salmon Creek and their tributaries in order to minimize impacts of land use on fisheries resources.	*Operational Mitigation* • The Okanogan Irrigation District Comprehensive Water Conservation Program would be implemented to conserve water and prevent excess irrigation runoff. • Streambanks along Project structures would be protected from erosion using methods such as boulder and timber armoring or rock gabions. • Work with landowners adjacent to the mainstem Okanogan River and Salmon Creek and their tributaries in order to minimize impacts of land use on fisheries resources.	*Operational Mitigation* • The Okanogan Irrigation District Comprehensive Water Conservation Program would be implemented to conserve water and prevent excess irrigation runoff. • Work with landowners adjacent to the mainstem Okanogan River and Salmon Creek and their tributaries in order to minimize impacts of land use on fisheries resources.

FISHERIES MITIGATION (CONT)	• Work with landowners adjacent to the mainstem Okanogan River and Salmon Creek and their tributaries in order to minimize impacts of land use on fisheries resources. *Resource Management Plan (RMP)* • The RMP would provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs. • The Streamflow and Reservoir Operation Plan would provide for monitoring streamflows and reservoir water levels and operation, as well as the associated impacts on Project goals. • The Stream Channel and Riparian Management Plan would provide for monitoring impacts associated with streamflow and provide actions to be taken as mitigation. • The Fisheries Management Plan would establish management criteria for each target species. • ***The*** Monitoring ***and Adaptive Management Plan would provide for ongoing adjustments to management plans as necessary***.	*Resource Management Plan (RMP)* • The RMP would provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs. • The Streamflow and Reservoir Operation Plan would provide for monitoring streamflows and reservoir water levels and operation, as well as the associated impacts on Project goals. • The Stream Channel and Riparian Management Plan would provide for monitoring impacts associated with streamflow and provide actions to be taken as mitigation. • The Fisheries Management Plan would establish management criteria for each target species. • The Monitoring and Adaptive Management Plan would provide for ongoing adjustments to management plans as necessary.	*Resource Management Plan (RMP)* Not applicable.	*Resource Management Plan (RMP)* • The RMP would provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs. • The Streamflow and Reservoir Operation Plan would provide for monitoring streamflows and reservoir water levels and operation, as well as the associated impacts on Project goals. • The Stream Channel and Riparian Management Plan would provide for monitoring impacts associated with streamflow and provide actions to be taken as mitigation. • The Fisheries Management Plan would establish management criteria for each target species. • The Monitoring and Adaptive Management Plan would provide for ongoing adjustments to management plans as necessary.

LAND USE and SHORELINES IMPACTS	Short-term construction impacts would occur to land uses adjacent or near the new pump station, at the mouth of Salmon Creek, or along the pipeline route. Such impacts might include temporary increases in localized noise levels and increases in traffic congestion as a result of construction-related truck traffic/routing or heavy equipment use. Properties along Lower Salmon Creek may experience increased regulation to protect habitat and water quality. Short-term, construction-related activity could indirectly affect nearby and adjacent land uses in the Town of Conconully. Such impacts might include temporary increases in localized noise levels and increases in traffic congestion as a result of construction-related truck traffic/routing or heavy equipment use.	Short-term construction impacts would occur to land uses adjacent or near the Shellrock pump station, along the pipeline route, and along the lower 4.3 miles of Salmon Creek. Such impacts might include temporary increases in localized noise levels and increases in traffic congestion as a result of construction-related truck traffic/routing or heavy equipment use. As a result of channel rehabilitation, land uses along portions of Salmon Creek may require greater regulation under the City's and County's Critical Areas Ordinance. Parcels adjacent to Lower Salmon Creek may require increased setbacks, new permits, review and mitigation, which may limit land use. Short-term, construction-related activity could indirectly affect nearby and adjacent land uses in the Town of Conconully. Such impacts might include temporary increases in localized noise levels and increases in traffic congestion as a result of construction-related truck traffic/routing or heavy equipment use.	Properties along Lower Salmon Creek may experience increased regulation to protect habitat and water quality. Short-term, construction-related activity could indirectly affect nearby and adjacent land uses in the Town of Conconully. Such impacts might include temporary increases in localized noise levels and increases in traffic congestion as a result of construction-related truck traffic/routing or heavy equipment use.	None.
LAND USE and SHORELINES MITIGATION	Because no significant land use impacts have been identified, no land use mitigation measures are required or proposed. Measures to address short-term construction impacts are addressed elsewhere within the appropriate DEIS section.	Because no significant land use impacts have been identified, no land use mitigation measures are required or proposed. Measures to address short-term construction impacts are addressed elsewhere within the appropriate DEIS section.	Because no significant land use impacts have been identified, no land use mitigation measures are required or proposed. Measures to address short-term construction impacts are addressed elsewhere within the appropriate DEIS section.	None proposed.
VISUAL RESOURCES IMPACTS	Construction of a new pump house station would remove existing riparian vegetation and alter the visual landscape. The new structure would be visible from the Okanogan River, and to properties adjacent and/or near the site.	Upgrading the Shellrock pump station would not change the visual landscape of the existing site. Construction of a new pipeline would result in short-term scarring of the landscape along the pipeline route.	Approximately 1,400 acres of farmland would be removed from production returning to the more arid, sparsely vegetated landscape characteristic of undeveloped land in the area.	Minimum monthly stream flows in Lower salmon Creek would remain at zero during most months, and the visual landscape would continue to present a degraded, dewatered view. Salmon Lake and Conconully

VISUAL RESOURCES IMPACTS (CONT)	Construction of a new pipeline would result in short-term scarring of the hillside as the pipeline climbs a 25% grade. A portion of the existing concrete canal feeding Salmon Lake would be removed and replaced with a buried pipeline. No long-term visual impacts would result from upgrading the existing canal. Regulating flow and re-establishing seasonal flows in Lower Salmon Creek would be a positive impact. Median reservoir elevations would be higher and seasonal fluctuations would be reduced, positively impacting the visual landscape. Minimum reservoir levels would decrease in some months.	Regulating flow and re-establishing seasonal flows in Lower Salmon Creek would be a positive impact. A portion of the existing concrete canal feeding Salmon Lake would be removed and replaced with a buried pipeline. No long-term visual impacts would result from upgrading the existing canal. Median reservoir elevations would be higher and seasonal fluctuations would be reduced, positively impacting the visual landscape. Minimum reservoir levels would decrease in some months. The Lower Salmon Creek visual landscape would be positively impacted by a combination of the reestablishment of riparian vegetation, site-specific treatment of eroding stream banks, floodplain reconnection, and land use management practices to enhance channel and habitat conditions. The addition of water to Salmon Creek would generally have positive impacts on the visual landscape by re-establishing a green riparian zone along the banks of the creek.	A portion of the existing concrete canal feeding Salmon Lake would be removed and replaced with a buried pipeline. No long-term visual impacts would result from upgrading the existing canal. Regulating flow and re-establishing seasonal flows in Lower Salmon Creek would be a positive impact. Median reservoir elevations would be higher and seasonal fluctuations would be reduced, positively impacting the visual landscape. Minimum reservoir levels would decrease in some months.	Lake reservoirs would experience lower lake levels during dry seasonal periods.
VISUAL RESOURCES MITIGATION	Other than short-term construction mitigation no other measures are proposed. Landscaping and screening would lessen the visual impact of the new pump house.	Other than short-term construction mitigation no other measures are proposed.	Other than short-term construction mitigation no other measures are proposed.	None proposed.

SOCIO-ECONOMIC IMPACTS	No effect on revenues or net income to district growers as compared to the No Action Alternative Pumping from the Okanogan River would increase, leading to higher costs to deliver the water for irrigation. There are no indirect and induced effects on output, income, and employment. There would be virtually no effect on reservoir recreation and the associated tourism-based economy in and around Conconully during wet or normal water years as compared to the No Action Alternative. In dry years, a small positive effect on recreation may be realized, as lake levels are stabilized and relatively higher than the comparable No Action Alternative dry water years.	No effect on revenues or net income to district growers as compared to the No Action Alternative. Pumping from the Okanogan River would increase, leading to higher costs to deliver the water for irrigation. There are no indirect and induced effects on output, income, and employment. There would be virtually no effect on reservoir recreation and the associated tourism-based economy in and around Conconully during wet or normal water years as compared to the No Action Alternative. In dry years, a small positive effect on recreation may be realized, as lake levels are stabilized and relatively higher than the comparable No Action Alternative dry water years.	Total crop revenue from production within the district is reduced by as much as a fourth, although net income to remaining district growers is unaffected. Pumping from the Okanogan River would increase, leading to higher costs to deliver the water for irrigation. Total output in the county is reduced annually by nearly $4.1 million, primarily affecting the agriculture sector. This output reduction represents about 0.3 percent of total output in the county, but the loss in the agricultural sector accounts for approximately 1.4 percent of total agricultural output. Income is reduced by nearly $1.8 million annually, and there is an associated loss of about 118 jobs. Most of these job losses are in the agriculture sector, and account for about two percent of employment in that sector. Impacts on property taxes are realized where formerly agricultural land changes to non-productive status. However, tax base impacts are negligible. There would be virtually no effect on reservoir recreation and the associated tourism-based economy in and around Conconully recreation during wet or normal water years as compared to the No Action Alternative. In dry years, a small negative effect on recreation may be realized as compared to the comparable No Action Alternative dry water years.	Agricultural crops may vary based on local and regional economic trends. There is an unknown impact of what would be required in the future for Endangered Species Act enforcement.
SOCIO-ECONOMIC MITIGATION	Higher pumping costs may be mitigated by the public sector covering additional costs that would be incurred over and above the No Action Alternative.	Higher pumping costs may be mitigated by the public sector covering additional costs that would be incurred over and above the No Action Alternative.	Lost income from agricultural land that is no longer in service would be offset by the water right purchase amount going to the owners of idled land.	None proposed.

SOCIO-ECONOMIC MITIGATION (CONT)	No mitigation is proposed for income and job losses.	No mitigation is proposed for income and job losses.	Higher pumping costs may be mitigated by the public sector covering additional costs that would be incurred over and above the No Action Alternative. No mitigation is proposed for income and job losses.	
PUBLIC SERVICES and UTILITIES IMPACTS	The demand for power would increase with increased pumping at the new station site. Short-term construction impacts may result in disruption of some public service utilities during excavation and trenching of the pipeline.	Increased pumping at Shellrock would raise demand for power. Short-term construction activities associated with rehabilitation of Salmon Creek or excavation and trenching of the pipeline could cause a temporary disruption in public services.	No impacts to public services and utilities have been identified.	Public utilities and services along Lower salmon Creek would remain relatively unchanged. The Feeder Canal would continue to slowly degrade and eventually become unstable without major repair work.
PUBLIC SERVICES and UTILITIES MITIGATION	Other than short-term construction mitigation no other measures are proposed.	Contractors and local officials would work with fire services to establish alternate routes to minimize any disruptions in public services along Salmon Creek. Short-term construction mitigation will also be required.	Other than short-term construction mitigation no other measures are proposed.	None proposed.
CULTURAL RESOURCES IMPACTS	The location of the proposed new pump station is in an area of high potential for cultural resources. Much of the route of the proposed new pipeline is in areas of moderate to high potential for cultural resources. The historic qualities of the feeder canal will be altered, however that impact has already been mitigated via completion of HABS/HAER documentation. Channel rehabilitation at the mouth of Salmon Creek will be conducted in areas of high potential for presence of cultural resources.	The upgrade to the pump station is not expected to have any impact. Much of the route of the proposed new pipeline is in areas of moderate to high potential for cultural resources. The historic qualities of the feeder canal will be altered, however that impact has already been mitigated via completion of HABS/HAER documentation. Channel rehabilitation in the area of the town dumpsite may expose areas containing cultural resources of unknown quality, composition, or significance.	Absent stream rehabilitation, higher flows would be present in Salmon Creek and any consequent erosion could produce an associated increase in unintended exposure of buried cultural resources. The historic qualities of the feeder canal will be altered, however that impact has already been mitigated via completion of HABS/HAER documentation.	Streambank erosion will continue to threaten unintended exposure of buried cultural resources. In particular, the current pace of exposure of unknown items and materials from the town dumpsite will continue. Cultural resources on the site of the proposed pump station and along the route of the proposed pipeline will not be disturbed. The historically significant feeder canal may continue to deteriorate. Any further bank deterioration/erosion associated with the existing feeder canal will threaten unintended exposure of buried cultural resources.

CULTURAL RESOURCES IMPACTS (CONT)	Higher flows would be present in Salmon Creek and any consequent erosion could produce an associated increase in unintended exposure of buried cultural resources	Channel rehabilitation in the lower portion of the creek will be conducted in areas of high potential for presence of cultural resources.		
CULTURAL RESOURCES MITIGATION	Comprehensive field investigation prior to conducting work, specifically including: • Intensive pedestrian survey of the identified APE areas. • Shovel test probes at the Okanogan pump station site. • Shovel test probes along the proposed pipeline near the town of Okanogan on banks, terraces, and landforms with less than 10% slope. Recommended spacing of test holes at 20-40 meter intervals. As an alternative to test probes, full cultural resource monitoring of all pipeline excavation on banks, terraces, and landforms with less than 10% slope would be appropriate. • Conduct further discussions with the Colville Tribe to determine the location of the TCP and to include any ethnographic information the Tribe is willing to share within this section or to be included within a Technical Report. • Additional field survey for historical resources. • Care should be taken to avoid any known cultural resources within the APE. This analysis is preliminary because of the difficulty in clearing assessing effects prior to selecting a preferred alternative and identifying the local commitment to avoidance or mitigation	Comprehensive field investigation prior to conducting work, specifically including: • Intensive pedestrian survey of the identified APE areas. • Shovel test probes at any areas that would be disturbed by the proposed upgrade to the Shellrock pump station. • Shovel test probes along the proposed pipeline near the town of Okanogan on banks, terraces, and landforms with less than 10% slope. Recommended spacing of test holes at 20-40 meter intervals. As an alternative to test probes, full cultural resource monitoring of all pipeline excavation on banks, terraces, and landforms with less than 10% slope would be appropriate. • Shovel test probes along those alluvial benches of Salmon Creek that will be affected by stream rehabilitation. Some benches have been noted to have little soil deposition and should be considered as having low probability of containing subsurface cultural resources. • Avoidance of the historic Okanogan Town trash dump located along the north bank of Salmon Creek. • Conduct further discussions with the Colville Tribe to determine the location of the TCP and to include	None proposed.	None proposed.

CULTURAL RESOURCES MITIGATION (CONT)	measures. • HABS/HAER documentation should be undertaken for demolition or alteration of historical resources. Salvage of building parts or the moving of historical resources is another form of mitigation. • In the event that human remains are discovered during the conduct of any of the fieldwork proposed, the protocol detailed within an Unanticipated Discovery Plan should be followed. The plan should be developed as part of an MOA prior to the completion of the Final EIS. Construction monitoring of areas with high sensitivity for archaeological resources should also be included within the MOA. • Have a cultural resource monitor be present on site if any work is conducted in the area of the town dumpsite. An option would be to conduct backhoe trench testing prior to bank stabilization. • Conduct an intensive pedestrian survey prior to starting construction on any component of this project that would disturb ground, including rehabilitation work at the mouth of Salmon Creek, the pipeline, and the pump station location. • Conduct a hydraulic assessment of the creek taking into account the proposed increase of stream flows and its effects on bank erosion. Increases in the water table should be considered. • If further testing determines there are very old (19th century)	any ethnographic information the Tribe is willing to share within this section or to be included within a Technical Report. • Additional field survey for historical resources. • Care should be taken to avoid any known cultural resources within the APE. This analysis is preliminary because of the difficulty in clearing assessing effects prior to selecting a preferred alternative and identifying the local commitment to avoidance or mitigation measures. • HABS/HAER documentation should be undertaken for demolition or alteration of historical resources. Salvage of building parts or the moving of historical resources is another form of mitigation. • In the event that human remains are discovered during the conduct of any of the fieldwork proposed, the protocol detailed within an Unanticipated Discovery Plan should be followed. The plan should be developed as part of an MOA prior to the completion of the Final EIS. Construction monitoring of areas with high sensitivity for archaeological resources should also be included within the MOA. • Conduct an intensive pedestrian survey prior to starting construction on any component of this project that would disturb ground, including rehabilitation work along the streambanks of Salmon Creek, the pipeline, and		

CULTURAL RESOURCES MITIGATION (CONT)	artifacts, avoid disturbance of the Okanogan town dumpsite, if possible. • Minimize disturbance to any discovered cultural resources, if possible.	Shellrock station. • Conduct a hydraulic assessment of the creek taking into account the proposed increase of stream flows and its effects on bank erosion. Increases in the water table should be considered. • Minimize disturbance to any discovered cultural resources, if possible.		
HEALTH AND SAFETY IMPACTS	Temporary increased noise, transport of large equipment, and degradation of air quality near construction sites. Increased risk of fire near construction operations. Increased stream flows in Lower Salmon Creek could raise the overall water table in the vicinity of the town dumpsite and/or speed streambank erosion near the dumpsite. Increased chance of hazardous spills of gas, oil, and hydraulic fluids due to presence of construction equipment. New pump station will introduce a new source of noise in Okanogan area. The pumps will be housed in a concrete structure to lessen noise.	Temporary increased noise, transport of large equipment, and degradation of air quality near construction sites. Increased risk of fire near construction operations. Increased stream flows in Lower Salmon Creek could raise the overall water table in the vicinity of the town dumpsite. Increased chance of hazardous spills of gas, oil, and hydraulic fluids due to presence of construction equipment. Operations within lower Salmon Creek will increase noise and risk of spills in this area for a couple months or more.	Temporary increased noise, transport of large equipment, and degradation of air quality near construction sites. Increased risk of fire near construction operations. Increased stream flows in Lower Salmon Creek could raise the overall water table in the vicinity of the town dumpsite and/or speed streambank erosion near the dumpsite. Increased chance of hazardous spills of gas, oil, and hydraulic fluids due to presence of construction equipment.	Erosion of the Salmon Creek stream bank is occurring and exposing some items that were deposited in the Okanogan town dumpsite. According to state and federal records, no evidence of leaching or contamination from hazardous or toxic materials has been detected thus far. Taking no action would result in the bank continuing to erode at its current rate, further exposing buried items and unknown other materials. Sloughing of the hillside into the feeder canal and potential failure of the canal would remain as a concern. Annual maintenance to keep the feeder canal functioning would be required.
HEALTH AND SAFETY MITIGATION	• Conduct a hydraulic assessment of Salmon Creek taking into account the proposed increase of stream flows and its effects on bank erosion and determine whether there would be increases in the water table and potential resultant leachates from the dumpsite.	• Investigate and identify possible contaminants in the Okanogan town dumpsite if proposed rehabilitation would impact the area. • Conduct a hydraulic assessment of Salmon Creek taking into account the proposed increase of stream flows and its effects on bank erosion and determine	• Conduct a hydraulic assessment of Salmon Creek taking into account the proposed increase of stream flows and its effects on bank erosion and determine whether there would be increases in the water table and potential resultant leachates from the dumpsite. • Any spills or releases of hazardous materials would be cleaned up and	None proposed

HEALTH AND SAFETY MITIGATION (CONT)	• Any spills or releases of hazardous materials would be cleaned up and disposed of or treated according to applicable regulations. Accidental releases of hazardous materials to the environment would be prevented or minimized through the proper containment of oil and fuel in storage areas. • A spill prevention, control, and countermeasures (SPCC) plan would be prepared prior to the start of construction, and implemented to minimize the potential for hazardous materials to enter surface or groundwater. • When working within or adjacent to any drainage ditch, watercourse, ravine, etc., the construction contractor would have an emergency spill containment kit to contain and remove any accidentally spilled fuels, hydraulic fluids, etc. • Equipment refueling and storage of fuels and hydraulic fluids or any other toxic or deleterious materials would not occur within 100 feet of surface water. • Strict procedures for disposal of common construction materials (e.g., concrete, paint, and wood preservatives) and petroleum products (e.g., fuels, lubricants, and hydraulic fluids) or any other hazardous materials used during construction would be followed. • Discharge of solid materials including building materials into waters of the United States would be avoided unless authorized by a Clean Water Act Section 404	whether there would be increases in the water table and potential resultant leachates from the dumpsite. • Any spills or releases of hazardous materials would be cleaned up and disposed of or treated according to applicable regulations. Accidental releases of hazardous materials to the environment would be prevented or minimized through the proper containment of oil and fuel in storage areas. • A spill prevention, control, and countermeasures (SPCC) plan would be prepared prior to the start of construction, and implemented to minimize the potential for hazardous materials to enter surface or groundwater. • When working within or adjacent to any drainage ditch, watercourse, ravine, etc., the construction contractor would have an emergency spill containment kit to contain and remove any accidentally spilled fuels, hydraulic fluids, etc. • Equipment refueling and storage of fuels and hydraulic fluids or any other toxic or deleterious materials would not occur within 100 feet of surface water. • Strict procedures for disposal of common construction materials (e.g., concrete, paint, and wood preservatives) and petroleum products (e.g., fuels, lubricants, and hydraulic fluids) or any other hazardous materials used during construction would be followed. • Discharge of solid materials	disposed of or treated according to applicable regulations. Accidental releases of hazardous materials to the environment would be prevented or minimized through the proper containment of oil and fuel in storage areas. • A spill prevention, control, and countermeasures (SPCC) plan would be prepared prior to the start of construction, and implemented to minimize the potential for hazardous materials to enter surface or groundwater. • When working within or adjacent to any drainage ditch, watercourse, ravine, etc., the construction contractor would have an emergency spill containment kit to contain and remove any accidentally spilled fuels, hydraulic fluids, etc. • Equipment refueling and storage of fuels and hydraulic fluids or any other toxic or deleterious materials would not occur within 100 feet of surface water. • Strict procedures for disposal of common construction materials (e.g., concrete, paint, and wood preservatives) and petroleum products (e.g., fuels, lubricants, and hydraulic fluids) or any other hazardous materials used during construction would be followed. • Discharge of solid materials including building materials into waters of the United States would be avoided unless authorized by a Clean Water Act Section 404 permit. • To the extent possible, excavation and grading would be timed to coincide with the dry seasons to reduce the potential for water	

HEALTH AND SAFETY MITIGATION (CONT)	permit. • To the extent possible, excavation and grading would be timed to coincide with the dry seasons to reduce the potential for water erosion. Water would be applied to control dust and minimize wind erosion. • To the extent feasible, slopes would be graded to no steeper than 2 horizontal: 1 vertical • All noise producing equipment and vehicles using internal combustion engines would be equipped with mufflers and air inlet silencers, where appropriate; be in good operating condition; and meet or exceed original factory specifications. Mobile or fixed "package" equipment (e.g., arc welders and air compressors) would be equipped with shrouds and noise control features that are readily available for that type of equipment. • To prevent accidental fires during construction of the Project, workers would be required to avoid idling vehicles in grassy areas and to keep welding machines and similar equipment away from dry vegetation.	including building materials into waters of the United States would be avoided unless authorized by a Clean Water Act Section 404 permit. • To the extent possible, excavation and grading would be timed to coincide with the dry seasons to reduce the potential for water erosion. Water would be applied to control dust and minimize wind erosion. • To the extent feasible, slopes would be graded to no steeper than 2 horizontal: 1 vertical • All noise producing equipment and vehicles using internal combustion engines would be equipped with mufflers and air inlet silencers, where appropriate; be in good operating condition; and meet or exceed original factory specifications. Mobile or fixed "package" equipment (e.g., arc welders and air compressors) would be equipped with shrouds and noise control features that are readily available for that type of equipment. To prevent accidental fires during construction of the Project, workers would be required to avoid idling vehicles in grassy areas and to keep welding machines and similar equipment away from dry vegetation.	erosion. Water would be applied to control dust and minimize wind erosion. • To the extent feasible, slopes would be graded to no steeper than 2 horizontal: 1 vertical • All noise producing equipment and vehicles using internal combustion engines would be equipped with mufflers and air inlet silencers, where appropriate; be in good operating condition; and meet or exceed original factory specifications. Mobile or fixed "package" equipment (e.g., arc welders and air compressors) would be equipped with shrouds and noise control features that are readily available for that type of equipment. • To prevent accidental fires during construction of the Project, workers would be required to avoid idling vehicles in grassy areas and to keep welding machines and similar equipment away from dry vegetation.	

3.0 EXISTING CONDITIONS, ENVIRONMENTAL IMPACTS, AND MITIGATION MEASURES

A Summary comparing the environmental impacts of the alternatives described in this chapter is included at the end of Chapter 2 in Table 2-11.

3.1 WATER QUANTITY

3.1.1 EXISTING CONDITIONS

3.1.1.1 Surface Water

Okanogan River

Watershed Characteristics

The 8,340 square mile Okanogan River watershed is the largest of the four main mid-Columbia River tributaries. About 75 percent of the watershed lies in the Canadian province of British Columbia, with the remaining 25 percent in north-central Washington state (FEMA 1995a). The eastern and western boundaries of the watershed are steep with jagged ridgelines at elevations ranging from 1,500 feet to more than 5,000 feet above the Okanogan River valley floor (WDOE, 1995). The high relief of the Okanogan River basin and arid climate of the eastern Cascades produce a hydrologic regime with large variability in annual and monthly streamflow. Streamflow patterns are affected by reservoir regulation at Okanogan and Skaha Lakes in Canada for flood control and irrigation, by natural storage associated with other lakes in the U.S. and Canada, and by numerous irrigation diversions supporting about 55,000 acres in Canada and 22,000 acres in the U.S.

Annual Runoff and Water Year Types

Okanogan River streamflow records since 1958 are available for the USGS station at Malott (#12447200). The Malott station is located at river mile 17.0 (upstream of the Columbia River), about 10 miles downstream of Salmon Creek, and has an upstream watershed area of 8,080 square miles (**Figure 3-1**). The watershed area is 8,900 square miles at the Columbia River. Okanogan River streamflow data are available since 1911, with a continuous record since 1929, for the USGS station at Tonasket (#12445000). The Tonasket station is located at river mile 50.8, with an upstream watershed area of 7,260 square miles (**Figure 3-1**). Comparison of the overlapping records at the Malott and Tonasket demonstrates that flows at Malott are approximately 4 percent higher than the flows at Tonasket. Based on this relationship, the flow record at Malott can be extended to include the Tonasket period of record (1911 through 1957) using a factor of 1.04.

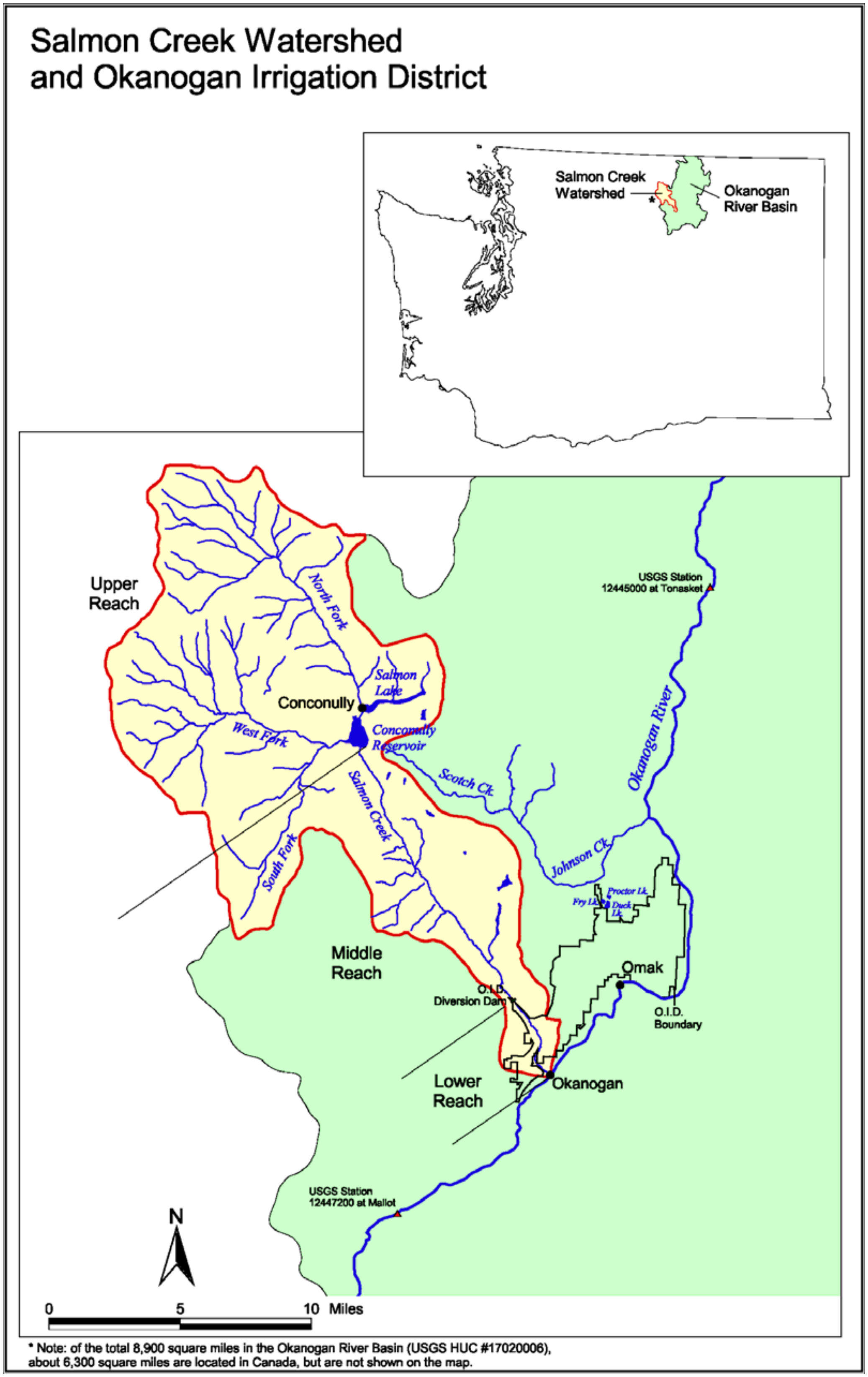
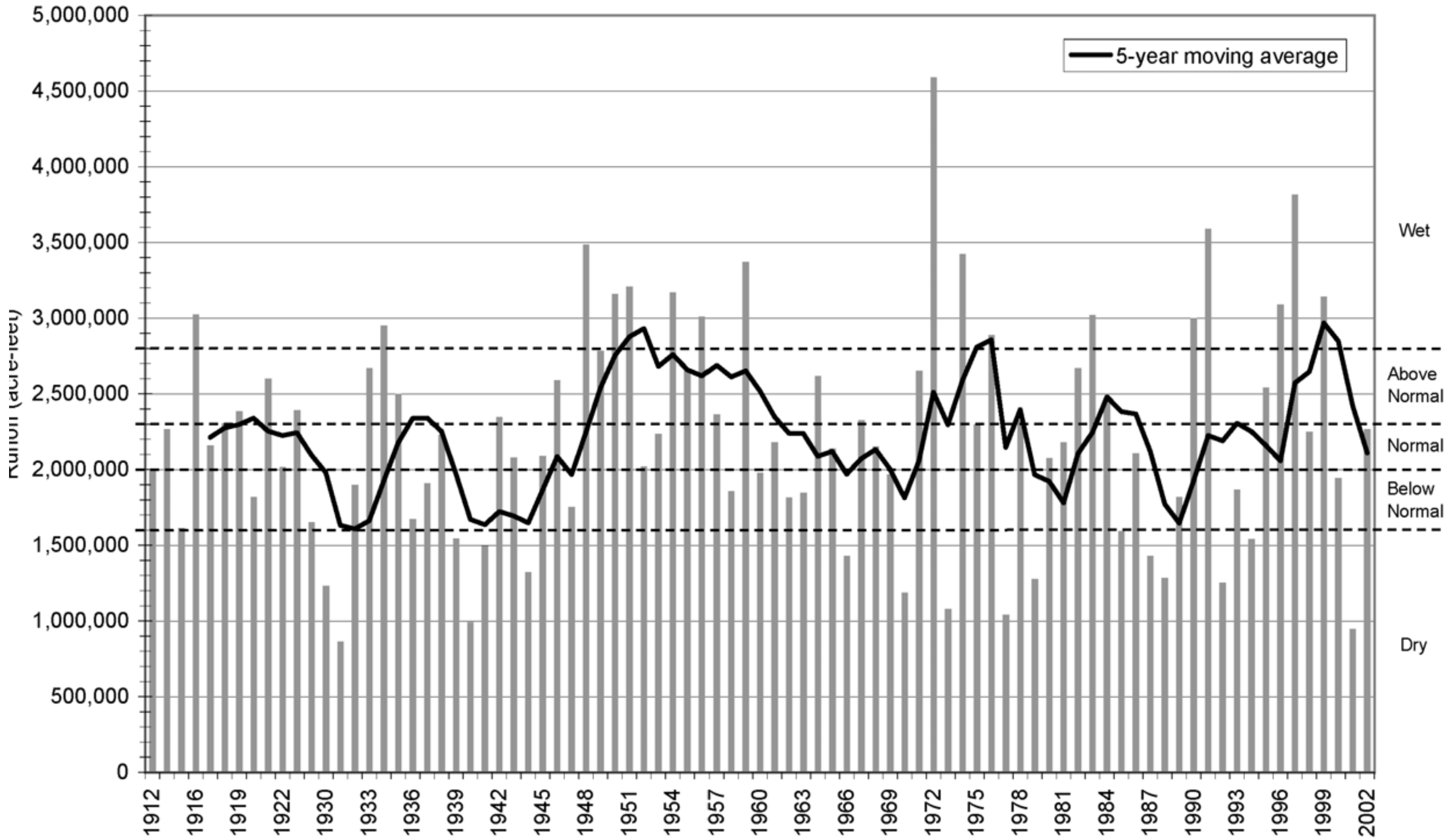


Figure 3-1. Salmon Creek Watershed Map.



*Streamflow measured at Mallot gage from 1958 to 2002. Comparison of overlapping flow records at the Malott and Tonasket gages demonstrates that flows at Malott are approximately 4% higher than the flows at Tonasket. Based on this relationship, the flow record at Malott can be extended back prior to 1958 by multiplying measured flows at the Tonasket gage (which began operating in 1911, and has continuously recorded flows since 1929) by 1.04.

Figure 3-2. Okanogan River Annual Runoff at Malott and Water Year Type (1912, 1914 through 24, and 1930 through 2002).

Annual streamflow volume (runoff) at the Malott gage station averages 2.2 million AF/year (3,100 cfs), but varies considerably, with a minimum of 0.9 million AF (1,200 cfs) in 1931 and maximum of 4.6 million AF/year (6,350 cfs) in 1972 (**Figure 3-2**). The long-term pattern of annual runoff generally shows wetter and drier cycles of several years duration, with very wet conditions only for a couple of years at a time.

Water year typing describes how wet or how dry a given year is in relation to all years on record. The annual runoff volumes at Malott were ranked to determine exceedence probabilities[1] and establish approximate runoff volume breaks between the five water year types (**Table 3-1**).

Table 3-1. Okanogan River Water Year Types.

Okanogan River Runoff[a] (Acre-feet/year)	Water Year Type	Probability Flow is Equaled or Exceeded
>2,800,000	Wet	0% to 19%
2,300,000 to 2,800,000	Above Normal	20% to 39%
2,000,000 to 2,299,999	Normal	40% to 59%
1,600,000 to 1,999,999	Below Normal	60% to 79%
<1,600,000	Dry	80% to 100%

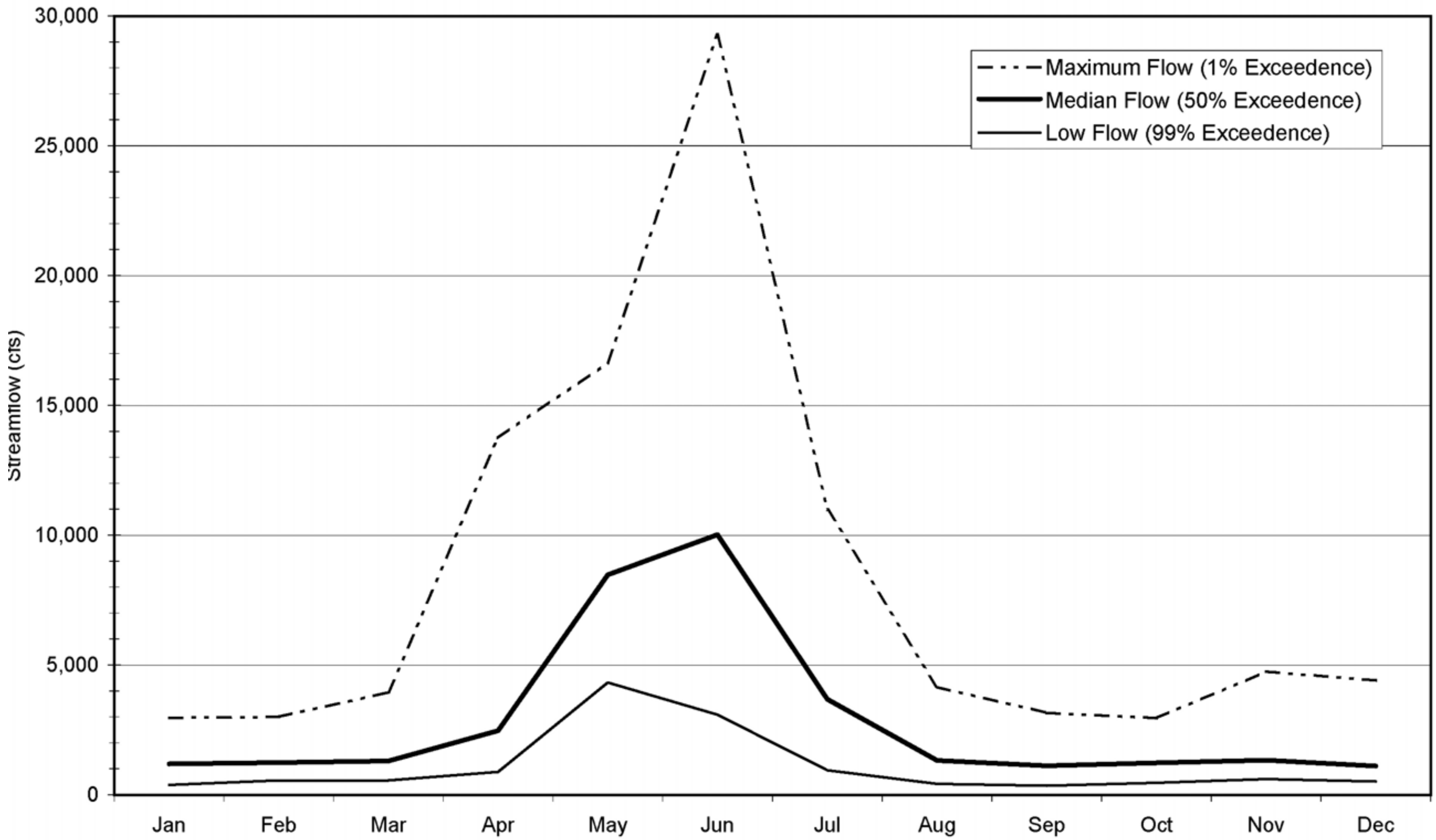
[a] Runoff at Malott USGS #12447200

Monthly Streamflow and Minimum Instream Flow Requirements

Monthly streamflow on the Okanogan River displays the large seasonal variation typical of major snowmelt river systems (**Figure 3-3**). Winter low flows are followed by rising streamflow in late spring, large snowmelt peaks in May and June, and a return to low flows by August (**Figure 3-3**). Approximately half of the annual runoff volume on the Okanogan River occurs during snowmelt in the months of May and June. Only a small amount of precipitation makes it to the streams outside of the spring and early summer months. Streamflow is consistently low September through March. The spring and early summer months experience a wide range from year to year, with a large variation between minimum, median and maximum streamflows.

The Washington Department of Ecology oversees both the appropriation of water for out-of-stream uses (e.g., irrigation, municipalities, commercial and industrial uses) and the protection of instream uses (e.g., water for fish habitat and recreational uses). Minimum instream flows for the Okanogan River were established by the Washington Administrative Code (WAC 173-549) in 1976 (**Table 3-2**). Although WAC minimum instream flows have been set by rule, these

[1] An exceedence probability is the statistical likelihood that an event will be equaled or exceeded during a given time period. For example, the probability that in any given year the annual runoff at Malott will exceed 2,800,000 AF/year is less than 20 percent, or less than two out of every ten years.



*Streamflow measured at Malott gage from 1958 to 2002. Comparison of overlapping flow records at the Malott and Tonasket gages demonstrates that flows at Malott are approximately 4% higher than the flows at Tonasket. Based on this relationship, the flow record at Malott can be extended back prior to 1958 by multiplying measured flows at the Tonasket gage (which began operating in 1911, and has continuously recorded flows since 1929) by 1.04.

Figure 3-3. Okanogan River Monthly Streamflow at Malott (1992, 1914-1924, 1930-2002).

Table 3-2. Okanogan River Monthly Streamflow Statistics and WAC Minimum Flows.

Okanogan River Monthly Streamflow Statistics and WAC Mimimum Flows(1911-1925 and 1929-2002)*

Monthly Runoff (Acre-Feet)

Years Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1%	182,299	168,077	242,213	816,864	1,022,063	1,739,826	674,428	254,727	187,717	181,368	281,952	270,171
10%	115,672	119,941	158,083	251,797	804,910	955,350	423,399	188,912	113,771	113,369	137,214	147,253
20%	100,089	96,386	121,040	213,721	677,695	841,500	364,577	137,740	86,878	91,763	109,055	112,020
30%	88,628	85,461	105,822	187,803	627,521	736,452	316,170	115,645	75,181	84,592	97,338	90,296
40%	78,547	76,601	85,180	176,022	577,482	661,353	257,935	102,939	70,322	78,170	88,130	76,911
50%	72,813	69,121	79,753	146,957	519,671	579,727	225,304	81,095	63,914	75,140	77,834	67,597
60%	63,390	62,319	68,924	129,571	459,408	489,595	170,646	70,219	54,585	68,765	72,093	63,856
70%	58,762	57,913	60,499	108,417	434,115	428,293	148,448	58,415	48,969	60,664	64,588	59,737
80%	50,074	51,249	54,171	93,496	356,756	346,282	117,366	45,385	38,684	51,482	55,310	55,094
90%	42,709	38,187	44,963	77,714	303,052	260,390	87,615	32,183	27,924	45,352	46,700	45,671
99%	22,977	30,956	33,518	47,576	241,935	155,905	38,620	14,777	14,272	25,736	25,505	25,460
Mean	66,777	65,765	79,285	145,132	485,872	544,065	221,572	86,753	60,721	68,899	78,929	74,443
WAC Minimum Instream Requirement												
	51,866	46,706	54,628	60,143	170,330	225,720	101,277	42,966	39,204	52,480	56,430	56,163

Monthly Streamflow (CFS)

Years Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1%	2,965	3,000	3,939	13,728	16,622	29,239	10,969	4,143	3,155	2,950	4,738	4,394
10%	1,881	2,141	2,571	4,232	13,091	16,055	6,886	3,072	1,912	1,844	2,306	2,395
20%	1,628	1,720	1,969	3,592	11,022	14,142	5,929	2,240	1,460	1,492	1,833	1,822
30%	1,441	1,525	1,721	3,156	10,206	12,376	5,142	1,881	1,263	1,376	1,636	1,469
40%	1,277	1,367	1,385	2,958	9,392	11,114	4,195	1,674	1,182	1,271	1,481	1,251
50%	1,184	1,234	1,297	2,470	8,452	9,743	3,664	1,319	1,074	1,222	1,308	1,099
60%	1,031	1,112	1,121	2,178	7,472	8,228	2,775	1,142	917	1,118	1,212	1,039
70%	956	1,034	984	1,822	7,060	7,198	2,414	950	823	987	1,085	972
80%	814	915	881	1,571	5,802	5,819	1,909	738	650	837	930	896
90%	695	682	731	1,306	4,929	4,376	1,425	523	469	738	785	743
99%	374	552	545	800	3,935	2,620	628	240	240	419	429	414
Mean	1,088	1,176	1,292	2,443	7,916	9,159	3,610	1,413	1,022	1,123	1,329	1,213
WAC Minimum Instream Requirement												
	845	835	890	1,013	2,775	3,880	1,650	700	660	855	950	915

Shaded areas represent flow exceedences where WAC minimum instream flows are not met.

*Streamflow measured at Mallot gage from 1958 to 2002. Comparison of overlapping flow records at the Mallot and Tonasket gages demonstrates that flows at Mallot are approximately 4% higher than the flows at Tonasket. Based on this relationship, the flow record at Mallot can be extended back prior to 1958 by multiplying measured flows at the Tonasket gage (which began operating in 1911, and has continuously recorded flows since 1929) by 1.04.

flows do not constrain senior water rights and the Okanogan River streamflow periodically falls below these levels. Monthly streamflow statistics for the Okanogan River at Malott (**Table 3-2** and **Figure 3-3**) can be compared to the WAC minimums to indicate the percent of years in which flows are below the thresholds. As might be expected, WAC minimum flows are consistently met in May, and are met for over 90 percent (9 out of 10 years) in April (93 percent) and June (94 percent). For the low flow months, an increased proportion of years that fall below the WAC minimum increases. Only 80 percent of the years meet the WAC minimums in September through January, and in March.

Review of the monthly Okanogan River streamflow record (**Appendix B-1**), indicates that flows fall below the monthly WAC minimums more often in drier water year types (**Table 3-3**). Dry water years are below the minimum flows set by rule for over half of the year, while normal and below normal water years may experience one or up to two months below minimum flows set by rule. Flows below WAC minimums are atypical in wet or above normal years.

Table 3-3. Instream Flow Below WAC Minimum Water Year Type (Existing Conditions).

Water Year Type	Average number of months per year WAC minimum instream flows are not met[a]	Probability Flow is Equaled or Exceeded[b]
Wet	Less than 1 (0.4)	0% to 19%
Above Normal	Less than 1 (0.3)	20% to 39%
Normal	~ 1 (1.2)	40% to 59%
Below Normal	1 to 2 (1.4)	60% to 79%
Dry	6 to 7 (6.4)	80% to 100%

[a] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Salmon Creek

Watershed Characteristics

Salmon Creek has a 167 square mile watershed and enters the Okanogan River at the town of Okanogan (**Figure 3-1**). Elevations in the Salmon Creek watershed range from a maximum of 8,242 feet at Tiffany Mountain to 2,318 feet at Conconully Reservoir and 810 feet at the confluence with the Okanogan River (USFS, 1997). The upper Salmon Creek watershed (above Conconully Reservoir) is bordered by the Chewuch (to the west), Middle Methow (to the southwest), and the Similkameen (to the north and east) watersheds (USFS, 1997). Downstream of Conconully Reservoir, Salmon Creek watershed is bordered by the Johnson Creek watershed to the north and east.

The watershed is elongate in shape and generally oriented on a northwest-southeast axis (**Figure 3-1**). The broad upper watershed contains about 70 percent of the drainage area and has a width of about eight to ten miles. Major tributaries in the upper watershed are the North, West, and South Forks of Salmon Creek. Runoff from the upper watershed is the primary water supply for the Okanogan Irrigation District (OID), and is stored in Salmon Lake and Conconully Reservoir.

Salmon Creek's watershed downstream of Conconully Reservoir is about 15 miles long and has several short side tributaries. The middle reach of Salmon Creek is about 11 miles long and conveys regulated flows downstream from Conconully Reservoir to the OID Diversion Dam (**Figure 3-1**). The lower reach of Salmon Creek extends for about 4.3 stream miles from the diversion dam through the City of Okanogan to the Okanogan River. For more than 80 years, the lower 4.3 stream miles of Salmon Creek have been dewatered under normal irrigation operations, except during spring runoff events that result in uncontrolled spill at the reservoirs and diversion dam.

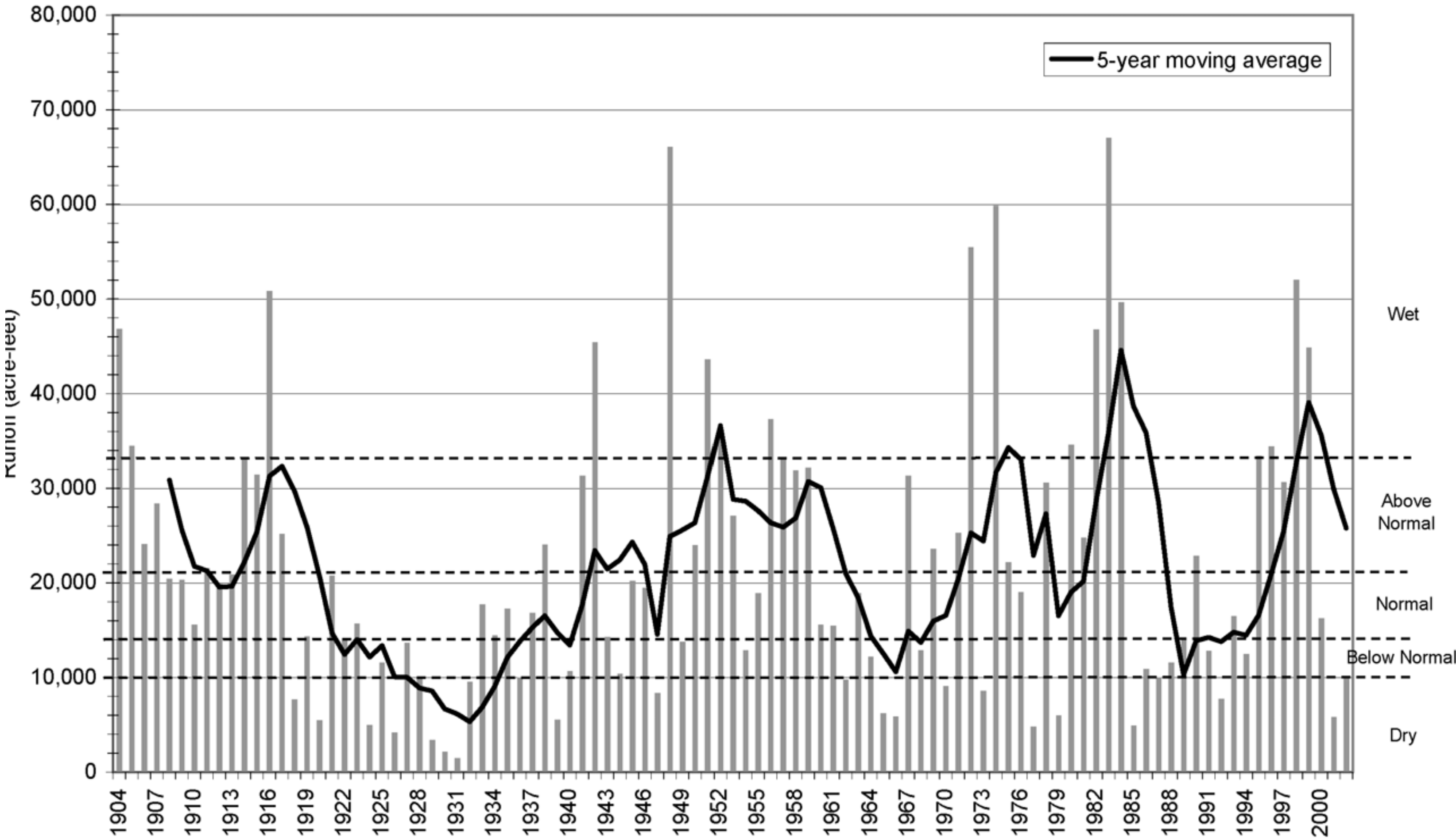
Annual Runoff and Water Year Types

Annual runoff of the Salmon Creek watershed has not been recorded systematically. However, records of inflow to the water supply reservoir, limited streamflow data, and long-term precipitation data relationships can provide estimates of the magnitude of unregulated runoff and its pattern from year-to-year. Since the early 1900s, irrigation diversions have prevented much of the runoff produced in the Salmon Creek watershed from reaching the Okanogan River.

Streamflow measurements of Salmon Creek are limited to a station near the City of Okanogan for the period from 1903 to 1910, and a station near Conconully for the period from 1910 to 1922. The Okanogan station provides some data prior to dam construction, and the Conconully station data represent the early years of dam construction (Walters, 1974). Salmon Creek annual runoff near Okanogan for the period 1904-1909, when the creek was unregulated and had only a few small diversions for irrigation, ranged from about 25,300 AF/year (35 cfs) to 57,800 AF/year (80 cfs), with an average of 35,400 AF/year (49 cfs) (WDOE, 1976). Salmon Creek annual runoff near Conconully during the period 1910 to 1922 averaged about 22,400 AF/year (31 cfs). The slightly reduced contributing area at Conconully, some drier water years, initial OID diversions, and evaporative losses from the newly constructed Conconully Reservoir all contribute to the decreased runoff measured from 1910 to 1922 (Walters, 1974).

Although measurements of unregulated streamflow upstream of Conconully Reservoir and Salmon Lake only exist for these few years in the early 1900s, records of reservoir operations were collected beginning around 1904. Continuous records of monthly reservoir releases are available since 1947 (**Appendix B-2**). These data were analyzed in relation to precipitation records to estimate reservoir inflow for the entire study period from 1904 to 2002. Reservoir inflow is used to represent unregulated runoff from the upper watershed for the entire 1904 to 2002 study period (**Appendix B-3**). It is estimated as being equal to the monthly reservoir outflow plus or minus changes in reservoir storage. This simplified estimation has several sources of imprecision, but provides a valid means of reconstructing runoff and streamflow values for the ungaged upper watershed.

The estimated annual unregulated runoff for the Salmon Creek watershed over the 1904 through 2002 period ranges from a minimum of 1,500 AF (2 cfs) in 1931 to a maximum of 67,000 AF (93



* Unregulated watershed runoff simulated from precipitation records years 1904-1946. For years 1947-2002, unregulated watershed runoff into Conconully Reservoir calculated from *Watershed runoff = monthly Conconully outflow + gain in total reservoir storage during month.* Runoff may be slightly underestimated, particularly in dry years, since storage data includes evaporation and seepage losses.

Figure 3-4. Estimated Salmon Creek Unregulated Annual Runoff into Conconully Reservoir and Water Year Type (1904-2002).

cfs) in 1983, with an average of 21,700 AF (30 cfs) (**Figure 3-4**). The large differences between minimum, median, and maximum annual runoff indicates the high variability of watershed runoff production. This natural variability in water supply is not unusual for the region, and formed part of the rationale to construct reservoirs and provide year-to-year carry over storage. The range of runoff produced by the Salmon Creek watershed can be extreme. For example, just 7,000 AF of total inflow to the reservoirs occurred during the 3-year period of 1929 through 1931, whereas 4,000 AF of inflow occurred in just one day on May 29, 1948 (Yates, 1968).

Water year typing for Salmon Creek (1904 through 2002) is based on the estimated unregulated upper watershed runoff (**Appendix B-3**). The annual runoff volumes were ranked to determine exceedence probabilities and establish approximate runoff volume breaks between the five water year types (**Table 3-4**).

Table 3-4. Salmon Creek Water Year Types.

Salmon Creek Unregulated Runoff (Acre-feet/year)	Water Year Type	Probability Flow is Equaled or Exceeded
>33,000	Wet	0% to 19%
21,000 to 32,999	Above Normal	20% to 39%
14,000 to 20,999	Normal	40% to 59%
10,000 to 13,999	Below Normal	60% to 79%
<10,000	Dry	80% to 100%

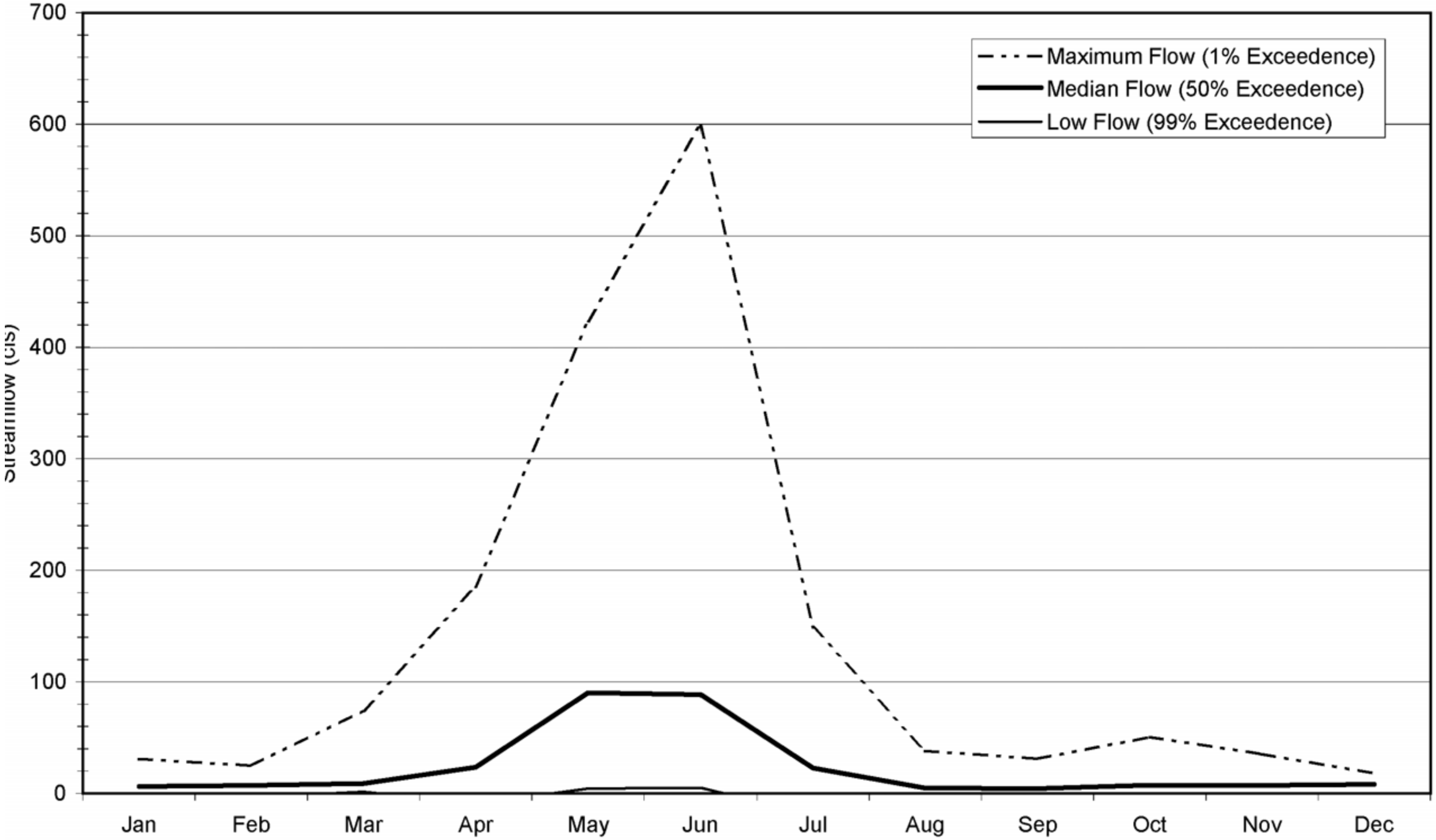
Monthly Streamflow

Monthly streamflow patterns on Salmon Creek can be described using limited historical gage records, relationships to precipitation patterns, and water system model estimates based on measured reservoir and diversion operations. No minimum instream flow requirements exist for Salmon Creek.

The seasonal streamflow pattern observed on Salmon Creek near Okanogan for the period 1904 through 1909, when the creek was unregulated, featured a low flow of about 15 cfs from August through March, and a high flow of about 114 cfs from April through July (Walters, 1974).

Annual average precipitation in the upper Salmon Creek watershed ranges from about 15 inches near Conconully to 30 inches in the mountains along the western edge of the watershed (Dames and Moore 1999). At elevations above 1,500 feet, precipitation as snowfall occurs from October through April in amounts about two to four times greater than those at lower elevations nearer the Okanogan River. Snowmelt is concentrated in late spring and early summer. Rainfall precipitation from May through September is typically less than one inch. Only a small amount of rainfall makes it to the streams. At lower elevations in Salmon Creek's middle and lower reaches, annual precipitation diminishes towards 12 inches.

The monthly estimates of unregulated upper watershed runoff for Salmon Creek are displayed in terms of exceedance probabilities in **Figure 3-5** (**Appendix B-3**). The figure demonstrates the



* Unregulated watershed runoff simulated from precipitation records years 1904-1946. For years 1947-2002, unregulated watershed runoff into Conconully Reservoir calculated from *Watershed runoff = monthly Conconully outflow + gain in total reservoir storage during month.* Low runoff months may be slightly underestimated since storage data includes evaporation and seepage losses, which is why minimum streamflow values for most months are zero.

Figure 3-5. Estimated Unregulated Salmon Creek Monthly Streamflow into Conconully Reservoir (1904-2002).

large seasonal variation typical of snowmelt river systems. Winter low flows are followed by rising streamflow in late spring, snowmelt peaks in May and June, and a return to low flows by August. Most of the annual runoff occurs during snowmelt from April and through July. Peak runoff occurs in May and June, which have median streamflows about 100 cfs each, but maximum streamflows of near 450 cfs and 600 cfs, respectively. Streamflow is consistently low August through March, with average streamflow estimated to be less than 10 cfs. The spring and early summer months experience a wide range from year to year, indicated by the range between minimum and maximum values. The estimated unregulated Salmon Creek streamflow into the reservoir represents both existing and historical conditions[2] for the upper reach of Salmon Creek.

The two reaches of Salmon Creek downstream of Conconully Dam are affected by irrigation deliveries and diversion. Reservoir and diversion operational data has been used to calculate historical monthly streamflow for the middle and lower reaches of Salmon Creek.

Streamflow in the middle reach occurs almost exclusively during the months of April through September, the irrigation release period (**Figure 3-6**). Historical land uses on uplands, combined with dewatering of the channel, have altered stream hydrology, reduced groundwater recharge, decreased riparian vegetation, and increased sediment production. The result is an adverse affect on the channel geometry and permeability, streambank stability, and riparian area, which has greatly decreased the habitat quality of lower Salmon Creek. Under existing conditions there is a streamflow loss of approximately 5 cfs over the lower 4.3 miles of Salmon Creek. During the remainder of the year, flow in the stream is limited to seepage from the dam and local unregulated inflow entering the stream below the dam. Seepage from the dam is on the order of 100 AF per month, or about 1.7 cfs (as determined during Salmon Creek Phase 1 studies from USBR data; reported Dames and Moore, 1999). Median streamflow in the middle reach of Salmon Creek is lower than for the unregulated inflow in May (when runoff is being captured for storage), but higher than the unregulated streamflow in July through September (when releases are conveyed for diversion downstream). Reservoir operations have little effect on major streamflow events; maximum flows in the middle reach are similar in magnitude and month (June) to unregulated reservoir inflow (**Figure 3-5**).

The lower reach of Salmon Creek is essentially dry during most months of most years (**Figure 3-7**). Almost all water released from Conconully Reservoir is diverted for irrigation needs at the OID diversion dam. Even during peak snowmelt months of May and June, the median flows in the lower reach are less than 50 cfs. Maximum flows in the lower reach are similar to, but slightly lower than the unregulated reservoir inflows (**Figure 3-5**) (reservoir operations have little effect on major streamflow events, and OID would attempt to recover as much spill as feasible at the diversion dam). Some sub-reaches of the lower 4.3 miles have surface water present in the stream due to local contributions from groundwater, even when no streamflow is conveyed across the OID diversion dam. The magnitude of these contributions has not been gaged but has

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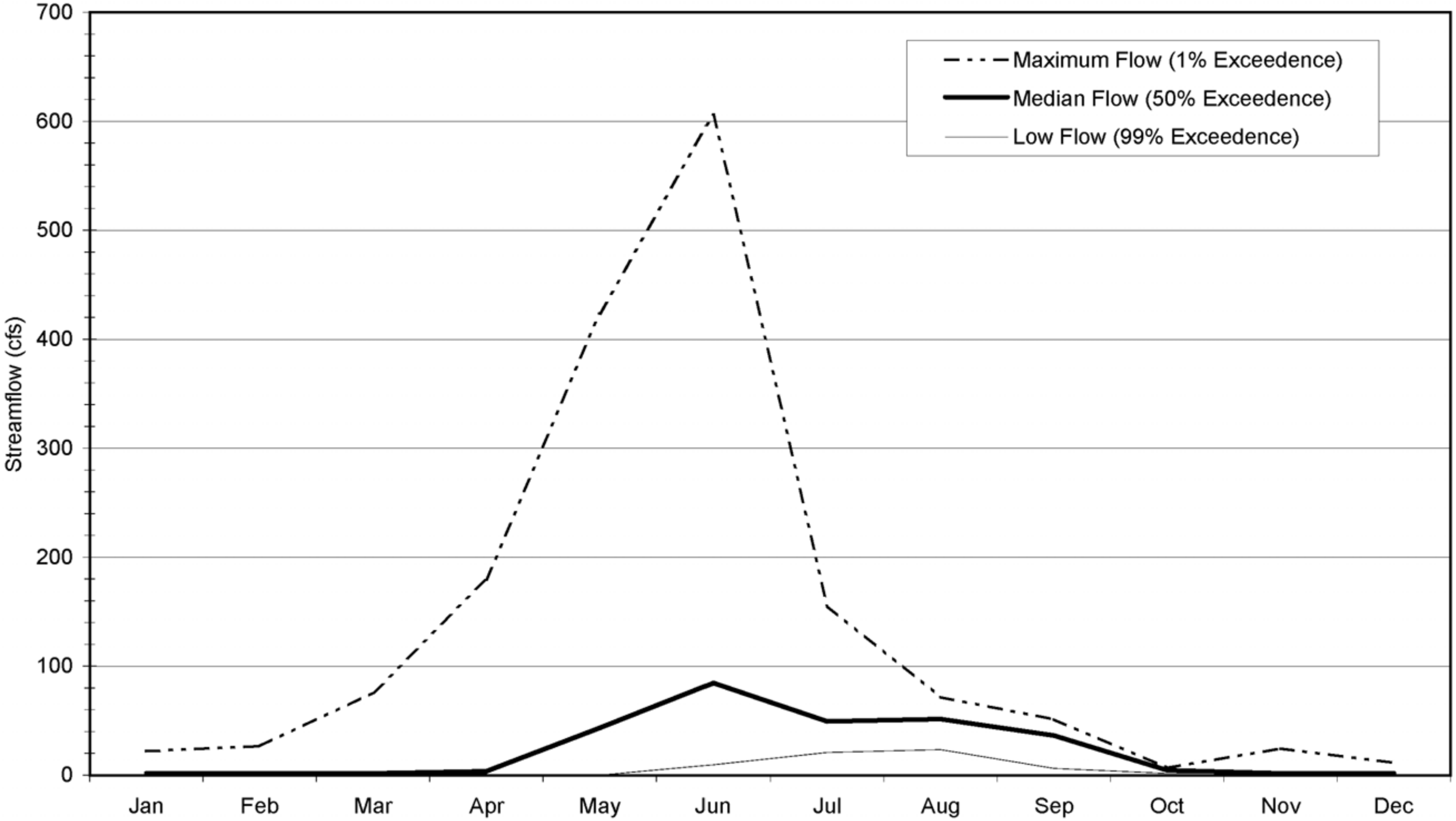
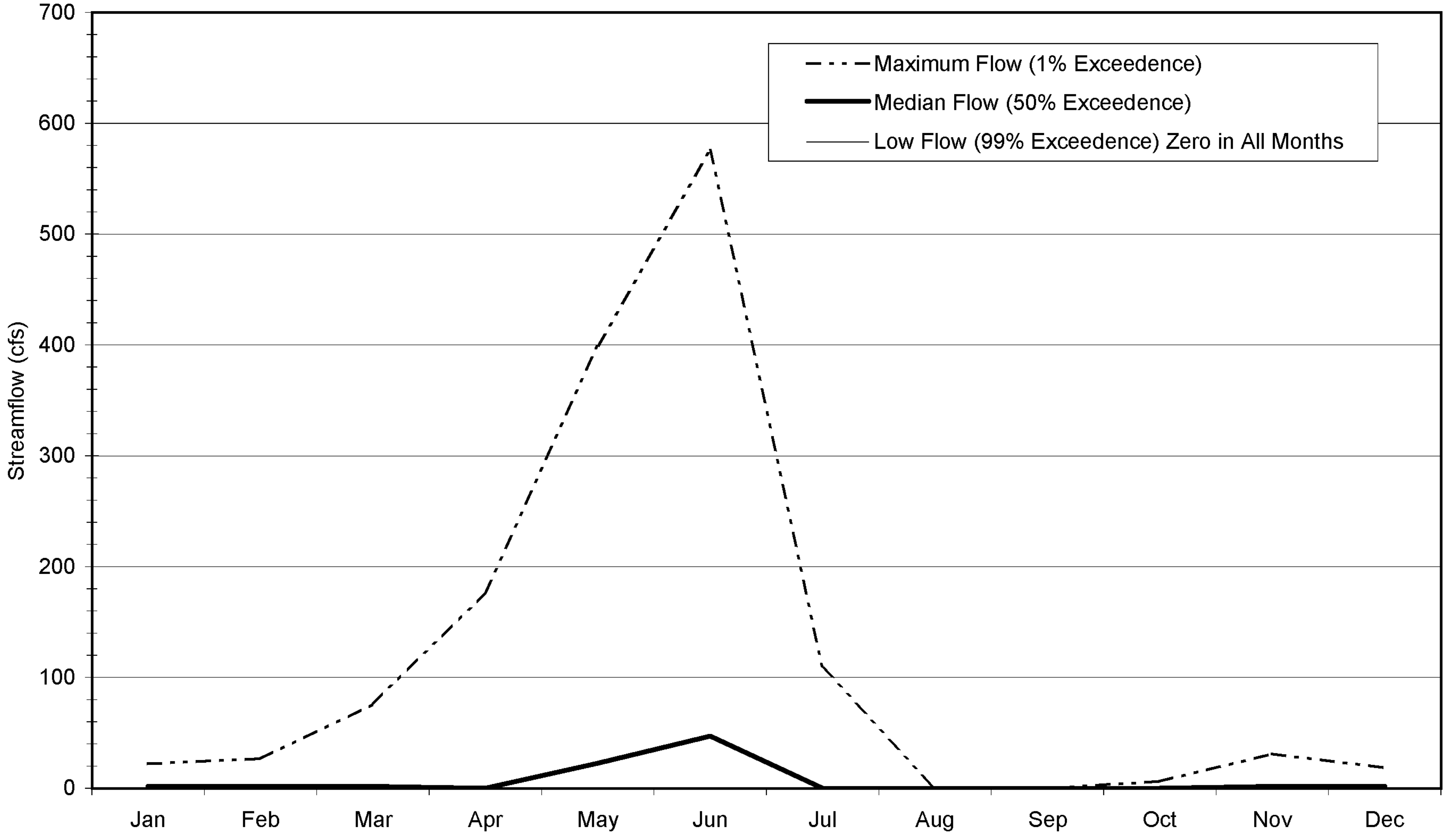
[2] The terms "existing" and "historical" refer to two similar but distinct data sets and simulations. "Existing" conditions are based on modeling streamflow for the 100-year period of record, and irrigation demand for the next five years based on current crops and water use as reported by OID. "Historical" conditions are actual data for streamflow and irrigation use based on records since 1904. Historical conditions do not quite match "existing" conditions because the historical data includes periods when the Okanogan Irrigation District operated less efficiently than it does today (before the main canal was lined and other conservation improvements were undertaken), and other changes in faciltities, water management, and operations. "Existing" conditions are a better simulation of likely a "no action" baseline going forward than strict reliance on historical averages would provide.



* Streamflow simulated from years 1904-1946, and based on measured reservoir releases and change in storage at Conconully for years 1947-2002. Low runoff months may be slightly underestimated since storage data includes evaporation and seepage losses, which is why minimum streamflow values for most months are zero.

Figure 3-6. Estimated Regulated Salmon Creek Monthly Streamflow in the Middle Reach (includes Reservoir Spill, Dam Seepage, and Middle Reach Gain or Loss) (1904-1998).



* Streamflow simulated from years 1904-1946, and based on measured reservoir releases and change in storage at Conconully for years 1947-2002.Low runoff months may be slightly underestimated since storage data includes evaporation and seepage losses, which is why minimum streamflow values for most months are zero.

Figure 3-7. Estimated Regulated Salmon Creek Monthly Streamflow in the Lower Reach (includes Reservoir Spill, Dam Seepage, and Middle Reach Gain or Loss) (1904-1998).

been observed to be less than 5 cfs (Dames and Moore 1999). Downstream of Watercress Springs, Salmon Creek evapotranspiration and percolation losses dry up the stream.

Johnson Creek

Johnson Creek has a 68.2 square mile watershed and is located northeast of the middle and lower reaches of Salmon Creek (**Figure 3-1**). Johnson Creek captures water from Scotch Creek east of Conconully Reservoir, and flows southeast towards Duck Lake, then northeast to meet the Okanogan River near the town of Riverside (**Figure 3-1**). Although the OID water system depends primarily on Salmon Creek, OID has a small (6 cfs maximum capacity) diversion on Johnson Creek about 4 miles upstream of its mouth. OID began diverting flows from Johnson Creek in the 1920s (Tom Sullivan, OID, personal communication, 2000). Diversion records are compiled and available for the period since October 1986. A U.S. Bureau of Reclamation stream gage near Riverside Wash recorded flows on Johnson Creek from May 1903 to September 1962 (USBR, 1962). The gage was just upstream of the confluence with the Okanogan River, downstream of the points of diversions for all water rights on the stream, including OID and other users. The unregulated natural streamflow of Johnson Creek is not known.

For the 1904 through 1961 period of record, Johnson Creek annual runoff ranged from a minimum of about 2,500 AF/year (3.5 cfs) in both 1929 and 1931 to a maximum of 7,800 ac-ft/yr (10.8 cfs) in 1948, with an average of 3600 AF/year (5 cfs) (**Figure 3-8**). Johnson Creek runoff is approximately 10 to 20 percent that of the estimated unregulated runoff from Salmon Creek for the same period. This ratio seems reasonable, since Johnson Creek has less than half the drainage area, much lower headwater elevations, and is on the leeward side of the major ridge lines.

For the period of record prior to increased irrigation use (1903 through 1917), Johnson Creek runoff is slightly higher than during the subsequent period (1918 through 1962) (**Table 3-5**). The reduction in mean and median streamflow may be due to natural environmental factors, but it is more likely the combined effect of multiple diversions, including OID. Comparison of the mean and median values suggests that 15 to 20 percent of the natural streamflow was diverted.

OID diversions from Johnson Creek between 1987-1998 averaged 1,483 AF/year (2 cfs), with a maximum of 2,156 AF/year (3 cfs), respectively. Typically, the maximum monthly diversion has occurred during the winter and spring, not in the summer (because OID has the most junior water right on the creek, and summer flows are not normally available). Exceptions occurred in 1997 and 1998 when there were no diversions during a few winter months. For those years, the mean monthly diversions from Johnson Creek ranged from 0 cfs to as high as 5.5 cfs (333 AF). OID regulates diversion flow rates based on visual observation of the streamflow to ensure sufficient flow remaining in the channel to satisfy the water rights of downstream users (Tom Sullivan, OID, personal communication, 2000).

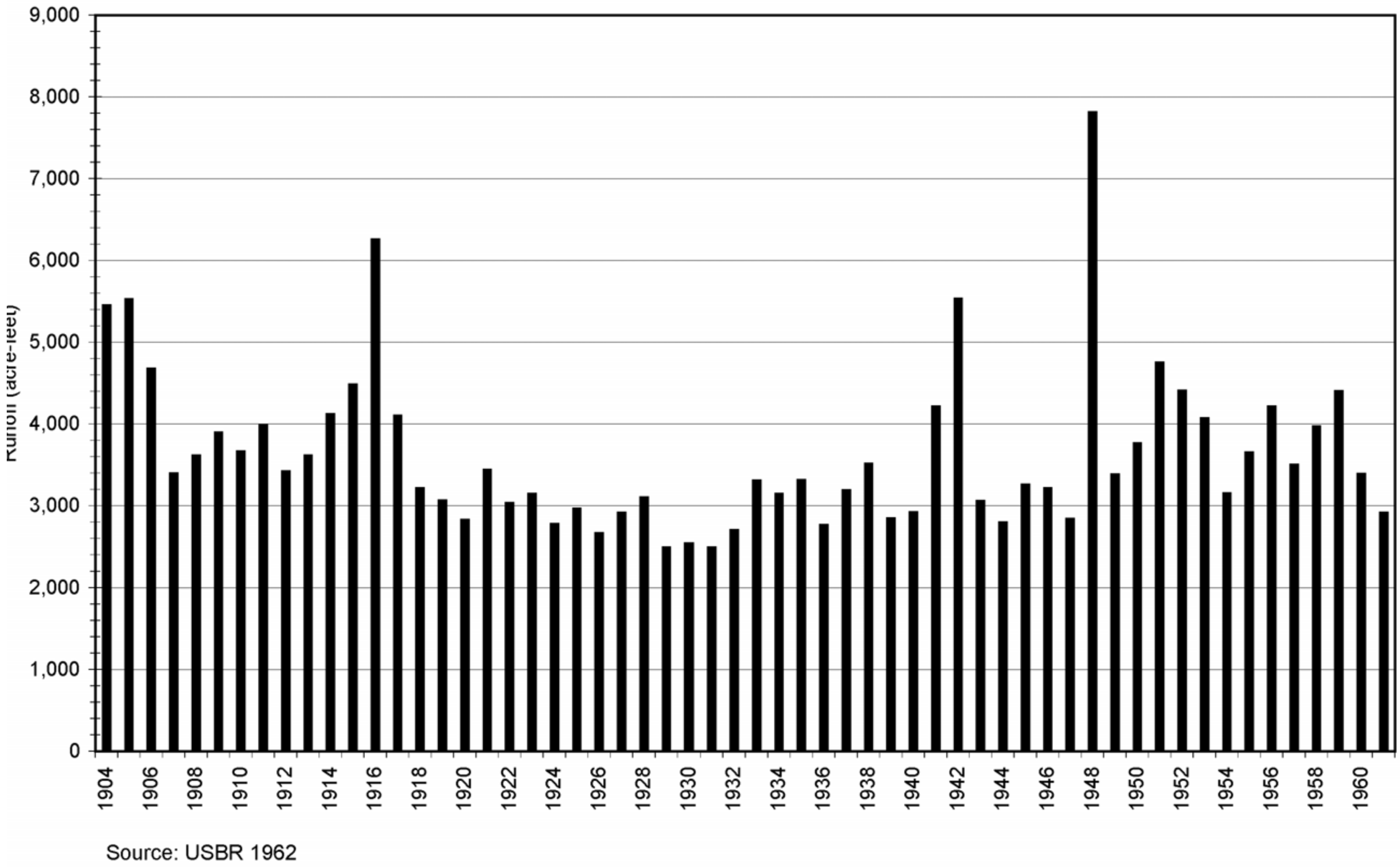


Figure 3-8. Johnson Creek Annual Runoff Near Riverside, WA (1904-1961).

Table 3-5. Johnson Creek Annual Streamflow Statistics Near Riverside Wash (1904 through 1961)

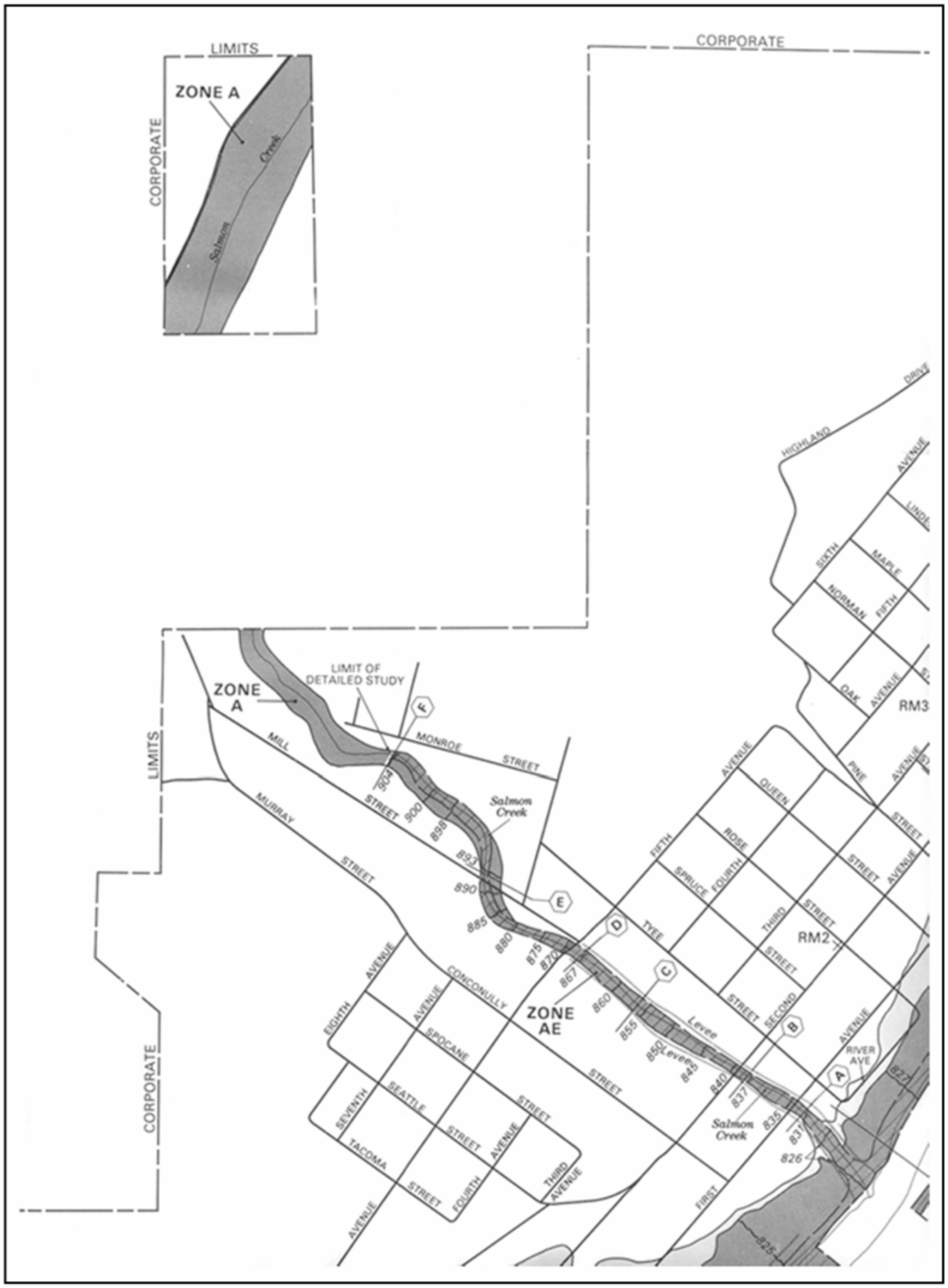
1903 through 1962: Entire period of record		
Mean	3,593 ac-ft/yr	4.96 cfs
Maximum	7,825 ac-ft/yr	10.81 cfs
Minimum	1,312 ac-ft/yr	1.81 cfs
Median	3,363 ac-ft/yr	4.64 cfs
1918 through 1962: Subsequent to significant use as a water supply, including diversions by the Okanogan Irrigation District		
Mean	3,419 ac-ft/yr	4.72 cfs
Maximum	7,825 ac-ft/yr	10.81 cfs
Minimum	2,505 ac-ft/yr	3.46 cfs
Median	3,165 ac-ft/yr	4.37 cfs
1903 through 1917: Prior to significant use as a water supply, including diversions by the Okanogan Irrigation District		
Mean	4,114 ac-ft/yr	5.68 cfs
Maximum	6,270 ac-ft/yr	8.66 cfs
Minimum	1,312 ac-ft/yr	1.81 cfs
Median	4,005 ac-ft/yr	5.53 cfs

3.1.1.2 Flood Hazard

Flood hazard focuses on the risk to persons and property from peak streamflow and inundation. The Federal Emergency Management Agency (FEMA) 100-year flood boundary (**Figure 3-9**) represents the area identified as having flood hazard, and requiring flood insurance under the National Flood Insurance Program. This regulatory floodplain was delineated in 1973 and 1976, and revised in 1995 for the incorporated City of Okanogan (FEMA, 1995a and 1995b). The City of Okanogan is exposed to risks of flood hazards from Salmon Creek and the Okanogan River.

The City of Okanogan experienced flood damage in 1948, primarily from Salmon Creek, and in 1972, primarily from the Okanogan River (FEMA, 1995a). Flooding has and may occur in the unincorporated reaches of Salmon Creek, but due to the low density of population and residential properties, flood hazards have not been subject to detailed study by FEMA.

The flood of 1948 quickly filled reservoirs and 47,000 AF spilled over Conconully Dam and past the OID diversion to the Okanogan River. In 1948, flooding washed out bridges and roads, inundated farmland and caused heavy damage in the towns (Yates, 1968). The 1972 event resulted in the declaration of the Okanogan River Valley as a Federal Disaster Area. Levees and dikes near the City of Okanogan were overtopped, the sewage treatment plant flooded, and several city blocks were inundated (FEMA, 1995a).



Source: Flood Insurance Rate Map for the City of Okanogan, Washington. Federal Emergency Management Agency, Aug. 2, 1995.

Zone A: No base flood elevations determined (professional judgement used to delineate 100-year flood boundary)

Zone AE: Base flood elevations determined

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Figure 3-9 100-year Flood Boundary – Salmon Creek, City of Okanogan

Although no gage data exist, an historic flood on Salmon Creek in May 1894 (Work, 1894) was estimated to have a peak discharge over 2,000 cfs and the 1948 flood peak discharge was estimated at over 1,500 cfs (approximately a 30-year return interval event). FEMA (1995a) has estimated floodflows and frequencies for Salmon Creek near Okanogan using various methods to analyze and extrapolate from existing data at the reservoirs by Conconully (**Table 3-6**). Comparison of estimated flood flows for Salmon Creek to other gaged streams in the Okanogan basin having similar climate, topography, and vegetation indicates that the calculated flows are reasonable (FEMA, 1995a).

Table 3-6. Salmon Creek Flood Frequency Statistics[a]

Return Interval (years)	Peak Discharge (cfs)
10-year	1,100
50-year	1,700
100-year	3,700
500-year	4,500

[a] (Source: FEMA 1995a)

In response to the large flood in 1948, the U.S. Army Corps of Engineers channelized the down-stream portion of Salmon Creek in the City of Okanogan (from the Okanogan River upstream to about River Mile 0.33), increasing hydraulic capacity and efficiency. Within the City of Okanogan, the 100-year flood is modeled to be entirely contained within the top of the leveed banks by FEMA (**Figure 3-9**). FEMA (1995a) reports that the channel modifications provide full protection against the 500-year flood, unless unusual blockage of the bridges over Salmon Creek occurs.

Most existing Salmon Creek flood hazards are erosion-related, and are focused within the leveed area. Inundation could be the principal flood hazard in the vicinity of the confluence with the Okanogan River (**Figure 3-9**). Historic flow regulation and channel modifications have resulted in substantial erosion during floodflows within and upstream of the City of Okanogan on lower Salmon Creek. The extreme flow regime of lower Salmon Creek, dominated by little or no flow but subject to infrequent uncontrolled spills, has inhibited riparian vegetation, decreased streambank stability, and contributed to streambed erosion. Riparian land uses that remove vegetation (e.g., grazing, fuel or timber harvest) have also reduced bank stability. The Salmon Creek channel continues to be vulnerable to streambank erosion during floods. Property loss can occur as a result of flood-related channel widening, and downstream sedimentation impacts may result from erosion of high streambanks.

3.1.1.3 Groundwater

<u>Okanogan River Valley Aquifer</u>

The Okanogan River valley is a wide glacially and fluvially-carved basin bounded by high bedrock-forming ridges and filled with successive layers of primarily glacial outwash and more recent alluvium. In the vicinity of Salmon Creek, the Okanogan River is incised within broad gently sloping terraces. The terraces and the current river channel are comprised of fine-grained silty to sandy alluvium overlying coarse-grained sandy gravelly glacial outwash. The deposits form the Okanogan River Valley aquifer. Groundwater levels in the aquifer are controlled mainly by the level of the river, and by groundwater gradients from adjacent tributary streams that recharge the aquifer.

Salmon Creek Valley Aquifer

The middle and lower Salmon Creek valleys are relatively narrow-elongated basins bounded primarily by bedrock, glacial outwash debris, and filled with relatively thin deposits of alluvium. Small unexplored shallow aquifers with little water yield likely occur along much of the valley. The small alluvial aquifer likely contributes about 0.1 to 2.0 cfs of flow to the Salmon Creek channel for much of the year. The small volume of flow maintained in the channel in the vicinity of Watercress Springs is evidence of this groundwater source.

A short distance downstream of Watercress Springs the Salmon Creek channel becomes dry as the flow maintained by groundwater goes subsurface and percolates down to the aquifer. The point at which the channel dries out depends on the time of year and the amount of flow in Salmon Creek. The depth to water in the Salmon Creek valley aquifer largely depends on Okanogan River levels. During spring floods on the Okanogan River and Salmon Creek, Salmon Creek aquifer levels reach their maximum and much closer to the ground surface. However, because of the high transmissivities of the alluvium, water levels decline rapidly to elevations below the creek grade.

Groundwater levels in the Salmon Creek aquifer are affected by pumping at Conconully, whose residents rely on the aquifer for rural agriculture and domestic uses. The City of Okanogan also affects groundwater levels through pumping of the aquifer and consumption of spring water.

Duck Lake Groundwater Basin

Duck Lake is located about three miles directly north of the town of Omak (**Figure 3-1**). It is a small lake of about 88 acres at elevation 1,232 and 284 acres at its maximum elevation of 1,247 feet msl, and is situated among smaller lakes (Fry and Proctor lakes). Together the three lakes lie in a relatively large depression that does not have natural surface inflows or outflows, but is tied to groundwater levels in what is locally called the Duck Lake groundwater basin. The depression is referred to as a kettle, which was formed during the late Pleistocene by the melting of a large, detached block of stagnant ice that had been wholly or partly buried by glacial sediments.[3]

The Duck Lake groundwater basin has been delineated through well data collected since 1958 and refraction seismic surveys conducted in 1970 and 1971. Natural recharge to the aquifer occurs primarily through groundwater migration from the Johnson Creek valley (to the northwest), and through deep percolation. The sum of natural recharge from these sources is estimated to be about 2,000 ac-ft per year (Jackson, undated memorandum). Groundwater flow

[3] See undated memorandum by Randy Jackson, Central Region, Washington Department of Ecology for a review of the geology of the area and the kettle basin in which Duck Lake sits.

out of the kettle basin likely discharges in minor quantities to seeps and springs downstream in the Okanogan valley, as well as contributing a small amount of base flow to the Okanogan River. The amount of recharge is strongly dependent on lake level, which is influenced by OID spill from its main canal and diversion from Johnson Creek. Groundwater is also extracted from wells for irrigation and domestic purposes.

Water diverted from Salmon or Johnson creeks quickly recharge the Duck Lake groundwater basin. Recharge is typically seasonal, occurring from Salmon Creek primarily during the irrigation season, but from Johnson Creek during the non-irrigation season, when flows are high enough that OID may exercise its junior water right. In general, seepage to groundwater increases when Duck Lake water levels rise above a base level of about 1,228 feet msl, which is probably the long-term average natural groundwater elevation in the area. Seepage to groundwater increases dramatically when Duck Lake reaches 1,232 feet msl.

Reported mean monthly estimates of natural upstream groundwater recharge are 2.7 cfs, while discharge estimates have ranged from 1.7 to 8.3 cfs. However, it is not known how these values actually vary through the year. It is also likely that the discharge from the basin to springs and the Okanogan River would increase with increased water tables associated with higher Duck Lake water levels. Duck Lake water use and regulation is discussed further below, in relation to OID water use.

3.1.1.4 Okanogan Irrigation District Water Use

Historic Operations Data

The Salmon Creek Phase 1 report (Dames and Moore, 1999) compiles available OID water supply and use data for the period from 1987 to 1998, and discusses data gaps and inconsistencies. Irrigation diversion records prior the mid-1980s are not representative of current water use because extensive rehabilitation work was undertaken on the irrigation system in the mid 1980s. In 1977, only 18 percent of the OID's delivery system was piped and pressurized. During the rehabilitation the remainder of OID was converted to a pressurized system, the main canal was relined with reinforced concrete (except for a small portion passing through competent rock), and the Okanogan River pumping stations were either abandoned (Robinson Flats) or rebuilt (Shellrock). This resulted in a much more efficient delivery system. Greater detail on OID water supply and water use is provided in **Appendix C**. The Phase 1 Report also summarizes the 1987 through 1998 operation data provided by OID (Dames & Moore, 1999).

Historical Irrigation Water Use

Total irrigation water delivery is defined as the quantity of water delivered to the farmers via OID's distribution system. Due to the presence of Duck Lake, the quantity of irrigation water delivered to the fields is different from the total supply of irrigation water. *Water supply* is the amount of water obtained from OID's water sources. *Water delivery* is the amount actually delivered to irrigation. *District efficiency* (the efficiency of the overall water delivery system) is defined by the ratio of water delivery to water supply. *On-farm efficiency* is defined by the ratio of crop requirements to water delivery. For EIS analysis, conveyance loss was estimated at 0.4%

and on-farm efficiency varied from 66 percent to 85 percent, depending on weather conditions (temperature and precipitation).

Total annual quantities of annual irrigation water delivery during the period 1987 through 2002 were analyzed to prepare the summary in **Table 3-7**[4]. As shown in **Table 3-7**, the average annual delivery of water to farmers from 1987 to 2002 was 15,518 AF/year. This compares to the average OID water supply of 17,720 AF. Thus, the overall efficiency of the water supply system is about 88 percent. The difference between water supply and water delivery, about 2,177 AF/year, is equal to the amount of seepage loss from Duck Lake. A very small amount, about 34 AF/year, also is lost through seepage from the main canal. In many years the OID canal (Salmon Creek) supplies over 90 percent of the water to farmers, with Duck Lake providing the remainder. Salmon Creek diversions are as low as 60 percent of total irrigation demand during dry years, with most of the remainder supplemented by Shellrock pumping. Duck Lake pumping is relatively constant from year to year.

Table 3-7. Annual Quantities of OID Irrigation Delivery by Source, 1987 through 2002 (AF/year).

	Salmon Creek	Duck Lake Pumping	Shellrock Pumping (Okanogan River)	Total OID Water Supply	Canal Spill and Seepage	Total Irrigation Delivery
Average Available	14,886	1,101	1,733	17,720	-2,201	15,518
Percent of OID water	84.0%	6.2%	9.8%	100%		
Minimum	10,665	309	0	12,702	-1,447	10,901
Maximum	20,834	2,141	5,910	21,531	-2,919	18,623

Crop Irrigation Requirements

Irrigation demand in OID is highly variable. As shown in **Table 3-7**, recent annual irrigation deliveries ranged from a minimum of 10,901 AF (1993) to a maximum of 18,623 AF in 1998. Many factors can contribute to the variability of irrigation demand. Important variables include temperatures during the irrigation season, rainfall prior to and during the irrigation season, cooling, soil type, crop type, irrigation efficiency, delivery efficiency, and farmer's estimates on how much crop watering is needed during different climate conditions. Not all of these factors can be quantified.

During Phase 1 studies, variation in irrigation demand was assumed to be driven primarily by irrigation season temperatures. Irrigation delivery was correlated to temperature and rainfall was also evaluated, but by itself did not correlate well to irrigation demand. For EIS analysis, crop irrigation requirements were estimated separately for cool and warm years. For cool years, the irrigation requirement was calculated to be 10,701 AF for existing OID irrigation lands, and for warm years it was calculated as 11,350 AF.

[4] Note that the table adds from left to right only for the average year. The amounts shown in the various columns for minimum and maximum occur at different moments in time; hence, they don't add across the table.

Supply of Water to OID

As shown in **Table 3-7**, OID obtains its water supply from Salmon Creek via the OID canal, Duck Lake, and the Okanogan River via the Shellrock pumping station. Duck Lake is supplied by the Johnson Creek diversion, OID canal spill, and local runoff.

Salmon Creek

The amount of water diverted from Salmon Creek depends on two primary factors: the runoff volume in Salmon Creek and OID's overall water demand, which in turn primarily depends upon climatic conditions. The largest diversions occur during high runoff conditions combined with a hot summer, as occurred in 1998. Conversely, the lowest diversions occur when a lower runoff year combines with a cool summer, as occurred in 1992.

From 1987 to 2002 Salmon Creek provided 84 percent of the total water supply of OID. Over this period of record, the volume of Salmon Creek runoff used by OID ranged from a minimum of 10,665 AF/year in 2002 to a maximum of 20,834 AF/year in 1998 with an average 14,886 AF/year (**Table 3-7**). The proportion of unregulated runoff[5] diverted from Salmon Creek to support OID irrigation ranged from 40 percent in a wet year (1998) to 216 percent[6] in a dry year (2001) (**Table 3-8**). Since 1987, about 71 percent (i.e., 238,177 AF) of the total unregulated flow (i.e., 335,423 AF) has been diverted at the OID Diversion Dam. However, in an average year, about 95 percent of the unregulated runoff is diverted. The substantial difference between the long-term average and annual average reflects the large volumes of unregulated inflow water that occur in some wet years. During some dry years, there has not been sufficient inflow water to meet OID needs and as a result no flow was spilled over the weir and net storage in Conconully and Salmon reservoirs may have been less at the end of the year than the previous year. In some wet years, large amounts of runoff generated from spring snow melt or summer rainstorms filled the reservoirs and flowed over the weir to the Okanogan River.

Table 3-8. Summary of OID Demands on Salmon Creek, 1987 through 2002.

	Total Unregulated Inflow	Total Salmon Creek Diversion	Total Weir Spill	% of Unregulated Inflow to OID	Total Release From Conconully	% of Total Release to OID	% of Total Release Spilled Over Weir
1987-2002 Totals	335,423	238,177	104,829	71%	343,006	69%	31%
Average for 16 years	20,964	14,886	6,552	95%	21,438	81%	19%
Maximum single year	52,010	20,834	31,194	216%	52,028	100%	60%
Minimum single year	5,832	10,655	0	40%	10,655	40%	0%

Supplemental Pumping from Duck Lake and Shellrock

Duck Lake provided 6.2 percent and the Okanogan River provided 9.8 percent of the total water supply to OID from 1987 to 2002 (**Table 3-7**). Duck Lake pumping quantities do not vary

[5] Total outflow from Conconully Reservoir plus accumulated net storage in the reservoir.
[6] In a given year, the percent diverted may exceed 100% because of reservoir carryover storage.

significantly due to the pump size, water rights limitations, and the limited ability of the lake to store water. Since 1987, the volume pumped from Duck Lake has ranged from 309 AF in 1996 to 2,065 AF in 1987. Shellrock pumping, on the other hand, varies widely, supplementing Salmon Creek and Duck Lake during years of below average runoff. There was no water pumped at Shellrock during 8 of the previous 16 years, while pumping ranged from 4,499 to 5,910 AF during five years in the same period. At a current operating capacity of 25 cfs, Shellrock pumping station can potentially pump up to 7,800 AF during the irrigation season (under the No Action Alternative). Since the maximum annual quantity of pumping during 1987 through 1998 was only 5,910 AF, the total supply capability of Shellrock has been only partially used (although the entire capacity of the plant would be needed during a critical drought period).

Conconully Reservoir and Salmon Lake Reservoir Storage and Use

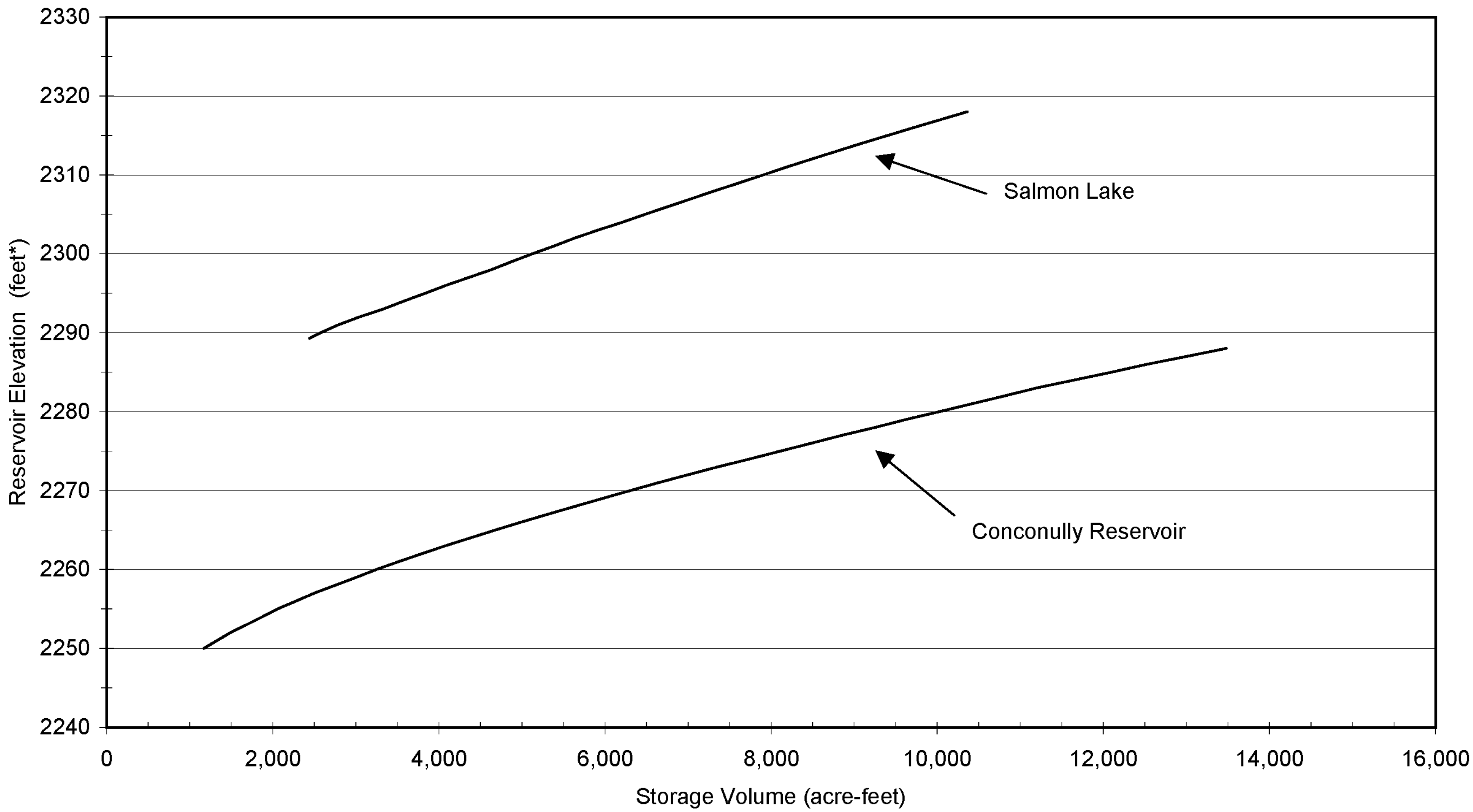
Figure 3-10 shows the amount of water in storage at different water surface elevations in Conconully and Salmon Lake Reservoirs. The maximum active storage capacity of Conconully Reservoir is about 13,000 AF, while that of Salmon Lake is about 10,500 AF. Conconully Reservoir surface area increases rapidly with elevation; Salmon Lake surface area increases more moderately.

Records of Conconully and Salmon Lake reservoir storage utilization for the period 1947 through 1998 show the amount of water in storage and the storage used by OID in each year (**Figures 3-11 and 3-12**). A large part of the storage in the reservoirs is used each irrigation season; remaining storage is available for carryover to the next year. Conconully Reservoir is drawn upon more frequently and to a greater magnitude than Salmon Lake reservoir. In many years the storage in Salmon Lake reservoir is not used at all, and is carried over into the next year. OID has relied upon Conconully Reservoir storage more heavily in part due to restrictions on the use of the Salmon Lake feeder canal, which increase the risk of not being able to refill Salmon Lake. The minimum Conconully Reservoir storage during the 1947-1998 period of record occurred in 1966 at about 2,000 AF. It was particularly low in 1966 due to two consecutive dry years and because it was completely drained in 1965 for outlet maintenance. Salmon Lake's minimum storage occurred in 1970 at just over 2,000 AF.

Duck Lake Storage and Use

Historical operations data for the period 1987 through 2002 were used to develop the parameters for the Duck Lake water budget contained in the water supply model. During 1987-2002 the magnitude of inflows to Duck Lake were substantially greater than outflows; the difference is the amount lost to seepage (and evaporation to a lesser degree). Total inflow averaged 3,684 AF/year, whereas total pumping to OID at the Duck Lake pump station averaged only 1,101 AF per year. Thus over the 16-year period, on average only 30 percent of the water entering Duck Lake has been used by OID for irrigation.

OID diverted large amounts of excess water to Duck Lake in the late 1990s when runoff in Salmon Creek was high. At the same time, Duck Lake pumping was cut back due to pump problems.



* Based on Okanogan Irrigation District Datum, 4/15/97

Figure 3-10. Salmon Lake and Conconully Reservoir Storage Elevation Curves

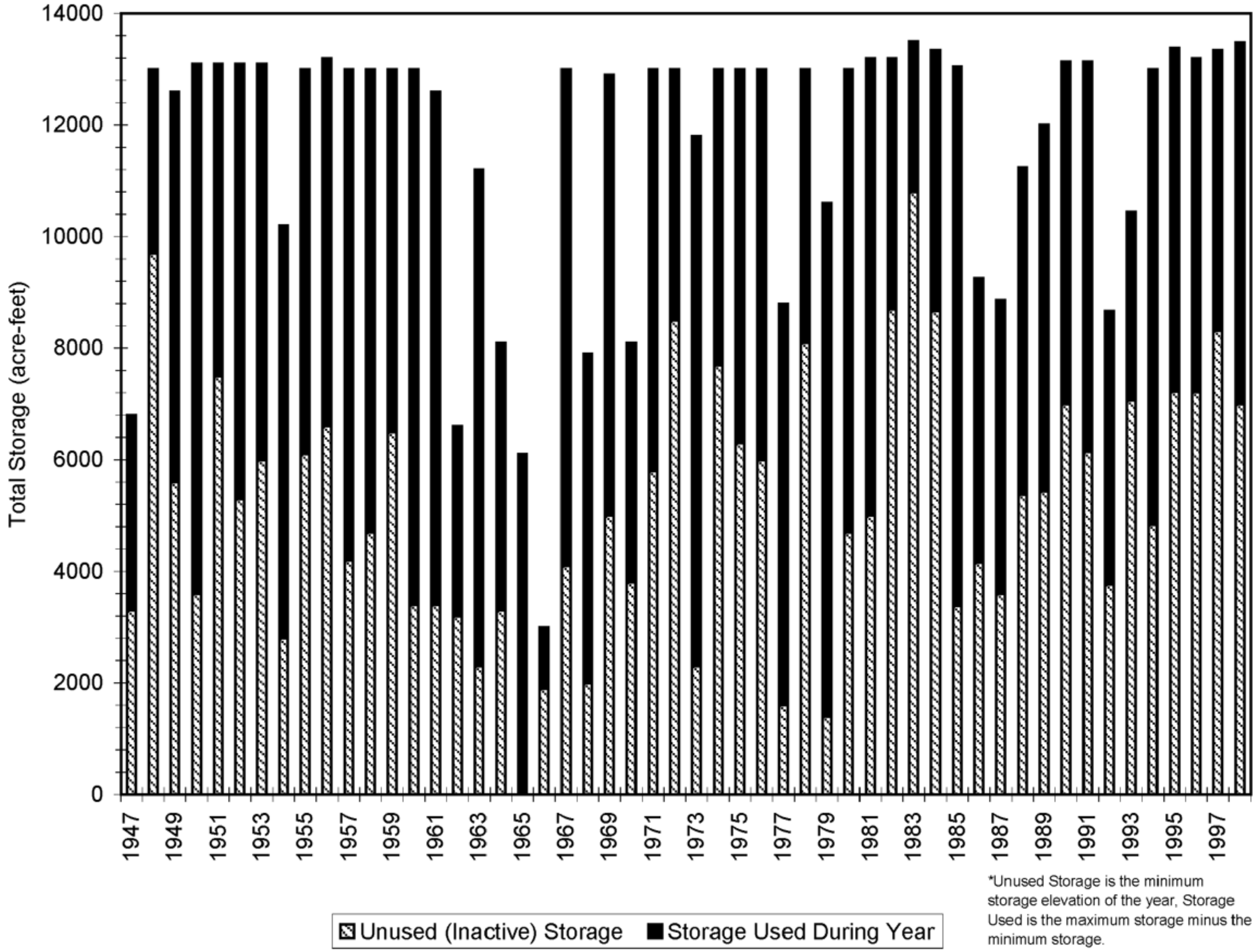


Figure 3-11. Measured Storage Utilization in Conconully Reservoir (1947 – 1998)

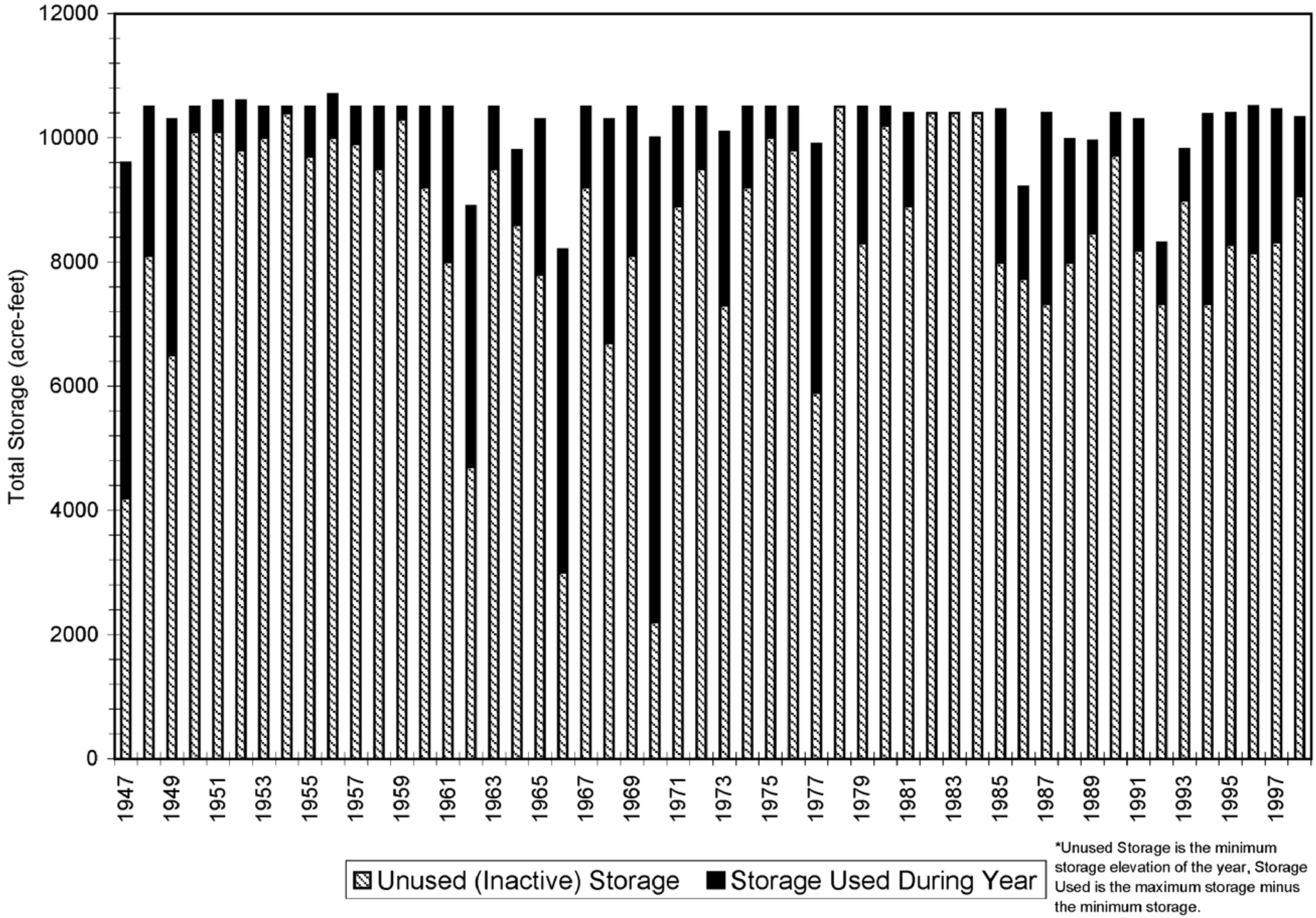


Figure 3-12. Measured Storage Utilization in Salmon Lake Reservoir.

Between 1995 and 1998, 7% to 17% of the total inflow to Duck Lake was pumped by the OID. Because of the high volume of inflow and low pumping rates, the lake elevation rose above 1240 feet. As a consequence of the higher water elevations and high hydraulic heads that were established, seepage losses increased rapidly above an elevation of about 1232 feet. Thus, most of the added inflow during this time was lost to seepage and surcharging of the Duck Lake Groundwater Basin.

Greater operational efficiency of water use from Duck Lake (defined as the percent of the total inflow used by OID) could be achieved by managing water levels to minimize seepage loss. Water supply modeling conducted for the Phase I study (Dames and Moore, 1999) determined that the overall water use of Duck Lake could increase to about 60 percent if lake elevations were kept low (to minimize seepage) and if spill were limited only to that needed for operational requirements and water sale contracts. Since 1987, efficiencies above 60 percent have occurred only twice and generally are less likely due to unavoidable seepage losses that would occur when higher lake elevations are maintained. For example, annual seepage loss is estimated to be approximately 960 AF at an average lake elevation of 1228 feet; 1,332 ac-feet at 1233 feet; and 2,670 ac-feet at 1238 feet (see **Appendix C** for more detail**)**.

EIS analysis took account of opportunities for managing the Duck Lake impoundment in conjunction with other water supplies as part of setting Salmon Creek target flow volumes. Storage for use on a seasonal basis at Duck Lake is constrained by court-established minimum and maximum lake levels and by the hydrogeology of the area.

Since the basin receives artificial recharge, may require unique groundwater management, and could be defined as a separate aquifer system, it was designated as a groundwater subarea under RCW 90.44 and by Order DE 74-24 (October 18, 1974). The 3,320-acre Duck Lake Groundwater Management Subarea is defined in WAC 173-132. As allowed under RCW 90.44, OID filed a claim of ownership of artificially stored groundwater in the subarea and a claim for right to withdrawal of artificially stored groundwater. Order DE 85-20 presents Ecology's findings and order regarding the OID claim. In Order DE 85-20, Ecology defines Duck Lake as a "groundwater lake," with its water surface altitude reflecting the local ground water table and "an integral part of the principal aquifer underlying the subarea." OID sends water to Duck Lake during high water flows for recharge, but is limited by canal capacity. Order DE 85-20 foundthat in some years the District diverts more water into Duck Lake than it pumps out during the irrigation season, while in other years the reverse is true. Over a 50-year period, Duck Lake was found to vary between elevation 1226.75 and 1246.72, and these levels have been incorporated in the order as minimum and maximum lake levels which must be maintained as a constraint on pumping and storage.

Order DE 85-20 accepts OID ownership of artificially stored groundwater in the amounts of 3,780 AF (maximum) and 2,084 (mean annual) recharge. Withdrawals of artificially recharged groundwater may be made using the OID Duck Lake pump, at a rate not to exceed 10 cfs (4,488 gpm). Withdrawal is limited to 2,700 AF per year and is "limited to beneficial use; provided the district continues its historic recharge practices."

In addition to its right to artificially stored groundwater, OID has a 1992 Certificate of Adjudicated Water Right to 20 cfs and 6,356 ac-ft. The certificate states that this right is for supplemental irrigation of 1,589 acres from April 1 to October 31, with an August 23, 1918 priority. This water right probably has been reduced to 10 cfs based on non-use of the full water right. OID's 1992 Adjudicated Certificate is considered a supplemental supply, whether to OID's artificially stored groundwater or to its other sources.

Ecology has determined that no further public water (as opposed to OID's artificially stored groundwater) is available for appropriation in the Duck Lake Groundwater Management Subarea, and has closed the subarea and denied applications proposing further withdrawals from the Subarea.

Order DE 85-20 limits pumping to a total of 10 cfs, (i.e., OID cannot also pump 15 cfs diverted under the Johnson Creek water right). Capture and reuse of return flows is normally allowed within a user's boundaries, and water spilled to Duck Lake from OID operations would fall into this category. Spill under historic practices was used in establishing the district's ownership of artificially stored groundwater at Duck Lake, so any reduction in spill would reduce the 2,700 acre-foot water right for artificially stored groundwater. This could be offset, however, by diversion to Duck Lake during high flows in anticipation of recapturing and reusing spills, thus keeping the OID artificially-stored groundwater bank "whole." The reuse of water spilled to Duck Lake in excess of the allowed rate and annual volume of withdrawal under DE 85-20 is assumed maximized under current operations, so this is not considered a source of additional water.

3.1.2 WATER QUANTITY IMPACTS

3.1.2.1 Introduction

OID Water System Model

A water supply model was developed as part of the Phase I Joint Study on Salmon Creek (Dames & Moore, 1999) to simulate the current operations of the Salmon Creek and OID water supply systems, and to quantify how much additional water could be provided by various water supply alternatives. For the EIS, this model was updated and used again to examine water quantity differences among the four EIS alternatives. **Appendix C** provides a detailed description of model structure, parameters, and the assumptions used to describe all the alternatives.

Simulated Streamflow and Reservoir Levels

Water model output is provided in **Appendix D**. Statistical analysis of the water system model output has been used to compare monthly values of various hydrologic parameters for the No Action (baseline) and each Alternative at several locations of interest. All monthly data statistics and impact comparisons referred to in the following discussions are illustrated in the graphs provided in **Appendix D**. **Appendix D-1** provides a summary of model input and output data. Conconully Reservoir and Salmon Lake elevations exceedence curves are shown in **Appendix D-2** and simulated elevations for the two reservoirs are shown in **Appendix D-4**. All estimated flows in this section for Salmon Creek are displayed graphically in **Appendix D-5** and flow exceedence curves for the creek are presented in **Appendix D-3**. Estimated flows for Okanogan River are displayed in a summary table in **Appendix D-6**. **Appendix D-7** summarizes OID annual deliveries.

3.1.2.2 Alternative 1: Okanogan River Pump Station and Pipeline

Streamflow

Alternative 1 would provide overwintering flows in the middle and lower reaches of Salmon Creek that have not been provided under historic irrigation operations.

Middle Salmon Creek

Alternative 1 reduces the unnaturally high summer flows that occurred in the middle reach under historic irrigation operations.

The estimated median monthly streamflow in the middle reach of Salmon Creek under Alternative 1 would decrease in July through September, but increase for the months from November through May. The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. Alternative 1 would decrease middle reach streamflows by about 25 cfs in July, August, and September, when Okanogan River pumping would replace the need to convey Salmon Creek water through the middle reach. Alternative 1 would provide overwintering flows for fish survival, increasing the median from nearly zero to 5-10 cfs in the months of November through March. Variability in streamflow magnitudes between the three fish passage flow regimes would be most evident in April, May, and August, but similar for all other months. The median streamflow in April would increase from about 15 cfs up to approximately 25 cfs, increase in May by 30 to 40 cfs, and decrease in August by 30-40 cfs, depending on which fish passage flow regime is assumed.

The estimated minimum monthly streamflow in the middle reach of Salmon Creek under Alternative 1 would increase about 2 to 6 cfs in the months November through March and 14 to 21 cfs in April, but decrease by up to 23 cfs in July, August, and September, when compared to current operations. Alternative 1 minimum streamflows in April, May, and June would be a function of both the instream flow requirements for fish passage in the lower reach and irrigation needs at the OID diversion dam. In May, minimum streamflow in the middle reach would increase by about 4 to 15-20 cfs. During June, minimum streamflow in the middle reach would increase about 8 cfs for the steelhead and chinook fish passage flow regime, but would be similar to the No Action Alternative for the other two fish passage flow regimes.

Lower Salmon Creek, Flow Below Wier

Alternative 1 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

The estimated median monthly streamflow on lower Salmon Creek below the weir under Alternative 1 would increase for all months. Alternative 1 would provide median monthly flows of about 5 to 12 cfs July through October to a channel reach that would remain dry under the No

Action Alternative. Alternative 1 would increase median flows from about 1 cfs to 7-10 cfs in November through March. Streamflow in April would increase from zero to about 15 to 23 cfs, and from 15 to roughly 42-55 cfs in May, depending on which fish passage flow regime is assumed. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, May, and August.

The estimated minimum monthly streamflow on lower Salmon Creek below the weir under Alternative 1 would increase for all fish passage flow regimes by about 3-7 cfs October through March, and by about 12 to 24 cfs in April, May, and June. Minimum monthly streamflow would decrease to zero in July and August for flow regimes designed to pass steelhead only. All fish passage flow regimes have zero cfs minimum flows in August. The steelhead and Chinook flow regime would maintain about 5 cfs more in the channel in June compared to the steelhead only flow regime, and would be the only regime providing flow in the channel in July.

Lower Salmon Creek, Flow at Mouth

Alternative 1 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

The estimated median monthly streamflow in the lower reach of Salmon Creek at the mouth under Alternative 1 would increase for all months. Median monthly streamflow would increase from 0-1 cfs to 3-8 cfs in the months of July through March, from zero to 12-18 cfs in April, and from 12 cfs to 33-43 cfs in May. The seasonal peak of about 38 cfs in June would not change substantially. The median monthly streamflow in the lower reach would be similar for all three fish passage regimes between June and March. The greatest variations would be in April and May, based on differences in the target species' migration requirements.

The estimated minimum monthly streamflow in the lower reach of Salmon Creek at the mouth would increase under Alternative 1 by about 3-5 cfs October through March, and by about 9 to 18 cfs in April, May, and June for all fish passage flow regimes. Minimum monthly streamflow would decrease to zero in July and August for steelhead only flow regimes. All fish passage flow regimes would have zero cfs minimum flows in August. Only the steelhead and Chinook fish passage flow regime would remain at zero through September. The steelhead and Chinook flow regime would maintain about 5 cfs more in the channel in June compared to the other fish passage flow regimes, and in the only scenario with flow in the channel in July.

Okanogan River, Shellrock to Salmon Creek

The average monthly percentage of the Okanogan River that would be pumped under Alternative 1 increases for all fish flow regimes over all water year types (**Table 3-9**). However, neither the magnitude nor the seasonality of the increased pumping would adversely affect streamflow in the Okanogan River in wet, above normal, normal or below normal water years. The number of months below WAC minimum flows in these water year types would be identical to the No Action Alternative (**Table 3-9**). However, pumping from the Okanogan River under Alternative 1 during dry water years would slightly increase the average number of months below WAC minimum flows (this increase may not be statistically significant, however).

Table 3-9. Percent of Okanogan River Pumped and Number of Months Below WAC Minimum Flows, No Action vs. Alternative 1.

Water Year Type	No Action Alternative		Alternative 1	
	Percent of Okanogan River Pumped [a]	Number of Months Below WAC Minimum Flows [b]	Percent of Okanogan River Pumped [a,c]	Number of Months Below WAC Minimum Flows [b]
Wet	0.01	0.4	0.42 to 0.45	0.4
Above Normal	0.10	0.3	0.63 to 0.68	0.3
Normal	0.06	1.2	0.82 to 0.92	1.2
Below Normal	0.21	1.4	0.96 to 1.09	1.4
Dry	0.83	6.4	1.82 to 2.13	6.5

[a] In the water model, the percent of flow pumped on a monthly basis from the Okanogan River at Shellrock was simulated for all years on record. The monthly percentages were averaged to determine the mean monthly percentage of flow pumped from the Okanogan River for a given year. The mean monthly percentage of flow pumped in a given year was then ranked by water year type and averaged again to calculate the mean monthly percentage of water pumped in a year for each of the five water year types.

[b] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[c] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Table 3-10 indicates the water rights that exist in this reach of the Okanogan River. If the proposed Project pumps when minimum flows established under the WAC are not met, it could reduce water otherwise available to these water right holders.

Table 3-10. Okanogan River Water Rights in Affected Reach.

Control Number	Name	Priority Date	Flow (cfs)	Acre-Feet	Irrigated Acres	Purpose
S4-26334GWRIS	Dickson, Warren	8/14/79	0.87		39	IR
S4-29882	Dickson, Warren	12/22/88	0.87	4	40	IR
S4-*01799CWRIS-01464	Gillespie, David et al.	7/21/26	1.5		87	ST, IR
S4-*21369CWRIS-10746	Gillespie, David	12/13/68	0.46	59	23	IR
S4-CCVOL1-3P56	Gillespie, David	7/21/26	0.51			ST, IR
S4-CCVOL1-4P124	Gillespie, David	7/21/26	0.775			ST, IR
CS4-SWC357	Okanogan Irrigation District	12/21/79				none stated
S4-004273CL	Turner, Charles	0/0/1910			14	IR
S4-*01774CWRIS-00357	Twenty-Nine Pump Co	7/3/26	7.0		1200	IR
S4-*22043CWRIS-11228	Alta Vista Irrigation District	2/24/70	2.0	174	52	IR
S4-*02929CWRIS-00592	City of Okanogan	4/9/30	1.5			MU, CI
S4-*08571CWRIS-06610	Arnold, A.A.	8/23/48	0.05	21.6	5	IR
S4-01266CWRIS	Fowler, M.F.	7/8/71	0.12	9.7	3	IR

Okanogan River, Salmon Creek to Malott

Salmon Creek inflow to the Okanogan River would increase under Alternative 1 for all water year types (**Table 3-11**). The increase would double or triple the Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years, the increase would be four to five times that of the No Action Alternative.

Table 3-11. Salmon Creek Inflow to the Okanogan River as a Percentage of Okanogan River Streamflow at Malott, No Action vs Alternative 1.

Water Year Type	No Action Alternative [a]	Alternative 1 [a,b]
Wet	0.25	0.58 to 0.60
Above Normal	0.21	0.53 to 0.57
Normal	0.19	0.57 to 0.61
Below Normal	0.13	0.54 to 0.55
Dry	0.09	0.66 to 0.69

[a] In the water model, Salmon Creek inflow into the Okanogan River as a percentage of total monthly Okanogan River streamflow measured between Salmon Creek's mouth and Malott was simulated for all years on record. The monthly percentages were averaged to determine Salmon Creek's mean monthly percent contribution of flow to the Okanogan River for a given year. The mean monthly percent contribution of Salmon Creek inflow in a given year was then ranked by water year type and averaged again to calculate the mean monthly percent contribution of Salmon Creek inflow in a year for each of the five water year types.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Water right holders downstream of Salmon Creek also could be affected by reduced water availability if water is pumped during times when WAC minimum flows are not met.

Reservoir Levels

Salmon Lake

The estimated median monthly Salmon Lake reservoir water surface elevation under Alternative 1 would increase by 1 to 3 feet for the months of August through March. In March through July, median lake elevations for all three fish passage flow regimes and the No Action Alternative would be nearly identical. In May, June, and July, median Salmon Lake elevations would be at full active storage capacity (2,318 ft, 10,500 AF). Alternative 1 would reduce the seasonal fluctuation in lake level that has occurred under historic irrigation operations. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The high reservoir elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir.

The estimated minimum monthly Salmon Lake reservoir water surface elevation under Alternative 1 would increase in all months. Alternative 1 would reduce the seasonal variation of minimum reservoir elevations. The minimum monthly reservoir elevation varies for each of the three fish passage flow regimes, based on the different target species' migration requirements and simulated reservoir operations. The “steelhead only” fish flow regimes would have minimum Salmon Lake levels several feet higher than steelhead and Chinook flow regime. The increased minimum reservoir water levels would provide more seasonally and annually consistent surface and groundwater availability along the margins of Salmon Lake reservoir.

Conconully Reservoir

The estimated median monthly Conconully Reservoir water surface elevation under Alternative 1 would increase by ten to twenty feet for the months of August through April, such that the median reservoir elevation would be at full active storage capacity (elevation 2287 ft) in all months. Alternative 1 would eliminate the large seasonal fluctuation in median reservoir elevation that has occurred under the historic irrigation operations. The median reservoir elevation under Alternative 1 would be similar for the three fish passage flow regimes. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The reservoir water levels would provide more seasonally consistent surface and groundwater availability along the margins of Conconully Reservoir.

The estimated minimum monthly Conconully Reservoir water surface elevation Under Alternative 1 would be increased by ten to twenty feet for the steelhead only flow regimes, such that the minimum reservoir elevation remains within ten feet of the active storage capacity in all months. The minimum Conconully reservoir elevations under the steelhead and Chinook flow regime would decrease from January to July, but increase August to December compared to the No Action Alternative. Alternative 1 would eliminate the large seasonal fluctuation in minimum reservoir elevation that has occurred under the historic irrigation operations. The increased minimum reservoir water levels under "steelhead only" regimes would provide more seasonally and annually consistent surface and groundwater availability along the margins of Conconully Reservoir than the No Action Alternative.

Flood Hazards

Reservoir Margins

The estimated maximum monthly Salmon Lake water surface elevations under Alternative 1 would be comparable to the No Action Alternative from April to October of each year. From November to February the maximum monthly lake level would be reduced by as much as 1.2 feet, with the lowest elevation occurring during February. Alternative 1 would provide a slight benefit in reducing flood hazard from the No Action Alternative.

The estimated maximum monthly Conconully Reservoir water surface elevations Under Alternative 1 would be comparable to the No Action Alternative in all months except October. The maximum monthly Conconully reservoir spill volume and the 10% exceedence spill volume under Alternative 1 would decrease relative to the No Action Alternative in April, May and June. This would provide a minor beneficial flood hazard reduction. These small volume differences may reflect minor operational changes due to the release of fish flows in spring, but the available storage capacity created in the reservoir would be small enough that the monthly maximum elevation statistics do not change.

Middle Reach Salmon Creek

The estimated maximum monthly streamflow and the 10% exceedence streamflow in the middle reach of Salmon Creek would be similar to the No Action Alternative in magnitude and seasonality. No adverse or beneficial impacts to flood hazard would occur in the middle reach under Alternative 1.

Lower Reach Salmon Creek

The estimated maximum monthly streamflow streamflow and the 10% exceedence streamflow in the lower reach of Salmon Creek under Alternative 1 would be comparable to the No Action Alternative in both magnitude and seasonality. No adverse or beneficial impacts to flood hazard would occur in the lower reach under Alternative 1.

Flooding/Inundation

Reservoir Margins

Wetland inundation along the Salmon Lake reservoir margin would increase slightly under Alternative 1, since the lake would experience an increase in median elevation in most months, and the maximum elevations would remain similar to the No Action Alternative. Under the steelhead only fish flow regimes, minimum Salmon Lake elevation would also increase several feet in all months.

Wetland inundation along the Conconully Reservoir margins would increase in most months of the year under Alternative 1, since the median lake elevation would increase to near the maximum active storage elevation, and the maximum lake level remains similar to the No Action Alternative. Under the steelhead only fish flow regimes, minimum monthly Conconully reservoir elevation would also increase several feet in all months.

Middle Reach Salmon Creek

Flooding and riparian wetland inundation along the middle reach of Salmon Creek under Alternative 1 would be similar to the No Action Alternative since the magnitude, seasonality, and frequency of high streamflow volume would be similar to the No Action Alternative, and the channel capacity would not be modified.

Lower Reach Salmon Creek

Flooding and riparian wetland inundation along the river reach of Salmon Creek under Alternative 1 would be subject to the same magnitude, seasonality and frequency of high streamflow volumes as under the No Action Alternative.

Groundwater

Okanogan River Valley Aquifer

Groundwater recharge and levels along the Okanogan River Valley aquifer under Alternative 1 would experience a decrease in the vicinity of the new pump station and down gradient towards the mouth of Salmon Creek on average compared to the No Action alternative. These effects are not quantitatively modeled, but since the number of times flows would fall below WAC minimums would slightly increase in dry years, the effects may be measurable. However, the localized groundwater decreases would be partially offset by increased Salmon Creek inflow to the Okanogan River about 1.25 miles downstream of the new pump station. Average pumping from the Okanogan River would increase under Alternative 1 by between 6,600 AF for steelhead only to 7,100 AF for steelhead and Chinook over the No Action Alternative. Streamflow at the mouth of Salmon Creek would increase by about 5,100 AF, even in dry years. Therefore, the worst case decrease in potential groundwater recharge to this reach of the Okanogan River valley aquifer would be about 1,500 AF for steelhead only and 2,000 AF for steelhead and Chinook.

Reservoir Margins

The groundwater levels along the margins of Salmon Lake reservoir and Conconully Reservoir would be more consistent seasonally and from year to year under Alternative 1 compared to the No Action Alternative, as median lake levels are increased. During normal to wet years, groundwater levels around the reservoirs would experience less seasonal variability. For dry years, Salmon Lake and Conconully Reservoir would experience increased groundwater recharge and levels for the “steelhead only” fish flow regimes. The minimum lake levels under the steelhead and Chinook fish flow regime would not increase minimum lake levels substantially at Salmon Lake, and would decrease it slightly in some months at Conconully Reservoir. Overall, the impact to groundwater along the reservoir margins would be a substantial benefit, increasing recharge volumes and reducing fluctuations in local groundwater gradients.

Salmon Creek Valley Aquifer

Groundwater levels and recharge along the middle reach of Salmon Creek under Alternative 1 would likely experience a seasonal shift, since median and minimum streamflow would increase in fall, winter, and spring months, but would decrease in summer. The magnitude of flow volumes would be similar to the No Action Alternative, as indicated by consistent simulated average annual flow. The increase of base flows, distributing flow throughout more of the year may, result in more consistent groundwater levels.

Groundwater recharge potential in lower Salmon Creek under Alternative 1 would increase compared to the No Action Alternative, since median and minimum streamflow volumes increase and the total flow volume released/spilled over the OID weir would increase by a few thousand acre feet per year, in all water year types.

Duck Lake Aquifer

The Duck Lake maximum pumping rate and annual sales would not increase under Alternative 1, but the average annual volume pumped from Duck Lake would increase by about 200 AF for the "steelhead only" flow regimes and 300 AF for the steelhead and Chinook flow regime (**Appendix D-1**). The minimum and maximum Duck Lake elevations would be the same as the No Action Alternative, although the season and pattern of pumping may vary. No substantial impacts to the Duck Lake aquifer groundwater levels or recharge would occur under Alternative 1.

OID Water Availability

Alternative 1 would have no effect on critical period irrigation deliveries to OID members.

3.1.2.3 Alternative 1: Feeder Canal Upgrade

Streamflow

The feeder canal upgrade would increase the maximum rate of diversion from the North Fork Salmon Creek from 30 cfs under existing and historical conditions to 90 cfs. The frequency of feeder canal use would also be expected to increase, since its operational safety would be improved. Only limited data regarding historical operation of the feeder canal or records of North Fork Salmon Creek streamflow exist, and the monthly time-steps of the water system model provide only a rough representation of feeder canal operations. Therefore, the discussion of hydrologic impacts is based on qualitative analysis.

Operation of the upgraded feeder canal would potentially decrease streamflow for the short reach (4500 feet) of North Fork Salmon Creek within the town of Conconully between the OID feeder canal intake and the upstream end of Conconully Reservoir. This impact would be common to all alternatives. No operational schedule for the feeder canal has been established. Operation of the upgraded feeder canal diversion would likely be focused on moderate to high runoff events in the North Fork Salmon Creek, primarily in May and June of normal, above normal and wet years. However, operation of the feeder canal may occur in other months, and in other water year types. Operation of the feeder canal under OID water rights would allow the District to divert all flows above 1.33 cfs in the North Fork. If operated at maximum capacity, the upgraded feeder canal could decrease peak streamflow by as much as 60 cfs during moderate to high runoff events compared to existing and historical operations. The North Fork streamflow is a portion of total estimated unregulated watershed runoff (**Appendix B-3**). It is likely that operation of the upgraded feeder canal would decrease streamflow in the diverted reach of the North Fork to the legal minimum flow (1.33 cfs, as set by OID water rights) more frequently than under the existing and historical operations.

Reservoir Levels

Operation of the upgraded feeder canal would increase the ability of OID to reliably refill Salmon Lake reservoir using diversion from the North Fork Salmon Creek. The effects of the upgraded diversion have not been modeled discretely from the Alternatives. However, the increased median, minimum and maximum Salmon Lake reservoir water surface elevations simulated within each Alternative are facilitated by the upgrade to the feeder canal.

Flood Hazards

The increased capacity of the feeder canal intake could potentially decrease peak streamflow by as much as 60 cfs compared to existing and historical operations. Operation of the upgraded feeder canal during high flow events would therefore, reduce the potential flood hazards to persons and property adjacent to the quarter-mile long diverted reach between the OID feeder canal intake and the upstream end of Conconully Reservoir.

Flooding/Inundation

Operation of the upgraded feeder canal during moderate and high flow events would reduce the potential for overbank flow and inundation of riparian areas within the quarter-mile long diverted reach between the OID feeder canal intake and the upstream end of Conconully Reservoir.

Groundwater

Operation of the upgraded feeder canal on the North Fork Salmon Creek would have surface hydrology effects in the quarter-mile long reach downslope of the Salmon Lake dam and reservoir and immediately upstream of the Conconully Reservoir. It is likely that groundwater recharge within this reach is dominated by down-valley groundwater flow along the North Fork Salmon Creek, downslope groundwater flow under Salmon Lake, and the groundwater support provided by water surface elevations in Conconully Reservoir.

The feeder canal upgrade would create minor surface hydrology decreases and possible local reductions in soil moisture along the short reach of the North Fork channel below the canal diversion. However, it would not produce any net change in local groundwater recharge. The magnitude and duration of surface hydrology changes would be small compared to groundwater source volumes and recharge rates. In addition, the water diverted from the North Fork Salmon Creek would be conveyed to and stored in adjacent Salmon Lake, which would continue to provide recharge to local groundwater.

3.1.2.4 Alternative 1: Stream Rehabilitation

Stream rehabilitation under Alternative 1 consists of removing the gravel bar at the mouth of Salmon Creek. This action would not affect water quantity within Salmon Creek or elsewhere in the system.

3.1.2.5 Alternative 2: Upgrade Shellrock Pumping Plant

Streamflow

Alternative 2 would provide overwintering flows in the middle and lower reaches of Salmon Creek that have not been provided under historic irrigation operations.

Middle Salmon Creek

Alternative 2 would reduce the unnaturally high summer flows that have occurred in the middle reach under historic irrigation operations and would continue under the No Action Alternative.

The estimated median monthly streamflow in the middle reach of Salmon Creek under Alternative 2 would decrease in July through September, but increase for November through May relative to the No Action Alternative. The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. Alternative 2 would decrease middle reach streamflow by about 25 cfs in July, August, and September when Shellrock pumping from the Okanogan River reduces the need to convey Salmon Creek water through the middle reach. Alternative 2 would provide overwintering flows for fish survival, increasing the median from nearly zero to 5-10 cfs in the months of November through March. The median streamflow in April would increase from about 15 cfs to approximately 35 cfs, would increase in May by 20 to 30 cfs, and would decrease in August by about 30 cfs. Minor differences (5 to 10 cfs) in the resulting monthly medians depend on which fish passage flow regime is assumed.

The estimated minimum monthly streamflow in the middle reach of Salmon Creek under Alternative 2 would increase about 2 to 6 cfs in the months November through March and 15 to 30 cfs in April, but would decrease by up to 25 cfs in July, August, and September when Shellrock pumping replaces the need to convey Salmon Creek water through the middle reach. Estimated minimum streamflows in April, May, and June are a function of both the instream flow requirements for fish passage in the lower reach and irrigation releases to the OID diversion dam. In May, estimated minimum streamflow in the middle reach would increase about 4 to 20-25 cfs. During June, estimated minimum streamflow in the middle reach would increase about 8 cfs for the steelhead and Chinook fish passage flow regime, but only by a couple cfs for the steelhead only flow regimes.

Lower Salmon Creek, Flow Below Weir

Alternative 2 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations and would not be provided under the No Action Alternative.

Under Alternative 2, the median monthly streamflow below the weir would increase by about 4 to 10 cfs November through March for all three fish passage flow regimes. Stream flow in April would increase from zero to about 15 to 32 cfs, and in May from about 15 to 30-35 cfs, depending on which fish passage flow regime is applied. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would increase flow in the channel by about 10 cfs in July and August, while under all other scenarios, the channel is dry.

The minimum monthly streamflow in lower Salmon Creek below the weir would increase under Alternative 2 by about 2 to 9 cfs during November through March for all fish passage flow regimes. Minimum monthly streamflow would increase in April, May, and June by 7 to 32 cfs, depending on the target fish species flow requirement. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would maintain about 15 cfs more in the channel in June compared to the other fish passage alternatives. It is the only scenario with flow in the lower Salmon Creek channel in July.

Lower Salmon Creek, Flow at Mouth

Alternative 2 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

Under Alternative 2, the estimated median monthly stream flow in the lower reach of Salmon Creek at the mouth would increase by about 2 to 9 cfs November through March for all three fish passage flow regimes. Estimated stream flow in April would increase from zero to about 12 to 25 cfs, and in May from about 13 to 23-28 cfs, depending on the target fish species flow requirements. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would increase flow in the channel by about 10 cfs in July and August, while under all other scenarios, the channel is dry.

Under Alternative 2, the estimated minimum monthly stream flow in the lower reach of Salmon Creek at the mouth would increase by about 2 to 8 cfs November through March for all fish passage flow regimes. Estimated minimum monthly stream flow would increase in April, May, and June range from 6 to 25 cfs, depending on the target fish species flow requirement. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would maintain about 10 cfs more in the channel in June compared to the other fish passage regimes, and is the only scenario with flow in the channel in July.

Okanogan River, Shellrock to Salmon Creek

The average monthly percentage of the Okanogan River that would be pumped under Alternative 2 would increase for all fish flow regimes over all water year types (**Table 3-12**). However, the increased percentage would not be of a magnitude or seasonality that adversely affects stream flow in the Okanogan River. The number of months with flow below WAC minimums various water year types would remain identical to the No Action Alternative (**Table 3-12**).

Table 3-12. Percent of Okanogan River Pumped and Number of Months Below WAC Minimum Flows, No Action vs Alternative 2

Water Year Type	No Action Alternative		Alternative 2	
	Percent of Okanogan River Pumped [a]	Number of Months Below WAC Minimum Flows	Percent of Okanogan River Pumped [a,c]	Number of Months Below WAC Minimum Flows[b]
Wet	0.01	0.4	0.33 to 0.34	0.4
Above Normal	0.10	0.3	0.49 to 0.51	0.3
Normal	0.06	1.2	0.64 to 0.65	1.2
Below Normal	0.21	1.4	0.76 to 0.77	1.4
Dry	0.83	6.4	1.44 to 1.19	6.4

[a] In the water model, the percent of flow pumped on a monthly basis from the Okanogan River at Shellrock was simulated for all years on record. The monthly percentages were averaged to determine the mean monthly percentage of flow pumped from the Okanogan River for a given year. The mean monthly percentage of flow pumped in a given year was then ranked by water year type and averaged again to calculate the mean monthly percentage of water pumped in a year for each of the five water year types.

[b] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[c] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Table 3-10 summarizes the water rights that exist in this reach of the Okanogan River. If the proposed Project pumps when minimum flows established under the WAC are not met, it could reduce water otherwise available to these water right holders.

Okanogan River, Salmon Creek to Malott

Salmon Creek inflow to the Okanogan River would increase under Alternative 2 for all water year types (**Table 3-13**). The increase would represent a doubling or tripling of Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years the increase would be four to five times that under the No Action Alternative. Water right holders downstream of Salmon Creek could be affected by reduced water availability if water is pumped during times when WAC minimum flows are not met.

Table 3-13. Salmon Creek Inflow to the Okanogan River as a Percentage of Okanogan River Streamflow at Malott, No Action Compared to Alternative 2

Water Year Type	No Action Alternative [a]	Alternative 2 [a,b]
Wet	0.25	0.54 to 0.57
Above Normal	0.21	0.47 to 0.54
Normal	0.19	0.50 to 0.58
Below Normal	0.13	0.45 to 0.56
Dry	0.09	0.52 to 0.72

[a] In the water model, Salmon Creek inflow into the Okanogan River as a percentage of total monthly Okanogan River streamflow measured between Salmon Creek's mouth and Malott was simulated for all years on record. The monthly percentages were averaged to determine Salmon Creek's mean monthly percent contribution of flow to the Okanogan River for a given year. The mean monthly percent contribution of Salmon Creek inflow in a given year was then ranked by water year type and averaged again to calculate the mean monthly percent contribution of Salmon Creek inflow in a year for each of the five water year types.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Reservoir Levels

Salmon Lake Reservoir

The estimated median monthly Salmon Lake reservoir water surface elevation this alternative is the same or increased by 1 to 3 feet in August through January (**Appendix D-4**). The median lake elevation in February and March would increase or decrease by a foot compared to the No Action Alternative, depending on the fish passage flow regime. In April, median lake elevation would be about 2 feet lower than the No Action Alternative, while in May through July, median lake elevations for all three fish passage flow regimes and the No Action Alternative would be nearly identical. In May, June, and July, median Salmon Lake elevations would be maintained at full active storage capacity (2,318 ft, 10,000 AF). The median lake elevation would be higher and would reduce the seasonal fluctuation of Salmon that have occurred under historic irrigation operations. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The high reservoir elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir.

The estimated minimum monthly Salmon Lake water surface elevation under this alternative would be lower than the No Action Alternative January through July for all three fish flow regimes. Minimum Salmon Lake elevations would decrease by 2 to 5 feet in January, February, and July and by less than 3 feet August through December. The minimum Salmon Lake elevations in February through June would decrease by 8 to 12 feet, depending on the fish species target flow requirements. The decreased minimum water surface elevations in Salmon Lake (despite increased median lake levels) indicate the increased operational use of Salmon Lake, as facilitated by the upgraded feeder canal.

Conconully Reservoir

The estimated median monthly Conconully Reservoir water surface elevation under Alternative 2 would increase in all months, except May, June, and July, which would remain at maximum active storage level (**Appendix D-4**). The median water surface elevation would increase by about 5 feet in March and August to about 10 feet in September. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The increased median reservoir elevations in late summer through winter would increase surface inundation and groundwater availability along the reservoir margins.

Flood Hazards

Reservoir Margins

The estimated maximum monthly Salmon Lake elevations under Alternative 2 would be the same as the No Action Alternative from April to October of each year. From November through March the maximum monthly lake levels would be reduced up to 1.6 feet, with the lowest elevation occurring in February (**Appendix D-4**). Alternative 2 would represent a slight beneficial impact for reduction of flood hazard from the No Action Alternative.

The estimated maximum monthly Conconully Reservoir elevations under Alternative 2 would be comparable to the No Action Alternative in all months except October (**Appendix D-4**). No change in flood hazard would occur along the margins of Conconully Reservoir.

The estimated maximum monthly Conconully Reservoir spill volume and the 10% exceedence spill volume would decrease under Alternative 2 relative to the No Action Alternative in April, May, and June (**Appendices D-2, D-4**). This would be a minor beneficial reduction of flood hazard. These small volume differences may reflect minor operational charges due to the release of fish flows during spring, but the available storage capacity created in the reservoir would be small enough that the monthly maximum elevation statistics do not change.

Middle Salmon Creek

The estimated maximum monthly streamflow and the 10% exceedence streamflow in the middle reach of Salmon Creek under Alternative 2 would be similar to the No Action Alternative in magnitude and seasonality (**Appendices D-3, D-5**). No adverse or beneficial impacts to flood hazard in the middle reach would occur under Alternative 2.

Lower Salmon Creek

The estimated maximum monthly and 10% exceedance streamflow in the lower reach of Salmon Creek under Alternative 2 would be similar to the No Action Alternative in magnitude and seasonality (**Appendices D-3, D-5**). No adverse or beneficial impacts to flood hazard in the lower reach would occur under Alternative 2.

Flooding/Inundation

Reservoir Margins

Wetland inundation along the Salmon Lake reservoir margins would increase slightly under Alternative 2, since the lake would experience an increase in the median elevation in most months, and the maximum lake level would remain similar to the No Action Alternative (**Appendix D-4**).

Wetland inundation along the Conconully reservoir margins would increase in most months of the year under Alternative 2, since the median lake level would increase to near the maximum active storage elevation (**Appendix D-4**), and the maximum lake level remains similar to the No Action Alternative.

Middle Salmon Creek

Flooding and riparian wetland inundation along the middle reach of Salmon Creek under the Alternative 2 would be similar to the No Action Alternative since the magnitude and frequency of high streamflow volume would be similar (**Appendix D-5**), and the channel capacity would not be modified.

Lower Salmon Creek

Flooding and riparian wetland inundation along lower Salmon Creek under the Alternative 2 would be subject to the same pattern of extreme high flow magnitude and seasonality as under the No Action Alternative (**Appendix D-5**). However, portions of the lower reach that are modified for channel rehabilitation may experience minor increases in overbank flow and inundation of adjacent re-contoured floodplains. These areas of potential benefit would be limited to reaches that have suitable valley width to allow floodplain recontouring.

Groundwater

Okanogan River Valley Aquifer

Groundwater recharge and levels along the Okanogan River Valley aquifer under the Alternative 2 would experience a potential decrease in the vicinity of and down gradient towards the mouth of Salmon Creek, at least during dry years or below normal years, when the percentage of Okanogan River pumped would be approximately one percent or more. These effects are not quantitatively modeled, but since the Frequency with which WAC minimum flows are not met would not increase in duration (**Table 3-12**), it would be unlikely that groundwater recharge would be decreased.

In addition, the potential localized, short-term groundwater decrease would be offset by increased Salmon Creek inflow to the Okanogan River 3.2 miles downstream. Average Shellrock pumping would increase almost 5,000 AF under the Alternative 2 compared to the No Action Alternative (**Appendix D-1**). However, Salmon Creek inflow volume to the Okanogan River would increase about 5,100 AF, even in dry years.

Reservoir Margins

The estimated groundwater levels along the margins of both Conconully Reservoir and Salmon Lake would be relatively constant throughout the year during normal to wet years under the Alternative 2, and would experience less seasonal variability relative to the No Action Alternative. During dry years, groundwater levels would be slightly higher in the fall and early winter months relative to the No Action Alternative in Conconully Reservoir, but slightly lower throughout the rest of the year. During dry years, groundwater levels around Salmon Lake would be depressed throughout the year relative to the No Action Alternative.

Salmon Creek Valley Aquifer

Estimated groundwater levels and recharge along the middle reach of Salmon Creek under the Alternative 2 would likely experience a seasonal shift since median and minimum streamflow would increase in fall, winter, and spring months, but decrease in summer (**Appendix D-5**). The magnitude of flows would be similar although the timing would be shifted, as indicated by the consistent simulated average annual flow. The increase of base flows over much of the year may result in more consistent seasonal groundwater levels.

Groundwater recharge potential in lower Salmon Creek under the Alternative 2 would be increased compared to the No Action Alternative, since median and minimum streamflows increase and the total flow volume released/spilled over the OID weir increases by a few thousand AF per year, in all water year types (**Appendix D-5**).

The groundwater levels and recharge in lower Salmon Creek under the Alternative 2 would be influenced by the channel rehabilitation features, which contain several design elements intended to produce increased recharge within the riparian corridor. Design factors that should increase groundwater inputs include higher wetted area associated with low flow channel, flows that will sufficiently remove fines (which retard permeability), design guidelines that require unsealed banks and greater floodplain water storage and seepage relative to the No Action Alternative.

Duck Lake Aquifer

The estimated Duck Lake maximum pumping rate would increase under the Alternative 2, but the annual average volume pumped from Duck Lake and annual storage retained in Duck Lake to recharge artificial groundwater storage would be maintained at 500 AF (no change from the No Action Alternative) (**Appendix D-1**). The minimum and maximum Duck Lake water surface elevations would be the same under the Alternative 2 and the No Action Alternative, although the season and pattern of pumping may vary. No substantial impacts to Duck Lake Aquifer groundwater levels or recharge would occur under the Alternative 2.

OID Water Availability

Alternative 2, combined with the provision of flows for steelhead and chinook, results in a small critical period shortage that would occur when conditions are similar to the early 1930's drought period. The shortage would be equal to a capacity of about 10 cfs and is modeled to persist for four years, with a peak critical storage deficit of 1678 AF per year in the second year of the drought sequence. This deficit would occur even though pumping from Duck Lake and Shellrock would be maximized when critical storage volumes in Conconully and Salmon Lake reservoirs fell below 15,000 ac-ft. Thus, the model suggests that the significantly greater instream flow demands for maintaining chinook species would impact the OID water system when drought conditions are similar to those experienced in the late 1920's and early 1930's.

3.1.2.6 Alternative 2: Feeder Canal Upgrade

The environmental impacts would be the same as described in **Section 3.1.2.3**.

3.1.2.7 Alternative 2: Stream Rehabilitation

Streamflow

Potential water quantity impacts of the stream rehabilitation may include short-term disruption of flow during construction and long-term changes to flow during operation. Operational stream flow and groundwater impacts are discussed in **Section 3.1.2.5**. Over the operational period, minor beneficial effects to surface hydrology from stream rehabilitation include increased flow depths under low to moderate streamflow magnitudes within the reconfigured fish passage low flow channel.

Construction of the rehabilitated channel in Lower Salmon Creek would occur when the channel is dewatered and when the probability of spill is low. It is expected that channel rehabilitation construction activities within the lower reach of Salmon Creek could readily be scheduled without the need for a temporary bypass or dewatering. It is possible that minor (1-2 cfs) surface flow would be present in the work areas closest to Watercress Springs, or in the vicinity of drainage/treatment outfalls within the City. However, construction requirements would not be likely to create or require complete elimination of small seepage flows.

Flood Hazards

No adverse impact to the existing flood hazard would occur with full stream rehabilitation, since the channel would be designed to pass the base flood (100-year flood) without increasing the area or water surface elevation of the existing regulatory floodplain. Recontouring of channel bed and banks would be designed to alter overbank flow and flood water retention at portions of lower Salmon Creek that have adequate valley width (e.g., upstream of city limits-downstream of Watercress Springs). While some minor flood storage benefit may occur, it would be unlikely to cause a measurable decrease flows in the 100 year water surface elevations.

Flooding/Inundation

Some minor beneficial effects on floodplains and wetland inundation might occur under full stream rehabilitation. The recontouring of channel bed and banks would be designed to increase the frequency of overbank flow and floodwater retention, at portions of lower Salmon Creek that have adequate valley width (e.g., upstream of the City limits-downstream of Watercress Springs). However, it is unlikely that measurable increases in riparian wetland innudation would occur.

Groundwater

Groundwater recharge would not be expected to increase under Stream Rehabilitation alone, since the volume and timing of water released or spilled to lower Salmon Creek would not change under the No Action Alternative. However, it is possible that groundwater recharge might experience slight benefits from the recontouring of channel bed and banks in the portions of lower Salmon Creek that have adequate valley width (e.g., upstream of the City limits-downstream of Watercress Springs). Any recharge benefits would occur only in the same limited number of months and years that experience spill to lower Salmon Creek under the No Action Alternative.

Loss of groundwater to surface flow via interception, extraction, or other means would not be expected to increase under Stream Rehabilitation. The channel bed elevations would not be excavated below the normal groundwater levels, and no new groundwater pumping would occur.

3.1.2.8 Alternative 3: Water Rights Purchase

Streamflow

Alternative 3 would provide overwintering flows in the middle and lower reaches of Salmon Creek that have not been provided under historic irrigation operations and would maintain base flows at the mouth of the creek.

Middle Salmon Creek

Alternative 3 reduces the unnaturally high summer flows in the middle reach that occurred under historic irrigation operations.

The estimated median monthly streamflow in the middle reach of Salmon Creek under Alternative 3 would decrease in July through September, but increase in November through May compared to historic operation. The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. Alternative 3 would decrease middle reach streamflows by about 25 cfs in July, August and September, when irrigation demand would be reduced compared to the No Action Alternative. Alternative 3 would provide overwintering flows for fish survival that increase the median from near zero to 5-10 cfs in the months of November through March. Variability in the streamflow magnitudes between the three fish flow regimes would be most evident in April and May. The median streamflow in April would increase from about 15 cfs up to approximately 35 cfs, and by about 20 to 22 cfs in May, depending on which fish flow regime is assumed.

The estimated minimum monthly streamflow in the middle reach of Salmon Creek under Alternative 3 would increase about 2 to 6 cfs in the months of November through March and 10 to 30 cfs in April, but decrease about 7 to 10 cfs in months of June through August compared to historic operation. Alternative 3 minimum monthly streamflow in April through August would be a function of both instream demand and needs for OID irrigation. Minimum flows would be highest in April (for the two steelhead only Alternatives), while the minimum required for the steelhead and Chinook salmon during summer would keep the middle reach minimums closer to the No Action than for steelhead only.

Lower Salmon Creek, Flow below Wier

Alternative 3 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

The estimated median monthly streamflow in lower Salmon Creek below the weir would increase in all months for the steelhead and Chinook flow regime, and in all months except July and August for the steelhead only regimes compared to historic operation. Median monthly streamflow would increase by 3 to 7 cfs from September through March. Increases in April would range from 15 to 30 cfs (larger for the steelhead only regimes) and would be about 20-25 cfs in May.

Under Alternative 3, the minimum monthly streamflow in lower Salmon Creek below the weir would increase about 3 to 5 cfs October through February for the steelhead only flow regimes, and about 5 to 8 cfs for the steelhead and Chinook regime. Minimum streamflows would be substantially increased March through June (by 10 to 30 cfs, depending on the fish flow regime). Minimums would also be increased from zero to about 10 cfs July through September, for the steelhead and Chinook flow regime.

Lower Salmon Creek, Flow at the Mouth

The estimated median monthly streamflow for the lower reach Salmon Creek at the mouth under Alternative 3 would be increased in all months for the steelhead and Chinook flow regime, and in all months except July and August for the steelhead only flow regimes. The median streamflow would increase 3 to 7 cfs September through March for all fish flow regimes. Increases in April and May would be the largest and most varied. Depending on species requirements, median flow increases in April would vary from about 10 cfs for steelhead and Chinook to about 25 cfs for steelhead without the channel rehabilitation. Increases in May would be about 20 to 22 cfs. Only the steelhead and Chinook regime would provide median flow greater than zero in July and August.

Under Alternative 3, the estimated minimum monthly streamflow in lower Salmon Creek at the mouth would increase about 3 to 5 cfs October through February for the steelhead only regimes and about 5 to 8 cfs for the steelhead and Chinook flow regime compared to historic operation. Minimum streamflows would be substantially increased March through June (by 10 to 30 cfs depending on the fish flow regime). Minimums would also increase from zero to about 10 cfs July through September for the steelhead and Chinook flow regime.

Okanogan River, Shellrock to Salmon Creek

The percentage of Okanogan River that would be pumped under Alternative 3 would increase for all fish flow regimes over all water year types (**Table 3-14**). However, neither the magnitude nor seasonality of increased pumping would adversely affect minimum streamflow in the Okanogan

River. The number of months below WAC minimum flows would be identical to the No Action Alternative (**Table 3-14**).

Table 3-14. Percent of Okanogan River Pumped and Number of Months Below WAC Minimum Flows, No Action vs Alternative 3

	No Action Alternative		Alternative 3	
Water Year Type	Percent of Okanogan River Pumped [a]	Number of Months Below WAC Minimum Flows	Percent of Okanogan River Pumped [a,c]	Number of Months Below WAC Munimum Flows [b]
Wet	0.01	0.4	0.21 to 0.24	0.4
Above Normal	0.10	0.3	0.33 to 0.36	0.3
Normal	0.06	1.2	0.44 to 0.46	1.2
Below Normal	0.21	1.4	0.52 to 0.54	1.4
Dry	0.83	6.4	1.01 to 1.03	6.4

[a] In the water model, the percent of flow pumped on a monthly basis from the Okanogan River at Shellrock was simulated for all years on record. The monthly percentages were averaged to determine the mean monthly percentage of flow pumped from the Okanogan River for a given year. The mean monthly percentage of flow pumped in a given year was then ranked by water year type and averaged again to calculate the mean monthly percentage of water pumped in a year for each of the five water year types.

[b] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[c] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Okanogan River, Salmon Creek to Malott

Salmon Creek inflow to the Okanogan River would increase under Alternative 3 for all water year types (**Table 3-15**). The increase would be a doubling or tripling of Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years, the increase would range from four to nine times that under the No Action Alternative.

Table 3-15. Salmon Creek inflow to the Okanogan River as Percentage of Okanogan River Streamflow at Malott, No Action vs Alternative 3

Water Year Type	No Action Alternative [a]	Alternative 3 [a,b]
Wet	0.25	0.57 to 0.62
Above Normal	0.21	0.51 to 0.60
Normal	0.19	0.54 to 0.68
Below Normal	0.13	0.49 to 0.65
Dry	0.09	0.55 to 0.89

[a] In the water model, Salmon Creek inflow into the Okanogan River as a percentage of total monthly Okanogan River streamflow measured between Salmon Creek's mouth and Malott was simulated for all years on record. The monthly percentages were averaged to determine Salmon Creek's mean monthly percent contribution of flow to the Okanogan River for a given year. The mean monthly percent contribution of Salmon Creek inflow in a given year was then ranked by water year type and averaged again to calculate the mean monthly percent contribution of Salmon Creek inflow in a year for each of the five water year types.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Reservoir Levels

Salmon Lake

The estimated median monthly Salmon Lake reservoir water surface elevation under Alternative 3 would increase 1 to 3 feet August through February, and decrease 1 to 3 feet in April compared to the No Action Alternative. In May, June and July, median lake level for the three fish flow regimes and the No Action Alternative would be the same, at full active storage capacity (2,318 ft). Alternative 3 would reduce seasonal fluctuation in Salmon Lake level that has occurred under historic operations. A large volume of water would be consistently in storage, providing water for releases to meet instream flow requirement in the middle and lower reaches of Salmon Creek. The high water surface elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir.

The estimated minimum monthly Salmon Lake reservoir water surface elevations under Alternative 3 would increase in July through March for the two steelhead flow regimes and decrease in all months for the steelhead and Chinook flow regime compared to historic operation. Alternative 3 would reduce the seasonal variability of minimum reservoir elevations slightly. The steelhead only flow regime would increase minimum Salmon Lake reservoir elevation by 3 to 7 feet in late summer through early winter. The steelhead and Chinook flow regime would decrease minimum reservoir elevation by 2 to 6 feet in all months.

Conconully Reservoir

The estimated median monthly Conconully Reservoir water surface elevation under Alternative 3 would increase in August through April by 5 to 10 feet, such that median reservoir elevation would be near full active storage in most months. Alternative 3 would eliminate the large seasonal fluctuation in median reservoir elevation that has occurred under historic conditions. The estimated median Conconully reservoir elevation would be similar for all three fish flow regimes. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow demands in the middle and lower reaches of Salmon Creek. The reservoir levels would provide more seasonally consistent surface and groundwater accumulations along the margins of Conconully Reservoir.

The estimated minimum monthly Conconully Reservoir water surface elevation under Alternative 3 would increase August through March, and decrease in May and June for the steelhead flow regimes and decrease in all months for the steelhead and Chinook flow regime compared to historic operation. The minimum Conconully Reservoir elevation would increase 5 to 10 feet in fall and winter for the steelhead flow regimes, and drop 1 to 3 feet in May and June. Decreases in minimum reservoir elevation for the steelhead and Chinook flow regime would range from less than a foot in September and October to as much as 7 or 8 feet (April).

Flood Hazards

Reservoir Margins

The estimated maximum monthly Salmon Lake water surface elevations under Alternative 3 would be comparable to the No Action Alternative from March to November of each year. From December to February the maximum monthly lake levels would be reduced up to 1.6 feet, with the lowest elevation occurring during February. Alternative 3 would provide a slight beneficial flood hazard reduction compared to the No Action Alternative. However, the sight increase in available flow storage capacity occurs in months with low probability of flood events and the reservoirs are not authorized for flood storage.

The estimated maximum monthly Conconully Reservoir water surface elevations under Alternative 3 would be comparable to the No Action Alternative in all months except October. The maximum monthly Conconully Reservoir spill volume and 10% exceedence spill would decrease under the Alternative 3 in April, May, and June. This would be a minor beneficial flood hazard reduction. The small volume differences may reflect minor operational changes due to the release of fish flows in spring, but the available storage capacity created in the reservoir would be small, and does not alter the maximum monthly reservoir elevation statistics.

Middle Salmon Creek

The estimated maximum monthly streamflow and 10% exceedence streamflow in the middle reach of Salmon Creek would be similar to the No Action Alternative in magnitude and seasonality. No adverse or beneficial impacts to flood hazards in the middle reach would occur under Alternative 3.

Lower Salmon Creek

The estimated maximum monthly flow and 10% exceedence in lower Salmon Creek under Alternative 3 would be comparable to the No Action Alternative in both magnitude and seasonality. No adverse or beneficial impacts to flood hazards in the lower reach would occur in Alternative 3.

Flooding/Inundation

Reservoir Margins

Wetland inundation along the Salmon Lake reservoir margins would increase slightly under Alternative 3 since the lake would experience increases in median lake level in most months, and maximum elevation would remain similar to the No Action alternative. Under the steelhead only fish flow regimes, minimum Salmon Lake elevations would also increase by a few to several feet.

Wetland inundation along the margin of Conconully Reservoir would increase in most months of the year under Alternative 3 since the median lake level would increase to near the maximum active storage, and maximum lake level remains similar to the No Action Alternative. Under the steelhead only fish flow regimes, minimum Conconully Reservoir levels would also increase several feet in most months.

Middle Salmon Creek

Flooding and wetland inundation along the middle reach Salmon Creek under Alternative 3 would be similar to the No Action Alternative since the magnitude, seasonality, and frequency of high streamflow volumes would be similar and the channel capacity would not be modified.

Lower Salmon Creek

Flooding and riparian wetland inundation along the lower reach of Salmon Creek under Alternative 3 would be driven by the same magnitude, seasonality, and frequency of high streamflow volumes as under the No Action Alternative.

Groundwater

Okanogan River Valley Aquifer

Groundwater recharge and levels along the Okanogan River Valley aquifer under Alternative 3 would experience a small potential decrease in the vicinity of the Shellrock pump station and down gradient towards Salmon Creek. The effects are not quantitatively modeled, but since the frequency with which flows fall below WAC minimums does not increase (**Table 3-14**), it would be unlikely that groundwater recharge would be substantially reduced. The potential local groundwater decreases would be more than offset by increased Salmon Creek inflow to the Okanogan River 3.2 miles downstream of Shellrock. Average pumping from the Okanogan River under the Alternative 3 would increase by from 2,200 AF (steelhead) to 2,700 AF (for steelhead and Chinook) over the No Action Alternative (**Appendix D-1**). Flow at the mouth of Salmon Creek would increase by about 5,100 AF, even in dry years. Therefore, the net impact to the Okanogan River Valley aquifer would be beneficial, providing about 2,400 AF surplus for the steelhead only flow regimes and a little over 800 AF of surplus under the steelhead and Chinook flow regime.

Reservoir Margins

The groundwater levels along the margins of Salmon Lake and Conconully Reservoir would be more consistent seasonally and from year to year under Alternative 3 compared to the No Action Alternative, as median water surface levels, and some minimum lake levels are increased. During normal to wet years, groundwater levels around the reservoirs would experience less seasonal variability. For dry years, Salmon Lake and Conconully Reservoir would experience increased groundwater recharge and levels for the steelhead only fish flow regimes. The minimum lake levels under the steelhead and chinook fish flow regime would not increase substantially at Salmon Lake, and would decrease slightly in some months at Conconully Reservoir. Overall, the impact to groundwater along the reservoir margins would be a substantial benefit, increasing recharge volumes and reducing fluctuations in local groundwater gradients.

Salmon Creek Valley Aquifer

Groundwater levels and recharge along the middle reach of Salmon Creek under Alternative 3 would likely experience a seasonal shift, since median and minimum streamflow would increase in fall, winter, and spring months, but decrease in summer. The magnitude of flow volumes would be similar to the No Action Alternative, as indicated by consistent simulated average annual flow. The increase of base flows, distributing flow throughout more of the year, may result in more consistent groundwater levels.

Groundwater recharge potential in lower Salmon Creek under Alternative 3 would be increased compared to the No Action Alternative, since median and minimum streamflow volumes would increase and the total flow volume released/spilled over the OID weir would increase by a few thousand acre felt per year in all water year types.

Duck Lake Aquifer

The Duck Lake maximum pump rate would be increased, but storage retained for artificial groundwater recharge would not be increased under Alternative 3. The average volume of water pumped from Duck Lake would decrease by about 300 AF (for the steelhead and Chinook flow regime) or almost 550 AF (for the steelhead only flow regime). The minimum and maximum Duck Lake elevations do not change. No adverse impact to the Duck Lake aquifer would occur under Alternative 3, and a small potential benefit may result.

OID Water Availability

Alternative 3 combined with the provision of flows for steelhead and Chinook would result in a small critical period shortage that would occur when conditions are similar to the early 1930's drought period. The shortage is modeled to persist for two years, with a peak critical storage deficit of 674 AF per year in the first year of the drought sequence. This deficit would occur even though pumping from Duck Lake and Shellrock would be maximized when critical storage volumes in Conconully and Salmon Lake reservoirs fell below 15,000 ac-ft. Thus, the model suggests that the significantly greater instream flow demands for maintaining Chinook species would impact the OID water system when drought conditions are similar to those experienced in the late 1920s and early 1930s.

OID Service Area Water Availability

Reduced irrigation in the OID service area could have local effects on the static water level in wells, as groundwater recharge may be locally reduced. Such an effect has been noted in other areas where irrigation has been significantly reduced due to conservation or land retirement (e.g., the Sequim-Dungeness Valley in WRIA 18). Aquifer recharge from applied irrigation (or leaking ditches) is not a natural recharge source, therefore ground water withdrawals from the aquifer that is artificially recharged are not protected from impairment.

3.1.2.9 Alternative 3: Feeder Canal Upgrade

The impacts would be the same as described in **Section 3.1.2.3**.

3.1.2.10 Alternative 3: Stream Rehabilitation

Since there would be no stream rehabilitation associated with this alternative, the impacts would be the same as the No Action Alternative.

3.1.2.11 No Action Alternative

Streamflow Impacts

Upper Salmon Creek

Estimated streamflow in the upper reach of Salmon Creek would remain unregulated under all of the alternatives, similar to the existing and historical conditions (**Figure 3-5**). Natural variability in watershed runoff production would continue to produce differences by water year type as a function of climatic influences. The water system model assumes that the volume and pattern of runoff from the unregulated upper watershed would remain the same under all alternatives.

Middle Salmon Creek

The median and minimum monthly estimated streamflow in the middle reach of Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions (**Appendix D-5**). The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. The No Action Alternative would continue to provide high summer flows in the middle reach, similar to historical irrigation operations (**Figure 3-6**). Simulated median monthly streamflow in the middle reach of Salmon Creek from May through September is slightly greater (3 to 6 cfs) under the No Action Alternative than for historic irrigation operations. Minor differences are primarily due to standardized operation assumptions used to model future operations, versus actual variations in historic operations.

Lower Salmon Creek

The median and minimum monthly estimated streamflow in lower Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions (**Appendix D-5**). Under the No Action Alternative, the median flows in the lower reach would remain near zero and the minimum flow would be zero in most months, as under the historical irrigation operations (**Figure 3-7**). Minor differences are primarily due to standardized operation assumptions used to model future operations, versus actual variation in historic operations.

Okanogan River, Shellrock to Salmon Creek

The estimated percentage of Okanogan River streamflow that would be pumped would increase under the No Action Alternative's simulated standard future operations relative to the District's pumping patterns since the irrigation system was improved in 1987[7]. However, under the No Action Alternative, the frequency with which flows fall below WAC minimum instream flows for the Okanogan River between the Shellrock pump station and Salmon Creek would be identical to existing and historical conditions. The distribution of occurance of flows below WAC instream minimums distribution by water year type under the No Action Alternative would be the same as for the historical irrigation operations (**Table 3-3** and **Appendix D-6**).

Okanogan River, Salmon Creek to Malott

Estimated Salmon Creek inflow will continue to comprise between about one tenth to two tenths of a percent of the Okanogan River flow under the No Action Alternative, similar to existing and historical conditions (**Table 3-16**). Salmon Creek inflow would comprise about two tenths of a percent of Okanogan River monthly streamflow in normal, above normal, and wet water year types, and between 0.09 and 0.13 percent in dry and below normal years under the No Action Alternative.

Table 3-16. Salmon Creek Inflow to the Okanogan River as a Percentage of Okanogan River Streamflow at Malott

Water Year Type	Salmon Creek Inflow to Okanogan River (%)	
	Historical	No Action Alternative
Wet	0.24	0.25
Above Normal	0.20	0.21
Normal	0.19	0.19
Below Normal	0.12	0.13
Dry	0.11	0.09

Reservoir Levels

Salmon Lake Reservoir Levels

The estimated minimum, median, and maximum monthly Salmon Lake water surface elevation under the No Action Alternative would remain similar to the existing and historical condition. The minimum Salmon Lake elevation would be between 2,280 ft and 2,285 ft in January through March, increases to around 2,293 ft in May and June, then decreases in July and August to stabilize at about 2,282 ft for the remainder of the year. The maximum Salmon Lake elevation would be at the active storage maximum of 2,318 ft. Minor differences from existing and historical conditions occur due to the model's assumptions of standardized future operations, versus actual variation in historical operations (See **Appendix D-4**).

[7] This occurs because the most recent 16 years of Shellrock operation are not fully representative of the entire 99-year water record, and the No Action Alternative considers the full 99-year record in modeling the No Action Alternative

Conconully Reservoir Levels

The estimated minimum, median, and maximum monthly Conconully Reservoir water surface elevation under the No Action Alternative would be similar to the existing and historical conditions. The minimum Conconully Reservoir elevation would be about 2,249 ft January through March, increases to 2,264 ft in June, then decreases in July and August to stabilize at about 2,247 ft for the remainder of the year. The median Conconully Reservoir elevation would be about 2,280 ft January through March, increases in April to the active storage maximum of 2,287 ft in May, June, and July, then decreases in August and September to stabilize around 2,275 ft for the remainder of the year. The maximum Conconully Reservoir elevation would be at the active storage maximum of 2,287 ft every month of the year except October, when the lake elevation is one foot lower (**Appendix D-4**). Minor differences from existing and historical conditions occur due to the model's assumptions of standardized future operations, versus actual variation in historical operations.

Flood Hazards

Reservoir Margins

No daily maximum or peak reservoir water surface elevation data exist for either Salmon Lake or Conconully Reservoir. Estimated maximum monthly reservoir elevations (1% exceedence) and the monthly Conconully spill volumes are the best available model output to form a basis for interpreting flood hazards.

The estimated maximum monthly Salmon Lake water surface elevation under the No Action Alternative would be the same as existing and historic operations in both magnitude and seasonality. The maximum monthly Salmon Lake elevation is at the full active storage capacity of 2,318.4 ft every month of the year (**Appendix D-4**). The No Action Alternative does not include facilities or operational changes from existing or historical operations that would be expected to modify flood hazards along the margins of Salmon Lake reservoir.

The estimated maximum monthly Conconully Reservoir water surface elevation under the No Action Alternative would be the same as existing and historic operations in both magnitude and seasonality. The maximum monthly Conconully Reservoir elevation is at full active storage capacity of 2287 ft every month of the year (**Appendix D-4**).

The estimated maximum monthly Conconully Reservoir spill volume under the No Action Alternative is the same as existing and historical operations in both magnitude and seasonality (**Appendix B-2**). Based on existing and historical operations, the maximum monthly unregulated reservoir inflow (**Figure 3-5**) would be essentially the same as the maximum monthly streamflow in the middle reach (**Figure 3-6**) below the dam (600 cfs). According to the Bureau of Reclamation, the OID reservoirs are not authorized for flood storage. Monthly volume similarities upstream and downstream of the dam show that the reservoir do not reduce flood peak volumes, and this remains true under the No Action Alternative as compared historical operations.

The No Action Alternative does not include facilities or operational changes from existing or historical operations that would be expected to modify flood hazards along the margins of Conconully Reservoir, or flood hazards generated by spill from Conconully Reservoir.

Middle Salmon Creek

No instantaneous peak flow data or daily peak streamflow data exist for the middle reach of Salmon Creek. Estimated maximum monthly streamflows (1% exceedence) are the best available model output as a basis for interpreting flood hazards, as they include the effect of Conconully Reservoir spill to the middle reach.

The estimated maximum monthly streamflow for the middle reach Salmon Creek under the No Action Alternative is the same as existing and historical operations in both magnitude and seasonality (**Figure 3-6** and **Appendix D-5**). The No Action Alternative does not include facilities or operational changes from existing or historical operations that would be expected to modify the 100-year flood hazards along the middle reach of Salmon Creek.

Lower Salmon Creek

No instantaneous peak flow data of daily peak streamflow data exist for the lower reach of Salmon Creek. Estimated maximum monthly streamflows (1 % exceedence) are the best available model output as a basis for interpreting flood hazards, as they include the effect of Conconully Reservoir spill and spill across the OID diversion dam.

The estimated maximum monthly streamflow on lower Salmon Creek under the No Action Alternative is similar to the existing and historical condition in seasonality and slightly reduced in magnitude (**Figure 3-7** and **Appendix D-5**). The maximum monthly streamflow on lower Salmon Creek is 450 cfs under the No Action Alternative, about 125 cfs less than the maximum monthly flow for existing and historical operations (**Figure 3-7**). This slight reduction in flow volume may represent a beneficial effect of the assumed standardized operations, improved reservoir inflow-release monitoring and automation to facilitate partial OID diversion of Conconully spill under the No Action Alternative in comparison to historical practices. However, this difference does not indicate that a net beneficial impact results from the No Action Alternative.

It is assumed that no actions would be taken by others under this Alternative that would worsen the 100-year flood flows, floodplain, or floodway. The 100-year flood hazard would be confined within the levee system in the City of Okanogan as it is for the existing condition (**Figure 3-9**).

Flood hazards to property associated with channel instability and bank erosion under the existing and historical operations would continue with the No Action Alternative, although a minor lessening of maximum monthly streamflow could produce a slight decrease.

Flooding/Wetland Inundation

Reservoir Margins

The seasons and frequency of months that Salmon Lake and Conconully Reservoir will be at maximum active storage capacity under the No Action Alternative would be similar to the existing and historical condition. Wetland areas along the reservoir margins would experience inundation depth and frequency similar to the existing and historical condition under the No Action Alternative.

Middle Salmon Creek

Along the middle reach of Salmon Creek, the existing stream channel experiences minor overbank flows that inundate riparian wetlands every several years. Flooding and riparian wetland inundation along the middle reach of Salmon Creek under the No Action Alternative will be similar to the existing and historical condition, since the magnitude seasonality, and frequency of monthly streamflow volumes is similar (**Appendix D-5**), and the channel capacity would not be modified.

Lower Salmon Creek

Along the lower reach of Salmon Creek, particularly downstream of Watercress Springs, existing floodplains and wetlands are hydrologically disconnected from the channel due to historical erosion that has lowered the channel bed relative to the top of the banks. Only very infrequent, extreme high streamflow events are large enough to overtop the banks and inundate riparian areas, and then only for very short duration. Flooding and riparian wetland inundation along the lower reach of Salmon Creek under the No Action Alternative will be similar to the existing and historical condition, since the magnitude seasonality, and frequency of monthly streamflow volumes is similar (**Appendix D-5**) and the channel capacity would not be modified.

Groundwater

Okanogan River Valley Aquifer

Groundwater levels and recharge in the Okanogan River Valley Aquifer under the No Action Alternative would be similar to existing and historical conditions. Monthly streamflow volumes and frequencies in lower Salmon Creek are similar, producing similar seasonal and inter-annual contributions to the Okanogan River Valley Aquifer. Pumping from the Okanogan River would increase slightly, from the standardized operation[8] of Shellrock under the No Action Alternative. However, the changes in pumping due to modeled standardization would likely affect water years that already have higher Okanogan River flows, and experience high groundwater recharge. The magnitude of pumping increase would be very small relative to recharge in those

[8] "Standardized" refers to operations simulated for the full 99-year water record under the rules described for No Action Alternative in Chapter 2 and Appendix 3-D.

years. No measurable effect on groundwater would be expected under the No Action Alternative compared to existing and historical conditions.

Reservoir Margins

Groundwater levels and recharge along the reservoir margins under the No Action Alternative would be similar to existing and historical conditions. Monthly reservoir levels would occur at similar elevations and frequency, indicating comparable long-term groundwater recharge in the vicinity of the reservoirs.

Middle Reach Salmon Creek

Groundwater levels and recharge along the middle reach of Salmon Creek under the No Action Alternative would be similar to existing and historical conditions. Monthly streamflow volumes and frequencies in the middle reach of Salmon Creek are similar, producing similar seasonal and annual groundwater recharge.

Lower Reach Salmon Creek

Groundwater levels and recharge from surface streamflow along lower Salmon Creek under the No Action Alternative would continue to be minimal, as under existing and historical conditions. The volume of water released to lower Salmon Creek through uncontrolled spill at Conconully and the OID diversion dam would not be modified under the No Action Alternative. Monthly streamflow amounts and frequencies would be similar, producing similar seasonal and annual groundwater recharge.

Duck Lake Aquifer

The Duck Lake pumping rates, the volume of Duck Lake water sales, and canal spill under the No Action Alternative would be similar to existing and historical conditions (**Appendix D-7**). Groundwater recharge at Duck Lake under the No Action Alternative would be the same as under existing and historical conditions. Minor differences may occur due to the modeled assumptions of standardized future operations and improved monitoring of canal spill, in comparison to varied historical operations.

3.1.3 MITIGATION MEASURES

The following mitigation measures address potential adverse effects of the Alternatives. In most cases, the nature or magnitude of effect would be similar for each of the alternatives, therefore the mitigation measures are similar. If alternative-specific effects require distinct mitgation, it is identified below.

3.1.3.1 Flood Hazards

Flood hazards under the No Action and all three Alternatives are similar during peak runoff season (May, June). All three water supply Alternatives will result in the median Conconully Reservoir elevation being maintained at or near maximum capacity for most months. The potential for flooding in Salmon Creek below Conconully increases if the reservoir would be at or near capacity and cannot store a large runoff event. However, the reservoirs are not authorized for flood storage. No mitigation measures would be required, however, the following mitigation would be recommended to provide a beneficial improvement from the No Action condition:

- The reservoir management component of the Stream Management Plan could consider incorporating a flood storage rule, however this would require a change in the authorized uses of the reservoirs to include flood storage. Based on the area-capacity curves, a rule that creates a peak flow storage buffer for about 500 cfs could be included without the need to lower reservoir elevations more than about one foot.

3.1.3.2 Groundwater

Okanogan River Valley Aquifer

Alternative 1 increases pumping capacity on the Okanogan River by up to 55[9] cfs. This may create localized, seasonal groundwater drawdown in close proximity to the new pump station. The extent and severity of this potential adverse impact would vary with the local geologic conditions and location of any water supply wells. Because of these uncertainties, the following mitigation would not be required, but is recommended:

- Any drawdown effects on ground water supply at existing wells would be compensated by deepening existing wells and/or by subsidizing the incremental increase in pumping costs.

Salmon Creek Valley Aquifer

While groundwater levels should generally increase within the lower Salmon Creek valley alluvial aquifer, some uncertainty exists about the degree and extent of groundwater increases in lower Salmon Creek after channel rehabilitation.

- A pre and post-construction groundwater monitoring program should be included as part of the Stream Management Plan to evaluate the net effects on groundwater. If monitoring indicates that groundwater recharge and levels are unexpectedly decreased, modifications to instream flow hydrographs through regulation of reservoir releases could be considered for mitigation.

[9] Although the new Okanogan River pump station would be sized at 80 cfs, the District currently can pump 25 cfs at Shellrock; the difference (55 cfs) is the potential increase in pumping capacity on the river.

Duck Lake Aquifer

The Stream Management Plan should include groundwater monitoring within the Duck Lake Aquifer to ensure that overall water system operations prevent groundwater impacts.

3.1.4 UNAVOIDABLE ADVERSE IMPACTS

3.1.4.1 Streamflow

The No Action Alternative would continue to provide unnaturally high median and minimum flows in the middle reach, while the lower reach would have zero flow in most months. The frequency and magnitude of spills at Conconully would also remain similar to existing conditions. Under the No Action flow regime, it is expected that channel incision and channel widening will continue to progress upstream through the Watercress Springs area, with negative impacts on water quality, fish passage, and riparian property. Bank stabilization measures and construction of grade control structures would be necessary to prevent further channel degradation.

Alternative 1 would decrease streamflow in the 1.35 miles of Okanogan River from the new pump station to Salmon Creek, and may increase the frequency of WAC minimum in dry years. Although the magnitude of the effect would be small, it would be larger than for the Alternative 2 or Alternative 3. No mitigation would be available without resulting in additional adverse impacts to OID water supply or fish flow regimes.

Alternative 2 would decrease streamflow in the 3.20 miles of Okanogan River from Shellrock to Salmon Creek, but does not increase the frequency of WAC minimum. Although the magnitude of the effect would be small (and would be less than Alternative 1), no mitigation is available without resulting in additional adverse impacts to OID water supply or fish flow regimes.

Alternative 3 would decrease streamflow in the 3.20 miles of Okanogan River from Shellrock to Salmon Creek, but does not increase the frequency of WAC minimum. Although the magnitude of the effect would be smaller than Alternatives 1 and 2, no mitigation would be available without resulting in additional adverse impacts to OID water supply or fish flow regimes.

3.1.4.2 Groundwater

Alternative 1 would increase pumping capacity on the Okanogan River by up to 55 cfs. This may create localized, seasonal groundwater drawdown in close proximity to the new pump station. The extent and severity of this potential adverse impact is uncertain.

Alternative 3 would reduce irrigated farmland by about 30 percent, potentially reducing local recharge to groundwater and affecting nearby wells. However, this effect is uncertain and would likely be attenuated by the modern irrigation systems already in place.

3.1.4.3 OID Water Availability

Under Alternative 2, when instream flows are provided for both steelhead and Chinook, a small critical period shortage occurs in irrigation delivery to OID when drought conditions are similar to those experienced in the early 1930s drought. The shortage is modeled to persist for four years, with a peak critical storage deficit of 1678 AF per year.

Under Alternative 3, when instream flows are provided for both steelhead and Chinook, a small critical period shortage occurs in irrigation delivery to OID when drought conditions are similar to those experienced in the early 1930s drought. The shortage is modeled to persist for two years, with a peak critical storage deficit of 674 AF per year.

3.2 WATER QUALITY

3.2.1 EXISTING CONDITIONS

Salmon Creek and the Okanogan River are classified as Class A (Excellent) waters by the State of Washington Department of Ecology. Characteristic uses for Class A include:

- water supply (domestic, industrial, and agricultural)
- stock watering
- fish and shellfish (including salmonid migration, rearing, spawning, and harvesting)
- wildlife habitat
- recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment)
- commerce and navigation.

Water quality standards associated with this classification for Salmon Creek are presented in **Appendix E**. Water quality limitations are described below for Salmon Creek and the Okanogan River.

3.2.1.1 Okanogan River

The Okanogan River is on the State of Washington Department of Ecology 1996 and 1998 Clean Water Act Section 303(d) list for temperature approximately 10 miles downstream from the confluence. DDT has been found in fish tissue in several reaches, and although it is not listed for water in reaches near Salmon Creek based on the 1998 list, it may be listed in reaches near Salmon Creek based on the 2002 list (Mark Peterschmidt, Department of Ecology, personal communication, 2003).

Based on data collected by the State of Washington Department of Ecology and others in the Okanogan River at Malott (**Table 3-17**), Ecology stated that there is a "consistent late summer water temperature criteria violation (annual violations from 1983 through 1993). Fish within the watershed are subject to poor water quality and low flow conditions, as well as critically high water temperatures during summer months" (Ecology, 1995). Data show that other problems include a consistent exceedance of lead and mercury criteria, and sedimentation problems (Ecology, 1995).

Table 3-17. Summary of Okanogan River water quality at the long-term water quality monitoring station at Malott (approximately15 miles downstream from Salmon Creek), based on Washington Department of Ecology data from 1990-2000.

	Flow	Conduc tivity	Fecal Coliform	Ammonia Nitrogen	Nitrate + Nitrate Nitrogen	Dissolved Oxygen	pH	Suspen-ded Solids	Tempe rature	Total Phospho rus	Turbi dity
	(cfs)	(umhos/cm)	(#/100ml)	(mg/L)	(mg/L)	(mg/L)	(pH)	(mg/L)	(deg C)	(mg/L)	(NTU)
Average	3431	217	25	0.01232877	0.0370748	10.80	8.15	22	9.99	0.032	7.4
Minimum	448	86	1	0.01	0.01	7.2	7.1	1	-1.3	0.010	0.7
Maximum	18400	331	150	0.07	0.158	14.7	8.8	405	24.9	0.241	176

Erosion and Sedimentation

Under most flow conditions, the Okanogan River generally has higher suspended sediment and total suspended solids (TSS) concentrations than Salmon Creek. At the Ecology long-term water quality monitoring station at Malott (approximately 15 miles downstream from Salmon Creek), suspended solids ranged from 1 to over 400 mg/L, with the highest values more typically in the 50 to 150 mg/L range from 1990 through 2002 (**Figure 3-13**). The average reading at Malott was 22 mg/L. Turbidity ranged from 0.7 to 176 NTU, averaging 7.4 NTU. The standard for the Okanogan River (Class A freshwaters) is "turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less." Although the background turbidity has not been calculated, based on the average turbidity or 7.4 NTU, it appears that the standard is exceeded. This may be expected during storm and high flow events. TSS concentrations increase in the spring, showing an annual spike that coincides with high flow.

Water Temperatures

Water temperatures have been collected at the Ecology long-term water quality monitoring station at Malott (**Table 3-17 and Figures 3-14 and 3-15**). For Class A freshwaters, the State standard is "the temperature shall not exceed 18 degrees C (64 degrees F) due to human activities." However, when natural conditions exceed 18 degrees C (64 degrees F), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 degrees C. Small incremental temperature increases are also allowed for point and nonpoint sources. It is not known if natural conditions in the Okanogan River exceed 18 degrees C (64 degrees F), or what temperature increases are due to point and nonpoint sources. However, temperatures in the Okanogan River downstream from Salmon Creek (at Malott) do occasionally exceed 20 degrees (68 degrees F) in summer.

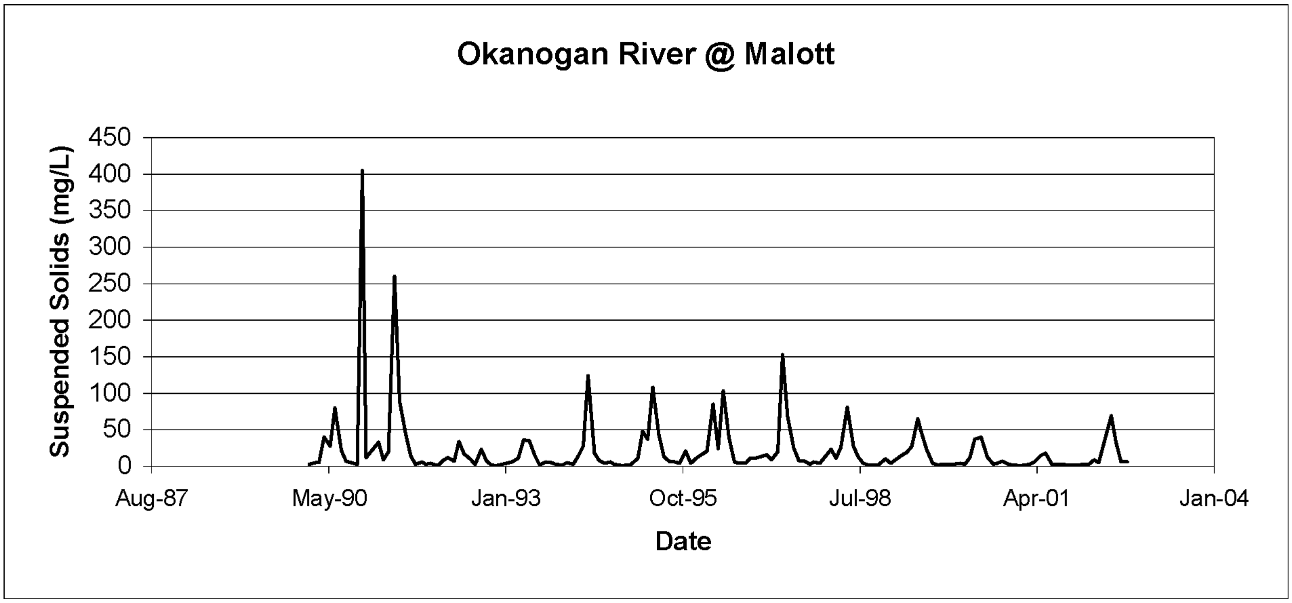


Figure 3-13. Okanogan River Suspended Solid Concentrations at Malott.

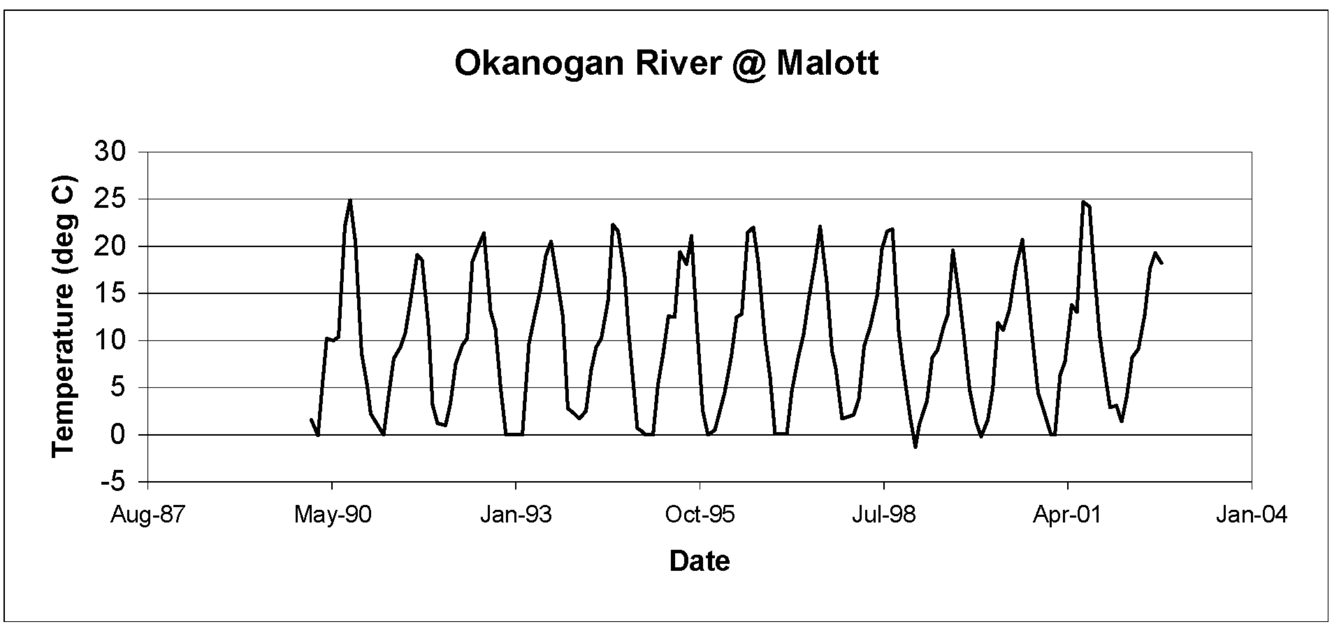


Figure 3-14. Okanogan River Temperatures at Malott.

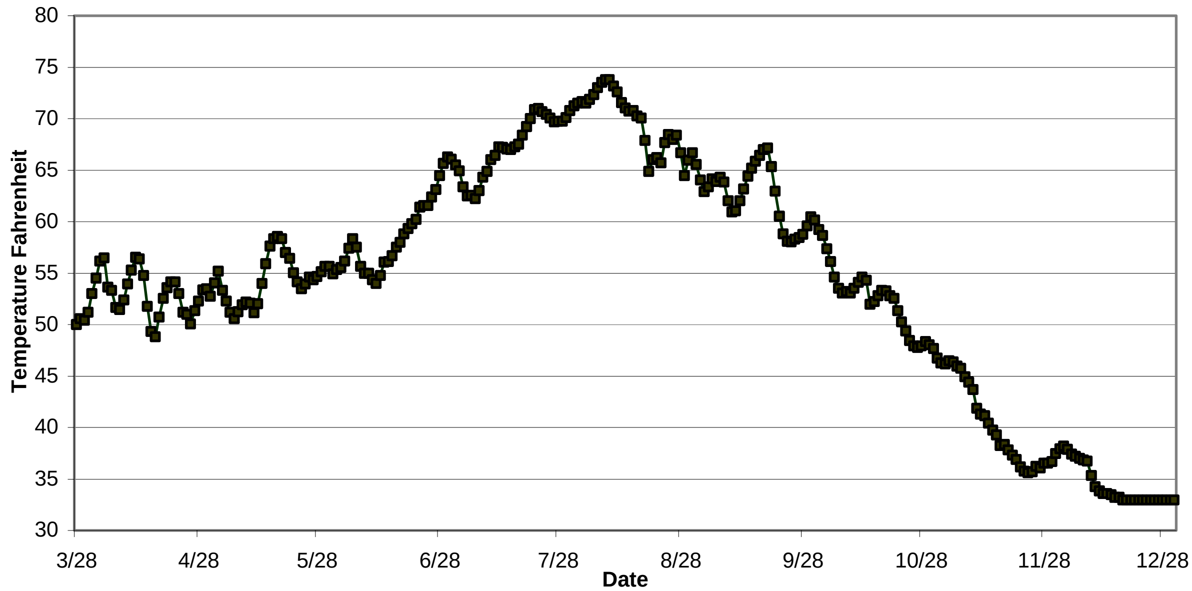


Figure 3-15. Daily Average Okanogan River Water Temperatures (degrees F) during 2000 at Malott, Washington.

3.2.1.2 Salmon Creek

Salmon Creek is on the State of Washington Department of Ecology 1996 and 1998 Clean Water Act Section 303(d) list for instream flow in the lower reach (the condition that the action alternatives would address). The 2002 list has not been finalized, but will probably not include any other analytes (Mark Peterschmidt, Department of Ecology, personal communication, 2003). Some reaches of the Okanogan River are listed for temperature, DO, pH, fecal coliform, and several pesticides. Immediately downstream from the confluence with Salmon Creek the Okanogan River is listed only for fecal coliform.[10] The river is not listed for any analytes immediately upstream from Salmon Creek.

Erosion and Sedimentation

The banks of lower Salmon Creek have significant stability problems and were surveyed and mapped in March 2003 to evaluate stability, erosion, and sedimentation issues. The survey began at Salmon Creek's confluence with the Okanogan River and extended approximately 1.8 miles upstream to the lower section of Watercress Springs, near the OID access road bridge crossing. Results and previous observations show that the lower 1.8 miles of Salmon Creek is generally very unstable with severe erosion, sedimentation and bank degradation or modification

[10] Fecal coliforms are not described in the EIS based on a decision not to include this analyte (impacts were not anticipated).

in multiple locations. These bank conditions can cause significant water quality problems and associated issues for fish and other aquatic life.

Although Salmon Creek generally has lower TSS concentrations than the Okanogan River, it is possible that bank erosion, particularly during storms and when flows are spilled or released from Conconully Reservoir, causes high levels of short-term suspended sediment and TSS concentrations in the creek. However, local observations during high flows have indicated that TSS is suprisingly low compared to the Okanogan River, even during these events. Temperatures can become elevated and DO reduced in some lower reaches due to the lack of riparian vegetation in some areas and the extremely low flows. These problems can contribute to other associated water quality problems, including loadings of total dissolved solids, metals, or nutrients potentially associated with bank materials, changes in pH, or increased algal and other plant growth.

The source material of lower Salmon Creek's valley floor and streambanks is formed from the Pogue-Cashmont-Cashmere association, which is described as a stony fine sandy loam material formed in Pleistocene glacial till and outwash terraces in elevations ranging from 700 to 1,500 feet. The vast majority of lower Salmon Creek's banks have a substrate composed of this unsorted glacial outwash with particle sizes typically dominated by boulder and cobble material, but also including a mixture of sand and gravel that often forms a matrix supporting the coarser material. Some reaches exhibiting prior flooding also contain a thin veneer of fine sand and silt/clay overbank deposits on top of the glacial outwash. Other than locations with the mantle of fine overbank deposits, layering of bank material is non-existent.

Channel incision (i.e., lowering of the bed through degradation) and eroding banks are prevalent throughout lower Salmon Creek, extending about 1.6 miles upstream from the Okanogan River. A knickpoint (i.e., an abrupt break in the longitudinal bed profile) in the channel at Watercress Springs marks the uppermost advance of the incision and bank instability. In general, banks along the lower 1.8 miles of Salmon Creek are at least 6 feet high, with many banks greater than 10 feet high. Most are more than 45 degrees, and many approach or exceed vertical slopes. Approximately 20 percent of the banks have sparse to no vegetation, a condition that is critical for resisting erosion.

The formation of Salmon Creek's banks can be classified into three categories. In the first category are banks that were formed by fluvial downcutting into the unsorted glacial outwash matrix. As a result, these banks have material ranging from fine sand to boulder. The height and steepness of these banks depends on the extent of downcutting. In several reaches where a floodplain used to be connected with the channel, accelerated downcutting has incised the channel and lowered the bed below the former floodplain elevation by about 4 feet. Consequently, banks have been oversteepened beyond the critical point at which gravitational forces are greater than the shear strength of the bank material, resulting in mass failure of material into the creek. High flows that once were released out onto the floodplain are now confined to the incised channel, concentrating fluvial energy and increasing the potential to erode banks. When high flows winnow away the sand and gravel material in the banks, the boulders and cobble lose their support structure and tumble to the bank toe. Much of the coarse material at the base of the bank is likely too coarse to be transported by Salmon Creek flows, so it remains in place and provides protection from further fluvial bank erosion by lower magnitude floods. However, some of this material has been transported downstream to the mouth of the creek under very high flow conditions where it has been deposited in an aggrading bar at the mouth of the creek. In addition, uprooting of vegetation and instability created by the collapse of the coarse material widens the channel and allows mass wasting of finer bank material into the channel for eventual transport downstream.

The second category includes bank types where about 10 percent of the banks are colluvial material (not stream-deposited alluvium) originating from Salmon Creek's valley side slopes. This colluvial material is also unsorted, with a substrate dominated by boulder and cobble, yet containing a larger percentage of loose sand than the banks formed in the valley floor outwash. Colluvial banks are at least 15 feet tall, but can extend for over 100 feet up valley side slopes. These steep and unvegetated banks are typically located on the outside of meander bends and likely contribute a substantial amount of fine sediment to Salmon Creek from sediment entrainment by high flows.

The third bank type is described as fill material, which for the most part is composed of glacial outwash material that has been mechanically pushed up to increase bank heights. Practically all of the banks along the section of channel that runs through the town of Okanogan have been altered to provide flood protection for homes and businesses that have encroached upon the channel. Filled banks are often fortified with concrete rubble or rock gabion in an attempt to reduce active erosion. The height of filled banks often exceeds 10 feet, and many are very steep and show evidence of recent sloughing of fine material into Salmon Creek.

Channel incision and bank erosion has been intensified by long-term alteration of the historic flow regime and riparian land uses. For most of the year, it is typical for all of Salmon Creek downstream of the OID diversion to have practically no flow other than seepage at Watercress Springs. During high runoff years, however, uncontrolled spills at the diversion dam send varying amounts of streamflow into lower Salmon Creek for short periods of time. These extremes in the flow regime of lower Salmon Creek have increased bank instability. Loss of a baseflow has reduced riparian vegetation, which in turn has lessened the ability of banks to resist erosion from the uncontrolled spills. Direct removal of riparian vegetation (primarily in the middle reach) for lumber, firewood, and rangeland improvement, as well as grazing, has further reduced bank stability and increased the amount of fine sediment eroded into the channel.

Water Temperatures

Water temperature data for Salmon Creek are limited to data collected in recent years by the Colville Confederated Tribes, including at the OID diversion dam and at an upper section. Average daily water temperature data for 2001 show values ranging from approximately 4 to 9 degrees C (40 to 48 degrees F) in March and November, to 18 to 19 degrees C (65 to 67 degrees F) in July and August (**Figure 3-16).** Temperatures are generally 1 to more than 10 degrees F higher at the diversion dam than at the upstream location, with the exception of during October and November when they are lower at the dam. Although it is not known if background conditions cause temperatures to exceed the standard of 18 degrees C (64 degrees F) in Salmon Creek, temperatures likely exceed this value in downstream, low-flow areas in summer. Data do not appear to be available in these areas in July or August.

Field water temperatures were also measured at multiple locations along the length of Salmon Creek during a reconnaissance survey on April 15, 2003. Temperatures ranged from 11.5 degrees C (53 degrees F) at the mouth to 6 degrees C (43 degrees F) in the North Fork at the diversion upstream of Conconully Lake. These temperatures were obtained over the course of

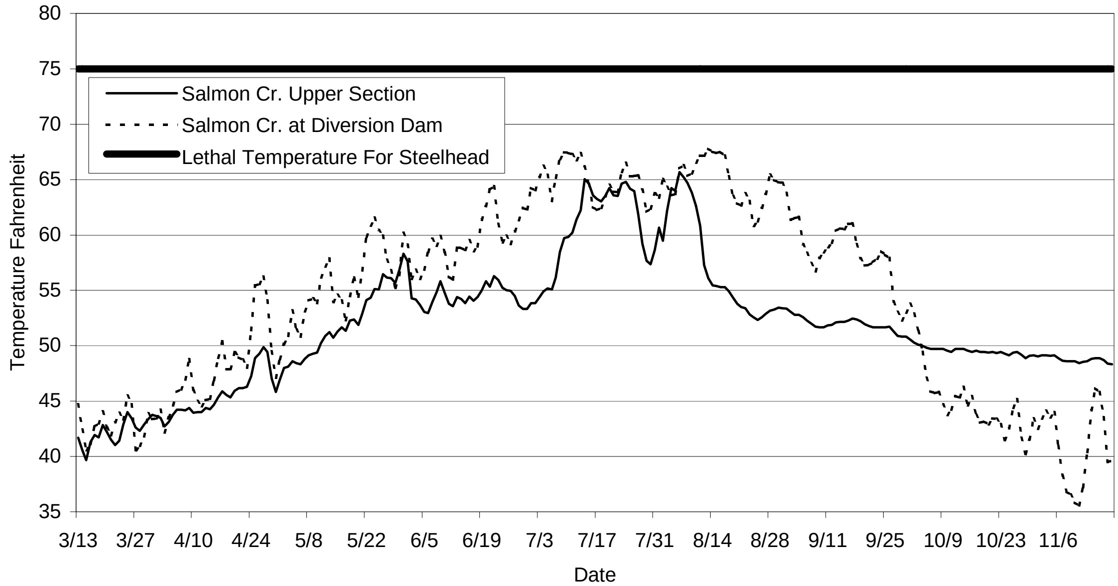


Figure 3-16. Daily Average Salmon Creek Water Temperatures (degrees F) within the Middle Reach during 2001.

the day in an upstream direction. These results indicate water cooler than in the Okanogan River, but with some warmer temperatures in the lower reaches near the mouth under low-flow conditions.

3.2.2 WATER QUALITY IMPACTS

3.2.2.1 Alternative 1: Okanogan River Pump Station and Pipeline

This alternative also would divert water from the Okanogan River by pumping water from the river to the OID main canal for irrigation and allow natural flows and release from the Conconully Reservoir to meet minimum stream flows for fish in Salmon Creek.

Okanogan River

Erosion and Sedimentation

Minor, short-term adverse water quality impacts associated with erosion and sedimentation would occur with this alternative. The pump station would be located up out of the channel and away from the river bank to avoid potential impact with stream meander, erosion, and sedimentation. The floor of the station would be placed above the elevation of the 100-year floodplain. The intake structures in the Okanogan River would be located over a deep hole on the inside bend of the river to minimize impacts and disturbance to the bed during both construction and operation. The bank would be shaped and protected from erosion by use of boulder and timber armoring and/or gabion baskets. Screens for the intake pipes would be placed in a part of the river channel with a relatively stable bed. Mat gabions would be secured under the screens to prevent streambed erosion.

The pipeline from the pump station to the OID main canal would not cross any major surface water features and no obvious stream crossings were observed during field reconnaissance. Only minor adverse erosion and sedimentation impacts associated with construction of the pipeline are expected due to the absence of water.

Mitigation for sediment would be required in the design and operation, because water pumped to the OID main diversion canal and used for agricultural irrigation would be taken from the Okanogan River, which has higher TSS concentrations than the OID's Salmon Creek source. The design includes a water filtration system to remove most solids, a sediment pond, and settling of solids within the canal itself. This design should assure that water with higher TSS from the Okanogan River would not impact irrigation activities. There would be no change in return flows or additional impacts from irrigation water entering either Salmon Creek or the Okanogan River.

Although there would be few adverse impacts from this alternative, short-term erosion and sedimentation impacts during construction of the pump station, intake structures, and the pipeline could occur. Best management practices (BMPs) would be used to reduce impacts of stormwater runoff and control sediment loads generated during construction of these structures. This would include ensuring that sediment generated from construction of the pump station and pipeline do not enter nearby waterways, and that river bank and bed disturbance and erosion during construction of the intakes would be minimized. Typical erosion control practices would include silt fences and diverting and retaining runoff in sediment ponds. The pipeline does not cross any significant waterways and construction BMPs would be used for the pipeline where necessary.

The provision of flows from Salmon Creek would have some small long-term benefits to the Okanogan River downstream from the confluence, when good quality Salmon Creek water (water with lower TSS concentrations) mixes with poorer Okanogan River water.

Water Temperature

Pumping from the Okanogan River could have small-scale long-term impacts on the river by decreasing flows and increasing the magnitudes of some water quality parameters, including increasing temperatures and decreasing DO. However, these impacts are expected to be minor given the small flow to be diverted relative to the flows in the river. Pumping from the Okanogan River will have minor long-term adverse effects on erosion and sedimentation in the river. Based on historical monthly flows in the Okanogan River, monthly distribution of pumping from the Shellrock Station, pumping 5100 AFY from the Okanogan River would divert no more than approximately 1 percent of the river's historical average flow in any given month. Effects would be greatest in August or September, when river flows are low and irrigation requirements are high (assuming the historical monthly distribution of pumping continues). Pumping from the Okanogan River would account for no more than approximately 3 percent of the river's tenth percentile low flow (i.e., 90 percent of the monthly flows for the given month exceed this flow) in August or September, based on the historical flows. Pumping volumes are small enough to cause insignificant changes in water quality, including erosion, sedimentation, TSS, water temperature, and DO, even during historically dry, low-flow years.

No adverse water temperature impacts are expected from construction or operation of the pump station, intakes, or pipeline from the station to the OID main canal.

Salmon Creek

Erosion and Sedimentation

Returning flows to Salmon Creek would have generally long-term positive effects on water quality in the creek. The water would be cooler, but the flow should not be high enough to entrain much sediment. Based on historical data and planned flow releases, Salmon Creek flows would be approximately two to five times the creek's historical monthly flow in August and September. Although it is possible that returning flows to the creek could cause increased erosion and sedimentation problems if the Rehabilitation Alternative is not implemented, the additional flows are expected to be too small to cause any significant problems. Although increased flows in Salmon Creek that would result from this alternative could increase bank erosion and stream sedimentation in the absence of mitigation, flows generally would be low enough that this would not be a problem.

Water Temperature

Returning water to lower Salmon Creek would be have long-term positive effects. Salmon Creek flows are expected to be approximately two to five times higher in August and September. This would decrease water temperatures and increase DO in the creek. It could also provide benefits to the Okanogan River downstream from the confluence. There could be some adverse effects on water temperature and DO in Salmon Creek if bank failure and channel widening continues and the water becomes shallower, with subsequent increases in temperature and DO. These impacts would partly depend on when and how the flows are added.

3.2.2.2 Alternative 1: Feeder Canal Upgrade

Erosion and Sedimentation

There could be minor short-term erosion and sedimentation impacts to surface waters during construction of this component. The canal does not cross any major streams or other surface water features. Construction activities could cause some localized erosion and sedimentation in the vicinity of the canal after construction and in the North Fork Salmon Creek at and immediately downstream from the headworks. Some adverse short-term effects on water quality, particularly suspended sediment and solids, could result. However, use of standard construction BMPs, including silt fences and sediment ponds for stormwater, would reduce these effects.

Water Temperature

There would be no significant water temperature impacts on surface waters from the feeder canal upgrade. The canal does not cross any major streams or other surface water features, and moving the water from an open canal to an enclosed pipeline is not anticipated to cause any detectable change in water temperature in Salmon Lake or the North Fork of Salmon Creek.

3.2.2.3 Alternative 1: Stream Rehabilitation

This component would include removing the gravel bar at the mouth of Salmon Creek to pass both fish and floodwaters.

Erosion and Sedimentation

The primary purpose of this component would be to provide better passage for fish migration. This component would, however, cause short-term erosion and sedimentation at the mouth of Salmon Creek and in the Okanogan River. Part of the creek channel would be altered with large earthmoving equipment, which would cause short-term localized erosion and sedimentation at the mouth of Salmon Creek and in the Okanogan River downstream from the confluence, particularly during higher flow and storm events. Within a few years as the streambanks stabilize, there would be a reduction in erosion and sedimentation. To reduce short-term impacts, construction activities would occur in the late summer or early fall under no-flow conditions and when fish are not migrating. These activities and impacts would require standard mitigation measures used in stream reconstruction programs. Any adverse impacts associated with stream rehabilitation construction would be minor, short-term, and minimized using BMPs.

Water Temperature

This component would have no impact on water temperature in Salmon Creek.

3.2.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

This alternative would include diverting water from the Okanogan River by pumping water from the Okanogan River to the OID main canal for irrigation. This would allow natural flows and release from the Conconully Reservoir to meet minimum stream flows for fish in Salmon Creek during critical periods when water is needed.

This alternative is not expected to have any important adverse impacts on erosion and sedimentation in either the Okanogan River or Salmon Creek. Construction of upstream and downstream wing walls would reduce the amount of sedimentation taken into pump sump. Raising the sill of the intake opening would reduce the amount of bedload sediment entering the intake, again reducing the amount of sediment entering the sump to be pumped through the irrigation delivery system.

Water quality in the Okanogan River downstream of the confluence with Salmon Creek would be improved under this alternative. Cleaner Salmon Creek water would be delivered to the Okanogan River downstream from where the sediment-laden Okanogan River water would be removed. The addition of water to Salmon Creek would generally have positive effects on water quality in the creek by increasing flows.

Although short-term minor impacts could occur during modification of the intake structures, these would be minimized using typical construction BMPs. Work would be accomplished during an irrigation season when plant operations are not needed and the maximum river water surface during construction is elevation 822.0 feet. Modifications to the plant would require that it be dewatered. An earthen cofferdam with a sheetpile cutoff wall would be needed to channel river flows away from the plant during construction. Once the area between the cofferdam and plant is dewatered, the sediment deposits both inside and upstream of the plant would be removed.

The pipeline from the pump station to the OID main canal would not cross any major surface water features and no obvious stream crossings have been identified. Only minor erosion and sedimentation impacts associated with construction of the pipeline are expected due to the absence of water.

Mitigation for sediment would be required in the design and operation, because water pumped to the OID main diversion canal and used for agricultural irrigation would be taken from the Okanogan River, which has higher TSS concentrations than the OID's Salmon Creek source. The design includes a water filtration system to remove most solids, a sediment basin built into a portion of the existing main canal, and settling of solids within the canal itself. Almost two miles of new 30-inch ductile pipeline would be needed to carry sediment-laden Okanogan river water from Shellrock pump station to the main canal where the sediment basin would be located. This design should assure that water with higher TSS from the Okanogan River would not impact irrigation activities. There would be no change in return flows or additional impacts from irrigation water entering either Salmon Creek or the Okanogan River.

Although there would be few adverse impacts from this alternative, short-term erosion and sedimentation impacts during installation of new pumps at the pump station, intake structures, the pipeline, and widening of the main canal for the sediment basin could occur. Best management practices (BMPs) would be used to reduce impacts of stormwater runoff and control sediment loads generated during construction of these structures. This would include ensuring that sediment generated from construction of the pipeline and sediment basin does not enter nearby waterways, and that river bank and bed disturbance and erosion during construction of the intakes would be minimized. Typical erosion control practices would include silt fences and diverting and retaining runoff in sediment ponds. The pipeline does not cross any significant waterways and construction BMPs would be used for the pipeline where necessary.

Impacts would be similar to those described for Alternative 1 but with a lower pumping volume, any effects would be muted as compared to the new pump alternative.

3.2.2.5 Alternative 2: Feeder Canal Upgrade

The water quality impact would be the same as described in **Section 3.2.2.2**.

3.2.2.6 Alternative 2: Stream Rehabilitation

This component includes reconstructing a stable channel and other rehabilitation in the lower reach to pass both fish and floodwaters.

Erosion and Sedimentation

The primary purpose of this component is to provide better passage and habitat for fish migration, however stream rehabilitation measures would reduce erosion and sedimentation in the long term. This component would, however, cause short-term erosion and sedimentation within Salmon Creek and the Okanogan River. Parts of the creek would be diverted and channel banks, bed, and floodplain areas would be altered with large earthmoving equipment. These activities would cause short-term localized erosion and sedimentation in the lower reaches of Salmon Creek and in the Okanogan River downstream from the confluence, particularly during higher flow and storm events. Within a few years as the banks stabilize, there would be a reduction in erosion and sedimentation. Establishment of riparian habitat improvements and natural channel design would reduce loadings of sediment and suspended sediment/solids concentrations during high flow events/storms. To reduce short-term impacts, construction activities would occur in the late summer or early fall dry season. These activities and impacts would require standard mitigation measures used in stream reconstruction programs. Any adverse impacts associated with stream rehabilitation construction would be minor, short-term, and minimized using BMPs.

Any improvements in water quality that occur in Salmon Creek, would contribute to improved water quality in the Okanogan River below its confluence with Salmon Creek.

Water Temperature

This component would contribute towards lowering water temperatures in Salmon Creek. Riparian plantings would provide shade to help cool water temperatures, although it will take several years for riparian vegetation to become established and contribute towards shading so the beneficial effects would not be noticeable for 5-10 years. Modeling studies in the Entiat River Watershed on the eastern slope of the Cascades showed that increasing riparian planting and associated shade by 50 percent had much greater effects on reducing water temperatures than increasing flows by 10 percent. Although this may also be true for Salmon Creek, flows may be increased by significantly higher percentages in the downstream reach as part of the Action Alternatives, resulting in more pronounced temperature reductions. A channel design that increases water depths and velocities and other instream physical habitat features will also help to reduce temperatures and increase DO. These channel changes (and the addition of flow) generally may not decrease water temperatures and increase DO to the extent that riparian planting and associated shade does, but when used in combination these methods all help to improve water quality.

3.2.2.7 Alternative 3: Water Rights Purchase

No new pump infrastructure for pumping is proposed with this alternative. This alternative would not have any adverse affect on the Okanogan River and would have less impact to Salmon Creek than the other water supply alternatives because there is no stream rehabilitation associated with this alternative. There would be a potential beneficial effect of lower water temperatures in the Okanogan River downstream from its confluence with Salmon Creek. No adverse impacts on erosion and sedimentation are anticipated. Irrigation return flows would be reduced proportionally, potentially improving water quality in the waterways. Addition of water to Salmon Creek through water rights purchase would generally have long-term positive effects on water quality in the creek by increasing flows. Although additional and higher flows in the creek could cause increased erosion and sedimentation problems if stream rehabilitation is not implemented, flows generally would be low enough that this would not be a problem.

3.2.2.8 Alternative 3: Feeder Canal Upgrade

The environmental impact would be the same as described in **Section 3.2.2.2**.

3.2.2.9 No Action Alternative

Long-term erosion, sedimentation, and water temperature impacts created by existing conditions could continue and worsen under the No Action Alternative.

Erosion and Sedimentation

Under the No Action Alternative if no preventative measures are taken to control channel incision on Salmon Creek, it is plausible that ultimately the streambanks downstream of the knickpoint in Watercress Springs that are in the early stages of incision and bank erosion would resemble the highly unstable and eroding banks of those farther downstream. The banks would be taller, steeper, have less vegetation, and slough fine material into the channel. Channel incision, and subsequently, bank erosion, would most likely continue to propagate upstream. How much farther upstream and at what rate is not certain. A longitudinal bed profile of Salmon Creek shows a distinct breakpoint and reduction in slope upstream of Watercress Springs (about 2.75 miles upstream of the Okanogan River). The presence of the springs and the break in slope suggest that bedrock underlying the channel may be acting as a grade control on slope at that location. If a natural bedrock grade control does exist there, it may resist channel incision and halt further knickpoint propagation.

For reaches at a more advanced stage of incision (downstream of Watercress Springs), further channel degradation would predominantly come in the form of bank erosion and channel widening rather than additional bed downcutting. The channel bed in lower Salmon Creek is composed predominantly of coarse cobble and boulder, with very little sand and gravel on the surface. As Salmon Creek downcut through the glacial outwash and eventually became incised, fine material available for transport was washed downstream, leaving behind a channel lag deposit composed of material too coarse to be transported by most flood flows. However, some of this material has been transported and deposited at the mouth under very high flow conditions. Although fine material likely exists beneath the surface, it is shielded from fluvial erosion by the coarse lag deposit on the surface. Because the bed material is so coarse and practically immobile at most flows, future channel erosion in already incised sections of channel would continue to come in the form of bank erosion and retreat rather than additional downcutting of the bed. High flows would continue to entrain fine sediment that would cause coarse material to collapse to the bank toe and vegetation to be uprooted. The use of rip-rap and rock gabions to strengthen banks would continue to be necessary in an attempt to limit bank erosion.

Water Temperature

Elevated water temperatures in the Okanogan River, both upstream and downstream from the Salmon Creek confluence would also continue under the No Action Alternative.

Under the No Action Alternative temperatures would continue to be elevated in the lower reach of Salmon Creek when water is present. These elevated temperatures may worsen as the stream continues to degrade. Continued bank erosion may cause additional channel widening, loss of riparian habitat/vegetation and shading, leading to higher temperatures where this occurs. Additional sedimentation and aggradation also may lead to shallower flow depths leading to higher temperatures when water is present.

3.2.3 MITIGATION MEASURES

3.2.3.1 Erosion and Sedimentation

For Alternatives 1 and 2, because water with higher TSS concentrations from the Okanogan River would be pumped to the diversion canal and used for agricultural irrigation, a water filtration system, including a sediment pond, would be installed to remove most solids. Many mitigation measures have been incorporated into the design of the pump houses, intake structures, pipelines, and erosion control devices and are described above. The only other mitigation measures required would primarily consist of standard BMPs during construction activities.

Short–term impacts from construction of the rehabilitation in Salmon Creek would require several mitigation measures. Construction work would only occur when the streambed is dry. Channel banks, bed, and riparian/floodplain areas would be altered with large earthmoving equipment while the stream is dewatered. Mitigation measures would include the following:

- delineating and preparing appropriate work zones, including staging and access areas
- proper siting of equipment, and chemical storage areas away from surface waters
- minimizing slope disturbance from roads
- ensuring that storm water runoff from roads drains to outlets
- physical screening of areas to remain undisturbed
- installing erosion and sediment control measures during site preparation
- using silt fences, straw bales, sediment ponds

- minimizing crossing the stream and use of bridges as much as possible
- avoiding sensitive wetland and riparian areas
- inspecting construction site during or immediately after a rain event
- stockpiling additional erosion and sediment control equipment
- steam-cleaning of vehicles and equipment offsite regularly
- checking vehicles for oil, grease, gas, hydraulic fluid, and anti-freeze leaks and repair, as necessary
- using adequate slopes, bank stabilization, and revegetation methods to minimize erosion

3.2.3.2 Water Temperature

Mitigation measures to minimize any short-term impacts would include those discussed above for erosion and sedimentation. All of these measures can also help to minimize adverse impacts on water temperature.

3.2.4 UNAVOIDABLE ADVERSE IMPACTS

3.2.4.1 Erosion and Sedimentation

There are no unavoidable adverse impacts associated with the action alternatives. There may be unavoidable adverse long-term impacts to water quality associated with the No Action Alternative. These long-term impacts include continued incision and bank instability and erosion in downstream reaches of Salmon Creek, as well as farther upstream (possibly to the knickpoint[11] at Watercress Springs) over time. Lack of action would contribute to increases in TSS, as well as increases in water temperature and decreases in DO. The use of rip-rap and rock gabions to strengthen banks would continue to be necessary in an attempt to limit bank erosion.

3.2.4.2 Water Temperature

There are no unavoidable adverse impacts on water temperature associated with the action alternatives. There could be, however, unavoidable adverse impacts associated with the No Action Alternative. These include potential increases in water temperature in Salmon Creek and the Okanogan River due to activities in the watershed, and alteration of the riparian zone, including floodplain encroachment and removal of vegetation, particularly in Salmon Creek. The small flows and significant bank erosion and sedimentation problems in Salmon Creek are expected to continue to cause channel widening, shallower flows, and higher water temperatures.

[11] A knickpoint is a located at that point along the longitudinal profile of a stream at which slope changes. Typically, the term is used where the change in slope is migrating upstream. The location of a knickpoint may be controlled by bedrock. Significant erosion typically occurs below a knickpoint, as it migrates upstream.

3.3 WETLANDS AND VEGETATION

3.3.1 EXISTING CONDITIONS

The Salmon Creek watershed and the vicinity of its confluence with the Okanogan River are located in the Okanogan Highlands Physiographic Province, as described by Franklin and Dyrness (1973). The watershed exhibits a varied topography, including forested hills, stream corridors with riparian and wetland vegetation; upland valley areas with pastures and orchards, cheatgrass grasslands, native shrublands; and urban development. The following paragraphs describe the location of general vegetation types within the Project area. The vegetation types are described in more detail in the section on Vegetation Communities that follows.

Conconully Reservoir, at the upstream end of the Project, is surrounded by ponderosa pine (*Pinus ponderosa*) forest. Douglas fir forest, with ponderosa pine as a co-dominant, covers the upper reaches of the Salmon Creek watershed below Conconully Reservoir, and is also found above the shrub zone on the southwest side of Salmon Creek. In the lower elevations of the Okanogan watershed in the Project area, ponderosa pine dominates where the annual precipitation is 14 to 16 inches. Douglas-fir (*Pseudotsuga menziesii*) is dominant in areas where the annual precipitation is 16 to 18 inches (NRCS, 1980).

Salmon Creek from Conconully dam to the OID diversion is a perennial stream bordered by a band of riparian vegetation, except where the vegetation has been removed for agricultural purposes. Downstream of the OID diversion, riparian vegetation is patchier in distribution and is completely lacking in some areas, particularly Segment III (See **Figure 2-7**). Between the OID diversion and the bluff above the Okanogan River, vegetation along the proposed pipeline route consists of an intermingling of agricultural uses and sagebrush/grass communities. Before reaching the Okanogan River, the proposed pipeline route crosses an urban area and ends in the riparian belt bordering the river. The riparian vegetation along the Okanogan River at this point consists of black cottonwood and white alder trees.

3.3.1.1 Vegetation Communities

Ponderosa Pine

Ponderosa pine forest (*Pinus ponderosa*) is widely distributed in eastern Washington (Franklin and Dyrness, 1973). This community occupies drier sites than any other forest type except western juniper (*Juniperus occidentalis*). Co-dominant tree species could include western juniper, quaking aspen (*Populus tremuloides*), Douglas-fir, and Oregon oak (*Quercus garryana*). Ponderosa pine forests are usually relatively open. Understory species could include white snowberry (*Symphoricarpos albus*), shiny-leaf spirea (*Spiraea betulifolia* var. *lucida*), interior rose (*Rosa woodsii*), and Nootka rose (*Rosa nutkeana*).

Douglas Fir Forest

Douglas fir forest is dominated by varying combinations of Douglas fir (*Pseudotsuga menziesii*), ponderosa pine, lodgepole pine, and tamarack (*Larix occidentalis*) (Franklin and Dyrness, 1973).

Understory species could include white snowberry, shiny-leaf spirea, interior rose, and Nootka rose, or any of several grasses such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Agropyron spicatum*), or needle & thread grass (*Hesperostipa comata*).

Three-tip Sage -- Idaho Fescue

The three-tip sage--Idaho fescue community is a shrub-steppe type consisting of a mosaic of shrubs (mostly three-tip sagebrush) and grasses (Franklin and Dyrness, 1973). Pre-European grasses were primarily bunchgrasses, including Idaho fescue, bluebunch wheatgrass, and Sandberg's bluegrass (*Poa sandbergii*). Native bunchgrasses have mostly been replaced, however, by non-native grasses, particularly cheatgrass. This community occurs within Salmon Creek watershed as far upstream as Conconully Reservoir, where urban and agricultural uses have not altered the landscape.

Big Sagebrush --Bluebunch Wheatgrass

The big sagebrush--bluebunch wheatgrass community is a medium-tall shrubland dominated by big sagebrush, with a grassland understory (Franklin and Dyrness, 1973). Pre-European grasses were primarily bunchgrasses, particularly bluebunch wheatgrass. Native bunchgrasses have mostly been replaced by non-native grasses, particularly cheatgrass. Big sagebrush--bluebunch wheatgrass stands are found along the Okanogan River valley and could occur in the lower reaches of the Salmon Creek watershed where urban and agricultural uses have not altered the landscape.

Steppe and Non-Native Grassland

Steppe communities in eastern Washington include those dominated by bluebunch wheatgrass, Idaho fescue, needle & thread grass, and other native grassland species. However, in disturbed areas and abandoned farmland, the non-native cheatgrass (*Bromus tectorum*) often becomes the permanent vegetation. Grasslands of this type, intergrading with shrub-steppe vegetation, are found along the lower reaches of Salmon Creek where riparian vegetation is absent in Segments III and IV (**Figure 2-7, 2-8)**, as well as along parts of the Okanogan River water exchange pipeline route.

Riparian

Where woody riparian vegetation is present along lower Salmon Creek, it is dominated by willow species (*Salix* spp,) or a mosaic of willow and black cottonwood. Farther upstream, white alder can also be dominant. This community also includes forested wetland areas mapped by the National Wetland Inventory along Salmon Creek (NWI, 2003). At the proposed new pump station location on the Okanogan River, the vegetation consists of black cottonwood and white alder trees. At the existing Shellrock pump station on the Okanogan River, the vegetation consists of willow and white alder.

Freshwater Marsh

The freshwater marsh (Palustrine Emergent Wetland) community may be dominated by a variety of herbaceous species, depending on substrate and water depth. Common plants in shallow standing water conditions include cattail (*Typha latifolia*), several bulrush species (*Scirpus* spp.), and burred (*Sparganium* spp.). In the drier reaches, where the surface may dry out but subsurface is persistently wet, numerous sedges (*Carex* spp.) and rushes (*Juncus* spp.) dominate. Spikerush, (*Eleocharis* spp.) also can be an important component in this seasonal flooded margin. Grasses that are commonly associated with this community include, tufted hair grass (*Deschampsia caespitosa*), bluejoint reedgrass (*Calamagrostis canadensis*), and reed canary grass (*Phalaris arundinacea*). In the Project area, this vegetation is best developed at Watercress Springs and at scattered locations along Salmon Creek.

Agricultural Types

Agricultural areas within the Project vicinity include pastures along Salmon Creek and apple orchards along the pipeline route for the Okanogan River water exchange alternative.

Urban

Vegetation in urban areas consists primarily of landscape species, usually non-natives. Non-landscape species present include non-native invasive species, such as Russian thistle (*Salsola iberica*) and knapweeds (*Centaurea* spp.).

3.3.1.2 Wetland Communities

The National Wetland Inventory (NWI) has mapped a variety of wetland habitats in the Project area. These include the open water areas of Conconully Lake and Conconully Reservoir, freshwater marshes with varying degrees of inundation along Salmon Creek, forested wetlands on Salmon Creek upstream of the OID diversion, and the channels of Salmon Creek and the Okanogan River (NWI, 2003; Cowardin et al., 1979).

3.3.1.3 Special Status Plant Species

Twenty-six special status plant species are reported from the Salmon Creek watershed and vicinity. One species, crenulate moonwort (*Botrychium crenulatum*), is a federal species of concern and a state sensitive species (WDNR2003c). Two species, sparse-leafed sedge (*Carex tenuiflora*) and nagoonberry (*Rubus acaulis*) are state-listed as threatened. Nineteen species are state sensitive species, including tall agoseris (*Agoseris elata*), northern bentgrass (*A. borealis*), crenulate moonwort (*Botrychium crenulatum*), hair-like sedge (*Carex capillaris*), narrow-leafed sedge (*C. eleocharis*), poor sedge, (*C. magellanica* ssp. *irrigua*), Scandinavian sedge (*C. norvegica*), Canadian single-spike sedge (*C. scirpoidea* var. *scirpoidea*), many-headed sedge (*C. sychnocephala*), valley sedge (*C. vallicola*), Snake River cryptantha (*Cryptantha spiculifera*), slender crazyweed (*Oxytropis campestris* var. *gracilis*), Kotzebue's grass-of-parnassus (*Parnassia kotzebuei*), snow cinquefoil (*Potentilla nivea*), glaucous willow (*Salix glauca*), Tweedy's willow (*Salix tweedyi*), nodding saxifrage (*Saxifraga cernua*), pygmy saxifrage (*S.*

rivularis), and blue-eyed grass (*Sisyrinchium septentrionale*). Four species are state review species, including blackened sedge (*Carex atrosquama*), different nerve sedge (*Carex heteroneura*), white-scaled sedge (*Carex xerantica*), and Gray's bluegrass (*Poa arctica* ssp. *arctica*). Phenology and habitat information for these species are provided in **Table 3-18**. Crenulate moonwort and the state-listed species are described in more detail below.

Table 3-18. Special-Status Plant Species Potentially Occurring in the Salmon Creek Project Area.

Common Name Scientific Name	Status[a]	Growth Form	Flowering Period[b]	Potential to Occur
Tall agoseris *Agoseris elata*	WS	Perennial herb	Jun-Aug	Meadows, open woods, and exposed rocky ridge tops on various slope aspects, from low elevations to timberline; in areas with little to no canopy cover. Elevations from (500) 2900 to 7800 feet. Reported from high-elevation locations in or adjacent to the Salmon Creek watershed. May occur in the Project area.
Northern bentgrass *Agrostis borealis*	WS	Perennial herb		Moist, arctic-alpine areas. Reported from a high-elevation location in or adjacent to the Salmon Creek watershed. Unlikely to occur in the Project area.
Crenulate moonwort *Botrychium crenulatum*	FSC, WS	Fern	N/A	Reported from locations in the Douglas fir forests upslope of the ponderosa pine forests adjacent to Conconully Reservoir. May occur in the Project area.
Blackened sedge *Carex atrosquama*	WR2	Perennial herb		Mountain meadows. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Hair-like sedge *Carex capillaris*	WS	Perennial herb	Jun-Aug	Streambanks, wet meadows, wet ledges, and marshy lake shores. Elevation ranges from 2800 to 6500 feet. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Narrow-leafed sedge *Carex eleocharis*	WS	Perennial herb		Reported from the vicinity of Conconully Reservoir. Likely to occur in the Project area.
Different nerve sedge *Carex heteroneura*	WR2	Perennial herb		In the Project vicinity, this species has been reported from several high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Poor sedge *Carex magellanica* Ssp. *Irrigua*	WS	Perennial herb		In the Project vicinity, this species has been reported from 2 high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Scandinavian sedge *Carex norvegica*	WS	Perennial herb	Fruit in Aug	Moist alpine turf or montane grasslands. Elevation 7500- 11516 feet. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.

Table 3-18. Special-Status Plant Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name Scientific Name	Status[a]	Growth Form	Flowering Period[b]	Potential to Occur
Canadian single-spike Sedge *Carex scirpoidea* var. *scirpoidea*	WS	Perennial herb	Jun-Aug	Occurs in open, sunny sites, often at the edge of wet meadows, on calcareous substrates. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Many-headed sedge *Carex sychnocephala*	WS	Perennial herb	Jun-Aug	Moist or wet ground adjacent to marshes or along lake shores, sometimes somewhat alkaline. Substrates vary from rather rocky to sandy and silty soils. Elevation ranges from 1000 to 3000 feet. Reported from the vicinity of Conconully Reservoir. Likely to occur in the Project area.
Sparse-leafed sedge *Carex tenuiflora*	WT	Perennial herb	(fl) Jul -Aug (seeds)	Bogs, fens, swamps, wet grassy areas, occasionally in seepage areas in forests. In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed. May occur in the Project area.
Valley sedge *Carex vallicola*	WS	Perennial herb		In the Project vicinity, this species has been reported from the tributaries of Salmon Creek upstream of Conconully Reservoir. May occur in the Project area.
White-scaled sedge *Carex xerantica*	WR2	Perennial herb	Fruits mature in summer	Grasslands, open slopes, and mountain parks from high plains to subalpine elevations. In the Project vicinity, this species has been reported from the tributaries of Salmon Creek upstream of Conconully Reservoir. May occur in the Project area.
Snake River cryptantha *Cryptantha spiculifera*	WS	Perennial herb	May-Jul	Dry, open, flat or sloping areas in stable or stony soils; where overall cover of vegetation is relatively low. In the Project vicinity, this species has been reported from Pine Creek and the Okanogan valley north of Salmon Creek. May occur in the Project area.
Slender crazyweed *Oxytropis campestris* Var. *gracilis*	WS	Perennial herb	May-Jun	Montane and sub-montane. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Kotzebue's grass-of-parnassus *Parnassia kotzebuei*	WS	Perennial herb		Low arctic, or alpine; in damp depressions such as lakeshores and snow patch areas. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Gray's bluegrass *Poa arctica* ssp. *Arctica*	WR2	Perennial herb		Alpine to subalpine. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.

Table 3-18. Special-Status Plant Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name Scientific Name	Status[a]	Growth Form	Flowering Period[b]	Potential to Occur
Snow cinquefoil *Potentilla nivea*	WS	Perennial herb		Arctic-alpine. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Nagoonberry *Rubus acaulis*	WT	Perennial herb	mid-Jun-Jul	Montane meadows, and bogs or woods to alpine tundra. Elevation 7000-9000 feet. In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Glaucous willow *Salix glauca*	WS	Shrub	Jun-Jul	Moist open places to open slopes, mid-montane to above timberline. In the Project vicinity, this species has been reported from a single high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Tweedy's willow *Salix tweedyi*	WS	Shrub	ID Jun-Jul	Streambanks, moist meadows, seeps, and bogs at moderate to fairly high elevations in the mountains. Elevation 5200 to 7200 feet. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Nodding saxifrage *Saxifraga cernua*	WS	Perennial herb	Jul-Aug; reproduces via bulblets	Streambanks, moist rocks, and glacial detritus. Circumboreal in alpine zones. In the Project vicinity, this species has been reported from two high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Pygmy saxifrage Saxifraga rivularis	WS	Perennial herb	Jul-Aug	Moist locations, in boreal zones. In the Project vicinity, this species has been reported from high-elevation locations in the Salmon Creek watershed. Not likely to occur in the Project area.
Blue-eyed grass *Sisyrinchium septentrionale*	WS	Perennial herb	May-mid-Jul	Occurs primarily in open wet meadows, sometimes in association with perennial streams and sometimes within a mosaic that includes forested wetlands. Elevation 2100 to 6100 feet. Reported from one location near the northeast side of the Salmon Creek watershed. May occur in the Project area.

[a]: Codes are as follows:
FSC federal Species of Concern (an unofficial status)
WE state listed as endangered
WT state listed as threatened
WS Washington sensitive species
WR2 Washington review species - R2 taxa have unresolved taxonomic questions.
Sources: WDNR 2000, WDNR 2003b, Hitchcock and Cronquist 1973, IDFG 2003, McJannet et al. 1997, Newsholme 1992, WYNDD 2002
[b]: Or other cited periods when positive identification is possible.

Crenulate Moonwort

This perennial fern develops a single shoot divided into two morphologically different fertile and sterile fronds, four inches tall or less. Plants emerge in mid- to late spring. Spores are released in summer and early fall. This species is found in moist meadows, creek banks, shrub- or tree-dominated wetlands, springy spots, and wet roadside areas. In the Salmon Creek watershed, crenulate moonwort is reported from the Douglas-fir forest that occupies the slopes above the ponderosa pine forest that surrounds Conconully Reservoir (WDNR, 2003c). This species could potentially occur in the Project area.

Sparse-leafed Sedge

Sparse-leafed sedge (*Carex tenuiflora*) is state-listed as threatened (WDNR 2003b). This sedge is a perennial herb that flowers in July and produces seeds in August. This species is found in bogs, fens, swamps, wet grassy areas, and occasionally in seepage areas in forests (WDNR, 2000). In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed (WDNR, 2003c). Sparse-leafed sedge could potentially occur in the Project area.

Nagoonberry

Nagoonberry (*Rubus acaulis*) is state-listed as threatened (WDNR, 2003b). This species is a perennial herb that flowers from mid June through July (WYNDD, 2002). Nagoonberry is found in montane meadows, and bogs or woods up to alpine tundra (Hitchcock, 1973). In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed (WDNR, 2003c). Nagoonberry is not likely to occur in the Project area.

3.3.2 WETLAND AND VEGETATION IMPACTS

3.3.2.1 Alternative 1: Okanogan River Pump Station and Pipeline

Construction of the new pump station would result in the loss of riparian vegetation, primarily white alder and cottonwood, at the proposed site. Implementation of this alternative would result in the return of flow in lower Salmon Creek. The change in flow regime resulting from the implementation of this alternative would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation. Because of the relatively small area needed for the station (less than one acre), and the possible enhancement of riparian vegetation on lower Salmon Creek resulting from flow releases under this alternative, the loss at the site is expected to be minor.

Construction of the pipeline would result in temporary loss of upland vegetation, primarily cheatgrass grassland, in Omak and in an abandoned orchard near the main canal. This impact is expected to be minor.

Construction of the water filtration system and sediment pond would result in the permanent loss of upland shrub-steppe vegetation near Diversion 2. This impact is expected to be minor.

Implementation of Alternative 1 would result in minor impacts to vegetation and wetland habitat during construction. This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation.

3.3.2.2 Alternative 1: Feeder Canal Upgrade

Implementation of the feeder canal upgrade would result in temporary disturbance of vegetation along the canal route during removal and upgrade of the existing canal and during installation of the proposed pipeline. The portion of the feeder canal that is removed and replaced by a pipeline would likely be maintained in an early seral stage to permit access for maintenance purposes and to prevent damage to the buried pipeline from tree roots. Neither installation nor maintenance of the pipeline is expected to result in significant impacts to wetland or other vegetation communities in the section of pipeline that would be installed in the existing canal. Direct impacts to sensitive species that occur in wetland or riparian areas could result from this alternative, particularly where work is conducted at the headworks and at the diversion from the North Fork. Elimination of water leakage from the canal may cause areas below the canal fed by the leaks to dry up. Implementation of the mitigation measures provided in **Section 3.3.3** would reduce potential adverse impacts from construction to a low level.

Operation of the upgraded feeder canal would potentially decrease streamflow for the short reach of North Fork Salmon Creek between the OID feeder canal intake and the upstream end of Conconully Reservoir. Operation of the upgraded feeder canal during moderate and high flow events would reduce the potential for overbank flow and inundation of riparian areas within the stream reach between the OID feeder canal intake and the upstream end of Conconully Reservoir. This stream reach is short, and these potential impacts are considered to be minor.

3.3.2.3 Alternative 1: Stream Rehabilitation

Construction would result in temporary impacts to riparian vegetation at the mouth of Salmon Creek. Direct impacts to special status species that occur in wetland or riparian areas could result from this alternative. Implementation of the mitigation measures provided in **Section 3.3.6** would reduce potential adverse construction impacts to a minor level, and these impacts would be off-set by the long-term improvement in riparian conditions.

3.3.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Construction that would be needed at the Shellrock pump station may impact existing riparian vegetation at the construction site, particularly in the areas where the wing walls will be constructed. This potential adverse impact would be limited to less than one acre and is expected to be minor. Implementation of Alternative 2 would result in the return of flow in lower Salmon Creek. The change in flow regime resulting from the implementation of this alternative would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation. Potential adverse impacts would be offset by the possible enhancement in riparian conditions on lower Salmon Creek due to increased flow releases for fish.

Construction of the pipeline would result in temporary loss of upland vegetation near Omak. There are no wetlands inventoried in the location of the pipeline route, however the route passes through two draws that are mapped as wet areas on Okanogan County maps. The location of the pipeline follows an existing unsurfaced road for part of its length through established orchards. Total impact to vegetation is expected to be minor.

Installation of the sediment basin in the main canal to clean sediment from Okanogan River water before it is delivered to irrigation would result in some temporary impact to upland vegetation around the main canal where construction would take place. This impact would be minor due to a small amount of area impacted. See **Section 3.4.2.6** for impacts related to implementing stream rehabilitation in conjunction with this alternative.

3.3.2.5 Alternative 2: Feeder Canal Upgrade

Wetland and vegetation impacts would be the same as described in **Section 3.3.2.2**.

3.3.2.6 Alternative 2: Stream Rehabilitation

Construction may result in temporary impacts to riparian vegetation. This alternative would result in the long-term enhancement of riparian vegetation in much of lower Salmon Creek. Direct impacts to special status species that occur in wetland or riparian areas could result from this alternative. Implementation of the mitigation measures provided in **Section 3.3.3** would reduce potential adverse construction impacts to a minor level, and these impacts would be offset by the long-term improvement in riparian conditions. Portions of the lower reach of Salmon Creek that are modified for channel rehabilitation may experience minor increases in overbank flows and inundation of adjacent, recontoured flood plains. However, these areas would be limited to reaches that have suitable valley width to allow floodplain recontouring. Increased overbank flows may benefit the establishment of riparian and wetland vegetation in this reach.

3.3.2.7 Alternative 3: Water Right Purchase

Implementation of Alternative 3 would result in the return of flow in lower Salmon Creek. The change in flow regime resulting from the implementation of this alternative would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation.

3.3.2.8 Alternative 3: Feeder Canal Upgrade

Wetland and vegetation impacts would be the same as described in **Section 3.3.2.2**.

3.3.2.9 Alternative 3: Stream Rehabilitation

There would be no stream rehabilitation or associated impacts with this alternative.

3.3.2.10 No Action Alternative

Under the No Action alternative, stream incision and bank erosion downstream of Watercress Springs is likely to continue. Slightly increased flows from conservation measures, if they occur at all, are unlikely to affect riparian vegetation. Uncontrolled bank erosion would continue to reduce the extent of riparian vegetation along lower Salmon Creek, or result in a change in species composition. Installing bank protection could result in a change in species composition of the riparian vegetation.

3.3.3 MITIGATION MEASURES

3.3.3.1 Wetland Avoidance

A wetland delineation would be conducted prior to construction of the water supply alternatives or the stream rehabilitation component. Wetland boundaries outside the construction footprint would be flagged and fenced off to avoid impacts from construction equipment.

3.3.3.2 Rare Plant Avoidance

Prior to any construction activities with any Project components, special-status plant surveys would be conducted to locate any plant populations within the construction corridors. These surveys would be conducted in the summer when the plants are readily identifiable. Areas within the construction corridor containing special-status plant species, if found, would be fenced off so that construction equipment could avoid impacts to such species to the extent compatible with Project goals.

3.3.3.3 Sediment Control

Sediment and pollution control measures would be implemented during construction activities associated with action alternatives. To ensure no transport of disturbed materials from upland sites into waterways, straw bales and silt fences would be placed downslope from upland grading locations prior to construction. BMPs for stream channel construction, as specified in **Section 3.2.3,** would be implemented during stream rehabilitation to minimize impacts to riparian vegetation.

3.3.3.4 Avoidance of Important Habitats and Habitat Features

Construction would avoid removal of important habitat features such as large trees or other perching areas and nesting habitats, where possible. To minimize impacts to important habitats, construction equipment and staging areas would be located to avoid impacts to wetland buffer areas and large, well-established vegetation, as well as to avoid priority habitats such as wetlands, riparian areas, shrub-steppe, and native grasslands.

3.3.4 UNAVOIDABLE ADVERSE IMPACTS

No unavoidable adverse impacts to wetland or vegetation resources are expected to occur from implementation of any of the alternatives other than the No Action alternative. Continued channel degradation is expected to occur under the No Action alternative, which would result in loss of riparian vegetation.

3.4 WILDLIFE

3.4.1 EXISTING CONDITIONS

The Project vicinity contains nine vegetation communities and their associated wildlife habitats, which support a diversity of wildlife. For a detailed discussion of vegetation communities within the Project area, see **Section 3.3.1**. The nine vegetation communities can be grouped into seven wildlife habitats, including ponderosa pine forest, riparian, freshwater marsh, shrub-steppe (three-tip sage and big sage communities), eastside grassland, agricultural, and urban. Wildlife habitats were classified according to the system in Wildlife-Habitat Relationships in Oregon and Washington (Johnson and O'Neil, 2001; NHI-IBIS, 2003).

3.4.1.1 General Wildlife Species

The following subsections discuss representative amphibians, reptiles, birds, mammals, and game species expected to occur in the Project area. Information regarding wildlife species known or expected to occur in the Project area has been obtained from the Washington GAP program data (WDFW, 1999).

Amphibians

Amphibians expected to occur include Pacific treefrog (*Hyla regilla*), western toad (*Bufo boreas*), and the non-native bullfrog (*Rana catesbeiana*). All species of amphibians require water or cool moist areas for reproduction. Riparian communities support the highest levels of amphibian species richness and diversity in Washington. Streamside pools and low-flow shallows can provide breeding habitat for a variety of species of frogs, toads, and newts. Other species of salamanders and newts would utilize adjacent moist, terrestrial habitats underneath fallen logs and leaf litter.

Reptiles

Reptiles that may be found include western fence lizard (*Sceloporus occidentalis*), northern alligator lizard (*Gerrhonotus coeruleus*), and western skink (*Eumeces skiltonianus*). Snakes likely to occur include the common garter snake (*Thamnophis sirtalis*), western rattlesnake (*Crotalus viridis*), racer (*Coluber constrictor*), and gopher snake (*Pituophis melanoleucus*).

Birds

Birds are the most abundant vertebrates in the Project area. Barn swallows (*Hirundo rustica*), western bluebird (*Sialia mexicana*), western meadowlark (*Sturnella neglecta*), American robin (*Turdus migratorius*), Canada goose (*Branta canadensis*), American kestrel (*Falco sparverius*), and turkey vulture (*Cathartes aura*) are found in non-native grasslands and agricultural lands.

Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*), and song sparrow (*Melospiza melodia*) are more abundant in riparian habitats. Great blue heron (*Ardea herodias*.), belted kingfisher (*Ceryle alcyon*), and various species of waterfowl utilize the near shore areas of rivers and creeks for foraging and nesting. Swifts, swallows, and flycatchers can be found foraging over open water habitats.

Coniferous forests, including ponderosa pine and eastside mixed coniferous forests (usually dominated by Douglas fir), provide habitat for many birds and mammals. Spotted towhee (*Pipilo maculatus*) and sparrows would forage in the understory of ponderosa pine forests. Bird species found in ponderosa pine and mixed conifer forests include the hairy woodpecker (*Picoides villosus*), sharp-shinned hawk (*Accipiter striatus*) and brown creeper (*Certhia americana*).

Non-native bird species that occur in the Project area include brown-headed cowbird (*Molthrus ater*), wild turkey (*Meleagris gallopavo*), ring-necked pheasant (*Phasianus colchicus*) and chukar (*Alectoris chukar*).

Mammals

A number of small mammals are common to the Project vicinity. Common bat species include big brown bat (*Eptesicus fuscus*), California myotis (*Myotis californicus*), and hoary bat (*Lasiurus cinereus*). Other small mammals expected to occur include voles (*Microtus* spp.), western harvest mouse (*Reithrodontomys megalotis*), Cascade golden-mantled ground squirrel (*Spermophilus saturatus*), northern pocket gopher (*Thomomys talpoides*), striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*), red squirrel (*Tamiasciurus hudsonicus*), bushy-tailed woodrat (*Neotoma cinerea*), deer mouse (*Peromyscus maniculatus*), and raccoon (*Procyon lotor*). Larger mammals in the Project vicinity include coyote (*Canis latrans*), red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), and mountain lion (*Felis concolor*).

Game Species

Big game species near Project components could include white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and black bear (*Ursus americanus*). Other game species include upland game birds, such as blue grouse (*Dendragapus obscurus*), chukar, and wild turkey; waterfowl, such as mallard (*Anas platyrhynchos*), pintail (*Anas acuta*), and Canada goose; and mammals, such as cottontail rabbit (*Sylvilagus nuttallii*).

3.4.1.2 Special Status Wildlife Species

Forty-four special status wildlife species may occur in the Project vicinity (WDFW, 1999). Habitat descriptions and an evaluation of the potential to occur in the Project area are provided in **Table 3-19**. One species, blue grouse, is tracked by the state, but is not protected. Federally-listed species may also have state status, and species with state status may also be federal species of concern. Habitat conditions for federal- and state-listed species are described in more detail below.

Gray Wolf

The gray wolf (*Canis lupus*) is federally listed as threatened and state listed as endangered (WDNR 2003a). This species historically was found in a variety of habitats. In Washington, the gray wolf is currently found only in the northern Cascades, probably in forests. Wolves in the Pacific states feed primarily on ground squirrels, rabbits, and hares, but will also take larger mammals such as deer and elk (Ingles, 1965). Wolves may pass through the uppermost elevations of the Salmon Creek watershed, but are unlikely to occur in the Project area.

Bald Eagle

Western Washington has one of largest concentrations of bald eagles (*Haliaeetus leucocephalus*) (FT, WT) in the contiguous United States. This species is federally and state-listed as threatened (WDNR 2003a). Bald eagles are common breeders along salt and fresh water at lower elevations throughout western Washington (Cassidy, 2003). Bald eagles are uncommon breeders along major rivers and lakes in eastern Washington. Bald eagles are typically found in coniferous forest habitats with large, old growth trees near permanent water sources such as lakes, rivers, or ocean shorelines. They require large bodies of water with abundant fish and adjacent snags or other perches for foraging (Csuti et al., 1997). Bald eagles prey mainly on fish, and occasionally on small mammals or birds, by swooping from a perch or from mid-flight. Nests are found in large, old growth, or dominant trees, especially ponderosa pine with an open branchwork, usually 50 to 200 feet above the ground. Habitat for the bald eagle is present at Conconully Reservoir and along the Okanogan River.

Grizzly Bear

The grizzly bear (*Ursus arctos*) is federally and state-listed as threatened (WDNR 2003a). This bear is an omnivore that once ranged as far south as central California, but is now found in the United States only in Alaska and the northernmost parts of the Cascade Range and the Rocky Mountains. In Washington, the grizzly bear inhabits montane forests (Burke, 2002) and alpine meadows (UMMZ, 2003). Grizzly bears may pass through the uppermost elevations of the Salmon Creek watershed, but are unlikely to occur in the Project area.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area.

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
BIRDS			
American avocet *Recurvirostra americana*	Protected	Beaches, flats, shallow lakes, and prairie ponds. Locally common in freshwater ponds & wetlands of the Columbia Basin in central Washington.	May occur at Conconully Reservoir.
Bald eagle *Haliaeetus leucocephalus*	FT, WT	Coasts, rivers, large lakes & also mountains & open country in winter. Locally, western Washington, and uncommon breeders along major rivers & lakes in eastern Washington.	May occur at Conconully Reservoir and on the Okanogan River.
Black tern *Chlidonias niger*	FSC, WM	Fresh marshes, lakes, & coastal waters in migration. Locally, most common east of the Okanogan & Columbia Rivers.	May occur at Conconully Reservoir.
Black-backed woodpecker *Picoides arcticus*	WC	Fir & spruce forests, recent burns. Uncommon permanent residents in Washington's mountains from the Cascade crest east.	May occur at Conconully Reservoir.
Black-crowned night-heron *Nycticorax nycticorax*	WM	Marshes & shores. Roosts in trees. Locally, most common in central & southern Columbia Basin. Winter roosts in northwest Washington, along Columbia River & Tri Cities area.	May occur at Conconully Reservoir, along Salmon Creek, and in the Okanogan River.
Blue grouse *Dendragapus obscurus*	None	Coniferous & mixed mountain forests in summer & in conifer forests at higher elevations in winter. Locally at all elevations throughout most of Washington	May occur at Conconully Reservoir.
Burrowing owl *Speotyto cunicularia*	FSC, WC	Open grassland, prairies, airfields, farmland. Nests in ground burrows. Locally, shrub-steppe zone of eastern Washington, & warmest areas of Columbia Basin in winter.	May occur along lower Salmon Creek and on the pipeline route for the Okanogan River water exchange alternative.
Eared grebe *Podiceps nigricollis*	Protected	Prairie lakes, ponds & also open lakes, salt bays & ocean in winter. Locally, lower elevations up to ponderosa pine zone in eastern Washington, including east of Okanogan River & Columbia Basin.	May occur at Conconully Reservoir.
Flammulated owl *Otus flammeolus*	WC	Open pine, fir forests in mountains. Locally, uncommon breeders east of the Cascades in the ponderosa pine belt May to August.	May occur at Conconully Reservoir.
Lewis` woodpecker *Melanerpes lewis*	WC	Scattered or logged forests, foothills, burns, river groves. Locally, breed in eastern Washington at transition zone between Ponderosa pine & shrub-steppe habitats.	May occur at Conconully Reservoir, and in riparian vegetation along lower Salmon Creek and on the Okanogan River.
Loggerhead shrike *Lanius ludovicianus*	FSC, WC	Semi-open areas with lookout posts (scrub, wire, trees). Locally, eastern Washington spring to early fall, & in winter uncommon in Columbia River bottoms of southeast Washington	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
Merlin *Falco columbarius*	WC	Open woods, cliffs, tundra, adjacent to grassland. Also marshes, open coasts & foothills in migration. Locally, rare breeder in coastal forests of state's outer coast & Puget Sound. Taiga Merlin rare breeder in high-elevation boreal forests of the north Cascades & northeastern Washington, & Prairie Merlins occur in state during migration. Common in major valleys, Puget Sound & coast in winter.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Northern goshawk *Accipiter gentilis*	FSC, WC	Deciduous & coniferous forests, especially in mountains, forest edges. Lowland in winter. Locally, common along eastern slope of Cascades, & less common in the Olympic Mountains & southwestern Washington.	May occur at Conconully Reservoir.
Pied-billed grebe *Podilymbus podiceps*	Protected	Ponds, lakes, marshes, & also salt bays in winter. Locally, lower elevations throughout Washington, except lower slopes of eastern Cascades.	May occur at Conconully Reservoir.
Pileated woodpecker *Dryocopus pileatus*	WC	Conifer, mixed & hardwood forests, woodlots. Locally, uncommon at low to mid-elevations throughout state. More common in western than in eastern Washington.	May occur at Conconully Reservoir.
Prairie falcon *Falco mexicanus*	WM	Mountainous grasslands, open hills, prairie, plains. Locally, uncommon breeders in eastern Washington shrub-steppe zone. Nest in basalt coulees' cliff faces.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Red-necked grebe *Podiceps grisegena*	WM	Lakes, ponds & also salt water in winter. Locally, northeastern Washington, especially lower river valleys. Also coast of Washington & in Puget Sound in winter.	May occur at Conconully Reservoir.
Sage sparrow *Amphispiza belli*	WC	Dry, brushy foothills, chaparral, sage. Also deserts in winter. Locally, common to uncommon breeders in sagebrush of Columbia Basin, & rare in Okanogan Valley.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Sage thrasher *Oreoscoptes montanus*	WC	Brushy slopes, sagebrush, mesas. Also deserts in winter. Locally, common breeders in eastern Washington end of March to mid-August.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Sharp-tailed grouse *Tympanuchus phasianellus*	FSC, WT	Prairie, open thickets, brushy groves, coulees, clearings, open burns in coniferous forests.	May occur along lower Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & at Conconully Reservoir.
Vaux`s swift *Chaetura vauxi*	WC	Lakes, rivers, open sky over woodlands. Locally, common breeders spring to fall in forested areas throughout Washington. & also below lower treeline in residential areas of eastern Washington.	May occur anywhere in the Project area.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
White-headed woodpecker *Picoides albolarvatus*	WC	Mountain pine forests. Locally, uncommon & local in the ponderosa-pine forests of the eastern Cascades, & east of Okanogan River & rare in Blue Mountains.	May occur at Conconully Reservoir.
Mammals			
Big brown bat *Eptesicus fuscus*	Protected	Usually urban & rural areas. Least common in heavily forested regions. Roosts & hibernates in man-made structures (homes, mine caves, storm sewers, etc.).	May occur along lower Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & at Conconully Reservoir.
California myotis *Myotis californicus*	Protected	Brushy, dessert or grassy areas & desert-shrub-oak woodland up to ponderosa. Roost in crevices & cracks of canyon walls, & in caves & mineshafts.	May occur along lower Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & at Conconully Reservoir.
Fisher *Martes pennanti*	FSC, WE	Prefer continuous conifer & hardwood forests, with high canopy closure & many hollow trees for dens.	May occur at Conconully Reservoir.
Fringed myotis *Myotis thysanodes*	FSC, WM	Mountain woodlands. Night & day roosts, & hibernation in caves, mines, & buildings. Moderate mountain elevations.	May occur at Conconully Reservoir.
Gray wolf *Canis lupus*	FT, WE	North Cascades of Washington. Forested areas, open tundra.	Unlikely to occur in the Project area.
Grizzly bear *Ursus arctos*	FT, WT	Mountainous regions & open areas such as tundra, alpine meadows & coastlines with dense cover. Hibernates in high mountains in winter.	Unlikely to occur in the Project area.
Little brown myotis *Myotis lucifugus*	Protected	In summer, colonies near water bodies in very hot area with temperatures to 131°F in attic, behind siding or under bridges. Single males also in bark & rock crevices, & groups of males in caves. Hibernate in caves or mines.	May occur at Conconully Reservoir, along Salmon Creek, & along the Okanogan River.
Long-eared myotis *Myotis evotis*	FSC, WM	Roosts in trees, cabins, caves, abandoned mines, & other sheltered areas in coniferous forest regions. 0 to 9600 ft.	May occur anywhere in the Project area.
Long-legged myotis *Myotis volans*	FSC, WM	Montane or subalpine forest, ponderosa pine woodland, pinon juniper woodland, & montane shrub with willow. Roosts in abandoned buildings, ground cracks, crevices, & spaces beneath tree bark, & hibernate in caves & mine tunnels. Most common 6500 to 10000 feet.	May occur at Conconully Reservoir.
Lynx *Lynx canadensis*	FT, WT	Forested areas, swamps.	May occur at Conconully Reservoir.
Pallid bat *Antrozous pallidus*	WM	Rocky, mountainous areas near water & over open grasslands. Day roost warm, horizontal opening. Night roost open, near foliage. Hibernate in buildings, caves, roof cracks.	May occur anywhere in the Project area.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
Small-footed myotis *Myotis ciliolabrum*	FSC, WM	Rock outcrops on open grasslands, canyons in foothills, or lower mountain woodlands. Day roosts in cracks & crevices in cliffs, beneath tree bark, in mines & caves, & in human dwellings. Night roosts under natural or human-induced structures. Hibernate in caves, mines, & tunnels. Low elevations to 9500 ft.	May occur anywhere in the Project area.
Townsend`s big-eared bat *Plecotus townsendii*	FSC, WC	*From* coniferous forests & woodlands, deciduous riparian woodland, semi-desert & montane shrublands. Roosts include limestone caves, lava tubes, & human-made structures.	May occur anywhere in the Project area.
Western gray squirrel *Sciurus griseus*	FSC, WT	Fairly open oak & pine-oak forests.	Unlikely to occur in the Project area.
White-tailed jack rabbit *Lepus townsendii*	WC, game	Barren, grazed, cultivated lands, grasslands.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Wolverine *Gulo gulo*	FSC, WC	Boreal forests, mountains or open plains & brushlands. Rough beds of grass or leaves in caves or rock crevices, in burrows made by other animals, or under a fallen tree, & occasionally construct their nests under the snow.	May occur at Conconully Reservoir.
Yuma myotis *Myotis yumanensis*	FSC, protected	From juniper & riparian woodlands to desert regions near open water. Roost in caves, attics, buildings, mines, underneath bridges, & other similar structures.	May occur along Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & on the Okanogan River.
Amphibians			
Columbia spotted frog *Rana luteiventris*	FSC, WC	Still water, & streams & creeks. Breed in flooded margins of wetlands, ponds & lakes. Egg masses in areas with little or no shading from vegetation. Breeding in the Columbia Basin, at elevations near 1800-2000 feet, & the Okanogan Highlands at sites 2000 to above 4500 feet.	May occur in wetlands & ponded areas on Salmon Creek, near Conconully Reservoir, & on the Okanogan River.
Northern leopard frog *Rana pipiens*	FSC, WE	Steppe vegetation zones & lakes, ponds, creeks & rivers. Columbia Basin & Okanogan. 500 to 1500 ft.	May occur in wetlands & ponded areas on Salmon Creek, near Conconully Reservoir, & on the Okanogan River.
Western toad *Bufo boreas*	FSC, WC	Forested, brush or mountain meadow. Breeds in ponds or shallow lake edges with hatchlings & tadpoles in warmest, shallowest water. Toadlets under rocks near ponds or in brush & adults underground, under large debris or in grass & brush. In streams & springs during dry periods. 0 to 7400 ft.	May occur in wetlands & ponded areas on Salmon Creek, near Conconully Reservoir, & on the Okanogan River.

a: Codes are as follows:
FT federally listed as threatened
FSC federal species of concern
WE listed by Washington State as endangered
WT listed by Washington State as threatened
WC candidate species for listing by Washington State
WS Washington State sensitive species
WM Washington State monitored species
Protected This species has no official state listing status, but it is classified by WDFW as protected wildlife.
Sources: WDFW 2002, WNHP 2002, Burt and Grossenheider 1980, Peterson Field Guides; Corkran and Thoms 1996, Franklin and Dyrness 1973, Peterson 1990.

Lynx

The lynx (*Lynx canadensis*) is federally and state-listed as threatened (WDNR, 2003a). This is a boreal species that formerly occurred from the Pacific to the Atlantic coasts, as far south as Oregon and Colorado. The lynx is usually found in dense forest with some openings. The primary food of the lynx in much of its range is the snowshoe hare (*Lepus americanus*), but it also takes birds, other small mammals, and even young deer (Csuti, et al., 1997). Suitable habitat for this species is present in the forests around Conconully Reservoir.

Fisher

The fisher (*Martes pennanti*) is a federal species of concern and is state-listed as threatened (WDNR, 2003a). This species is found primarily in mature, closed-canopy coniferous forests, frequently along riparian corridors (Csuti et al., 1997). In the western United States, the fisher is restricted to the mountains, as far south as the Sierra Nevada in California. The fisher feeds on small mammals, amphibians, reptiles, birds, and eggs. Habitat for this species is present in the forests around Conconully Reservoir.

Northern Leopard Frog

The northern leopard frog (*Rana pipiens*) is a federal species of concern and is state-listed as threatened (WDNR 2003a). This frog is widely distributed from Nevada through the eastern United States. In Washington, this species is found primarily in the central basin and on the Snake River in northeastern Washington. However, it has been reported from the Okanogan River upstream of the confluence with Salmon Creek. The northern leopard frog prefers quiet or slow-moving waters, including marshes, wet meadows, vegetated irrigation canals, ponds and reservoirs (Csuti, et al., 1997). The adults feed on both invertebrates and small vertebrates. Habitat for this species is present in the Project area.

Sharp-Tailed Grouse

The sharp-tailed grouse (*Tympanuchus phasianellus*) is a federal species of concern and is state-listed as threatened (WDNR 2003a). This grouse historically ranged from southern British Columbia, along the eastern slope of the Cascades south to California, and east to Colorado and Utah. This species is found in a variety of habitats, including grasslands, shrublands, and partially cleared forests (Ehrlich et al., 1988). In Washington, this species is currently known only from eight isolated populations in Douglas, Lincoln, and Okanogan Counties (Cassidy, 2003). The areas with the largest subpopulations in Okanogan County are Tunk Valley and Nespelem (Cassidy, 2003). The sharp-tailed grouse feeds on vegetation, including leaves, buds, flowers, and fruits (Ehrlich et al., 1988).

Limited habitat for this species is present in the patches of shrub-steppe/grassland between the Okanogan River and the OID diversion, as well as open margins of the forest in the vicinity of Conconully Reservoir. However, this habitat is interrupted by urban areas and extensive orchards.

Western Gray Squirrel

The western gray squirrel (*Sciurus griseus*) is a federal species of concern and is state-listed as threatened (WDNR 2003a). This squirrel is an arboreal species that is active all year. This species feeds on a variety of seeds and fungi, as well as fruit, green vegetation, and insects. The primary habitat for the western gray squirrel is woodlands of deciduous or broadleaf evergreen trees, dominated by oaks and occasional pines (Csuti et al., 1997). However, this species also occupies riparian forests and mixed coniferous forests. The current range of the western gray squirrel just reaches the western edge of the Salmon Creek watershed (WDFW, 1999), but it is unlikely to occur in the Project area.

3.4.2 WILDLIFE IMPACTS

3.4.2.1 Alternative 1: Okanogan River Pumping Station Facilities

Construction of the new pump station would result in the permanent loss of riparian habitat, primarily white alder and cottonwood, at the proposed site. Because of the relatively small area needed for the station, and the possible enhancement of riparian habitat on lower Salmon Creek that may result from increased flows under this alternative, the loss is expected to be minor.

Construction could result in direct impacts to wildlife species present in the Project area. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce potential impacts to a low level.

Construction of the pipeline would result in temporary loss of upland habitat, primarily cheatgrass grassland. This impact is expected to be less than significant. Implementation of the mitigation measures provided in **Section 3.4.3** would further reduce potential impacts.

Construction of the water filtration system and sediment pond would result in the permanent loss of upland vegetation near Diversion 2. This impact is expected to be minor.

Implementation of the Okanogan River water exchange alternative would result in minor impacts to wildlife and wildlife habitat during construction. This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime in Salmon Creek associated with the implementation of this action alternative would provide beneficial conditions in which riparian habitat typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian habitat currently exists and would improve conditions for existing riparian habitat.

3.4.2.2 Alternative 1: Feeder Canal Upgrade

Implementation of the feeder canal upgrade would result in temporary disturbance of wildlife habitat along the canal route during removal of the existing canal and installation of the proposed pipeline. The pipeline route would likely be maintained in an early seral stage to permit access for maintenance purposes and to prevent damage to the buried pipeline from tree roots. Because the pipeline would be installed in the location of the existing canal, and because much of the route passes through the settlement of Conconully to the reservoir, neither installation nor maintenance of the pipeline is expected to result in significant impacts to wildlife habitat.

Animals present in the construction zone, or that stray into it, could be killed during construction activities. Animals could also be adversely affected by maintenance activities. Mitigation measures provided in **Section 3.4.3** would reduce these effects to a low level.

3.4.2.3 Alternative 1: Stream Rehabilitation

Construction would result in temporary adverse impacts to riparian habitat at the mouth of Salmon Creek. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce temporary adverse impacts to wildlife habitat.

Channel construction activities would occur in the late summer to early fall, however, direct impacts to wildlife species, including amphibians and riparian-nesting birds, could result. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce potential adverse impacts to a low level.

3.4.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Relocation of the intake and any other construction at the Shellrock pump station that is required may impact existing riparian vegetation at the construction site. This potential adverse impact would be limited to a small area and is expected to be minor. Potential adverse impacts also would be offset by the improvement in riparian habitat on lower Salmon Creek.

Construction of the pipeline would result in temporary loss of upland habitat, primarily cheatgrass grassland. This impact is expected to be less than significant. Implementation of the mitigation measures provided in **Section 3.4.3** would further reduce potential impacts.

Construction of the sediment basin in the main canal would result in the temporary impact to a small area around the construction site. This impact is expected to be minor.

Upgrading the Shellrock pumping plant would result in minor impacts to wildlife and wildlife habitat during construction. This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime in Salmon Creek associated with the implementation of this action alternative would provide beneficial conditions in which riparian habitat typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian habitat currently exists and would improve conditions for existing riparian habitat. See **Section 3.4.2.6** for impacts related to implementing stream rehabilitation in conjunction with this alternative.

3.4.2.5 Alternative 2: Feeder Canal Upgrade

The impacts to wildlife would be the same as described in **Section 3.4.2.2**.

3.4.2.6 Alternative 2: Stream Rehabilitation

Portions of the lower reach of Salmon Creek that are modified for channel rehabilitation may experience minor increases in overbank flows and inundation of adjacent, recontoured flood plains. However, these areas would be limited to reaches that have suitable valley width to allow floodplain recontouring. Increased overbank flows would benefit the reestablishment of riparian and wetland vegetation in this reach.

Construction would result in temporary adverse impacts to riparian habitat in the lower reach of Salmon Creek, but would be more than offset by the resulting enhancement of riparian habitat in much of lower Salmon Creek. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce temporary adverse impacts to wildlife habitat.

Channel construction activities would occur in the late summer to early fall, however, direct impacts to wildlife species, including amphibians and riparian-nesting birds, could result. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce potential adverse impacts to a low level.

3.4.2.7 Alternative 3: Water Right Purchase

This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime in Salmon Creek could provide beneficial conditions in which some riparian habitat typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian habitat currently exists and would improve conditions for existing riparian habitat. There are no adverse impacts to wildlife or wildlife habitat associated with this alternative.

3.4.2.8 Alternative 3: Feeder Canal Upgrade

The impacts to wildlife would be the same as described in **Section 3.4.2.2**.

3.4.2.9 Alternative 3: Stream Rehabilitation

Since rehabilitation would no be implemented with this alternative, there would be no impacts.

3.4.2.10 No Action Alternative

Under the No Action Alternative, changes from existing conditions are not likely to result in significant effects on terrestrial wildlife. Stream incision and bank erosion are likely to continue to varying degrees along the length of Salmon Creekbut because much of the Lower Salmon Creek corridor has already incurred heavy loss of riparian vegetation, further loss of habitat is unlikely to have an important effect on wildlife. However, lateral and vertical erosion occurring immediately downstream of Watercress Springs is likely to result in further loss of the riparian vegetation currently present in this area. Uncontrolled bank erosion could reduce the extent of riparian vegetation or result in a change in species composition. Installing bank protection in areas with riparian vegetation could result in a change in species composition. Any of these conditions could result in a change in extent and type of riparian habitat available to wildlife species.

3.4.3 MITIGATION MEASURES

In order to reduce potential impacts to wildlife, the following mitigation measures would be implemented.

3.4.3.1 Avoid Disturbing Special Status Wildlife Species

Prior to any construction activities for any component, a qualified biologist would conduct site-specific surveys to evaluate the potential for special status wildlife to occur within the construction corridors. Any areas within the construction corridor that are occupied by special status species would require consultation with the appropriate regulatory agency. Areas could be flagged so that construction equipment could avoid impacts to the species. Sensitive habitats in the Project area, but outside the construction footprints of the stream rehabilitation projects, would also be flagged for avoidance. If construction occurs during the breeding season for special status raptors, a no-disturbance buffer would be established around any active nests found within 0.5 mile of the construction zone. Resource managers would be consulted prior to construction activities. Timing of construction or maintenance operations that may affect important activities (breeding, feeding, etc.) of special status species would be timed to avoid or minimize disturbance.

A biological resource education program for construction crews would be conducted before construction activities begin. The education program would include a brief review of the special-status species and other sensitive resources that could exist in the Project area, locations where they may be encountered, and their legal status and protection under the State and Federal Endangered Species Acts. The education program would include materials describing sensitive resources, resource avoidance, mitigation measures, permit conditions, and possible fines for violations of state or federal environmental laws.

3.4.3.2 Avoid Disturbing Breeding Birds

If vegetation removal during construction occurs during the breeding season for migratory birds, a qualified biologist would conduct surveys to locate any active bird nests within the construction corridors. Areas within the construction corridor containing active nests, if found, would be flagged so that construction equipment can avoid impacts to the nests. If vegetation that must be removed to complete the Project is found to have active nests, removal of that vegetation would be postponed until after the nesting season.

3.4.3.3 Sediment Control

Sediment and pollution control measures would be implemented during construction activities. BMPs for stream channel construction, as specified in **Section 3.2.3,** and measures to avoid transport of upland materials into waterways, as specified in **Section 3.3.3**, would be implemented during construction to minimize impacts to riparian habitat

3.4.3.4 Avoid Important Habitats and Habitat Features

Construction would avoid removal of important habitat and habitat features as specified in **Section 3.3.3**.

3.4.4 UNAVOIDABLE ADVERSE IMPACTS

No unavoidable adverse impacts to wildlife or wildlife habitat are expected to occur from implementation of any of the alternatives other than the No Action alternative. Continued channel degradation is expected to occur under the No Action alternative, which would result in loss of riparian habitat. This loss may be permanent, depending on methods employed to strengthen eroding banks.

3.5 FISHERIES

3.5.1 EXISTING CONDITIONS

3.5.1.1 Overview

Potentially affected waterbodies within the Project area include Salmon Creek and the Okanogan River. The Okanogan River originates in British Columbia, Canada and flows into the Columbia River in Washington State at approximately river mile (RM) 534 (distance upstream from where the Columbia River enters the Pacific Ocean). Salmon Creek enters the Okanogan River at approximately RM 26 (distance upstream from confluence of the Okanogan with the Columbia River). Salmon Creek has a total watershed area of about 167 square miles and is approximately 42 miles long. While Salmon Creek inflows comprise only about 2 percent of the Okanogan average annual flow at Malott, (WDOE, 1995), it has been identified as having perhaps the best potential for improving fish production in relation to other Okanogan River tributaries (Dames & Moore 1999).

The specific area potentially affected in the Okanogan River is from just downstream of the mouth of Salmon Creek (RM 26) to upstream of the existing Shell Rock pump station at RM 29.0 or to the new Okanogan pump station alternative at RM 27.1. The area of interest for the Salmon Creek watershed is divided into three reaches including; 1) the lower reach, extending from the confluence of Salmon Creek and the Okanogan River upstream to the Okanogan Irrigation District (OID) diversion dam (RM 4.3); 2) the middle reach, from the OID diversion dam to the Conconully Reservoir (RM 15.3); and, 3) the upper reach, which includes both reservoirs (Conconully Reservoir and Salmon Lake) as well as the north, south, and west forks of Salmon Creek. Fisheries resources and habitat conditions are discussed for each waterbody and reach of Salmon Creek below.

3.5.1.2 Okanogan River

Fisheries Resources

Anadromous[12] runs of summer chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*0. nerka*), and smaller runs of steelhead trout (*O. mykiss*) are found in the Okanogan River and tributaries, including its Canadian reaches. Other resident (non-migratory) salmonids in this system include mountain whitefish (*Prosopium willamsoni*), rainbow trout (*0. mykiss*), westslope cutthroat trout (*0. clarki clarki*), kokanee (*O. nerka)*, and possibly bull trout (*Salvelinus confluentus*). Important native resident and non-salmonid species in the Okanogan watershed include mountain whitefish (*Prosopium willamsoni*), pygmy whitefish (*Prosopium coulteri)*, lake chub (*Couesius plumbeusI),* peamouth chub (*Mylocheilus caurinusI*), northern pikeminnow (*Ptychocheilus oregonensis*), longnose dace (*Rhinichthys cataractae*), leopard dace (*Rhinichthys falcatus*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), bridgelip sucker (*Catostomus columbianus*), chiselmouth (*Acropheilus alutaceus*), prickly sculpin (*Cottus asper*), slimy sculpin (*Cottus cognatus*), torrent sculpin (*Cottus rhotheus*),and Pacific lamprey (*Lampetra tridentatus*), an anadromous species. Eastern brook trout (*Salvelinus fontinalis*) is an exotic (non-native) salmonid introduced to the area. Some of these species are federally listed as threatened or endangered or are considered state sensitive species due to depressed population levels in the region, as described by species below.

Various exotic warm water species have been introduced into the Okanogan watershed (OWC, 2000). These include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomelui*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrocherus*), yellow perch (*Perca flavescens*), pumpkinseed sunfish (*Lepomis gibbosus*), black bullhead (*Ictalurus melas*), brook trout (*Salvelinus frontinalis*), lake whitefish (*Coregonus clupeaformis*), carp (*Cypinus carpio),* brown bullhead (*American nebulosis*), black crappie (*Pomoxis nigromaculatus*), tench (*Tinca tinca*), and walleye (*Stizosledion vitreum*). Warm water resident fish supply the majority of the total basin biomass for fish and many are contributors to predation on juvenile salmonids in the reservoirs and tailraces associated with mid-Columbia dams (OWC, 2000).

Summer chinook

Summer chinook are referred to as "ocean-type" because they out-migrate as sub-yearlings and spend little time in their natal streams and rivers (Mathews and Waples, 1991; Waples et al., 1991; Myers et al., 1998). Following spawning in late September through early November (peaking in mid October), eggs are incubated. Emergence of the newly hatched fish (fry) occurs between January and April. Juveniles leave the Okanogan River from one to four months after emergence. These fish have an extended residence period in fresh water through a protracted downstream migration. Sub-yearlings rear in the mid-Columbia impoundments for various periods of time during their outmigration (Peven and Duree, 1997). After 4 to 5 years in the ocean, summer chinook salmon migrate back to the Okanogan River from July through late September to spawn.

[12] Anadromous fish migrate to ocean as part of their life cycle.

The spatial distribution of spawners in the watershed is fairly discontinuous. Summer chinook spawn in limited areas in the Okanogan River in the 61 miles between Zosel Dam (RM 78 and creates Lake Osoyoos) and the town of Malott (RM 17.0). The Similkameen River is the largest tributary to the Okanogan River and enters at RM 74. On the Similkameen River, summer chinook spawn in the nine-mile reach from Enloe Dam (RM 9) downstream to Driscoll Island (just upstream of the confluence with the Okanogan River). In general, the run strength of summer chinook salmon was low in the 1970s and 1980s (Chapman et al. 1994a), with runs of 532 in 1977 and 617 in 1985 (WDOE, 1995). Summer chinook run sizes have increased overall during the past decade, averaging 12,618 per year through Wells Dam between 1994 and 2003. Run sizes were 44,503 in 2003 and 62,595 in 2002.

Spring chinook

Spring chinook salmon in the Okanogan are referred to as “stream-type” salmon because they have a longer freshwater residency than the Okanogan River summer chinook salmon. Okanogan spring chinook spend a year or more in fresh water. They typically enter mid and upper Columbia River tributaries from late April through July and hold in pools until onset of spawning (Chapman et al., 1995). Spawning generally occurs from late July through September and eggs typically hatch in late winter. Fry emerge from the gravel in April or May (Peven, 1992). Out-migration also occurs in April and May. Because spring chinook spend more time in fresh water, out-migrants (smolts) are much larger than their ocean-type (subyearling) counterparts.

Spring chinook salmon are considered extirpated from the Okanogan River drainage (**Table 3-20**). Historical records indicate that they occurred in at least three systems including Salmon Creek (Craig and Suomela, 1941), tributaries upstream of Lake Osoyoos (Chapman et al., 1995), and possibly Omak Creek (Fulton, 1968). There were probably several life history strategies that historically existed in the Similkameen River watershed prior to construction of Enloe Dam in 1920, although there is no clear evidence that chinook salmon passed the natural falls on the lower Similkameen River.

Steelhead Trout

Steelhead trout are the anadromous form of rainbow trout. Hatchery and wild-run summer steelhead trout return to the Okanogan River in October. Steelhead stage (stop migrating and remain in one general area) in locations with favorable habitat conditions until mid-March or April. In April, they begin ascending tributaries and then typically spawn in mid-April. After spawning, many adults out-migrate and, unlike other anadromous species, can return in following years to spawn again. Incubation of eggs normally occurs from April through September and juveniles typically outmigrate during the last part of April and first part of May (summary in Dames & Moore, 1999).

Few wild steelhead currently use the Okanogan River. Although records concerning steelhead abundance in the Okanogan watershed are not complete, Mullan et. al. (1992) estimate that few steelhead historically used the Okanogan River. Evidence suggests that steelhead used Salmon Creek and possibly other tributaries in the Okanogan Basin (Chapman et al. 1994b). During the spring of 2002, CCT fisheries biologists caught summer steelhead in the Okanogan River, holding near the mouth of Salmon Creek (Fisher, per. comm. June 26, 2002). These steelhead are likely returning to Salmon Creek as a result of a reestablishment program. The Washington Department of Fish and Wildlife in coordination with the Colville Confederated Tribes (CCT) have released approximately 10,000 to 15,000 steelhead smolts downstream of the OID diversion dam on Salmon Creek in recent years. The Washington Water Trust leases water from the OID. Flows are provided long enough to imprint the smolts to Salmon Creek and then increased to flush smolts to the Okanogan River. The returning adults are possibly attracted to ground water sources from the watershed when insufficient flows preclude migration into Salmon Creek (Fisher, pers. comm. 2003).

Table 3-20. Special-Status Fish Species Potentially Occurring in the Salmon Creek Project Area. (Source: WDFW 2003).

Common Name *Scientific Name*	ESA Status		Potential to Occur in Project Area
	Federal	Washington	
Bull trout (Columbia Basin) *Salvelinus confluentus*	Threatened	State Candidate	May occur in the Okanogan Basin but are believed to be extirpated downstream of Enloe and Zosel dams. Historically may have been present in Salmon Creek, although interbreeding with eastern brook trout may have eliminated this species from the watershed.
Chinook salmon, spring run (Upper Columbia) *Oncorhynchus tshawytscha*	Endangered	State Candidate	Spring chinook salmon are considered extirpated from the Okanogan River, including Salmon Creek. This race typically uses larger streams and smaller rivers for spawning.
Steelhead (Upper Columbia) *Oncorhynchus mykiss*	Endangered	State Candidate	Steelhead use the Okanogan River. They spawn and rear in tributaries. Steelhead use Salmon Creek when access (water) is available. They have recently been released in the Salmon Creek drainage.
Westslope cutthroat *Oncorhynchus clarki lewisi*	Species of Concern	None	The status of westslope cutthroat trout in the Okanogan is unknown. It is speculated that these trout are not native to the Okanogan River watershed; those currently present in Toats Coulee, and Salmon Creek may have been planted.
Pacific lamprey *Lampetra tridentata*	Species of Concern	None	Recently constructed Pacific lamprey redds (11) were observed in April 2003 in the Similkameen River, a major tributary of the Okanogan River, upstream of Salmon Creek near Oroville, WA. (Ward, 2003).

Note: The lake chub (*Couesius plumbeus*), leopard dace (*Rhinichthys falcatus*), mountain whitefish (*Catostomus platyrhynchus*) and Umatilla dace (*Rhinichthys umatilla*) are all listed as state candidate species, and the pygmy whitefish (*Prosopium coulteri*) is listed as a state sensitive species. All of these species have the potential to occur in the upper Columbia sub-basin and within the Okanogan watershed. However, there are no current documented occurrences in the Okanogan River or in Salmon Creek and they are not thought to be present in the area of the Project (per. comm. Barlett, WDFW August 6, 2003).

Rainbow Trout

Rainbow trout are the resident form of steelhead trout. Rainbow trout spawn and rear in tributaries and do not appear to utilize the Okanogan River to any significant degree. Rainbow trout are basically spring spawners. They spawn in smaller tributaries or inlet/outlet streams of lakes from March to August but mainly from mid-April to late June (Lindsey et al., 1959; Hartman, 1969). Eggs usually hatch in approximately four to seven weeks and with emergence from mid-June to mid-August. Fry of lake-resident spawners move to the lake environment almost immediately and the stream-resident spawners remain in the streams after emergence (Scott and Crossman, 1973).

Sockeye Salmon

Sockeye salmon exhibit three general historical life history strategies in the Okanogan River basin. This includes anadromous sockeye salmon, which spawn in fresh water and grow to adults in the ocean. A few of the anadromous sockeye salmon remain in fresh water to complete their life cycle for one or more generations (residual sockeye salmon). All generations of resident kokanee salmon (fresh water form of sockeye salmon) complete lifecycles in fresh water (Chapman et al., 1995b).

Washington Department of Fisheries reported that Okanogan sockeye salmon spawn in the Okanogan River in and upstream of Lake Osoyoos. They begin migrating up the Columbia River in late-June and peak in early July (WDF et al., 1993). Chapman et al. (1995b) reported sockeye salmon migrating later with a peak migration at Rock Island Dam (RM 453), on the Columbia River the third week in July. Migration may be impeded by as much as three weeks in some years by high water temperatures during mid-summer in the Okanogan River (Major and Mighell, 1966; Mullan, 1986; Swan et al., 1994; Alexander et al., 1998; and Chapman et al., 1995). Sockeye salmon congregate at the confluence of the Okanogan River and Columbia River when water temperatures exceed about 21^{o}C to 22^{o}C and only migrate up the Okanogan River when temperatures fall below this level (Major and Mighell, 1966; Allen and Meekin, 1980; Alexander et al., 1998; and Chapman et al., 1995b). Spawning occurs upstream of Lake Osoyoos in tributaries under high flow years but predominantly in the mainstem Okanogan River or in the lake. Spawning occurs during late September through October (Swan et al., 1994; WDF et al., 1993; and Chapman et al., 1995b). Fry emerge and migrate downstream to Lake Osoyoos, which has been ranked as one of the most productive of all sockeye salmon rearing lakes in the Columbia River Basin. Data from Chapman et al. (1995b) indicate that currently sockeye salmon smolts leave Lake Osoyoos in mid-to late May and migrate past Rock Island Dam in May (Peven, 1987).

According to WDFW and Western Washington Treaty Indian Tribes (1993), a healthy stock of sockeye salmon continues to use the Okanogan basin for spawning and rearing. The Okanogan Sockeye salmon are not listed under ESA, but the run strength of anadromous sockeye salmon in the Okanogan River is highly variable. Population is limited by reduced rearing habitat in the north basin of Lake Osoyoos. Spawning populations ranged from about 20,000 to 35,000 fish in 1993. The 1986-1995 average run size was 28,460 fish. Recent escapement has ranged from a low of 1,662 in 1994 to a high of 127,857 in 1966 as measured at Wells Dam (Hansen 1993).

Kokanee Salmon

Kokanee salmon are the freshwater form of sockeye salmon that rears most of its life in a standing water body and then moves up a tributary to spawn. Maturing adults stage in early August and migration occurs in early September with spawning activity in September and October. Fry emerge from January through May and move immediately to a lake environment (Scott and Crossman 1973, ENTRIX and Golder 2003, and Fisher pers. comm. 2003). Kokanee are not likely to use the Okanogan River in the area of the Project. They do inhabit the upper reaches of Salmon Creek. These fish inhabit Conconully Reservoir, spawning along its shorelines and tributaries, including the North and West forks of Salmon Creek.

Pacific Lamprey

The spawning run of returning adult Pacific lamprey enter freshwater from April to June and completes migration into streams in September. Adults overwinter in freshwater streams, then move upstream to headwaters to spawn from April to October of the following year (Scott and Crossman, 1973). Spawning habitat consists of gravel with a mix of pebble and sand in the tail areas of pools and riffles (Kan, 1975). After spawning, the adults die within 3 to 36 days. The larvae (called ammocoetes) burrow into the substrate and filter-feed on diatoms, detritus, and algae. They remain in the substrate for 5 to 7 years before metamorphosis into juveniles and migration to the ocean. This transformation occurs between July and October and the morphological and physiological changes allow the lamprey to survive in saltwater environments. After entering the ocean, the lampreys become parasitic to soft-scaled fish. It is estimated that Pacific lamprey remain in this environment for 20 to 40 months before returning to freshwater to spawn (Kan, 1975).

Historical distribution of Pacific lamprey in the Columbia River Basin followed that of salmon (Simpson and Wallace, 1978). Lamprey numbers have decreased significantly as the number of dams and the amount of development have increased within the Columbia River Basin; they are a federally listed species of concern. Little is know about the Pacific lamprey population in the Okanogan River or Salmon Creek, although lamprey likely do not use Salmon Creek due to passage constraints. Recently constructed Pacific lamprey redds (11) were observed in April 2003 in the Similkameen River, a major tributary of the Okanogan River, upstream of Salmon Creek near Oroville, WA. (Ward, 2003). Lamprey counts at Rocky Reach Dam on the Columbia River near Wenatchee, declined from 17,200 in 1969 to less than 200 in 1976 (Mullan et al., 1986).

Bull Trout

Bull trout have both anadromous and migratory resident populations. It is unlikely that the anadromous form is found in the Project area. The resident form of bull trout uses headwater areas that are typically in pristine environments. Spawning begins in late August, peaking in September and October. After spawning, adult bull trout overwinter in mainstem rivers and lakes. Newly-hatched fish emerge from the gravel the following spring and normally migrate to mainstem or lakes as two-year-olds. These fish may not mature until they are seven to eight year olds, and rarely reach sizes greater than 14 inches in length (WDFW, 2003).

The status of bull trout in the Okanogan watershed is unknown but they are believed to be extirpated downstream of Enloe Dam located at RM 8.8 on the Similkameen River and Zosel Dam at RM 78 on the Okanogan River (USFWS, 1998). Bull trout in the Columbia River basin were listed as endangered under the ESA in 1999. The Okanogan River is not suitable habitat for bull trout due to the requirement of cold, clean waters with clean gravel/cobble substrate for successful spawning and rearing (ENTRIX and Golder, 2003). Bull trout are documented to have used only Salmon Creek and Loup Loup Creek in the Okanogan Basin. Bull trout were reported in creel census records from the 1940s and 1950s in the north fork of Salmon Creek (K.

Williams, pers. comm. to Nancy Wells, ENTRIX Technical Assessment Group and Golder, 2003). They are not expected to be present in the Okanogan River in the Project area and are discussed below for Salmon Creek.

Westslope Cutthroat Trout

Adult cutthroat trout spawn in spring and early summer. Eggs usually hatch in six to seven weeks and alevins remain in the gravel for another one to two weeks. Emergence can take place through August, when some fry move into the lake environment. Cutthroat are a federally listed species of concern. The status of cutthroat trout in the Okanogan watershed is unknown. Cutthroat trout are not expected to use the Okanogan River in the area of the Project. Cutthroat trout may occur in Salmon Creek as described below and have been observed in the North Fork.

Habitat Conditions

Presently, habitat conditions in the mainstem of the Okanogan River are marginal for salmonids due to high water temperatures, poor quality spawning habitat, and poor water quality (Washington State Department of Ecology, 1996. In general, salmonids probably use the Okanogan River in the area for migration and some staging at the mouth of Salmon Creek. Spawning and rearing habitat for coldwater salmonids appears to be extremely limited, if not completely absent. However, salmonids that tend to spend limited time (short life history phases) in the mainstem Okanogan and Similkameen Rivers have had some success. This life strategy is particularly important to avoid extreme conditions in the summer when temperatures are the highest and flows are lowest. The more successful native species using the Okanogan River mainstem include summer chinook salmon (which hatch and emigrate early in the spring), steelhead, and mountain whitefish (Mullan et al., 1992). Warm water, low velocities and heavy sedimentation in the mainstem limit use by salmonids.

Okanogan River water temperatures often exceed lethal tolerance levels for salmonids in the mid- to late summer. These high temperatures are a result of natural conditions (low gradient and solar radiation on the upstream lakes), but are exacerbated by low summer flows caused by dam operations and irrigation. High water temperatures in late summer and fall form a thermal limitation or barrier that effectively excludes juvenile salmon from rearing in most of the basin, except during the first few weeks after emergence. High water temperatures in the lower Okanogan River also create a thermal barrier for anadromous salmonid passage, sockeye in particular. Sockeye salmon have been observed using the mouths of creeks as thermal refuges during return migrations along the reach of the Okanogan, near the confluence of Salmon Creek (Fisher per. comm., 2003). Water temperatures pose the most difficult problem for increasing the survival of most ocean-type and stream-type salmonids in the basin. Chapman et al. (1994a) plotted water temperature in the Okanogan River at Oroville and Tonasket, showing that mean midsummer daily temperatures were frequently well over 70°F in 1986 and 1987. Hansen (1993) plotted mean daily temperatures near Zosel Dam at 70°F or higher for at least 50 days in 1992, and higher than 77°F for periods of up to 10 days. Hansen (1993) speculated that the alteration of flow regimes by upstream structures have possibly changed retention times in Lake Osoyoos that exacerbate the problem. Adult passage through lower Okanogan River (downstream of Lake Osoyoos) may be blocked in certain years by a thermal barrier during late July and early August (Pratt et al., 1991).

Physical migration barriers, including the extraction of water from tributaries, are an important constraint to anadromous fish production in the Okanogan River watershed. Historical irrigation systems likely caused problems for migrating salmon. The main irrigation canals on the floodplains of Okanogan River were constructed parallel to the river channel and intercepted most tributary streams (Wissmar, et. al, 1994). Anadromous fish barriers on Omak Creek, Salmon Creek and the Similkameen River have restricted access to a considerable amount of tributary spawning and rearing habitat for the migrating fish in the basin. Recently, improvements in passage conditions have been evaluated for these tributaries and have actually been implemented on Omak Creek. A fish ladder has recently been constructed at the OID diversion dam on Salmon Creek.

Local conditions near the confluence of Salmon Creek do not differ greatly from the Okanogan River as a whole. The area of the Okanogan River from the mouth of Salmon Creek, upstream to the alternative pumping station locations is likely used exclusively for migration and some staging, especially in the warm summer months. Observations indicate sockeye salmon use the mouths of tributaries to the Okanogan River as thermal refuge during return migrations. Water temperatures throughout this localized reach create significant concerns to salmonid health.

3.5.1.3 Salmon Creek, Reservoirs and Tributaries

Fisheries Resources

Salmon Creek

Historically, the fisheries in the Salmon Creek watershed included anadromous chinook salmon, coho salmon, chum salmon, and steelhead (Mullen et al., 1994; cited in Fisher et al., 1997). Resident species included rainbow trout, westslope cutthroat trout, and bull trout (Mongillo, 1993). Both steelhead trout and spring chinook salmon runs utilized a large part of the Salmon Creek watershed, including both the west and south forks of Salmon Creek. Salmon Creek provided a large portion of the good spawning habitat for steelhead trout and spring chinook salmon in the entire Okanogan basin (USFWS, 1949). Prior to diversions for irrigation, Salmon Creek had a significant fishery, with runs of considerable size, and provided important subsistence, cultural, and economic value to native peoples, especially the nearby Okanogan Indian Tribe. Early European settlers also harvested fish for consumption. It is reported that anadromous fish ascended to the upper basin streams as late as 1908, when a fish ladder was built at the BOR diversion weir. Shortly after that (1910), Conconully Dam was completed and, in most seasons, any water not delivered to irrigation was used to fill the reservoir. This resulted in the lower reach being completely dry for extended periods of time and largely resulted in the extirpation of anadromous fish from Salmon Creek (USFWS, 1949).

Presently, fish stocks found within Salmon Creek are primarily resident rainbow trout and brook trout. The lack of streamflow below the diversion dam (lower reach) during spring and summer has precluded fish from inhabiting this lower area and has largely prevented migration of adult anadromous fish into Salmon Creek from the Okanogan River. The lower reach has been dewatered, to some degree, since the irrigation diversion began extracting water over 90 years ago (1910). During high water events, there is sufficient water available for adult fish migration. It has been hypothesized that, during these infrequent flood events that typically occur during the spring and correspond to migration times, steelhead trout and possibly chinook salmon could utilize this reach as a migration corridor. Some kokanee salmon are present in this reach from fish that have spilled over the reservoir during flood events. Steelhead trout and chinook salmon can use the middle and upper reaches of Salmon Creek if access is provided (Mullin et. al., 1994; cited in Fisher et al., 1997). In an effort to restore steelhead populations, the Washington Department of Fish and Wildlife has implemented a stocking program in coordination with the Colville Confederated Tribes. Approximately 10,000 to 15,000 steelhead smolts are stocked downstream of the OID diversion dam and water is leased from the OID to provide flows to flush the smolts to the Okanogan River (Fisher et al. 1997, C. Fisher, pers. comm., 2003).

Although spring chinook salmon and steelhead trout do not currently complete their life cycles in Salmon Creek, examination of existing literature reviews and personal communications with biologists familiar with Salmon Creek and nearby populations provide an estimate of likely timing for important life stages of these anadromous fish (Fisher, pers. comm. 2003; ENTRIX and Golder, 2003; Dames and Moore, 1999; Fisher et al., 1997). For steelhead trout, upstream migration and spawning takes place beginning the latter part of March and can continue through the end of May. Eggs incubate from April through July, with outmigration for smolts occurring April through late May the following year. For example, if an adult spawns in spring of 2003, the smolts produced would typically outmigrate in spring of 2005. Spring chinook migrate upstream and spawn from May through August, with incubation of eggs continuing through February. Smolts outmigrate in April through May the following year. Spring chinook migrate upstream and spawn from May through August, with incubation of eggs continuing through February. Smolts outmigrate in April through May.

Reservoirs and Tributaries

Currently, fish species that are known to use the reservoirs and upper tributaries of Salmon Creek include rainbow trout, kokanee salmon, largemouth bass, eastern brook trout, goldfish, and west slope cutthroat trout. Bull trout, a federally listed species (**Table 3-20**), may also occur. All of these species have naturally reproducing populations, although rainbow trout are supplemented by hatchery stocks in the reservoirs. The upper watershed does continue to support a local fishery. Kokanee salmon, resident rainbow trout, and eastern brook trout naturally reproduce in or upstream of the reservoirs. These fish spawn in the north and west folks of Salmon Creek, which enter the reservoirs, or along the reservoir shorelines.

Both Salmon Lake and Conconully Reservoir are managed as hatchery production rainbow trout fisheries (Fisher et al., 1997). The reservoirs are stocked with about 75,000 fry (90 fish per pound) and 25,000 fingerling (15 fish per pound). However, low lake levels in recent years have required an additional stocking of 10,000 catchable-sized trout (2.5 fish per pound). This stocking is needed to offset the lower productivity in the reservoirs due to a decreased water volume. Fishing pressure has been estimated at 60,000 angler days on Salmon Lake and approximately 35,000 angler days for Conconully Reservoir (letter from Barlett, WDFW, June 27, 2002).

Kokanee salmon have been established as a self-sustaining population in the reservoirs since 1990. Spawning appears to occur on beaches within the reservoir (letter from Barlett, WDFW, June 27, 2002) and likely includes the mouths of the upper tributaries. During the fall, kokanee salmon would use the diversion channel between Conconully Reservoir and Salmon Lake as a migration/spawning corridor. This channel is often dewatered in the fall, limiting both fish migrations and available spawning habitat (Fisher et al., 1997). In the recent past when the channel has been dry, the Washington Department of Fish and Wildlife has collected kokanee to artificially spawn and rear fry in a hatchery. These fry are subsequently used to augment natural reproduction within the watershed (Ken Williams, WDFW, per. comm. as cited in Fisher et al., 1997).

Largemouth bass were introduced to the reservoirs around 1990 (Ken Williams, WDFW, pers. comm. as cited in Fisher et al., 1997). Goldfish, which can weigh several pounds each, were introduced into Salmon Lake, and may now occur in Conconully Reservoir. Currently, there is a sustainable population of largemouth bass in both Salmon Lake and Conconully Reservoir. The more frequent and severe water fluctuations in Conconully Reservoir during spawning and incubation periods decrease bass production compared to Salmon Lake (Fisher et al. 1997). In Salmon Lake, the rocky shoreline and fluctuating water levels have mitigated impacts from these introduced species. In general, the largemouth bass in Conconully Reservoir have impacted the resident trout through competition and predation (letter from Barlett, WDFW, June 27, 2002).

Bull trout may still be present in the Salmon Creek drainage and they are a federally listed endangered species (**Table 3-20**). Historical records indicate bull trout were present in the North Fork Salmon Creek (Chelan PUD, 1998), although interbreeding with eastern brook trout (*Salvelinus fontinalis*), which were first introduced in 1951, may have eliminated this species from the watershed (Fisher et al., 1997). If bull trout are in the Salmon Creek watershed, they would be in the upper watershed, upstream of and potentially using Conconully Reservoir (Fisher et al., 1997). Like bull trout, westslope cutthroat trout distribution and abundance is not known. However, westslope cutthroat were collected during sampling in the North Fork Salmon Creek in 1996 (C. Fisher pers. comm. 2003).

Habitat Conditions

Lower Reach of Salmon Creek

The portion of Salmon Creek extending from the Okanogan Irrigation District's (OID) diversion dam to the confluence with the Okanogan River is approximately 4.3 miles in length. Geomorphic and hydrologic conditions within this reach are currently inadequate for fish passage, spawning or rearing. The lower reach of Salmon Creek has been dewatered under normal irrigation operation, except during spring runoff events that result in uncontrolled spill at the reservoirs and diversion dam.

Historical land uses on uplands, combined with yearly dewatering of the channel, have altered vegetation and sediment production. These changes have created a direct and permanent manipulation of the stream channel, stream banks, and riparian vegetation. The result is an adverse affect on the channel geometry and permeability, streambank stability, and riparian area, which has greatly decreased the habitat quality of lower Salmon Creek. In general, the channel cannot maintain surface water flow due to the course bed materials and subsequent lowering of the water table. Riparian vegetation that would help maintain stability and provide shade to the stream has been eliminated in large areas. The stream channel and banks have therefore become unstable, resulting in further deterioration of the stream during flood events. In addition, at the mouth of Salmon Creek, a large delta has formed from the transport of large sediment in the lower reach. The delta extends into the Okanogan River and is approximately 8 feet higher than the base water level of the Okanogan River. Even when flows exist, this alluvial fan impedes fish passage.

Middle Reach of Salmon Creek

The middle reach is approximately 11 miles in length and extends from the OID diversion dam (RM 4.3) to Conconully Dam (RM 15.3). NRCS (1999) conducted the most extensive survey of stream morphology and associated habitat conditions. Related studies generally support the results of the NRCS surveys (Fisher and Fedderson 1998, Hansen 1995, USFS 1997). Construction and operation of Conconully Reservoir has altered the shape of the natural hydrograph in this reach but NRCS found that the nature and magnitude of these alterations are not likely detrimental to salmonid use in this reach. Both Conconully Reservoir and Salmon Lake are operated as irrigation storage reservoirs. While in most years storage occurs during the anticipated period of peak runoff, the reservoirs fill and spill during normal and above normal snowpack years.

In general, riparian vegetation and floodplain function varies from good to poor depending upon location within the reach. Within the four miles below Conconully Dam, the stream corridor is narrow and steep and largely inaccessible. This section of the middle reach does not support extensive agriculture or grazing in the stream corridor and the general condition of the riparian vegetation and floodplain function is quite good. Between the former town of Ruby (RM 10.3) and the OID diversion dam, a distance of approximately six miles, the stream corridor is extensively used for livestock pasture, or hay, wheat, and barley fields. In some locations the stream appears to have been moved from its natural watercourse. The general condition of the riparian vegetation and degree of floodplain development has a negative effect on streambank stability, sediment and nutrient loading. The general condition of riparian vegetation is poor in some areas and likely has some negative influence on stream temperature, allochthonous input (i.e., leaves), benthic production and cover. However, observation of this reach suggests that more than half of this 11-mile stream reach has good riparian shade and good potential for allochthonous input (ENTRIX and Golder, 2003).

Reservoirs and Upper Tributaries (North, South and West Forks of Salmon Creek)

The Upper Salmon Creek watershed consists of the north fork, west fork, and south fork and drains the approximate 119-square-mile upper Salmon Creek watershed. The South Fork Salmon Creek flows into the West Fork about one mile southwest of Conconully at RM 1.3 of the West Fork. The West Fork and North Fork both flow into Conconully Reservoir. Water is diverted from the North Fork through a feeder canal that flows into Salmon Lake. Conconully Reservoir has 450 surface acres with a maximum depth of 50 feet. Salmon Lake has a maximum depth of 110 feet and 313 surface acres. Conconully Reservoir is subject to greater variations because of irrigation operations and limitations imposed by the current condition of the North Fork Feeder Canal to Salmon Lake (restricting the flexibility of water delivery from Salmon Lake to Conconully Reservoir).

Fish habitat within the upper watershed has been altered by past management activities, including dredge and placer mining, timber harvest, livestock grazing, and road construction. Stream surveys have concluded that a lack of large woody debris (LWD), with a subsequent deficiency in the number of pools, and embedded substrate exists in the South Fork. Stream surveys suggest that past logging along riparian corridors is the basis for this lack of LWD. In addition, past mining in the North Fork has resulted in the streambed being dominated by large-size substrate, which leads to marginal spawning habitat for small salmonids (Fisher et al., 1997).

The North Fork feeder canal transports water from about RM 0.5 on the North Fork to Salmon Lake. During field reconnaissance in April 2003, it was estimated that about 7 cfs was being diverted from a total flow of about 16 cfs above the diversion (approximately 40 percent of the total flow). The canal is approximately 0.7 miles in length and is constructed of concrete. Most of the bottom of the canal is exposed concrete with few areas of sandy to small gravel substrate. The upper portion (less than 50 feet) of the North Fork feeder canal may provide some minimal habitat for salmonid rearing, although field surveys (April 2003) indicate that the substrate appears to be too small for spawning and no evidence of reproductive behavior was observed (neither redds nor fish).

3.5.2 FISHERIES IMPACTS

Impacts are analyzed for operation and construction of the action alternatives. Impacts are described for the Okanogan River, and the lower reach, middle reach, and upper reach (including reservoirs and North Fork feeder canal) of Salmon Creek. Impact analysis relies on the water quantity (**Section 3.1**) and water quality (**Section 3.2**) analyses. This section addresses stream flow impacts on fish habitat and related production, focusing on the reaches of Salmon Creek. The stream reaches were modeled to simulate streamflows and reservoir levels using the water models described in Section 3.1 and **Appendix C.** **Appendix D** provides the model output and a statistical analysis of the output and summary graphs of the model output.

As described in **Section 3.1**, the No Action Alternative is very similar to existing and historical conditions, in respect to hydrology, especially on a watershed-scale. Therefore, the No Action alternative uses historical stream flow averages. Streamflow life stage requirements for anadromous fish were used to develop simulated streamflows for the Action and No Action Alternatives.

To estimate impacts of fish habitat and potential production related to water supply alternatives, the instream flow scenarios were overlaid on the species and life stage requirements described above (**Section 3.5.1**). For the middle and lower reaches of Salmon Creek, minimum flow requirements were estimated that would provide adequate protection of the species and life stages in each season. To distinguish these from legal minimum flows (which are not established for Salmon Creek), these are termed "minimum flows for fish" in this section. These estimates of minimum flows for fish are not considered optimum, but would likely maintain anadromous life stages in Salmon Creek and protect populations over generations. Flows below the estimated minimum flows for fish could affect survival. **Table 3-21** provides a summary of steelhead trout and chinook salmon use in Salmon Creek by lifestage and the estimated minimum flows for fish by reach for protection. The time period of use by the steelhead and chinook salmon life stages are shown as gray bars across the months of the year. Corresponding to each species life stages is the estimated monthly minimum flows for fish for each reach in Salmon Creek, and for Lower

Salmon Creek rehabilitation. Impacts were determined by comparing these survival requirements to the amount of water delivered to each reach, as simulated in the streamflow model for each alternative (where applicable).

Extensive work has been done to estimate the potential for salmonid returns to the Okanogan River system as a result of the proposed restoration of this portion of Salmon Creek. **Appendix H** contains a letter from CCT responding to a review of the project by the NWPPC Independent Science Review Panel (CCT, April, 2002). The letter documents production estimates ranging from 6 to 804 steelhead and approximately 121 to 184 chinook.

Changes in reservoir levels (Conconully Reservoir and Salmon Lake) also could affect fish. Reservoir levels also were modeled (see **Section 3.1** and its associated appendices). The timing and magnitude of changes in reservoir levels provide a basis for estimating impacts to the impoundments and feeder streams.

Minimum flow requirements are established for the Okanogan River by the Washington Department of Ecology by rule for protection of aquatic resources. Placed into the Washington Administrative Code (WAC), these regulatory minimum flows represent a "water right for the river" and constrain only junior water rights (those water rights granted later in time than the date the regulatory minimum instream flows were established); they do not affect senior water rights existing at the time minimum flows were promulgated. Regulatory minimum flows are intended to "provide for preservation of wildlife, fish, scenic, aesthetic and other environmental values, and navigational values" (RCW 90.54.020). Changes in the number of of the WAC minimum flow level (flow levels lower than required) as compared to the historical record are used to estimate the impact.

In conjunction with stream rehabilitation and water supply, steelhead trout and chinook salmon could be reintroduced in the future. Natural run pacific lamprey may also utilize spawning and rearing habitat in Salmon Creek following rehabilitation and/or improved flows. Because these are ESA-listed species, their return to the creek with improved flows or access could conflict with some present and future land and water use practices.

The broodstock selected for chinook salmon would likely be "early returning" spring type. It is thus expected that the progeny would also be "early returning." Return migration and spawning could be timed to avoid the potential thermal barrier to fish passage that develops in the warmer summer months (CCT, March 2002). A likely candidate, at least initially, for stocking is the Carson stock spring chinook salmon. This stock has been approved in both Omak Creek and the Okanogan River and is currently being used in both systems (CCT, March 2002). This stock is not federally protected, making stocking, handling, and management less complicated. The source and use of this spring Chinook salmon stock and the development of a monitoring and evaluation plan may be developed based on the outcomes of the NEPA process (CCT, March 2002). Steelhead trout that are presently used for planting in Salmon Creek are a listed stock. The use of listed steelhead trout may change in the future, but no decision has been made. Any final decision would be contingent upon consultation with, and approval by, NOAA Fisheries. The potential for use of early returning broodstock is described in **Appendix H**, as part of the CCT response to the NWPCC Independent Science Review Panel review.

Table 3-21. Estimated fish use and minimum instream flows by month for species life stage requirements, by stream reach and stream rehabilitation alternative for Salmon Creek.

Species and Life Stage[3]	Stream Reach and Alternative	Month Monthly minimum flow value or range in cubic feet per second[3](acre-feet/month)) Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Summer Steelhead	Middle reach[1]	4(246)	4(222)	4(246)	15(891)	15(921)	15(891)	10(614)	10(614)	10(594)	4(246)	4(238)	4(246)
	Lower reach – with stream rehabilitation[2]			15(356)	15(891)	5-25 (812)							
	Lower reach – without stream rehabilitation[2]			15-25 (495)	20-25 (1,337)	5-25 (812)							
Rearing/Overwintering		1/1-3/31									10/1-12/31		
Spawning/Migration					3/20-5/14								
Incubation					4/1-9/31								
Adult Outmigration					4/1-5/25								
Smolt Outmigration					4/1-5/25								
Rearing[4]								7/1-9/1					
Spring Chinook	Middle reach[1]	7(430)	7(388)	7(430)	7(416)	20 (1,228)	20 (1,188)	20 (1,228)	20 (1,228)	7(416)	7(430)	7(416)	7(430)
	Lower reach – with stream rehabilitation[2]					20 (1,228)	20 (1,188)	20(594)					
Rearing/Overwintering		1/1-4/30											
Spawning/Migration						5/1-8/31							
Incubation		1/1-2/28				5/1-12/31							
Smolt Outmigration					4/1-5/31								
Rearing/Overwintering							6/1-12/31						
Chinook and Steelhead	Middle reach[1]	7(430)	7(388)	7(430)	15(891)	20 (1,228)	20 (1,188)	20 (1,228)	20 (1,228)	10(594)	7(430)	7(416)	7(430)
	Lower reach – with stream rehabilitation[2]			15(356)	15(891)	20-25 (1,287)	20 (1,188)	20(594)					

1. -Minimum flow requirements change on 1st of each month.
   -Middle reach recommended instream flows are independent of stream rehabilitation in the lower reach.
2. -Minimum flow requirements change on various dates within month, as some life stages require additional flows for only part of the month (see Appendix 3.1-F for details).
3. -Estimated from existing literature and personal communication with biologists familiar with Salmon Creek and nearby systems (Dames and Moore 1999, ENTRIX, Inc. and Golder 2003, C. Fisher personal comm. 2003).
   -Dark bars show the time period of important use by a species and life stage.
4. -Although rearing takes place all year, the period shown here is related to additional water needs for rearing during this time period.

3.5.2.1 Alternative 1: Okanogan River Pump Station

Okanogan River

Construction

Construction of Alternative 1 would have minor impacts on the Okanogan River bottom at the location where the pump would be located. The sand bar and deep hole in this location are not expected to change in any important ways. Using preventive measures, and perhaps some maintenance, little to no stream meander, erosion, or sedimentation is expected to occur. To prevent erosion near the intake pipes, mat gabions would be placed in a part of the river channel with a relatively stable bottom. Pilings driven into the streambed in front of the screens would prevent damage from floating debris. As debris accumulates on the pilings, flow can be redirected toward the bank. Periodic removal of debris would be required to prevent erosion. Placement of the gabions and pilings would disturb and eliminate the aquatic habitat in the footprint of these structures. It could also provide additional habitat for warm water predators of out-migrating salmon. To minimize or avoid potential erosion and sedimentation resulting from the pump station construction, it would be located away from the riverbank and above the elevation of the 100-year floodplain. Additionally, the bank would be protected from erosion using methods such as boulder and timber armoring or rock gabions (URS, 2002). Pipeline construction would utilize Best Management Practices (BMPs) to minimize erosion and to control runoff. The pipeline would not cross any streams or other surface water bodies influent to the Okanogan River.

Construction activities associated with this alternative would have some negative impacts on fish by causing short-term and localized sedimentation and erosion. BMPs would be used to minimize these impacts.

Screens for the intake pipes would be activated wedge-wire drums, selected using NOAA Fisheries screen criteria for protection of anadromous fish. This screen type was the preferred alternative considered because of its reliability, low maintenance costs, low initial capital costs, and its proven effectiveness in screening adult and juvenile anadromous fish without harm (URS, 2002). The possible negative impacts to fish are potential entrainment or impingement, although these impacts are expected to be minimal, assuming the fish screens are properly maintained.

Operation

Alternative 1 could decrease flows in the Okanogan River by up to 55 cfs. The percentage of Okanogan River flows that would be pumped under Alternative 1 increases for all fish flow regimes over all water year types (**Section 3.1**). However the increased percentage pumped would not be of a magnitude or at a time that would adversely affect streamflow in the Okanogan River in wet, above normal, normal or below normal water years. In these years there would be no change in the frequency with which in stream flows fall below of WAC regulatory minimums as compared to the No Action Alternative (**Section 3.1**). During dry water years pumping from the Okanogan River would slightly increase the frequency with which flows fall below WAC minimums (by approximately three more days of WAC exceedence per year). As with

Alternative 2, impacts to fish would be minor, given the relatively small percentage of the total flow in the Okanogan withdrawn.

Water flow in the river downstream from its confluence with Salmon Creek would be supplemented with cooler, higher quality water flowing from Salmon Creek. The Salmon Creek water would reduce local water temperatures and improve localized water quality in the river. Salmon Creek inflow to the river would increase under this Alternative for all water year types (**Section 3.1**). The increase represents a doubling or tripling of Salmon Creek inflow to the Okanogan in wet and normal water years. For below normal and dry water years the increase is four to five times that of the No Action Alternative. This would have a beneficial impact for salmonid fisheries in the Okanogan River downstream of the confluence with Salmon Creek. This direct and positive impact would create a small thermal refuge, with increased benefits provided during dry water years when conditions in the Okanogan are more severe.

The potential thermal benefit was investigated in some detail in 2000 by the Colville Tribe (CCT, 2002):

> *The proposed pump station, at least conceptually, is intended to deliver "warm" water from the Okanogan River to orchards and farmland within the irrigation district while allowing "cool" water (peak-66.3^{o}F [2000], CCT, unpublished data) historically diverted from Salmon Creek to flow downstream. In addition, this would also address Washington Department of Ecology's (WDOE's) 303d listing of inadequate flows in lower Salmon Creek. The cool water, which has been diverted historically for irrigation, would flow through the lowermost 4.3-mile reach of Salmon Creek to the Okanogan River, providing benefit to both adult and juvenile salmonids. In addition, this "cool" water discharge from Salmon Creek would likely create a thermal refuge in the Okanogan River, and likely be utilized by migrating sockeye salmon. Based upon radio-telemetry tagging studies conducted by Douglas County PUD, sockeye have held in cool water refugia created by tributaries, such as Aneas Creek (~ 4 cfs, 64 ^{o}F, CCT, unpublished data), during migration through the Okanogan River. The thermal refugia may also be used by juvenile salmonids. For instance, Belchik (1997) reported extensive use of thermal refugia at tributary mouths in the Klamath River.*

Negative impacts of water flowing from Salmon Creek into the Okanogan may occur. When water is flowing through lower Salmon Creek, more frequent sedimentation could lead to continued short-term increases in TSS and suspended solid concentrations in the Okanogan River at, and downstream of, the confluence with the creek. These potential impacts are expected to have minor impacts, if any, on fish in the Okanogan River because they would be short-term and localized at the confluence with the creek, and therefore avoidable for fish in the Okanogan.

A thermal barrier potentially could exist between the pump station and the mouth of Salmon Creek. The barrier could delay or impede migrating salmonids (i.e. Sockeye, Summer Chinook), particularly during low flow conditions.

Lower Salmon Creek

Alternative 1 would reestablish seasonal fish migration flows in lower Salmon Creek that do not occur under the historic irrigation operations and that would not be provided under the No Action Alternative. This alternative would reestablish winter base flow in the lower reach (proportionally greater in the upstream section that was dewatered under the historic irrigation operations and would continue to be dewatered under the No Action Alternative. The median monthly streamflow on lower Salmon Creek below the weir (upstream area) under this action alternative would increase for all months, except July and August in normal or drier years. This Alternative also reestablishes seasonal fish migration flows in lower Salmon Creek (at the mouth) that do not occur under historic irrigation operations.

Alternative 1 is best represented in **Table 3-22** by the *steelhead trout without channel rehabilitation* option. The option of partial rehabilitation, such as removal of the gravel bar, was not modeled. In the table, the greatest difference between estimated minimum flow needs for fish and simulated flow delivery would be during April. The deficit in April would be about five cfs, which could be important but is likely an artifact of the way in which the water model handles flows during this month. When compared to minimum flow estimates, the difference between simulated flow in dry versus normal years would be relatively minor. It appears that this alternative could provide flow volumes close to the minimum flow estimates for all options during dry years, indicating a potential stability in habitat during all water year types.

Increased water supply without stream rehabilitation could result in minimal increased stream bank erosion and overall habitat degradation below the OID diversion. The removal of the bar at the mouth of Salmon Creek and increased flows associated with this alternative would provide improved passage for steelhead trout to the middle reach of Salmon Creek, where spawning gravels and overall better habitat conditions would permit successful spawning and juvenile survival of some fish. However, the poor condition of the lower reaches of Salmon Creek may remain inadequate for spring chinook passage and survival. Chinook salmon would likely remain extirpated from Salmon Creek. Only with channel rehabilitation efforts in lower Salmon Creek, in combination with passage flows, would conditions be adequate for chinook salmon survival.

Without stream channel rehabilitation, steelhead survivability through generations would be uncertain. April is the most important month for steelhead trout adult migration, yet this month could have the greatest deficit of water (again, this appears to be an artifact of modeling). It is important to note that during dry years, the water delivered would be similar to an average year in terms of meeting minimum flow needs estimated for steelhead trout. This consistent amount of water, even during low flow years, would increase the potential for long term sustainable populations of steelhead trout.

Overall, this alternative would have long-term beneficial impacts to Salmon Creek fish populations. Direct benefits include water volumes sufficient to provide passage for anadromous fish. Without full channel rehabilitation, steelhead would still benefit from increased flows, and careful water management (i.e., in the amount and timing of water needed for different species/life stage flow needs – see Resource Management Plan) could increase the possibility of a sustainable population over generations. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT 1997, ESA 1997, UCSRB 2003).

Table 3-22. Build new 80 cfs pumping station. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate when minimum flows for fish would not be met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]												
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	4	4	6	14	15	15	8	7	10	4	4	4
	50%	8	10	8	15	86	92	26	10	10	4	9	9
	10%	14	15	16	85	285	234	73	28	18	17	20	15
Steelhead/chinook with channel rehabilitation	90%	7	7	7	15	21	19	18	18	8	7	7	7
	50%	7	9	7	15	75	92	27	19	9	7	7	7
	10%	15	16	13	72	285	234	73	28	17	16	20	15
Steelhead without channel rehabilitation	90%	4	4	8	22	15	15	4	8	10	4	4	4
	50%	8	10	9	23	81	91	26	11	10	4	9	9
	10%	14	15	16	84	285	234	73	28	18	17	20	15
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				6	15	5-25 (13)							
Steelhead/chinook with channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				6	15	20-25 (21)	20	10					
Steelhead without channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				15-25 (8)	20-25 (23)	5-25 (13)							
Lower Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	3	3	5	12	12	12	2	1	8	3	3	3
	50%	7	8	6	12	43	40	8	6	8	3	7	7
	10%	11	12	13	63	202	150	17	8	8	9	15	12
Steelhead/chinook with channel rehabilitation	90%	6	6	5	12	17	16	8	0	1	6	5	5
	50%	6	7	5	12	33	40	8	3	5	6	5	5
	10%	12	13	10	53	202	150	18	8	8	8	15	12
Steelhead without channel rehabilitation	90%	3	3	6	18	12	12	0	0	8	3	3	3
	50%	7	8	7	18	39	40	4	2	8	3	7	7
	10%	11	12	13	63	202	150	18	8	8	9	15	12

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Middle Salmon Creek

Alternative 1 would reduce the unnaturally high summer flows that occurred in the middle reach under historic irrigation operations. This action alternative would reestablish winter base flows that are not provided under historic irrigation operations. The median monthly streamflow in the middle reach of Salmon Creek under Alternative 1 would decrease in July through September, but would increase for the months from November through May (**Appendix D-5**). Middle reach streamflows would decrease by about 25 cfs in July, August, and September, when Okanogan River pumping replaces the need to convey Salmon Creek water through the middle reach, which would be more typical of summer flows experienced by fish. Winter base flows for fish survival would increase the median from nearly zero to 5 to 10 cfs in the months of November through

March. Variability in streamflow magnitudes between the three passage flow regimes should be most evident in April, May, and August, but would be similar for all other months. The median streamflow in April increases from about zero to 15 to 25 cfs, would increase in May by 30 to 40 cfs, and would decrease in August by 30 to 40 cfs, depending on which fish passage flow regime is applied.

Table 3-22 illustrates that Alternative 1 would meet minimum flow estimates for nearly all species and rehabilitation options except for the 90 percent exceedence level in the middle reach. The deficits are only 1-2 cfs in June through September for chinook and steelhead trout combined, 1-3 cfs in April, July and August for steelhead with channel rehabilitation, and up to 6 cfs in July and August for steelhead without rehabilitation. At the 50 percent exceedence level, there is a one cfs deficit during August and September for the steelhead trout/chinook salmon combination. This time period mostly affects incubation and rearing for both species and the end of the chinook salmon migration. The effects of this small deficit could be limited with refined water management (ie. amount and timing of water needed for different species/life stage flow needs – see Resource Management Plan, 3.5.3.3).

This alternative would provide long-term benefits to both species and under all options in the middle reach. Direct benefits include water volumes sufficient to provide anadromous passage for adults and smolts, spawning, incubation of eggs, emergence, rearing, and overwintering habitat. Resident fish (rainbow trout and brook trout) would also benefit through increased habitat availability and suitability, although competition with anadromous fish would occur. Indirect benefits to aquatic habitat would result from flow stabilization. The provision of anadromous fish access to and enhancement of productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

Upper Salmon Creek

No changes to the upper reaches of Salmon Creek streamflow would occur under this action alternative. The unregulated inflow is assumed to remain the same for the tributaries entering the Project reservoirs.

This action alternative would keep the median lake elevation higher and would reduce the seasonal fluctuation of Salmon Lake that occurs under irrigation operations. A large volume of water would consistently be available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The minimum monthly Conconully Reservoir water surface elevation under Alternative 3 would increase from August through March and would decrease in May and June for the steelhead flow regimes and decreased in all months for the steelhead and chinook flow regime (**Appendix D**).

Non-native fish populations (such as largemouth bass) may increase due to stabilized and increased water levels in the project reservoirs and may decrease resident salmonids i.e. kokanee and rainbow trout. Lower water temperatures (especially during the summer months), increased habitat availability, and the increase in inlet stream areas would be likely to increase native fish survivability and productivity. Resident species, including kokanee salmon and rainbow trout would likely benefit, though increased predation may lead to no net change in the rainbow population. Long-term beneficial impacts would likely occur to reservoir resident fisheries and additional opportunities would likely be provided through changes in fisheries management. An indirect benefit may be the opportunity to change management strategies in the upper reach given more stability and flexibility in reservoir operations.

3.5.2.2 Alternative 1: Feeder Canal Upgrade

Okanogan River

This component would have minor impacts on the Okanogan River. It would increase flexibility of water management and perhaps decrease the amount of water pumped from the Okanogan River.

Lower and Middle Salmon Creek

This component would have minor beneficial impacts on fish in the middle or lower reaches of Salmon Creek. It would permit greater control of water levels in Salmon Lake and, therefore, better regulation of water releases into the Conconully Reservoir via a diversion channel. Better control of storage in the reservoirs (and thus better regulation of water available for irrigation and for release into Salmon Creek), would enhance this alternative by providing more water and better results for the current stocking of steelhead trout on the middle reach. It might also provide more water during upstream (adult steelhead trout) and downstream (adult and smolt steelhead trout) migration. More flexibility in water supply operation could have indirect and beneficial impacts to both resident and anadromous fish in the middle reach of Salmon Creek by providing water during important migration periods.

There would be no adverse impacts to fish associated with rehabilitation of the feeder canal since it would be dewatered during construction. Impacts would be limited to those associated with any instream modifications to the headworks.

Upper Salmon Creek

Construction Impacts

Some localized fish impacts may result from construction during feeder canal upgrade activities. Impacts would occur at and immediately downstream of the headworks, in the canal itself and in the immediate vicinity of the outflow of North Fork Salmon Creek into Conconully Reservoir. Short-term adverse impacts may include loading of suspended sediment and solids. Long-term effects may include the degradation of habitat at the present canal entrance in the North Fork of Salmon Creek. The field reconnaissance survey indicated that this habitat is not of high quality and would mostly be limited to a small area that could be used by rearing resident fish. A new pipeline replacing the canal would directly eliminate the area of habitat within the footprint of the new structure. In the section near Salmon Lake where the pipeline leaves the current alignment, there would be minimal to no impact because the present canal does not provide important aquatic habitat. Short-term water quality impacts could be minimized through implementation of construction BMPs and timing of construction activities.

Operation Impacts

Operation of the upgraded feeder canal could decrease streamflow for approximately 0.5 mile of North Fork Salmon Creek between Conconully Reservoir and the OID feeder canal intake. No operational schedule for the feeder canal has been established. Operation of the upgraded feeder canal diversion would likely be focused on moderate to high runoff events in North Fork Salmon Creek, primarily in May and June of normal, above normal and wet years. However, operation of the feeder canal pipeline may occur in other months, and in other water year types. If operated at maximum capacity, the pipeline could decrease peak streamflow in this short reach by as much as 60 cfs during moderate to high runoff events compared to existing and historical operations. The upgraded feeder canal would decrease streamflow in this reach of North Fork Salmon Creek to the legal minimum flow (1.33 cfs) more frequently than under the existing and historical operations. This would likely occur during moderate to low flows such as those observed during field reconnaissance in April 2003 when flows were estimated below 20 cfs. Impacts to fisheries would include reduction in instream habitat in this short reach during the diversion period. The greatest impact would likely be at the mouths of the inlet stream used for migration and spawning. The decreased flow would likely affect both spring (rainbow trout) and fall (kokanee salmon) spawners. This would probably not be important considering the current conditions of low flow in the relatively small area impacted (in relation to the North Fork Salmon Creek in total). Timing of low flows would be the same as current conditions, but the overall flow would likely be lower.

Upgrading the canal would permit greater water supply to, and therefore greater storage in, Salmon Lake. It would allow increased flexibility in water management of Salmon Lake and Conconully Reservoir. Salmon Lake and Conconully Reservoir are stocked to provide rainbow trout fisheries. Low water levels in recent years have required increased stocking to offset the low productivity resulting from lower reservoir levels. Greater control over water flow into Salmon Lake via the feeder canal could permit greater management of water levels and, thus, management of available fish habitat. This alternative would maintain water levels at a greater elevation and maintain them for a longer period without as much fluctuation when compared to present conditions. Somewhat lower water temperatures would likely result, and more fish habitat would be present for salmonids. This would likely decrease habitat for warm water species as compared to present conditions. Because largemouth bass spawn on reservoir and lake margins, reduced water level fluctuations are likely to increase their reproductive success. Cooler water could decrease algae and other aquatic plant growth and would likely increase in dissolved oxygen.

Desirable resident fish likely to experience greater survivability and productivity include kokanee salmon and rainbow trout. However, improved largemouth bass reproductive success may lead to increased predation on goldfish, kokanee, and rainbow trout, all of which use similar habitat. With greater habitat availability, kokanee and rainbow trout populations are not expected to be reduced by the potentially increased predation, and may even increase in biomass. If more fish are produced through natural spawning and survival, rainbow trout fry and fingerling stocking requirements may decrease, and stocking of catchable-sized fish during extreme low reservoir years may be eliminated. Over time, as stocking decreases and rainbow trout become self-sustaining (as kokanee salmon currently are), genetic variation and therefore fish survivability would increase. Better regulation of water flowing through the diversion channel between Conconully Reservoir and Salmon Lake may also limit ongoing habitat dewatering during the fall, creating a direct positive impact for resident fisheries.

North, West and South Forks of Salmon Creek

Kokanee and resident rainbow trout naturally reproduce in the reservoirs, spawning in the North and West Forks of Salmon Creek. Limited spawning may occur in the upper portion of the existing feeder canal, though no records of this occurrence were found. Channeling all the diverted water into a pipe would eliminate any spawning in the feeder canal. Decreased flows below the diversion in North Fork Salmon Creek could also impact spawning in the North Fork.

3.5.2.3 Alternative 1: Stream Rehabilitation

The focus of stream channel rehabilitation in this alternative is removal of the alluvial fan at the mouth of Salmon Creek in order to provide for anadromous fish migration.

Okanogan River

Construction-related sedimentation would lead to a short-term increase in TSS and suspended concentrations in the Okanogan River near the mouth of Salmon Creek and immediately downstream. The removal of the large substrate bar at the confluence would have the potential to affect the Okanogan River. Since this work could be done when there is little or no flow in the lower reach of Salmon Creek and low flow in the Okanogan River, construction BMPs would minimize the impact. There would be increased, but short-term, sedimentation during the period when flows were again returned to the lower reach channel. Impacts to fisheries resources would be minimal and short-term.

Salmon Creek

Construction

There would be very little to no water present in the lower reach of Salmon Creek during construction. It is possible that minor (1 to 2 cfs) surface flow may be present in the work areas in the vicinity of drainage/treatment outfalls within the City. Stream rehabilitation construction would result in a release of sediment when water is returned to the lower reach, with short-term increases in total suspended solids (TSS) and suspended concentrations. Construction of the rehabilitated channel at the mouth of Salmon Creek would likely take several weeks.

Operation

Removing the bar at the mouth of Salmon Creek would provide access to migrating fish with less water than is required under current conditions. This would increase access to the middle reach of Salmon Creek for anadromous fish.

At this time, no changes to current steelhead stocking practices are planned in association with Salmon Creek rehabilitation, although removing the migratory barrier at the mouth of the creek would likely have a positive impact on this program. As steelhead and/or chinook salmon return, rainbow trout, brook trout, and salmon productivity could decrease in the middle reach. If resources become limited, larger steelhead trout or chinook salmon could out-compete smaller trout salmon, also preying on juveniles. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

There would be no direct impacts within the middle reach of Salmon Creek as a result of implementing this component, only the indirect benefits associated with improving access through the lower reach of Salmon Creek.

3.5.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Okanogan River

Construction

Construction impacts to Okanogan River fisheries resources would be limited to construction during alteration of the intake structure. The new wing walls and raised sill would require the intake structure to be dry. River flow would be diverted to minimize impacts to fish from construction work. There would be a temporary increase in suspended sediments in the area of construction and downstream. The construction area would be dewatered to the extent practical to minimize the amount of water impacted. Direct disturbance of some aquatic habitat would occur, but this is expected to be short-term and minor. Intake screens would be modified to meet state and federal requirements, avoiding impacts from impingement or entrainment.

Operation

Increased pumping at Shellrock could result in increased impacts over current conditions. However, these impacts are likely to be minor. The frequency with which flows fall below WAC minimums in various water year types remains identical to the No Action Alternative (**Section 3.1**). There would not be large changes to water quality or quantity in the Okanogan River and therefore, impacts to fish habitat and production would be minimal. The percentage of the Okanogan River that would be pumped under this alternative would increase for all fish flow regimes over all water year types (**Section 3.1**). Potential direct impacts are related to reduction of flow, impingement (fish driven against the inlet screen by high velocity intake flows), and entrainment (fish drawn into the water being pumped from the river) at the inlet structure. Indirect impacts are related to degradation of water quality in the area between the Shellrock pump station and the mouth of Salmon Creek. Through planning and proper maintenance of pump station operation, impacts are likely to be minor in this area and would be seasonal in nature.

Although Salmon Creek inflow would contribute a small percentage of the Okanogan River Flow for this alternative (**Section 3.1**), the contribution would increase as compared to the No Action Alternative. Long-term beneficial impacts to fish in the Okanogan are expected to result from water flowing from Salmon Creek into the Okanogan. In 2000, high water temperatures peaked at 74°F in the Okanogan River at Malott (downstream of the Salmon Creek mouth), while temperatures in the Middle Reach of Salmon Creek peaked at 66.3°F (CCT unpublished data in CCT, March 2002). Therefore, a modest volume of water in the Okanogan River near the confluence of Salmon Creek would be cooled (and suspended sediments would be diluted as well) when water is released into lower Salmon Creek. This could have long-term beneficial impacts to anadromous fish that could use the area as a small thermal refuge during migration.

Flow releases to the lower reach would be timed to optimize passage in Salmon Creek and therefore, the small thermal refuge benefit could locally benefit steelhead trout and chinook salmon jiuveniles in the Okanogan River. Temperatures in the Okanogan River are generally highest in July, August, and September. While the waters flowing from Salmon Creek would be beneficial to the Okanogan River at any time, water would not be released into lower Salmon Creek during these warmest summer months. Therefore the timing of upstream migration and outmigration for some species would not coincide with flows in lower Salmon Creek. For example, there appears to be a thermal barrier that blocks adult sockeye salmon migration in the Okanogan River in certain years during late July and early August. Okanogan River spring flow augmentation from Salmon Creek would not likely benefit this sockeye salmon migration.

Lower Salmon Creek

There would be no construction impacts as a result of the upgrade to Shellrock Pump Station in any reach of Salmon Creek.

Alternative 2 would re-establish seasonal fish migration flows in lower Salmon Creek that do not occur under the historic irrigation operations and that would not be provided under the No Action Alternative. Alternative 2 could reestablish some winter base flow in the upstream area of the lower reach, which was decreased under the historic irrigation operations and which would continue to be dewatered under the No Action Alternative. Under Alternative 2, the median monthly streamflow below the OID diversion weir (upstream portion of the lower reach) increases by about 4 to 10 cfs from November through March for all three fish passage flow regimes (**Appendix D-5**). Stream flow in April would increase from zero to about 15 to 32 cfs, and in May from about 15 to 30 to 35 cfs, depending on which fish passage flow regime is applied. The greatest variability in flow magnitudes between the fish passage flow regimes is found in April, July, and August.

Table 3-23 provides a summary of minimum flow requirements for fish passage provided by Alternative 2. The period of concern for the lower reach focuses on anadromous fish migration periods, which occur from May through July. Comparison of estimated minimum flows to the simulated streamflows for this alternative (represented in the table by *steelhead with rehabilitation* or *steelhead/chinook with rehabilitation*) indicates that there would be sufficient water to provide passage for steelhead trout and chinook salmon with rehabilitation during wet water years (10 percent exceedence). Steelhead trout minimum flow estimate options are met or exceeded for all water year types (10 percent, 50 percent, and 90 percent exceedence). There would be an average monthly deficit of water for the steelhead trout/chinook salmon combination during March, April and July under an average water year (50 percent exceedence) or any drier years. The average monthly shortage ranges from one to four cfs. These shortages are relatively minor and could be managed through a refined water supply management plan(see

Resource Management Plan, 3.5.3.3) and flows may be sufficient to serve fish needs when examined more closely.

Overall, this alternative would have long-term beneficial impacts to Salmon Creek fish populations in the lower and the middle reaches. Direct benefits include water volumes sufficient to provide passage for anadromous fish and improved habitat suitability in some areas. Indirect benefits would include water quality improvements such as decreased temperatures, decreased dissolved/suspended sediment, improved gravel quality with less embedded fine substrate, and more complex and productive habitat such as pools created from large wood pieces in the stream. These benefits are an indirect result of riparian enhancement, channel and bank stabilization, and flow stabilization. Resident species would benefit from increased survival and production (probably restricted to the upstream portion of the lower reach), offset by increased competition from anadromous species. Anadromous species (both steelhead trout and chinook salmon) would greatly benefit with channel rehabilitation incorporated with Alternative 2. This could result in a sustained, naturally reproducing population of both species. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

Middle Salmon Creek

Alternative 2 reduces the unnaturally high summer flows that have occurred in the middle reach under historic irrigation operations and reestablishes winter base flows that are not provided under historic irrigation operations. Under this action alternative, flows in the middle reach decrease in July through September (when Shellrock pumping from the Okanogan River reduces the need to convey Salmon Creek water through the middle reach), but increase for November through May (**Appendix D-5**).

Table 3-23 provides the comparison of estimated minimum flows for fish species and lifestages as compared to simulated flows expected to occur in the middle reach with this alternative. The flows provided for this alternative meet or exceed all of the minimum flow requirements for all species and life stages of concern.

This alternative would have long-term beneficial impacts to Salmon Creek fish populations. Direct benefits include water volumes sufficient to provide anadromous passage for adults and smolts, spawning, incubation of eggs, emergence, rearing, and overwintering habitat. Currently resident fish populations are limited by overwintering flows, so the provision of such flows will enhance their survival. Resident fish (rainbow trout and brook trout) would also benefit through increased habitat availability and suitability, although competition with anadromous fish would increase. Indirect benefits to aquatic habitat include water quality improvements such as decreased temperatures, decreased dissolved/suspended sediment, improved gravel quality with less embedded fine substrate, and more complex and productive habitat such as pools created from large wood pieces in the stream. These benefits are an indirect result of riparian enhancement, channel and bank stabilization, and flow stabilization. Anadromous species, especially steelhead trout, would greatly benefit since passage is provided in the lower reach resulting in access to the good habitat in the middle reach.

Table 3-23. Upgrade Shellrock pump station. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate which minimum flow requirements would not be met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]												
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	4	4	11	28	26	16	13	12	11	4	4	4
	50%	**6**	**8**	**11**	**28**	**75**	**88**	**22**	**18**	**11**	**5**	**5**	**4**
	10%	14	15	16	79	285	231	71	27	17	15	17	14
Steelhead/chinook with channel rehabilitation	90%	7	7	7	15	21	23	21	20	11	7	7	7
	50%	**7**	**7**	**7**	**15**	**72**	**88**	**26**	**21**	**11**	**8**	**7**	**7**
	10%	15	15	13	74	283	230	71	27	17	15	17	14
Steelhead without channel rehabilitation	90%	4	4	12	32	20	16	12	11	11	4	4	4
	50%	**6**	**8**	**12**	**32**	**67**	**88**	**22**	**18**	**11**	**5**	**5**	**4**
	10%	14	15	16	79	283	230	71	27	17	15	17	14
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3] (monthly flow average of minimum flow estimate[4])				6	15	5-25 (13)							
Steelhead/chinook with channel rehabilitation[3] (monthly flow average of minimum flow estimate[4])				6	15	20-25 (21)	20	10					
Steelhead without channel rehabilitation[3] (monthly flow average of minimum flow estimate[4])				15-25 (8)	20-25 (23)	5-25 (13)							
Lower Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	3	3	8	22	19	7	0	0	2	0	3	3
	50%	**5**	**6**	**8**	**22**	**28**	**34**	**0**	**0**	**5**	**1**	**3**	**3**
	10%	11	12	12	55	194	147	17	2	8	6	14	11
Steelhead/chinook with channel rehabilitation	90%	6	6	5	12	17	16	8	2	4	3	5	5
	50%	**6**	**6**	**5**	**12**	**27**	**36**	**9**	**7**	**6**	**4**	**5**	**5**
	10%	12	12	10	50	194	148	19	13	8	7	13	11
Steelhead without channel rehabilitation	90%	3	3	9	25	15	7	0	0	2	0	3	3
	50%	**5**	**6**	**9**	**25**	**23**	**34**	**0**	**0**	**5**	**1**	**3**	**3**
	10%	11	12	13	56	194	146	17	2	8	6	14	11

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Upper Salmon Creek

No changes to the upper reach Salmon Creek streamflow (tributaries to the reservoirs) would occur under the Shellrock Pump Station Upgrade Alternative. The unregulated inflow is assumed to remain the same for the No Action and all Alternatives (**Appendix B-3**).

This action alternative would keep the median Salmon Lake elevation higher and would reduce the seasonal fluctuation of the lake as compared to historic irrigation operations. A large volume of water is consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The higher reservoir elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir. The median monthly Conconully Reservoir water surface elevation under Alternative 2 is increased in all months, except May, June, and July, which already operate at maximum active storage capacity.

As a result of stabilizing and increasing water levels during the summer and fall in the Project reservoirs, there could be a positive effect on fish habitat and salmonid production. Lower water temperatures (especially during the summer months), and the increase in inlet stream areas would be likely to increase native fish survivability and productivity. Resident species, including kokanee salmon and rainbow trout would be likely to benefit. However, non-native fish populations (such as largemouth bass) may also increase due to stabilized and increased water levels in the project rservoirs and prey on resident salmonids i.e. kokanee and rainbow trout. Long-term beneficial impacts would be likely to occur to reservoir resident fisheries and additional opportunities would likely be provided through changes in fisheries management.

3.5.2.5 Alternative 2: Feeder Canal Upgrade

Impacts would be the same as described in **Section 3.5.2.2**.

3.5.2.6 Alternative 2: Stream Rehabilitation

The focus of stream channel rehabilitation is reconstructing a stable stream channel in the lower 4.3 miles (lower reach) that would provide for anadromous fish migration and passage of flood flows while maintaining channel stability, reducing erosion and sedimentation, and reducing the risk of property loss. This component would modify the lower flow channel shape and size and decrease the minimum streamflow required for adequate fish passage. This will reduce the total volume of water needed for fish passage and/or allow greater flow management flexibility.

Okanogan River

Construction

Construction-related sedimentation would lead to a short-term increase in TSS and suspended concentrations in the Okanogan River near the mouth of Salmon Creek and immediately downstream. The construction activities in the lower two miles of the lower reach, especially the removal of the large substrate bar at the confluence, would have the greatest potential to affect the Okanogan River. Since this work could be done when there is little or no flow in the lower reach of Salmon Creek and low flow in the Okanogan River, construction BMPs would minimize the impact. There would be increased, but short-term, sedimentation during the period when flows were again returned to the lower reach channel. Potential water quantity and water quality impacts of stream rehabilitation on the Okanogan would be negligible. Impacts to fisheries resources would be minimal and short-term.

Operation

Full channel rehabilitation of Salmon Creek would be expected to have long-term beneficial impacts to the Okanogan River fish habitat, primarily related to the increased quantity and quality of water discharged at the mouth of Salmon Creek. Stabilization of the bed and banks of lower Salmon Creek would reduce erosion and thus sediment entering the Okanogan River. Rehabilitation would also include revegetation of areas disturbed by construction, including streambanks. The combination of channel rehabilitation, revegetation efforts, and increased streamflow would be expected to produce net benefits to water quality discharged from Salmon Creek to the Okanogan River. Specific benefits from termperature reduction due to channel shading by riparian vegetation would likely be limited in area and take several years to be achieved.

Lower Salmon Creek

Construction

There would be very little to no water present in the lower reach of Salmon Creek during construction. It is possible that minor (1 to 2 cfs) surface flow may be present in the work areas closest to Watercress Springs, or in the vicinity of drainage/treatment outfalls within the City. Stream rehabilitation construction would result in a release of sediment when water is returned to the lower reach, with short-term increases in total suspended solids (TSS) and suspended concentrations.

Operation

The stabilized channel in the lower reach of Salmon Creek would reduce channel erosion, increase stream shade, lower surface water temperatures, and provide a low flow channel that is adequate to provide migration of fish with much less water than is required under current conditions. This would increase the quality and quantity of habitat within the lower creek and provide better access to the middle reach of Salmon Creek for anadromous fish. Channel rehabilitation would include revegetation of stream banks in Salmon Creek, but the areal extent of riparian vegetation, degree of overhanging/shading, and the number of years needed to achieve shading are uncertain. Therefore, decreased stream temperature in Salmon Creek due to riparian revegetation is considered a minor benefit compared to the greater benefits from increased volumes of cool water from the watershed and storage sources. Increased quantity and quality of water would benefit fisheries habitat. Channel rehabilitation would be expected to have long term beneficial impacts to the lower reach of Salmon Creek. Direct beneficial impacts would include creation of wetted area (habitat), especially in the lower two miles where, with appropriate flows, migration would be made possible for anadromous fish species. Also, both resident and anadromous species would directly benefit from overall improvement and availability of habitat in both the middle and lower reaches through increased habitat diversity. Indirect benefits would largely consist of improved water quality resulting from restored riparian areas. In turn, this would lead to decreased water temperature, increased large woody debris recruitment, and long term reduction of sediment.

At this time, no changes to current steelhead stocking practices are planned in association with Salmon Creek rehabilitation, although channel rehabilitation would likely have a positive impact on this program. It is expected that with any of the Action Alternatives, current stocking practices would continue with approximately the same number (10 to 15 thousand annually) of summer steelhead being stocked in Salmon Creek. Following return migration, and at the time of spawning, redd surveys would be conducted. Based on habitat availability, stocking numbers would be increased as needed, to maximize habitat use (Fisher pers. comm., 2003). The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

There would be no direct impacts within the middle reach of Salmon Creek as a result of implementing this component, only the indirect benefits associated with improving the lower reach of Salmon Creek.

Upper Salmon Creek

The Channel Rehabilitation Alternative is not expected to affect the reservoirs or tributaries.

3.5.2.7 Alternative 3: Water Rights Purchase

Under this alternative, no infrastructure components are involved. Therefore no construction impacts are expected and the only change from existing conditions would be operations.

Okanogan River

The percentage of Okanogan River water that would be pumped under Alternative 3 would increase for all fish flow regimes over all water year types (**Section 3.1**). However, the increased percentage pumped would not be of a magnitude that would adversely affect minimum streamflow in the Okanogan River. The number of months with WAC minimum flow would be identical to the No Action Alternative.

Salmon Creek inflow to the Okanogan River would increase under this action alternative for all water year types (**Section 3.1**). The increase would represent a doubling or tripling of Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years the increase would range from four to nine times that under the No Action Alternative. As discussed in the other Action Alternatives, a long-term beneficial impact would be the provision of better salmonid habitat, especially a small thermal refuge to fish migrating in the Okanogan River. The water flowing from Salmon Creek would directly improve water quality at and immediately downstream of the confluence with the Okanogan.

Lower Salmon Creek

Alternative 3 would reestablish seasonal fish migration flows in lower Salmon Creek that did not occur under the historic irrigation operations. The median monthly streamflow in lower Salmon Creek below the diversion dam would increase in all months for the steelhead trout and chinook salmon flow regime, and would increase in all months except July and August for the steelhead-only regimes (see **Appendix D**). Under this action alternative, the median monthly streamflow for the lower reach of Salmon Creek (measured at the mouth) would increase in all months for the steelhead trout and chinook salmon flow regime, and would increase in all months except July and August for the steelhead-only flow regimes (see **Appendix D**).

Table 3-24 illustrates that, with this alternative, represented in the table by *steelhead without rehabilitation*, all estimated minimum flow needs for steelhead trout would be met or exceeded during all water years, including dry years, when compared to simulated flows. Steelhead trout would receive migration flows that would result in successful passage for this species. It can be inferred from the flows for the *steelhead trout/chinook salmon option with channel rehabilitation* option that Alternative 3 would be unable to pass Chinook salmon and would be below the estimated minimum flows needed for steelhead in March and April during normal water years. Even with rehabilitation, during March there would be a one cfs deficit and during April there would be a 3 cfs deficit. These deficits are based on model outputs and conservative estimates of the amount of water needed to provide adequate passage and overwintering flows. The deficits for chinook salmon without rehabilitation would likely be even greater.

Overall, this alternative would have long-term beneficial impacts to Salmon Creek fish populations in the lower reach. Direct benefits include water volumes sufficient to provide passage for steelhead and improved habitat suitability in some areas. Indirect benefits would include water quality improvements such as decreased temperatures, as an indirect result of flow stabilization. Resident species would benefit from increased survival and production (probably restricted to the upstream portion of the lower reach), offset by increased competition from anadromous species. Anadromous species (both steelhead trout and chinook salmon) would greatly benefit if channel rehabilitation were incorporated. This could result in a naturally reproducing population of both species. The proposal in Alternative 3 to not include channel rehabilitation would still benefit steelhead and may sustain a population over generations. Chinook salmon would not likely receive long-term benefit from this alternative without channel rehabilitation, in terms of a naturally reproducing and sustainable population. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT 1997, ESA 1997, UCSRB 2003).

Middle Salmon Creek

Alternative 3 reduces the unnaturally high summer flows in the middle reach that occur under historic irrigation. This action alternative would reestablish winter base flows that are not provided under historic irrigation (see Appendices).

This action alternative would meet or exceed all estimated minimum flows for all species under all options. Steelhead trout would experience beneficial impacts associated with provision of flows to Salmon Creek under this alternative. Direct benefits include water volumes sufficient to provide anadromous passage for adults and smolts, spawning, incubation of eggs, emergence, rearing, and overwintering habitat. Resident fish (rainbowand brook trout) would also benefit through increased habitat availability and suitability, although there may be competition with anadromous fish. Indirect benefits to aquatic habitat would result from flow stabilization. Steelhead trout would benefit since passage would be provided in the lower reach resulting in access to the good habitat in the middle reach. The provision of anadromous fish access to and enhancement of productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT 1997, ESA 1997, UCSRB 2003).

Table 3-24. Purchase water rights. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate which minimum flow requirements would not be met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]												
MIDDLE REACH		Month											
Middle Reach Minimum Flow Estimates (cfs)[2]		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	4	4	11	27	26	15	11	10	10	4	4	4
	50%	**7**	**8**	**11**	**28**	**78**	**89**	**24**	**16**	**10**	**4**	**4**	**7**
	10%	14	15	16	76	284	233	73	29	18	16	18	14
Steelhead/chinook with channel rehabilitation	90%	7	7	7	15	21	21	21	21	11	8	7	7
	50%	**7**	**7**	**7**	**15**	**71**	**88**	**24**	**22**	**12**	**8**	**7**	**7**
	10%	15	15	13	74	282	230	71	27	17	15	17	14
Steelhead without channel rehabilitation	90%	4	4	12	32	20	15	11	10	10	4	4	4
	50%	**7**	**8**	**12**	**32**	**74**	**89**	**24**	**16**	**10**	**4**	**4**	**7**
	10%	14	15	16	76	282	233	73	29	18	16	18	14
LOWER REACH		Month											
Lower Reach Minimum Flow Estimates (cfs)[2]		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead with channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				6	15	5-25 (13)							
Steelhead/chinook with channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				6	15	20-25 (21)	20	10					
Steelhead without channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				15-25 (8)	20-25 (23)	5-25 (13)							
Lower Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	3	3	8	22	19	7	0	0	2	1	3	3
	50%	**5**	**6**	**8**	**22**	**40**	**48**	**0**	**0**	**5**	**2**	**3**	**5**
	10%	11	12	13	59	206	160	30	2	8	9	14	11
Steelhead/chinook with channel rehabilitation	90%	6	6	5	12	17	16	11	10	8	4	5	5
	50%	**6**	**6**	**5**	**12**	**35**	**46**	**13**	**12**	**8**	**5**	**5**	**5**
	10%	12	12	10	53	202	159	32	16	8	8	13	11
Steelhead without channel rehabilitation	90%	3	3	9	25	15	7	0	0	2	1	3	3
	50%	**5**	**6**	**9**	**25**	**36**	**48**	**0**	**0**	**5**	**2**	**3**	**5**
	10%	11	12	13	59	205	160	30	2	8	9	14	11

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Upper Salmon Creek

No changes to the upper reach Salmon Creek streamflow would occur under Alternative 3. The unregulated inflow is assumed to remain the same for the No Action and all Alternatives (**Appendix B-3**).

This action alternative would keep the median lake elevation higher and would reduce the seasonal fluctuation of Salmon Lake that occurs under historic irrigation operations. A large volume of water would consistently be available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The median monthly Conconully Reservoir water surface elevation under Alternative 3 would increase in August through April by 5 to 10 feet, such that median reservoir elevation would be near full active storage in most months (see **Appendix D**). The median Conconully Reservoir elevation would be similar for all three fish flow regimes. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow demands in the middle and lower reaches of Salmon Creek. The reservoir levels would provide more seasonally consistent surface and groundwater accumulations along the margins of Conconully Reservoir.

As a result of stabilizing and increasing water levels during the summer and fall in the Project reservoirs, there would be a potential positive effect on fish habitat. Lower water temperatures (especially during the summer months), and the increase in inlet stream areas would be likely to increase native fish survivability and productivity. Resident species, including kokanee salmon and rainbow trout would be likely to benefit though non-native fish populations (such as largemouth bass) may also increase due to stabilized and increased water levels in the project rservoirs and may prey on resident salmonids. Long-term beneficial impacts would be likely to occur to reservoir resident fisheries and additional opportunities would likely be provided through changes in fisheries management.

3.5.2.8 Alternative 3: Feeder Canal Upgrade

Impacts would be the same as described in **Section 3.5.2.2**.

3.5.2.9 Alternative 3: Stream Channel Rehabilitation

There would be no impacts expected since no rehabilitation is proposed as part of this alternative.

3.5.2.10 No Action Alternative

Okanogan River

Pumping at the Shellrock pump station would continue to affect flow in the Okanogan River.. WAC minimum instream flow violations for the Okanogan River between Shellrock and Salmon Creek would remain identical to existing and historical conditions. This would not result in any major change to water quality or quantity in the area and therefore would not create any new impacts to existing fish habitat or production. Salmon Creek inflow would continue to comprise from one to three percent of the Okanogan River flow under this alternative, which is similar to existing and historical conditions (**Section 3.1**).

With the No Action Alternative, there would be continued sedimentation that leads to a short-term increase in total suspended sediment (TSS) concentrations in the Okanogan River at and downstream of the confluence with Salmon Creek. This would typically occur in the spring. Loading of total dissolved solids, metals and other nutrients, and changes in pH would also occur from Salmon Creek flood and storm flows entering the river, resulting in short-term, localized impacts on fish health and habitat. The alluvial bar formed by sediments at the mouth would continue to act as a barrier to fish migration in most years.

Flow of cooler Salmon Creek water into the Okanogan River would continue to be intermittent, unreliable, and restricted. No reliable thermal refuge for Okanogan River anadromous fish would exist at or near the mouth of Salmon Creek.

Lower Salmon Creek

The median monthly streamflow in lower Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions and would remain near zero in most months (**Appendix B-2**).

Table 3-25. Alternative 4 - No Action. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate which minimum flow requirements are not met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]												
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
No Action	90%	2	2	2	0	9	19	30	32	19	4	2	2
Alternative	**50%**	**2**	**2**	**2**	**0**	**47**	**88**	**53**	**53**	**41**	**5**	**2**	**2**
	10%	2	6	11	56	286	235	73	62	48	6	2	2
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3]				6	15	5-25							
(monthly flow average of minimum flow estimate)[4]						(13)							
Steelhead/chinook with channel rehabilitation[3]				6	15	20-25	20	10					
(monthly flow average of minimum flow estimate)[4]						(21)							
Steelhead without channel rehabilitation[3]				15-25	20-25	5-25							
(monthly flow average of minimum flow estimate)[4]				(8)	(23)	(13)							
Lower Reach Simulated Flows (cfs)[1]													
No Action	90%	1	1	1	0	0	0	0	0	0	0	1	1
Alternative	**50%**	**1**	**1**	**1**	**0**	**12**	**36**	**0**	**0**	**0**	**0**	**1**	**1**
	10%	1	5	9	41	202	151	17	0	0	0	1	1

Flows not met for either the steelhead or the steelhead/chinook option
Flows met for the steelhead option but not met for steelhead/chinook option

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Table 3-25 provides a comparison of monthly flows at 10, 50, and 90 percent exceedence (from the simulated streamflows) and the corresponding flows needed to meet the minimum instream flow for fish species. The lower reach is considered only for migration life stages (**Table 3-21**).

In the lower reach, estimates of minimum flows for fish are provided as a range in some months (**Table 3-25**). The range is provided where minimum flows for fish change during the month due to "ramping up and down" (variation) of flows or providing "pulses" of water. These changes in flow are provided to simulate natural conditions, such as freshets, or to stimulate the fish to migrate. Also, some minimum flows for fish are not timed to start at the beginning or end of the month. For example, **Table 3-21** shows that minimum flow for steelhead trout spawning migration starts on March 20. Since the exceedence flow output (produced by the streamflow model) is provided as monthly averages (and not as partial months), the estimated minimum flows for fish were treated comparably and are shown as monthly averages. Monthly flow averages are provided in parenthesis below the estimated minimum flows for fish in **Table 3-21**. These monthly average minimum flows for fish are necessary only in the lower reach where minimum flows for fish fluctuate or do not begin at the first or end of a month.

By comparing the minimum flows for fish to the simulated flows for the No Action Alternative (**Table 3-25**), an estimate of impact to fish migration is possible. The 50 percent exceedence flows represent an average flow scenario for the creek. Passage would be unsuccessful throughout the migration period for steelhead at this flow. The only period in which a steelhead/chinook combination could migrate successfully in an average year would be June. High flow years (10 percent exceedence flows) may be able to provide passage for both species, though the combined passage and habitat requirements of chinook salmon would likely remain unmet with no channel rehabilitation.

The lack of water in the creek below the OID diversion would continue to eliminate approximately 4.3 miles of potential/historic fish migration corridor under most conditions. This would continue to have a long term impact on the survival of naturally producing populations of steelhead trout and chinook salmon and on exclusion of resident species. Without provision of passage from the Okanogan to the middle reach of Salmon Creek, anadromous species would largely remain extirpated from Salmon Creek, except for release programs for steelhead and small water releases that could allow limited migration. Stream bank erosion and degradation would continue to occur particularly during storms and other high flow events. This would continue the associated degradation of water quality and quantity. Deposition of large substrate (i.e. boulders) and the removal of gravel and fine sediment during flood events would continue throughout the reach (especially at the mouth of Salmon Creek) making migration more difficult.

Middle Salmon Creek

The median monthly streamflow and minimum monthly streamflow in the middle reach of Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions (**Appendices B and D**). The No Action Alternative would continue to provide high summer flows in the middle reach, similar to historical irrigation operations (Figure 3-6). Due to irrigation water releases, during normal years middle reach flows are two to five times higher than would be required by fish during the months of May through September. As described above, this water is diverted at the downstream end of the middle reach and is not released to the lower reach unless there is spill over the diversion weir.

In a normal water year (50 percent exceedence), estimated minimum flow needs are not met for steelhead trout or chinook salmon from November through April. Chinook salmon minimum flows would not be met in October. The deficit of water during these months affects overwintering and rearing potential for both chinook salmon and steelhead trout. The largest deficit would occur in the latter part of March and April when steelhead adults are migrating upstream and downstream, spawning, and smolts are outmigrating. Chinook salmon would be impacted during the first half of smolt outmigration (April).

In general, the No Action Alternative represents a “reverse hydrograph” (proportional streamflow amounts are opposite from normal quantities expected under natural conditions) in the middle reach of Salmon Creek when compared to natural conditions. During the spring months, such as April, smolts would be outmigrating and adult steelhead would be migrating upstream and spawning during this high flow period. During the spring, reservoir filling prevents normal streamflow amounts from entering the middle reach Salmon Creek. As summer progresses and normal stream flow typically would decrease, the need for irrigation water increases leading to unusually high flows in the middle reach during late summer and early fall. During the rearing and overwintering periods (winter), reservoir filling again reduces flows from what would occur under a normal hydrograph. The resident fish populations would continue to be affected in the same manner as current conditions. Impacts of current conditions on resident fish have not been documented but are considered negative, especially during low flow periods such as overwintering.

Currently, in the middle reach of Salmon Creek, anadromous fish cannot achieve a sustainable and naturally reproducing population under the No Action alternative. Resident fish populations are likely to be impacted negatively by inadequate flows during winter and early spring. This alternative results in long term negative impact to both anadromous and resident fish habitat and populations.

The continued exclusion of anadromous fish from the Salmon Creek drainage is contrary to state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT. 1997, UCSRB 2003).

Upper Salmon Creek

Streamflow in the upper reach of Salmon Creek would remain unregulated under the No Action Alternative, similar to the existing and historical conditions (**Figure 3-5**). Natural variability in watershed runoff production would continue to produce differences by water year type as a function of climatic influences, as well as vegetation removal and forest fires in the upper watershed. Fish production in the upper tributaries would remain unchanged.

The median, minimum, and maximum monthly water surface elevations for both Salmon Lake and Conconully reservoirs are similar to the existing and historical condition under the No Action Alternative. Impacts to the reservoir fisheries would result from continuation of low water surface levels in late summer fall, particularly during dry years. The water level of Salmon Lake would be at its lowest in September, then would slowly rise in April and drop back down from July to September (**Appendix D**). With no upgrade to the North Fork feeder canal or supplementation of irrigation flows, the ability to manage lake levels would remain impaired.

As a result of seasonally low water levels in the Project reservoirs, there would be a direct negative effect on fish habitat and resulting lower production. Higher water temperatures (especially during the summer months), and dewatering of inlet stream areas could continue to decrease in native fish survivability and productivity. Continued rainbow trout stocking efforts, including catchable sizes would likely be required to support a sport fishery in some years. Other resident species, including kokanee salmon and rainbow trout that utilize habitat in the reservoirs and inlet stream areas would continue to have lower survivability and productivity. Additionally, with limited water stored in Salmon Lake, the channel between the two reservoirs would continue to be frequently dewatered during the fall. This would further decrease kokanee salmon survival and productivity, as this spawning area would be limited in availability and success.

3.5.3 MITIGATION MEASURES

To reduce potential impacts to fisheries, the following mitigation measures would be implemented. See **Table 3-26** for a summary of mitigation actions.

Table 3-26. Summary of recommended mitigation measures for construction and operation impacts.

	Project Alternative Involved				
Mitigation Action	No Action	Feeder Canal Upgrade	Stream Rehabilitation	Upgrade Shellrock Pumping Plant	New 80 cfs Capacity Pump Station
CONSTRUCTION MITIGATION					
Have emergency spill containment kits available to contain and remove accidentally spilled fuels, hydraulic fluids, etc. immediately.		X	X	X	X
All equipment refueling and fuel storage would not occur within 100 ft. of any surface water. All equipment refueling and fuel storage would not occur within 100 ft. of any surface water.		X	X	X	X
Disposal of waste materials and washing of equipment would not occur within 100 ft. of any watercourse, ravine, drainage ditch, etc.		X	X	X	X
A spill prevention , control and countermeasures plan (SPCC) would be developed prior to the start of construction.		X	X	X	X
Construction of steep, straight roads, which could result in concentration of runoff and channelization, would be avoided.		X	X	X	X
Access roads and pipelines would be sited to avoid water bodies and riparian areas. When in close proximity, sedimentation control structures would be put in place prior to beginning work.		X	X	X	X
All construction access roads, staging areas, and any other disturbed upland or riparian vegetated area would be revegetated following construction.		X	X	X	X
Pump intake devices would be located in areas of river where disturbance to the streambed and stream bank are minimized. They would also be located on mat gabions to help prevent disturbance.				X	X
To the greatest extent possible, construction activities would be timed around periods of lowest fish use and instream flows.		X	X	X	X
Operation Mitigation					
A water filtration system would be constructed to mitigate for water being used from the Okanogan River with a high total suspended solid concentration.				X	X
Pilings would be driven into the streambed in front of fish screens to prevent damage by floating debris, maintaining functionality of fish screens.		X	X	X	X
Pump intake structures would be located in locations where they would have the least impact when in operation.				X	X
The Okanogan Irrigation District Comprehensive Water Conservation Program would be implemented to conserve water and prevent excess irrigation runoff.	X	X	X	X	X

Table 3-26. Summary of recommended mitigation measures for construction and operation impacts. (continued)

	Project Alternative Involved				
Mitigation Action	No Action	Feeder Canal Upgrade	Stream Rehabilitation	Upgrade Shellrock Pumping Plant	New 80 cfs Capacity Pump Station
Pump intake and diversion canal fish screens would be designed in accordance with NOAA Fisheries specifications and utilized to prevent fish from entering pumping structures or irrigation canals and to prevent injury.		X	X	X	X
Pump station would be located away from the riverbank and above the elevation of the 100-year floodplain.					X
Streambanks along Project structures would be protected from erosion using methods such as boulder and timber armoring or rock gabions.		X		X	X
Work with landowners adjacent to the mainstem Okanogan River and Salmon Creek and their tributaries in order to minimize impacts of land use on fisheries resources.	X	X	X	X	X
Resource Management Plan (RMP)					
The RMP would provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs.	X	X	X	X	X
The *Streamflow and Reservoir Operation Plan* would provide for monitoring streamflows and reservoir water levels and operation, as well as the associated impacts on Project goals.	X	X	X	X	X
The *Stream Channel and Riparian Management Plan* would provide for monitoring impacts associated with streamflow and provide actions to be taken as mitigation.	X	X	X	X	X
The *Fisheries Management Plan* would establish management criteria for each target species.	X	X	X	X	X
The *Monitoring and Adaptive Management Plan* would provide for ongoing adjustments to management plans as necessary.	X	X	X	X	X

3.5.3.1 Construction

Various construction activities are associated with the Action Alternatives. All construction activities have the potential to disturb fisheries resources in the Project area, though impacts can be avoided or minimized. To avoid or minimize these impacts, construction Best Management Practices (BMPs) would be utilized. During any period of construction, all impacts would be regularly monitored and BMPs would be put in place or altered to address these impacts.

To protect water quality, various preventive measures would be taken. All equipment refueling and fuel storage would occur in locations at least 100 feet from any surface water. Disposal of waste materials and washing of equipment would also occur at least 100 feet from any surface water, as well as from any watercourse, ravine, drainage ditch, or other feature where water may potentially flow. Prior to beginning construction, work zones would be delineated and prepared, including staging and access areas, in locations that would minimize disturbance. Additionally, to deal with any chemical spill, emergency spill containment kits would be available on-site to immediately contain and remove accidentally spilled fuels or any other potentially hazardous materials. A spill prevention, control, and countermeasures (SPCC) plan would also be developed prior to any construction activities.

To avoid stream bank erosion and sedimentation, construction of steep, straight roads for construction that could result in concentration of runoff and channelization, would be avoided. Access roads to build the pipeline would also be situated to avoid water bodies and riparian areas. Clearing of vegetation would be minimized. When in close proximity to water bodies, sedimentation control structures would be placed prior to beginning work. Structures include straw bales along stream banks and sediment ponds in runoff areas to catch excess water and sediment loads, riprap, boulder and timber armoring to strengthen banks and limit bank erosion, and silt fences and rock gabions to prevent rocks and other debris from falling into water bodies.

All construction access roads, staging areas and any other disturbed upland or riparian vegetated area would be revegetated following construction. This is important to control stream-bank erosion and sedimentation.

If either Alternatives 1 or 2 are chosen, a water filtration system, including a sediment pond, would be constructed to mitigate for water being used with higher total suspended solid concentrations. New pump intakes for these options would be designed and constructed to minimize disturbance and impact to the streambed during construction and also operation.

To further minimize impacts on fish, construction activities would be timed to avoid periods of fish use and instream flows. Stream rehabilitation in lower Salmon Creek would occur at times when when the channel is dry and no fish are present. Likewise, work on the Salmon Lake Feeder Canal, the diversion in North Fork Salmon Creek, and the Okanogan River would take place when flows are at their lowest and fish use is at a minimum.

3.5.3.2 Operational Mitigation

Many of the above actions, such as bank stabilizing and sediment retention structures, and revegetation of disturbed areas would continue to be utilized during post-construction activities, if required. Inspection and maintenance of these measures would be done on a regular basis.

For Alternatives 1 or 2, fish screens based on NOAA Fisheries specifications would be placed on the water intake pipes to minimize fish entrapment and injury. Currently the Shellrock pump has screens, however they do not meet NOAA Fisheries criteria with respect to sweeping velocity, and there are concerns over high approach velocities at low river flows. The existing fish screen at the OID diversion in Salmon Creek meets NOAA criteria but is currently only minimally successful. A fish ladder has been recently constructed at the OID diversion that is adequate to pass fish. There is an existing issue with lack of flows to operate either the fish bypass or the fish ladder. This is a flow related problem and not a screen design problem. Fish can be trapped when the bypass is shut down so fish are not bypassed to the “dry” stream below the diversion dam. Under those alternatives that provide streamflow below the diversion, this problem would be alleviated. These issues can be adequately resolved after fish passage through the lower reach is reliably available during the migration periods. All fish screens would be inspected and maintained on a regular basis.

Collaboration with landowners in the Project vicinity, in particular on land adjacent to Salmon Creek and its tributaries, would be critical and would take place to minimize or improve land use impacts. Coordination with landowners and management of land use activities would be ongoing with mitigation actions implemented and altered as needed.

3.5.3.3 Resource Management Plan

The successful operation and subsequent management of the Project would require construction, operation, and performance standards and monitoring. A Resource Management Plan (RMP) would be developed and implemented to provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs. Adaptive management principles would be incorporated into the RMP to ensure improvement over time. The RMP would likely include the following:

- Streamflow and reservoir operations
- Stream channel and riparian maintenance
- Fisheries management
- Agricultural interface
- Agency coordination
- Monitoring and adaptive management

Of particular importance to fish impact mitigation are the streamflow and reservoir operations, stream channel and riparian management, and fisheries management. As described in the impact section, several of the minimum flow estimates for different species and life stages would not be met by the action alternatives. This may be in part an artifact of modeling. It is likely that those flows that would be within a few cfs of meeting minimum flow estimates, could be refined to minimize impact to the population as a whole and to increase the possibility of a long-term sustainable population. There are other opportunities to enhance fisheries populations in the Project area related to increased supply and flexibility of using high quality Salmon Creek water.

The RMP would maximize the potential to meet the goals of both resident and anadromous fisheries enhancement through identification of streamflow and reservoir operations. This would include the following objectives.

Refine the knowledge of minimum flow requirements for all species and life stages, especially after stream rehabilitation.

- Refine water supply and release scenarios to fulfill specific needs of each species and life stage –specific needs.

- Attenuate peak streamflows that otherwise would damage newly constructed channel sections or streambank stabilization treatments.
- Maintain base streamflow sufficient to sustain multiyear (albeit temporary) irrigation of riparian vegetation.
- Reserve storage for OID in case of pump station malfunction.
- Maintain and possibly enhance existing reservoir fisheries.

The RMP would provide guidance for implementation of stream channel projects and riparian management actions and the degree to which adequately funded and well-focused actions could be taken to mitigate for undesirable high or low streamflow conditions. A monitoring program would be developed, which would annually assess the stability of instream and streambank treatments, groundwater and surface water interactions, signs of channel instability and bank failure, indicators of channel degradation or aggradation, and the vitality or rate of recovery of riparian plantings or enclosure areas. It would also set forth site-specific monitoring protocols to watch problem areas and determine rates of change, as well as corrective actions to take to avoid problems of major significance.

The RMP would address fisheries management and establish management criteria for each target species. Important components would be likely to include habitat-related production (i.e., egg-to-fry survival, smolt to adult returns, or passage success), habitat availability and suitability, natural production, interspecies competition, hatchery outplants, condition of rearing fish (i.e., food availability), and (eventually) management of the Salmon Creek system with respect to stream flows, reservoir operations, and harvest.

The RMP would include a monitoring and adaptive management plan to provide a basis for ongoing adjustment of management plans by using each step in a management program to gather information and reflect upon how the natural system is behaving under the management regime.

3.5.4 UNAVOIDABLE ADVERSE IMPACTS

Under the No Action Alternative, habitat degradation would continue (as described in **Sections 3.1 and 3.2**). These continuing adverse impacts would further limit habitat and water quality for fish in Salmon Creek and the Okanogan River, making attempts to recover listed and extirpated species more costly and difficult. There are no unavoidable adverse impacts to fisheries from the Action Alternatives.

3.6 LAND AND SHORELINE USE

3.6.1 EXISTING CONDITIONS

3.6.1.1 Lower Salmon Creek Area

This analysis of existing land and shoreline uses in the vicinity of proposed Project actions is based upon Okanogan County Assessor's records and visual observation of the Project area. The analysis along Salmon Creek is limited to those parcels that lie all or partially within 300 feet of the centerline of Salmon Creek. This includes 197 individual parcels and excludes much of the public right of way contained within the streets and roads of the City of Okanogan and Okanogan County. **Figure 3-17** provides an overview of land use designations within the Project area.

The Lower Salmon Creek area includes a wide range of land uses from fairly dense commercial and residential land uses within the corporate limits of the City of Okanogan to low density residential and agricultural land uses in the unincorporated areas. There are also several parcels of publicly owned property including the City of Okanogan's Alma Park along the southern edge of the Creek from First Avenue to the Okanogan River, a City owned boat launch ramp and overlook just north of the confluence with the Okanogan River, an old landfill, and several adjacent undeveloped parcels and the Salmon Springs watershed area (part of the City's overall water supply). Okanogan County also owns a portion of the area, primarily the right-of-way for the Salmon Creek Road.

From its mouth upstream to First Avenue, Salmon Creek is straddled by public land owned by the City of Okanogan. The City has a well on either side of the Creek in this area and there is also a small parcel of private land with two single-family residences adjoining the City property at the mouth.

Between First and Second Avenues, land uses are primarily commercial in nature. Between Second and Fifth Avenues land uses are mixed and include commercial, a large nursing home facility, a church and several single and multi-family residential units. Upstream from Fifth Avenue to the OID Diversion, land uses are primarily single family residential that give way to undeveloped land, city owned properties and small farms upstream from the City limits.

Jurisdiction of the Lower Salmon Creek area is divided between Okanogan County and the City of Okanogan. Within the corporate limits, the City manages land use with its comprehensive plan and zoning, subdivision, flood damage prevention, SEPA ordinances, and shoreline master program. Within the unincorporated area, Okanogan County manages land use with its comprehensive plan and zoning, subdivision, flood damage prevention, critical areas, and SEPA ordinances.

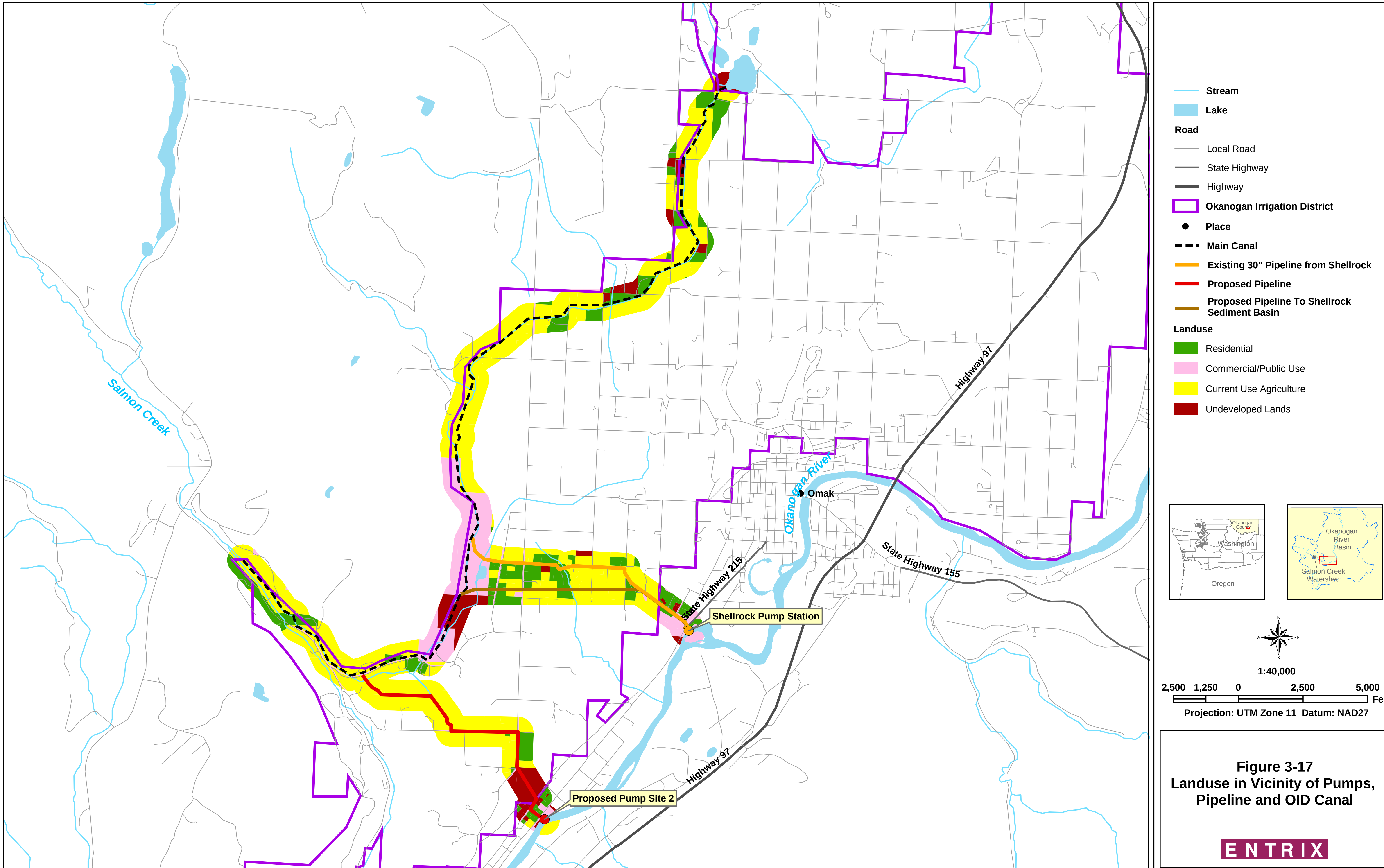


Figure 3-17
Landuse in Vicinity of Pumps, Pipeline and OID Canal

ENTRIX

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The City of Okanogan's comprehensive plan provides the following designations for the land along Lower Salmon Creek: *Institutional* from the mouth upstream to First Avenue; *Central Business* from First to one-half block west of Second Avenue; *Mixed Residential* from one-half block west of second to Fifth Avenue; *Single Family Residential* on the south side of Mill Street from Fifth Avenue upstream to the vicinity of the Mill Street Bridge and *Institutional* on the north side of Mill Street. The balance of the area within the City limits is *Single Family Residential* along the Creek and north and *Rural Residential* to the south.

The City of Okanogan's Zoning Code regulates land uses along Lower Salmon Creek via the application of zoning districts, each with its own set of allowed uses, setbacks, and other variables. From the mouth upstream to Third Avenue, the land adjoining the Creek is zoned C-1, the City's downtown commercial district. Between Third and Fifth Avenues the zoning changes to R-4, the City's multi-family residential zone. From Fifth Avenue upstream to the City limits (including the former landfill site), the land adjoining the Creek is zoned R-3, a mixed single and multi-family zone.

In addition to the comprehensive plan designations and zoning districts, portions of the area also lie within the 100-year flood plain of Salmon Creek and the Okanogan River. Land along the Okanogan River is also regulated under the City of Okanogan's Shoreline Master Program (SMP). Regulation of development within the floodplain requires that structures for human habitation be elevated to 1 foot above the 100-year flood elevation and other uses are required to be flood-proofed.

The City's SMP regulates land uses within 200 feet landward on a horizontal plane from the ordinary-high-water-mark (OHWM) or the floodway boundary of the Okanogan River. The City's SMP designates the first 25 feet landward of the OHWM as Conservancy with the remainder of shoreline jurisdiction designated as Urban. Development within lands designated as "Conservancy" by the City's SMP is limited to actions that are water-dependent or that are required to protect or enhance the shoreline area. Construction or development of non-water-dependent uses are generally prohibited in the "conservancy" environment.

Okanogan County's Comprehensive Plan was adopted in 1964. The plan designates the land along Lower Salmon Creek outside the Okanogan city limits as *Intensive Agriculture* and it is zoned Minimum Requirement District. The "Intensive Agriculture" designation is intended to recognize the agricultural nature of existing land uses, however the Minimum Requirement District places mimimal requirements on development, primarily lot size, bulk, height and setbacks. Most land uses are permitted outright within this zoning district. Only those uses that have a significant potential for negative impacts require a conditional use permit. All residential and most commercial uses are allowed. **Table 3-27** provides data on current land use within the Project area.

Table 3-27. Current Land Use in Project Areas.

Land Use	Lower Salmon Creek Rehabilitation		Okanogan River Pump Station/Pipeline		Salmon Lake Feeder Canal		Shellrock Point Pipeline	
	Acres	Number of Parcels	Acres	Number of Parcels	Acres	Number of Parcels	Acres	Number of Parcels
Residential								
Single Family	140	87	20.54	18	14.05	52	55.57	17
Multi Family	3.41	5	0	0	0	0	0	0
Commercial	3.35	13	2.95	4	3.06	7	3.75	2
Public/Semi Public								
City	54.79	14	0.78	1	0	0	0.71	1
County	0.26	2	0	0	0	0	0	0
Churches	1.47	4	0	0	0	0	0	0
Schools	0.92	2	0	0	0	0	0	0
US	39.68	1	0	1	308.33	8	0	0
Hospital	0	0	0	0	0	0	22.56	4
Agriculture	916	28	373.51	19	46.78	2	156.54	15
Undeveloped	36.6	41	51.15	9	26.2	7	2.5	1
Total Land Area	1196.48	197	448.93	52	398.42	76	241.63	40

3.6.1.2 Okanogan River Pump Station and Pipeline Route

The proposed pump station site is located in a commercial area with auto-oriented commercial uses to the north and west, the County Historical Society's Museum and a few single-family homes to the south and agricultural land and a single family home to the east across the Okanogan River.

The pipeline route crosses S.R. 215 in a narrow strip of auto-oriented commercial land uses that quickly give way to vacant commercial lots and a narrow band of single family residential uses along N. Fourth Avenue. Due to the steep hillside, the western side of Fourth Avenue is undeveloped all the way to the edge of the flat with the exception of a City well facility. Land use shifts to commercial agriculture with a few scattered single-family homes for the remainder of the pipeline route.

Jurisdiction of the Pump Station/Pipeline area is divided between Okanogan County and the City of Okanogan. The City of Okanogan's comprehensive plan provides the following designations for the land at the proposed pump station site and along the pipeline route include: *Institutional* and *Industrial* at the pump station site, and *Single Family Residential* for the pipeline route in the City.

The City of Okanogan's Zoning Code regulates land uses in the Project area via the application of zoning districts, each with its own set of allowed uses, setbacks, etc. The pump station site and the first part of the pipeline route is zoned C-2, the City's auto-oriented commercial district. Between S.R. 215 and Fourth Avenue, the zoning changes to R-3, a mixed single and multi-family zone. West of Fourth Avenue the pipeline route leaves the city limits.

In addition to the comprehensive plan designations and zoning districts, the pump station and the initial portions of the pipeline route lie within the 100-year flood plain of the Okanogan River and are regulated under the City of Okanogan's Flood Hazard Prevention Ordinance and Shoreline Master Program (SMP). Regulation of development within the floodplain requires that structures for human habitation be elevated to 1 foot above the 100-year flood elevation and other uses are required to be flood-proofed.

The City's SMP regulates land uses within 200 feet landward on a horizontal plane from the ordinary-high-water-mark or the floodway boundary of the Okanogan River. The City's SMP designates the first 25 feet landward from the OHWM as Conservancy with the remainder of shoreline jurisdiction designated as Urban.

Okanogan County's Comprehensive Plan was adopted in 1964. The plan designates the land along the pipeline route as *Intensive Agriculture* and it is zoned Minimum Requirement District.

3.6.1.3 Feeder Canal

This analysis of existing land and shoreline use is based upon Okanogan County Assessor's records and visual observation of the Project area. The analysis is limited to those parcels that lie all or partially within 300 feet of the centerline of the feeder canal. This includes 76 individual parcels and excludes the public right of way contained within the streets and roads of the Town of Conconully and Okanogan County in the Project area.

The feeder canal area includes primarily single-family residential uses (both permanent as well as seasonal), an undeveloped mountainside, and a few commercial uses.

From the headgate on the North Fork of Salmon Creek, the feeder canal right-of-way forms a boundary between a number of permanent and seasonal residences and vacant lots and the sparsely timbered lower reaches of Funk Mountain. The canal route contours south and east along the slope of the mountain until it empties into Salmon Lake.

The feeder canal area is divided between Okanogan County and the Town of Conconully. Within the corporate limits, the Town manages land use with its community plan. At present, the Town has not adopted zoning, subdivision, flood damage prevention, and SEPA ordinances nor is it required to have a shoreline master program. Within the unincorporated area, Okanogan County manages land use with its comprehensive plan and zoning, subdivision, flood damage prevention, critical areas, SEPA ordinances, and Shoreline Master Program.

The County's SMP regulates land uses within 200 feet landward on a horizontal plane from the ordinary-high-water-mark of Salmon Lake. The SMP designates the entire shoreline area of Salmon Lake as *Conservancy*. Any action affecting private utilities or other facilities and structures that lie on leased federal land would require review and approval under the Okanogan County Shoreline Master Program.

3.6.2 LAND USE IMPACTS

3.6.2.1 Alternative 1: Okanogan River Pump Station and Pipeline

Alternative 1 would impact land and shoreline use at the pump station site and along the pipeline route. The impact to existing land and shoreline uses would result primarily from construction activities and noise from the pump station when it is in operation. The greatest impact to land and shoreline use (beyond those related to construction with the shoreline and floodplain areas at the pump station site and initial portions of the pipeline route) would be constraints on development of properties adjoining the pipeline easement, and the removal of several rows of fruit trees along the northern edge of Glover Lane to accommodate construction of the pipeline.

Environmental impacts on land and shoreline use along Lower Salmon Creek depend on the resulting flow regime. The potential exists for greater regulation of adjoining land uses as a result of the existence of flows for longer period of times. These flows could increase the potential for creation of fish and wildlife habitat that would require protection under the City's and County's Critical Areas Ordinances. Also, if the mean annual flow of Salmon Creek is increased enough to meet or exceed 20 cfs, the City and County would be required to amend their shoreline master plans to include the shoreline of Salmon Creek as a regulated area.

The most likely impacts include imposition of increased setbacks and requirements for new permitting, review and mitigation. In addition, it is possible that certain types of land uses that are determined to have a negative impact on the critical areas could be restricted. With increased stream flows and better access, ESA listed species may return with more frequency. Adjacent property owners could be directly affected only through direct NOAA Fisheries enforcement against "take" or by third party lawsuits seeking to enforce against take. As described above, it is most likely the City or County would regulate land use.

3.6.2.2 Alternative 1: Feeder Canal Upgrade

The primary impact to existing land and shoreline uses resulting from the feeder canal upgrade would be construction related. Long-term impacts would be improved stability of the slope in the vicinity of the feeder canal, which would eliminate potential erosion and slide hazards that presently affect adjoining land uses.

3.6.2.3 Alternative 1: Stream Rehabilitation

The primary impact to existing land uses resulting from the rehabilitation of lower Salmon Creek would be disruptions caused by construction activities.

3.6.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

The upgrade of the Shellrock Pumping Station would include construction of a new pipeline from the existing pipeline near the south end of Hubbert Road westward to a new sediment pond to be constructed on the slope of Pogue Mountain west of the Okanogan Valley Golf Club. The new pipeline would deliver water to the OID's distribution system between Diversion No. 2 and the OID Headquarters off Douglas Road.

Upgrade of the pump station would have limited impact since most of the work would take place within the footprint of the existing facility.

The new pipeline route would begin with a tie into the OID's existing pipeline on the small flat above the end of Haussler Road. Land use in this area is a mixture of single-family residences and small farms accessed by Hubbert Road. The pipeline route would then head directly west up a short undeveloped hillside to Pogue Flat and an area dominated by commercial orchards. Approximately halfway across Pogue Flat, the pipeline route would cross two small riparian zones and then climb back to the flat to follow an existing road through commercial orchards. The pipeline would then cross the Conconully Highway to an area where land use changes to pasture lands and a narrow band of single-family residences that line Pogue Road. Once past the houses, the pipeline route would cross the 2nd, 3rd, 4th and 5th fairways at the Okanogan Valley Golf Club before ascending the undeveloped lower reaches of Pogue Mountain and terminating at the proposed sediment pond. The site of the sediment pond would be an undeveloped slope on Pogue mountain.

Jurisdiction of land uses for the Shellrock Pump Station and the proposed pipeline route lies with Okanogan County. The County's Comprehensive Plan designates the affected areas as *Intensive Agriculture* and all areas lie within the Minimum Requirement District under the County's Zoning Code.

This alternative would impact land and shoreline use at the pump station site and along the pipeline route. The impact to existing land and shoreline uses would result primarily from construction activities and noise from the pump station when it is in operation. The greatest impact to land and shoreline use (beyond those related to construction with the shoreline and floodplain areas at the pump station site and initial portions of the pipeline route) would be constraints on development of properties adjoining the pipeline easement, and potential removal of fruit trees to accommodate construction of the pipeline. There would be short-term disturbance due to construction across two seasonal riparian zones totaling less than 0.1 acres.

Impacts to land use along Lower Salmon Creek due to changes in the flow regime would be similar to those described for Alternative 1 in **Section 3.6.2.1**.

3.6.2.5 Alternative 2: Feeder Canal Upgrade

Land use impacts would be similar to those described for Alternative 1 in **Section 3.2.2.2**.

3.6.2.6 Alternative 2: Stream Rehabilitation

Land use impacts would be similar to those described for Alternative 1 in **Section 3.6.2.3**.

3.6.2.7 Alternative 3: Water Rights Purchase

Alternative 3 has greatest potential to impact land use due to the removal of water from land that is presently under some form of agricultural production. Once irrigation water is removed from a property, the land would no longer be viable for agricultural production and either would be converted to some other less water intensive use, or would lie fallow. In order for the land to be converted to some other use, which in the case of lands within the OID would most likely be for some form of low density residential uses, a source of domestic water must be found. This would most likely be in the form of individual exempt wells, except in the area of the Duck Lake Ground Water Management Subarea. Establishment of the Subarea effectively closed the basin to future groundwater withdrawals (Chapter 173-132 WAC). The Duck Lake Water Users Association provides a domestic water system and controls ground water withdrawals for land within portions of the OID, however the Association has expanded to the limits of its water right, and new connections are not available. OID has the right to artificially stored groundwater in the Duck Lake aquifer because it provides the primary source of recharge to the local aquifer (from water diverted from Salmon and Johnson creeks for storage in Duck Lake). OID has provided water service in the area, but artificial recharge would decline with reduced operations, resulting in less availability of water for new connections. It is difficult to predict the environmental impacts of this alternative due to the fact that the lands where the water would be purchased or leased have not been identified. This is important in that the potential for conversion to other types of land use would depend on location and ability to secure some form of domestic water.

Impacts to land use along Lower Salmon Creek due to changes in the flow regime would be similar to those described for Alternative 1 in **Section 3.6.2.1**.

3.6.2.8 Alternative 3: Feeder Canal Upgrade

Land use impacts would be similar to those described for Alternative 1 in **Section 3.2.2.2**.

3.6.2.9 Alternative 3: Stream Rehabilitation

No stream rehabilitation is proposed so no impacts are expected.

3.6.2.10 No Action Alternative

Under this alternative, changes in land use along Lower Salmon Creek and in the vicinity of the feeder canal and the pump stations and pipeline would be driven by changing economic conditions in the local area. Any new growth or development would need to be in compliance with City and/or County plans and regulations.

3.6.3 MITIGATION MEASURES

The primary impacts to land use arise from increased regulation, which is itself intended to mitigate the consequences of unplanned development.

The purchase of buffer easements to protect project improvements, particularly where rehabilitation has occurred should be considered.

No further mitigation for land or shoreline use is proposed.

Wherever feasible, new pipeline should stay within existing rights-of-way or easements and wherever possible it should be constructed along property lines in order to minimize or eliminate increased limitations on the use of the subject property.

The feeder canal upgrade mitigates any risks posed to downslope properties by the condition of the existing canal. No further mitigation is proposed.

3.6.4 UNAVOIDABLE ADVERSE IMPACTS

No unavoidable adverse impacts to land and shoreline use are anticipated as a result of any portion of the proposed Project.

3.7 VISUAL RESOURCES

3.7.1 EXISTING CONDITIONS

The visual landscape of the areas surrounding the proposed Project includes residential and commercial development, public facilities, and agricultural lands. Important visual and recreational features include Conconully Lake, Salmon Lake, Duck Lake, lower and middle reaches of Salmon Creek, the Okanogan River, and the topography of sagebrush covered hills. In general, many of the natural and agricultural landscape features and patterns are attractive and interesting, but they are not visually distinctive or unusual within the region.

Figure 3-18. New Pump Station Site.

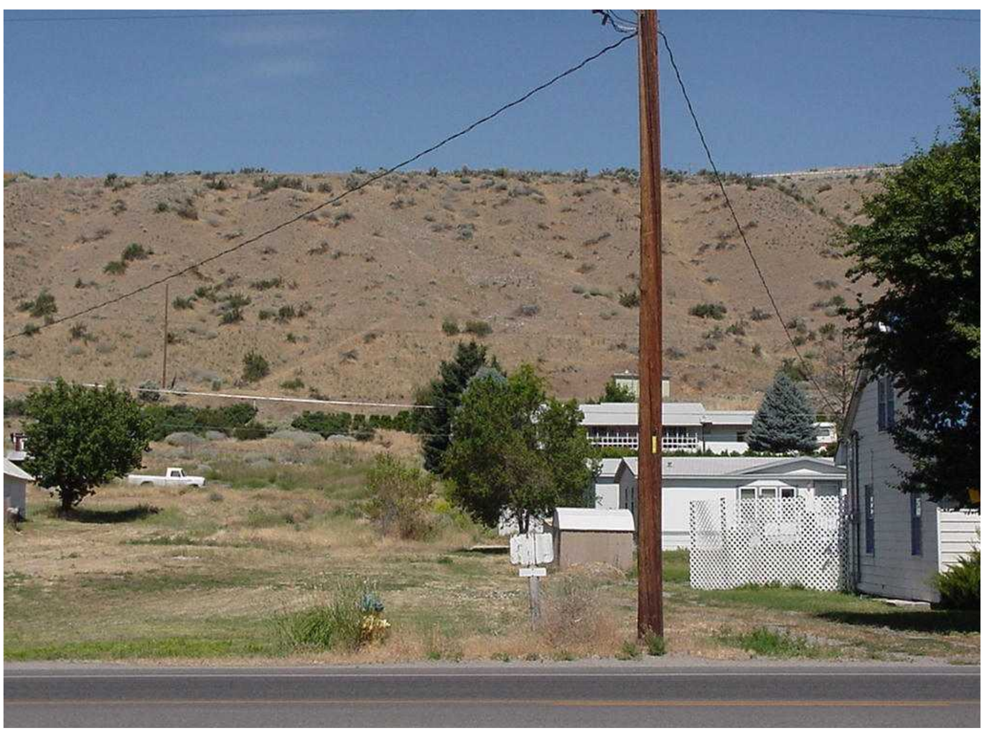

Figure 3-19. Pipeline Route

3.7.1.1 Pump Station/Pipeline

The Pump Station site is located in a commercial area with auto-oriented commercial uses to the north and west, the County Historical Society's Museum and a few single-family homes to the south and agricultural land and a single-family home to the east across the Okanogan River. The Pump Station site provides riparian vegetation to the waters edge, primarily consisting of white alder, cottonwood and other native vegetation (See **Figure 3-18**).

The pipeline route crosses S.R. 215 in a narrow strip of auto-oriented commercial uses, vacant commercial lots, and small clustering of single-family residences along North Fourth Avenue (See **Figure 3-19**). Due to the steep hillside on the west side of North Fourth Avenue, the pipeline passes through undeveloped areas with the exception of a City owned well facility at the edge of the flat. The remainder of the pipeline route is dominated by scattered commercial, agricultural, and residential uses.

Feeder Canal

The Feeder Canal area includes primarily single-family residences, an open pine forest on a mountain side, and a scattering of commercial uses. The headgate on the North Fork of Salmon Creek is in a very natural scenic setting in the creek adjacent to a road. The feeder canal right-of-way forms a boundary between a number of permanent and seasonal residences and the sparsely timbered lower reaches of Funk Mountain. The east end of the canal route contours through a relatively open, rocky, unstable slope of the mountain before it empties into Salmon Lake Reservoir. Overall, this area would be considered a natural appearing setting.

3.7.1.2 Lower Salmon Creek

The Lower Salmon Creek area includes a wide range of visual settings from fairly dense commercial and residential buildings within the corporate limits of the City of Okanogan to low density residential and agricultural land uses in the unincorporated areas. There are also several parcels of publicly owned property including the City of Okanogan's Alma Park along the southern edge of the Creek from First Avenue to the Okanogan River; a City owned boat launch ramp and river overlook just north of the confluence with the Okanogan River; an old landfill and several adjacent undeveloped parcels; and the Salmon Springs watershed area (part of the City's overall water supply). Okanogan County also owns a portion of the area, primarily the right-of-way for the Salmon Creek Road (see **Figure 3-20**).

Salmon Creek's watershed downstream of Conconully Reservoir is about 15 miles long and has several short minor tributaries. The middle reach of Salmon Creek is about 11 miles long and lies in a relatively scenic natural setting of riparian forest and agricultural lands. The lower reach of Salmon Creek extends for about 4.3 stream miles from the diversion dam through the City of Okanogan to the Okanogan River. This section of Salmon Creek is dewatered under normal irrigation operations, except during spring runoff events. Riparian vegetation along this stretch of the creek is sparse, and uncontrolled runoff has eroded the banks.

Figure 3-20. Lower Salmon Creek.

3.7.2 VISUAL IMPACTS

3.7.2.1 Alternative 1: Okanogan River Pump Station

This Alternative includes a new pump station that would be located on the west bank of the Okanogan River, within the limits of the City of Okanogan and about 1.3 miles upstream from the confluence of salmon Creek. Construction of a new pump house station would remove existing riparian vegetation and alter the visual landscape. The new structure would be visible from the Okanogan River, and to properties adjacent and/or near the site. The Project would include a new pump house, pumps, motors, control center, valves and related equipment. Associated with this Alternative would be a new pipeline, which would be approximately 10,630 feet long. It would follow County roads and existing BOR rights-of-way and easements over most of its length. The pipeline would be a buried 48-inch diameter spiral welded steel pipe. Short-term visual impacts may occur due to construction activities. These activities may include the use of heavy equipment, storage and staging areas near the proposed pipeline alignment, a construction facility office, and traffic impacts to some local roadways. Where the pipeline climbs a 25 percent grade some short term scarring of the hillside would occur as a result of trenching for the pipeline. Short-term construction impacts are not anticipated to result in significant visual impacts.

There would be no visual impacts to the upper or middle reaches of Salmon Creek as a result of Alternative 1. The addition of water to Lower Salmon Creek would generally have positive impacts on the visual landscape by reestablishing some riparian vegetation along the banks of lower Salmon Creek. Alternative 1 would promote the reestablishment of native riparian vegetation with the provision of fish flows positively impacting Lower Salmon Creek. No adverse visual impacts are anticipated as a result of this Alternative.

Salmon Lake Reservoir seasonal fluctuations would be reduced and Conconully Lake Reservoir water surface elevations would generally increase. There would be no important adverse visual impacts to Salmon Lake or Conconully Lake reservoir as a result of Alternative 1.

3.7.2.2 Alternative 1: Feeder Canal Upgrade

There would be no long-term negative visual impacts as a result of upgrading the existing canal. Approximately two-thirds of the canal would be left in place. The other one-third will have the canal removed but a buried pipeline installed in the same alignment. This area would actually look more natural in the long-term than the current condition. Upgrading the canal would improve the ability of the OID to maintain Salmon Lake levels, avoiding exposure of muddy shorelines, which impact the visual quality of the landscape.

Short-term construction activities would involve heavy machinery, temporary storage and office facilities, and temporary staging areas for pipe and miscellaneous construction materials. Construction materials and machinery would be stored on and adjacent to the existing feeder canal. The ground where the canal would be removed would look the most disturbed for the duration of construction activities and there would be a period of time before vegetation recovery occurs. The new alignment for the buried pipeline would also have a disturbed appearance for a short period of time. Upgrading the feeder canal is not expected to result in important adverse visual impacts because of the temporary and transitory nature of construction.

3.7.2.3 Alternative 1: Stream Rehabilitation

Short-term construction activities would involve the use of heavy machinery during late summer to early fall, temporary storage of equipment and construction materials, and increased traffic on local roads that access the Project area. Short-term construction impacts would be highly noticeable during the duration of the construction.

3.7.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Upgrading the Shellrock pump station would not significantly change the visual effect of the existing site. Alternative 2 includes stream rehabilitation, which would have a positive impact on the visual landscape. Alternative 2 would keep the median lake elevations higher and reduce seasonal fluctuations to a degree. Fluctuations would occur in Salmon Lake Reservoir, exposing muddy shoreline below the active storage elevation.

Associated with this Alternative would be a new pipeline, which would be approximately 10,200 feet long. It would follow roads over most of its length. The pipeline would be a buried 30-inch diameter ductile pipe. Short-term visual impacts may occur due to construction activities. These activities may include the use of heavy equipment, storage and staging areas near the proposed pipeline alignment, a construction facility office, and traffic impacts to some local roadways. Where the pipeline climbs a 25 percent grade some short term scarring of the hillside would occur as a result of trenching for the pipeline. Short-term construction impacts are not anticipated to result in significant visual impacts.

3.7.2.5 Alternative 2: Feeder Canal Upgrade

The impacts would be the same as described in **Section 3.7.2.2.**

3.7.2.6 Alternative 2: Stream Rehabilitation

The lower two miles of Salmon Creek would receive extensive reconstruction. Reconstruction would incorporate various treatment types to create a stream channel allowing adult fish to migrate upstream and convey floodwaters without excessive sedimentation, or property loss. The addition of water to Salmon Creek would generally have positive impacts on the visual landscape by reestablishing some riparian vegetation along the banks of the creek. It will take 5-10 years before this long-term impact of improvement is evident to the common observer. Short-term construction activities would involve the use of heavy machinery during late summer to early fall, temporary storage of equipment and construction materials, and increased traffic on local roads that access the Project area. Short-term construction impacts would be highly noticeable during the duration of the construction (expected to extend seasonally over a period of one or two years).

3.7.2.7 Alternative 3: Water Right Purchase

No infrastructure is associated with this Alternative. Water obtained through water rights purchase would be stored in Conconully and Salmon Lake Reservoirs and released into Salmon Creek using existing controls. Under Alternative 3, the visual landscape within the boundaries of the OID would be altered. Approximately 1,470 acres of farmland would be removed from production returning to a more arid, sparsely vegetated landscape than currently exists.

Under Alternative 3, there would be an overall positive impact to the visual landscape in the middle and lower reaches of Salmon Creek, with the regulation and provision of flows. No adverse visual impacts are anticipated as a result of this Alternative. This Alternative would enhance the visual landscape by promoting the reestablishment of riparian vegetation incident to flows for fish migration.

This alternative eliminates seasonal fluctuations in Conconully Lake and Salmon Lake reservoirs, such that median reservoir elevations are near full active storage in most months. No visual impacts are anticipated as a result of this Alternative.

3.7.2.8 Alternative 3: Feeder Canal Upgrade

The impacts would be the same as described in **Section 3.7.2.2.**

3.7.2.9 Alternative 3: Stream Rehabilitation

No stream rehabilitation is proposed so no impacts are expected.

3.7.2.10 No Action Alternative

Under this alternative lower Salmon Creek would continue to be dewatered in most years, and the Okanogan Irrigation District (OID) would continue to divert its irrigation water supply under existing water claims from its existing diversion dam at RM 3.4 on Salmon Creek. This trend is consistent with existing and historical conditions. In short, the visual landscape would remain unchanged except for continued bank erosion and further loss of already sparse riparian vegetation in Lower Salmon Creek (see **Figure 3-21**). The negative visual impact of the dewatered stream and degrading stream corridor would continue unabated.

Salmon Lake Reservoir

Conditions under the No Action Alternative would be similar to existing conditions. A small decrease in lake levels could occur, exposing muddy shorelines and stumps and impacting the visual quality of the landscape

Conconully Lake Reservoir

Under the No Action alternative, Conconully Lake Reservoir levels would be consistent with existing and historical conditions. A small decrease in lake levels could occur, exposing muddy shorelines and stumps and impacting the visual quality of the landscape (see **Figure 3-22**).

3.7.3 MITIGATION MEASURES

Vegetative screening should be considered for the new pump house under Alternative 1. No other significant visual impacts are identified which require mitigation.

3.7.4 UNAVOIDABLE ADVERSE IMPACTS

There are no unavoidable adverse impacts associated with the proposed alternatives as compared to the No Action Alternative.

3.8 SOCIOECONOMICS

3.8.1 EXISTING CONDITIONS

For the purposes of EIS analysis, the study region is defined as Okanogan County, Washington. Okanogan County is Washington's largest county in terms of land area, with nearly 3.4 million acres[13]. About 30 percent of the land within the county is in private ownership. The Colville Indian Reservation occupies approximately 700,000 acres of the county, and is located in the southeast corner of the county. The remainder of the county land area is made up of state and federal land[14]. A detailed Socioeconomics Resource Report is presented in **Appendix F**.

3.8.1.1 Population Characteristics

Age, race, and ethnic characteristics of the Okanogan County population, as recorded by the 2000 Census, are presented in **Table 3-28**. A total of 39,564 people lived within the county in 2000. The distribution among age groups is fairly similar to that of the state of Washington except for a slightly larger percentage, 14 percent, of county residents are over the age of 65, compared to less than 11 percent for the state, and a smaller percentage of county residents, 16 percent, belong to the age group of 20 to 34 years, compared to 21 percent for the state.[15]

Table 3-28. Age, Race, and Ethnicity Characteristics of Okanogan County Population

Note: Percentages may not appear to add to 100 due to rounding.

Source: U.S. Census Bureau, Census 2000, *Table DP-1 Profile of General Demographic Characteristics: 2000,* Geographic Area: Okanogan County, California.

Age, Race, and Ethnicity Characteristics	Number of People	Percentage of County Total
Age Group (years)		
0 to 19 years	12,012	30%
20 to 34 years	6,156	16%
35 to 44 years	5,757	15%
45 to 54 years	5,937	15%
55 to 64 years	4,145	10%
65 years and over	5,557	14%
Race		
White	29,799	75%
Black or African American	109	<1%
American Indian and Alaska Native	4,537	11%
Asian	176	<1%
Native Hawaiian and Other Pacific Islander	28	<1%
Some Other Race	3,791	10%
Two or More Races	1,124	3%
Hispanic Origin		
Hispanic	5,688	14%
Non-Hispanic	33,876	86%
TOTAL POPULATION	39,564	100%

13 3,371,698 acres, according to U.S. Department of Agriculture, *1997 Census of Agriculture*.
14 "Okanogan County Demographics," from the Okanogan County website, http://www.okanogancounty.org /DEMO.HTM, accessed June 9, 2003.
15 U.S. Census Bureau, Census 2000, Table DP-1 Profile of General Demographic Characteristics: 2000, Geographic Area: Washington.

Figure 3-21. Typical Summer Conditions of Lower Salmon Creek.

Figure 3-22. Low Storage Level for Conconully Lake Reservoir (October 2001).

The county population is predominantly white, with 75 percent of those counted by the 2000 Census identifying themselves as white. The next largest racial group is American Indian or Alaska Native, which accounts for 11 percent of the county population, likely due to the presence of the Colville Indian Reservation. Of the 4,537 people within Okanogan County that identified their race as American Indian or Alaska Native, 3,369 live on the reservation.[17] Another 10 percent of the county population identified themselves as "Some Other Race." Because the 2000 Census allowed the selection of more than one race for each person, another three percent of the county population selected "two or more races."

Hispanic origin is tallied separately from race, as a person of Hispanic origin can be of any race. Over 14 percent of the county's population identified themselves as being of Hispanic origin in the 2000 Census, as compared to 7 percent of the state population.[18] The economic dominance of agriculture and specifically labor-intensive orchard crops such as apples and cherries in Okanogan County has drawn many laborers of Hispanic origin to the area.[19]

Table 3-29. Okanogan County Cities and Population (2000).

City	Number of People	Percentage of County Total
Brewster	2,189	6%
Conconully	185	<1%
Coulee Dam (part)	915	2%
Elmer City	267	1%
Nespelem	212	1%
Okanogan	2,484	6%
Omak	4,721	12%
Oroville	1,653	4%
Pateros	643	2%
Riverside	348	1%
Tonasket	1,013	3%
Twisp	938	2%
Winthrop	349	1%
Incorporated	15,917	40%
Unincorporated	23,647	60%

Source: Washington State Office of Financial Management, Forecasting Division, June 28, 2002, April 1 Population of Cities, Towns, and Counties Used for Allocation of Selected State Revenues State of Washington, (Census 2000 series).

Most of the residents of Okanogan County, or 60 percent of the total population, live outside of the incorporated areas of the county, as shown in **Table 3-29**. The largest city is Omak, with a population of 4,721 people, or 12 percent of the county's residents. The cities of Okanogan, with

[16] U.S. Census Bureau, Census 2000, Table DP-1 Profile of General Demographic Characteristics: 2000, Geographic Area: Washington.

[17] U.S. Census Bureau, 2000 Census of Population and Housing, 2002, *Summary Population and Housing Characteristics*, PHC-1-49, Washington, p. 48.

[18] U.S. Census Bureau, Census 2000, Table DP-1 Profile of General Demographic Characteristics: 2000, Geographic Area: Washington.

[19] Washington State Employment Security Department, Labor Market and Economic Analysis Branch, September 2002, *Okanogan County Profile*, p. 6.

a population of 2,484, and Brewster, with a population of 2,189, each account for about six percent of the county total. The other cities and towns are even smaller, with the smallest being Conconully, with only 185 residents.

3.8.1.2 Okanogan County Economy

An input-output (I-O) model has been developed for this study, incorporating economic activity in Okanogan County. The model is used to measure the indirect effect that changes in crop production may have on the regional economy, in terms of changes in industry output, employment, and income. The model is based on IMPLAN ("impact analysis for planning"), a system of software and data used to perform economic impact analysis. Originally developed by the USDA Forest Service, the system is now maintained and marketed by the Minnesota IMPLAN Group, Inc. (MIG). The databases are developed by MIG annually, using data collected at the national, state, and county level for all possible elements from a variety of state and federal sources. The model developed for this study is based on 2000 data, the most recently available at the time of this analysis.

Table 3-30 displays the base data for the Okanogan County IMPLAN model developed for this study. Three different economic measures are presented here and would be referenced when discussing impacts later in this report. "Output" (also known as total industry output) is the first measure, and represents the value of production of goods and services by businesses in the local economy. This can serve as an overall measure of the local economy, and is useful for comparing regions and looking at impacts.

Table 3-30. 2000 Okanogan County IMPLAN Model

Industry	Output *($millions)*	Income *($millions)*	Employment *(# of jobs)*
Agriculture, Forestry, and Fishing	$202.329	$94.907	5,480
Mining	$17.024	$3.843	92
Construction	$119.066	$33.523	1,081
Manufacturing	$159.396	$40.709	1,172
Transportation, Communication, and Public Utilities	$56.535	$16.636	450
Trade (Retail and Wholesale)	$161.580	$72.227	4,165
Finance, Insurance, and Real Estate	$206.812	$22.947	1,062
Services	$223.606	$115.075	5,152
Government	$216.778	$156.300	4,618
Other[1/]	-$0.743	$1.232	119
TOTAL	$1,362.383	$557.401	23,391

[1/] For this model, "other" consists primarily of domestic services (such as cleaning and maid services), as well as an "inventory valuation adjustment," used to estimate the value of goods removed from inventory that were produced in a previous time period at a different value.

Source: 2000 IMPLAN data from Minnesota IMPLAN Group, Inc., with modifications by NEA.

The second measure is "Personal Income," which is the sum of employee compensation and proprietor income. Employee compensation represents total payroll costs, including wages and salaries paid to workers plus benefits such as health insurance, as well as retirement payments and non-cash compensation. Proprietor income includes payments received by self-employed individuals as income, such as income received by private business owners, doctors, or lawyers. This measure is useful to show how the employees and proprietors of businesses producing the output share in the fortunes of those businesses. The third measure is “Employment.” This represents the annual average number of employees, whether full- or part-time, of the businesses producing the output.

Nearly $1.4 billion in goods and services are produced within Okanogan County, with local industry supporting over 23,000 jobs and earnings in excess of $557 million. The most significant industries in terms of output, each accounting for about 15 to 16 percent of the total county output, are services; government; finance, insurance, and real estate; and agriculture, forestry, and fishing. Nearly 5,500 jobs, or 23 percent of county employment, are in the agriculture, forestry, and fishing industry, making it the largest employer in the county. Other significant employers are services, government, and wholesale and retail trade.

Employment and Earnings

Employment and earnings by industry are presented in **Figures 3-23** and **3-24**. These employment numbers from the Department of Commerce’s Regional Economic Information System (REIS) count all jobs, including non-agricultural wage and salary employment, agricultural employment, and non-agricultural jobs that are not covered by state unemployment insurance, such as the self-employed. These numbers may differ slightly from the IMPLAN model data, which are compiled from a number of sources.

The importance of agricultural production to Okanogan County’s economy is evident by the large share, nearly one-quarter of total county jobs, found either on farms or in the agricultural services, forestry, and fishing sector. Over 85 percent of these agricultural jobs are in fruit orchards.[20] Apples are the prominent crop produced in Okanogan County, although other orchard crops are also grown, such as pears and cherries. Livestock production, primarily cattle, is also an important element of the county’s agricultural sector.

The services sector is also a significant employer in Okanogan County, providing one-quarter of the total jobs in the county. One of the largest areas of employment in the services sector is health services, which includes private hospitals (public hospitals fall into the government category), dentist and doctor offices, nursing care facilities, and other health-related businesses.[21] Membership organizations also are significant employers in Okanogan County that belong to the services sector, and include unions, religious organizations, fraternal organizations, tribal administration, and similar groups. One of the larger employers in the county is the Colville Tribal Enterprise, which belongs to this division of the services sector.[22] Social services, such as individual and family social services, job training and vocational rehabilitation services, child day care, and residential care, and lodging services, such as hotels and motels, also provide employment within the county’s services sector.

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[20] Washington State Employment Security Department, Labor Market and Economic Analysis Branch, September 2002, *Okanogan County Profile*, p. 18.
[21] Ibid., p. 23.
[22] Ibid.

With 18 percent of employment, government is another significant employer in the county. Government is typically a large sector in all counties, but is even larger in Okanogan County due to the state and federal management of forests, parks, and dams in the county, as well as regulatory oversight of farming. Local government makes up about two-thirds of government employees, and many of these jobs are in primary and secondary education, as well as other executive and legislative work and public hospitals. A small portion of government employment is for the state, and includes employees of community colleges and social workers. The federal government has a large share, about 22 percent, of the government jobs in the county. Many of these jobs are related to the operation of the large irrigation system, while others are involved in land, mineral, or wildlife conservation.[23]

Retail and wholesale trade account for 14 and 5 percent of employment, respectively. Within the retail sector, eating and drinking establishments employ the most workers, followed by food stores and auto dealers and service stations.[24] About 80 percent of wholesale trade employment is related to wholesale fresh fruit and vegetable distribution, primarily for apples, but also pears, other tree fruits, grain, and livestock/meat products.[25]

The other sectors of the local economy are responsible for smaller shares of employment. Finance, insurance, and real estate provide a little over five percent of the total jobs in the county, most of these in real estate and banking. Manufacturing employment contributes slightly less than five percent of total jobs, and the majority of these jobs are in lumber and wood processing. About four percent of total county jobs are in construction, which includes special trade contractors, general building contractors, heavy construction workers, and other construction trade workers. Transportation, communication, and public utilities, with just over two percent of total employment, consists mainly of trucking and warehousing; communications such as telephone, television, or radio services; and utilities such as electric, gas, and sanitary services. About one-third of these jobs are in trucking and warehousing, related to the transportation of agricultural crops. Mining is the smallest sector in the county in terms of employment, with less than one percent of the total jobs found in this sector.

Earnings represent the sum of three components of personal income: wage and salary disbursements, other labor income (includes employer contribution to pension and profit-sharing, health and life insurance, and other non-cash compensation), and proprietors' income. Earnings reflect the amount of income that is derived directly from work and work-related factors. Earnings can be used as a proxy for the income that is generated within a geographical area by industry sectors, and can be used to identify the significant income-producing industries of a region or to show trends in industry growth or decline.

In terms of earnings, government is the largest sector in the county, with 27 percent of all earnings. The government sector accounts for just 18 percent of jobs in the county, but these jobs tend to be higher paying than those in some other sectors, such as agriculture or retail trade. The second largest county sector in terms of earnings is the services sector, contributing 24

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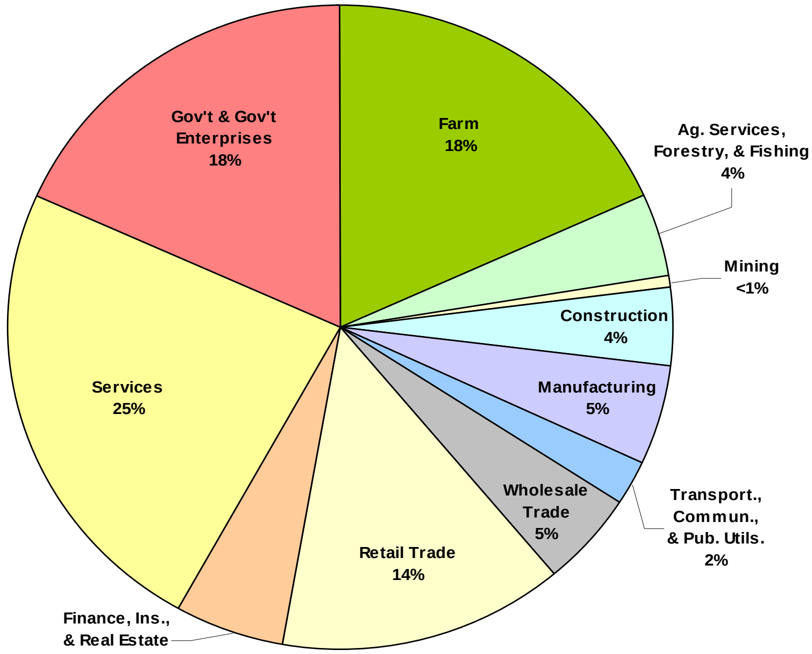
[23] Ibid.
[24] Ibid., p. 21.
[25] Washington State Employment Security Department, Labor Market and Economic Analysis Branch, *Okanogan County Profile*, September 2002, p. 21.



Source: U.S. Departı , May 2002, *Regional Economic Information S*

Figure 3-23. Okanogan County 2000 Employment by Industry.

Source: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, May 2002, *Regional Economic Information System (REIS), 1969-2000*, CD-ROM.

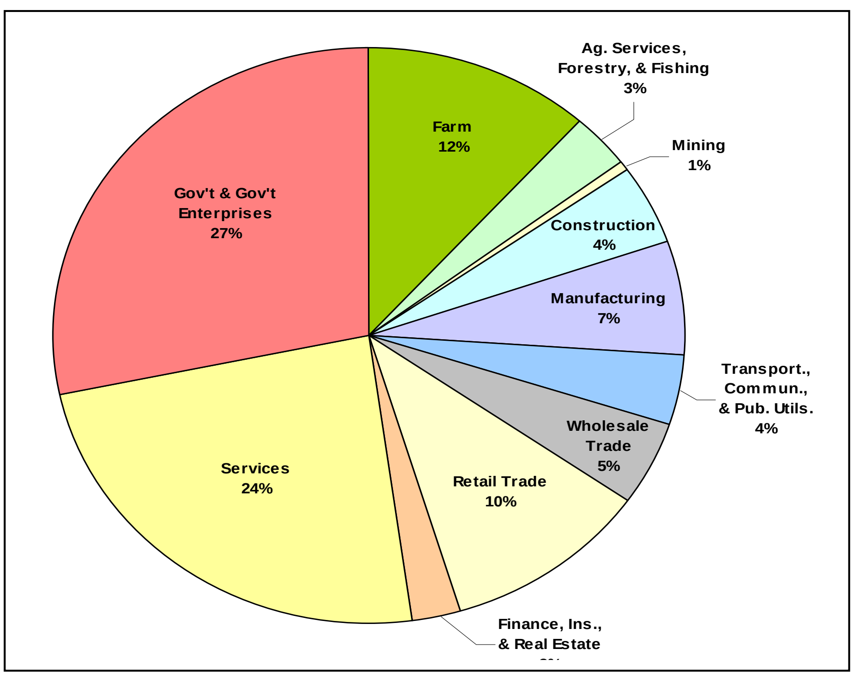


Figure 3-24. Okanogan County 2000 Earnings by Industry

percent of total earnings. As in the government sector, higher pay also characterizes the manufacturing and transportation, communication, and public utilities sectors, where five and two percent of total jobs, respectively, are responsible for seven and four percent of total earnings.

While agricultural jobs make up a large portion of county employment, earnings for farm and agricultural services, forestry, and fishing workers make up a lesser share of the total county earnings. Farm employment accounts for 18 percent of all jobs in the county, yet only contributes 12 percent of total earnings, and jobs in the agricultural services, forestry, and fishing sector account for four percent of total employment, yet only three percent of total earnings. The preponderance of part-time and seasonal workers in the agricultural industry, as well as the tendency for wages to be lower for these jobs than those in other industries, contributes to this lesser earning power. This is also true for retail trade, where employment makes up 14 percent of total jobs, but these jobs earn just 10 percent of the county's total earnings.

The labor force is made up of all persons 16 years of age or older within a specific geographic area who are either working or actively looking for work. The unemployment rate is the percentage of people within this labor force who are not employed, but still actively seeking work. The unemployment rate for Okanogan County has been almost five percentage points higher than the state average in the past three decades, only falling below 10 percent during the relatively prosperous 1990s.[28] The annual average unemployment rate for Okanogan County was 11.6 percent in 2002, compared to a rate of 6.4 percent for Washington State.[29]

The seasonal nature of many agricultural jobs leads to a changing unemployment pattern in Okanogan County throughout the year. During the summer months, the unemployment rate typically falls, as agricultural work opportunities increase, and the unemployment rate increases in the winter months when agricultural work opportunities decrease. This seasonality is typical of counties with agricultural or timber dependent economies.

Economic Well-Being

Personal income is another indicator of a region's economic vitality. Personal income encompasses not only earnings, such as wages and salaries and other work-related compensation as discussed previously, but also transfer payments and investment income. Transfer payments are comprised of payments such as income maintenance, unemployment insurance, retirement benefits, and medical payments. Investment income includes interest, dividends, and rent from investments.

Per capita income is calculated by dividing the total personal income by the total population for a particular area. This figure can be used to compare regions or time periods, and is a useful

[26] Ibid., p. 21.
[27] Washington State Employment Security Department, Labor Market and Economic Analysis Branch, *Okanogan County Profile*, September 2002, p. 21.
[28] Ibid., p. 10.
[29] Washington State Employment Security Department, Labor Market and Economic Analysis Branch, April 1, 2003, *2001 Annual Average Washington State Resident Civilian Labor Force and Employment*.

indicator of the character of consumer markets and the overall economic "well-being" of area residents. Per capita income provides a good measure of how personal income is growing relative to a population, but does not necessarily indicate how that income is distributed among the population.

Okanogan County's per capita income in 2000 was $20,117, which was substantially less than that of the state of Washington, or $31,230.[30] Okanogan County ranked 34th of Washington's 39 counties in terms of per capita income, with King County reporting the highest, at $45,536.[31]

Another measure used to indicate economic well-being in a region is the percentage of people who are estimated to live below the poverty level. These data are based on national levels set for minimum income requirements for various different sizes of households. There is no correction for the variation in costs of living among areas. For example, if housing prices and food prices in a county were lower than national levels, then a family in that county with an income at the national poverty level might be better off than a family with the same income living elsewhere in the nation. However, poverty figures can be useful to permit comparison between geographic areas and time periods.

The most recent available poverty data is from the 2000 Census, and is based on income levels reported for 1999. In 1999, 1,697 families in Okanogan County were found to have incomes below the poverty level, representing 16.0 percent of all families in the county for which poverty status was determined.[32] This is much greater than the 7.3 percent of families living in poverty that was reported for the state of Washington.[33] When individual people are counted, 8,311, or 21.3 percent, of the Okanogan County residents for which poverty status was determined lived below the poverty level in 1999.[34] This is also a far greater rate than that of the state, which reported that 10.6 percent of individuals for which poverty status was determined had incomes below the poverty level in 1999.[35]

3.8.1.3 Okanogan Irrigation District

The Okanogan Irrigation District (OID) in Okanogan County, Washington, was authorized in 1905 to serve 10,000 acres.[36] Currently, OID consists of 5,032 assessed acres near the Okanogan River. Irrigation water is primarily supplied to the district through a diversion from Salmon Creek, a tributary to the Okanogan River. Two storage facilities, Conconully Reservoir and Salmon Lake, store Salmon Creek flows and are operated to meet downstream irrigation demand within the district. Supplemental water supplies are pumped directly from the Okanogan River

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30 U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, May 2002, *Regional Economic Information System (REIS), 1969-2000*, CD-ROM.
31 Ibid.
32 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Okanogan County, Washington.
33 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Washington.
34 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Okanogan County, Washington.
35 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Washington.
36 The district was never built-out to serve the full 10,000 acres that were authorized.

at the Shellrock pumping station and from Duck Lake when Salmon Creek supplies are inadequate to meet irrigation demands.

The Salmon Creek diversion dam, located approximately 12 miles downstream from Conconully Reservoir, diverts water from Salmon Creek into the Main Canal. The Main Canal is 7.6 miles of open concrete lined canal that runs along the western border of the district. Water is diverted from the Main Canal into five laterals consisting of more than 44 miles of closed, pressurized pipeline. The maximum capacity of the Main Canal is estimated to be 80 cubic feet per second (cfs).

OID has more than 600 member accounts with assessable acres ranging from approximately 0.2 acres to 230 acres per account. The average assessed acreage per account in the district is 8.2 acres and the median is 3.5 acres. While the district supports a large number of full-time producers, part-time producers with primary sources of income other than farming manage much of the irrigated acreage. In addition, an increasing share of the district is being converted from commercial agricultural production to rural/residential uses with parcels smaller than five acres. According to OID crop reports, urban lands served by district water supplies increased from 115 acres in 1990 to approximately 550 acres in 1998. This trend toward smaller acreages within the district has continued in recent years. Currently, nearly one-third of the district's annual assessment fees are paid by members with less than five acres served by district water supplies.

Crops in OID consist primarily of tree fruits and forage crops. Approximately half of the assessed acres in the district are planted to tree fruits. Apples are the most prevalent tree fruit in the district, followed by pears and cherries. In addition, more than 1,300 acres are planted to pasture and hay crops.

Financial Conditions and Repayment Obligations

The projected total 2003 assessment for OID is approximately $650,000. Assessment charges vary according to the size of the account. Small acreages receiving OID service are generally assessed at a higher rate than larger acreages. Each account is charged a fixed fee of $50 per acre. **Table 3-31** shows how district charges vary with acreage.

Table 3-31. Okanogan Irrigation District Assessment Schedule, 2003

Acres	Assessment
0.01-1.00	$142
1.01-1.50	$213
1.51-2.40	$284
Remaining Acres	$120/acre

Source: Tom Sullivan, Okanogan Irrigation District.

In addition to assessments, OID receives revenue from a variety of sources including grants, interest, and charges to domestic well users benefiting from groundwater recharge at Duck Lake. Planned expenditures for 2003 include approximately $500,000 for operations and maintenance, $65,000 for debt repayment associated with the Shellrock facility, and nearly $210,000 in rehabilitation and betterment bond payments. Debt obligations are projected to remain relatively constant at approximately $60 per acre through 2013 but would decline to less than $14 following repayment of the rehabilitation and betterment bond in 2014.

Current Crop Production and Markets

Agricultural production within OID consists primarily of orchard crops. Apples are the most commonly produced tree fruit and are planted to more acres than any other crop produced in the district. Common apple varieties found in the district include Red Delicious, Golden Delicious, Gala, and Braeburn, among others. Pears and cherries are other important crops but are grown on fewer acres than apples. Growers in the district have increased the acreage of pears substantially due to poor apple market conditions in recent years. Similarly, cherry acreage has doubled in OID during the last five years but still represents a relatively small amount of district acreage. Other less hardy tree fruit has not increased in acreage substantially.

While orchard crops generate a major share of crop revenues within OID, forage crops are produced on a large portion of the district's irrigated acres. Hay and pasture production has generally been increasing over the last decade as orchard crops have been removed due to depressed prices and land has been subdivided and converted to small acreage rural/residential sites. Many of these rural/residential sites maintain small pastures or hay fields to support livestock on the property.

Table 3-32 provides the cropping history for OID from 1991 through 1998 as well as current estimates collected from parcel records maintained by the Okanogan County Assessor's Office. Currently, an estimated 3,907 acres (harvested acreage plus young trees) are irrigated compared to 4,317 acres in 1990. Although total apple acreage has declined by nearly 700 acres since 1990, total orchard acreage in production (including young trees) declined by only 315 acres over the same period as producers shifted from apples to other tree fruits.

Apple acreage by variety has not been historically collected and reported by OID.[37] Current apple variety information was obtained by reviewing Assessor field notes for each district parcel at the Okanogan County Assessor's Office. In total, 660 acres of Red Delicious, 287 acres of Golden Delicious, and 638 acres of other apple varieties remain in the district. This variety mix is consistent with a recent fruit survey of the Wenatchee District, which includes OID, conducted by the Washington Agricultural Statistics Service. The 2001 survey reported that of the 54,000 acres in the Wenatchee District, 41.5 percent were planted to Red Delicious, 16.5 percent were planted to Golden Delicious, and 42 percent were planted to other apple varieties.[38] Since 1993, Red Delicious acreage has declined by more than 25 percent throughout Washington State, while Golden Delicious acreage has shown only a slight decline. Total Washington State apple acreage was estimated at 192,000 acres in 2001, compared to 172,000 acres in 1993. Current estimates place Washington's total apple crop at 175,000 acres.[39]

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[37] Personal communication with Tom Sullivan, OID Manager, March 2003.
[38] Washington Agricultural Statistics Service, "Washington Fruit Survey 2001."
[39] Tom Schotzko, "Apple Outlook, 2002 Crop," Washington State University Cooperative Extension.

Table 3-32. Crop Production in Okanogan Irrigation District, Selected Years, 1990-Present

Harvested Acreage	1990	1991	1992	1994	1995	1996	1998	Current
Alfalfa/Other Hay	534	539	539	554	636	636	610	473
Pasture	828	808	808	876	805	805	800	870
All Apples	2,289	2,222	2,222	2,250	2,173	2,173	1,810	1,586
Red Delicious								*660*
Golden Delicious								*287*
Other Varieties								*638*
Apricots	3							4
Cherries	8	8	8	25	15	15	50	107
Peaches	31	31	31	25	17	17	10	5
Pears	458	456	456	450	260	260	260	436
Other Crops								30
Family Plots	106	113	113	24	127	127		
Total Harvested Acreage	4,257	4,177	4,177	4,204	4,061	4,061	3,550	3,510
Acres Not Harvested								
Cropland (young trees)	60	69	69	32	174	174	602	397
Fallow or Idle	470	571	571	365	301	96	76	321
Roads, ditches, drains	136	100	100	96	96	301	255	255
Urban/Suburban Lands	115	121	121	335	400	400	549	549
Total Acres Not Harvested	781	861	861	828	971	971	1,482	1,522
Total Assessed Acreage	5,038	5,038	5,038	5,032	5,032	5,032	5,032	5,032

Sources: Okanogan Irrigation District Crop Reports, 1990-1998. Okanogan County Assessor's Office.

Crop Value

The estimated market value of agricultural products sold in the county in 1997 was $133.5 million, primarily from crop production. An estimated 568 farms contain nearly 30,000 acres of orchard crops in Okanogan County.[40] In comparison, Washington State reported more than 300,000 acres in orchards. Washington State is the leading U.S. producer of apples and pears, producing approximately 50 percent of total U.S. apple and pear crops.[41] Orchard crops are labor and input intensive relative to many other irrigated crops. As a result, a large portion of the regional economy is comprised of industries that directly support orchard production with labor and input supply, as well as industries that process, package, and market the harvested fruit.

The total value of crops grown in OID in 2002 is estimated to be $12,152,039 (see **Table 3-33**). This estimate is based on 2002 crop prices and current crop information collected at the Okanogan County Assessor's Office and supplemented with historic crop reports provided by OID to account for parcels without crop information provided. Value per acre is based on the farm level rather than retail price of each crop.

[40] USDA, "1997 Census of Agriculture."
[41] Northwest Horticultural Council, May 2003.

Apples accounted for 37.5 percent of crop acres and contributed nearly 72 percent to total farm revenues within the district. Conversely, pasture and hay comprised 30 percent of the acres, but 4 percent of value. Pears are the second highest revenue crop in the district, earning 17.8 percent of the value from 10.3 percent of the acreage. Lastly, cherries make up 2.5 percent of the acres and 5.9 percent of value.

Table 3-33. Crop Acres, Value per Acre, and Total Crop Value, Okanogan Irrigation District, 2002

Crop	Acres	Value/Acre	Total Value	Percent of Acres	Percent of Value
Alfalfa	372	$810	$301,646	8.8%	2.5%
Other Hay	101	$845	$84,930	2.4%	0.7%
Pasture	870	$435	$375,638	20.6%	0.8%
Apples	1,586	$5,381	$8,533,949	37.5%	71.9%
Pears	436	$4,842	$2,111,724	10.3%	17.8%
Cherries	107	$6,528	$696,500	2.5%	5.9%
Apricots	4	$3,132	$12,234	0.1%	0.1%
Peaches	5	$6,895	$35,419	0.1%	0.3%
Other Minor Crops	30	$-	$-	0.7%	0.0%
Young Trees	397	$-	$-	9.4%	0.0%
Fallow/Idle	321	$-	$-	7.6%	0.0%
Total	4,22842		$12,152,039	100.0%	100.0%

Note: Totals may appear not to add precisely due to rounding.

Source: Washington Growers Clearing House, May 2003, Washington State Agricultural Statistics Service.

Apple prices vary considerably by variety. Red Delicious prices have been consistently below other varieties over the last five years. According to published Washington crop budgets for Red Delicious, the breakeven price is approximately $13.20 per pack. As shown below, the average price did not reach the breakeven level between 1997 and 2002. Furthermore, there has only been one year in the last decade that the Red Delicious price has exceeded $13.00.[43] Some newer Red Delicious crops are able to earn a profit because of high quality fruit production. However, older trees, which represent the majority of Red Delicious acres in Washington State and OID, generally have a lower packout of high quality fruit and earn lower prices. On average, Red Delicious producers have experienced estimated net losses of approximately $1,000 per acre in recent years.[44]

Golden Delicious is a marginal performing apple variety with prices high enough in some years to earn a profit, but below breakeven levels in others. Much of the acreage consists of trees more than 20 years old, which can make it difficult to produce and market the highest quality fruit. The estimated breakeven price for Golden Delicious is $13.09 per pack (about 42 pounds). Average prices were above breakeven levels in four of the last five years and average net returns

[42] The column does not total to 5032 acres because of lands reported by the District in “roads, ditches, and drains” and “urban/suburban” lands (see Appendix F Socioeconomics Resource Report for more detail). Also, no value was assigned to “minor crops” because the specific crops that fall in this category are undocumented.
[43] Washington Growers Clearing House, May 2003.
[44] Derived from crop budgets assembled by Jim DuBruille, Wenatchee Valley College, and Washington State University Cooperative Extension.

for Golden Delicious with good yields have been approximately $450 per acre in recent years. However, older trees, with lower yields and less high quality fruit, have generally experienced losses.

Other apple varieties such as Gala and Fuji earn higher prices and tend to be more profitable than Red and Golden Delicious. For example, the average estimated net returns to Gala and Fuji production have been $1,328 and $793 per acre, respectively.

3.8.1.4 Recreation: Conconully Reservoir and Salmon Lake

Okanogan County Overview

In 1972, the North Cascades Scenic Highway (Highway 20) was completed, thus significantly reducing the travel time for people from Seattle and other areas on the I-5 corridor to the scenic North Cascades and to Lake Chelan. Since that time, tourism has increased in importance in Okanogan County.[45] Okanogan County offers impressive vistas, including large glaciers in the North Cascades. It also offers opportunities for alpine and nordic skiing, hiking, biking, mountain and rock climbing, snowmobiling, fishing, hunting, lake and river recreation, rodeos, pow-wows, and other outdoor activities.[46]

Conconully and the Recreation-Based Economy

The city of Conconully is on the North Fork of Salmon Creek, and was originally settled as a mining community. Dams form two lakes near the city: Salmon Lake, an off-stream storage reservoir, and Conconully Reservoir, formed just downstream within Salmon Creek. Conconully is located approximately 19 miles from Okanogan and 16 miles west of Riverside.

Employment within the town of Conconully is highly dependent upon recreation. The Conconully Chamber of Commerce's membership directory includes seven camping and lodging facilities, three of which also provide boating access and rentals, three restaurants, and one general store.[47] One additional motel was not listed in the membership directory. Conconully State Park also provides access for fishing, camping, and boating. Another general store and one recreational vehicle park closed within the last three years. Privately owned or rented cabins and summer homes dot the area, with some 28 summer homes along the north shore of Salmon Lake.[48]

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[45] Twisp Chamber of Commerce, 2002, "Welcome to Twisp, Washington!" Webpage: http://www.twispinfo.com/history.html, accessed June 17, 2003. Okanogan County Tourism Council, 2002, "Camping and Fishing Guide to Washington's Okanogan County." The Omak Chronicle, Inc.

[46] The Omak Chronicle, Inc., 2002, *Vacationland: The Official Visitors' Guide to Okanogan Country 2002-03*, The Chronicle, Omak, Washington. Omak-Okanogan County Chronicle, 2003, *InfoBook Okanogan County 2003*, Omak, Washington.

[47] Omak-Okanogan County Chronicle, 2003.

[48] Highlands Associates, n.d., Salmon Creek Project: Salmon Lake Level Increase Built Environment Analysis, Okanogan, Washington.

Fishers and boaters impact the Conconully economy by paying locally for camping spaces and other lodging, paying for boat rentals and launch fees, and buying fishing equipment, gasoline for boats and cars, camping supplies and equipment, and food and drink. During fall and winter, hunters and snowmobile enthusiasts rent cabins or motel rooms, and frequent the restaurants and the general store in town.

Recreation businesses and tourism are service sectors with a dominant role in the local economy. Service sectors generally receive lower income per worker than professional or production market sectors. Median household income in Conconully was $23,314 in 1999, which is lower than the 1999 median household income for Okanogan County of $29,726.[49]

Patrons and Recreational Activities

The peak visitation period for all businesses and the state park generally falls between late April and early November. Fishing is dominant in late April through May. Another peak occurs in August when families with children come for swimming and water sports. Weekends, holidays, and Conconully celebrations, including those in the winter, provide other visitation opportunities.

Business owners estimate the number of visitors from the "westside" (western Washington) range from a low of no winter visitors, to a high of 95 percent of all summer visitors. Businesses open only in the spring through fall season report a range of 65 to 95 percent of their visitors are from the westside. Out-of-county visitors from the "eastside," primarily the areas of Wenatchee, Spokane, and the Tri-Cities, are estimated to constitute a low of five percent for seasonal businesses, to a high of 50 percent of all visitors to year-round businesses. During the winter, visitors from Omak and Okanogan constitute from zero to about 10 or 15 percent of the visitors, with the rest generally being local residents.

Spring and summer fishing and motorized water sports are the foundations of Conconully's recreation economy, with business owners estimating that 60 to 90 percent of their April through August visitors fish and participate in water-based recreation. Camping and room rentals increase along with visitation for fishing and water sports. Fishing is mostly for trout stocked in the lakes. In addition to the Washington Department of Fish and Wildlife's stocking of rainbow trout, local residents purchased large, fast-growing, sterile trout and stocked the lakes with those. Most fishing, approximately 70 percent, is catch and keep. Other activities occurring in the summer include over 30 family reunions per summer, about 12 weddings per summer (mostly at the state park), four-wheeling, hiking, biking, bird watching, and even "deer counting." Hunting and snowmobiling generally provide fewer out-of-county visitors but are nonetheless important contributors to the town's economy in the fall and winter seasons.

Recent Conditions and Recreation

Owners of Conconully businesses and the Conconully State Park manager were interviewed to determine: (1) the nature and capacity of businesses, including during peak seasons; (2) the types

[49] U.S. Census Bureau, 2000, *Census 2000 Summary File 3 (SF3) Sample Data*, Table: "P56, Median Household Income in 1999 (Dollars) by Age of Householder." Omak-Okanogan County Chronicle, 2003.

of patron activities the businesses support, the origin of their patrons, and visitation length; and (3) opinions regarding the qualitative relationship between lake levels and visitation. The findings of these interviews are summarized below.

Due to serious drought since 1999, Conconully residents and business owners have experienced a consistent decline in spring and summer water levels at both Salmon Lake and Conconully Reservoir. The record of lake levels discussed below documents this observation. During the height of the fishing and summer seasons in 2001 and 2002, and at the beginning of the fishing season in 2003, lake levels were low enough to expose large expanses of muddy flats up to lakeshores and around boat launches and docks. Boating, water-skiing, swimming, and fishing activities were severely affected.

After experiencing more than one year of low lake levels, it is reported that a large percentage of repeat visitors to Conconully decided not to return. In addition, it was reported that some tourists saw the condition of the lakes, and left to look for another location to camp. Business owners reported that they began to see their profits decline dramatically and are concerned that their businesses may ultimately fail if lake levels do not improve. Additional details about recreation facilities and business interviews may be found in **Appendix F**.

Historic records on lake levels are available for a period of 58 years for Salmon Lake and Conconully Reservoir. In 45 of the 58 years (78 percent) of record, the annual maximum level of Salmon Lake was within two feet of the maximum level for all years, and in 48 of the 58 years (83 percent), it was within three feet. This indicates that during this period the supply of water from the watershed feeding the lake was able to fill the lake close to capacity in about three out of four years. The pattern displayed in the data indicates that it has been rare for the lake to not fill to near capacity two years in a row. The exception to this pattern began in 1999 and continues to the present due to drought, with the highest lake level reached during this period in 2002, when the highest level was about 20 feet below full capacity.

A similar but more extreme pattern occurs in Conconully Reservoir. In 36 of the 58 years of record (62 percent), the annual maximum level was within two feet of the maximum level for all years, and in all 58 years, the annual maximum level was within three feet of this maximum.

3.8.1.5 Tax Base and Property Values

There are several facets to the taxation of an agricultural enterprise in the State of Washington. Farmland can be taxed at its highest and best use value. In Okanogan County this is considered its market value for agricultural production. Under state law, agricultural land can also be taxed as “open space.” If the agricultural land is planted to perennial plants, such as orchards and vineyards, the trees and vines may be taxed. Personal property, such as farm machinery and irrigation systems, is also taxed.

Valuation of Open Space Agricultural and Farm Land

The Department of Revenue uses code numbers to identify the different types of land use.[50] The code numbers, corresponding land use description, and assessed value per acre are presented in **Table 3-34**.

Table 3-34. Open Space Agricultural and Farm Land Values

Land Use Code	Land Use	2002 Current Use Valuation per acre*	2003 Current Use Valuation per acre**
831	Orchard	$600	$672
832	Irrigated Alfalfa	$400	$500 to $921
833	Dryland Alfalfa	$100	$129
834	Improved Pasture	N/A	N/A
835	Irrigated Pasture	$150	$200
836	Range Land	$6	$6
837	Dryland Grain	$100	$100

*Okanogan County Assessor valuation, January 30, 2002.

**Okanogan County Assessor valuation, January 29, 2003.

Taxation of Perennial Plants, including Orchards and Grapes

For tax purposes, crops are divided into two classifications: (1) growing crops (tax exempt) and (2) perennial plants (taxable). To distinguish between the two groups, the Washington Department of Revenue states that "growing crops" are grown from soil for annual production, and "perennial plants" produce fruit or some other vegetation that are harvested annually.[51] Fruit orchards and grape vineyards are considered perennial plants.

When the perennial plants qualify the land for farm and agricultural classification, the assessor needs to determine if the market dictates that the perennial plant has a true and fair market value, irrespective of the highest and best use of the land. If this is the case, that value is the improvement value when the land is classified as farm and agricultural land.[52] **Table 3-35** provides the valuation for different types of perennial plants.

Under certain circumstances, perennial plants may have true and fair value of zero as a result of limited yields of the plants or change in market conditions for the crop.[53] In Okanogan County, orchards are taxed a flat rate because of current poor markets for the varieties of apples commonly grown.[54] In addition, Red and Golden Delicious trees more than 16 years old are not taxed.

[50] Department of Revenue, April 1999, "Land Use Codes"
[51] State of Washington, Department of Revenue, October 2002, "Property Tax Advisory."
[52] State of Washington, Department of Revenue, October 2002, "Property Tax Advisory."
[53] State of Washington, Department of Revenue, October 2002, "Property Tax Advisory."
[54] Personal communication with Jim White, Chief Appraiser, Okanogan County, April 8, 2003.

Agricultural and farm land in Okanogan County that does not meet criteria for open space is assessed using market value (comparable sales). This results in a wide range of values as sales in different areas vary.[55]

Table 3-35. Valuation of Perennial Plants

Fruit Types	Value Per Acre
Apple	$1,000
Pear	$1,500
Cherry	$2,000
Stone Fruits	$1,000
Wine Grape Vines	$1,000

Irrigated Land Values

In recent years, the market value of land with water rights in Okanogan County and within OID has declined dramatically. Currently, it is estimated that bare ground with OID water rights is selling at between $1,000 and $2,000 per acre compared to $6,000 per acre in the mid-to late-1990s. However, the majority of the recent transactions are "forced sales" prompted by foreclosure. In general, there are few buyers in the market relative to the availability of land. One local expert indicated that land with water rights outside of the district is selling for a higher price due to the relative ease in transferring of water rights to new lands and new uses, whereas such transfers of irrigation district water rights are more difficult to accomplish.[58] The low market value of irrigated land within OID has resulted in a conversion from commercial agricultural to rural/residential use in some areas of the district. These subdivided parcels, which retain rights to OID water, tend to sell for a significantly higher per acre price than land remaining in agricultural use.[59]

Non-Irrigated Land Values

Non-irrigated parcels in OID are assessed using market values. There are approximately 80 parcels of land in the district that are larger than five acres and designated as agricultural or farm land not classified as open space or undeveloped land. The average market value per acre for these parcels is $3,054, with values ranging from a low of $567 per acre to a high of $11,571 per acre. The wide range of value contained in this data set limits its use for analytical purposes.

[55] Personal communication with Jim White, Chief Appraiser, Okanogan County, June 11, 2003.
[56] Personal communication with Jim White, Chief Appraiser, Okanogan County, April 8, 2003.
[57] Personal communication with Jim White, Chief Appraiser, Okanogan County, June 11, 2003.
[58] Personal communication with Richard Witt, Appraiser, June 16, 2003.
[59] Personal communication with Jim White, Chief Appraiser, Okanogan County, May 2003.

Levy Rate

The levy rate is the rate per $1,000 of assessed value used to determine the property tax; that is, the assessed value of your property multiplied by the levy rate for the area that a property lies within determines the annual amount of property taxes. This amount can change from year to year based on changes in assessed value and/or the levy rate.[60] The levy rate is found in the Taxing Code Authority database for Okanogan County and ranges between 12.81 and 14.65 for the parcels discussed in this report.[61] For purposes of analysis the average levy rate, 13.73, is used.

Summary of Valuation

The appraised values for agricultural land vary widely in the assessment database. An objective of EIS analysis is to evaluate the impacts of changing agricultural land from irrigated to non-irrigated on the tax base and taxes. The methods used to value open space use (**Table 3-34**) offer the best chance of making a meaningful comparison of this. As presented in this table, irrigated cropland is valued from $500 to $921 per acre. For analytical purposes, a mid-range value of $725 per acre is used. Non-irrigated cropland is valued between $100 and $129 per acre and a mid-range value of $125 is used. Thus, when an acre changes from an irrigated status to a non-irrigated status but remains in agricultural production, its use value changes $600.

3.8.2 SOCIOECONOMIC IMPACTS

Section 3.8.2 describes the direct and indirect economic impacts of all the alternatives. Three distinct flow regimes representing different enhancement options (steelhead with channel rehab, steelhead/chinook with channel rehab, steelhead without rehab) were analyzed for each alternative. Each enhancement option results in different water supply volumes to OID from each source available to the district. However, while the mix of water supply may differ among the three enhancement options, the Water Allocation Model estimates that overall district crop water needs are met in most years. Consequently, the impacts are presented for each alternative, but separate impacts are not provided for each of the enhancement options.

3.8.2.1 Alternative 1: Okanogan River Pump Station

It is assumed that OID would not bear any of the fixed costs associated with constructing the facility or pipelines to convey the water to the district. However, OID would pay pumping costs equivalent to the annual pumping costs identified under the No Action Alternative ($97,021 per year). Pumping costs beyond the No Action level would be assumed to be paid by an entity located outside of Okanogan County. The Water Allocation Model estimates that pumping from the Okanogan River would average 9,491 AF annually and that district irrigation needs are fully met in all years.

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[60] Okanogan County Assessor's Office, February 2003, www.okanagancounty.org/Assessor.
[61] Okanogan County Assessor's Office, 2003, "2003 Levy Rates Okanogan County."

The effect on reservoir recreation of the Okanogan River Pump Exchange Alternative is to reduce the seasonal fluctuation of lake levels, but not change the absolute levels of the lake in wet or normal water years, as compared to the No Action Alternative. In dry years, lake levels may the same or slightly higher as the No Action Alternative. The net effect is that the Okanogan River Pump Exchange Alternative is expected to have a somewhat positive effect on reservoir recreation and the associated recreation-based economy in Conconully.

3.8.2.2 Alternative 1: Feeder Canal Upgrade

There are no additional socioeconomic impacts anticipated as a result of the feeder canal upgrade.

3.8.2.3 Alternative 1: Stream Rehabilitation

Rainbow trout, brook trout, and some kokanee spilled over during flood events can be found in the middle reach of Salmon Creek. However, Washington Department of Fish and Game prohibits any fishing in the reaches of Salmon Creek below Conconully, and this has been the case for some years.[62] The lower reach of the creek is dewatered except in rare cases of flood conditions. The lack of flow in this reach has prevented fish from inhabiting this area.

It is likely that additional water would be beneficial to game species in addition to the target species (see **Section 3.5**). However, this benefit may be mitigated by competition between game fish and populations of steelhead and Chinook (see **Section 3.5**). It is uncertain under what conditions the middle and/or lower reaches may be opened to sport fishing, given that endangered species might be taken incidentally if sport fishing were to occur in the same reaches. Thus, there are no impacts on the recreation economy to be assessed as a result of this component.

3.8.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Under the Shellrock Pump Upgrade Alternative, it is assumed that OID would only be responsible for pumping costs up to the amount estimated under the No Action Alternative ($97,021 per year) and that an entity other than OID would pay capital and operating costs above that amount. Under the alternative, the Water Allocation Model estimates that district irrigation needs are fully met in all years for two of the enhancement options and all but four of the 99 model years analyzed under the other enhancement option (steelhead and Chinook) according to the Water Allocation Model. The level of shortage identified by the model is within the range allowed by the shortage criteria. As a result, the long-term cropping pattern, total production, crop revenue, and net income within the district are estimated to not change relative to the No Action Alternative. The shortages, which occur during periods of extreme sustained drought, would require the district to ration water supplies and may result in a small reduction in crop yields. However, the level and duration of the estimated shortages indicate that yield losses are

[62] Washington Department of Fish and Wildlife, May 1, 2003, Fishing in Washington, Sport Fishing Rules, 2003/2004 Pamphlet Edition, Olympia, Washington, p. 72, Webpage: http://www.wa.gov/wdfw/fish/regs/2003/2003sportregs.pdf, accessed July 8, 2003. Personal communication with Ryan Layton, Conconully State Park Ranger, April 29, 2003.

likely to be very minor and are therefore not specifically addressed in this analysis. As a result, the cropping pattern, total production, and crop revenue within the district is estimated to not change relative to the No Action Alternative.

The effect on reservoir recreation of the Shellrock Pump Upgrade Alternative is to reduce the seasonal fluctuation of lake levels, but not change the absolute levels of the lake in wet or normal water years, as compared to the No Action Alternative. In dry years, the lake levels may actually be slightly higher. Therefore, the Shellrock Pump Upgrade Alternative is expected to have a somewhat positive effect on reservoir recreation and the associated recreation-based economy in Conconully.

3.8.2.5 Alternative 2: Feeder Canal Upgrade

The impacts would be the same as described in **Section 3.8.2.2**.

3.8.2.6 Alternative 2: Stream Rehabilitation

This section provides a discussion of the economic benefits associated with the rehabilitation of Salmon Creek. While it is noted that the actual quantification of these benefits is extremely difficult – some would say impossible – it is nevertheless important to acknowledge that there would be non-market benefits associated with the objectives of the proposed Project.

Rainbow trout, brook trout, and some kokanee spilled over during flood events can be found in the middle reach of Salmon Creek. However, Washington Department of Fish and Game prohibits any fishing in the reaches of Salmon Creek below Conconully, and this has been the case for some years.[63] The lower reach of the creek is dewatered except in rare cases of flood conditions. The lack of flow in this reach has prevented fish from inhabiting this area.

It is likely that additional water and stream rehabilitation would be beneficial to game species in addition to the target species (see **Section 3.5** above). However, this benefit may be mitigated by competition between game fish and populations of steelhead and Chinook (see **Section 3.5** above). It is uncertain under what conditions the middle and/or lower reaches may be opened to sport fishing, given that endangered species might be taken incidentally if sport fishing were to occur in the same reaches. Thus, there are no impacts on the recreation economy to be assessed as a result of this component.

Stream restoration involves the repair of a natural resource asset. In the case of Salmon Creek, the objective of the restoration of flows is the enhancement of spawning and rearing habitat for salmon and steelhead. This restoration and enhancement of the fishery is expected to produce benefits to society. Some of these benefits result from direct use of the fishery. Other benefits may not involve direct use but may still be important in understanding the total benefits associated with the repair of a natural resource asset.

[63] Washington Department of Fish and Wildlife, May 1, 2003, Fishing in Washington, Sport Fishing Rules, 2003/2004 Pamphlet Edition, Olympia, Washington, p. 72, Webpage: http://www.wa.gov/wdfw/fish/regs/2003/2003sportregs.pdf, accessed July 8, 2003. Personal communication with Ryan Layton, Conconully State Park Ranger, April 29, 2003.

The direct use value comes from fishing and other visits to the resource involving non-consumptive use such as viewing the fish, bird watching, etc. Non-market valuation techniques are commonly used to quantify these types of benefits. These involve devising a way to measure use, such as establishing a relationship between fish catch, angler effort, and a per day value for the number of days or the number of fish per angler. Typically the value is estimated using a non-market valuation technique such as the travel cost method and the contingent valuation method. Principles and guidelines for using these techniques for evaluating benefits from federal water resource projects are contained in "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", published by the U.S. Water Resources Council, March 1973.

In addition to direct use values, there are nonuse values. Randall and Peterson[64] define these as option value, quasi-option value, and existence value. Option value and quasi-option value relate to the value of maintaining options for the future and differ only in how the existence of future information is treated. Existence value is the value an individual obtains from just knowing something exists. In a natural resource context, this typically means maintaining a natural resource in a certain condition (or preserving it). If a particular state of resource condition declines, such as the diminishing of the population of a species, then individuals would suffer a loss in existence value. Conversely, the restoration of a natural resource that has been perceived as diminished would result in a gain in existence value to individuals.

Because of the size of the Salmon Creek Project and its predominantly local nature, gains in direct use values are likely to be small, particularly if measured using the travel cost method, which is one possible method for site measurement. On the other hand, measurement of existence value using contingent valuation methods is likely to identify significant values over a wider geographic area. Loomis[65] studied the existence value of the removal of dams on the Elwha River and the restoration of the river for anadromous fish habitat in Washington. He found that the mean annual value per household locally (Clallam County) was $59 per year for ten years, for the state $73, and $68 in the rest of the United States. Since Salmon Creek is a small project and has not received widespread publicity as did the Elwha dams, a similar study would likely produce much lower values for Salmon Creek. It is cited here to illustrate that existence values exist, can be measured, and can be perceived to exist over a wider geographic area than use values. In a companion study, Loomis[66] included a variable for distance from the site to test the idea that values would be lower the farther removed the respondents to the survey were from the site. He found this to be true. However, since a majority of households were outside the immediate site, even though their values diminished with distance the sheer preponderance of numbers meant that a large part of the total benefit came from outside the immediate area.

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[64] Peterson, George L., and Alan Randall, eds., 1984, *Valuation of Wildland Resources*, Chapter 1, Westview Press, Boulder, CO, p. 29.
[65] Loomis, John B., February 1996, "Measuring the economic benefits of removing dams and restoring the Elwha River: Results of a contingent valuation survey," *Water Resources Research*, Vol. 32, pp. 441-447.
[66] Loomis, John B., 1996, "How large is the extent of the market for public goods: evidence from a contingent valuation survey," *Applied Economics*, pp. 779-782.

3.8.2.7 Alternative 3: Water Right Purchase

Under the Water Purchase Alternative, water rights would be permanently acquired from OID and used to meet instream flow objectives in Salmon Creek. The structure, acceptability, and possible implementation of the alternative are uncertain at present. As a result of this uncertainty, a review of existing water acquisition programs was conducted to provide guidance on water acquisition methods that have been effective in other areas. This is included in **Appendix F**. In addition to the information provided in **Appendix F,** a brief description of the water leasing program in Salmon Creek is provided below.

The Washington Water Trust (WWT), with funding provided by BPA, has leased over 4,550 AF from irrigators in the Okanogan Irrigation District to enhance streamflow in Salmon Creek. WWT is a private non-profit organization established in 1998 that is dedicated to streamflow restoration and water quality improvement in rivers and streams in the state of Washington. The Salmon Creek water-leasing program was established in 2000.

Prices paid by the WWT have been negotiated with the Okanogan Irrigation (OID) District Board and have been set at a fixed price for all participating acres in the district. The term of lease contracts are for one year from April 1 through March 31. Prices on an acre basis have increased from $135 in 2000 to $175 in 2002. During that period, OID irrigation assessment fees have averaged approximately $125/ per acre. Voluntary participants are all members of the irrigation district, and are required to pay the district assessment fee on acres enrolled in the water-leasing program. Participating acres have involved primarily idle land previously used to produce orchard crops. Other participating acres were primarily used to grow pasture and hay crops.

Table 3-36 presents summary information on the Salmon Creek Water Leasing Program. Program participation nearly doubled between 2000 and 2002. During the bank's first year of operations, 42 irrigators enrolled 322 acres in the program. In 2002, 60 irrigators enrolled 624 acres, leaving approximately 1,900 AF of water in lower Salmon Creek during the irrigation season. In 2003, OID elected to not participate in the water-leasing program due to poor water supply conditions in upstream storage facilities and concern about meeting the district's water needs for permanent crops.

Table 3-36. Salmon Creek Water Leasing Program, 2000-2003.

Year	Acres	$/Acre	AF	$/AF
2000	322	$135	966	$45
2001	573	$145	1719	$48
2002	624.36	$175	1873.08	$58
2003	No Water Leasing Program			

Source: Washington Water Trust and Okanogan Irrigation District.

Table 3-37 provides detail on the participating acres in the program. More than 80 percent of the acreage consisted of recently pulled orchard crops (primarily low valued apple varieties) and acreage that had been idle for a number of years. The remaining acreage participating in the program included small fields of pasture and alfalfa.

Table 3-37. Participating Acreage in Salmon Creek Water Leasing Program, 2002.

Crop	2002 Acres
Alfalfa	69
No Crop	135
Pasture	34
Pulled Orchard	373
Unknown	13
Total	624

Source: Okanogan Irrigation District and Okanogan County Assessor's Office.

Participation by irrigators in the water leasing program was primarily motivated by an interest to cover assessment charges on idle land rather than an economic decision concerning whether or not to produce a crop during that year. The program structure and factors associated with decisions for a *permanent* sale, as opposed to a single year lease, of water rights would be significantly different. Consequently, information on the Salmon Creek water leasing program was not used in this analysis to provide guidance on analysis of the Water Purchase Alternative.

The following criteria and assumptions are applied in the analysis of the Water Purchase Alternative. These criteria and assumptions were developed from the requirements specified by the OID Board, review of existing transfer programs, discussions with Ecology, and analysis of property values in the area.

Water would be made available to the instream flow water right through irrigated land retirement. The same volume of water (5,100 AF) would be allocated to instream flows in Salmon Creek in all years, and with the possible exception of small volumes in good water years would not be carried over as reservoir storage for use in subsequent years, due to limitations in storage capacity.

For analytical purposes, crop acres are retired according to estimated profitability with the least profitable crops retired first. This is consistent with observed activity in other water purchase programs.

No crops are retired from accounts with less than five assessed acres. Small acreage properties (less than five acres) are generally not used for commercial agriculture. Any agricultural income from these properties contributes little to the overall income of the residents. Furthermore, these rural/residential parcels sell for a significantly higher price per acre than larger agricultural properties within the district boundaries. Consequently, it is less likely that the small acreage properties would be willing to permanently sell their water rights.

The water right purchaser would pay the annual irrigation assessment for retired acres, in perpetuity. This is consistent with approaches used in other existing water right purchase programs. This is an important assumption because it allows assessment fees to remaining district members to be unaffected by land retirement. If the assessment fee on the retired land was not continued, district fixed costs would spread over fewer acres and assessment fees would increase as a result. The higher assessment fees could have additional impacts on crop production and income within the district.

A water purchase price is not determined in this analysis for permanently transferred water. However, the decline in net income estimated by the Agricultural Production Model represents the estimated *minimum* level of payment that would be required to leave irrigators with net incomes equal to that which would have been earned through irrigated crop production. A premium above this amount is typically required to bid water away from irrigators. The level of premium depends upon many specific factors that were not analyzed in this study including water right transferability, alternative land uses, regional water demand, regional water supply, and crop outlook.

Because there are little, if any, return flows to lower Salmon Creek, it is assumed in this analysis that the full diversion quantity would be transferable to an instream flow water right.

Under the Water Purchase Alternative, the Water Allocation Model estimates that irrigation diversions by OID would range between 9,972 and 10,679 among the three enhancement options. Despite the smaller district size, pumping from Shellrock would be significantly increased over the No Action Alternative, on average. Pumping at Shellrock would increase to as much as 5,092 AF in an average year, compared to 2,414 AF under the No Action Alternative. Under one of the flow enhancement options, crop water requirements are not fully met in two consecutive years out of the 99 model years. The shortage criteria are not violated and the remaining district acreage (following the water right sale) would not be impacted in the long-term. The shortages may result in a small reduction in crop yield but the impact is expected to be insignificant due to the low level of shortage.

Table 3-38. Change in OID Cropping Pattern Under Alternative 3.

Crop	Acreage Change
Hay	-444
Pasture	-497
Apples	-260
Pears	-190
Cherries	0
Apricots	0
Peaches	0
Other Minor Crops	0
Young Trees	-79
Urban Yards/Gardens	0
Fallow/Idle	0
Roads, Ditches, and Drains	0
Total Acreage Reduction	-1,470

Table 3-38 summarizes the change in cropping pattern and irrigated acres associated with the Water Purchase Alternative.

Total irrigated acreage within OID is reduced by 1,470 acres under this alternative. Hay and pasture acres are reduced by 941 acres. Orchard crops, primarily consisting of apples, are reduced as well. Due to the reduction in orchard crops, the estimated acreage in young trees is also reduced.[67]

Estimated changes in revenue and net income are shown in **Table 3-39**. Total grower revenue is estimated to decline by $2.9 million annually. Net income is not projected to change, however, because it is assumed that the reduction in income is exactly offset by payments to growers participating in the water purchase program.

Table 3-39. Change in Revenue and Net Income, Alternative 3.

Alternative	Change in Revenue to Irrigators	Change in Net Income to Irrigators
3	-$2,913,048	$0

For the Water Purchase Alternative, the losses anticipated in agricultural revenue were also entered into the economic impact model for Okanogan County and are presented in **Table 3-40**. The agricultural revenue loss results in additional indirect and induced losses of economic output within the local economy, with the total loss to output of nearly $4.1 million. Job losses associated with the change in agricultural revenue are fairly significant, and are estimated to be 118 jobs. Most of the jobs lost are farm labor directly involved in the production and harvesting of the crop that is no longer produced. These job losses represent about two percent of the total jobs in the directly affected agricultural sectors. Income losses are approximately $1.8 million in Okanogan County.

Table 3-40. Economic Impacts of Change in Agricultural Revenue, Alternative 3.

Impacts	Direct	Indirect	Induced	Total
Output *($)*	-$2,913,048	-$502,140	-$639,924	-$4,055,112
Income *($)*	-$1,356,617	-$203,545	-$213,318	-$1,773,479
Employment *(jobs)*	-96.0	-11.9	-10.5	-118.4

The effect on reservoir recreation of the Water Purchase Alternative is to reduce the seasonal fluctuation of lake levels. The absolute levels of the lakes in wet or normal water years would remain unchanged, as compared to the No Action Alternative. Average lake levels are reduced only in Salmon Lake and Conconully Reservoir during dry water years. The impact is relatively small, however, as levels average no more than 3.7 feet less than those achieved in the No Action Alternative during the recreation season. The maximum lake level impacts at Conconully Reservoir and Salmon Lake occur in dry years during June, where the elevation is 5.2 feet below the No Action Alternative. On balance, the Water Purchase Alternative is expected to have a small but negative effect on reservoir recreation.

67 It is assumed that no more than 15 percent of the orchard acres are in young trees.

3.8.2.8 Alternative 3: Feeder Canal Upgrade

The impacts would be the same as described in **Section 3.8.2.2**.

3.8.2.9 Alternative 3: Stream Rehabilitation

There would be no impact associated with this alternative.

3.8.2.10 No Action Alternative

Apple production within OID and much of eastern Washington is currently in a transitional period. Poor fruit prices for some prevalent varieties caused by overproduction, international competition, and quality considerations have prompted growers to shift to alternative crops, including other tree fruits, new apple varieties, and annual crops. Currently, some acreage within OID that has historically produced tree fruits is idle as producers decide what crops to plant. Other acreage with trees removed is being used for forage crops either as a temporary or permanent crop change.

Orchardists have pulled a significant portion of the older varieties of apple trees out of production in Okanogan County, and throughout the state. One local expert estimates that growers have removed the trees on 15 percent of the apple acreage in Okanogan County, primarily consisting of Red and Golden Delicious. Some of this acreage has not yet been replanted to trees or other crops and remains fallow. This trend is more dramatic in the northern fruit growing areas of the county including OID, where there tends to be colder sites that are less attractive for fruit production than other available land in the region.[68] Within OID, approximately 25 to 30 percent of the apple acreage with older, less marketable varieties has been pulled in recent years, with nearly half of the acreage currently not replanted to tree crops.

Because these shifts are currently taking place within the district, a projected baseline that differs from the current cropping pattern is used to represent the No Action Alternative. The projected baseline is determined through crop and acreage shifts estimated by an agricultural production model. Details regarding the development of this model are provided in **Appendix F**. **Table 3-41** compares the current crop acreage with the crop acres applied to the No Action Alternative.

The projected baseline (No Action Alternative) contains a higher number of acres in pasture and hay crops, fewer apple acres, and more pear and cherry acres. These changes are consistent with current trends in the district and reflect the transition from less profitable Red and Golden Delicious to other crops and apple varieties. Overall acreage devoted to orchard crops is projected to decline slightly from 2,535 to 2,515 acres. Acreages in minor crops and urban yards/gardens were held constant.

[68] Personal communication with Dan McCarthy, Okanogan County Pest Control, April 30, 2003.

Table 3-41. Comparison of Current Crop Acres with No Action Alternative Acres.

Crop	Current Acres	No Action Alternative
Hay	473	636
Pasture	870	970
Apples	1,586	1,467
Red Delicious	*660*	*185*
Golden Delicious	*287*	*98*
Other Apples	*638*	*1,184*
Pears	436	449
Cherries	107	213
Apricots	4	4
Peaches	5	5
Other Minor Crops	30	30
Young Trees	397	377
Urban Yards/Gardens	549	549
Fallow/Idle	321	76
Roads, Ditches, and Drains	255	255
Total	5,032	5,032

According to the Water Allocation Model used for this EIS, annual water diversions to OID average 15,745 AF from all supply sources and range between 13,149 and 19,201 AF. The Water Allocation Model allows OID to respond to reduced water supplies through short-term improvements in on-farm irrigation efficiency and increased pumping from the Shellrock Pump Station. According to the Water Allocation Model, these two actions allow OID to divert and pump adequate water supplies to fully meet crop irrigation needs in all model years for the No Action Alternative.

Based on data provided by OID, the variable cost (energy and O&M) of operating Shellrock averaged $40.19 per acre-foot pumped in 2001 and 2002. Under the No Action Alternative, pumping from Shellrock is estimated to increase over historic levels. Between 1987 and 2002, OID pumped an average of 1,733 AF annually from Shellrock. In comparison, the Water Allocation Model predicts that OID would pump an average of 2,414 AF from Shellrock each year. The estimated annual variable cost associated with this level of pumping is $97,021, compared to $69,642 historically. This increased level of pumping would result in somewhat higher assessment charges to district members due to higher water delivery costs. In this analysis, the increased pumping costs above historic levels are incorporated into the No Action Alternative as an increase in production costs. **Table 3-42** provides a summary of the cropping pattern, revenues, and returns estimated under the No Action Alternative.

Table 3-42. OID Crop Acres, Revenues, and Net Income, No Action Alternative.

Crop	Model Acres	Revenue per Acre	Costs per Acre	Net Income per Acre	OID Revenue	OID Net Income
Alfalfa	591	$767	$728	$39	$453,225	$22,831
Other Hay	45	$878	$847	$31	$39,232	$1,384
Pasture	969	$432	$420	$12	$418,766	$11,938
Apples	1,467	$5,308	$4,833	$475	$7,786,644	$696,318
Pears	450	$4,509	$4,308	$201	$2,029,066	$90,466
Cherries	213	$7,323	$5,843	$1,480	$1,559,743	$315,237
Apricots	4	[a]	[a]	[a]	[a]	[a]
Peaches	5	[a]	[a]	[a]	[a]	[a]
Other Minor Crops	30	[a]	[a]	[a]	[a]	[a]
Young Trees	377	[a]	[a]	[a]	[a]	[a]
Urban Yards/ Gardens	549					
Fallow/Idle	76					
Roads, Ditches, and Drains	255					
Total	5,032				$12,286,675	$1,138,173
Adjusted for Additional Pumping at Shellrock					$12,286,675	$1,110,795

[a] Crop revenues, production costs, and returns were not calculated for minor crops (apricots, peaches, and "other") and young trees. Acreages in minor crops were assumed not to vary under the alternatives and therefore were not explicitly modeled.

Under the No Action Alternative, annual revenues and net income to producers within the district are estimated to be $12,286,675 and $1,138,173, respectively. These revenues and net returns do not include minor crops or annual costs associated with young (non-bearing) fruit trees. Total net income is reduced to $1,110,795 after adjusting for the increased costs associated with pumping additional water above historic levels at Shellrock.

3.8.3 MITIGATION MEASURES

Each of the three action alternatives would result in increased pumping from the Okanogan River by OID, in order to offset lost water supply from Salmon Creek. Pumping would result in higher costs to OID for delivery of water for irrigation, both in terms of additional energy costs plus (depending upon alternative) capital investment and O&M for the pumps. In order to minimize the impact of these higher costs on OID, a distinct element of all three action alternatives would be for the public sector to cover additional capital investment, water right purchase, and pumping costs that would be incurred over and above the No Action Alternative. This section describes those mitigation costs.

Under Alternative 1, it is assumed that OID would not be required to pay any capital or operational costs associated with the Okanogan River pump above the pumping costs estimated under the No Action Alternative. The capital costs for the 80 cfs pump were estimated to be between $4.7 million and $7.0 million, depending upon whether or not the facility would be designed to deliver pressurized water to all OID laterals.[69] Estimated annual electricity costs ranged from $92,000 to $350,000 using an electricity price of $0.0165/kwh.[70] Currently, the electricity price is $0.0285/kwh.[71] **Table 3-43** provides an estimate of the annual pumping costs from the proposed Okanogan River pump station using recent estimates of the costs of pumping at the Shellrock facility and average pumping volume estimated by the Water Allocation Model. Thus, the total mitigation costs would be the capital cost for the pump, plus an annual cost of $284,393.

Table 3-43. Anticipated Public Sector Mitigation Costs

Alternative	Estimated Capital Cost	Additional Pumping Cost ($/year)
1	$7.3 million	$284,393
2	$10.2 million	$202,062
3	$5.9 million	$107,620

For Alternative 3, the full cost of the water rights purchase has not been determined. However, the economic model estimates that a minimum annual payment of $251,647 would be required in order to induce water right holders to consider a permanent sale of the necessary quantity of water rights. This annual payment represents the net income that would have been earned by the district members had they continued to irrigate rather than participate in the water purchase program. In addition, the annual OID assessment for retired acres with water rights in the amount of $176,400 would be borne by the purchaser. Finally, additional pumping costs of $107,620 would be incurred. Thus, the mitigation costs associated with Alternative 3 would amount to about $535,668 annually. In order to provide a comparison with the other alternatives, the estimated minimum annual payment to irrigators and the OID assessment charges for the retired acres are capitalized in **Table 3-43** using a discount rate of six percent for a 30 year period. This discount rate represents a conservative estimate of the long-term real returns to irrigated crop production. The estimated capitalized cost of the Water Purchase Alternative is $5.9 million in addition to an annual pumping cost of $107,620 per year.

For Alternative 2, it is assumed that OID would not be required to pay annual costs associated with increased use of Shellrock and would also not pay any of the capital costs needed to upgrade the facility. The cost of upgrading the facility was estimated to be $10.3 million.[72] However, this cost is considered preliminary at this time. Additional pumping costs of $202,062 would also be an annual mitigation cost with this alternative.

3.8.4 UNAVOIDABLE ADVERSE IMPACTS

There are no unavoidable adverse impacts anticipated as a result of Alternatives 1 and 2, to the extent that the public sector absorbs mitigation costs as described in **Section 3.8.3**. There is an impact associated with fixed resources from the public sector being perpetually dedicated to this

[69] Dames & Moore, July 30, 1999, Joint Study on Salmon Creek: Draft Report.
[70] Independent Economic Analysis Board, May 25, 2001, Economic Review of Instream Water Supply Components of the Salmon Creek Project.
[71] Personal communication with Tom Sullivan, OID manager, June 2003.
[72] U.S. Department of the Interior, Bureau of Reclamation, April 2004. Shellrock Pump Station Improvements - Feasibility Study Report of Findings - Addendum.

Project as compared to projects elsewhere. For Alternative 3, the regional economy would absorb a loss in output in the amount of $4.1 million, loss in income of $1.8 million, and a loss of approximately 118 jobs, primarily in the agricultural sector. These losses are unavoidable and not mitigated, but represent only a small percentage of the agricultural sector and so are not considered significant. Several measures could be considered for reducing or minimizing the loss of jobs. A fund could be established to support job retraining for affected workers. Efforts could be made to minimize the number of labor-intensive crop acres that would be retired, or retirement could be targeted to the least productive land through incentives. Finally, efforts could be made to support continued on farm water conservation measures to reduce the number of acres that should be retired.

3.9 PUBLIC SERVICES AND UTILITIES

3.9.1 EXISTING CONDITIONS

3.9.1.1 Lower Salmon Creek

Analysis of existing public services and utilities is based upon information provided by the City of Okanogan and Okanogan County and visual observation of the Project area. Other service providers were contacted to determine the scope of their service with the Project area. The analysis is limited to services and utilities that lie all or partially within 300 feet of the centerline of the lower 4.3 miles of Salmon Creek.

The Lower Salmon Creek area includes a variety of public services and utilities. Primary service and utility providers include the City of Okanogan (water, sewer, garbage, parks, fire protection, streets and bridges, library, law enforcement – under contract to County Sheriff, land and shoreline use permitting), Okanogan County (roads and bridges, sanitary landfill), Washington State Department of Transportation (Second Avenue is State Route 215), Okanogan PUD (electricity and telecommunications), Okanogan Irrigation District (irrigation diversion and distribution facilities), Fire Protection District 3 (co-located with City of Okanogan), Qwest (telecommunications), Charter Communications (cable television), Hospital District 3 (Mid Valley Hospital in Omak), Television and FM District 1 (maintains repeater service), Lifeline Ambulance (a private emergency medial services provider) and NCI Datacom (a private wireless telecommunications company).

The City of Okanogan provides the greatest number of services and utilities within the 4.3-mile Project area. From its mouth upstream to First Avenue, Salmon Creek is straddled by public land owned by the City of Okanogan. The City has a well on either side of the Creek, a boat launch ramp and river overlook and Alma Park, a developed community park with play equipment, sports courts and an outdoor swimming pool. The first utility crossing is a 9-inch cast iron universal water main circa 1959. The water main is under the bridge along 2^{nd} Ave. S. The sewer main is a 16-inch ductile iron pipe located along First Avenue South, between Man Hole MH(Man Hole)200 and MH210, about 35 feet downstream, and is buried approximately 5 feet.

From the First Avenue Bridge upstream the stream banks have been channelized and stabilized, partially through an Army Corps of Engineers flood control project and partially by adjoining landowners in an effort to stave off erosion of property along the Channel. The next utility crossing, a 12-inch ductile iron water main inside a 24-inch casing, 40 feet long, occurs in the vicinity of the Second Avenue Bridge approximately 206 feet upstream above Fifth Avenue South. The water main is buried approximately 5 feet.

Upstream from Second Avenue to the Fifth Avenue Bridge the channelization/stabilization continues. The next utility crossing is a 6-inch cast iron water main circa 1960. The water main is located along Eighth Avenue South, and is buried approximately 5 feet.

Upstream from the Fifth Avenue Bridge to the Mill Street Bridge, the stream channel has not been channelized or stabilized. The next utility crossing is an 8-inch concrete sewer main located between MHK240 and MHK230 under the bridge, and is buried approximately 2½ feet deep.

From the Mill Street Bridge upstream to the City limits, water and sewer mains are confined to the public right-of-way within Mill Street, south of the stream and Monroe Street north of the stream.

There are four bridge crossings of Salmon Creek within the City. The bridges are located at First Avenue, Second Avenue, Fifth Avenue and Mill Street. The Mill Street Bridge is scheduled for replacement over the next twelve months (the existing bridge is under load restrictions). The new bridge, a cooperative project of the City of Okanogan with funding through the Washington State Department of Transportation, would allow for a wider stream channel and would be better aligned with the stream. In addition, the City has a small bridge over Salmon Creek in the vicinity of Salmon Springs that provides access from the County road to the springs.

The City provides a variety of services within its corporate limits. The City of Okanogan Volunteer Fire Department, with a paid chief and 27 volunteers, is based at the fire station adjoining City Hall at 235 Oak Street. The City Fire Department has a mutual aid agreement with Fire District 3 whereby they share volunteers, equipment and the City Fire Hall. This means that the entire Lower Salmon Creek Project Area is served through the combined efforts of the City and District. The City also provides a variety of parks and recreation facilities, with Alma Park and the Boat Launch Ramp and Overlook located adjacent to Salmon Creek.

Services and utilities provided by Okanogan County with the Lower Salmon Creek area are primarily roads and bridges. The Salmon Creek Road, Glover Lane and the Danker Cutoff are County Roads within the Lower Salmon Creek area. The County also maintains two crossings, the Stadler Bridge just below the intersection of Salmon Creek Road and Glover Lane and a box culvert upstream from the intersection of the Salmon Creek Road and the Danker Cutoff.

The Okanogan Public Utility District is the provider of electrical power and is beginning to deploy a fiber optic network in cooperation with several private companies. The PUD's network of easements and rights-of-way is also used by other telecommunications providers (Qwest, Charter Telecommunications, etc.). The PUD has nine crossings of Salmon Creek, all above ground.

Qwest, the area's primary telephone service, has buried phone lines along the Salmon Creek Road and Glover Lane.

3.9.1.2 Okanogan River Pump Station and Pipeline Route

These areas have a variety of public services and utilities. Primary service and utility providers include the City of Okanogan (water, sewer, garbage, parks, fire protection, streets and bridges, library, law enforcement – under contract to County Sheriff, land and shoreline use permitting), Okanogan County (roads and bridges, sanitary landfill), Washington State Department of Transportation (Second Avenue is State Route 215), Okanogan PUD (electricity and telecommunications), Okanogan Irrigation District (irrigation diversion and distribution facilities), Fire Protection District 3 (co-located with City of Okanogan), Qwest (telecomunications), Charter Communications (cable television), Hospital District 3 (Mid Valley Hospital in Omak), Television and FM District 1 (maintains repeater service), Lifeline Ambulance (a private emergency medial services provider) and NCI Datacom (a private wireless telecommunications company).

The Pump Station site lies entirely within the City of Okanogan while the pipeline route is primarily within the unincorporated area. The proposed pump station site is located adjacent to S.R. 215, which is not only a significant transportation corridor but a major utility corridor. The City has an 8-inch water main and the PUD a 7.620KV/13.20KV overhead distribution line along the western edge of the highway right-of-way and the City has a 12-inch sewer force main also in the right-of-way.

From S.R. 215 westward, the pipeline route is planned to run through an easement or right-of-way to Fourth Avenue North, a primitive road maintained by the City and County. The City has an 8-inch water main along Fourth Avenue N. that connects City Well No. 3 with the City's water system. This well is located in close proximity to the planned pipeline crossing of Fourth Avenue North. In addition to the PUD's line along S.R. 215, two others are affected by this portion of the pipeline route: a line crossing north/south approximately one-half of the distance between S.R. 215 and Fourth Avenue North; and a 7.620KV/13.20KV distribution line with fiber optic cable along the western right-of-way of Fourth Avenue North.

After the pipeline route crosses Fourth Avenue North, there are no utility issues along the route to the top of Pogue flat. From that point the route lies with the county-owned rights-of-way along the eastern edge of the Conconully Highway and northern edge of Glover Lane. The route also follows an existing pipeline easement that contains a 8-inch OID irrigation line. Other utilities along this route include a PUD line along the western edge of the Conconully Highway and a line and underground phone cable along the northern edge of Glover Lane.

3.9.1.3 Feeder Canal

The feeder canal route includes a variety of public services but very little in regards to utilities. Primary service and utility providers include the Town of Conconully (sewer, garbage, fire protection, streets and bridges, law enforcement land use permitting), Okanogan County (roads and bridges, sanitary landfill), Okanogan PUD (electricity and telecommunications), Okanogan Irrigation District (operates and maintains Feeder Canal), Qwest (telecomunications), Charter

Communications (cable television), Hospital District 3 (Mid Valley Hospital in Omak), Television and FM District 1 (maintains repeater service) and Lifeline Ambulance (a private emergency medial services provider).

The feeder canal lies within lands served by the Town of Conconully and Okanogan County. The utilities affected by the proposed Project include the North Fork Salmon Creek Road in the vicinity of the head gate and the Sinlahekin Road, both maintained by Okanogan County. The feeder canal crosses under Sinlahekin Road, which is also the right-of-way for a PUD line and the County's low pressure sewer main that serves the cabins on Salmon Lake.

3.9.2 Public Services And Utilites Impacts

3.9.2.1 Alternative 1: Okanogan River Pump Station and Pipeline Route

Only water supply Alternative 1 impacts public services and utilities at the pump station site and along the pipeline route. The impacts to existing services and utilities would include an increased demand for power at the pump station site and utility interruptions while the pipeline is constructed and crosses existing City water and sewer mains and PUD distribution lines and Qwest phone lines.

3.9.2.2 Alternative 1: Feeder Canal Upgrade

Impacts to public services and utilities resulting from the feeder canal upgrade include a significant improvement in the OID's ability to divert and store water for its members and the temporary disruption of the sewer service to the Salmon Lake Area.

3.9.2.3 Alternative 1: Stream Rehabilitation

Impacts to existing public services resulting from the rehabilitation of lower Salmon Creek would primarily be disruptions caused by construction activities. No utilities would be moved or interrupted by the rehabilitation of the stream channel.

3.9.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

This alternative would have less impact on public services and utilities use than Alternative 1 because it is an upgrade of the existing pumping facility rather than construction of a new one. The upgrade may increase power demand but the infrastructure is in place to provide the needed electricity. The impacts would include utility interruptions while the pipeline is constructed and crosses existing City water and sewer mains and PUD distribution lines and Qwest phone lines.

3.9.2.5 Alternative 2: Feeder Canal Upgrade

The impact would be the same as described in **Section 3.9.2.2.**

3.9.2.6 Alternative 2: Stream Rehabilitation

The impact would be the same as described in **Section 3.9.2.3**.

3.9.2.7 Alternative 3: Water Rights Purchase

The impacts to public services and utilities from the water supply alternative based on acquisition, through purchase or lease, of OID water rights would impact the OID through reduced demand for water and on the PUD with a corresponding reduced demand for electrical power. No impacts to other service and utility providers are anticipated.

3.9.2.8 Alternative 3: Feeder Canal Upgrade

The impact would be the same as described in **Section 3.9.2.2.**

3.9.2.9 Alternative 3: Stream Rehabilitation

There would be no impacts from stream rehabilitation with this alternative.

3.9.2.10 No Action Alternative

Lower Salmon Creek Vicinity

Under this alternative public utilities and services along Lower Salmon Creek and the pump station/pipeline route would remain relatively unchanged subject to changing economic conditions in the local area and utility and road projects planned by the City and/or County, PUD or other providers.

Feeder Canal Vicinity

Under this alternative the existing feeder canal would continue to be maintained in its current condition. Other services and utilities would remain relatively the same subject to changing economic conditions in the local area and utility and road projects planned by the Town and/or County, PUD or other providers.

3.9.3 MITIGATION MEASURES

3.9.3.1 Lower Salmon Creek Vicinity

Mitigation measures along Lower Salmon Creek would primarily be construction related to ensure minimum disruption to existing water, sewer, power and telecommunications customers.

Mitigation measures with the pump station and pipeline routes would be directly related to the scope and extent of construction. Construction of the pump station would require careful design, engineering, and construction methods that reduce or eliminate impacts and interruptions of utilities. This is particularly important where the Alternative 1 pipeline route intersects the water main connecting a 550,000-gallon reservoir with the north end of the City's water system in the vicinity of Well No. 3. In addition, construction would necessitate crossings of S.R. 215, Fourth Avenue North, and the Conconully Highway. After construction, each roadway crossing would be returned to as near pre-project conditions as possible.

3.9.3.2 Feeder Canal Vicinity

The proposed feeder canal upgrade can almost be considered mitigation in its own right as the present canal is prone to leakage and has fallen into disrepair.

3.9.4 UNAVOIDABLE ADVERSE IMPACTS

There are no unavoidable adverse impacts to public services and utilities.

3.10 CULTURAL RESOURCES

3.10.1 EXISTING CONDITIONS

3.10.1.1 Introduction

This section provides background information and context on cultural resources in the project area, describes previously identified historic, archaeological, and ethnographic resources, and provides information about potential areas of sensitivity for archaeological and ethnographic resources. Chapter 27.53.060 RCW provides for protection of cultural resources on private and public lands in the State of Washington. Section 106 of the National Historic Preservation Act (NHPA), as amended, requires that any federal agency having direct or indirect jurisdiction over a proposed federal or federally assisted undertaking, or issuing licenses or permits, must consider effects on historic properties. This section describes the current condition of cultural resources in the Project area and the potential impacts of alternative actions to cultural resources.

Methodology

Information regarding previously recorded archaeological and historic resources within the Area of Potential Effect (APE) was obtained from OAHP records, including the National Register of Historic Places (NRHP) and the Washington Heritage Register. Investigators reviewed NRHP determinations of eligibility within the APE generated through prior Section 106 reviews, and a prioritization of areas for cultural resource discovery potential and sensitivity in the Okanogan Highlands (Mierendorf, 1981). The two main repositories for existing information consulted for this analysis included the BPA Collections Library in Portland, OR, and the OAHP, in Lacey, WA.

A BPA archaeologist and the Assistant State Archaeologist conducted an onsite visit in April 2003 to determine the APE of proposed alternatives and develop an overview of cultural resources that may be present at the location of Project components (see **Table 3-44** for a description of the APE). An environmental protection specialist conducted an onsite visit in July to determine the history and current condition of the Okanogan town dumpsite. This visit was conducted in coordination with the Okanogan city planner. Interviews were conducted with nearby long-time residents of the town. The city planner provided information from city records. Information about Salmon Lake Dam was provided by the U.S. Bureau of Reclamation (BOR), which recently completed a Historic Archaeological Engineering Record (HAER) for the dam and associated structures. This section summarizes the results of these field visits and existing data records.

Agency and Tribal Consultation

BPA identified the Confederated Tribes of the Colville Indian Reservation (Colville Tribes) as the primary tribes with Ceded Lands and/or Usual and Accustomed Areas within the APE. The Colville Tribes are one of the sponsors of the Salmon Creek Project. BPA has held meetings with the Colville Tribes to scope and address tribal concerns relative to cultural and natural resources (water, fisheries, wildlife, and botanical) that could be impacted by the proposed Project (See Appendix G).

BPA met with the Colville Tribe History and Archaeology Department on two occasions and discussed the proposed APE. Discussions have also taken place with the Colville Tribe to provide a description of their Traditional Cultural Properties (TCP) in the area, however this information has not yet been obtained.

Following Section 106 regulations, BPA has notified the State Historic Preservation Office that the Project is an "undertaking" as defined in 36 CFR 800.16(Y). BPA obtained concurrence from the Washington SHPO regarding the APE for this project (Appendix G). Coordination with the SHPO would continue throughout the environmental review process, and would include requests for concurrence on NRHP recommendations, determinations of effect, and consultation on proposed measures to avoid or mitigate effects to historic resources.

The Pacific Northwest Office of the BOR owns the facilities associated with the Okanogan Irrigation Project. Alterations or additions to existing facilities have taken place in the past, which have required their own Section 106 consultations. As a cooperating agency on this Project proposal, BOR has been instrumental in providing information from recently completed cultural resource reviews and mitigation requirements on their facilities.

Area of Potential Effect

As required under NHPA, the Area of Potential Effect has been determined for all proposed components of this Project. The determination was made by BPA and concurrence provided by the Washington State Office of Archaeology and Historic Preservation. The dispersed geography of the components of the Project alternatives has resulted in six specific areas of potential effect as shown in **Table 3-44**. The table also shows the alternative for which the specific area is applicable.

Table 3-44. Areas of Potential Effect (APE).

APE	Project Component	APE Description	Alternative or Component
A	Lower Salmon Creek rehabilitation work from the confluence of Salmon Creek and Okanogan River upstream for 4.3 miles to the Okanogan Irrigation District (OID) diversion dam.	100 feet wide on each bank of Salmon Creek along entire length of component (4.3 miles).	Alternative 2
B	Proposed 80 cfs pump station located on the west bank of the Okanogan River.	An approximate area of 100 ft. x 100 ft., to include the area of bank shaping and armoring, an intake to be located on the bank, and a pump station structure.	Alternative 1
C	Upgrade of the Shellrock pumping facility to 35 cfs from the current use at 24 cfs.	The area immediately surrounding the pump station and intake location. Area immediately surrounding settling pond.	Alternative 2
D	Proposed new pipeline from the proposed pump station on the west bank of the Okanogan River to Diversion 2 of the OID.	15 feet on each side of the centerline of the designed alignment of the new pipeline.	Alternative 1
E	The Salmon Lake feeder canal replacement option of burying a pipeline along the current alignment of the canal.	50 feet on each side of the centerline of the current canal alignment.	Alternatives 1, 2, and 3
F	Proposed new pipeline from the Shellrock pump station on the Okanogan River to a sediment basin in the main canal of the OID.	15 feet on each side of the centerline of the designed alignment of the new pipeline.	Alternative 2

Source: Bonneville Power Administration, Washington Office of Archaeology and Historic Preservation, July, 2003 (except F)

Field Survey

The overall region of Salmon Creek/Conconully/Okanogan has been the subject of much historic and prehistoric investigation that offers generally relevant information. Preliminary joint field reconnaissance conducted by BPA and OAHP in April 2003 and a single, on-site visit by a BPA environmental protection specialist in July 2003 are the only site-specific investigation that has been done. This field work was conducted prior to the final determination of the APE and so was unable to provide comprehensive reconnaissance at that time. The subsequent APE determination now should enable the necessary cultural resource work to be completed. This information will be compiled into a Section 106 Technical Report prior to completion of the Final EIS.

As part of preliminary joint field reconnaissance conducted by BPA and OAHP in April 2003, additional actions and field work were jointly recommended to be accomplished prior to the publication of the Record of Decision for this Project:

Archaeological Resources

- Intensive pedestrian survey of the identified APE areas.
- Shovel test probes at the Okanogan pump station site and at any areas that would be disturbed by the proposed upgrade to the Shellrock pump station.

- Shovel test probes along any proposed pipeline near the town of Okanogan on banks, terraces, and landforms with less than 10% slope. Recommended spacing of test holes at 20 to 40 meter intervals. As an alternative to test probes, full cultural resource monitoring of all pipeline excavation on banks, terraces, and landforms with less than 10% slope would be appropriate.
- Historic documentation of the Salmon Lake Feeder Canal (HABS/HAER completed).
- Shovel test probes along those alluvial benches of Salmon Creek that would be affected by stream rehabilitation. Some benches have little soil deposition and should be considered to have a low probability of containing subsurface cultural resources.
- Avoidance of the historic Okanogan Town trash dump located along the north bank of Salmon Creek.

Additional Cultural Properties:

It is recommended that further discussions with the Colville Tribe be conducted to determine the location of any TCPs and to include any ethnographic information the Tribe is willing to share within this section or to be included within a Technical Report.

3.10.1.2 Historic Resources Overview

Early Fur Trading Influences

Fur trappers and traders were the first Euro-Americans to enter the territory in the vicinity of the Project area. For interior tribes, the fur trade era was between 1807 to 1843. The former date includes the year of the Corps of Discovery's (Lewis and Clark [1803-1806]) journey back from their epic expedition west to the Pacific Ocean. At that time Lewis and Clark met with "numerous parties of traders wending their way to the heart of the wilderness which these explorers [Lewis and Clark] had just left". The latter date (1843) is the year of the first great influx of Euro-Americans, often called the "great migration," to cross the Great Plains to Oregon and California (Bruce 2003).

Although the fur trade was a short-lived economic enterprise, it was the *only* one of importance between Euro-Americans and Indian peoples before 1846 in the Trans-Mississippi West. Its existence profoundly affected Indian peoples living in the Project area as it did indigenous peoples living elsewhere in the Trans-Mississippi West during those years. Moreover, the fur trade era influenced and hastened emigration and development patterns of non-indigenous peoples into western lands, and generally expedited economic and political gain by Euro-Americans throughout the Trans-Mississippi West.

Effects of the fur trade commerce typically influenced Indian peoples before actual contact with Euro-Americans took place. This happened through various means that lasted into the contact period. This included the introduction of European, British, and American trade goods that were passed on tribe-to-tribe, and, which in time, created a dependence by Indian people on such goods and the procurement of those goods, and that gradually led to a falling away of their own means of production of implements and ornaments of cultural importance.

A second, more pernicious pre-contact-Euro-American effect of the fur trade was the introduction of diseases, many of which were not formerly experienced by indigenous people. These diseases included smallpox, measles, malaria, and venereal disease. Native peoples had little or no resistance to these afflictions.

Despite disruption of their life ways through the introduction of trade goods and other Euro-American influences, and decimation of their people through disease transmitted to them by non-indigenous people, Indians were, and continued to be, essential to the successful operation of the fur trade in the Trans-Mississippi West until the demise of the fur trade as a lucrative enterprise in the 1840s. In large part, Indians "were themselves the producers; that is, they trapped the beaver and hunted the buffalo, whose skins they exchanged for whatever the white men brought into their country" (Bruce 2003).

Establishment of forts, posts, or houses as they were variously named provided for trade and protection of traders and trappers. In 1811, David Stuart, an agent of John Jacob Astor's Pacific Fur Company, established Fort Okanogan about half a mile from the confluence of the Okanogan River with the Columbia River. Chosen to serve as the northern outpost of Astor's fur empire, the fort was the first American settlement in what later became the state of Washington. Fort Okanogan was later taken over by the Hudson's Bay Company when the Pacific Fur Company moved to another site one mile southeast of the fort. Trapping and fur trading were to remain the primary industries in the Okanogan region up through the mid-1800s. Thereafter, the industry slowly declined as otters and beavers were subject to overkill, causing fur stocks to be depleted.

Fort Okanogan was sited on a major north-south trail used by Indians. This trail, which became known as the Hudson's Bay Brigade Trail, was used to trade furs along a network of outposts in southern interior of British Columbia and northern Washington between 1826 to about 1845. Each winter the furs traded at the posts in the northern interior were brought to Fort St. James, the headquarters of New Caledonia, with dog sledges. As soon as the ice broke up, generally about April 20, boats loaded with cargoes of furs started from Stuart Lake to pick up the furs from Fort Fraser, Fort McLeod and Fort George (now Prince George.) At Alexandria, the horse brigade started out for Fort Okanogan, sometimes accompanying and sometimes following the Thompson's River brigade, which was taking out the furs of the Kamloops district. There was a general rendezvous of the Thompson, New Caledonia and Colville traders at Fort Okanogan, and then a senior officer took charge of the united brigade for the boat run to Fort Vancover (Wilson 1966).

Mining

Many prospectors were busy along the waters of the Columbia River and on both sides of the Canadian boundary in the late 1850's. Reports of gold in the Thompson and Fraser rivers in British Columbia in 1856-57 produced the great "rush" of 1858 to those streams. Prospectors passed through the Okanogan Valley on their way to the Cariboo gold fields of British Columbia. The route was sometimes referred to as "The Okanogan Trail.", but its extension into the Cariboo mining district of British Columbia caused it to become labeled "The Cariboo Trail," and it is best known by that name. The Cariboo Trail was more of a route than a trail. The miners and cattleman who used it sometimes came up one side of a river or lake, sometimes the other. They cut across open country freely (Wilson 1999), but generally traveled to the east of the project area through the Okanogan valley.

The late 1880s and early 1890s saw renewed economic development in the region with the onset of railroad construction in the county. The Pacific Northern and Great Northern railroads began their inroads into the county in 1881 and 1892, respectively. As rail construction reached further into the region's interior, an increasing number of settlers, as well as necessary goods and supplies, were afforded easier access into the county. However, it was the discovery of gold by Chinese railroad laborers in the 1880's that precipitated the steady influx of newcomers, mostly prospectors from the east and Midwest (Conconully Chamber of Commerce 2000).

With the flurry of gold rush settlement came the proliferation of mining towns such as Conconully and Ruby in the county's central mining district, each of which claimed county seat for a time during this period. While most newcomers came in search of gold and eventually picked up and moved farther west, many found the region to their liking and chose to settle. Their efforts were aided by the opening of the Columbia and Moses reservations to permanent homesteading and mining in 1886.

Known Historic Resources

An old city dump is located less than one-mile northwest of Okanogan, Washington. The site lies on both banks of Salmon Creek. The majority of the property on which the dump is located is owned by the City of Okanogan, although it may extend to an adjacent private property. The stream channel in the vicinity of the dumpsite has experienced downcutting, water table decline, and loss of riparian vegetation. It continues to experience stream bank failure during high stream flow events. Remnants of an old wooden bridge that traversed the creek and allowed access to the east bank still remain. The actual dumpsite covers approximately 6 acres of the City property.

Accounts of dump operations go back to at least 1941. The City dump was used by farmers, residences, and businesses from the local community. Regular deposits were made by the city dump truck. Dumping occurred at random locations throughout the site. Once an area was full, the City would burn the debris and then cover and level it with native fill taken from the hillside to the east. Dumping occurred on both sides of the creek and in some instances right up to the creek. The site was closed in the mid-1970s.

Soil surfaces within the dump are speckled with broken and melted glass, tin cans, and small amounts of other solid waste. There are isolated areas where lenses of debris can be seen in the deep cut bank sections (10 feet or greater) of the creek. The debris lenses are located in the upper one half section of the bank cut, which demonstrates that the severe bank cuts and subsequent exposure of solid waste are the result of high spring or winter flows. There were small amounts of scattered debris located along the bottom of the creek bed. It is likely there are additional historic artifacts buried within the site.

There currently is one historic building within the town of Okanogan, the Okanogan Post Office. Other historic buildings may be located within the towns, however, their locations (and their areal relationship to the several alternatives and components of this Project proposal) are not fully identified as they are not found close to any elements of any of the proposed alternatives.

Within the overall Okanogan Irrigation District area, Okanogan Project facilities have been reviewed for NRHP eligibility. The Salmon Lake feeder canal and dam were built in 1920 as part of the Okanogan Project. Both structures have been determined to be eligible for listing on the National Register of Historic Places (NHRP) because the Salmon Lake Project was one of the first irrigation projects undertaken by Reclamation and the first authorized in Washington State. Conconully Dam has already been placed on the NRHP. **Table 3-45** summarizes the NRHP status of Okanogan Project facilities.

Table 3-45. Eligibility Status of Okanogan Project facilities for National Register of Historic Places.

Project Component	Eligibility Status
Conconully Dam	Listed on NRHP 9/6/74
Salmon Lake Dam	Determined eligible 11/29/84, HAER completed 3/03
Salmon Creek Diversion and Cipoletti weir	Determined eligible 11/29/84, HAER completed 3/03
Hi & Low Line Main Canals	Determined eligible 11/29/84
Patrol House (demolished)	Determined not eligible
Robinson Flat Pump Plant	Determined eligible
Duck Lake Pump Plant	Determined eligible
Power Plants—Drops 1 & 2	Determined eligible
Distribution laterals	Determined not eligible 9/5/84

Source: Lynne MacDonald, Archaeologist, US Bureau of Reclamation, electronic correspondence, 6/13/03

3.10.1.3 Prehistoric Resources

Regional Overview and Context

Organization of Tribes

Ray (1933 and 1936) asserted the Plateau's uniqueness as a definite culture area based on linguistic groupings, subsistence orientation, and intergroup socio-economic relationships. Though his extensive field research over simplified certain behaviours and cross-cultural differences, he satisfactorily demonstrated that the aboriginal Interior Plateau was essentially a "single social system".

According to Ray, in this part of the aboriginal Plateau, villages often joined together as larger political units, called bands. Two types of bands were recognized by Ray (1939, in Ross 1968).

> *One [type of band] is merely the embryonic tribe developing under indirect influence from the Plains. Its most objective marks are common action in war and the recognition of a common war chief. Subjectively it involves a weakly developed national feeling and pride in the strength of unity. The tendency [towards this type] is…observed among the Wenatchi, Columbia, Spokane, Palus, and Kalispel. The second subtype is characteristic of the western Plateau of Canada [including the Nespelem's neighbors to the west, the southern Okanogan]…. Here the band is merely one unit of an expanded autonomous local group. Instead of the tiniest settlements maintaining strict independence, as among the Sanpoil, a*

> *small number within a relatively small range join together in a mutually advantageous union. In this case the group is looked upon in the same light as a large village. It is essentially a union of domestic and peacetime order.*

Given these variations in Plateau ethnic group organization between groups and even, over time, within groups, designating territories of Plateau ethnic groups can be difficult.

> *The exactitude with which boundaries are drawn varies greatly…. Where the village is the political unit boundaries are automatically exact so far as the settlements themselves are concerned, but intervening and tributary territory must be divided arbitrarily, or be used in common. In the typical organization of the Plateau, territorial segmentation is highly specific along river courses, but hunting territory is invariably used in common by a number of villages or small bands…The actual line of division [between villages] is seldom geographically intermediate, but is determined with regard to fishing grounds…Hunting and gathering grounds, on the other hand, cannot be so neatly parceled out…It must be emphasized at this point that these distinctions and differences are largely formal and structural, not economically functional. (Ray 1939, in Ross 1968)*

Early ethnographies also identify underlying problems associated with territorial lines of ethnic groups in the Plateau.

> *Teit (1930) described them partly by territory and partly by speech. He subdivided the Okanogan ethnic group by "tribes" as the Okanogan proper, the Sanpoil, the Colville, and the Lakes. Later studies revealed that the Okanogan proper were divided into two regional distinct groups, the northern Okanogan of Canada and the Sinkaietk of the Okanogan River in Washington. The Sinkaietk, as we have observed, were comprised of many localized, nearly autonomous villages, but they have not been clearly differentiated from the Wenatchi, Methow, and Moses-Columbia on any but dialectal grounds (Spier 1936). Walters (1938) compared the groups on a purely territorial basis. Spier observed that "dialectic and territorial affiliations systematically relate to the larger groupings …[However,] one must not assume that dialect and tribal [territorial] groupings were always one and the same thing" (1936). (Ross 1968)*

Few if any ethnic groups in the aboriginal Plateau would have recognized the boundaries designated by anthropologists. With the possible exception of the eastern groups like the tribalistic Nez Perce and Spokane who had experienced substantial Plains influence, Plateau inhabitants were not much concerned about ethnic group boundaries (Ross 1968).

Tribal Culture

Walker (1967, in Ross 1991) succinctly delineated the principal elements of ethnographic Plateau culture as:

- *Riverine settlement patterns.*
- *Reliance on aquatic foods as a major element of their diet.*
- *A complex fishing technology.*
- *Mutual cross-utilization of subsistence resources with other ethnic groups of the Plateau.*
- *Extension of kinship ties into other ethnic groups of the Plateau through systematic intermarriage.*

- *Extension of trade links throughout the Plateau by institutionalized trading partnerships.*
- *Relatively simple political organization.*

Salmon was central to the economy, cultural, and spiritual lives of the Plateau people. The bountiful salmon and steelhead runs of the Columbia River provided the Plateau people with one of their main subsistence resources. Salmon also occupied a central place in their cultural and spiritual life. Each tribe had a narrative of how, in an earlier, "mythological" time, the most powerful being, Coyote, brought salmon to the people. The people eagerly awaited the first arrival of fish from the ocean in the spring, and marked the first catch of the season with five days of ceremony and elaborate ritual behavior. In practicing the first salmon ceremony, the people assured the yearly return of the fish – both by following the laws laid down by the Creator, and by allowing sufficient fish to escape to spawn the next generation. Nineteenth century Euroamerican visitors to the Plateau described with awe the tens of thousands of pounds of fish harvested and prepared by the Indians at their principal fisheries (Ortolano et al. 2000).

Salmon and other fish were caught in nearly all the rivers, streams, and lakes in the region. Each tribe had its own fishing locations, and also shared in the harvest at the large intertribal fisheries, following the anadromous fish in their course upriver. The tribe that controlled a particular fishery appointed a salmon chief to oversee the harvest, distribution, and proper observance of ritual. In most years there was a surplus that could be traded for items and materials not found in their own territory, such as shells and baskets from the coast. Games, horse racing, gambling, and trade took place at the camps surrounding the fisheries (Ortolano et al. 2000).

Salmon nourished the Indian people physically, providing one-quarter or more of the caloric needs for most of the Plateau tribes. The annual salmon ceremony and the salmon stories told throughout the year were central to spiritual life, they reflected the reverence native peoples held for all life forms. The distribution of fish to all members of the community and to all visitors reinforced core cultural values of egalitarianism and generosity. The intertribal gatherings that accompanied the salmon harvest promoted reciprocal and peaceful relationships across the Plateau (Ortolano et al. 2000). The tribes were guided in all their choices and relationships by certain well-defined beliefs and values. Emphasis in education, training, religion, and all social and political action, was strongly placed on this system of values. The responsibilities of chiefs and other leading men were primarily the support of these principles. Issues and matters of a material nature were of distinctly less importance (Ray 1977).

Land Use – Subsistence and Settlement

The most significant writing of mutual cross-utilization of economic resources in the Interior Plateau is Walker's (1967) work, which firmly established the importance of dependence of Plateau peoples upon fishing and root gathering during the aboriginal and early historical periods (Ross 1991).

> *Logistically, the winter location reflected ease of water travel and communication, driftwood, certain hydrophytes, availability of particular animals, and weather. During the winter peoples lived mostly on stored foods and the occasional foray to hunt or fish, accomplished individually or with a small group.*

Winter residence was an often semi-subterranean conical lodge of pole covered with sewn tule mats, and was usually occupied by one or more extended families. Double layers of mats and banked earth provided a comfortable environment. Smoke from heat and cooking fires was vented by a "long appeture in the middle of the roof (Teit 1927). Large communal lodges were also constructed and the oblong cedar bark lodge was large enough to house as many as four families (Teit 1927). This structure was sometimes used throughout the year.

Other structures in the cultural landscape were women's menstrual huts of conical construction from cedar bark, old tule mats, and sewn skins. An important structure used almost daily throughout the Plateau was the sweathouse. This dome-shaped low structure was constructed by bending willow and covering with skin, bark, or old tule mats. Permanent sweathouses were further covered with overlaid sod or earth. A sweathouse, according to size, would accommodate three to eight individuals who used the structure and its paraphernalia for spiritual purification, physical cleansing, socialization, social control, and on occasion for curing.

Winter was a time for socialization, story-telling, trading, games and gambling, courting, the maintenance and manufacture of tools and weapons, curing ceremonies, and certain important rites of intensification which were important to the general welfare of the participants.

Briefly, summer camps tended to be located at major food resource sites, and reflected the need for sharing technologies when mutually exploiting a common resource. This was particularly true for fishing stations as large numbers of people from different groups converged to exploit a channeled migratory food.

Root digging and berry collecting camps in the spring were invariably relatively small since little if any cooperation is required in gathering plant foods. With the exception of the occasional berdache, women's camps were occupied by women and young children when digging roots. Late summer and early fall camps, often on higher elevations, had no division of labor by sex as men would frequently spend the day deer hunting and women collecting, with both sexes sharing the camp as extended families.

[Hunting, fishing, and gathering] delineated the annual round into three major phases (Keeler 1973); these activities tended to overlap with one another and, consequently, articulated to form a complete annual cycle of resource exploitation (Liljeblad 1972). Each economic complex exhibited its own particular technology of predation and gathering, division of labor, location of subsistence, supernatural ritual, storage techniques, and even patterns of distribution. (Ross 1991)

Ross (1968) discusses two major types of settlements – the large winter village and the smaller summer camp – that existed in the aboriginal Plateau. The winter village location was often determined by fuel, topography, and relative warmth. The summer camp location was determined largely by the availability of fish, game, and roots. Ross described this seasonal round:

As soon as the fish season is over, the Indians again withdraw into the interior or mountains, as in the spring, and divide into little bands [camp groups] for the purpose of hunting the various animals of the chase…The Indians, after passing a month or six weeks in this roving state congregate into larger bands [villages] for the purpose of passing the winter on the banks of small rivers, where wood is plentiful. (Ross 1849, in Ross 1968)

Far more mobile than the Colville, the Lakes were canoe-oriented rather than horse or foot oriented and placed a greater emphasis on hunting than fishing or plant gathering. The Colville subsisted mostly on fish, while their northern neighbors depended equally on fishing, hunting, and gathering. The Colville had four great hunts: in spring for deer and sheep; in late fall for deer, sheep, elk, and bear; in midwinter for deer; and in late winter for sheep. Deer ceremonialism and ritual feasting has been reported (Ackerman 1996).

The catching of salmon and the manufacturing and care of fishing equipment was usually the job of men, while the women were responsible for butchering the fish and preparing it for winter storage by means of sun-drying and smoke-drying. In 1866, a government official among the Colville estimated that their diet was largely comprised of salmon, most of which was caught at Kettle Falls. Chance (1973) has estimated that salmon made up 50% of the Colville diet. Salmon fishing at communal sites such as Kettle Falls was under the direction of a salmon chief. This person performed a ceremony to mark the catch of the first salmon, a ritual that symbolized the people's dependence on the annual salmon harvest (Ackerman 1996).

Each man got his turn at the fishing stations, and each woman received a share of the catch to dry for winter use. Mourning Dove, born in 1888 and the granddaughter of a Colville chief, wrote: "Everyone got an equal share so that the fish would not think humans were being stingy or selfish and so refuse to return (Miller 1990)" (Ortolano et al. 2000).

First-fruits and first-roots ceremonies were held in the spring to thank the spirits of the plants for the return of the crop. Dancing and feasting were central components of these rituals. Sometimes entire families participated in harvesting plant foods, although it was generally the task of women. The digging grounds and berry-picking patches were not considered either village or group property, and although the women worked together, each kept her own harvest. Many plant foods were stored for winter consumption (Ackerman 1996). The Sanpoil would periodically join with other Plateau tribes for a buffalo hunting trip to the Plains, but since only the buffalo hides were brought back to the Plateau the meat could not be considered an essential part of the annual diet (Ray 1932).

The Sanpoil had three kinds of residences, the winter mat house, the semi-subterranean lodge, and the summer mat lodge. Additionally, there was a mat hut used when traveling, a menstrual lodge, and a sweat lodge. In post contact times, the canvas-covered tipi replaced the mat hut for summer use. The semi-subterranean lodge is the older housing type and was falling into disuse in protohistory. The winter mat lodge was about sixteen feet wide, but varied in length. It could house two to eight families (Ray 1933).

If a death occurred in the winter, all parts of the house were burned except the mats. Every winter house was taken apart anyway, but the poles were cached. The poles were not used again for a house, but the mats were reused. For rebuilding a winter house, a new location was sought, perhaps in the same general vicinity, very likely on a clean site without the debris that commonly collected around dwellings. Mats were reused in temporary huts too. At the fishing grounds, the summer mat houses were rectangular flat-roofed structures. It housed several related families (Ray 1933).

Establishment of the Colville Reservation

The first Colville Reservation was established by executive order on April 9, 1872. The Executive Order states the intention to place the Methow (determined at the time to number 316), Okanogan (n=340), Sanpoil (n=538), Lake (n=230), Colville (n=631), Kalispel (n=420), Spokane (n=725), Coeur d'Alene (n=700), and "such other Indians as the Department saw fit to locate" there for a total population of about 4,200. It was a large reservation, bounded on the south by the Spokane River, on the west by the Columbia River, on the north by the International Border, and on the east by the Pend Oreille River and the Idaho State border.

However, within three months a second executive order countermanded the first and changed the boundaries moving the reservation west of the Columbia River. By excluding the land east of the Columbia River, the new reservation also effectively excluded several of the tribes placed on the original Colville Reservation, namely the Spokane, Pend d'Oreilles, and Coeur d'Alenes. The new reservation consisted of 2.9 million acres of the heart of the Okanogan highlands, a rocky, dry landscape. This land was not as productive as that of the original reservation, with far less acreage available for the self-sustaining land-use practices insisted upon by the Indian agents. The government intended assimilation of the natives to Euroamerican lifestyles in part by implementing an agricultural lifeway, but the land available was generally unsuited to these practices (Ackerman 1996).

Further, gathering groups like the Chelan, Entiat, and Methow onto what was homeland of the southern Okanogan, Lakes, Colville, Sanpoil, and Nespelem tribes was considered an intrusion and added to the already tense atmosphere. In an attempt to resolve the trouble created, a separate Columbia Reservation was created through executive orders in April 1879 and March 1880 through agreement with the Columbia's powerful headman Chief Moses. By 1883, settlers had applied pressure to obtain land on the Columbia Reservation that ultimately led to its being returned to public domain in 1886. By 1884, Moses and most of the people in the four tribes of the Columbia confederacy had moved to the Colville Reservation (Lahren 1998), however it took military intervention to force the Entiat and Chelan onto the reservation. In 1885, the Chief Joseph (Wallowa) band of Nez Perce were allowed to return from their forced placement in the Indian Territory, and being unwelcome on the Nez Perce Reservation were allowed to settle on the Colville Reservation. This created additional conflicts as the Nez Perce were still remembered as enemies of many of the other tribes already on the Colville Reservation. The Palouse people had included the northern Columbia Basin in their annual round in late prehistory and many had drifted to the Colville Reservation as staying in their traditional territory along the Snake and Palouse Rivers became untenable.

Social and cultural turmoil reigned on the Colville Reservation during the early 1880s as their daily lives were impacted by the events described above and below including:

> *The creation and the quick termination of the neighboring Columbia-Moses reservation; the Homestead Act; increased alcohol consumption; Euro-American religious beliefs (which led to the burning down of the Chelan mission while the Jesuit missionary was absent); encroachment on the reservation, which caused hostilities including murder; and various Unites States government actions, including the placing of the unrelated Joseph Nez Perce non-treaty political prisoners in the same vicinity as the Sanpoil and Nespelem pacifists in 1885. (Reichwien 1988).*

In 1892, the Colville Reservation was reduced by approximately half to about 1.5 million acres as pressure from mining interests led the U.S. government to purchase the north half of the reservation. Inter-tribal strife on the reservation was further aggravated since many of the tribes felt that Moses and the Nez Perce had arranged the sale of the land. The remaining south half of the reservation was allotted in 1906, and then opened for homesteading in 1916 (Lahren 1998).

Construction of the Grand Coulee Dam devastated the way of life of the upper Columbia River tribes. In the 1930s most of the Colville people lived along rivers. The loss of anadromous fish, destruction of wildlife habitat, loss of access to gathering grounds, and loss of prime agricultural lands and homes eliminated the economic base of many members of the Colville and Spokane reservations. The Colville Tribe later estimated that the reservoir displaced 2,000 of its members (Ortolano et al. 2000). Inundation of the river valleys above the dam took much of the best reservation farm land, and forced half or more of the Colville tribe's population and a number of Spokanes to move from their homes with minimal compensation. Grand Coulee Dam severely damaged the physical and spiritual health of tribal members throughout the region (Ortolano et al. 2000 – final report annexes).

Known Prehistoric Resources

Little is definitively known about prehistoric cultural resources within the overall Project area. Field analysis, as recommended above, should identify what, if any, such resources may be present.

Potential Prehistoric Resources

The region encompassing the Salmon Creek Project has received significant cultural resources attention over the years. From this work it is possible and appropriate to develop certain generalizations about the types of prehistoric resources that would be expected to be present and about the types of landscapes and locations where such resources might be found. The types of sites that have the potential to be present in the project area include habitation sites, hunting camps, fishing stations, tool procurement areas, or ritual sites. These potential areas are described in more detail below.

Habitation sites often hold the potential to yield information about prehistoric adaptations and settlement patterns and thus many of these sites would be considered potentially eligible for inclusion in the NRHP. Archaeological sites containing housepit features are generally thought to represent a more sedentary lifestyle. Housepit features have the potential to yield information on aspects of human behavior including technology, resource procurement, subsistence and adaptation strategies, trade networks, and social stratification. Housepit sites are generally documented along the river shore and on islands (Greengo 1986). Intact datable materials, the preservation of floral and faunal remains on structure floors, variations in housepit design and orientation, and the presence of associated or subfloor features are all important contributing aspects involved in the investigation of habitation structures.

Another type of habitation site is the open camp or small habitation site. These types of sites do not generally exhibit specific evidence for habitation structures although some form of temporary structure may be suggested by the varied artifact content of occupations at these sites. Small habitation or open campsites are thought to represent temporary occupation by small groups of people at resource procurement or processing camps. That temporary structures may not have left archaeological evidence of their presence at sites is also an important consideration in documenting subsistence and settlement patterns within the Project area. These types of sites may contain significant information in regards to resource procurement and processing activities through the potential preservation of floral and faunal remains, and in the types and stages of lithic materials left at these locations. These sites may yield important information for National Register evaluation if they contain intact stratigraphic deposits and preserved materials.

Procurement of natural resources such as toolstone material, fish, freshwater aquatic species, plants for food, medicine, or other household needs, mammalian species, or avian species are generally considered the types of activities associated with resource procurement and processing sites. Hunting camps or stations will generally include specific tools, faunal remains, and lithic debitage associated with procurement and processing of animal remains. The environmental setting of hunting camps may include topographic or man-made features associated with hunting blinds, precipices, ridges, rock alignments, or canyons that would have been used to procure game species. Projectile points, chopping tools, scraping tools, hammerstones, utilized flakes, and anvils may be anticipated artifacts associated with hunting stations. Fishing stations may contain features such as boulder aggregations, shallow depressions, or other cobble features. Net weights, grooved notched cobbles, numerous utilized flakes, stone points, and bone tools are anticipated artifacts associated with fishing camps. Plant processing sites may be recognized by features such as roasting pits or bedrock mortars and by artifacts such as grinding implements. These types of resource procurement and processing sites are important because of their potential to yield information about prehistoric subsistence strategies and cultural adaptations that occur through time due to variations in climate conditions and societal preferences for various resources.

Toolstone raw material procurement and processing sites are evidenced by the presence of a variety of debitage stages, the presence of cores, blanks, the predominance of primary or decortication flakes at quarry sites, hammerstone, flaked cobble scatters, broken tools and projectile points, and possibly discrete knapping areas within other sites. These scatters are often associated with natural outcrops of raw material, some of which is toolstone quality. The analysis of lithic materials may reveal attributes of specific tool reduction techniques or possibly provide information on complete diagnostic stone tools. Toolstone quarry areas may provide additional information on group mobility patterns, trade networks, travel routes, and be related peripherally to other seasonal round activities. The presence of non-local raw materials and the reduction stages of lithic debitage associated with non-local toolstone materials also may provide important data related to trade networks and exchange systems as well as to types of raw material preferred by specific groups or individuals as well as to tool production techniques using a variety of raw toolstone materials.

Ritual sites can include cairns, rock art, burials, and cemeteries. These property types are associated with religious and ceremonial activities that necessitate tribal involvement with any investigations and should be treated with care and sensitivity. Ritual properties are important not only because they represent physical manifestations of spiritual values of prehistoric peoples but also because they are important culturally and spiritually to modern Native Americans. Ritual sites may be considered significant under more than one NRHP criterion factor and thus care needs to be used not only in correctly identifying cairns from modern property markers or talus pits associated with burials as opposed to those that may have been used for storage facilities.

3.10.1.4 Evaluation Criteria

The description of impacts to cultural resources uses the following definitions for potential discovery of cultural resources and likelihood of impact due to Project components.

Areas with high sensitivity include:

- Banks, terraces, and landforms with slopes less than 10 percent on the first two benches above the Okanogan River.
- Above-ground activities near historic structures.
- Alluvial benches in the lower reaches of Salmon Creek.

Areas with moderate sensitivity include:

- All landforms with slopes greater than 10 percent in the vicinity of the first two benches above the Okanogan River.
- Cobble benches with minimal soil deposition along Salmon Creek.

All other areas not described above are considered low sensitivity.

3.10.2 CULTURAL IMPACTS

3.10.2.1 Alternative 1: Okanogan River Pump Station and Pipeline Route

The location of the proposed pump station is immediately adjacent to the Okanogan River, and has a high likelihood of discovery of cultural resources. This area is likely to have a high density of prehistoric use and is in a zone of high sensitivity to impact (Mierendorf, 1981).

The new pipeline route from the proposed pump station on the west bank of the Okanogan River crosses State Route 215 from the pump station site and proceeds over flat, undeveloped land. It then rises up a 25-percent grade to Pogue Flat. It continues north along Conconully Road and west on Glover Road to the Diversion 3 pump station, then crosses orchard land to terminate at Diversion 2. Approximately 85 percent of the route lies on Pogue Flat, which has a 1.5 percent grade. Most of this route would have a moderate to high sensitivity to disturbance. Between the river flat and Pogue Flat is a narrow, old river terrace, which has a historic housesite on it, and is a high probability area for historic and prehistoric remains.

This alternative would increase stream flows in Salmon Creek. Impacts could include an increase in streambank erosion in portions of the creek sensitive to higher flows. This could have the potential of unearthing cultural resources at a faster rate than they would be without the increased stream flow. The only difference between this alternative and the No Action Alternative is the shortened timeframe for the effects of erosion to take place within the floodplain and streambanks of Salmon Creek.

3.10.2.2 Alternative 1: Feeder Canal Upgrade

Reconstruction of this canal would alter it from its current condition and remove a portion of the canal and replace it with a pipeline to improve operations and efficiency. For approximately three-quarters of the length of the canal, the existing alignment would be used; the remaining quarter of the existing alignment would not be followed in the upgrade (see Section 2.2.2). Because the canal was determined eligible for the NRHP in a previous study, A Historic American Engineering Record (HAER, March 2003) has been completed for the Salmon Lake Dam, including this canal. This documentation was considered mitigation for construction activities conducted at Salmon Lake Dam in 2000-2002. No further work related to the canal as a cultural resource is needed.

3.10.2.3 Alternative 1: Stream Rehabilitation

The mouth of Salmon Creek is thought to be an area used as a prehistoric fishing camp and winter residence area, and therefore is expected to have a high potential density of cultural resources. Lower Salmon Creek above the mouth and first terrace was a winter residence area, which is expected to have a moderate to high density of cultural resources (Mierendorf, 1981). Overall sensitivity of land use zones range from high on the Okanogan streambank to the first terrace to moderately high along the lower Salmon Creek drainage. Rehabilitation work at the mouth of Salmon Creek would have a moderate to high likelihood of unearthing or disturbing cultural resources.

3.10.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

The location of the proposed additional work is immediately adjacent to the Okanogan River, and has a high likelihood of discovery of cultural resources. This area is likely to have a high density of prehistoric use and is in a zone of high sensitivity to impact (Mierendorf, 1981).

The new pipeline route would branch off the existing pipeline just east of Pogue Flat. It continues due west across Pogue Flat following an existing dirt road. Approximately 90 percent of the route lies on Pogue Flat, which has a 1.5 percent grade. Most of this route would have a moderate to high sensitivity to disturbance.

This alternative would increase stream flows in Salmon Creek. Impacts could include an increase in streambank erosion in portions of the creek sensitive to higher flows. This could have the potential of unearthing cultural resources at a faster rate than they would be without the increased stream flow. The only difference between thies alternative and the No Action Alternative is the shortened timeframe for the effects of erosion to take place within the floodplain and streambanks of Salmon Creek.

3.10.2.5 Alternative 2: Feeder Canal Upgrade

The impacts would be the same as described in Section 3.10.2.2.

3.10.2.6 Alternative 2: Stream Rehabilitation

The Conceptual Rehabilitation Plan for Lower Salmon Creek (June 2002) states that the segment of stream in the vicinity of the town dumpsite requires substantial channel reconstruction, localized bed or bank stabilization, reestablishment of riparian vegetation, and year-round moisture to sustain it. Any restoration activities within the vicinity of the Okanogan town dump site would likely expose debris contained within the dump, however, exposure to such debris is likely to be encountered only in isolated areas of the site. If the site was used from the 1940s to the 70s, and the material in it was regularly burned, there are not likely to be significant artifacts still present. If the dump was used earlier in the 20th century, there might be some materials of interest, but if they were burned and pushed around, they are not likely to be very significant. If the dump was used in the 19th century, there might be some significant materials there. Avoidance of disturbance to the area in the vicinity of the town dumpsite is recommended, however, some armoring of the bank to prevent further erosion may be necessary.

The mouth of Salmon Creek is thought to be an area used as a prehistoric fishing camp and winter residence area, and therefore is expected to have a high potential density of cultural resources. Lower Salmon Creek above the mouth and first terrace was a winter residence area, which is expected to have a moderate to high density of cultural resources (Mierendorf, 1981). Overall sensitivity of land use zones range from high on the Okanogan streambank to the first terrace to moderately high along the lower Salmon Creek drainage. Rehabilitation work would have a moderate to high likelihood of unearthing or disturbing cultural resources.

There is a moderate to high likelihood of prehistoric artifacts being present within the area that would be impacted by rehabilitation activities. Some benches were noted to have little soil deposition and should be considered as having a low probability of containing subsurface cultural

3.10.2.7 Alternative 3: Water Rights Purchase

This alternative would increase stream flows in Salmon Creek. Impacts could include an increase in streambank erosion in portions of the creek sensitive to higher flows. This could have the potential of unearthing cultural resources at a faster rate than they would be without the increased stream flow. The only difference between this alternative and the No Action Alternative is the shortened timeframe for the effects of erosion to take place within the floodplain and streambanks of Salmon Creek.

3.10.2.8 Alternative 3: Feeder Canal Upgrade

The impacts would be the same as described in Section 3.10.2.2.

3.10.2.9 Alternative 3: Stream Rehabilitation

There would be no stream rehabilitation under this alternative.

3.10.2.10 No Action Alternative

Erosion would continue to occur along unstable streambanks during active stream flows in the winter and during storm events. Cultural resources may become visible following these high flow events or become further buried in sediment deposition areas. Potential cultural resources from the town dumpsite are already being exposed by current stream flow. This would continue to occur under the No Action Alternative.

No disturbance to cultural resources would occur at the site of the proposed Okanogan pump station and along its associated pipeline or along the additional pipeline required for the Shellrock pump station as a result of this Project.

The feeder canal would continue to deteriorate with time, particularly on its east end near Salmon Lake, where active sloughing and debris falls are damaging the canal. Active maintenance would continue to be needed to keep the feeder canal functional.

3.10.3 Mitigation Measures

There are a number of recommendations for further work that should take place prior to the development of specific mitigation measures. These recommendations were listed above as part of the Existing Conditions section.

- Avoidance is the best form of mitigation. Once the preferred alternative is selected, and prior to the Final EIS, care should be taken to avoid any known cultural resources within the APE. This analysis is preliminary because of the difficulty in assessing effects prior to selecting a preferred alternative and identifying the local commitment to avoidance or mitigation measures.
- HABS/HAER documentation could be undertaken for demolition or alteration of historical resources. Salvage of building parts or the moving of historical resources is another form of mitigation.
- In the event that human remains are discovered during the conduct of any of the fieldwork proposed, the protocol detailed within an Unanticipated Discovery Plan should be followed. Such a plan should be developed as part of a Memorandum of Agreement (MOA) prior to the completion of the Final EIS. Construction monitoring of areas with high sensitivity for archaeological resources should also be included within the MOA.

Listed below are additional potential mitigation measures that could be included in the MOA:

- Shovel test probes 50 centimeters in diameter and up to one meter deep would have to be conducted prior to commencement of any construction activity or disturbance on banks, terraces, and landforms with slopes less than 10 percent. This would include the area around the Okanogan pump station, Shellrock pump station, alluvial benches of Salmon Creek where rehabilitation work is proposed, and over 90 percent of the pipeline proposed for the Okanogan pump station and 65 percent of the pipeline route for Alternative 1. Backhoe testing is a possible option, or requiring a cultural resource specialist to monitor excavation of the high sensitivity areas.

- A cultural resource monitor should be present on site if any work is conducted in the area of the town dumpsite. An option would be to conduct backhoe trench testing prior to bank stabilization.
- Conduct an intensive pedestrian survey prior to starting construction on any component of this Project that would disturb ground, including rehabilitation work along the streambanks of Salmon Creek.
- Conduct a hydraulic assessment of the creek taking into account the proposed increase of stream flows and its effects on bank erosion. Increases in the water table should be considered.
- If further testing determines there are very old (19th century) artifacts, avoid disturbance of the Okanogan town dumpsite, if possible.
- Minimize disturbance to any discovered cultural resources, if possible.

3.10.4 Unavoidable Adverse Impacts

The alteration of the feeder canal would be a significant unavoidable adverse impact that has been mitigated previously with HABS/HAER documentation. Unknown archaeological resources and TCP areas may be present within the APE. These resources, if present, should be avoided. Further discussion of unavoidable adverse impacts should be revisited pending full field investigation as recommended. [1, 2]

3.11 HEALTH AND SAFETY

This section describes the current public health and safety conditions in the vicinity of Project components. It also describes the sources of potential human health and safety impacts caused by proposed Project construction and operation. Human health can be affected by changes in background noise, by introduction of toxic or hazardous chemicals on the land or in the water during construction and operation of Project components, or by changes in frequency of fire or other catastrophic events. Health and safety risks consist of those that could be experienced by construction or operations and maintenance personnel, as well as by the general public.

3.11.1 Existing Conditions

3.11.1.1 Regulatory Framework

A variety of federal and state safety regulations and guidelines apply to Project design and construction. Federal safety regulations are issued under the authority of the Occupational Safety and Health Act. State safety regulations are issued under the Washington Industrial Safety and Health Act. In addition, the National Electrical Manufac-turers Association and the

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[1] Letter from Bonneville Power Administration to Washington Office of Archaeology and Historic Preservation (Rose, Donald L., 6/12/2003)

[2] Letter from Washington Office of Archaeology and Historic Preservation to Bonneville Power Administration (Williams, Scott, 6/18/2003)

Institute of Electrical and Electronics Engineers issue standards for the design of electrical equipment and controls. The Okanogan County Building Code (which is based on the Uniform Building Code) sets standards for fire, life, and structural safety aspects of buildings and related structures.

Several portions of the Code of Federal Regulations (CFR) governing the handling of hazardous materials would potentially apply to the proposed Project, including:

- 40 CFR 112 (Spill Prevention Control and Countermeasures)
- 40 CFR 262-266 (Resource Conservation and Recovery Program)

Whether these and other regulations apply to the Project would depend on the exact quantities and types of hazardous materials used and stored onsite.

3.11.1.2 Noise Regulations

The Washington Administrative Code (173-60 WAC) provides the applicable noise standards for Washington State. The Washington regulation specifies noise limits at the receiving property for three types of land which roughly correspond to residential, commercial/recreational, and industrial/agricultural uses:

- Class A: Residential property where people reside and sleep
- Class B: Commercial and recreational property requiring protection against noise interference with speech
- Class C: Industrial and agricultural property where economic activities are of such a nature that higher noise levels are anticipated

Table 3-46. State of Washington Noise Regulations (173-60-040 WAC)

	Sensitivity of Receiving Property		
Sensitivity of Noise Source	Class A	Class B	Class C
Class A	55 dBA	57 dBA	60 dBA
Class B	57 dBA	60 dBA	65 dBA
Class C	60 dBA	65 dBA	70 dBA

Note: Standard applies at the property line of the receiving property.

Source: WAC 173-60-040.

The areas proposed for activity associated with this Project are a combination of Class B in the vicinity of the proposed pump station in Okanogan and the Shellrock facility, and Class A for much of the remaining area. **Table 3-46** summarizes the maximum permissible levels applicable to noise received at residential areas and commercial and recreational property. Construction noise and alarms or safety devices are exempted from the limits in **Table 3-46** between the hours of 7 a.m. and 10 p.m. (per 173-60-050 WAC).

In addition, the regulations specify that:

(a) Between the hours of 10:00 p.m. and 7:00 a.m. the noise limitations of the foregoing table shall be reduced by 10 dBA for receiving property within Class A.

(b) At any hour of the day or night the applicable noise limitations above may be exceeded for any receiving property by no more than:

(i) 5 dBA for a total of 15 minutes in any one-hour period; or

(ii) 10 dBA for a total of 5 minutes in any one-hour period; or

(iii) 15 dBA for a total of 1.5 minutes in any one-hour period.

3.11.1.3 Methodology

The primary sources of information for this section are published information and descriptions of health and safety risks related to construction projects in environmental analyses of similar projects.

A review of Federal and state databases for unauthorized releases of hazardous materials or hazardous waste was conducted. No sites or facilities in the vicinity of Project components appear on any state or federal list that tracks hazardous materials. The only facility identified that could result in some impact as a result of proposed Project activities is the old Okanogan town dumpsite.

On July 21, 2003, a BPA environmental protection specialist conducted a site reconnaissance of the town dumpsite. Chris Johnson, planner for the City of Okanogan, and an additional unidentified long-time resident of Okanogan were interviewed and present during the site reconnaissance. The objective of the site reconnaissance and interviews was to obtain information indicating the likelihood of identifying recognized environmental conditions in connection with the town dumpsite.

3.11.1.4 Affected Environment

The Project study area lies in a sparsely to moderately populated rural agricultural area consisting of rangeland, farms, and orchards. A portion of the stream rehabilitation is proposed for more densely populated areas within the town of Okanogan. Potential hazards on the site include the fire hazard presented by dry crops and grasses (especially in the summer months) and some construction on moderately steep hills. Another potential hazard is the former town dumpsite that is located along Salmon Creek less than one mile northwest of Okanogan, Washington (see Section 3.10.1 for a description of the Okanogan town dump).

As described in Section 3.10.1, operation of the dump occurred from the 1940s or earlier until the dump was closed in the mid-1970s. Waste observed at the dumpsite includes broken and melted glass, tin cans, and small amounts of other solid waste. In addition, lenses of debris are visible at the dumpsite along the banks of Salmon Creek, which has experienced severe bank cuts from high runoff flows and subsequent exposure of solid waste (**Figure 3-25**).

Available information indicates that the town dump was not attended by an on-site operator during its operation, did not have specific hours of operation, and did not have any restrictions on what could be placed at the site. In addition, there are no records or documentation available that pertain to the operation of the dump (Walasavage, 2003). It is thus not possible to identify the potential contents of the dump from available records, and whether any hazardous waste or other

Figure 3-25. Salmon Creek Streambank with Debris Visible in Top Third of Bank. Note Lack of Streambank Vegetation and Water in the Stream Channel.

materials have been disposed of and possibly contaminated the site. However, the dumpsite does not appear on any Federal and state hazardous waste databases or lists.

Due to the lack of record keeping for the site, it is also difficult to assess the full extent or depth of the dumping area. There is evidence that dumping did occur right up to the creek in isolated areas, however, these areas are limited to the top one half of the exposed creek bank. This suggests that significant erosion has occurred since the dumping activities were terminated. Areas of the dump that were exposed along the creek bed appear to be visible as a result of high spring or winter flows that are naturally occurring.

Noise

Typical sound levels of familiar noise sources and activities are presented in Table 3-47. The human perception of a doubling of loudness is reflected in the scale as an increase of 10 dBA (A-weighted decibel). Therefore, a 70 dBA sound level would sound twice as loud as a 60 dBA sound level to most individuals. People's perception of noise increases depending upon the nature of the background noise compared to the intruding noise. If the background noise is of the same character as the intruding noise (e.g., new traffic noise added to existing traffic noise),

Table 3-47. Common Sound Levels/Sources and Subjective Human Responses.

Thresholds/ Noise Sources	Sound Level (dBA)	Subjective Evaluations[1]	Possible Effects on Humans
Human threshold of pain Carrier jet takeoff (50 ft)	140	Deafening	Continuous exposure to levels above 70 can cause hearing loss in majority of population
Siren (100 ft) Loud rock band	130		
Jet takeoff (200 ft) Auto horn (3 ft)	120		
Chain saw Noisy snowmobile	110		
Lawn mower (3 ft) Noisy motorcycle (50 ft)	100	Very loud	
Heavy truck (50 ft)	90		
Pneumatic drill (50 ft) Busy urban street, daytime	80	Loud	
Normal automobile at 50 mph Vacuum cleaner (3 ft)	70		Speech interference
Large air conditioning unit (20 ft) Conversation (3 ft)	60	Moderate	
Quiet residential area Light auto traffic (100 ft)	50		Sleep Interference
Library Quiet home	40	Faint	
Soft whisper (15 ft)	30		
Slight rustling of leaves	20	Very faint	
Broadcasting studio	10		
Threshold of human hearing	0		

[1] Note that both the subjective evaluations and the physiological responses are continual without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the individuals exposed to noise.

then people generally cannot detect differences less than one (1) dBA. However, if the intruding noise is of a different character than the background noise (e.g., the whine of a new turbine superimposed onto rural background noise) then the intruding noise could be easily discernible even if it adds less than 1 dBA to the background noise level.

Currently, noise levels are faint to moderate in the sparsely populated portions of the Project area and moderate to loud in the urban areas of Okanogan during daytime hours. All areas are predominantly very faint to faint during nighttime hours. Residents adjacent to the Shellrock pumping station have erected barriers to abate the noise coming from the pumps, which run around the clock during the summer irrigation season in most years and are not housed in any structure that dampens the noise.

3.11.1.5 Evaluation Criteria

- Impacts to health and safety from the proposed Project would be considered high (and significant) if exposure to a site-related hazard resulted in a substantial, increased risk to human health and safety for site personnel or the general public (assuming those exposed were following site safety procedures and obeying applicable laws--for example not trespassing).
- Impacts to health and safety from the proposed Project would be considered moderate if exposure to a site-related hazard resulted in some risk to human health and safety for site personnel or the general public (assuming those exposed were following site safety procedures and obeying applicable laws).
- Impacts to health and safety from the proposed Project would be considered low if exposure to a site-related hazard resulted in a minor risk to human health and safety for site personnel or the general public (assuming those exposed were following site safety procedures and obeying applicable laws).

3.11.2 Health and Safety Impacts

3.11.2.1 General Impacts During Construction

Public health and safety risks for construction workers and the general public associated with construction of any of the Project components would be low if appropriate health and safety procedures are employed. Even with appropriate safety procedures during construction, minor health and safety risks exist for workers and visitors. Each contractor would maintain a safety plan in compliance with State of Washington requirements.

Highway-authorized vehicles and construction equipment would be fueled, serviced, and cleaned offsite. Construction equipment that is transported to the Project site on flatbed trucks (because such equipment is not authorized for operation on the highway) would be fueled and serviced onsite during the construction phases. All fueling and servicing of such equipment, whether on or off the Project site(s), would be in accordance with typical construction practices and in compliance with applicable laws and regulations. A spill prevention, control, and countermeasures (SPCC) plan would be required to minimize the impacts of any spills that occur.

Any construction off of surfaced roads would create a risk of fire if operations occur during the dry summer months. Driving of vehicles or equipment through dry brush and grass, or sparks generated during digging, blasting, or bulldozing operations can ignite dry fuels.

Operation of vehicles and equipment during construction would contribute to the degradation of air quality in the area, although it would be of short duration. There would be noise impacts due to the operation of heavy equipment, but this would take place only during appropriate hours between 7 a.m. and 10 p.m.

3.11.2.2 General Impacts During Operation and Maintenance

Health and safety risks for Project personnel and the general public during operation and maintenance of pump stations, the feeder canal, and pipelines would be low, if appropriate prevention and response procedures are used. Nevertheless, potential health and safety risks during operation and maintenance of Project components would exist.

No extremely hazardous materials (as defined by 40 CFR 335) are anticipated to be produced, used, stored, transported, or disposed of as a result of this Project. Potential risks associated with storage and use of these materials would be minimized through compliance with applicable local, state, and federal environmental laws and regulations.

3.11.2.3 Impacts Common to All Three Action Alternatives

All of the Action Alternatives would have a potential impact associated with the increase of stream flows in Salmon Creek. Increased summer stream flows may raise the water table in the vicinity of the town dumpsite between May and September. It is uncertain what the impact of this seasonal change in water table would be or what this change would mean to the water table level during the remainder of the year. It is possible that a permanent, annual increase in summer flow could lead to an overall, year-round increase in the water table. There is no expected change to the water flows that have typically occurred during spring during the past 90 years. However, even if there would be no increase in groundwater recharge in other seasons, the higher summer flows levels could lead to a higher late summer water table level that would then be supplemented by the fall/winter/spring hydrology. Therefore, the winter water table levels would also stand a chance of being higher (assuming inputs and outputs to the system are constant with historical rates). It is expected that the environmental effect of increased stream flow during the summer months would be low, however, additional investigation into the potential impact on the water table in lower Salmon Creek and the potential for leachates from the dumpsite is recommended.

3.11.2.4 Alternative 1: Okanogan River Pump Station and Pipeline

The physical components of this alternative include the proposed Okanogan pump station and the proposed new pipeline from the Okanogan pump station to Diversion 2. The following potential impacts to health and safety may occur due to construction activities.

Potential Releases of Hazardous Materials to the Environment

Hazardous materials used during construction of the pump station and pipelines would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Construction vehicles would be serviced from portable fuel trucks.

Small quantities of fuel, oil, and grease may leak from construction equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations. If a large spill from a service or refueling truck were to occur, contaminated soil would be placed in barrels or trucks by a licensed, qualified waste contractor for offsite disposal. Appropriate procedures would depend on the waste classification of the contaminated soil. For example, if soils were to classify as dangerous waste, they would be transported to a permitted hazardous waste disposal facility.

If a spill were to involve hazardous materials equal to or greater than the specific reportable quantity, all federal, state, and local reporting requirements would be met. Other wastes likely to be generated include: used oil, spent antifreeze, unused adhesives, and discarded chemicals and residuals. Non-hazardous solid waste associated with construction activities could include empty containers, scrap wood, scrap metal, and trash.

In general, the construction contractor would be considered the generator of waste oil and miscellaneous hazardous waste produced during facility construction and would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations and standards. This would include licensing, personnel training, accumulation limits, reporting requirements, and record-keeping.

Although it is not anticipated, in the event that contaminated soil is encountered during excavation activities for proposed Project facilities, the soil would be segregated, sampled, and tested to determine appropriate disposal/treatment options. If required, the soil would be hauled to a Class I landfill or other appropriate soil treatment and recycling facility.

Noise

Construction of the new pump house in the town of Okanogan would introduce a new source and location for the noise associated with pumps. The pumps would be housed in a concrete pump house building designed to mitigate noise. State ordinances regarding noise would be enforced. The structures surrounding the location of the proposed pump house are mostly commercial and would be considered class B sensitivity. To the south is the County Historical Museum; to the east is the river; to the north is an auto-body shop and a tire store; and across the street to the west is an ATV/snowmobile store and a vacant lot. The nearest residential homes are to the south of the ATV/snowmobile store and vacant lot. The impact of introduced noise is expected to be low.

Risk of Fire

The risk of fire during construction or operation of the water supply pipelines and pump station would be low if proper fire prevention equipment and procedures are followed during construction of the pipeline. Operation of the pump station or pipelines would have no impact on the risk of fire.

3.11.2.5 Alternative 1: Feeder Canal Upgrade

General construction related impacts would occur by bringing in heavy equipment to complete proposed work. Changes to background noise levels would be expected and minor impacts to air quality and risk of introduction of hazardous materials such as fuels and oil may occur during construction. These impacts would be of short duration, although possibly noticeable to local residents since background levels of noise are faint and the quality of air in the vicinity of Conconully is very good.

Potential risks to landowners would be minimized by coordinating construction activities with access needs and landowner schedules. Unauthorized visitors would be discouraged during construction hours by the presence of construction workers and warning signs.

The risk of fire during construction would be dependent upon the time of year of construction. However, the overall risk would be low if proper fire prevention equipment and procedures are followed during construction the pipeline. Operation of the pipeline and canal would have no impact on the risk of fire.

3.11.2.6 Alternative 1: Stream Rehabilitation

This component would involve work along the streambanks and in the streambed at the mouth of Salmon Creek. General construction related impacts would occur by bringing in heavy equipment to complete proposed work. Changes to background noise levels would be expected and minor impacts to air quality and risk of introduction of hazardous materials such as fuels and oil may occur during construction. These impacts would be of short duration.

Potential risks to landowners would be minimized by coordinating construction activities with access needs and landowner schedules. Unauthorized visitors would be discouraged during construction hours by the presence of construction workers and warning signs.

The risk of fire during construction would be dependent upon the time of year of construction. However, the overall risk would be low if proper fire prevention equipment and procedures are followed during construction.

3.11.2.7 Alternative 2: Upgrade Shellrock Pumping Plant

The only source of introduction of hazardous materials would be from construction equipment spills or leakage along the water supply pipeline during construction and operation. The potential for environmental impact would be low. Construction work at the Shellrock facility would not be as extensive as the work described in Section 3.11.2.1. Impacts due to construction of the pump facility would be similar to Alternative 1, but perhaps shorter in duration.

Upgrading this facility and regular annual use would increase the frequency and duration of noise generated by the pumps. There currently is no pump house to contain the noise generated by the pumps. A pump house to mitigate generation of noise is recommended.

3.11.2.8 Alternative 2: Feeder Canal Upgrade

Impacts would be the same as described in Section 3.11.2.5.

3.11.2.9 Alternative 2: Stream Rehabilitation

This component would involve work along the streambanks and in the streambed of the lower 4.3 miles of Salmon Creek. General construction related impacts would occur by bringing in heavy equipment to complete proposed work. Changes to background noise levels would be expected and minor impacts to air quality and risk of introduction of hazardous materials such as fuels and oil may occur during construction. These impacts would be for up to two years.

Stream rehabilitation activities within the vicinity of the dumpsite could expose debris contained within the dump. This exposure could result primarily from excavation of soils for stabilizing and reconstructing the streambed and its banks in the vicinity of the dumpsite. However, due to the dispersed nature of debris at the dumpsite, exposure of such debris is likely to be encountered only in isolated areas of the site. In addition, it is not known whether petroleum, hazardous waste, or other toxic materials may have been disposed of at the dumpsite, and it is thus uncertain if any of this debris would present a health and safety risk.

Streambank stabilization and reestablishment of riparian vegetationcould slow the current rate of bank erosion and exposure of debris. It appears that a majority of the erosion currently taking place is due to high water flow events and the lack of vegetation along the banks. Reconstruction of the lower two miles of the stream bed would strive to create a stream channel that conveys floodwaters without excessive erosion, sedimentation, or property loss. Overall risk of damage due to flooding may be decreased if stream channel rehabilitation is completed and established before the next flood event occurs. Timing of such an event would be critical.

Potential risks to landowners would be minimized by coordinating construction activities with access needs and landowner schedules. Unauthorized visitors would be discouraged during construction hours by the presence of construction workers and warning signs.

The risk of fire during construction would depend on the time of year of construction. However, the overall risk would be low if proper fire prevention equipment and procedures are followed during construction.

3.11.2.10 Alternative 3: Water Right Purchase

This alternative would not have an impact upon health and safety due to construction activities, although the impacts associated with increased water flows in lower Salmon Creek would occur.

3.11.2.11 No Action Alternative

There would be no change to noise levels associated with this alternative. No construction or operation related hazards or effects would be introduced.

Erosion of the Salmon Creek stream bank is occurring and exposing some items that were deposited in the dump site. According to state and federal records, no evidence of leaching or contamination from hazardous or toxic materials has been detected thus far. Taking no action would result in the bank continuing to erode at its current rate, further exposing buried items and unknown other materials.

Sloughing of the hillside into the feeder canal and potential failure of the canal would remain as a concern. Annual maintenance to keep the feeder canal functioning would be required.

3.11.3 Mitigation Measures

- Investigate and identify possible contaminants in the Okanogan town dumpsite if proposed rehabilitation would impact the area.
- Conduct a hydraulic assessment of Salmon Creek taking into account the proposed increase of stream flows and its effects on bank erosion and determine whether there would be increases in the water table and potential resultant leachates from the dumpsite.
- Any spills or releases of hazardous materials would be cleaned up and disposed of or treated according to applicable regulations. Accidental releases of hazardous materials to the environment would be prevented or minimized through the proper containment of oil and fuel in storage areas.
- A spill prevention, control, and countermeasures (SPCC) plan would be prepared prior to the start of construction, and implemented to minimize the potential for hazardous materials to enter surface or groundwater.
- When working within or adjacent to any drainage ditch, watercourse, ravine, etc., the construction contractor would have an emergency spill containment kit to contain and remove any accidentally spilled fuels, hydraulic fluids, etc.
- Equipment refueling and storage of fuels and hydraulic fluids or any other toxic or deleterious materials would not occur within 100 feet of surface water.
- Strict procedures for disposal of common construction materials (e.g., concrete, paint, and wood preservatives) and petroleum products (e.g., fuels, lubricants, and hydraulic fluids) or any other hazardous materials used during construction would be followed.
- Discharge of solid materials including building materials into waters of the United States would be avoided unless authorized by a Clean Water Act Section 404 permit.
- To the extent possible, excavation and grading would be timed to coincide with the dry seasons to reduce the potential for water erosion. Water would be applied to control dust and minimize wind erosion.
- To the extent feasible, slopes would be graded to no steeper than 2 horizontal: 1 vertical
- All noise producing equipment and vehicles using internal combustion engines would be equipped with mufflers and air inlet silencers, where appropriate; be in good operating condition; and meet or exceed original factory specifications. Mobile or fixed "package" equipment (e.g., arc welders and air compressors) would be equipped with shrouds and noise control features that are readily available for that type of equipment.

- To prevent accidental fires during construction of the Project, workers would be required to avoid idling vehicles in grassy areas and to keep welding machines and similar equipment away from dry vegetation.

3.11.4 Unavoidable Adverse Impacts

There are no foreseeable unavoidable adverse impacts associated with any of the Project components.

3.12 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This section of NEPA asks the Lead Agency to consider whether a proposed action is sacrificing a resource value that might benefit the environment in the long term, for some short-term value to the sponsor or public.

The central purpose of the Salmon Creek Project is to achieve an enhancement of long-term productivity, by taking action to rehabilitate Lower Salmon Creek that would provide passage flows and improve the low flow channel in Lower Salmon Creek to allow migrating salmonids access to good quality habitat in the middle reach of Salmon Creek; contribute to the recovery of salmonids listed as threatened or endangered under the Endangered Species Act; improve and reestablish riparian vegetation in Lower Salmon Creek; and reconnect Lower Salmon Creek to its floodplain.

The uses of the environment proposed to achieve these goals include commitments of water and farmland (discussed in **Section 3.13** below); the use of the existing Shellrock pump station site or proposed new Okanogan River pump station site; the pipeline corridor to connect the proposed new Okanogan River pump station to the Okanogan Irrigation District conveyance facilities; and the use of existing storage reservoirs at Conconully Reservoir and Salmon Lake.

Overall, the proposal's use of the environment results in substantial long-term benefits in exchange for very little unavoidable adverse impact. The long-term benefits include Lower Salmon Creek rehabilitation, contributions to the recovery of listed salmonids, better maintenance of reservoir levels for recreation in most months under most scenarios, and the preservation of reliable irrigation water supply and the socioeconomic benefits to the local area of the agricultural sector of its economy (unless the water rights purchase alternative is chosen as the preferred action). The short-term environmental uses are limited to sites and routes temporarily disturbed for construction (principally for Alternative 1 and stream rehabilitation), and the siting of the proposed new pump station under Alternative 1.

3.13 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Resources proposed to be used to achieve the environmental enhancements described in **Section 3.12** and maintain long-term environmental productivity are primarily water and farmland.

Water supply alternatives considered under this EIS principally shift the source of water (Alternatives 1 and 2) for irrigation, or reduce the use of it (Alternative 3). Water withdrawals for irrigation are shifted from Salmon Creek to the Okanogan River through pumping from the River to the irrigated lands of the Okanogan Irrigation District, allowing the storage and use of natural flows for instream flows and environmental values in Salmon Creek. Water use for irrigation is reduced under Alternative 3 by the purchase of water rights and the retirement of 1470 acres of irrigated land. The retirement of irrigated land represents an additional resource commitment in removing productive farmland from production.

Other minor commitments of resources are involved in the construction materials that would be invested in stream rehabilitation, the construction or upgrading of pumping plants (Alternatives 1 and 2), and the construction of a new pipeline (Alternative 3).

3.14 CUMULATIVE IMPACTS

NEPA and its implementing guidelines require an assessment of the proposed Project in the context of past, ongoing, and reasonably foreseeable future actions that together may create impacts beyond the impacts of the proposed Project. Past actions affecting the Salmon Creek watershed have significantly impacted its functionality as anadromous fisheries habitat, creating both local and regional impacts to sustainable salmonid populations. Some of these actions were undertaken to develop an irrigation-based farming economy in the Salmon Creek area. Ongoing and foreseeable future actions could affect the functionality of Salmon Creek and the local economy in many ways, both positively and negatively. Ongoing and future actions are subject to political, legislative, and fiscal uncertainties. The assessment of cumulative impacts in the local and regional sense is therefore relatively speculative. This section describes past, ongoing and reasonably foreseeable future actions relevant to this Project.

3.14.1 PAST ACTIONS

3.14.1.1 Hydroelectric Development of Columbia River System

The development of hydroelectric facilities on the Columbia River and commercial harvest have had substantial positive effects on the growth of the economy of the Pacific Northwest, and have also had substantial negative effects on anadromous fish runs in the basin. Rock Island Dam was the first mainstem dam constructed on the Columbia River. Construction began in 1929 and was completed before the 1932 adult fish migrations. Counts of fish passing through the Rock Island Dam fish ladders began in 1935. Although two fish ladders were constructed at the Project, fish passage was restricted until a third ladder was constructed in 1940 (Craig and Suomela, 1941).

Anadromous fish runs to the upper Columbia River dramatically changed as a result of the construction of Grand Coulee Dam, which blocked these species from an estimated 1,140 miles of potential spawning and rearing habitat (Fish and Hanavan, 1948). This habitat loss directly and significantly impacted the fisheries resources of the Colville Confederated Tribes. The U.S. Fish and Wildlife Service began the Grand Coulee Fish Maintenance Program (GCFMP) in 1939 to relocate returning adults from the upper river runs to accessible drainages downstream of Grand Coulee Dam. Between 1939 and 1943, salmon and steelhead were intercepted at Rock

Island Dam and transported to the Wenatchee, Entiat, Methow, and Okanogan rivers to spawn (Peven, 1992). Some of these intercepted fish were also artificially spawned and their progeny reared and released from hatcheries in the Wenatchee, Entiat, and Methow rivers (Craig and Suomela, 1941). Despite this extensive recovery program, adult returns of these relocated fish were estimated at 1 percent or less (Mullan, 1987).

3.14.1.2 Development of Salmon Creek Watershed

Anadromous fish species known or suspected to have historically occurred in Salmon Creek include spring chinook and summer steelhead. The construction of the Conconully Dam by the Bureau of Reclamation in 1910 and the OID diversion dam in 1916 significantly impacted the functionality of Salmon Creek for salmonid usage in the following years and up to the present. However, the construction of these projects also supported the development of an irrigation-dependent farming economy in the local area. The OID diversion dam is located 4.3 stream miles above the mouth of Salmon Creek. For more than 80 years, these lower 4.3 stream miles of Salmon Creek have been dewatered under normal irrigation operations, except during spring runoff events that result in uncontrolled spill at the reservoirs and diversion dam. Historical land use-related effects of upland vegetation and sediment production, altered streamflow regimes, and direct manipulation of streambanks and/or riparian vegetation have adversely affected the channel geometry, streambank stability and riparian aquatic habitat value of lower Salmon Creek. The lack of streamflow below the diversion dam has historically precluded fish migration into lower Salmon Creek from the Okanogan River. Fish passage above the Conconully Dam is not possible due to the lack of passage structures. Recently, the Bureau of Reclamation installed fish passage structures at the OID diversion dam, allowing passage to the middle reach of Salmon Creek.

3.14.2 Ongoing and Reasonably Foreseeable Future Actions

3.14.2.1 Federal Actions

BPA, the U.S. Corps of Engineers (USCOE), and the BOR are the Action Agencies under the NOAA Fisheries and USFWS Biological Opinions on the Federal Columbia River Power System (FCRPS). In compliance with the Endangered Species Act, these Action Agencies are implementing the *Draft Endangered Species Act Implementation Plan for the FCRPS Biological Opinions (2002-2006)*. This plan addresses a "gravel to gravel" approach to threatened and endangered anadromous fisheries recovery, focusing on the operations of the hydroelectric power system, aquatic habitat, hatcheries, and harvest programs. An extensive recovery program for listed species has resulted from this plan and will continue through the time period for the Alternatives considered in this EIS. The Alternatives are consistent with the Immediate Habitat Priorities (2002-2006) of the Implementation Plan. The Plan states, "In the **tributaries**, the Action Agencies will implement projects in priority sub-basins that improve flow, passage, and screening problems (Federal Caucus, 2001)."

BPA will also continue to fund and implement elements of the Northwest Power and Conservation Council (Council) Fish and Wildlife Program consistent with its obligations under the Federal Power Act and the Northwest Power Act of 1980. These programs will be coordinated to the extent practicable with the programs developed in the Draft Implementation Plan described previously.

The Council is conducting sub-basin planning as part of the Council's Columbia River Basin Fish and Wildlife Program. The Upper Columbia Salmon Recovery Board (UCSRB) has agreed to a province-focused approach to sub-basin planning. Okanogan is one of six sub-basins contributing to the Columbia Cascade Province Plan. Sub-basin plans will help direct the Bonneville Power Administration funding of projects that protect, mitigate, and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system. The alternatives are consistent with the kind of actions that will be identified by the sub-basin and province plans for salmon recovery. The Salmon Creek Project has been funded in part through the Council and is being considered by the Council under its Major Project Review process.

Since the OID is a BOR Project, the BOR is the federal agency responsible for ESA compliance related to the irrigation project. BOR and NOAA Fisheries could initiate Section 7 consultation under the Act at some time in the future. Such consultation could result in requirements for "reasonable and prudent alternatives" to current operations affecting Salmon Creek. The consultation scenario would not be likely under any of the Alternatives. This action is reasonably foreseeable under the No Action Alternative.

The NRCS is proposing to implement stream improvement projects in the middle reach of Salmon Creek in cooperation with individual landowners.

3.14.2.2 State Actions

The governors of Washington, Oregon, Idaho, and Montana released a combined "Recommendation for the Protection and Restoration of Fish in the Columbia River Basin (July, 2000)." This joint statement prescribed a series of general salmon recovery actions for the states, including habitat reforms, harvest reforms, hatchery reforms, and funding and accountability.

Washington State's 1998 Salmon Recovery Planning Act developed the program under which the state will support and fund watershed and habitat restoration projects. The Alternatives are consistent with and would benefit the goals of the Act, if implemented. Funding for parts of the Alternatives could be generated through the state's Salmon Recovery Funding Act. The Alternatives are also consistent with the state's Watershed Planning Act. Alternative 1 alternatives generate from voluntary joint cooperation and planning by the OID and the Colville Confederated Tribes, with input from local stakeholders and community members.

The state could also in the future address TMDL requirements for either or both the Okanogan River in the vicinity of the mouth of Salmon Creek and Salmon Creek itself. Future water rights adjudications in the general Project area could also be possible. Water right decisions will be made on pending applications in the Project APE.

3.14.2.3 Local and Private Actions

There currently are no large new land use development actions known that could affect Salmon Creek. Land use actions of local governments and private citizens could occur in the future that would potentially enhance or diminish the potential for water use to restore Salmon Creek fisheries. In any case, future actions by these entities designed to enhance Salmon Creek fish populations would need to be integrated and sustainable to have long-term beneficial effect. Actions at the local and private level that are not consistent with a plan to improve resource sustainability could have significant deleterious effects on remaining fisheries resources. Market forces may lead to changes in land use in the Project area, such as conversion of currently irrigated land to fallow or other uses. Local and regional entities addressing imperatives for salmon recovery could provide support and funding for Salmon Creek Alternatives as part of required mitigation for Project activities or in compliance with 4(d) Rule or HCP programs.

3.14.2.4 Tribal Actions

Salmon Creek Project Alternatives, in conjunction with other proposed actions in the Okanogan watershed sponsored by the CCT, would have measurable positive impacts on the fisheries resources. The Alternatives, however, represent a potential for collaborative and adaptive resource management between the CCT, OID, and the local community. The Alternatives are consistent with a trend toward collaborative, multi-stakeholder planning and management of water, watershed, and fisheries resources in which Tribes and irrigators are emerging leaders. The Joint Committee formed by the CCT and OID is joined in this trend by the collaboration of irrigators with the Umatilla Tribes on the Umatilla Basin Project, and the Jamestown S'Klallam Tribe with the Sequim Dungeness Valley Agricultural Water Users' Association.

In a less collaborative, potentially confrontational scenario, competing water needs could be addressed through extensive, costly, and time-consuming litigation. Such a scenario could develop under the No Action Alternative.

3.14.3 Cumulative Impacts of the Alternatives

3.14.3.1 The Action Alternatives

Ten areas of potentially significant cumulative impacts, both beneficial and adverse, are identified under the imposition of various action alternatives. These potential impacts are described in the following sections.

Water Supply for Irrigation

Under Alternative 3, the purchase of water rights to ensure the level of flow to support sustainable salmon populations in Salmon Creek will diminish the number of irrigated acres potentially in production in Okanogan County. In conjunction with potential future market pressures that could also reduce irrigated acreage as growers respond to low prices by retiring land, the combined cumulative effect on the local economy could be significant. The impact on the broader regional economy would not be significant.

Fisheries

Under all Alternatives, the provision of water sufficient to sustain either or both summer steelhead and spring chinook salmon in Salmon Creek is a significant beneficial impact that enhances the ongoing and future efforts of federal, state, tribal and local agencies in the restoration of salmon runs to the Columbia Basin.

On a regional basis, the Alternatives would produce a potential thermal refuge at the mouth of Salmon Creek that could be used by fish migrating further upstream in the Okanogan, where elevated temperatures currently present a major barrier to upstream migration. This thermal refuge would add a cumulative benefit to the other efforts addressing Upper Columbia Basin salmon restoration by providing a small thermal refuge upstream of the Wells reservoir.

Cumulative impacts to fish may occur from the interactions of this project with other ongoing and future projects within the Okanogan River, its tributaries, and neighboring watersheds. There are currently approximately 50 federal and state projects in the Okanogan Basin (Golder August 2003). Many of these are assessment and monitoring projects, but may lead to future restoration/enhancement or reintroduction/augmentation projects that are not described below. Of the 50 projects, twelve projects are considered particularly pertinent to the cumulative impacts assessment for this project. Eight of the twelve projects are related to enhancement/restoration of habitat, and four to fish reintroduction or augmentation. Restoration and enhancement projects can have short-term impacts, such as sedimentation from construction activities. Long-term benefits include a decrease in overall sediment loads, lower water temperatures and overall higher quality fish habitat. These projects are expected to improve survivability and productivity of fish within the Okanogan and its tributaries, including Salmon Creek.

Restoration or enhancement projects where cumulative impacts may occur include Salmon Creek land acquisitions by the Bureau of Land Management and Department of Natural Resources. The lands acquired are along Salmon Creek and allow access for restoration projects and are managed in a manner that promotes stream habitat recovery. An Okanogan River bank restoration and maintenance project sponsored by Public Utility District (PUD) No. 1 of Douglas County has involved various enhancement projects along nearly 17 miles of PUD owned shoreline. The Upper Columbia Region Fish Enhancement Group has also been involved with enhancement and restoration (project number 01-1436) designed to protect and restore flood plain processes for nine miles of spawning, rearing, and migratory habitat supporting listed sockeye, steelhead, and chinook salmon at the confluence of the Okanogan and Similkameen Rivers. The Okanogan Irrigation District is also implementing agricultural water conservation to improve instream flows in Salmon Creek (Salmon Recovery Funding Board (SRFB) project number 00-1144).

The Colville Confederated Tribe's (CCT) Omak Creek Restoration projects (SRFB project numbers 99-1611 and 00-1683) and Omak Creek Road Decommissioning (SRFB project number 01-1420) will restore riparian habitat, reduce surface and bank erosion, reduce water temperature and sediment yield, and provide passage and habitat to anadromous and resident species. Omak Creek is a major tributary to the Okanogan River at RM 31. While there are no current Natural

Resource Conservation Service (NRCS) projects in the Salmon Creek vicinity, preliminary coordination with landowners is underway for restoration/conservation activities.

Reintroduction and augmentation of fish species in the Okanogan River and its tributaries, increases the potential for harvestable anadromous and resident fish populations in the Okanogan River, Salmon Creek, and other tributaries. Stocking of some hatchery fish can increase interspecies and intraspecies competition. If sustainable population levels are eventually achieved through improved habitat and resulting fish production, more stable fisheries will result in harvest opportunities for sport, commercial, subsistence and cultural purposes within the Okanogan and its tributaries, as well as the Columbia River and Pacific Ocean. Successful species may be removed from the ESA list.

As mitigation for the fish migration blockage created by the Chief Joseph Dam on the Columbia River, the CCT has been operating a rainbow and brook trout hatchery since 1986 (BPA project number 198503800). These fish are planted in area lakes and streams. The CCT has also conducted an experimental re-introduction of sockeye salmon in Skaha Lake, one of series of 6 lakes in British Columbia at the head of the Okanogan River (BPA project number 200001300), and has been involved with the Ellisforde Acclimation Pond (BPA project number 200200100) at RM 25 on the Okanogan River and the Omak Creek Acclimation Pond, which aid in acclimation of hatchery spring and summer chinook and summer steelhead for reintroduction in the Okanogan River and its tributaries. An additional CCT project will propagate local Okanogan River summer and fall chinook (BPA project number 200399917).

Terrestrial Biology

The Alternatives would benefit wildlife, vegetation and wetland resources by rehabilitating the riparian corridor in Lower Salmon Creek. This benefit will support and enhance current efforts to protect and restore habitat in the region, and would counter ongoing cumulative loss of habitat.

Stream Erosion and Sedimentation

Cumulative erosion and sedimentation impacts in Lower Salmon Creek would be reduced by the significant positive effects of stream rehabilitation. Construction in the upstream part of the lower reach and in the middle reach would be on a smaller scale and would slightly increase sedimentation in the Okanogan downstream of the mouth of Salmon Creek for a short time.

Water Temperature

The Alternatives would reduce water temperatures in Salmon Creek and could create a thermal refugia at the mouth of the creek (in the Okanogan River), countering long-term trends that have seen cumulative increases in water temperatures and concomitant loss in habitat value.

Streamflow

Increased groundwater pumping from future development of exempt wells on riparian parcels could diminish base flows. The Alternatives provide increased base flows on the order of 4 to 7 cfs, and may also increase groundwater recharge. These beneficial effects of the Alternatives may at least partially offset potential future adverse cumulative effects on Salmon Creek base flow from riparian groundwater pumping.

Potential new surface water diversions within the affected reach of the Okanogan River are represented by pending applications to Ecology for diversions in the affected reaches of the river (**Table 3-48**). The total diversion rate and volume of the pending surface water right applications are small compared to river flow. Increased groundwater pumping from future development of exempt wells on riparian parcels could also diminish flows. However, the number and total volume of riparian exempt wells in the foreseeable future are likely to be small. Cumulative effects on Okanogan River streamflow with Alternatives 1 and 3 are adverse, but of small magnitude in all water years. Cumulative effects on Okanogan River streamflow with Alternative 1 are adverse, and could be somewhat significant in dry years and less substantial in below normal water years.

Table 3-48. Okanogan River Pending Water Right Applications in Affected Reaches.

File Number	*Name*	Type of Application	Priority Date	Flow (cfs)	Acre-Feet	Irrigated Acres	Purpose
S4-32441	Fitzhugh	New	4-19-96	0.18 cfs	0	80	irrigation, stockwater
CG4-GWC691-D	Fisher	Change to surface source	7-1-98	240 gpm (0.53 cfs)	100		none stated

Groundwater

Although a local cone of depression may form in the vicinity of the Shellrock and new Okanogan River pump stations during peak pumping periods, public water service is available in these areas and new exempt wells are not expected to be developed in large numbers. Pending applications to Ecology for new groundwater rights in the affected reaches of the Okanogan River (**Table 3.14-1**) include several substantial applications for irrigation, domestic use, and fish propagation purposes. These new applications, together with pumping under Alternatives 1 or 2, could cumulatively affect groundwater levels in the area, however Ecology is required to apply tests that include water availability, nonimpairment of existing rights, and the public interest in approving any new water rights (including the change in water rights that would be required for Alternatives 1 or 2).

Buildout of undeveloped parcels along Salmon Creek would likely use groundwater supply from exempt wells. However, the Alternatives increase groundwater recharge potential. The beneficial effect of the Alternatives may at least partially offset potential future adverse cumulative effects on Salmon Creek base flow from groundwater pumping.

The Alternatives may cause decreases in seepage to the Duck Lake aquifer, which, in combination with any changes in OID sales storage of groundwater, could cumulatively reduce groundwater supply available to serve domestic use, either from exempt wells or via existing water purveyors. Alternative 3 would reduce irrigation recharge and could locally lower the static water level in wells. Reduction of artificial recharge is not considered an impairment of a water right, however this could interact with large future groundwater withdrawals to cumulatively affect the ability to obtain groundwater at shallower levels, increasing local well drilling costs.

Socioeconomics

Alternative 3 supplements a trend in the decline of net productive agricultural acreage, particularly apple cultivation. In conjunction with existing and potential future market forces, this could lead to a small reduction in employment in the Okanogan County agricultural sector but is not expected to represent a significant impact to the economy on a regional basis.

Cultural Resources

The Alternatives would tend to have a net cumulative beneficial impact on the cultural values of the Colville Confederated Tribes. The harvesting of salmon and the use of salmon in traditional activities are important elements of the cultural milieu of the Tribes. Past actions have devastated local fish production, and most of the traditional fishing grounds of the CCT were lost due to the Grand Coulee dam construction. While the salmon may not return to Salmon Creek in the thousands as a result of the Alternatives, the return of these species to the area would represent a significant cultural benefit to the tribal people.

Land Use

Alternative 1 would continue the long-term development of Okanogan River frontage in the Okanogan-Omak area.

3.14.3.2 The No Action Alternative

There are eight areas where cumulative impacts of the No Action Alternative could be significant. These areas are discussed below.

Water Supply for Irrigation

Under the No Action Alternative, potential future actions of NOAA Fisheries and other federal agencies could lead to proscriptive reasonable and prudent alternatives to current water supply operations on Salmon Creek resulting from Section 7 consultation under ESA. Conflicting water use issues potentially could be addressed through litigation rather than through collaborative planning and win-win negotiation.

Fisheries

There would be no contribution to overall salmon recovery in the Upper Columbia Basin under the No Action Alternative. The habitat considered the best remaining unused salmonid habitat in the Upper Columbia Basin would stay unconnected from the Okanogan River and the Columbia River System. A potential thermal refuge at the mouth of Salmon Creek would not be available to assist salmonids migrating upstream within the Okanogan River. The No Action Alternative would counter the cumulative effects of the sustained long-term effort in the region and throughout the Northwest to recover salmonid populations and restore habitat.

Terrestrial Biology

Continued channel degradation is expected to occur under the No Action alternative, which would result in continuing loss of riparian vegetation. This loss could be permanent, and would continue habitat loss in riparian corridors that has accumulated with property development in the middle and lower reaches and loss of flow in the lower reach.

Stream Erosion and Sedimentation

Cumulative adverse erosion and sedimentation impacts from a number of activities in the Okanogan River and Salmon Creek watersheds have occurred over many decades. These include increased, and in some areas severe, erosion and sedimentation problems in downstream reaches of Salmon Creek from channelization, floodplain encroachment, bank disturbance and loss of riparian habitat, aggradation, and a modified flow regime. These activities and problems have caused increases in suspended sediment and solids concentrations and loads during some higher flows. Under the No Action Alternative, these existing cumulative impacts would likely continue, increasing erosion and sedimentation problems in the lower reaches of Salmon Creek.

Water Temperature

Cumulative adverse water temperature impacts have occurred from a number of activities in the Okanogan River and Salmon Creek watersheds over many decades. Water temperatures in some lower Salmon Creek locations have probably increased with high temperatures occurring with greater frequencies and over larger reaches as physical conditions have degraded. These changes have resulted from increases in the diversion and use of water (and subsequent lack of instream flows), channelization and downcutting, bank erosion and associated loss of riparian vegetation, and aggradation causing shallower, slower flow in some areas. Under the No Action Alternative, the existing cumulative impacts discussed above would likely continue causing elevated water temperatures. Ongoing activities in the Okanogan River and Salmon Creek watersheds would continue to require more water, thereby continuing to increase water temperatures. Alteration of the riparian zone, including floodplain encroachment and removal of vegetation, would also continue to increase water temperatures. This is particularly true along Salmon Creek, where the smaller flows and significant, ongoing bank erosion and sedimentation problems would continue to cause channel widening, shallower flows, and higher water temperatures

Socioeconomics

Under the No Action Alternative, market forces alone would determine the number of acres within the Project area that stay in apple cultivation. There would be no opportunity to afford monetary benefits to growers who would choose to sell water rights for environmental restoration.

Cultural Resources

There would be no increased opportunity to enrich the cultural traditions of the CCT through local salmonid enhancement. The best remaining habitat in the area to support reintroduced summer steelhead and spring chinook runs would remain unconnected to the Okanogan River and the Columbia River System. The No Action Alternative would counter the cumulative effects of the sustained long-term effort in the region and throughout the Northwest to recover salmonid populations and restore habitat.

Land Use

Ongoing, incremental loss of riverbank lands to erosion is projected to be a continued effect of not rehabilitating lower Salmon Creek. This would lead to cumulative loss of land and shoreline.

4.0 PERTINENT FEDERAL, STATE, AND LOCAL REQUIREMENTS

This chapter addresses federal statutes, implementing regulations, and Executive Orders potentially applicable to the proposed project. This Draft EIS (DEIS) is being sent to tribes, federal agencies, and state and local governments as part of the consultation process for this project.

4.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

This DEIS was prepared by Bonneville Power Administration (BPA) pursuant to regulations implementing the National Environmental Policy Act (NEPA) (42 USC 4321 et seq.), which requires federal agencies to assess the impacts that their actions may have on the environment. The NEPA was signed into law on January 1, 1970, and became effective immediately. NEPA is this country's basic national charter for environmental responsibility. It establishes an environmental policy for the nation, provides an interdisciplinary framework for environmental planning by federal agencies, and contains action-forcing procedures to ensure that federal agency decision-makers take environmental factors into account. NEPA allows federal agencies broad discretion concerning the degree of substantive environmental protection they may require when approving proposed actions. The specific purposes of NEPA as stated in the statute are:

- To declare a national policy and promote efforts that will encourage productive and enjoyable harmony between humans and their environment
- To promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate human health and welfare
- To enrich the understanding of the ecological systems and natural resources important to the nation
- To establish a Council on Environmental Quality (CEQ)

Under NEPA, congress authorizes and directs federal agencies to carry out their regulations, policies, and programs as fully as possible in accordance with the statute's policies on environmental protection. NEPA requires federal agencies to make a series of evaluations and decisions that anticipate adverse effects on environmental resources. This requirement must be fulfilled whenever a federal agency proposes an action, grants a permit, or agrees to fund or otherwise authorize any other entity to undertake an action that could possibly affect environmental resources. BPA will take into account potential environmental consequences and will take action to protect, restore, and enhance the environment.

4.2 ENDANGERED SPECIES ACT (ESA)

The Endangered Species Act of 1973 (ESA) (16 USC 1536) as amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, plants, and the preservation of the ecosystems on which they depend. The purpose of ESA is to conserve the ecosystems upon which the endangered and threatened species depend and to conserve and recover listed species. Under the law, species may be listed as either "endangered" or “threatened”. “Endangered” is defined as a species in danger of extinction throughout all or a significant portion of its range. “Threatened” is defined as a species likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. All federal agencies are to protect listed species and preserve their habitats. Federal agencies must utilize their authorities to conserve listed species and ensure that their actions do not jeopardize the continued existence of listed species. The Interior Department’s U.S. Fish and Wildlife Service (USFWS) and the National Oceanographic and Atmospheric Administration Fisheries Service (NOAA Fisheries) work with other agencies to plan or modify federal projects so that they will have minimal impact on listed species and their habitat.

The USFWS and NOAA Fisheries administer the act. The USFWS has primary responsibility for terrestrial and freshwater organisms, while NOAA Fisheries’ responsibilities are mainly for marine species such as salmon and whales. The act defines procedures for listing species, designating critical habitat for listed species, and preparing recovery plans. It also specifies prohibited actions and exceptions.

Section 7(a) requires federal agencies to ensure that the actions they authorize, fund, and carry out do not jeopardize endangered or threatened species or their critical habitats. In the relatively few cases where the USFWS determines that the proposed action will jeopardize listed species, they must issue a “biological opinion” offering “reasonable and prudent alternatives” about how the proposed action could be modified to avoid jeopardy to listed species.

The law provides for designations of “critical habitat” for listed species when judged to be “prudent and determinable”. Critical habitat includes geographical areas on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection. Critical habitat may include areas not occupied by the species at the time of listing but that are essential to the conservation of the species. Critical habitat designations affect only federal agency actions or federally funded or permitted activities.

The law’s ultimate goal is to “recover” species so they no longer need protection under the ESA. The law provides for recovery plans to be developed describing the steps needed to restore a species to health. Appropriate public and private agencies, institutions, and other qualified persons assist in the development and implementation of recovery plans.

USFWS requires that a biological assessment is prepared if threatened or endangered species might be impacted by a federal action. If the project moves forward, a Biological Assessment will be prepared for the selected alternative.

Potential impacts to threatened and endangered plants, wildlife, and fish species are discussed in **Sections 3.1 through 3.5**.

4.3 FISH AND WILDLIFE CONSERVATION ACT

The Fish and Wildlife Conservation Act of 1980 (16 USC 2901 et seq.) encourages federal agencies to conserve and promote conservation of non-game fish and wildlife species and their habitats. In addition, the Fish and Wildlife Coordination Act (16 USC 661 et seq.) requires federal agencies undertaking projects affecting water resources to consult with the USFWS and the state agency responsible for fish and wildlife resources. These agencies are to be sent copies of this DEIS and their comments will be considered.

Mitigation designed to conserve fish and wildlife and their habitat is provided in the sections on **Fisheries** and **Wildlife** in **Chapter 3**. Standard erosion control measures would be used during construction to control sediment movement into streams, protecting water quality and fish habitat.

4.4 ESSENTIAL FISH HABITAT

Public Law 104-297, the Sustainable Fisheries Act of 1996, amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). This established new requirements for essential fish habitat descriptions in federal fishery management plans and required federal agencies to consult with NOAA Fisheries on activities that may adversely affect essential fish habitat. The NOAA Fisheries issued a final rule on January 17, 2002 to revise the regulations implementing the essential fish habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act (Federal Register 67, No. 12). The Magnuson-Stevens Act requires all fishery management councils to amend their fishery management plans to describe and identify Essential Fish Habitat for each managed fishery. The Pacific Fishery Management Council has issued such an amendment in the form of Amendment 14 (1999) to the Pacific Coast Salmon Plan. This amendment covers Essential Fish Habitat for all fisheries under NOAA Fisheries jurisdiction that would potentially be affected by the proposed action. Essential Fish Habitat includes all streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon. Activities above impassible barriers are subject t o consultation provisions of the Magnuson-Stevens Act.

Under Section 305(b)(4) of the act, NOAA Fisheries is required to provide Essential Fish Habitat conservation and enhancement recommendations to federal and state agencies for actions that adversely affect Essential Fish Habitat. Whenever possible, NOAA Fisheries uses existing interagency coordination processes to fulfill Essential Fish Habitat consultations with federal agencies.

No species administered under the amended Magnuson-Stevens Fishery Conservation and Management Act occurs in the vicinity of the proposed project. However, it is within the historical range of coho and Chinook salmon, therefore essential fish habitat will be addressed along with the ESA consultation.

4.5 HERITAGE CONSERVATION

Preserving cultural resources allows Americans to have an understanding and appreciation of their origins and history. A cultural resource can be an object, structure, building, site or district that provides irreplaceable evidence of natural or human history of national, state or local significance. Cultural resources include National Historic Landmarks, archeological sites, and other historic properties listed (or eligible for listing) on the National Register of Historic Places. Federal laws and regulations established for the management of cultural resources include:

- Antiquities Act of 1906 (16 U.S.C. 431-433)
- Historic Sites Act of 1935 (16 U.S.C. 461-467)
- Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. 470 et seq.), as amended
- National Environmental Policy Act of 1969 (42 USC Sections 4321-4327)
- Archeological Data Preservation Act (ADPA) of 1974 (16 U.S.C. 469 a-c)
- Archeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. 470 et seq.), as amended
- American Indian Religious Freedom Act of 1978
- Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. 3001 et seq.)
- Executive Order 13007 Indian Sacred Sites

BPA has undertaken the Section 106 (NHPA) consultation process for this project with the State Historic Preservation Officer for Washington, the Advisory Council on Historic Preservation, and the Tribal Historic Preservation Officer (THPO) for the Confederated Tribes of the Colville Reservation. BPA's 1996 government-to-government agreement with 13 federally-recognized Native American tribes of the Columbia River basin identifies the roles and responsibilities of both parties and provides guidance for the Section 106 consultation process with the Tribes.

Projects described in this Salmon Creek Project DEIS would constitute a federal undertaking if funding is provided by the federal Bonneville Power Administration (BPA) or the proposed projects affect U.S. Bureau of Reclamation (BOR) facilities. The BPA has the responsibility to act as the lead agency for initiation of Section 106 of the NHPA for the DEIS, but will coordinate with BOR in analyzing potential effects to BOR facilities.

Under Section 106 of the NHPA, the federal agency must consider the effects of the undertaking on historic properties. The NHPA defines the term "historic properties" as "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register of Historic Places..." (36 CFR 800.16). The term includes artifacts, records, and remains that are related to and located in such properties. It also includes properties of traditional religious and cultural importance, also referred to as "traditional cultural properties" (TCPs) that are eligible for inclusion in the National Register of Historic Places (NRHP).

The Office of Archaeology and Historic Preservation (OAHP) in Olympia, Washington, administers the state's NRHP program under the direction of the State Historic Preservation Officer (SHPO). The following NRHP criteria, identified in 36 CFR 60, serve as the basis for evaluating a historic property's eligibility for listing at the national, state, and local levels. The quality of significance in American history, architecture, archaeology, and culture is possible in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association, and:

- that are associated with events that have made a significant contribution to the broad patterns of our history; or
- that are associated with the lives of persons significant in our past; or
- that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- that has yielded, or may be likely to yield, information important in prehistory or history.

Resources less than 50 years old do not meet the NRHP criteria unless they are of exceptional importance.

Consideration of effects for the undertaking must include the Area of Potential Effect (APE). The APE includes "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist. The area of potential effects for an undertaking may be different for different kinds of effects caused by the undertaking." The intent of Executive Order 11593, Protection and Enhancement of the Cultural Environment, has been integrated into Section 110 of the NHPA through the 1980 amendments to the Act. Under NEPA, federal agencies must take into account impacts to historical resources, or those resources that are eligible for the NRHP, before a project is approved. The Section 106 process has been integrated with the NEPA process for this project.

Recent amendments to the NHPA specify that properties of traditional religious and cultural importance (also known as Traditional Cultural Properties) to a Native American tribe may be determined to be eligible for inclusion on the National Register of Historic Places (NRHP). In carrying out its responsibilities under Section 106, BPA is required to consult with any Native American tribe that attaches religious or cultural significance to any such properties.

The Native American Graves Protection and Repatriation Act (NAGPRA) requires consultation with appropriate Native American tribal authorities prior to the excavation of human remains or certain cultural items (including funerary objects, sacred objects, and cultural patrimony) on federal and tribal land. NAGPRA recognizes Native American ownership interests in some human remains and cultural items found on federal land and makes illegal the sale or purchase of Native American human remains, whether or not they derive from federal or tribal land. Upon request, federal agencies shall repatriate human remains to the culturally affiliated tribe.

Executive Order 13007 addresses "Indian sacred sites" on federal and tribal land. "Sacred site" means any specific, discrete, narrowly delineated location that is identified by a tribe or a tribal individual determined to be an appropriately authoritative representative of a Native American religion. The site is sacred by virtue of its established religious significance to, or ceremonial use by, a Native American religion, provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site. This order calls on agencies to do what they can to avoid physical damage to such sites, accommodate access to and ceremonial use of tribal sacred sites, facilitate consultation with appropriate Native American tribes and religious leaders, and expedite resolution of disputes relating to agency action on federal lands.

Construction, operation, and maintenance of the proposed project could potentially affect historic properties and other cultural resources. A cultural resource technical report will be prepared to determine if any historic properties or cultural resources are present and if they would be impacted by the proposed project prior to any final decision (see **Cultural Resources** section in **Chapter 3**).

Through the design process, BPA and/or other implementing agencies will try to avoid cultural resource sites. If a site cannot be avoided, BPA and/or other implementing agencies will work with the THPO of the CCT to determine if the site is eligible for a listing in the NRHP. If they are eligible, effects to the property will be evaluated and appropriate mitigation measures will be applied.

If, during construction, previously unidentified cultural resources that would be adversely affected by the proposed project are found, BPA and/or other implementing agencies would follow all required procedures set forth in the following regulations, laws, and guidelines: Section 106 (36 CFR Part 800) of the National Historic Preservation Act of 1966, as amended (16 USC Section 470); the National Environmental Policy Act of 1969 (42 USC Sections 4321-4327); the American Indian Religious Freedom Act of 1978 (PL 95-341); the Archeological Resources Protection Act of 1979 (16 USC 470a-470m); and the Native American Graves Protection and Repatriation Act of 1990 (PL 101-601).

4.6 CONSISTENCY WITH FEDERAL, STATE, AREA-WIDE, AND LOCAL PLANS AND PROGRAMS

4.6.1 WASHINGTON STATE ENVIRONMENTAL POLICY ACT (SEPA)

The State Environmental Policy Act (SEPA) was first adopted in 1971. Prior to its adoption, the public had voiced concern that government decisions did not reflect environmental considerations. State and local agencies had responded that there was no regulatory framework enabling them to address environmental issues. SEPA, which is modeled after NEPA, was created to fill this need. It gives state and local agencies the tools to allow them to both consider and mitigate for environmental impacts of proposals. SEPA is intended to ensure that environmental values are considered during decision-making by state and local agencies.

SEPA provides information to agencies, applicants, and the public to encourage the development of environmentally sound proposals. The environmental review process involves the identification and evaluation of probable environmental impacts, and the development of mitigation measures that will reduce adverse environmental impacts. This environmental information, along with other considerations, are used by agency decision-makers to decide whether to approve a proposal, approve it with conditions, or deny the proposal. SEPA applies to actions made at all levels of government within the state of Washington.

The SEPA rules provide the basis for implementing SEPA and establish uniform requirements for all agencies. A SEPA decision may be required by the Washington Department of Ecology (Ecology) if a decision is made by the lead or cooperating agencies of this EIS that would affect water rights. Either the Okanogan Irrigation District or Ecology, acting as lead agency for the project under SEPA, would need to make a threshold determination under SEPA guidelines prior to adoption of a plan to proceed with the project or to issue a permit to authorize it. This NEPA EIS could be adopted by the SEPA lead agency as part of the State's environmental review if it determines that the NEPA EIS satisfies all or part of its responsibilities to prepare an EIS or other environmental document.

4.6.2 FARMLAND PROTECTION

The Farmland Protection Policy Act (7 USC 4201 et seq.) directs federal agencies to identify and quantify adverse impacts of federal programs on farmlands. The Act's purpose is to minimize the number of federal programs that contribute to the unnecessary and irreversible conversion of agricultural land to non-agricultural uses.

Under Alternative 3, sufficient water rights would be purchased from OID to provide the 5,100 AF of water required for passage flows. This means approximately 1,470 acres, or 29 percent of District lands, would be retired from production.

4.6.3 FLOODPLAIN/WETLANDS ASSESSMENT

The Department of Energy mandates that impacts to floodplains and wetlands be assessed and alternatives for protection of these resources be evaluated in accordance with compliance with Floodplain/ Wetlands Environmental Review Requirements (10 CFR 1022.12), and Federal Executive Orders 11988 and 11990. Evaluation of project impacts on floodplains and wetlands is included in Chapter 3 of the DEIS and constitutes the floodplain/wetland assessment. BPA published a notice of floodplain/wetlands involvement for this project in the Federal Register as part of the Notice of Intent. The Record of Decision (ROD) will contain the statement of findings for floodplain/wetland impacts.

Portions of the project may be within the 100-year floodplain. In particular, this includes stream channel rehabilitation work, the feeder canal, and pump stations.

4.6.4 EXECUTIVE ORDER ON ENVIRONMENTAL JUSTICE

In February 1994, Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations, was released to federal agencies. This order states that federal agencies shall identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Minority populations are considered members of the following groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic if the minority population of the affected area exceeds 50 percent, or is meaningfully greater than the minority population in the project area.

The proposed project has been evaluated under Executive Order 12898 and would not have disproportionately high and adverse impacts on minority and low-income populations.

4.6.5 Hydraulic Project Approval (HPA) and Joint Aquatic Resources Permit Application Form (JARPA)

Construction activity in or near the water has the potential to kill fish or shellfish directly. More importantly, this activity can also alter the habitat that fish and shellfish require. Direct damage or loss of habitat results in direct loss of fish and shellfish production. Direct killing of fish or shellfish is usually a one-time loss. Damaged habitat, however, can continue to cause lost production of fish and shellfish for as long as the habitat remains altered. Major construction projects individually have a large potential for damage, however, more habitat is lost through the cumulative effects of many smaller projects, each with a minimal level of impact.

The state legislature has given the Department of Fish and Wildlife the responsibility of preserving, protecting, and perpetuating all fish and shellfish resources of the state. To assist in achieving that goal, the state legislature in 1949 passed a state law now known as the "Hydraulic Code" (RCW 75.20.100-160). Although the law has been amended occasionally since it was originally enacted, the basic authority has been retained. The purpose of the law is to ensure that damage or loss of fish and shellfish habitat does not result in direct loss of fish and shellfish production. The enactment of RCW 75.20.100-160 by the state legislature was recognition that virtually any construction within the high water area of the waters of the state has the potential to cause habitat damage. It was also an expression of a state policy to preclude that potential from occurring. The law's purpose is to see that required construction activities are performed in a manner to prevent damage to the state's fish, shellfish, and their habitat. By applying for and following the provisions of the HPA issued under RCW 75.20.100-160, most construction activities around water can be allowed with little or no adverse impact on fish or shellfish.

The major types of activities in freshwater requiring an HPA include, but are not limited to:

- Streambank protection
- Construction of bridges, piers, and docks
- Pile driving
- Channel change or realignment
- Conduit (pipeline) crossing
- Culvert installation

- Dredging
- Gravel removal
- Pond construction
- Placement of outfall structures
- Log, log jam, or debris removal
- Installation or maintenance (with equipment) of water diversions
- Mineral prospecting

A Joint Aquatic Resources Permit Application (JARPA) consolidates seven permit application forms for federal, state, and local permits. A JARPA would be used on this project to apply for:

- The HPA from WDFW,
- Water quality certifications or modifications from Ecology,
- Aquatic resource use authorizations from the Department of Natural Resources,
- Section 404 permit from the Army Corps of Engineers,
- Shoreline Management Act permits from participating local city or county agencies.

Currently, not all local government agencies use JARPA. This form would need to be submitted and permits and authorizations received prior to any work occurring within the streams, floodplains, or wetlands associated with this project.

4.6.6 WASHINGTON HERITAGE REGISTER AND ARCHAEOLOGICAL RESOURCES

The Office of Archaeology and Historic Preservation (OAHP) administers the Washington Heritage Register, a Washington-specific list of properties – similar to the NRHP – that meet specific criteria within the State of Washington.

The Archaeological Sites and Resources Act, as amended, (RCW 27.53) provides for the conservation, preservation, and protection of the state's archaeological resources. It combines certain elements of the NHPA and the federal ARPA, but also provides specific penalties for the disturbance or destruction of archaeological materials on both public and private lands.

5.0 LIST OF PREPARERS

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Kevin Freeman – Project Sponsor, ENTRIX, Inc. Responsible for senior review and overall completion of the EIS. Education: M.S. Geology, B.S. Geology. 30 years experience in geological and geohazards analysis, construction monitoring, NEPA/SEPA consistency analysis, site and route selection, project feasibility assessment, hazardous waste management and remediation, project management, and program management.

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Brent Hicks – Cultural Resources, ENTRIX Inc. Responsible for project management assistance, cultural resources review. Education: M.A. in Anthropology, Western Washington University. 13 years experience in cultural resources management.

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Harry Seely – Economist. NEA. Project Manager for socioeconomics tasks, evaluated effect of alternatives on the Okanogan Irrigation District, and addressed issues regarding the water purchase alternative. Education: M.S. Agricultural and Resource Economics, Oregon State University. 10 years of experience in natural resource economics and water rights valuation.

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Nancy H. Weintraub – Fish and Wildlife Environmental Team Lead. BPA. Responsible as one of the initial leads for BPA on the Salmon Creek EIS. Education: M.S. Zoology (Aquatic Biology) 1981 Texas A&M University. B.S. Ecosystems Analysis 1976. University of Wisconsin - Green Bay. 23 years experience in NEPA, Endangered Species, and other environmental analysis.

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6.0 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THIS STATEMENT WERE SENT

FEDERAL ENTITIES

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United States House of Representatives, Honorable Doc Hastings, Yakima, Washington

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United States Senate, Honorable Patty Murray, Seattle, Washington

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8.0 ACRONYMS AND GLOSSARY

100-year Floodplain – Areas that have a 1 percent chance of being flooded in a given year. (See Floodplain.)

Access road – Roads and road spurs that provide vehicular access to the project area. Access roads are built where no roads exist.

AF – Acre-feet.

Airshed – An air supply of a given geographic area, usually defined by topographic barriers or atmospheric conditions that confine air emissions.

Alluvium – Sediments deposited by flowing water.

Alternatives –Different choices available for a project.

Ambient noise – Noise from sources such as a substation that occur over a long period of time.

APE – Area of potential effect.

Aquatic bed – Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Aquatic beds generally occur in water less than 2 meters (6.6 feet) deep and are placed in the Littoral Subsystem (if in Lacustrine System).

Aquifer – Water-bearing rock or sediments below the surface of the earth.

BA – Biological assessment.

Backdropped – Landscape elements behind facilities; a background setting.

Biodiversity – A measure of the number of different species in a given area; species richness.

BMP – Best management practices.

BOR –Bureau of Reclamation, in the U.S. Department of the Interior.

BPA –Bonneville Power Administration, in the U.S. Department of Energy.

Cairn – A mound of stones erected as a memorial or landmark.

Caisson – A watertight structure within which construction work is performed under water.

Cataract – Large waterfall.

CFR – Code of Federal Regulation.

cfs – Cubic feet per second.

Circuit breaker – See power circuit breaker.

Clean Water Act (CWA) – A federal law intended to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, and secure water quality.

Colluvium – Soil material, rock fragments, or both, accumulated at the base of steep slopes.

Crossdrain – Channel or dip constructed across a road to intercept surface water runoff and divert it before erosive runoff volumes and concentrations occur.

Culvert – A corrugated metal or concrete pipe used to carry or divert runoff water from a drainage; usually installed under roads to prevent washouts and erosion.

Current – The amount of electrical charge flowing through a conductor (as compared to voltage, which is the force that drives the electrical charge).

Cut and fill – The process where a road is cut or filled on a side slope. The term refers to the amount of soil that is removed (cut) or added (fill).

dBA – The first two letters (dB) are an abbreviation for "decibel," the unit in which sound is most commonly measured. The last letter (A) is an abbreviation for the scale (A scale) on which the sound measurements were made. A decibel is a unit for expressing relative difference in power, usually between acoustic signals, equal to 10 times the common logarithm of the ratio of two levels.

Debris flow – Rapid movement of water-charged mixture of soil, rock, and organic debris down a steep stream channel.

DEIS – Draft Environmental Impact Statement.

Dissolved solids – Solids that are in solution.

DNR – State of Washington, Department of Natural Resources.

DO – Dissolved oxygen.

DSIs – Direct Service Industries.

Easement – A grant of certain rights to the use of a piece of land (which then becomes a "right-of-way"). BPA acquires easements for many of its transmission facilities. This includes the right to enter the right-of-way to build, maintain, and repair the facilities. Permission for these activities are included in the negotiation process for acquiring easements over private land.

Ecology – State of Washington, Department of Ecology.

Emergent – Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

Endangered species – Those species officially designated by the U.S. Fish and Wildlife Service that are in danger of extinction throughout all or a significant portion of their range.

Environmental Impact Statement (EIS) – A detailed statement of environmental impacts caused by an action, written as required by the National Environmental Policy Act.

EPA – Environmental Protection Agency.

Equivalent sound level (L_{eq}) – Generally accepted as the average sound level.

ESA – Endangered Species Act.

ESU – Environmentally significant unit.

Exceedence levels (L levels) – Refers to the A-weighted sound level that is exceeded for a specified percentage of the time during a specified period.

Exposure assessment – The process of estimating or measuring the intensity, frequency, and duration of human exposure to an agent (toxin, radiation, etc). Ideally, it describes the sources, pathways, routes, magnitude, duration, and patterns of exposure; the characteristics of the population exposed; and the uncertainties in the assessment.

Fiber optics – Special wire installed on the transmission line that is used for communication between one location and another.

Floodplain – That portion of a river valley adjacent to the stream channel that is covered with water when the stream overflows its banks during flood stage.

Forested – Characterized by woody vegetation that is 20 feet tall or taller.

Gabion basket – A cylindrical wicker basket filled with earth and stones, formerly used in building fortifications.

GIS – Geographic Information System. A computer system that analyzes graphical map data.

Glacial outwash – Materials deposited by glacial meltwaters.

Glacial-fluvial – Pertaining to glacial streams or sediments deposited by such streams.

GMA - Washington State Growth Management Act of 1990. This Act requires most counties and cities in Washington to adopt comprehensive plans.

HAER – Historic American Engineering Record.

Herbaceous – A plant having the characteristics of an herb, not woody; or having a green color and a leafy texture.

Hydrology – The science dealing with the properties, distribution, and circulation of water.

IMPLAN – IMpact Analysis for PLANning.

Intermittent – Referring to periodic water flow in creeks or streams.

Isolated wetland – A wetland that is not connected to other surface water bodies; although adjacent wetlands may be interconnected during high precipitation years.

Knickpoint – A knickpoint is located at that point along the longitudinal profile of a stream at which slope changes. Typically, the term is used where the change in slope is migrating upstream. The location of a knickpoint may be controlled by bedrock. Significant erosion typically occurs below a knickpoint, as it migrates upstream.

Lacustrine – Includes wetlands and deepwater habitats with all of the following characteristics: situated in a topographic depression or a dammed river channel; lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage, and total area exceeds 8 hectares (20 acres).

Lithic – Rock containing a large proportion of debris from previously formed rocks.

Loess – Sediment composed of mostly silt-sized particles, deposited by the wind.

Mass movement – The dislodgment and downhill transport of soil and rock materials tinder the direct influence of gravity. Includes movements such as creep, debris torrents, rock slides, and avalanches.

Mat gabions – A galvanized wire basket filled with selected stones used to stabilize stream banks to control erosion and prevent stream gravel from shifting.

Metric ton – Equivalent to 1000 kilograms or 2,205 pounds.

MIG – Minnesota IMPLAN Group, Incorporated.

Mitigation – Steps taken to lessen the effects predicted for each resource, as potentially caused by the Project. They may include reducing the impact, avoiding it completely, or compensating for the impact.

MOA – Memorandum of Agreement.

MOU – Memorandum of Understanding.

Multiplier effects – The total increase in income and employment that occurs in the local economy for each dollar of local project expenditure.

MWG – Montgomery Water Group.

National Environmental Policy Act (NEPA) – This act requires an environmental impact statement on all major federal actions significantly affecting the quality of the human environment [42 U.S.C. 4332 2(2)(C)].

NEA – Northwest Economic Associates.

NHPA – National Historic Preservation Act.

NMFS –National Marine Fisheries Service, in the U.S. Department of Commerce, NOAA. Now known as NOAA Fisheries.

NOAA – National Oceanic and Atmospheric Agency.

Non–attainment – An area which does not meet air quality standards set by the Clean Air Act for specified localities and periods.

Non-renewable – Not capable of replenishing.

Noxious weeds – Plants that are injurious to public health, crops, livestock, land or other property.

NPDES – National Pollutant Discharge Elimination System.

NRCS – Natural Resources Conservation Service, in the U.S**.** Department of Agriculture.

NRHP – National Register of Historic Places.

NWI – National wetland inventory.

NWP – Nationwide Permit.

OAHP – State of Washington, Office of Archaeology and Historic Preservation.

OID – Okanogan Irrigation District.

Oil spill containment – Units installed in a substation to collect oil spilled from equipment.

Open water – Water covers the surface at a mean annual depth of greater than 6.6 feet or areas less than 6.6 feet in depth that do not support rooted-emergent or woody plant species.

ORWP – Okanogan River Water Exchange.

Palustrine – Includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 parts per thousand.

Particulate matter (PM) – Airborne particles including dust, smoke, fumes, mist, spray, and aerosols.

PDEIS – Preliminary Draft Environmental Impact Statement.

Perennial – Streams or creeks with year-round water flow.

Permanently Flooded – Water covers the land surface throughout the year in all years.

Permeable – Capable of transporting liquids.

Prime and unique farmland – Prime farmland is land with the best combination of physical and chemical characteristics for producing food and other agricultural crops. Unique farmland is land other than prime farmland that is used to produce specific high-value food and fiber crops. It also has special characteristics to economically produce sustained high quality or high yields of specific crops.

PUD – Public Utility District.

Record of Decision (ROD) – The document notifying the public of a decision taken on a Federal action, together with the reasons for the choices entering into that decision. The Record of Decision is published in the Federal Register.

REIS – Department of Commerce, Regional Economic Information System.

Remedial action scheme – A set of fast, automatic control actions used to ensure acceptable power system performance following disturbances.

Resource protection area – A designation given to a stream reach by Washington State if the reach flows through a State Park, or is a component of the Washington State Scenic Rivers System, or if the reach has been designated as a component of the federal Wild and Scenic Rivers System or is being studied for potential designation.

Revegetate – Reestablishing vegetation on a disturbed site.

Right-of-way (ROW) – An easement for a certain purpose over the land of another, such as a strip of land used for a road, electric transmission line, pipeline, etc.

Riparian – Of, on, or relating to the bank of a natural course of water.

Riprap – Broken stones put in areas to prevent erosion, especially along river and stream banks.

Scabland – Areas scoured by ice age floods characterized by shallow soils and rock outcrops.

Scarp – An escarpment, cliff, or steep slope of some extent along the margin of a plateau, mesa, terrace, or bench.

Scoping – A part of the NEPA process where significant issues to be analyzed in detail in the environmental document are identified.

Scrub/shrub – Includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions.

Seasonally flooded – Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

Semi-permanently flooded – Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

SHPO – State Historic Preservation Office.

Slash windrows – Rows of slash or cut vegetation placed on the side of an access road to control erosion.

Sole source aquifer – An aquifer designated by the Environmental Protection Agency which provides at least half of an area’s drinking water.

SPCC – Spill Prevention Control and Countermeasures Plan.

Subsoiling – Breaking up compacted soils, without inverting them, using a plow or blade.

SWPP – Stormwater Pollution Prevention Plan.

Tackifiers – A water-based agent used to bind soil particles together to provide erosion protection.

Talus – Rock debris that has accumulated at the base of a cliff or steep slope.

TCP – Traditional cultural properties.

Temporarily flooded – Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

Threatened species – Those species officially designated by the U.S. Fish and Wildlife Service that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Transient noise – Noise from sources such as passing aircraft or motor vehicles that is usually of short duration.

TSS – Total suspended solids.

USBR – U.S. Bureau of Reclamation.

USFWS – U.S. Fish and Wildlife Service, in the U.S. Department of the Interior.

WAC – Washington Administrative Code.

Water bar – Smooth, shallow ditch excavated at an angle across a road to decrease water velocity and divert water off and away from the road surface.

WDW – State of Washington, Department of Wildlife.

Wetland – An area where the soil experiences anaerobic conditions because of inundation of water during the growing season. Indicators of a wetland include types of plants, soil characteristics and hydrology of the area.

Woodland – Land having a cover of trees and shrubs.

APPENDIX A:
Summary of Water Supply Alternatives Considered

Appendix A. Summary of Water Supply Alternatives Considered

WATER SUPPLY ALTERNATIVE	WATER AMOUNT AND TIMING	COST AND TIMEFRAME	ENGINEERING FEASIBILITY	REGULATORY REQUIREMENTS	ENVIRONMENTAL IMPACTS AND BENEFITS
WATER CONSERVATION ALTERNATIVES					
WC-1: District-wide Agricultural Water Conservation	2,300 acre-feet in an average year; 467-543 ac-ft firm yield.	$300,000, minimal annual costs. Most measures implemented within one year.	Measures can reduce spills by installing various devices and structures to provide better district-wide flow control.	No regulatory requirements to implement these measures. Transfer and lease conserved water to instream flow through the State Water Trust	Provides 1.5% to 9% of target for instream flows.
WC-2: OID Totally Pressurized Delivery System	2,400 acre-feet in an average year; 467-543 ac-ft firm yield.	$3.7 M facilities; $65k annual costs. One year to design/construct; 18+ months environmental compliance.	Pressurized main canal can deliver water on demand without need to spill.	No regulatory requirements to implement these measures. Transfer and lease conserved water to instream flow through the State Water Trust	Provides 1.5% to 9% of target for instream flows.
WC-3: Non-agricultural Water Conservation Purchase and Transfer	Insufficient potential identified to pursue.				
WATER EXCHANGE ALTERNATIVES					
WE-1: City of Okanogan Reclaimed Water Exchange	450,000 gpd (0.7 cfs)	The City does not treat to the standard required for water reuse; the cost of upgrades would be infeasible (ca. $1.5 M)	Small package treatment plants are available "off the shelf"	City's current treatment does not meet Washington State standards for water reuse	
WE-2: City of Okanogan Watercress Springs Exchange	300 gpm (0.67 cfs), 484 acre-feet	$2.2 M to $2.6 M facilities; about $40,000 annual O&M; negligible pumping cost. Time-frame to complete is 1-3 years.	Three feasible scenarios identified. The best engineering solution would be a new reservoir in the City.	Transfer City springs water claim to a City well. Convey springs water to avoid being taken by a senior water right claimant.	Provides 2-5% of minimum passage flows; offsets channel loss; supports riparian vegetation. Opportunity to develop springs fish habitat. Insufficient data to evaluate source impacts.

Appendix A. Summary of Water Supply Alternatives Considered

WATER SUPPLY ALTERNATIVE	WATER AMOUNT AND TIMING	COST AND TIMEFRAME	ENGINEERING FEASIBILITY	REGULATORY REQUIREMENTS	ENVIRONMENTAL IMPACTS AND BENEFITS
WATER EXCHANGE ALTERNATIVES (cont'd)					
WE-3: Okanogan River Water Exchange	Up to the full natural flow of Salmon Creek. Timing can be shaped by OID's dams/reservoirs. Firm yield up to natural firm yield of watershed (ca. 7,234 ac-ft/yr for 80 cfs alternative and 4,374 ac-ft/yr for 20 cfs alternative)	$1.8 M for 20 cfs pipeline; $4.7 M for 80 cfs pipeline, $7.0 M for 80 cfs pipeline/all pressurized system. Two to three years to complete.	Alternatives include 80 cfs exchange, serving full irrigation demand, and 20 cfs, providing fish flows only. Two alternative pipeline routes; the preferred route diverts upstream of the confluence of Salmon Creek-Okanogan River	Water right change as to place and purpose of use and point of diversion. New water rights application for additional Okanogan River diversions and for conversion of emergency water rights.	Provides up to 100% of target for instream flows. Returns Salmon Creek flows to natural levels. Storage at the top of the system can shape flows to meet flow needs for all life stages. Greatest opportunity for stream restoration and salmonid recovery. Improves temperature conditions in the Okanogan River.
WE-4: Salmon Creek/ Watercress Springs Water Right Claimants	0.76 cfs and 144 acre-feet		Service would be feasible, however diverters have decided that they would rather replace their existing diversion.	Requires agreement to sell, exchange or donate with claimants and water right change/transfer as to purpose, place of use and point of diversion.	Provides 2-5% of minimum passage flows; offsets channel loss; supports riparian vegetation.
WATER MANAGEMENT ALTERNATIVES					
WMan-1: Duck Lake Water Management	No new water is available. Water rights are supplemental. Potential to reduce spill to Duck Lake is captured under conservation alternatives	No alternatives requiring funds are identified. Duck Lake operations are scheduled as part of overall OID water management, at the cost of pumping.	Existing facilities are in place. No new facilities are identified under this alternative.	Water rights are supplemental to other OID sources. No changes are proposed.	No environmental impacts or benefits identified, as substantial changes in operations are not proposed.
WMan-2: OID Diversion 5 Re-regulation	500 acre-feet/year firm yield (conserved spill)	$100,000 to construct, minimal annual cost. Can be implemented within 12-18 months	A 100 acre-foot re-regulating reservoir can reduce spills.	Dam, water storage and construction permits, depending on size of reservoir.	Provides 1.5% to 9% of target for instream flows.

Appendix A. Summary of Water Supply Alternatives Considered

WATER SUPPLY ALTERNATIVE	WATER AMOUNT AND TIMING	COST AND TIMEFRAME	ENGINEERING FEASIBILITY	REGULATORY REQUIREMENTS	ENVIRONMENTAL IMPACTS AND BENEFITS
WATER MANAGEMENT ALTERNATIVES (cont'd)					
WMan-3: On-farm Water Management	Ranges from 63 acre-feet in a dry year to over 4,000 acre-feet in a wet year. Firm yield 1,023-1,153 acre-feet/year.	$500,000 to implement, no annual cost	Standard irrigation management practices can be improved through education, demonstration, and incentives.	No regulatory permits required. Conserved water can be protected instream through conveyance to the State Water Trust.	Provides 15% to 33% of target for instream flows.
WATER MARKETING ALTERNATIVES					
WMar-1: OID Member Irrigators Water Bank	Amount of water made available depends upon price and annual decisions by irrigators. Up to 1,585 acre-feet of water initially assumed available under annual or longer-term leases.	$100 to $600/acre-foot; available immediately	No engineering is required.	OID Board resolution to establish water bank. Water transfer needed as to place, purpose, and point of diversion. Water leased to instream flow may be required to be conveyed via the State Water Trust.	Provides 18% to 50% of target for instream flows.
WMar-2: Purchase Groundwater Stored at Duck Lake	2,200 acre-feet (may be reduced by water system improvements)	$700/acre-foot	Could be distributed using existing system.	Artificially stored groundwater may be taken at existing pumps under terms specified in Order DE 85-20.	Reduce availability of water for residential use in a closed basin.
WMar-3: Purvey to City of Omak	No water to Salmon Creek.	The objective of this alternative is to obtain Omak participation in financing selected alternatives.		Omak is consummating an agreement with OID to purchase artificially stored groundwater at Duck Lake. Thus, it is unlikely that the City would participate in other alternatives.	

Appendix A. Summary of Water Supply Alternatives Considered

WATER SUPPLY ALTERNATIVE	WATER AMOUNT AND TIMING	COST AND TIMEFRAME	ENGINEERING FEASIBILITY	REGULATORY REQUIREMENTS	ENVIRONMENTAL IMPACTS AND BENEFITS
WATER RIGHTS ALTERNATIVES					
WR-1: Duck Lake Water Association	No water available.				
WR-2: North Fork Salmon Creek Water Right Owners	1.33 cfs (963 acre-feet) (39 water rights and claims) (probably captured as return flows or unused water rights at Conconully Reservoir)	$1000-$2000/acre-foot, plus transaction costs. Minimum 18 months.	No engineering required.	Acquire and transfer up to 39 water rights and claims to instream flow, convey to State Water Trust.	
WR-3: Okanogan County	Total water rights owned by County sum to 246.45 acre-feet and 0.33 cfs			Considering small size of water rights and uncertainty of County as to their availability, this alternative was not pursued further.	
WATER STORAGE ALTERNATIVES					
WS-1: Aquifer Storage and Recovery	Actual extent of storage potential is unknown. This alternative assumes 5,100 acre-feet/year storage and 759-833 acre-feet/year firm yield.	A very rough planning level cost estimate is $2.5 O&M for implementation and $40k for O&M. This alternative could require 2-4 years to develop.	Groundwater storage may be feasible down-stream of Watercress Springs. Conceptual design assumes a 16-well injection system with associated intake, distribution pipe, pumps, controls and return pipe.	No special permit requirements in Washington for ASR. Advisable to amend Order DE 85-20 to protect the stored water.	Provides 9% to 19% of target for instream flows.
WS-2: Brown Lake	10,000 acre-feet of new storage; 1,316-1,349 acre-feet per year firm yield.	$7.3 M to $8.3 M for dam engineering and construction, land, pipelines. Minimal annual O&M. Three to five years to complete implementation.	Two dams would be required, together with diversion structures and pipelines. Could return flows to Salmon Creek or deliver to OID.	Change in water right point of diversion, full dam/reservoir permitting. Duck Lake level minima/maxima may constrain operations.	Provides 18% to 40% of target for instream flows. Dam construction has few impacts. Conveyance of water may provide incidental winter flows, or could reduce flows in middle reach of Salmon Creek.
WS-3: CCT Reservation Site		Distance from CCT reservation is economically infeasible.			

Appendix A. Summary of Water Supply Alternatives Considered

WATER SUPPLY ALTERNATIVE	WATER AMOUNT AND TIMING	COST AND TIMEFRAME	ENGINEERING FEASIBILITY	REGULATORY REQUIREMENTS	ENVIRONMENTAL IMPACTS AND BENEFITS
WATER STORAGE ALTERNATIVES (cont'd)					
WS-4: Green Lake	Perhaps 5,000 acre-feet of storage			Diversion, storage and amended dam permits	Alternative eliminated for impacts to scenic resource, wetlands, and recreation.
WS-5: Inter-basin transfer Scotch Creek Johnson Creek Fish Lake	No additional water available from Johnson or Scotch creeks.	Fish Lake alternative eliminated for cost of pumping to Salmon Lake.		Johnson Creek is closed; Scotch Creek diversion would impair Johnson Creek water rights.	Inter-basin transfers deplete one basin in favor of another. Fish Lake transfer may affect downstream wildlife area.
WS-6: Raise Salmon Lake Dam and Replace Feeder Canal	330 acre-feet per foot of increase in dam height. This alternative assumes 660 ac-ft of new storage, 990 ac-ft of new dedicated storage, and 200 ac-ft firm yield. Improving feeder canal avoids 36 ac-ft/yr in losses.	$2.1 M for parapet wall and buttress, plus replacing feeder canal with 80 cfs pipe. Annual O&M is part of existing baseline for OID.	Bureau of Reclamation has agreed that it would be feasible to raise the dam.	Amended water storage right and construction permits.	Provides less than 2% of target for instream flows.
WS-7: Scotch Basin	10,000 acre-feet of new storage		Two dams would be required, together with diversion structures and bypass ditches for Scotch and Coulee creeks.	Change in water right point of diversion, full dam/reservoir permitting. Duck Lake level minima/maxima may constrain operations.	Alternative eliminated for fatal flaws. Basin land owned by Dept Fish & Wildlife and managed for federal candidate species. High scenic quality. Local opposition.
WS-8: West Fork Salmon Creek	500 acre-feet potential firm yield.		Alternative eliminated because no feasible storage site was identified.	Diversion, storage and dam permits	

APPENDIX B:
Historical Monthly Streamflow and Reservoir Release Data

APPENDIX B-1:

Historical Monthly Streamflows for the Okanogan River at Malott

Appendix B-1. Historical Monthly Streamflows for the Okanogan River at Malott (Years 1911-1925 and 1929-2002*)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1911	-	-	-	-	-	-	-	-	-	68,489	61,591	66,924
1912	65,112	58,453	55,475	94,270	518,218	471,145	261,827	137,740	97,956	80,247	79,300	72,216
1913	-	-	60,499	103,784	457,245	754,882	328,895	146,594	99,748	103,866	98,286	87,578
1914	96,865	71,324	79,753	205,591	605,240	534,074	254,455	102,939	71,660	82,203	92,911	70,919
1915	62,064	62,161	68,746	196,304	345,843	283,119	170,646	121,184	73,040	76,108	88,401	67,109
1916	49,215	65,053	118,878	176,000	615,207	958,146	557,075	189,920	105,452	76,540	61,033	53,657
1917	50,714	47,022	55,077	54,703	381,879	812,148	369,482	117,972	70,260	64,824	72,093	63,856
1918	148,159	68,436	62,497	144,185	585,286	702,681	232,422	115,130	57,328	65,318	66,718	56,834
1919	59,737	49,872	57,699	146,957	645,065	721,667	340,633	112,062	66,251	54,466	71,594	57,664
1920	55,392	63,715	50,302	52,137	302,496	512,411	366,764	107,243	58,409	119,063	72,916	57,240
1921	52,190	53,481	74,481	108,417	627,521	899,294	326,486	102,157	50,868	78,332	101,457	126,991
1922	102,528	75,188	87,866	95,629	446,640	736,452	166,733	62,641	50,409	63,001	68,489	62,497
1923	81,956	57,354	65,600	144,844	577,482	724,015	334,373	119,619	75,181	75,140	71,434	66,543
1924	54,775	96,386	84,613	88,793	651,201	329,719	102,223	40,146	27,892	48,187	49,789	78,540
1925	82,389	85,306	51,037	222,229	725,188	428,293	138,440	47,446	29,409	-	-	-
1929	-	-	-	-	248,525	341,354	84,987	25,899	16,698	26,549	25,505	25,460
1930	22,977	33,819	33,769	200,298	325,209	349,714	117,366	32,902	22,521	28,240	36,320	28,289
1931	28,055	34,930	33,518	47,576	359,413	168,648	57,989	14,777	20,681	25,736	40,931	31,374
1932	25,404	51,358	131,192	180,304	550,012	422,424	145,091	58,415	42,990	56,593	115,562	118,219
1933	96,000	60,240	58,504	122,584	459,408	819,768	379,346	115,645	67,089	134,857	199,742	155,573
1934	128,371	108,242	182,280	816,864	783,176	383,897	134,939	67,354	38,684	60,664	136,113	112,020
1935	88,628	168,077	121,040	124,211	592,555	661,353	301,776	120,072	77,302	83,748	83,933	76,520
1936	60,254	35,656	44,730	181,774	564,633	400,556	123,181	56,463	43,585	53,766	55,310	52,839
1937	32,165	30,956	44,963	77,714	414,002	738,367	215,866	61,185	45,148	67,573	92,396	90,296
1938	88,999	78,263	105,822	237,261	757,024	579,727	152,463	45,385	35,461	46,983	48,422	52,396
1939	59,186	35,516	54,171	181,972	469,580	341,951	148,139	44,417	31,891	41,981	57,363	79,996
1940	45,659	39,288	44,919	138,131	333,158	183,083	38,620	20,353	14,272	45,352	44,003	47,193
1941	44,685	39,942	61,082	188,664	241,935	229,827	99,159	42,259	92,149	175,959	134,754	147,253
1942	114,924	88,131	64,348	178,984	551,001	595,500	251,016	131,727	86,878	86,280	97,338	102,033
1943	71,166	76,601	70,254	232,669	412,849	628,406	346,152	81,095	35,542	41,818	45,134	37,945
1944	31,380	38,187	34,380	58,335	303,052	489,595	127,988	38,348	31,788	48,776	55,154	65,483
1945	76,149	73,405	71,537	82,697	520,154	695,042	178,491	65,719	43,659	71,320	111,650	98,986
1946	90,275	68,394	89,905	183,104	850,202	604,581	251,614	103,084	82,492	92,870	89,266	84,654
1949	119,063	105,022	112,885	227,892	991,299	514,985	169,740	86,095	73,946	85,292	135,907	161,235
1950	74,461	91,185	152,051	159,094	559,340	1,195,777	392,689	125,488	59,521	88,340	111,959	149,477
1951	126,641	138,450	129,421	283,140	1,002,604	716,313	293,374	109,055	102,507	111,444	109,055	86,734
1952	79,567	88,803	84,818	191,094	673,832	398,991	196,201	82,533	67,006	68,431	48,047	43,004

Appendix B-1. Historical Monthly Streamflows for the Okanogan River at Malott (Years 1911-1925 and 1929-2002*)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1953	48,336	55,262	49,153	85,512	595,150	649,163	294,116	99,377	74,802	91,964	101,024	93,117
1954	72,813	91,351	83,459	82,986	634,337	799,176	607,093	193,503	155,243	133,601	161,750	154,419
1955	111,382	85,430	80,741	93,138	295,392	936,833	458,296	147,912	86,631	113,730	163,892	87,110
1956	92,540	65,133	98,347	219,470	923,345	804,056	316,170	108,067	67,795	105,781	100,654	107,943
1957	74,296	73,422	84,407	104,669	1,022,063	469,559	148,448	80,762	70,322	84,592	74,502	76,911
1958	74,646	69,121	76,232	138,996	633,838	346,282	112,068	48,407	51,090	85,793	90,288	129,987
1959	115,672	83,863	116,840	178,517	682,526	1,001,286	396,673	106,049	113,771	181,368	196,297	197,723
1960	119,196	99,024	85,180	213,721	422,136	525,175	167,191	65,904	63,390	74,151	76,567	67,676
1961	72,785	72,596	76,151	118,206	519,671	846,549	154,183	65,685	53,446	79,952	62,764	59,737
1962	78,547	113,628	76,270	170,141	333,254	491,832	168,894	70,686	49,296	70,033	88,130	104,287
1963	75,953	109,792	85,952	96,862	357,707	427,700	227,779	95,832	75,280	83,196	96,545	113,197
1964	100,089	76,554	79,972	110,722	316,701	1,006,830	413,246	121,532	110,128	127,076	89,159	67,597
1965	70,488	78,509	105,098	147,332	487,694	690,921	181,804	74,810	72,230	78,170	88,367	62,792
1966	71,181	58,947	54,466	135,986	346,658	315,711	153,905	50,411	42,196	56,046	62,233	81,121
1967	73,577	57,493	81,061	93,496	434,115	1,045,836	240,827	56,068	27,253	51,482	103,237	61,479
1968	97,000	125,391	130,581	84,982	450,311	664,666	234,214	75,462	63,914	76,151	86,981	61,885
1969	83,358	75,213	101,416	161,687	677,695	424,373	124,285	49,494	49,391	84,625	72,682	63,821
1970	53,840	44,778	51,842	57,933	285,872	440,708	79,879	28,005	30,496	44,683	35,806	34,709
1971	41,461	76,351	59,693	129,076	804,910	880,902	311,890	93,082	60,786	75,458	63,596	56,668
1972	77,972	83,112	189,011	259,598	1,007,959	1,739,826	674,428	232,393	111,652	83,873	74,349	56,014
1973	50,074	49,273	47,676	63,190	302,306	260,390	85,368	29,482	29,304	49,888	54,135	58,133
1974	63,390	85,461	162,142	284,368	681,991	1,198,692	531,670	174,715	58,877	67,910	60,378	55,094
1975	53,973	88,018	130,581	126,225	356,756	779,368	279,616	81,228	67,286	92,367	101,079	141,649
1976	107,415	122,459	114,484	129,571	654,034	647,361	470,230	224,453	132,601	85,358	105,257	96,961
1977	62,964	62,653	42,491	86,185	265,102	235,066	57,586	26,643	32,834	51,240	54,064	63,077
1978	58,762	80,367	101,851	176,022	508,108	650,806	225,304	73,424	114,662	100,525	135,511	101,416
1979	61,677	57,913	70,231	71,498	408,811	273,339	93,387	32,183	48,969	48,783	46,700	65,366
1980	48,740	62,319	59,552	140,927	659,063	486,110	179,804	66,439	67,461	70,943	79,438	156,123
1981	164,241	81,825	81,259	95,080	461,637	535,966	309,771	140,639	74,185	86,764	80,685	67,637
1982	64,845	86,919	122,918	127,888	467,735	777,704	416,097	188,912	137,887	105,197	86,209	87,773
1983	103,495	119,941	242,213	341,590	726,858	617,067	327,393	167,290	118,265	85,378	102,742	67,538
1984	182,299	131,332	158,083	187,803	321,473	729,353	321,374	127,076	82,447	76,487	76,982	55,123
1985	61,321	58,292	64,627	139,154	461,538	430,571	87,615	30,545	50,112	72,799	77,834	58,351
1986	50,510	61,684	169,112	192,199	444,946	610,414	179,626	107,059	61,572	68,765	83,101	76,824
1987	57,378	56,848	87,643	152,044	582,595	232,472	83,237	38,315	27,924	37,129	34,082	39,586
1988	33,145	34,591	36,879	126,926	411,127	332,383	109,510	32,080	22,123	39,592	59,838	45,671
1989	36,491	43,098	52,500	137,881	454,370	456,469	146,956	75,367	73,315	69,664	137,155	134,383

Appendix B-1. Historical Monthly Streamflows for the Okanogan River at Malott (Years 1911-1925 and 1929-2002*)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	79,537	61,608	68,924	251,797	446,708	885,258	408,573	186,001	91,381	91,763	281,952	147,312
1991	98,564	166,626	195,822	240,669	906,820	955,350	576,932	185,269	71,246	59,366	70,043	65,326
1992	60,115	67,932	113,494	183,170	316,899	155,905	117,117	48,162	43,316	54,749	54,680	37,866
1993	42,709	38,116	49,599	78,133	532,026	295,713	257,935	254,727	115,493	75,404	64,588	63,661
1994	91,223	53,776	107,569	287,773	455,638	206,831	98,248	38,224	54,585	53,308	44,898	47,843
1995	47,150	92,229	140,441	174,299	673,834	575,507	166,043	87,932	67,799	75,234	170,316	270,171
1996	146,579	135,170	186,199	416,671	550,737	841,500	364,577	143,788	82,027	68,070	81,972	72,735
1997	104,776	125,405	185,122	297,000	990,059	952,717	423,399	220,047	176,002	113,369	137,214	92,193
1998	87,098	112,084	128,591	197,386	741,470	463,261	226,063	63,037	43,659	58,863	65,578	61,626
1999	86,975	96,410	120,489	239,560	581,514	842,292	517,433	211,024	82,922	81,329	155,272	128,100
2000	101,216	87,540	68,868	223,403	456,238	455,420	217,101	70,219	76,804	70,035	65,756	49,963
2001	43,089	31,545	38,363	55,123	266,266	201,366	77,956	37,020	27,894	49,855	65,230	53,105
2002	72,389	51,249	68,969	157,208	532,084	852,095	263,917	71,641	51,158	46,376	49,797	48,944

*Streamflow measured at Malott gage from 1958 to 2002. Comparison of overlapping flow records at the Malott and Tonasket gages demonstrates that flows at Malott are approximately 4% higher than the flows at Tonasket. Based on this relationship, the flow record at Malott can be extended back prior to 1958 by multiplying measured flows at the Tonasket gage (which began operating in 1911, and has continuously recorded flows since 1929) by 1.04.

APPENDIX B-2:
Historical Monthly Release Record from Conconully Reservoir

Appendix B-2. Historical Monthly Release Record from Conconully Reservoir (1947-1997, 1000s Acre-feet)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1947	0	0	0	0	0	0.2	0.4	3.2	2	3.6	3.3	1.8
1948	0	0	0	0	0	0	0	5	37.7	5.4	3.8	3.1
1949	0	0	0.5	0.6	0.6	0.8	1.3	3.7	3.5	3.6	3.7	2.1
1950	0	0	0	0	0	0	0	2.3	6.9	4.4	4.3	3.4
1951	0	0	0	0	0	0	1.9	17.2	9.5	4.4	4.2	1.7
1952	0	0	1	1.1	1	0.9	4	14	6.3	4.1	4.1	3
1953	0.4	0	0	0	0	0	0.4	4.7	9.2	4.9	4.1	2.5
1954	0.1	0	0	0	0	0	0	2.3	3.2	3.9	4.1	1.7
1955	0	0	0	0	0	0	0	1.9	4.2	3.6	4.1	2.9
1956	0	0	0	0	0	0.2	3.2	12.6	10.9	4.1	3.4	2
1957	0	0	0	0	0	0	0	18	5.1	4.1	3.7	2.5
1958	2.5	0	0	0	0	0	0	15.3	6.2	4	4.5	2.3
1959	0	0	0	0	0	0	0	8.4	10	4	4.3	1.6
1960	0	1.1	1	0	0	0	0.3	2.3	5.8	4.5	4	1.8
1961	0.4	0	0	0	0	0	0.3	1.8	5.2	4.6	4.8	0.4
1962	0	0	0	0	0	0	0	1.6	2.6	2.5	2.9	2.5
1963	0	0	0	0	0	0.1	0.1	1.4	3.6	3.5	4.3	2.5
1964	0	0	0	0	0	0	0	1.4	1.9	3.4	3.7	1.8
1965	0	0	0	0	0	0	0	2.3	2.7	1.3	2.8	2.3
1966	0	0	0	0	0	0	0.8	2	1.7	2	0	1
1967	0	0	0	0	0	0	0	2.3	9	4.2	4.2	2.9
1968	0	0	0	0	0	0.5	0.7	5.6	4.2	2.1	3.3	0.7
1969	0.2	0	0	0	0	0	0.2	3.9	4.8	4.1	4	2.2
1970	0.3	0.1	0.1	0.2	0.2	0.1	0	0	0	4	3.5	0.3
1971	0	0	0	0	0	0	0	2	5.6	2.5	3.2	2.1
1972	0	0	0	0	0	0	2.8	19.8	19.1	4.8	3.8	2.4
1973	0	0	0	0	0	0	0.9	3.4	3.6	3.5	3.4	1.4
1974	0	0	0	0	0	0	1.6	19.2	20.9	4.9	3.9	2.4
1975	0	0	0	0	0	0.2	0.9	4.8	6.7	3.8	3.5	2.3
1976	0	0	0	0	0	0	1.1	4.2	4.9	4.5	3.6	2.6
1977	0	0	0	0	0	0	1.9	1.7	2.4	3	3.1	1.3
1978	0	0	0	0	0	0	0.3	2.5	6.3	4.8	3.8	1.5
1979	0	0	0	0	0	0	1	4	3.7	2.6	2.5	0.7
1980	0.6	0	0	0	0	0.6	0.4	9.7	6.7	4.4	4.5	2.5
1981	0	0	0	0	0	0	0.8	3	8.4	4.1	4.8	2.8
1982	0	0	0	0	0	0	0.1	15.2	15	6.8	3.8	2.4
1983	0	0	0	0	0	4	7.9	25.6	15.9	5.2	3.4	1.7

Appendix B-2. Historical Monthly Release Record from Conconully Reservoir (1947-1997, 1000s Acre-feet)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1984	0	0.67	0.48	1.2	1.39	4.46	5.76	6.43	20.23	6.39	3.17	2.44
1985	0	0	0	0	0	0.05	0.14	3.04	3.3	4.26	1.3	0.83
1986	0	0	0	0	0	0	0.09	2	3.05	2.1	2.71	1.2
1987	0	0	0	0	0	0	0.57	1.53	1.57	2.22	2.58	2.7
1988	0	0	0	0	0	0	0.17	0.92	1.29	2.04	2.73	2.22
1989	0.21	0.1	0.09	0.11	0.1	0.43	0.27	1.55	1.94	2.64	2.8	2.81
1990	0	0.13	0.09	0.11	0.1	0.11	0.69	1.36	7.76	3.64	3.02	2.55
1991	0.37	0.04	0.04	0.04	0.04	0.04	0.68	1.86	2.97	3.54	3.33	2.63
1992	0.55	0.11	0.11	0.11	0.12	0.11	1.02	2.29	1.92	1.37	2.35	1.68
1993	0	0	0	0	0	0	0.01	1.78	1.97	1.7	3.01	2.18
1994	0.38	0	0	0	0	0	0.35	3.45	3.08	4.04	3.121	2.42
1995	0.4	0	0	0	0	0	0	10.27	8.866	3.562	3.43	2.04
1996	0.99	0	0	0	0	0	2.13	9.81	7.07	4.18	3.04	1.079
1997	0.986	0	0	0	0	0	0	7.32	8.49	5.99	3.64	2.89

APPENDIX B-3:

Historical Monthly Streamflows for Salmon Creek into Conconully Reservoir

Appendix B-3. Historical Monthly Streamflows for Salmon Creek into Conconully Reservoir: Years 1904-2002*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1904	748	643	798	11,000	16,870	9,590	2,600	1,020	743	1,030	951	824
1905	762	648	1,840	4,310	7,430	10,590	4,340	1,540	797	926	674	651
1906	641	561	835	3,460	5,540	7,770	2,210	610	375	514	976	585
1907	472	438	549	1,740	10,920	8,170	2,170	1,320	844	590	635	564
1908	514	436	798	1,750	6,360	6,450	1,020	1,140	402	463	699	388
1909	265	459	1,210	1,370	4,220	5,710	1,590	2,340	1,190	319	1,070	590
1910	427	432	1,290	423	3,110	3,280	2,640	979	520	801	1,112	550
1911	449	320	892	1,452	4,695	10,545	191	722	699	381	417	785
1912	388	313	482	1,190	7,410	5,120	1,790	940	474	766	487	531
1913	377	291	348	1,290	6,500	7,250	2,180	970	253	507	534	385
1914	681	354	589	4,440	12,600	9,130	2,130	400	115	1,060	1,120	653
1915	584	546	1,190	6,000	10,400	6,690	3,160	970	139	540	671	570
1916	1,110	600	1,050	4,040	13,800	16,300	9,140	2,040	560	793	547	869
1917	610	535	532	1,200	6,920	10,100	2,220	500	650	576	618	709
1918	642	470	629	1,090	2,130	1,200	270	160	366	30	285	438
1919	303	324	428	1,817	5,644	3,414	585	466	276	411	319	338
1920	266	210	209	313	914	953	628	571	0	475	586	364
1921	249	376	307	1,248	7,378	8,500	872	150	298	667	298	408
1922	268	166	312	617	3,737	7,543	0	31	306	325	340	231
1923	267	200	287	1,380	4,553	5,115	1,914	722	254	418	352	258
1924	275	298	198	551	2,365	597	21	0	0	197	302	147
1925	176	460	365	1,632	5,213	2,492	323	45	243	254	212	152
1926	159	275	86	947	1,052	316	95	95	241	429	302	212
1927	106	152	161	579	3,242	5,516	1,452	382	531	758	489	297
1928	198	313	173	625	4,235	1,819	2,053	311	31	100	125	50
1929	90	152	185	91	911	1,440	106	10	-126	169	200	184
1930	87	154	131	260	339	544	185	-48	70	185	153	90
1931	117	97	129	179	258	294	59	-98	50	130	129	144
1932	132	94	162	756	4,300	2,758	603	94	150	170	255	70
1933	169	91	120	613	3,412	8,818	2,386	620	667	210	300	325
1934	205	129	731	5,322	4,190	1,903	424	139	254	249	595	288
1935	300	605	504	1,165	6,578	5,098	1,609	459	392	-175	330	397
1936	278	170	155	1,102	1,769	5,088	833	13	172	87	155	185
1937	176	159	209	461	3,156	8,831	2,228	326	250	269	385	374
1938	171	330	525	3,729	9,057	6,771	806	591	794	383	419	486
1939	183	303	497	1,183	1,311	1,066	0	0	114	262	228	415
1940	215	300	570	1,502	4,809	1,793	138	24	0	348	362	625

Appendix B-3. Historical Monthly Streamflows for Salmon Creek into Conconully Reservoir: Years 1904-2002*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	480	143	926	6,023	7,477	7,587	2,385	1,268	1,853	1,223	903	1,031
1942	938	580	825	4,792	17,433	13,303	4,137	1,253	537	397	609	641
1943	196	221	256	2,214	3,915	5,253	1,427	205	-127	420	232	68
1944	152	228	215	996	2,465	4,461	899	90	-5	217	424	269
1945	187	378	496	584	9,116	7,577	995	-100	89	29	403	437
1946	400	390	308	1,922	8,723	5,265	1,418	3	233	205	245	361
1947	258	200	500	1,000	2,100	2,900	300	-100	100	500	500	100
1948	200	200	200	600	18,700	35,600	5,500	2,300	1,000	700	500	600
1949	600	500	600	2,700	6,300	1,800	500	-300	200	200	400	300
1950	200	300	500	700	5,800	12,200	2,100	200	-100	700	800	600
1951	500	600	900	4,700	20,300	9,500	2,200	1,100	1,000	1,100	700	1,000
1952	700	500	800	7,400	15,800	6,300	2,100	300	500	200	300	700
1953	700	500	600	1,900	8,800	9,200	3,000	800	300	600	200	500
1954	400	400	500	-100	4,100	3,500	1,400	700	200	400	800	600
1955	500	300	400	700	3,700	8,900	2,800	300	100	300	400	500
1956	400	-200	700	4,100	17,600	10,600	2,200	600	-100	500	500	400
1957	300	300	500	900	21,300	4,500	1,100	100	300	3,100	400	500
1958	400	1,000	1,000	2,300	18,500	6,000	1,900	300	0	600	400	-500
1959	1,900	600	900	1,800	10,600	10,900	2,400	-200	1,200	1,200	400	500
1960	200	600	1,400	1,600	5,300	5,500	300	100	200	-400	600	200
1961	300	400	900	1,600	8,300	5,300	600	-300	-2,100	0	100	400
1962	200	400	700	800	2,500	2,200	300	900	100	600	500	600
1963	200	500	500	1,500	8,600	4,800	1,400	100	100	300	500	400
1964	300	400	600	300	1,400	5,200	1,400	900	700	100	600	300
1965	100	300	100	700	2,600	3,600	-1,200	0	200	0	-200	0
1966	0	-100	600	1,400	2,800	1,200	500	-2,300	500	300	400	600
1967	300	400	300	1,200	9,900	16,500	2,000	-300	-600	800	300	500
1968	400	700	600	1,000	7,400	3,100	-900	200	-900	400	300	600
1969	200	300	500	3,000	13,000	4,000	800	-100	600	500	400	400
1970	600	400	500	1,000	3,000	2,000	300	-300	500	300	200	600
1971	300	500	300	2,200	11,400	9,300	-200	-400	-300	800	900	500
1972	700	500	1,200	3,500	22,300	20,000	3,900	1,700	200	300	700	500
1973	500	800	200	700	2,800	1,100	0	-400	400	600	800	1,100
1974	700	800	900	7,000	21,200	22,400	4,000	600	500	600	600	600
1975	600	600	700	500	6,900	7,600	1,500	800	600	1,000	400	1,000
1976	600	700	600	1,100	6,600	4,900	1,200	1,500	800	700	0	300
1977	300	300	200	500	900	1,100	0	0	300	500	300	400

Appendix B-3. Historical Monthly Streamflows for Salmon Creek into Conconully Reservoir: Years 1904-2002*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1978	200	200	1,300	3,000	9,500	9,700	2,800	900	1,700	1,000	200	100
1979	100	300	600	700	1,800	500	0	200	100	600	700	400
1980	400	400	1,100	3,600	17,700	6,700	1,400	600	1,000	600	600	500
1981	400	1,000	800	900	7,500	7,800	1,800	700	400	1,200	1,400	900
1982	300	1,100	700	2,200	16,800	15,100	5,900	1,400	1,200	700	700	700
1983	700	900	2,800	9,800	26,000	15,400	5,200	1,900	1,000	830	2,090	430
1984	1,250	1,390	4,550	5,810	6,580	20,130	5,590	830	1,010	810	1,090	630
1985	720	430	750	-550	2,570	1,570	-390	-1,890	10	660	420	620
1986	390	470	820	1,430	3,850	2,460	170	-580	490	450	330	640
1987	360	430	750	1,980	4,340	1,550	90	-600	0	60	280	780
1988	360	310	500	2,560	3,850	3,800	-30	-480	-290	180	490	320
1989	350	410	750	1,630	4,800	4,400	340	-470	470	330	550	470
1990	410	400	570	1,600	4,990	10,520	1,880	550	60	450	860	560
1991	390	430	190	850	3,760	5,210	1,230	-160	-310	210	550	470
1992	540	650	850	690	950	1,280	2,320	-100	-250	800	0	0
1993	850	210	410	1,000	4,990	2,090	4,080	1,370	330	400	240	500
1994	430	470	330	3,280	5,310	2,320	-440	-147	-72	200	430	390
1995	470	510	1,650	4,660	13,720	8,618	1,360	420	-710	1,430	440	830
1996	500	530	550	4,790	11,120	14,657	1,900	-1,530	-275	1,130	280	775
1997	735	420	540	2,640	9,570	8,860	4,120	310	1,070	830	790	740
1998	560	995	1,065	6,610	21,700	11,582	4,748	1,519	500	847	1,235	649
1999	616	988	1,429	6,007	11,734	12,965	4,953	1,507	1,165	1,159	1,428	889
2000	813	617	892	3,688	4,198	2,996	1,799	-138	54	304	500	563
2001	323	345	456	-36	943	1,411	0	0	758	318	734	580
2002	523	280	420	989	3,543	3,388	101	-355	-270	211	344	840

* Unregulated watershed runoff simulated from precipitation records years 1904-1946. For years 1947-2002, unregulated watershed runoff into Conconully Reservoir calculated from: *Watershed runoff = monthly Conconully outflow + gain in total reservoir storage during month* . Low runoff months may be slightly underestimated since storage data includes evaporation and seepage losses. Negative runoff estimates occur for some months, particularly in dry years, where losses to outflow, evaporation, and seepage exceed the total gain in monthly reservoir storage.

APPENDIX B-4:
Estimated Monthly Exceedence for Salmon Creek into Conconully Reservoir

Appendix B-4. Estimated Monthly Exceedances for Salmon Creek into Conconully Reservoir (1904-2002*)

Monthly Runoff (Acre-Feet)

Years Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1%	1,900	1,390	4,550	11,000	26,000	35,600	9,140	2,340	1,853	3,100	2,090	1,100
10%	720	700	1,200	5,322	17,600	13,303	4,120	1,400	1,000	1,030	951	824
20%	610	600	900	3,688	11,400	9,700	2,400	970	699	800	700	649
30%	500	500	798	2,300	8,800	8,618	2,170	700	500	660	600	600
40%	410	436	600	1,740	6,920	6,771	1,800	500	392	540	500	560
50%	388	400	550	1,400	5,540	5,265	1,400	300	254	450	424	500
60%	300	330	500	1,102	4,340	4,500	872	100	200	381	400	400
70%	265	300	410	900	3,760	3,100	424	3	100	300	319	374
80%	200	221	287	690	2,800	1,903	170	-100	0	205	280	288
90%	159	154	185	461	1,400	1,200	0	-355	-250	100	200	144
99%	0	-200	86	-550	258	294	-1,200	-2,300	-2,100	-400	-200	-500
Mean	421	427	668	2,177	7,462	6,654	1,622	382	316	518	513	475

Monthly Streamflow (CFS)

Years Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1%	31	25	74	185	423	598	149	38	31	50	35	18
10%	12	12	20	89	286	224	67	23	17	17	16	13
20%	10	11	15	62	185	163	39	16	12	13	12	11
30%	8	9	13	39	143	145	35	11	8	11	10	10
40%	7	8	10	29	113	114	29	8	7	9	8	9
50%	6	7	9	24	90	88	23	5	4	7	7	8
60%	5	6	8	19	71	76	14	2	3	6	7	7
70%	4	5	7	15	61	52	7	0	2	5	5	6
80%	3	4	5	12	46	32	3	-2	0	3	5	5
90%	3	3	3	8	23	20	0	-6	-4	2	3	2
99%	0	-4	1	-9	4	5	-20	-37	-35	-7	-3	-8
Mean	7	8	11	37	122	112	26	6	5	8	9	8

* Unregulated watershed runoff simulated from precipitation records years 1904-1946. For years 1947-2002, unregulated watershed runoff into Conconully Reservoir calculated from: *Watershed runoff = monthly Conconully outflow + gain in total reservoir storage during month* . Low runoff months may be slightly underestimated since storage data includes evaporation and seepage losses. Negative runoff estimates occur for some months, particularly in dry years, where losses to outflow, evaporation, and seepage exceed the total gain in monthly reservoir storage.

APPENDIX C:
Salmon Creek and Okanogan Irrigation District Water System Model

Appendix C -- SALMON CREEK AND OID WATER SYSTEM MODEL

INTRODUCTION

A water supply model was developed as part of the Phase I Joint Study on Salmon Creek (Dames & Moore, 1999) to simulate the current operations of the Salmon Creek and OID water supply systems and to quantify how much additional water could be provided by various water supply alternatives. The model is described in detail in Section 3.0 of the Dames & Moore (1999) report. For the EIS, this model was updated and used again to examine water quantity differences among the four EIS alternatives. This appendix is a revision of Section 3.0 of the 1999 report.

Phase I Study Scope and Objectives

For the Phase I Study, the scope and objectives of the water system model included:

- Determine quality and extent of existing hydrological data as a basis for modeling.
- Create a reasonably complete data set for modeling. Include all available data and significant drought periods, particularly the 1930's drought period. Fill in and extrapolate from the record as required.
- Define long-term hydrological data sets for the water system model.
- Develop a system and reservoir operations model to evaluate the water supply yield and reliability of the existing water supply system for OID, and integrate instream flow requirements for anadromous salmonids.
- Determine how the existing irrigation system operates under existing water sources and demands.
- Evaluate daily and weekly flow releases to Salmon Creek and daily irrigation schedules in OID to the extent data allow.
- Assess upper watershed yield to assess the raising of Salmon Lake Dam.
- Evaluate the availability of water supply for instream flows in lower Salmon Creek, to evaluate the feasibility of meeting both OID irrigation demands and instream flows with various supplemental sources and physical improvements to the system.

The model used historical runoff data from the Salmon Creek watershed for the period 1904-1998 to simulate the operations of Conconully and Salmon Lake reservoirs, the OID irrigation withdrawals from Salmon Creek, input parameters per various water supply alternatives, and the resulting amount of instream flow in Salmon Creek. The model incorporated the complexity of the OID irrigation supply system, which obtains its water from three separate sources (Salmon Creek, Johnson Creek/Duck Lake, and the Okanogan River).

EIS Scope and Objectives

Although a number of water-system model runs were conducted as part of the Phase I Study to evaluate various water supply and water conservation options, additional water system model runs were necessary to assess impacts from the four alternatives. However, no new water system model subroutines were created for the EIS analyses. Minor revisions were made to certain components of the model. The revisions included 1) updating the model structure and simulation through to 2002 (i.e., adding four more years of input data including streamflow, reservoir storage, and OID usage data), 2) reviewing and revising crop water requirements and OID irrigation demands, 3) reviewing and revising the model's approach at delivery efficiency and the resultant monthly distribution of canal spill to Duck Lake, and 4) adding the instream flow requirements associated with each scenario (i.e., providing flows for steelhead only with channel rehabilitation, steelhead and chinook with channel rehabilitation, and steelhead only without channel rehabilitation).

At the outset, an attempt was made to structure each water system model alternative to address the EIS target water volume of 5100 ac-ft/year. Combinations of water supply alternatives were not modeled. The feeder canal upgrade was included with each water supply alternative. Unrestricted pumping was assumed for diversions from the Okanogan River under action alternatives 1 and 2 (no minimum flow restrictions are assumed on the Okanogan River).

Documentation for the water system model is provided in the sections below and in Appendix 3.1-E. While these model descriptions are extensive, they do not completely describe all aspects of the model. A user's manual describing all input, assumptions, calculations, and capabilities of the model was not prepared as part of Phase I scope of work or for this EIS.

WATER SUPPLY FIRM YIELD

Purpose and Accuracy of Model

The water supply model was used to:

- estimate how much water for instream flow could be obtained on a firm annual basis from each of the alternatives; and

- simulate the existing OID irrigation system to determine what quantity of Salmon Creek water is needed by OID and to verify that new water supplies would not adversely affect OID's firm irrigation supply.

The modeling of current irrigation operations was based on the OID Manager's descriptions of how the system is operated, on matching recent operations, and on insights gained from the modeling into which operational strategies resulted in the greatest firm yield from Salmon Creek.

The model accurately describes the magnitude and variability of OID irrigation demand, and the ability to supply that demand from Salmon Creek and the Duck Lake and Shellrock pumping stations. It was generally observed that the model could duplicate the operational patterns of OID in terms of average irrigation water supply and the magnitudes of pumping by Shellrock and Duck Lake. However, exact replications of recent yearly irrigation operations are less precise because all behaviors of the OID operators and farmers, and unpredictable events such as pump breakdowns, cannot be simulated by the model.

Although the model is capable of mimicking the irrigation system under many different potential operating rules and methods, further evaluation of the OID system with possible additional model refinements could be made.

Definition of Firm Water Supply for Irrigation and Instream Flow

For a water supply source to be considered firm, the water supply model must show that it could provide a dependable supply of water during all years in the 1904-2002 simulation period. The sequence of years with the lowest streamflow magnitudes (termed the critical period) is the drought period that extended from the late 1920s to the early 1930s. This drought period was at its worst in 1931, when only 1,500 acre-feet of runoff was measured in the Salmon Creek watershed (compared to the 99-year average of 21,600 acre-feet/year). The period when Conconully and Salmon Lake reservoirs did not fill, as predicted by modeling, lasted over ten years (from 1924 to 1934).

Thus, to be considered a “firm” supply, water for irrigation and instream flows must be provided in full in each year to meet the required water demand through the 1920-30s drought period. The model shows that under current operations the total reservoir storage would have become totally depleted at the end of the 1931 irrigation season. To get through a year like 1931, pumping from the Okanogan River would have to occur at a level equal to the full nominal capacity of Shellrock.

The analysis of firm capacity assumes a 22 percent channel seepage loss in the lower reach of the Salmon Creek channel, and applies this percent loss as a constant across all flows. This estimated loss is almost certainly conservative, as it is based on the observed losses that were measured during a single, short controlled release test conducted for the Phase I Study. The test was conducted before the spring freshet may have fully recharged the groundwater table, and did not consider the likelihood that such loss, expressed as a percent, is likely to vary with flow. Therefore, firm yields are probably understated.

WATER SUPPLY MODEL OVERVIEW

Overview

The water supply model for the Salmon Creek watershed and OID irrigation system is a monthly water balance model that uses historical monthly Salmon Creek flows in a reservoir operation, irrigation demand, and instream flow demand simulation. The model was created using an Excel spreadsheet that contains 131 columns of water balance calculations for each month of the 99-year simulation period (i.e., 1,188 rows). Overall, the Excel file is about 12 Mbytes in size and requires a minimum of a 133 MHz Pentium computer to operate efficiently. A schematic of the water supply model is shown in the 1999 Phase 1 Report (Dames & Moore, 1999)

A summary of the model components is provided in Attachment Table C-1. This table summarizes the input data for the model, explains the rules that define how irrigation supply, irrigation demand, and instream flow releases are determined, and identifies model components that can be modified to evaluate different irrigation and instream flow operations. Attachment Table C-2 summarizes how sources of water for irrigation supply and irrigation demand are prioritized in the model. Attachment Table C-3 is a listing of the spreadsheet calculation parameters and definitions. The attachment tables have not been modified from the Phase I report (Dames & Moore, 1999).

Historical Salmon Creek watershed runoff is input as a 99-year time series file of historic monthly watershed runoff (in acre-feet per month). This total is then split into the West, North, South, and Salmon Lake forks of Salmon Creek based on proportions developed from the drainage area and average elevation of each sub-watershed. These flows enter the reservoir system of Salmon Lake and Conconully reservoirs, with flow to Salmon Lake regulated by the capacity of the feeder canal. Water is released from the reservoirs based on demand for irrigation supply and instream flow, middle reach local inflow or seepage loss, and other operational criteria.

A separate water balance within the model represents the Duck Lake water storage system. This water balance includes canal spill, Johnson Creek diversion, groundwater seepage (and to a lesser extent evaporation loss), OID groundwater sale, and Duck Lake pumping. Parameters for the Duck Lake water balance, such as the estimated magnitude of seepage loss from the Duck Lake basin, are based on a separate water balance model conducted using the 1987-1998 data set of monthly inflows (canal spill and Johnson Creek), outflows (Duck Lake pumping), and lake elevations, as described in the Phase I report (Dames & Moore, 1999).

The total irrigation requirement determines the amount of water needed for irrigation delivery to OID farmers. The model makes initial assumptions of the magnitudes of supply from the Salmon Creek diversion (including additional for conveyance and spill loss), Duck Lake pumping, and Shellrock pumping. This initial assumption is primarily based on historical pumping rates for Shellrock. Pumping flows from Duck Lake are initially set at a relatively low rate for the No Action Alternative; little operating flexibility exists for Duck Lake because inflow is restricted to a relatively narrow range, and little storage exists in the lake. As a result, Duck Lake basically operates according to how much water is available each year.

The model simulation then adjusts the pumping and Salmon Creek diversion rates according to how much storage is available in the reservoirs, and whether spill occurs from Conconully Reservoir. During low reservoir storage conditions, Shellrock can be directed to operate at maximum pumping rates (as specified by a critical reservoir storage volume) to provide supplemental supply during drought periods. At the other extreme, when spill occurs, pumping is cut back and diversion from the creek is increased to the extent possible (subject to instream flow requirements). Optionally, greater pumping can be specified during warm years and less during cool years.

Streamflows in Salmon Creek are tracked from Conconully Dam to the mouth. On the middle reach, local inflow or loss is added or subtracted from the streamflow. On the lower reach channel losses are subtracted from the streamflow. Loss rates were estimated from flow data collected during the three-day controlled release study during Phase 1. Total loss in the lower reach during that study ranged from 14 percent to 31 percent. A total loss of 22 percent was assumed in the operational studies, as follows: lower reach stream flow losses were conservatively established at 6 percent of flow between the diversion dam and the springs, and 16 percent between the springs and the mouth of Salmon Creek. However, the actual loss is likely to approach a constant volume, rather than increase as a percentage of flow. The stream channel loss may also diminish to a smaller constant amount if the groundwater table is recharged once flows are provided to the lower reach. Therefore, this assumption of stream loss may result in a significant underestimate of instream flow volumes and benefits. Further field studies are recommended to resolve stream channel loss volumes.

Streamflows were evaluated at four streamflow assessment points: immediately upstream of the diversion dam (i.e., the lowest point of the Middle Reach), immediately below the diversion (i.e., flow over the Salmon Creek weir), immediately below Watercress Springs, and at the mouth of Salmon Creek.

The effects of OID pumping at Shellrock and under other alternatives, as well as changes in Salmon Creek discharges, are also tracked on the Okanogan River. Starting with the river flows above Shellrock, pumping flows are subtracted from the Okanogan River at Shellrock (and/or the new pumping station) and added at the mouth of Salmon Creek. This means the changes in Okanogan River flows, as compared to modeled existing conditions, can be determined at the three streamflow assessment points.

Instream flow for the middle and lower reaches of Salmon Creek is specified as a reservoir demand, similar to irrigation demand. . In specifying instream flow releases from the reservoir, flow gains or losses in the middle and lower reaches are accounted for. Also, no instream flow release occurs during reservoir spill because water is being released anyway.

Data Sources

Data used to develop time series input data and operational parameters for the water supply model are described below.

Okanogan Irrigation District

Data provided by OID included:

- Recent irrigation operations data, including monthly diversions from Salmon Creek, spill to Duck Lake, Johnson Creek diversion, Duck Lake and Shellrock pumping, and Duck Lake elevations for 1987-2002, and middle reach gain and loss data for four years. OID compiled and verified the accuracy of the 1987-2002 operations data (Paul Frazier, personal communication, June 7, 1999, with supplemental data from Tom Sullivan, personal communication, June 23, 2003).

- Recent (1999-2002) historical Conconully and Salmon Lake reservoir operation data, including monthly storage, and inflow and outflows (Tom Sullivan, personal communication, June 23, 2003).

- Miscellaneous historical operations data provided to the Phase I study team during the project kickoff meeting, held in Okanogan on February 1 and 2, 1999.

- Verbal descriptions of operations, as conveyed during work sessions and several telephone conversations.

- Draft Conservation and Management Plan, describing the current irrigation system facilities (OID 1998).

Bureau of Reclamation

Data provided by the Bureau of Reclamation included:

- Historical Conconully and Salmon Lake reservoir operation data, including monthly storage, inflow and outflows, which are stored on USBR computers in Boise, Idaho (J. . Doty, personal communication, March 9, 1999).

- OID provided a 1968 USBR operations study that documented the only source of Salmon Creek streamflow data for the period 1904-1946 (USBR 1968).

- OID provided the USBR Conconully and Salmon Lake dam Standard Operating Procedures manuals that contains data on the physical characteristics of the reservoirs (USBR 1989a, b).

- OID provided USBR Okanogan Project Water Supply Reports (i.e., monthly reservoir data) for 1973-1999.

National Oceanographic and Atmospheric Administration

Data obtained from NOAA included historical Omak and Conconully temperature and precipitation, available on the Internet and climatological publications.

U.S. Geological Survey

Data obtained from USGS included the following historical streamflow data:

- Okanogan River at Tonasket (No. 12445000, 1911-2002)
- Okanogan River at Malott (No. 12447200, 1966-2002)
- Okanogan River near Malott (No. 12447300, 1958-1967)
- Other streamflow data for regional streams, intended to be used to estimate Johnson Creek flows and Salmon Creek middle reach flows. However, no historical data could be located to estimate Johnson Creek runoff. For Salmon Creek, OID dam release and diversion records for four recent years were used to estimate middle reach inflow or loss.

Model Input Data

Model data is input into the water supply model on worksheets within the Excel file. These worksheets (which are multiple spreadsheets within a single Excel file) are described below:

General Input

General input include reservoir sizes, pumping capacities, Duck Lake groundwater pumping, and other facilities for existing and new facilities. Shaded cells in the worksheet indicate where user-defined model parameters may be modified (such as the capacity of Salmon Lake reservoir) in modeling irrigation operations for the various alternatives.

Input Time Series

Input time series include monthly flows for Salmon Creek and Okanogan River for the 1904-2002 simulation period, yearly climate data including precipitation, and yearly middle reach gain and losses. These data are not changed during model simulations.

Salmon Creek and Okanogan River flow data are based on historical records (See section below describing Salmon Creek, Okanogan River and climate data). Calculations are performed in the spreadsheet to determine Okanogan River flows at points upstream of the gauging station, based on Salmon Creek and Shellrock pumping flows that were estimated by the existing conditions model run. These three sets of Okanogan River flows – above Shellrock, between Shellrock and Salmon Creek, and below Salmon Creek – were produced and used to evaluate potential changes in Okanogan River flows under the alternatives due to increased pumping or a changed flow regime in Salmon Creek.

Annual temperature, precipitation, and middle reach gain/loss time series are also included. Omak mean summer temperatures, calculated by giving June a weight of 50 percent and July and August weights of 100 percent, are used to estimate annual total irrigation demands. Omak water year (October-September) precipitation is used to estimate Johnson Creek diversion flows because a correlation analysis determined that Johnson Creek diversion flow is best estimated by annual precipitation. Precipitation was used to estimate Johnson Creek flow because no historical data other than monthly OID diversion flows from Johnson Creek could be located for the Johnson Creek watershed.

The middle reach gain/loss time series is based on measured data provided by OID for 1988, 1989, 1997 and 1998. From these data, maximum gains and losses in the middle reach were determined. Correlation analyses indicated that total annual gains and losses are best estimated by the Omak March-July precipitation; a lookup function is used in the model to estimate annual gain or loss, and is then converted to monthly time series based on a fixed annual distribution. Winter seepage flows of 100 acre-feet/month (as determined from USBR Water Supply Report data) were then added to the gain/loss values to account for seepage from the dam during the non-irrigation season.

Irrigation Demand

Details on the total irrigation demand during warm and cool years are specified in the model. Based on OID data, a good correlation between mean Omak summer temperature and total irrigation delivery was found. Irrigation demand is specified in terms of an annual crop irrigation requirement and the on-farm efficiency. The annual irrigation demand is then distributed into April-October monthly demands based on percentages calculated from the 1987-2002 historical operations data.

Shellrock and Duck Lake operations parameters are also specified under irrigation demand. This includes pumping rates under average conditions (so that less pumping occurs in early and late season months, in proportion to total demand), the critical reservoir storage capacity at which pumping should be increased to maximum, and whether pumping is subject to instream flow limitation in the Okanogan River. For Duck Lake, maximum and minimum reservoir elevations are also specified. Also, it can be specified whether Shellrock pumping is to be stopped for the remainder of the year if reservoir spill occurs, which appears to be the current OID practice. Model sensitivity analyses confirmed that this is a good operational strategy because very little additional firm yield is obtained if Shellrock pumping is maximized in the months following reservoir spill (e.g., during July through September if spill stops in June).

District and On-Farm Efficiencies

Based on analysis of the crop census provided by OID, daily crop water requirements, and water delivery to farms and spills, existing irrigation efficiencies were determined. Percent efficiency for each measure was calculated based on the following formula:

> ***percent On-Farm Efficiency = (Total Crop Water Requirement) / (Total Delivery to the Farms)***

percent District Efficiency = (Total Delivery to the Farms) / (End of canal Spills + Total Delivery to the Farms)

percent Overall Efficiency = percent Farm Efficiency x percent District Efficiency

Based on these formulas it was concluded during the Phase I Study that the district efficiency was remarkably consistent across the period, averaging about 86% per year. The main factor affecting the district efficiency was spill and main canal losses. Further, on-farm efficiency appeared to be a function of water year type. In dry or water short years (i.e. 1993, 1994) farmers apply water conservatively and efficiencies exceeding 100 percent (i.e., deficit watering) were achieved. In wet years (i.e. 1998) water was liberally applied and annual efficiencies dropped to as low as 66 percent. Over all years in the period, on-farm efficiencies averaged 82 percent. The overall district efficiency, considering both district-wide and on-farm efficiencies, averaged 70 percent and ranged from 57 percent to 84 percent for the period. As compared to other irrigation districts in the region OID achieves a relatively high efficiency.

The Phase 1 iteration of the model assumed a constant canal spill of 13.4% plus an additional canal loss increment of 0.4% to reflect the overall 86% average efficiency. However, in our review of updated OID data for developing model input parameters, we determined that OID's management of canal spill was not constant during the year but was more a function of season, in that they were much more efficient during the summer months (i.e., when conveying large volumes of water) and less efficient during the non-irrigation season (Table C-1). Thus, the model rules were revised so that actual efficiencies were expressed by distributing canal spills according to OID's historical management practices shown in Table C-1.

Table C-1. 1987-2002 average OID monthly demand and distribution of water.

	Average Monthly Demand From Salmon Creek, Okanogan River and Duck Lake (ac-ft)	*Average Distribution of OID Delivery to Farms*	*Average Proportion of OID Canal Water Spilled to Duck Lake*
Jan	5	0.0%	1.7%
Feb	8	0.0%	3.2%
Mar	90	0.1%	21.8%
Apr	705	2.8%	34.2%
May	2547	14.1%	14.4%
Jun	3002	16.8%	13.5%
Jul	3848	22.6%	9.5%
Aug	3938	23.6%	8.0%
Sep	2955	17.5%	8.9%
Oct	510	2.4%	28.9%
Nov	80	0.1%	26.7%
Dec	31	0.0%	19.0%

Instream Flow Demand

Instream flow demand is the amount of water that must be released from Conconully and Salmon Lake reservoirs to meet required monthly instream flow rates. Instream flow demand is specified as one of the three flow scenarios described in the description of alternatives (Section 2.0). Separate flows are specified for the middle reach and the lower reach. It is assumed that flows in both reaches would be provided to satisfy instream flow requirements as specified in Tables C-2 and C-3.

Table C2. Middle Reach Salmon Creek: recommended minimum flows for fish *

	Monthly Volume acre-feet)	*Monthly Volume (acre-feet)*	*Monthly Volume (acre-feet)*
Species	Steelhead Only	Chinook Only	Steelhead & Chinook
Jan	246	430	430
Feb	222	388	388
Mar	246	430	430
Apr	891	416	891
May	921	1,228	1,228
Jun	891	1,188	1,188
Jul	614	1,228	1,228
Aug	614	1,228	1,228
Sep	594	416	594
Oct	246	430	430
Nov	238	416	416
Dec	246	430	430
Annual Sum	5,966	8,225	8,878

*a) The minimum instream flows for the Middle Reach include 'new' water needs in addition to irrigation conveyance through the reach. They are instream flow requirements.

*b) Minimum flows may be provided as part of seasonal irrigation conveyance (included within irrigation demand), or they are a 'new' water need when the irrigation conveyance in the middle reach does not equal or exceed these values.

*c) New water is needed in the Middle Reach for instream minimum flows in non-irrigation season months for all action alternatives.

*d) In some alternatives, new water is needed in the Middle Reach if irrigation conveyance is reduced.

Table C-3. Lower Reach Salmon Creek: recommended minimum flows for fish (passage only)*

	Monthly Volume (acre-feet)	*Monthly Volume (acre-feet)*	*Monthly Volume (acre-feet)*	*Monthly Volume (acre-feet)*
Lower Reach Rehab?	No	Yes	Yes	Yes
Species	Steelhead Only	Steelhead Only	Chinook Only	Steelhead & Chinook
Jan	-	-	-	-
Feb	-	-	-	-
Mar	495	356	-	356
Apr	1,337	891	-	891
May	812	812	1,228	1,287
Jun	-	-	1,188	1,188
Jul	-	-	594	594
Aug	-	-	-	-
Sep	-	-	-	-
Oct	-	-	-	-
Nov	-	-	-	-
Dec	-	-	-	-
Annual Sum	2,643	2,059	3,010	4,316

*a) The minimum instream flows for the Lower Reach represent 'new' water needed in addition to irrigation demand. It is possible that passage minimums during May or June may be met through spill in some years

*b) Additional water may occur in the Lower Reach from larger spills, and flows in the lower reach may be increased during 'non-irrigation' season months by minimum flows required in the Middle Reach that continue downstream of the OID diversion dam.

For the middle reach, no instream flow demand is placed on the reservoir if irrigation water is released; reservoir spill and/or local inflow already provide the flow. For the lower reach, since irrigation water is not conveyed in that reach, releases are to serve instream flow demand only (except during reservoir spill, which is not counted as an instream flow release). Channel seepage losses are added to the lower reach instream flow rates; therefore, the instream flow demand for the lower reach is adjusted to account for seepage losses.

Tables C-2 and C-3 summarize the three instream flow scenarios analyzed (*Chinook Only* was not analyzed per se as it has the same flow requirements as *Steelhead and Chinook*), the required amounts of water needed on a monthly basis for the middle and lower reaches, and the total amount of water needed for both reaches. The difference between the instream flow release at the diversion dam and the instream flow at the mouth of Salmon Creek is the quantity of channel seepage loss assumed for the lower reach. Since reservoir spill and local inflow will provide a portion of these instream flows, the actual average instream flow release at the diversion dam will be somewhat smaller.

Model Output

Model output consists of the following:

- A two-page run summary (first worksheet page in Excel file)

- Three pages of graphs showing annual Salmon Creek streamflows, irrigation water sources (pumping and diversions), and reservoir storages.

- Detailed listings of 99-years of monthly or annual spreadsheet calculations; normally only the annual summary is printed (eight pages for the annual summary versus 112 pages for the detailed monthly listing).

SALMON CREEK, OKANOGAN RIVER, AND CLIMATE DATA

Historical Salmon Creek Watershed Runoff

Historical watershed runoff for Salmon Creek is defined as the amount of runoff entering Conconully and Salmon Lake reservoirs. These data were calculated from monthly historical reservoir operations data recorded by the Bureau of Reclamation. Since these data already include the effects of historical reservoir evaporation, the model did not have to modify the inflow data to factor in evaporation losses.

Historical Flow Data

Annual and monthly historical runoff for the Salmon Creek watershed is provided in Appendices B-3, and shown graphically in Figures 3.1-4 and 3.1-5. Total watershed runoff is quantified in terms of acre-feet in Figure 3.1-4. Over the 99-year record, calendar year annual runoff varied between 1,500 in 1931 and 67,000 in 1983, with a mean of 21,635 acre-feet/year. The line showing the five-year moving average indicates that watershed runoff follows a clear pattern of multi-year wet and dry period cycles. Since Conconully and Salmon Lake reservoirs can hold only 1.47 years of irrigation water, the OID water supply is very susceptible to runoff conditions during occasional, but dramatic, dry cycles. During wet cycles most of the excess runoff is spilled.

Historical Reservoir Data

Appendix B-2 contains Conconully and Salmon Lake reservoir storage, inflow and outflow data. Plots of historical reservoir inflow and outflow, and storage utilization are shown in Figures 3.1-11 and 3.1-12 for the period 1947-1996 (these data are not available for years prior to 1947). The storage utilization plots show how much of the reservoir is used during each year: for catching the spring runoff for release during the April-October irrigation season. A large part of the storage in the reservoirs is used just to store the water needed during the current year; only that portion of storage remaining after the end of the irrigation season is available for carry-over to the next year. The minimum storage during the 1947-1998 period occurred in 1966; it was particularly depressed that year due to two consecutive dry years and because Conconully was completely drained in 1965 for outlet maintenance.

Figures 3.1-11 and 3.1-12 show the utilization of active storage in Conconully and Salmon Lake Reservoirs. Storage utilization is the water used during the year for capturing spring runoff for subsequent release for irrigation. This graph shows that Conconully Reservoir is drawn down much more frequently and with greater magnitude than Salmon Lake reservoir. In fact, in many years the storage in Salmon Lake reservoir is not utilized at all. This is because the feeder canal places a restriction on how quickly the reservoir can be filled. Thus, OID usually relies more on Conconully reservoir for irrigation release, and less upon Salmon Lake reservoir.

Salmon Creek Flow Exceedance

A flow exceedance shows, on a monthly basis, the percentage of years that streamflows historically have occurred at different flow magnitudes. The median flow is the same as the 50 percent exceedance, a one-in-ten year low flow is the same as the 90 percent exceedance (i.e., exceeded 90 percent of the time, or nine years out of ten), and the one-in-ten year high flow is the same as the 10 percent exceedance (i.e., exceeded only 10 percent of the time, or one year in ten).

Flow exceedences for Salmon Creek watershed runoff at Conconully Dam are shown in Figure 3.1-5. The data used to produce this graph are tabulated in Appendix B-3, and have been adjusted for historical evaporation loss (equal to about 1,600 acre-feet per year) to make the low-flow estimates more accurate. During the one-in-ten dry year, the natural flow of Salmon Creek falls to a minimum of about 2 cfs in September; during median flow years it is about 8 cfs. No data were available to estimate the magnitude of historic natural flows in lower Salmon Creek, which may be affected by seepage loss and/or gains from springs.

Streamflows in Salmon Creek below Conconully Dam are dramatically affected by two factors: the impoundment of spring runoff and the irrigation release schedule later in the spring and summer. As shown in Figure 3.1-5, stream flows in the middle reach occur almost exclusively during the months of April through September, the irrigation release period. During the remainder of the year, flow in the stream is limited to that seeping from the dam and local inflow entering the stream below the dam. Seepage from the dam is on the order of 100 acre-feet per month (based on data from a USBR Water Supply Report), or about 1.6 cfs. Available information is not reliable to estimate the magnitude of local inflow to the middle reach during the winter.

In the lower reach of Salmon Creek (see Figure 3.1-6), streamflow is limited to the occasional reservoir spill (occurring less than 50 percent of the time during the months of April, May, and June). The stream is essentially dry the remaining months, except possibly during wet years and occasional rainfall runoff events. Prior to 1996, no data are available on timing or magnitude of lower Salmon Creek flows; however, in that year a weir was installed on the OID main canal to allow measurement of flows passing the diversion.

Calculation of Watershed Runoff

OID personnel collect data on reservoir elevations and discharges daily; after conversion to monthly data, they are transmitted to the Bureau of Reclamation for documentation and archiving purposes. With the exception of the past several years, OID has not retained past records of reservoir operations in their offices.

Watershed runoff is calculated using the following equation:

Monthly watershed runoff = Conconully outflow + gain in total reservoir storage during month.

This equation provides a good estimate of total runoff over consecutive months, but for individual months it may not be precise because reservoir storage data are based on lake elevation readings, which do not give precise readings of total storage. For example, a 0.1-foot measurement error in the Conconully Reservoir elevation reading corresponds to a 50 acre-feet error in storage. Thus, a measurement that is not carefully read, or is affected by wave run-up due to wind, can be off by several hundred acre-feet. During low- flow months this can result in negative inflow readings. Evaporation and seepage loss can also add to a negative estimate of reservoir inflow if no storage is released. However, lack of precision for low flows is not an issue because the data are used for multi-year reservoir simulation, and precision errors cancel each other out during a relatively short period.

Other possible sources of error in the Salmon Creek watershed runoff data include measurement error in the weir below the dam (particularly when water flows over the spillway, resulting in poor flow estimates), calculation errors in converting daily data to monthly data, and data transcription errors when the Bureau of Reclamation entered data into their computer system. Original dam records were not available for data checking to verify records of historical data.

Historical Okanogan River Streamflows

Historical streamflow data for the Okanogan River were obtained from USGS gauging records. Records are available for the Malott gauge (located a short distance downstream of the City of Okanogan) for the period of 1958-2002. Prior to that, flow data from the Tonasket gauge (located a considerable distance upstream of Okanogan) for the period 1911-2002 were used. By comparing the overlapping periods of Malott and Tonasket gauging, it was found that Malott flows are approximately 4 percent higher than Tonasket flows. Thus, Tonasket gauging records for the period 1911-1957 were multiplied by 1.04 to represent the flows at Malott prior to 1958.

Historical Flow Data

Annual historical runoff for the Okanogan River watershed is shown in Figure 3.1-2. Appendix B-1 contains the monthly historical flow record for the Okanogan River. The average annual runoff in the Okanogan River is 2,193,000 acre-feet (water year), and has varied historically between a minimum of 860,000 acre-feet in 1931 to a maximum of 4,600,000 acre-feet in 1972.

When compared to annual Salmon Creek watershed runoff (Figure 3.1-4), the Okanogan River exhibits much less variation between the wet and dry cycles. The flow in the Okanogan River drops sharply only during extended dry periods such as the 1930s drought. The minimum annual flow occurred in 1931, when it fell to 39 percent of average. By comparison, Salmon Creek runoff in 1931 fell to just 7 percent of average.

Climate Data

As noted above, climatic data are used in the water supply model to estimate annual irrigation demand, streamflow in the middle reach of Salmon Creek, and annual Johnson Creek irrigation diversions. Climate data was reported in the Dames & Moore (1999) Phase I report; Appendix Tables 3B-12, 3B-13 and 3B-14 contain historical Omak monthly temperatures (1910-1998), Omak monthly precipitation (1904-1980), and Conconully monthly precipitation (1975-1998), respectively. Updated data through 2002 were available from the National Climate Data Center.

HISTORICAL OID WATER USE

Historic Operations Data

Drawing upon available district records, OID compiled historical water supply and use data for the period from 1987 to 2002. Because this information had not been previously compiled prior to the Phase I study, a considerable effort was expended to locate and tabulate the data, verify its accuracy, and correct any errors.

OID records prior to 1987 were not compiled because they represent the irrigation system prior to extensive rehabilitation work that occurred in the mid 1980s. In 1977 only 18 percent of the OID's delivery system was piped and pressurized. During the rehabilitation the remainder of OID was converted to a pressurized system, the main canal was relined with reinforced concrete (except for a small portion passing through competent rock), and the Okanogan River pumping stations were either abandoned (Robinson Flats) or rebuilt (Shellrock). This resulted in a much more efficient delivery system. Therefore, irrigation diversion records prior the mid-1980s are not representative of current water use.

The 1987-2002 operation data provided by OID included:

- Conconully and Salmon Lake reservoir inflow, change in storage and outflows.
- Salmon Creek irrigation diversion and flow below the diversion.
- Duck Lake canal spill, Johnson Creek diversion, Duck Lake pumping quantities and Duck Lake end-of-month elevations.
- Shellrock Pumping quantities.
- Total system supply, delivery and efficiency calculations.

A few data gaps appear within this tabulation (as shown by blank entries), mostly in the Salmon Creek streamflow measurement below the OID diversion. Prior to 1996, OID did not have the capability of accurately measuring flows in Salmon Creek below the diversion dam. Because all flow in Salmon Creek was diverted to the canal, there was no flow in lower Salmon Creek except during periods of reservoir spill. In addition, no water was released from Conconully

Dam during the irrigation off-season, and OID often diverted Salmon Creek into the canal to recharge Duck Lake. Thus, little information is available for historical flows in lower Salmon Creek.

During the Phase I study, inspection of the data revealed inconsistencies between the measurements of outflow at Conconully Dam and the OID Salmon Creek diversion. During the irrigation season the two measurements should be similar (except when reservoir spill occurs), with the difference attributed to local inflow or channel loss between the dam and diversion. However, the historical data showed frequent unexplained differences in the two measurements, more than what local inflow or loss could contribute. The most likely source of error was assumed to be the measurement of outflow from Conconully Dam. Prior to 1997, flows were periodically measured at a 20-foot rectangular weir a few hundred feet downstream of Conconully Dam. That weir measured seepage from the dam as well as spill. However, in 1997 an aluminum ramp flume was installed in the dam outlet tunnel. That device does not measure Dam seepage and spill, and there is concern that it has not been accurately calibrated. In all years, estimation of spill rates is very approximate.

Additional confidence in recorded Conconully Dam outflow and OID diversion rates can be obtained only through a detailed review of daily flow measurements at the dam and an evaluation of the measurement weirs. This would require a large effort to process the data, and OID records are probably limited to only recent years.

Supply of Water to OID

OID obtains its water supply from Salmon Creek via the OID canal, Duck Lake, and the Okanogan River via the Shellrock pumping station. Duck Lake is supplied by the Johnson Creek diversion, OID canal spill and local runoff. Thus, OID water supply is defined as:

OID Water Supply = Salmon Creek diversion + Duck Lake + Okanogan River (Shellrock) pumping

Total annual water supply from these sources during the period 1987-2002 is summarized in C-4. From 1987 to 2002 Salmon Creek provided 84 percent of the total water supply of OID. However, the amount of water diverted varied by a wide range: from 10,665 acre-feet in 2002 to 20,834 acre-feet in 1998. Years with lower diversions usually have high pumping rates at Shellrock (e.g., 1992), but there are exceptions (e.g., 1993).

Table C-4. . Annual Quantities of OID Water Supply, 1987-2002 (acre-feet/year)

Year	*Salmon Creek*	*Duck Lake*	*Okanogan River*	*Total Water Supply*
1987	12,555	2,065	4,679	19,299
1988	11,441	2,141	4,499	18,081
1989	13,916	1,352	1,961	17,229
1990	15,942	1,083	0	17,025
1991	17,590	1,295	0	18,885
1992	10,882	916	4,526	16,324
1993	11,337	1,016	349	12,702
1994	14,032	1,161	981	16,174
1995	13,545	395	0	13,940
1996	18,302	309	0	18,611
1997	16,345	425	0	16,770
1998	20,834	697	0	21,531
1999	19,936	1,355	0	21,291
2000	18,262	995	0	19,257
2001	12,603	667	4,823	18,093
2002	10,655	1,738	5,910	18,303
Average	14,886	1,101	1,733	17,720
Percent	84.0%	6.2%	9.8%	100%
Minimum	10,655	309	0	12,702
Maximum	20,834	2,141	5,910	21,531

The amount of water diverted from Salmon Creek depends on two primary factors: the runoff volume in Salmon Creek and OID's overall water demand, which in turn primarily depends upon climatic conditions. The largest diversions occur during high runoff conditions combined with a hot summer, as occurred in 1998. Conversely, the lowest diversions occur when a lower runoff year combines with a cool summer, as occurred in 1992.

Duck Lake provided 6.2 percent and the Okanogan River provided 9.8 percent of the total water supply to OID from 1987 to 2002. Duck Lake pumping quantities do not vary significantly due to the water rights limitations placed on the Johnson Creek diversion and the limited ability of the lake to store water. Shellrock pumping, on the other hand, varies widely and supplements Salmon Creek and Duck Lake during years of below average runoff. At a current operating capacity of 25 cfs, Shellrock pumping station can potentially pump up to 8,700 acre-feet during the irrigation season. Since the maximum annual quantity of pumping during 1987-1998 was only 5,910 acre-feet, the total supply capability of Shellrock has been only partially used.

Total Irrigation Water Delivery

Total irrigation water delivery is the quantity of water delivered to the farmers via OID's distribution system. Due to the presence of Duck Lake, the quantity of irrigation water delivered is different from the quantity of irrigation water supplied. *Water supply* is the amount of water obtained from OID's water sources. *Water delivery* is the amount actually delivered to irrigation. *District efficiency* (the efficiency of the overall water delivery system) is defined by the ratio of water delivery to water supply. *On-farm efficiency* is defined by the ratio of crop requirements to water delivery.

Total irrigation delivery is defined as:

Total Irrigation Delivery = Salmon Creek diversion – canal spill to Duck Lake + Duck Lake pumping + Okanogan River (Shellrock) pumping.

<u>Historical OID Water Delivery</u>

Total annual quantities of annual irrigation water delivery during the period 1987-2002 are summarized in Table C-5. The average annual delivery of water to farmers from 1987 to 2002 was 15,518 acre-feet/year. This compares to the average OID water supply of 17,720 acre-feet (Table C-4). Thus, the overall efficiency of the water supply system is about 87.6 percent. The difference between water supply and water delivery, about 2,200 acre-feet/year, is equal to the amount of seepage loss from Duck Lake (see section below describing Duck lake water balance). A very small amount, about 60 acre-feet/year, also is lost through seepage from the main canal.

In many years the OID canal supplies over 90 percent of the water to farmers, with Duck Lake providing the remainder. Cutback of Salmon Creek diversions to as low as 60 percent of total irrigation demand occurs during dry years, with most of the remainder supplemented by Shellrock pumping. Duck Lake pumping is normally relatively constant due to its 10 cfs pump capacity. However, in the past few years the capacity has been limited to 6.6 cfs due to pump mechanical problems.

Table C-5. . Annual Quantities of OID Irrigation Delivery, 1987-2002 (acre-feet/year)

Year	*Salmon Creek*	*Less Canal Spill*	*Duck Lake Pumping*	*Shellrock Pumping*	*Total Irrigation Delivery*
1987	12,555	-1,977	2,065	4,679	17,322
1988	11,441	-2,372	2,141	4,499	15,709
1989	13,916	-1,886	1,352	1,961	15,343
1990	15,942	-2,883	1,083	0	14,142
1991	17,590	-2,536	1,295	0	16,349
1992	10,882	-1,883	916	4,526	14,441
1993	11,337	-1,801	1,016	349	10,901
1994	14,032	-2,410	1,161	981	13,764
1995	13,545	-2,253	395	0	11,687
1996	18,302	-2,235	309	0	16,376
1997	16,345	-2,336	425	0	14,434
1998	20,834	-2,908	697	0	18,623
1999	19,936	-2,919	1,355	0	18,372
2000	18,262	-1,797	995	0	17,460
2001	12,603	-1,578	667	4,823	16,515
2002	10,655	-1,447	1,738	5,910	16,856
Average	14,886	-2,201	1,101	1,733	15,518
Minimum	10,655	-1,447	309	0	10,901
Maximum	20,834	-2,919	2,141	5,910	18,623

Duck Lake is an important component of OID's water supply system because it allows for reuse of spill from the main canal, and it stores early spring runoff from Johnson Creek for use later in the irrigation season. If Duck Lake were not present, the water supply provided by Johnson Creek would be largely unavailable and canal spill could not be reused.

Correlation of Irrigation Delivery to Climate Conditions

Irrigation demand in OID is highly variable. As shown in Table C-5, recent annual irrigation deliveries ranged from a minimum of 10,901 acre-feet in 2002 to a maximum of 18,623 acre-feet in 1998. Many factors can contribute to the variability of irrigation demand; for the OID important variables include temperatures during the irrigation season, rainfall prior to and during the irrigation season, frost protection, cooling, and farmer's estimates on how much crop watering is needed during different climate conditions. Not all of these factors can be quantified.

For the purposes of the water supply model, irrigation demand was assumed to vary according to irrigation season temperatures. After looking at various ways to quantify the mean summer temperature using Omak data, it was found for the Phase I modeling efforts that weighting factors of 0.5, 1.0 and 1.0, respectively, for June, July and August temperatures produced the best correlation of irrigation delivery to temperature. These estimates have not been modified for the EIS. Rainfall was also evaluated, but by itself did not correlate well to irrigation demand. However, rainfall is usually inversely correlated to temperature (e.g., low rainfall is associated with warmer temperatures, and vice versa), and thus the irrigation demand-temperature correlation does incorporate rainfall indirectly.

Duck Lake Water Balance

A separate Duck Lake water balance model for the period 1987-1998 was conducted during the Phase I study and then elements of this model were incorporated within the Phase 1 water supply model. This was done to account for the seepage losses from the lake, the limitations on minimum and maximum elevations imposed by Ecology Order DE 85-20, and to include OID's groundwater sales. For EIS analysis, the water balance in Duck Lake is defined by the sum of inflows from spill in the OID canal and Johnson Creek, less seepage loss and Duck Lake pumping by OID.

Estimated average, minimum and maximum annual Duck Lake water budget quantities for the 1987-1998 period are summarized in Table C-6. Also shown are updated (through 2002) quantities for canal spill, Johnson Creek inflow and Duck Lake pumping. Estimated quantities of seepage have not been updated because the Duck Lake water balance model was not updated and re-run.

Based on the 1987-1998 data set, total loss of Duck Lake water to seepage ranged between 1,300 and 3,700 acre-feet per year, with an average of about 2,600 acre-feet/year. The water balance analysis showed that seepage loss from Duck Lake is highly dependent on elevation. For example, even though total water supply to Duck Lake increased steadily between 1987 and 1998 and pumping decreased by a significant amount, the average elevation of Duck Lake increased by only about eight feet.

During the 1995-1998 period, high inflows and very low pumping rates resulted in much greater seepage losses than in the late 1980's, when inflows were lower and pumping was higher. The Duck Lake water balance model determined that, to match the observed data, seepage losses are on the order of 80 acre-feet/month at minimum lake elevations, but they increase to nearly 400 acre-feet/month at elevation 1,242 feet, which was common in 1998.

The elevation-storage curve is used to "buffer" the effects of monthly inflows and outflows, and determines the magnitude of fluctuation between maximum and minimum elevations in any given year. The water balance analysis estimated that Duck Lake and the connected shallow aquifer have a total usable storage of roughly 1,000 acre-feet in the lower 10 feet of the lake (between 1,227 and 1,237 feet), and up to roughly another 2,000 acre-feet in the upper 10 feet of the lake (up to 1,247 feet). These estimates are based on a simplified model and are very approximate.

Table C-6. Duck Lake Water Budget, 1987-1998 (acre-feet/year)

	Inflow		*Outflow*	
Year	Actual Canal Spill	Actual Johnson Creek	Estimated Seepage	Actual Pumping
Average	2290 (2,201)	1,483 (1,482)	2,626	1,071 (1,101)
Minimum	1,801 (1,447)	1,009 (861)	1,328	309 (309)
Maximum	2,908 (2,919)	2,156 (2,312)	3,675	2,141 (2,141)

Note: 1987-2002 quantities are in parentheses; the Duck Lake water balance model was not re-done, so updated seepage values are not available

Historical Operation of Duck Lake

Historical operations data for the period 1987-2002 were used to develop the parameters for the Duck Lake water budget contained in the water supply model. During 1987-2002 the magnitude of inflows to Duck Lake were substantially greater than outflows; the difference is the amount lost to seepage (and evaporation to a lesser degree). Total inflow averaged 3,684 acre-feet/year, whereas total pumping to OID at the Duck Lake pump station averaged only 1,101 acre-feet per year. Thus over the 16-year period, on average only 30 percent of the water entering Duck Lake has been used by OID for irrigation.

OID diverted large amounts of excess water to Duck Lake in the late 1990s during the high runoff conditions in Salmon Creek. In addition, Duck Lake pumping was cut back due to pump problems. Between 1995 and 1998, only 7% to 17% of the total inflow to Duck Lake was pumped by the OID. Because of the high volume of inflow and low pumping rates, the lake elevation rose above 1240 feet. As a consequence of the higher water elevations and high hydraulic heads that were established, seepage losses increased dramatically above an elevation of about 1232 feet. Thus, most of the added inflow during this time was lost to seepage and surcharging of the Duck Lake Groundwater Basin.

Water Balance Analysis

For Phase I study, the water balance in Duck Lake was governed by the following equation:

Duck Lake storage = Canal inflow + Johnson Creek inflow – seepage loss – Duck Lake pumping

Of the parameters in the above equation, all were known except the magnitude of seepage loss and the elevation-storage relationship for Duck Lake, which affected the calculation of monthly storage change. These parameters were estimated by creating a water balance model on a spreadsheet. An iterative process, involving varying the parameters in the loss rate equation and elevation-storage curve to match actual Duck Lake elevations, was used to calibrate the water balance. The equations for seepage loss and storage were assumed to follow an exponential curve function.

Table C-7 summarizes the resulting change in storage predicted by the model . The results reported in the Dames & Moore (1999) Phase 1 study showed a good match of modeled versus historical lake elevations for 1987-1998 data set using the assumed seepage loss rates and storage curve. However, the match was poorer in the early to mid-1990's, possibly due to poor data and/or unusual climate conditions.

Table C-7. . Duck Lake Water Budget, 1987-1998 (acre-feet/year)

	Inflow		*Outflow*		
Year	Actual Canal Spill	Actual Johnson Creek	Actual Pumping	Estimated Seepage Loss	Estimated Change in Storage
1987	1,977	1,372	2,065	1,328	-44
1988	2,372	1,322	2,141	1,448	+104
1989	1,886	1,281	1,352	1,560	+255
1990	2,883	1,396	1,083	2,660	+536
1991	2,536	1,009	1,295	2,471	-2221
1992	1,883	1,514	916	2,404	+77
1993	1,801	1,850	1,016	2,388	+247
1994	2,401	1,529	1,161	3,282	-504
1995	2,253	1,823	395	3,426	+255
1996	2,235	2,156	309	3,423	+658
1997	2,336	1,335	425	3,451	-204
1998	2,908	1,208	697	3,675	-256
Average	2,290	1,483	1,071	2,626	—
Minimum	1,801	1,009	309	1,328	—
Maximum	2,908	2,156	2,141	3,675	—

ANALYSIS OF EIS ALTERNATIVES

General Modeling Procedures

The four action alternatives were modeled following a rule that maintained the current firm yield for irrigation demand and allocated all additional water to instream flow. Each alternative water supply source was added to the model, and instream flow release rates for the middle and lower reaches of Salmon Creek were specified. If a new water supply source provided more than 100 percent of the instream flow need, the model showed that total water supply for irrigation and instream flow exceeded the demand, and a surplus of reservoir storage remained during the 1930s drought period. However, if demand exceeded supply, reservoir storage became exhausted in 1931 as indicated by negative storage in the model. To achieve a balance of supply and demand, the instream flow release was adjusted downward (using a factor between 0 percent and 100 percent) so that the total reservoir storage reached zero in 1931, in accordance with the definition of firm water supply described above.

If instream flow requirements are reduced during drought periods and/or irrigation curtailments are imposed, the operation of the water supply system will be less constrained by the need to maintain firm supply during the critical period, and greater volumes of water could be provided for instream flows during average and wet years. However, this water management strategy was not explored.

Modeling of the Alternatives

Appendix D provides a summary of essential model input and output data for the four action alternatives and the three flow scenarios (i.e., a total of 10 separate model runs). Appendix D contains printouts of model output for the four alternatives, documenting model parameters and simulation results. For simplicity and model control, certain operational conditions regarding Duck Lake were kept constant for all the model runs. These included:

- the Duck Lake Pumping capacity was kept constant at 10 cfs;
- the minimum Duck Lake elevation of 1226.75 ft had to be achieved before any pumping could occur;
- pumping from Duck Lake automatically occurred when the Duck Lake elevation exceeded 1232.0 ft; this is considerably less than the maximum permissible water elevation of 1247 ft, but by setting the maximum relatively low, less water was lost to seepage and greater operational efficiency was achieved;
- 500 acre-feet/year would be sold from Duck Lake artificially stored groundwater (i.e., the Duck Lake groundwater bank) to domestic, commercial and/or industrial users.

Most of the other pumping rules for Duck lake, Shellrock or the new 80 cfs pump varied to some extent depending on the water demands specified for each alternative and flow scenario. The only constant pumping rule was that there was not any cutback of pumping when the WAC instream flow requirements were not met. This assumption is supported by recognizing that even though WAC instream flow requirements are met only about 75% of the time, the relative proportion of pumped volumes to Okanogan river flow is usually very low. Further, except for the No Action Alternative, the Feeder Canal capacity was assumed to be a constant 90 cfs for all runs.

Modeling procedures and results for the water supply alternatives are described below. For each viable alternative, the water supply model was used to estimate how much water could be obtained on a firm annual basis to supply each of the three instream-flow scenarios. The process used to determine the firm yield of each alternative was described above. Discussion of the modeling conducted for each alternative is provided below. Appendix D contains printouts of model output for the modeled alternatives, documenting model parameters and simulation results.

No Action Alternative

To evaluate the EIS alternatives, the water supply conditions for the No Action Alternative had to be defined. This condition defined the baseline, from which the alternatives were compared. Under the No Action Alternative, it was determined that OID's existing water supply sources were adequate to provide a firm supply of water to the irrigation system under all years of the 1904-2002 simulation period, assuming maximum pumping rates (25 cfs for 175 days or 7,856 ac-ft/year) of Shellrock are utilized throughout the irrigation season. These results were an improvement over the Phase I results, which predicted that under the same scenario (i.e., 25 cfs pump rate at Shellrock), a shortage would occur during the early 1930's drought period, equal to a capacity of about 24 cfs, with a peak volume deficit of 6,250 ac-ft in 1931. This deficit was assumed to begin affecting irrigation supply when the total reservoir storage fell below 3,000 ac-ft. Under the current model version several changes have been made, so the different results are likely attributed to a combination of:

- varying the monthly distribution of canal spill based on current OID practices rather than assuming a constant throughout the year; this yielded greater overall annual efficiency in the demand and distribution of simulated monthly water quantities;
- a minor reduction of the annual OID crop water requirements to reflect the predicted needs over the next 5 years rather than the crop water requirements that have occurred over the last 16 years;
- following the Duck Lake pumping rules strategy as outlined above;
- increasing the critical storage level to 9,500 ac-ft (rather than 3,000 ac-ft) at which maximum pumping from Shellrock occurred; and
- reconfiguring the maximum monthly pumping load factors for Duck Lake and Shellrock to allow maximum pumping at any time.

These adjustments were made in an attempt to maximize the current OID practices and would reflect potential management strategies designed to conserve water for a critical drought period. The exercise also demonstrates that although the current water system model does not exactly reflect OID operations, further refinements and improvements to the model are possible.

For the No Action Alternative, the water system model predicts a firm yield of 448 ac-ft of flow over the Salmon Creek weir and 354 ac-ft at the mouth of Salmon Creek (Appendix D-1). Average annual flow over the weir is estimated at 10,501 ac-ft/yr. The predicted average combined storage for the 99-year period was 19,178 ac-ft/yr, with a minimum annual storage volume (occurring in 1931) 1,748 ac-ft. Predicted average annual total OID demand from the water supply system is 15,745 ac-ft/yr, with an overall district efficiency of 70%. Under this alternative, Salmon Creek supplies about 78% (12,229 ac-ft/yr), Shellrock 15% (2,414 ac-ft/yr) and Duck Lake 7% (1,101 ac-ft/yr) of the total supply. Predicted average annual efficiencies for on-farm and delivery are 77% and 91% (compared to 76% and 86% for the Phase I study), respectively.

Action Alternative 1 Okanogan River Pump Water Exchange

This alternative involves constructing a new 80 cfs pump station on the Okanogan River to supply water to the OID irrigation canal. This would allow OID to reduce Salmon Creek diversions for irrigation water, leaving more water for instream flow needs. The only change to model assumptions from the No Action Alternative involved the abandonment of all pump capacity from Shellrock, and the installation of a greater capacity pump farther downstream. All other pumping rules for Duck Lake were the same, and it was assumed (by the model structure) that water would be pumped from the new 80 cfs pump station first before taking water from the Salmon Creek diversion combined storage.

The model assumed that pumping would provide water directly to the OID main canal (just downstream of lateral #1). Pumping would occur at maximum pump capacity or the irrigation demand, which ever was lower, except during periods of reservoir spill. During spill, pumping would be cut back and Salmon Creek diversions would increase (subject to instream flow requirements). During low-runoff years, the model supplements the irrigation supply with Duck Lake pumping. Irrigation demand not supplied by pumping would be obtained from Salmon Creek.

The total amounts of water supplied for the three flow scenarios under the new 80 cfs Okanogan River pumping alternative are summarized in Appendix D-1. The water system model predicts firm yields ranging from 4,027 to 5,081 ac-ft for the three flow scenarios, and 5,100 to 6,435 ac-ft of flow over the Salmon Creek. Average annual flow over the weir is much higher than the No Action Alternative and ranged from 16,990 to 17,342 ac-ft/yr. This is a reflection of maintaining higher overall storage volumes in Conconully and Salmon Lake reservoirs. For the three scenarios under this alternative the average combined storage for the 99-year period ranged from 21,640 to 22,840 ac-ft/yr (compared to 19,178 ac-ft for the No Action), with minimum annual storage volumes ranging from 2,223 to 13,568 ac-ft (compared to 1,748 ac-ft for the No Action).

Predicted average annual total OID demand from the water supply system is 16,155 ac-ft/yr (slightly higher – about 2.6% - than the No Action Alternative due to lower efficiencies), with an overall district efficiency of 68%. Under this alternative, Salmon Creek supplies about 33-35%, the new pump station 56-59% and Duck Lake 8-9% of the total supply. Predicted average annual efficiencies for on-farm and delivery are 77% and 89%, respectively.

Action Alternative 2 Upgrade Shellrock Pumping Plant

This alternative involves upgrading Shellrock to take the full 35 cfs allowed under OID's water rights. The additional 10 cfs of pump capacity would allow OID at certain times to reduce the demand on Salmon Creek for irrigation water, leaving more water for instream flow needs.

Only a few of other modeling rules that were applied for the No Action Alternative were changed. It was assumed that Duck Lake could pump at a maximum capacity at any time during the irrigation season. All other pumping rules for Duck Lake were the same, and it was assumed (by the model structure) that water would be pumped from Shellrock first before taking water from the Salmon Creek diversion combined storage. Further, maximum pumpage from Shellrock was invoked when combined storage went below 15,000 ac-ft (as opposed to 9,500 ac-ft for the No Action). Further, pumping would occur at maximum pump capacity or the irrigation demand, which ever was lower, even during periods of reservoir spill. This allowed more water to be saved in reservoir storage to cover the critical drought period. During low-runoff years, the model supplements the irrigation supply with Duck Lake pumping. Ultimately, irrigation demand not supplied by pumping would be obtained from Salmon Creek.

The total amounts of water supplied for the three flow scenarios under the Shellrock Upgrade Alternative are summarized in Appendix D-1. The model predicts no shortages for the two Steelhead flow scenarios, but that under the flow scenario for Steelhead and Chinook, a small shortage would occur when conditions are similar to the early 1930's drought period. The shortage is modeled to persist for four years, with a peak critical storage deficit of 1,678 acre-feet per year in the second year of the drought sequence. This deficit occurred even though pumping from Duck Lake and Shellrock was maximized when critical storage volumes in Conconully and Salmon Lake reservoirs fell below 15,000 ac-ft. Thus, the model suggests that the significantly greater instream flow demands for maintaining Chinook species will impact the OID water system when drought conditions are similar to those experienced in the late 1920's and early 1930's.

After adjusting for the critical storage deficit, the water system model predicts firm yields ranging from 4,027 to 5067 ac-ft for the three flow scenarios, and 5,100 to 6,417 ac-ft of flow over the Salmon Creek weir. Average annual flow over the weir is much higher than the No Action Alternative and ranges from 15,636 to 16,706 ac-ft/yr. This is a reflection of the instream flow needs and maintaining higher overall storage volumes in Conconully and Salmon Lake reservoirs. For the three scenarios under this alternative the average combined storage for the 99-year period ranged from 21,153 to 21,594 ac-ft/yr (compared to 19,178 ac-ft for the No Action), with minimum annual storage volumes ranging from 180 to 346 ac-ft (compared to 1,748 ac-ft for the No Action).

Predicted average annual total OID demand from the water supply system ranged from 14,425-15,225 ac-ft/yr (about 3.4-8.4% lower than the No Action Alternative due to higher efficiencies), with an overall district efficiency of 72-76%. Under this alternative, Salmon Creek supplies about 41-46%, Shellrock 47-52% and Duck Lake 7% of the total supply. Predicted average annual efficiencies for on-farm and delivery are 78-82% and 93%, respectively.

Action Alternative 3 Okanogan Irrigation District Water Right Purchase

This alternative involves the purchase of 5,100 ac-ft/yr of water rights from the OID. The effect of this alternative is to reduce OID demands on Salmon Creek water, and make it available for the specified instream flow demands for Steelhead or Steelhead and Chinook.

To achieve the intent of this alternative, OID irrigation demands had to be reduced by some amount to reflect the loss of 5,100 ac-ft/yr. This essentially meant retiring acreage and reducing the overall OID on-farm crop water requirements by the four following steps:

1) **Determine crop water demand per acre**. A revised total crop water demand for the OID 5,032 acres was estimated based on projected crop type per acre for the next five years (the average demand worked out to be 2.19 ac-ft/acre - at an average OID system efficiency 67%, the total demand works out to be 3.27 ac-ft/acre).

2) **Determine total crop water demands.** Based on these numbers, the average, minimum and maximum crop water demands were calculated to be 11,025, 10701, and 11,350 ac-ft, respectively (which is a little less than what OID currently claims).

3) **Determine total on-farm water demands**. Assuming minimum and maximum on-farm efficiencies of 66% and 85%, respectively, yields minimum and maximum total on-farm water demands (i.e., what is delivered to farms - canal spill in Duck Lake is additional) of 12,590 and 17,196 ac-ft, respectively (these values yield a slightly smaller range than what OID has done historically since 1987).

4) **Reduce on-farm water demands by reducing acreage**. The objective was to retire enough acreage to achieve on average (over the 99-year period) approximately 5,100 ac-ft/yr less water demand from system. The total acreage was reduced by iteratively multiplying the existing acreage by a fraction (i.e., 0.68 or 3422 acres) within the model to achieve a long-term average of approximately 5,100 ac-ft. At an average system efficiency of approximately 67% this means that the total reduction of 1,610 acres (or 5,032 – 3,422 acres) on average would be about 3,422/0.67 = 5,107 ac-ft.

The above scenario yielded minimum and maximum crop water demands of 7,277 and 7,718 ac-ft/yr, respectively, which are 3,424 and 3,632 ac-ft/yr, respectively, lower than the No Action Alternative crop water demands. At 66% and 85% efficiencies the minimum and maximum on-farm water demands worked out to be 8,561 and 11,694 ac-ft/yr. Subtracting from the minimum and maximums in (3) yielded differences of 4029 and 5502 AF, respectively.

All other modeling rules applied for the No Action Alternative were assumed except for the allowing Duck Lake to pump at maximum capacity at any time during the irrigation season. All other pumping rules for Duck Lake were the same, and it was assumed (by the model structure) that water would be pumped from Shellrock first before taking water from the Salmon Creek diversion combined storage. Further, maximum pumpage from Shellrock was invoked when combined storage went below 15,000 ac-ft (as opposed to 9,500 ac-ft for the No Action). Further, pumping would occur at maximum pump capacity or the irrigation demand, which ever was lower, even during periods of reservoir spill. This allowed more water to be saved in reservoir storage to cover the critical drought period. During low-runoff years, the model supplements the irrigation supply with Duck Lake pumping. Ultimately, irrigation demand not supplied by pumping would be obtained from Salmon Creek.

The total amounts of water supplied for the three flow scenarios under the Water Rights Purchase Alternative are summarized in Appendix D-1. The model predicts no shortages for the two Steelhead flow scenarios, but that under the flow scenario for Steelhead and Chinook, a small shortage would occur when conditions are similar to the early 1930's drought period. The shortage is modeled to persist for two years, with a peak critical storage deficit of 674 acre-feet per year in the first year of the drought sequence. This deficit occurred even though pumping from Duck Lake and Shellrock was maximized when critical storage volumes in Conconully and Salmon Lake reservoirs fell below 15,000 ac-ft. Thus, the model suggests that the significantly greater instream flow demands for maintaining Chinook species will impact the OID water system when drought conditions are similar to those experienced in the late 1920's and early 1930's.

After adjusting for the critical storage deficit, the water system model predicts firm yields ranging from 4,027 to 5,973 ac-ft for the three flow scenarios, and 5,100 to 7,565 ac-ft of flow over the Salmon Creek weir. Average annual flow over the weir is much higher than the No Action Alternative and ranged from 17,202 to 18,606 ac-ft/yr. This is a reflection of the higher instream flow demands and maintaining higher overall storage volumes in Conconully and Salmon Lake reservoirs. For the three scenarios under this alternative the average combined storage for the 99-year period ranged from 21,226 to 22,004 ac-ft/yr (compared to 19,178 ac-ft for the No Action), with minimum annual storage volumes ranging from 426 to 2,911 ac-ft (compared to 1,748 ac-ft for the No Action).

Predicted average annual total OID demand from the water supply system ranged from 9,972 to 10,679 ac-ft/yr (or about 63-68% of the No Action Alternative due to primarily the retired acreage), with an overall district efficiency of 70-75%. Under this alternative, Salmon Creek supplies about 41-51%, Shellrock 54-51% and Duck Lake 5-8% of the total supply. Predicted average annual efficiencies for on-farm and delivery are 75-82% and 92-93%, respectively.

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Attachment Table C-1. Model Components and Operation Rules

Not Modified from 1999 Phase 1 Report (Dames and Moore)

Model Component	Variables	Definition	Operation Rules	Modifications for Irrigation or Instream Flow Yield
Inflow time series	Unregulated Salmon Creek	Total monthly runoff volumes for entire Salmon Creek watershed above Conconully Dam	Used to calculate watershed runoff into storage reservoirs	None
	Distribution factors for Salmon Creek tributaries	Percent of total watershed runoff in each tributary	46% for North Fork, 35% for West Fork, 16% for South Fork, and 3% for Salmon Lake tributary	None
	Middle reach gain or loss	Flow volumes entering Salmon Creek middle reach, either as gain (during wet years) or loss (during dry years)	Gain or loss is based on Omak March-July precipitation. Volumes are included in the irrigation demand calculation	None
	Omak mean summer temperature	Historical average yearly summer temperatures, based on following weighting: (0.5*June + 1.0*July + 1.0*Aug)/2.5	Used to determine OID irrigation demand and (optionally) pumping rates in Duck Lake and Shellrock	None
	Omak precipitation	Historical precipitation at Omak, for water year and March-July.	Used to determine middle reach gain or loss (March-July) and Johnson Creek diversion (water year).	None
	Historical Okanogan River flows	Historical monthly flow in Okanogan River, adjusted to reflect unregulated Salmon Creek discharge to the river	Used to evaluate impacts of pumping on river flows	None
Irrigation Demand	Maximum Irrigation Requirement	Required water supply to farms during warm years (75 deg. or higher)	Irrigation demand is based on crop irrigation requirement and pro-rated between max and min based on average Omak temperature.	Modify based on new crops, acres of irrigation, or OID Water Bank.
	Minimum Irrigation Requirement	Required water supply to farms during cool years (67 deg. or higher)		
	On farm efficiency	Crop irrigation requirement divided by water supplied to farms	Determined by recent irrigation practices. Currently ranges between 66% for warm years to 98% for cool years.	Change efficiency based on conservation or revised operation practices.
Duck Lake Groundwater Demand	Annual groundwater sale	Total annual quantity of groundwater pumped from Duck Lake system	Firm pumping rates during all years, unaffected by Duck Lake storage level. Annual distribution based on specified monthly percents. Assumed to equal 500 ac-ft/yr.	Increase to 1000 ac-ft/yr. See report for discussion of whether 1000 ac-ft/yr can be attained.

Attachment Table C-1. Model Components and Operation Rules

Not Modified from 1999 Phase 1 Report (Dames and Moore)

Model Component	Variables	Definition	Operation Rules	Modifications for Irrigation or Instream Flow Yield
Delivery System	Conveyance efficiency	Percent of canal flow loss to seepage	Set to constant 0.6%	Assume 0% under pressurized conveyance system
	Operation efficiency	Percent of canal flow spilled to Duck Lake	Set to constant 13.4%	Assume 0% under pressurized irrigation operations
Duck Lake Water Balance	Johnson Creek inflow	Monthly inflow from Johnson Creek diversion, based on historical rates correlated to annual Omak precipitation. Total annual quantity is distributed into monthly amounts based on specified percentages.	Water balance includes Johnson Creek inflow, seepage loss, groundwater pumping, and canal spill. Total rates and quantities for each are based on analysis of 1986-1998 Duck Lake inflow, outflow, and elevation.	Modify pumping rates and rules to improve Duck Lake yield or peak pump capacity (see below)
	Seepage Loss	Loss of Duck Lake storage to seepage and evaporation.		
Duck Lake Pumping	Pump capacity	Capacity of pump in cfs	Monthly pumping volumes are limited by installed capacity	None (fixed at 10 cfs by water right).
	Maximum Pump Rate	Pumping rate during warm years (75 deg. or higher)	Normal pump rates when Duck Lake is between minimum and maximum levels, and reservoir storage is above critical. Monthly pumping volumes are based on monthly pump load factors to match monthly irrigation demand.	Modify rates to increase yield, subject to other operational rules
	Minimum Pump Rate	Pumping rate during cool years (67 deg. or higher)		
	Maximum Duck Lake elevation	Maximum operating level of Duck Lake	Increase pumping rate to peak capacity to keep Duck Lake level below maximum	Reduce elevation to minimize seepage loss, at the expense of lower peak firm capacity.
	Minimum Duck Lake elevation	Minimum operating level of Duck Lake	Decrease pumping if elevation falls below minimum	None
	Critical reservoir storage for reserve Duck Lake pumping	Storage in combined system (Conconully, Salmon Lake, etc.) to trigger additional pumping	Pumping rate is increased to peak capacity to maximize yield, subject to minimum elevation rule.	Set critical storage higher to trigger more frequent maximum pumping

Attachment Table C-1. Model Components and Operation Rules
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Model Component	Variables	Definition	Operation Rules	Modifications for Irrigation or Instream Flow Yield
Shellrock Pumping	Pump capacity	Capacity of pump in cfs	Monthly pumping volumes are limited by installed capacity	Increase pump capacity
	Maximum Pump Rate	Pumping rate during warm years (75 deg. or higher)	Normal pump rates when reservoir storage level is above critical. Monthly pumping volumes are based on monthly pump load factors to match monthly irrigation demand. Pumping is reduced when reservoir spill occurs.	Modify rates to increase yield, subject to other operational rules
	Minimum Pump Rate	Pumping rate during cool years (67 deg. or higher)		
	No Shellrock Pumping during remainder of year if spill occurs	Flag for indicating pump operation during years of spill	If "Yes", pumping stops for remainder of year if spill occurs. If "No", pumping resumes in first month of no spill.	Set to "No" to maximize pumping during years when spill occurs.
	Critical reservoir storage for reserve Shellrock pumping	Storage in combined system (Conconully, Salmon Lake, etc.) to trigger additional pumping	Pumping rate is increased to peak capacity to maximize pumping yield.	Set critical storage higher to trigger more frequent maximum pumping
Emergency Supplemental Pumping	Pump capacity that can be installed under emergency authorization during extended drought period	Capacity of pump in cfs.	Pumping occurs when total storage falls below critical level. Capacity and critical storage level are based on amount needed to achieve firm water supply under current operation and irrigation demand.	None. No emergency pumping is assumed for OID operations.
	Critical reservoir storage for supplemental pumping	Storage in combined system (Conconully, Salmon Lake, etc.) to trigger additional pumping		
New Pumping Facilities	New Okanogan River Pumping (upstream or downstream of Salmon Creek)	Capacity of new pumping station, pumping water from Okanogan River to head of OID canal	Pumped water is supplied to canal at monthly quantities up to the maximum irrigation demand in the canal. Pumping occurs only during irrigation season. Location of pump station determines affects the flow in the Okanogan River.	Add new pumping to supplement or replace Shellrock, allowing reduced irrigation withdrawal from Salmon Creek.

Attachment Table C-1. Model Components and Operation Rules
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Model Component	Variables	Definition	Operation Rules	Modifications for Irrigation or Instream Flow Yield
New Pumping Facilities (cont'd)	Pumping from Salmon Creek to Brown Lake	Total capacity of pump diversion from Salmon Creek to new storage reservoir at Brown Lake	Monthly pumping rates are specified for all months of the year. Storage is released to OID canal based on specified monthly outflow rates. If total capacity is greater than monthly pumping rates, additional spill will be diverted up to installed capacity.	Add new storage for new dam, providing additional system storage capacity
	Pumping from Salmon Lake to Aquifer Storage and Recovery	Total capacity of pump diversion from Salmon Lake to new aquifer storage reservoir		
Other Water Supply	Watercress Springs water supply	Monthly flow volumes supplied to Salmon Creek from Watercress Springs	Flows are added to Salmon Creek in constant monthly amounts	New water supply sources to provide/supplement instream flows
	Other supply	Monthly flow volumes supplied from other sources to upper or lower segment of Salmon Creek		
Reservoir System	Conconully storage	Total active reservoir storage volume	Natural runoff of Salmon Creek is stored by reservoir. Runoff in excess of capacity is spilled.	None
	Salmon Lake storage	Total active reservoir storage volume		Increase storage of existing reservoir with raised dam, providing additional system storage capacity
	New West Fork storage	Total active reservoir storage volume		Add new storage for new dam, providing additional system storage capacity
	New Brown Lake or Aquifer storage	Total active reservoir storage volume (for either facility; it is assumed that both facilities will not be evaluated together)	Offline reservoir is supplied by new pump facility	Add new storage for new dam, providing additional system storage capacity
	Feeder canal capacity	Capacity of feeder canal from North Fork to Salmon Lake reservoir	Diversion from North Fork is limited to feeder canal capacity	Increase canal capacity to provide additional water to Salmon Lake
	Storage release factors	Percent of total system demand released from each reservoir	Monthly storage release from the reservoirs is proportioned based on these factors.	Modify to optimize storage release, such that all reservoirs are equally depleted to zero storage during critical year.

Attachment Table C-1. Model Components and Operation Rules

Not Modified from 1999 Phase 1 Report (Dames and Moore)

Model Component	Variables	Definition	Operation Rules	Modifications for Irrigation or Instream Flow Yield
Instream Flow Demand	Salmon Creek lower reach, upper segment loss Salmon Creek lower reach, lower segment loss	Loss of stream flow to channel seepage	Loss is expressed as constant percent of total stream flow.	None
	Instream flow demand	Monthly flow rates to be released from reservoir for the lower reach of Salmon Creek	Instream flow scenario is specified. Water supply demand is placed on reservoir storage in addition to irrigation demand. If irrigation demand or spill provided the instream flow, this release is not counted as an instream flow.	Add new instream demand for lower Salmon Creek
	Percent of instream flow release met	Factor to modify magnitude of instream flow release	Used to determine how much of the total instream flow demand is met by a given alternative.	Total instream flow demand is met if 100% is specified.
	Daily flow release	Daily flow schedule for instream flow release	Used to specify variable instream flows using daily flow rates over a two-week period. Daily flows are converted to monthly flow rates.	Variable instream flow rates.

Attachment Table C-2. Prioritization of Water Supply Sources
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Order of Water Supply Calculations	Rules
1. Total reservoir demand	• Based on mean Omak summer temperature and irrigation conveyance and operation efficiencies, total irrigation demand is calculated • Instream flow rates are added to reservoir demand • Initial assumptions on pumping rates for Duck Lake and Shellrock are determined (based on percent of total installed capacity) and subtracted from irrigation demand to be supplied from reservoir. • Reserve pumping capacity from Shellrock (during low reservoir storage), supplemental emergency pumping (during critically low reservoir storage), and new Okanogan River pump facilities are subtracted from reservoir demand • Total reservoir demand is adjusted for middle reach inflow or outflow, and for increased or decreased canal losses that are caused by the modified pumping rates describe above.
2. Duck Lake Pumping	• Allowable Duck Lake pumping rate (subject to maximum and minimum lake levels) is determined through a water balance of that system. • Optionally, different pumping rates can be specified for warm and cool years, and maximum capacity can be done during critical drought periods when total system storage (Conconully + Salmon Lake) falls below a specified minimum storage. • Additional pumping at Duck Lake reduces the diversion from Salmon Creek, resulting in lower canal loss; this adjustment is made in model.
3. Shellrock Pumping	• Optionally different pumping rates can be specified for warm and cool years, and pumping at maximum capacity (up to the monthly irrigation demand) can be done during critical drought periods as described above. • Shellrock pumping is minimized when the reservoir spills, either for the entire year or just for the months of spill. Less pumping means more diversion from Salmon Creek, resulting in additional canal loss.
4. Required reservoir release	• Conconully and Salmon Lake reservoirs are operated to supply the irrigation demand not supplied by Duck Lake, Shellrock, or the new pump facilities. • New alternative reservoirs (i.e., raising Salmon Lake, new West Fork, Brown Lake, and ASR) are operated similarly.
5. Salmon Creek and Okanogan River flows	• Flow in lower Salmon Creek is calculated based on the specified instream flow releases, reservoir spill, and channel loss. • Flow in Okanogan River is calculated based on historical flow rates above Shellrock, total amount of Okanogan River pumping, and discharge of Salmon Creek.

Attachment Table C-3. Model Supply Model Parameters
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Column Number	Category	Parameter	Description
1	General input	Year	Calendar year
2		Month	Jan-Dec label
3		Average Omak summer temperature	Used to estimate irrigation demand and (optionally) pumping rates for Shellrock and Duck Lake
4		Water year precipitation	Used to estimate Johnson Creek diversion amount
5	Watershed runoff	Total unregulated watershed runoff.	Total natural flow entering Conconully and Salmon Lake reservoirs
6		North Fork.	Percent of total watershed runoff partitioned to North Fork. Fixed at 46%.
7		West Fork	Percent of total watershed runoff partitioned to West Fork. Fixed at 35%.
8		South Fork	Percent of total watershed runoff partitioned to South Fork. Fixed at 16%.
9		Salmon Lake Fork	Percent of total watershed runoff partitioned to Salmon Lake tributary. Fixed at 3%.
10	Total Reservoir Demand	Assumed initial Shellrock pumping	Monthly pumping rate based on model input. Will be subsequently modified if spill is available to reduce pumping or critical storage requires additional pumping.
11		Max Shellrock flow under WAC minimum instream flow	Based on input water right, the maximum allowable monthly pumping at Shellrock when flow in Okanogan River falls below WAC minimum instream flow rate.
12		Irrigation demand - demand at laterals	Initial estimate of diverted Salmon Creek water needed for delivery to farmers, based on model input.
13		Irrigation demand - additional canal loss	Additional diverted water to make up for canal seepage loss and end spill
14		Instream flow release - middle reach	Required instream flow based on model input. Checks to determine if irrigation demand already provides flow in middle reach.
15		Instream flow release - lower reach	Required instream flow based on model input.
16		Brown Lake or ASR - diversion from Salmon Creek	Based on input data, amount of reservoir release needed for pumping from Salmon Creek to Brown Lake or ASR.
17		Brown Lake or ASR - release during critical period	Based on input data, amount of water released from Brown Lake or ASR during when system storage falls below level specified in input.
18		Less middle reach flow	Middle reach flow, input as a time series, is factored into the irrigation demand (i.e., middle reach inflow is available for diversion)
19		Pumping adjustments - Shellrock critical period	Additional Shellrock pumping occurs if system storage falls below level specified in input.
20		Pumping adjustments - Shellrock limit during WAC	Pumping is reduced to amount in column (11) if Okanogan River flow falls below WAC minimum
21		Pumping adjustments - additional pumping for system deficit	If specified, additional pumping to meet critical period demand is provided from separate source (e.g., emergency pump installation or equivalent reduction in irrigation demand) if system storage falls below level specified in input.
22		Pumping adjustments - adjustment of canal loss	Based on the amount of reduced or increased Shellrock pumping, the canal loss in column (13) is adjusted.

Attachment Table C-3. Model Supply Model Parameters
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Column Number	Category	Parameter	Description
23	Total Reservoir Demand (cont'd)	New Okanogan River pumping - less new pumping	Total reservoir demand is reduced by new Okanogan River pumping. Canal losses remain the same with pumping and thus do not need to be adjusted.
24		New Okanogan River pumping - adjust for pump limit during WAC	Pumping is reduced to amount specified in input data if Okanogan River flow falls below WAC minimum
25		Total demand	Total reservoir demand from Salmon Lake and Conconully reservoir storage
26	Salmon Lake Reservoir	Salmon Creek demand	Total demand in column (25) multiplied by input factor "percent of reservoir release from Salmon Lake"
27		Total reservoir release	Equal to column (26)
28		Reservoir inflow	Inflow to Salmon Lake reservoir, equal to feeder canal capacity of North Fork plus Salmon Lake Fork.
29		Storage before diversion	Previous month's storage (33) plus current month inflow (28)
30		Storage after diversion	Storage before diversion (29) minus Salmon Creek demand (26)
31		Revised spill	Amount of storage after diversion that is greater than reservoir capacity
32		Total outflow	Reservoir release (27) plus spill (31)
33		End storage	End of month storage after inflow, release, and spill
34	Conconully Reservoir	Required reservoir release	Total demand in column (26) multiplied by input factor "percent of reservoir release from Conconully"
35		Storage adjustment from previous month	Storage from column (101) that was derived from spill and pumping refinements later in the model.
36		Reservoir inflow	Inflow to Conconully reservoir, equal to Salmon Lake outflow plus West Fork, South Fork and amount left in North Fork after feeder canal diversion
37		Storage before diversion	Previous month's storage (41) plus current month inflow (34) plus storage adjustment (35)
38		Storage after diversion	Storage before diversion (37) minus required reservoir release (34)
39		Spill	Amount of storage after diversion that is greater than reservoir capacity
40		Total outflow	Reservoir release (34) plus spill (39)
41		End storage	End of month storage after inflow, release, and spill
42	Combined system storage	Combined system storage	Total storage in Conconully and Salmon Lake reservoirs at end of month
43	Reduce pumping during spill; add spill to Salmon Creek diversion	Shellrock pumping with adjustments: Shellrock pump	Initial estimate of Shellrock pump, equal to column (10)
44		Shellrock pumping with adjustments: Shellrock critical	Shellrock critical period pumping, equal to column (19)
45		Shellrock pumping with adjustments: Additional spill to Shellrock	If spill is available, Shellrock pumping is reduced and water is sent to canal
46		Shellrock pumping with adjustments: Canal losses	Adjustment to canal loss because Shellrock pumping has no conveyance or end spill loss
47		Shellrock pumping with adjustments: Revised pump	Revised estimate of Shellrock pumping
48		Revised spill	Revised Conconully spill after reducing Shellrock pumping and sending more water to OID canal

Attachment Table C-3. Model Supply Model Parameters
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Column Number	Category	Parameter	Description
49	Reduce pumping during spill; add spill to Salmon Creek diversion (cont'd)	New Okanogan pumping: Okanogan Pumping	New Okanogan pumping, from column (23)
50		New Okanogan pumping: additional spill to canal	If spill is available, Okanogan River pumping is reduced and water is sent to canal
51		New Okanogan pumping: revised pumping	Revised estimate of Okanogan River pumping
52		Revised spill	Revised Conconully spill after reducing Okanogan River pumping and sending more water to OID canal
53		Additional pumping to Brown Lake: Brown pump	Brown Lake pumping, from column (16)
54		Additional pumping to Brown Lake: additional spill to Brown Lake	If pump capacity is available during spill, pump up to maximum rate to Brown Lake or ASR
55		Additional pumping to Brown Lake: revised pumping	Revised estimate of pumping to Brown Lake, equal to column (16) plus column (54)
56		Revised spill	Revised Conconully spill after additional Brown Lake pumping
57	Do not count instream flow release during spill	Unadjusted instream flow - middle reach	Instream flow release for middle reach, from column (14)
58		Unadjusted instream flow - lower reach	Instream flow release for lower reach, from column (15)
59		Revised instream flow - middle reach	If spill occurs during month, reduce instream flow release quantity because spill would have occurred anyway
60		Revised instream flow - middle reach	If spill occurs during month, reduce instream flow release quantity because spill would have occurred anyway
61		Revised spill	Revised Conconully spill after adding back instream flow that actually is spill.
62	New Brown Lake Reservoir/ Aquifer Storage and Release	Required reservoir release	Release from Brown Lake, as specified in input data. Same as column (17).
63		Reservoir inflow	Amount of pumping to Brown Lake or ASR, equal to column (55)
64		Storage before diversion	Previous month's storage (68) plus current month inflow (63)
65		Storage after diversion	Storage before diversion (64) minus required reservoir release (62)
66		Spill	Amount of storage after diversion that is greater than reservoir capacity
67		Total outflow	Reservoir release (62) plus spill (65)
68		End storage	End of month storage after inflow, release, and spill
69	OID Canal	Salmon Creek diversion	Total amount of water diverted from Salmon Creek, based on reservoir release and pumping adjustments: (12) + (13) + (19-24) + (45) + (50) + (67)
70		New Okanogan River pumping	Revised estimate of pumping from column (51)
71		Conveyance loss	Canal conveyance loss based on percentage entered in input data times canal flow
72		Canal spill	Canal spill based on percentage entered in input data times canal flow
73		Net canal supply	Total canal supply delivered to laterals

Attachment Table C-3. Model Supply Model Parameters
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Column Number	Category	Parameter	Description
74	Duck Lake Water Balance	Johnson Creek diversion	Johnson Creek diversion, based on regression of annual diversion amount (input time series data) and water year Omak precipitation (column 4)
75		Canal spill	Canal spill from column (72)
76		Storage adjustment from previous month	Storage from column (100) that was derived from spill and pumping refinements later in the model.
77		Total inflow	Total inflow to Duck Lake, columns (74) + (75) + (76)
78		Storage before diversion	Previous month's storage (87) plus current month inflow (77)
79		Duck Lake pumping adjustments: assumed initial	Initial assumed Duck Lake pumping rate, from input data
80		Duck Lake pumping adjustments: additional critical	If specified, additional Duck Lake pumping if lake storage falls below a specified level
81		Duck Lake pumping adjustments: Adjust for storage available	If lake storage falls below minimum specified in input, reduce pumping rate to the amount of storage that is available
82		Duck Lake pumping adjustments: Excess above maximum elevation	If lake storage goes above maximum specified in input, increase pump rate (up to maximum rate) to keep below maximum elevation.
82a		Additional canal spill for storage deficit	If Duck Lake falls below minimum allowable elevation, increase canal spill.
83		Duck Lake pumping adjustments: total	Total Duck Lake pumping rate
84		OID groundwater sale	Amount of groundwater sales from Duck Lake, fixed based on input data
85		Seepage loss	Amount of seepage lost from Duck Lake. Based on seepage curve in input data (developed from historical data)
86		Total outflow	Total outflow from Duck Lake, including pumping, groundwater sale and seepage
87		End storage	End-of-month storage in Duck Lake
88		Elevation	End-of-month Duck Lake elevation, based on interpolation of storage-elevation curve in input data
89	Increase diversion for no Shellrock during spill; decrease for increased Duck pumping	Shellrock pumping	Shellrock pumping rate from column (47)
90		Spill during year?	Flag that tells if spill occurs during the year. Resets to zero each January.
91		Reduced Shellrock pump	If input is set to "Yes" and spill during year flag is "1", Shellrock pumping stops for remainder of year. Results in additional Salmon Creek diversion.
92		Increased Duck Pump	Adjustments to Duck Lake pumping, equal to difference between actual pumping and that initially assumed. Usually results in less Salmon Creek diversion.
92a		Increase canal spill only for Duck Lake deficit	If Duck Lake falls below minimum allowable elevation, increase canal spill. From column (82a).
93		Change to diversion without losses	Total change to diversion due to adjustments in columns (91) and (92).
94		Change in conveyance loss	From column (93), the amount of increased or decreased canal conveyance loss
95		Change in canal spill	From column (93), the amount of increased or decreased canal spill
96		Change to diversion with losses	Sum of column (93) + (94) + (95)

Attachment Table C-3. Model Supply Model Parameters
Not Modified from 1999 Phase 1 Report (Dames and Moore)

Column Number	Category	Parameter	Description
97	Increase diversion for no Shellrock during spill; decrease for increased Duck pumping (cont'd)	Revised Salmon Creek diversion	Sum of column (96) + (69)
98		Revised canal loss	Column (94) plus column (71)
99		Revised conveyance loss (spill)	Column (95) plus column (72)
100		Change in canal spill; return back to Duck Lake	Adjustments to spill to Duck Lake, returned to Duck Lake in the following month in column (76)
101		Change in canal diversion; return back to Conconully	Adjustments to canal diversion from Salmon Creek, returned to Conconully Reservoir in the following month in column (35)
102	Salmon Creek Flows	Flow above weir	Middle Reach flow, equal to reservoir release plus spill plus Middle reach gain/loss
103		OID irrigation diversion	Diversion from Salmon Creek to OID canal, equal to column (97)
104		Flow below weir	Lower reach flow below diversion, equal to column (102) minus column (103)
105		Flow at Watercress	Lower reach flow at Watercress springs, equal to column (104) minus reach loss specified in input data for upper portion of lower reach
106		Flow at Mouth	Lower reach flow at mouth, equal to column (105) minus reach loss specified in input data for lower portion of lower reach
107	Okanogan River Flows	Above Shellrock	Historical Okanogan River flows above Shellrock, from time series input. Based on Malott USGS flows adjusted for regulated Salmon Creek and Shellrock Pump flows as estimated from Existing Condition model
108		Shellrock to Salmon Creek	Column (107) flows minus Shellrock pumping, as estimated from Existing Condition model
109		Salmon Creek to Malott	Column (108) flows minus Salmon Creek at mouth flows, as estimated from Existing Conditions model
110	Total Irrigation Delivery	Salmon Creek diversion	From column (103)
111		Canal seepage loss	From column (94)
112		Canal conveyance loss (spill)	From column (95)
113		Duck Lake pumping	From column (83)
114		Shellrock pumping	From column (89) minus column (91)
115		Critical period shortage	From column (19)
116		New Okanogan River pumping	From column (70)
117		Total Irrigation Delivery	Sum of columns (110) to (116)

APPENDIX D:
Water System Input and Output

APPENDIX D -- INTRODUCTION

Appendix D provides a summary of output data generated by the water system model for all the alternatives. The figures and charts in the appendices use the alphanumeric codes specified below to identify the ten (10) modeled runs that represent the four alternatives. The use of these codes helped the compilation and organization of model input and output data:

1a New 80 cfs pump on the Okanogan River, steelhead only, channel rehabilitation
1b New 80 cfs pump on the Okanogan River, steelhead and Chinook, channel rehabilitation
1c New 80 cfs pump on the Okanogan River, steelhead only, no channel rehabilitation

2a Upgrade Shellrock to 35 cfs, steelhead only, channel rehabilitation
2b Upgrade Shellrock to 35 cfs, steelhead and Chinook, channel rehabilitation
2c Upgrade Shellrock to 35 cfs, steelhead only, no channel rehabilitation

3a 5100 AF water rights purchase, steelhead only, channel rehabilitation
3b 5100 AF water rights purchase, steelhead and Chinook, channel rehabilitation
3c 5100 AF water rights purchase, steelhead only, no channel rehabilitation

4 No Action Alternative

Please note, the model runs presented in this Appendix include more combinations than were carried forward for EIS analysis in the current group of EIS alternatives. For example, each of the water supply action alternatives was modeled both with and without stream rehabilitation. Each water supply alternative was also modeled to supply the flow regime for steelhead only and steelhead with chinook (See Table 3-21).

Appendix D is organized as follows:

D-1. Summary of Model Input and Output Data for All Alternatives and Flow Scenarios

D-2. Monthly Water Level Elevation Exceedance Graphs for Conconully and Salmon Lakes for All Alternatives and Flow Scenarios

There are 20 charts in this appendix, 10 for each lake representing the 10 model runs. The charts are presented as pairs (for Conconully and Salmon Lakes) in the order of the alphanumeric codes listed above.

D-3. Monthly Streamflow Exceedance Graphs for four locations along Salmon Creek for All Alternatives and Flow Scenarios

There are 40 charts in this appendix. The four locations are listed in order for each of the 10 model runs. Salmon Creek above the weir (bottom of Middle Reach), Salmon Creek below the weir (top of lower reach), Salmon Creek at the mouth, and Conconully Spill.

The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel.

D-4. Comparative Graphs of Simulated Monthly Lake Elevation Data

There are 18 charts in this appendix. The first nine compare the three flow scenarios of the three alternatives (3 x 3) to the No Action Alternative for Salmon Lake. The second nine show the same comparisons for Conconully Lake. Each set of three graphs shows the comparisons for the i) minimum, ii) median, iii) 10%, and maximum lake elevations.

D-5. Comparative Graphs of Simulated Monthly Streamflow Data for Salmon Creek

There are 30 charts in this appendix. The charts are in four groups representing the following four locations along Salmon Creek: i) Conconully Reservoir Spill, ii) the downstream end of the Middle Reach above the weir at the OID diversion, iii) the upstream end of the Lower Reach below the weir at the OID diversion, and iv) the downstream end of the Lower Reach at the mouth. Within each group are nine charts (only three for the Conconully Reservoir Spill group) that compare Alternative 4 (No Action) to the high, median and minimum monthly streamflows for Alternatives 1, 2 and 3.

The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel.

D-6. Summary Table of Simulated Effects of Salmon Creek Flows on Okanogan River Flows per Water Year Type for All Alternatives

The table lists by row five water year types for the four alternatives streamflow-related data used to quantify the impact of Salmon Creek flows on Okanogan River flows.

D-7. Summary of Simulated Annual Totals or Annual Averages for OID Irrigation Delivery Data

There are 10 tables in this appendix. Each table summarizes the 99-year record (and average, maximum and minimum) of simulated annual totals for OID irrigation delivery data for the 10 model runs that include the No Action Alternative and the three flow scenarios for the 3 alternatives (or 3 x 3 tables). The data are in acre-feet and consist of Salmon Creek Diversion, Canal Seepage, Canal Spill, Pumpage from Duck Lake, Pumpage from Okanogan (either Shellrock or the new 80 cfs pump), Critical Period Shortage, Total Irrigation Delivery, and the Total Demand from the System. Also provided are the calculated Delivery Efficiencies, and the Maximum and Minimum On-farm Efficiencies.

APPENDIX D-1:
Summary of Model Input and Output Data for All Alternatives and Flow Scenarios

Appendix D-1. Summary of Model Input and Output Data for All Alternatives and Flow Scenarios

Action Alternatives	Alternative 1 New 80 cfs Pump on Okanogan			Alternative 2 Upgrade Shellrock to 35 cfs			Alternative 3 5100 ac-ft Water rights Purchase			Alternative 4 No Action	
Channel Condition	**Channel Rehabilitation**		**No Channel Rehab**	**Channel Rehabilitation**		**No Channel Rehab**	**Channel Rehabilitation**		**No Channel Rehab**	**No Channel Rehab**	
Flow Scenarios	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***None***	
EXISTING SYSTEM FACILITIES											
System Reservoir Storage Capacity											
Conconully Reservoir active storage	13000	13000	13000	13000	13000	13000	13000	13000	13000	13000	ac-ft
Salmon Lake Reservoir active storage	10500	10500	10500	10500	10500	10500	10500	10500	10500	10500	ac-ft
Total system storage:	23500	23500	23500	23500	23500	23500	23500	23500	23500	23500	ac-ft
Combined Minimum Storage For Model Run (must be > 0)	*13568*	*2223*	*11898*	*180*	*346*	*661*	*3150*	*428*	*2824*	*1748*	ac-ft
Reservoirs											
Feeder canal capacity	90	90	90	90	90	90	90	90	90	30	cfs
Percent of reservoir release from Conconully	55.0%	63.0%	55.0%	55.0%	54.6%	55.0%	57.0%	54.0%	57.0%	60.0%	
Percent of reservoir release from Salmon Lake	45.0%	37.0%	45.0%	45.0%	45.4%	45.0%	43.0%	46.0%	43.0%	40.0%	
Shellrock Pumping Rules											
Installed capacity	0	0	0	35	35	35	25	25	25	25	cfs
Maximum pump rate, warm years	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	
Minimum pump rate, cool years	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	
Stop pumping for year if spill occurs?	No	No	No	No	No	No	No	No	No	Yes	
Critical system storage for maximum pumping	0	0	0	15000	15000	15000	15000	15000	15000	9500	ac-ft
Cut back pumping during WAC restriction?	No	No	No	No	No	No	No	No	No	No	
Maximum pump rate under water right	0	0	0	35	35	35	35	35	35	35	cfs
Duck Lake Pumping Rules											
Installed capacity	10	10	10	10	10	10	10	10	10	10	cfs
Maximum pump rate, warm years	5%	5%	5%	60%	100%	65%	5%	100%	5%	5%	
Minimum pump rate, cool years	5%	5%	5%	60%	100%	65%	5%	100%	5%	5%	
Maximum Duck Lake elevation:	1232.00	1232.00	1232.00	1232.00	1232.00	1232.00	1232.00	1232.00	1232.00	1232.00	feet
Minimum Duck Lake elevation:	1226.75	1226.75	1226.75	1226.75	1226.75	1226.75	1226.75	1226.75	1226.75	1226.75	feet
Okanogan River Pumping Rules											
Maximum Pump Rate Design	80.0	80.0	80.0	0	0	0	0	0	0	0	
Maxiumum Pumping Required During Drought Years	57.3	43.0	52.4	0	0	0	0	0	0	0	cfs
Okanogan River downstream of Salmon Creek	0	0	0	0	0	0	0	0	0	0	cfs
Cut back pumping during WAC restriction?	No	No	No	No	No	No	No	No	No	No	
Maximum pump rate under water right	35	35	35	35	35	35	0	0	0	35	cfs

Appendix D-1. Summary of Model Input and Output Data for All Alternatives and Flow Scenarios

Action Alternatives	**Alternative 1 New 80 cfs Pump on Okanogan**			**Alternative 2 Upgrade Shellrock to 35 cfs**			**Alternative 3 5100 ac-ft Water rights Purchase**			**Alternative 4 No Action**	
Channel Condition	**Channel Rehabilitation**		**No Channel Rehab**	**Channel Rehabilitation**		**No Channel Rehab**	**Channel Rehabilitation**		**No Channel Rehab**	**No Channel Rehab**	
Flow Scenarios	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***None***	
OID IRRIGATION DEMAND											
Duck Lake Retained Storage for Artificial Groundwater Recharge											
Annual quantity	500	500	500	500	500	500	500	500	500	500	ac-ft/yr
Irrigation Water Demand											
Crop Irrigation Requirement, warm years	11,350	11,350	11,350	11,350	11,350	11,350	7,718	7,718	7,718	11,350	ac-ft/yr
On-farm efficiency:	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	ac-ft/yr
Maximum irrigation delivery:	17,196	17,196	17,196	17,196	17,196	17,196	11,694	11,694	11,694	17,196	ac-ft/yr
Crop Irrigation Requirement, cool years	10,701	10,701	10,701	10,701	10,701	10,701	7,277	7,277	7,277	10,701	ac-ft/yr
On-farm efficiency:	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	ac-ft/yr
Minimum irrigation delivery:	12,590	12,590	12,590	12,590	12,590	12,590	8,561	8,561	8,561	12,590	ac-ft/yr
Irrigation Efficiency:											
Conveyance loss:	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	
Operational spill to Duck Lake (see Table 3.1-D-1):	distributed monthly	distributed monthly	distributed monthly	distributed monthly	distributed monthly	distributed monthly	distributed monthly	distributed monthly	distributed monthly	distributed monthly	
INSTREAM FLOW DEMAND AND MODEL RESULTS											
Lower Reach Losses											
Lower Reach - above Watercress Springs	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	
Lower Reach - below Watercress Springs	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	
Salmon Creek Instream Flow											
Middle Reach (above weir)											
Specified flow schedule (exclusive of lower reach)	5968	8882	5968	5968	8882	5968	5968	8882	5968	0	ac-ft/yr
Modeled average annual flow	22650	22666	22651	22661	22670	22587	22653	22669	22653	22730	ac-ft/yr
Modeled minimum actual flow	5290	8139	5835	8116	7862	8089	7672	8648	7672	5424	ac-ft/yr
Salmon Creek at weir											
Modeled average annual flow	17342	16990	17163	15592	16706	15636	17202	18606	17208	10501	ac-ft/yr
Modeled minimum actual flow (should be 5100 for EIS*)	5100	6435	5100	5100	6417	5100	5100	7565	5100	448	ac-ft/yr

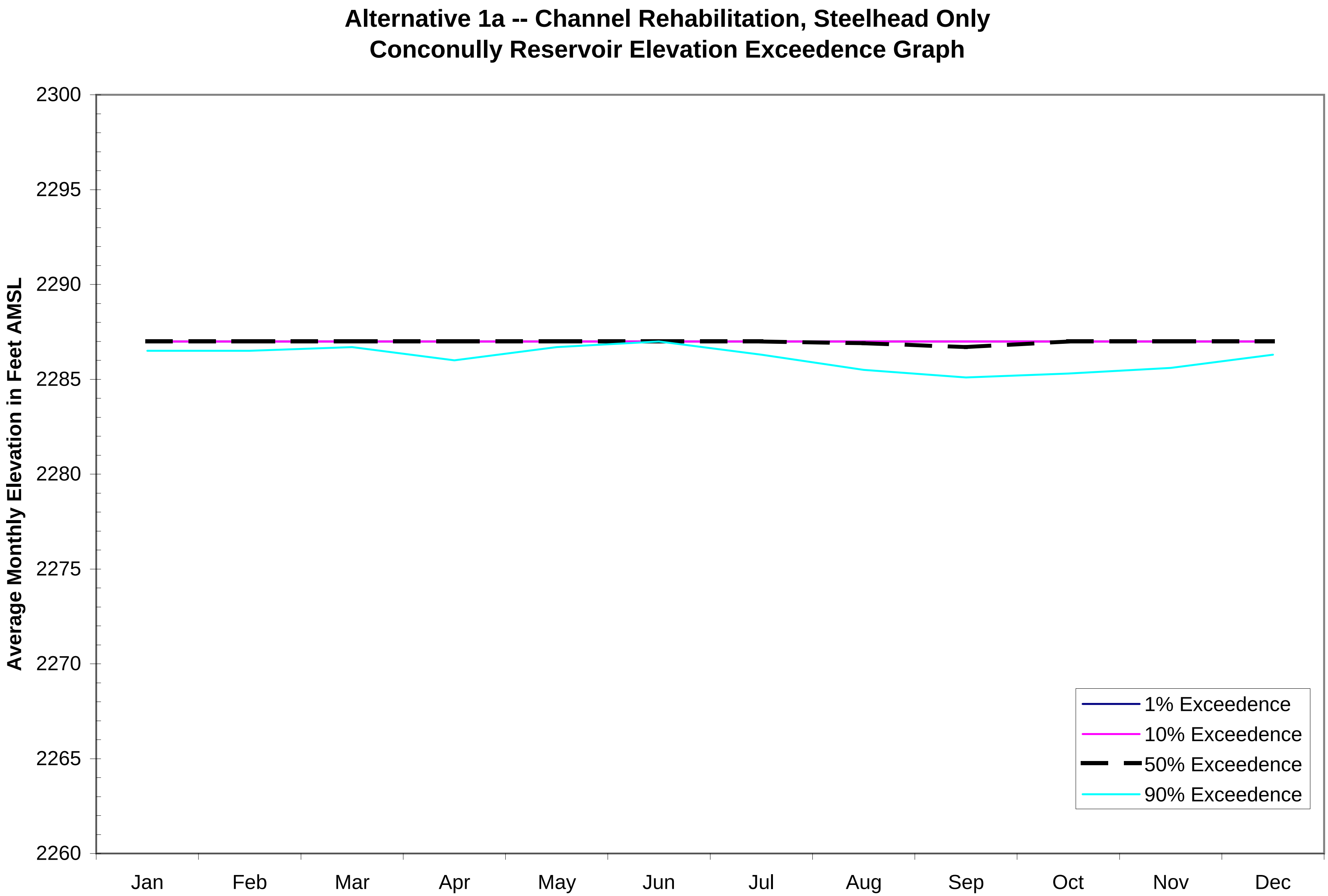
Appendix D-1. Summary of Model Input and Output Data for All Alternatives and Flow Scenarios

Action Alternatives	**Alternative 1 New 80 cfs Pump on Okanogan**			**Alternative 2 Upgrade Shellrock to 35 cfs**			**Alternative 3 5100 ac-ft Water rights Purchase**			**Alternative 4 No Action**	
Channel Condition	**Channel Rehabilitation**		**No Channel Rehab**	**Channel Rehabilitation**		**No Channel Rehab**	**Channel Rehabilitation**		**No Channel Rehab**	**No Channel Rehab**	
Flow Scenarios	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***Steelhead Only***	***Steelhead and Chinook***	***Steelhead Only***	***None***	
Lower Reach (at mouth)											
Specified flow schedule (exclusive of upper reach)	2059	4317	2644	3808	4319	3774	3748	4317	3747	0	ac-ft/yr
Modeled average annual flow	13693	13415	13552	12311	13191	12346	13582	14691	13588	8292	ac-ft/yr
Modeled minimum actual flow	4027	5081	4027	4027	5067	4027	4027	5973	4027	354	ac-ft/yr
AVERAGE ANNUAL MODEL OUTPUT											
Firm Yield at Mouth of Salmon Creek	4027	5081	4027	4027	5067	4027	4027	5973	4027	354	
Salmon Creek diversion to OID Canal	5308	5676	5488	7069	5964	6951	5452	4064	5445	12229	ac-ft/yr
Canal spill and seepage loss	-1810	-1822	-1819	-1054	-1015	-1046	-700	-834	-697	-1396	ac-ft/yr
Shellrock pumping	0	0	0	7153	7442	7173	4672	5092	4679	2414	ac-ft/yr
Duck Lake pumping	1355	1412	1383	1003	977	999	555	806	552	1101	ac-ft/yr
New Okanogan River pumping	9491	9079	9293	0	0	0	0	0	0	0	ac-ft/yr
Critical period shortage	0	0	0	0	41	0	0	9	0	0	ac-ft/yr
Total Water Delivered to Farms	14345	14345	14345	14171	13410	14077	9979	9137	9979	14348	ac-ft/yr
Total Demand From System	16155	16167	16164	15225	14425	15123	10679	9972	10676	15745	ac-ft/yr
Delivery Efficiency	89%	89%	89%	93%	93%	93%	93%	92%	93%	91%	
On-Farm Efficiency	77%	77%	77%	78%	82%	78%	75%	82%	75%	77%	
Overall District Efficiency	68%	68%	68%	72%	76%	73%	70%	75%	70%	70%	
Total system capacity shortage	0	0	0	0	10	0	0	5	0	0	cfs maximum
	0	0	0	0	1698	0	0	674	0	0	ac-ft/yr maximum
Critical Storage Level	0	0	0	0	9000	0	0	5000	0	0	ac-ft

* Note - due to model structure and governing rules for the order of calculations, the flows over the weir could not be reduced to 5100 ac-ft per year without also reducing the lower reach instream flows below specified flow demands. In essence, during certan times of the year flow over the weir is controlled more by lower reach demands than middle reach demands when OID demands are also being met. A minor but still signficant amount of model restructuring would be necessary to correct the order of calculations, and achieve the EIS target volume of 5100 ac-ft.

APPENDIX D-2:

Simulated Conconully and Salmon Lake Reservoir Elevation Exceedance Curves


Alternative 1a -- Channel Rehabilitation, Steelhead Only
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
2295
2290
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2280
2275
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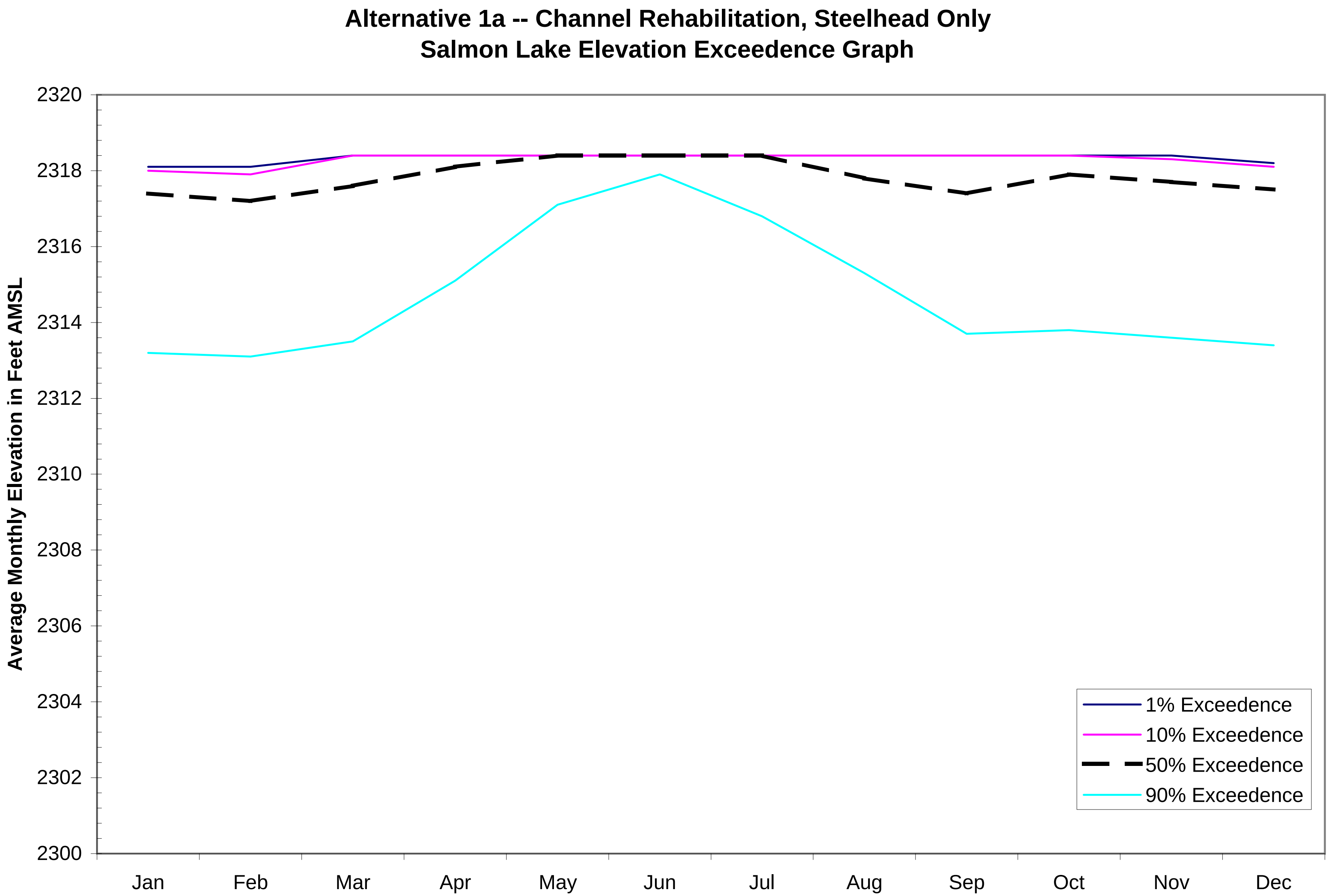
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1a -- Channel Rehabilitation, Steelhead Only
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
2318
2316
2314
2312
2310
2308
2306
2304
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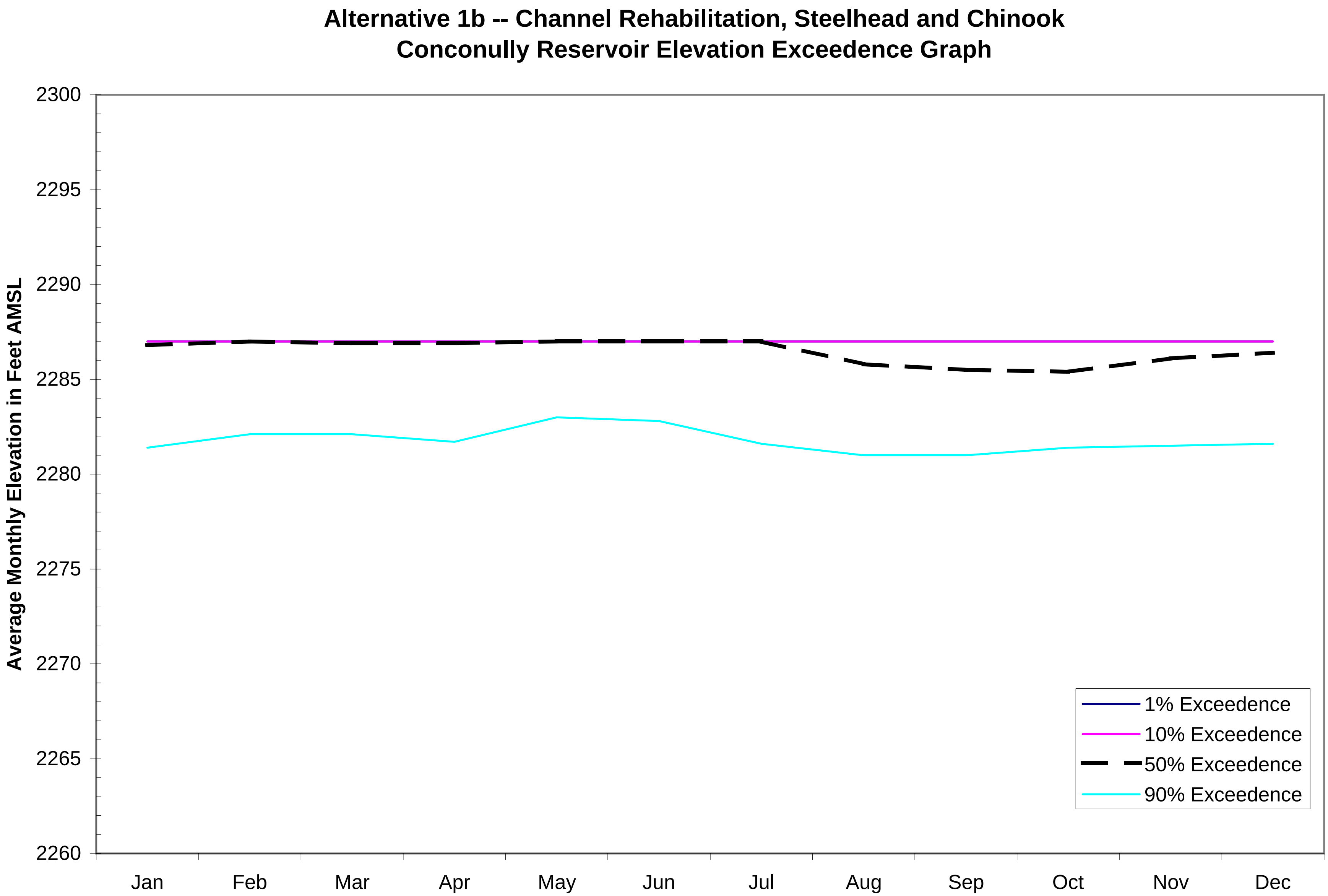
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1b -- Channel Rehabilitation, Steelhead and Chinook
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
2295
2290
2285
2280
2275
2270
2265
2260
Jan
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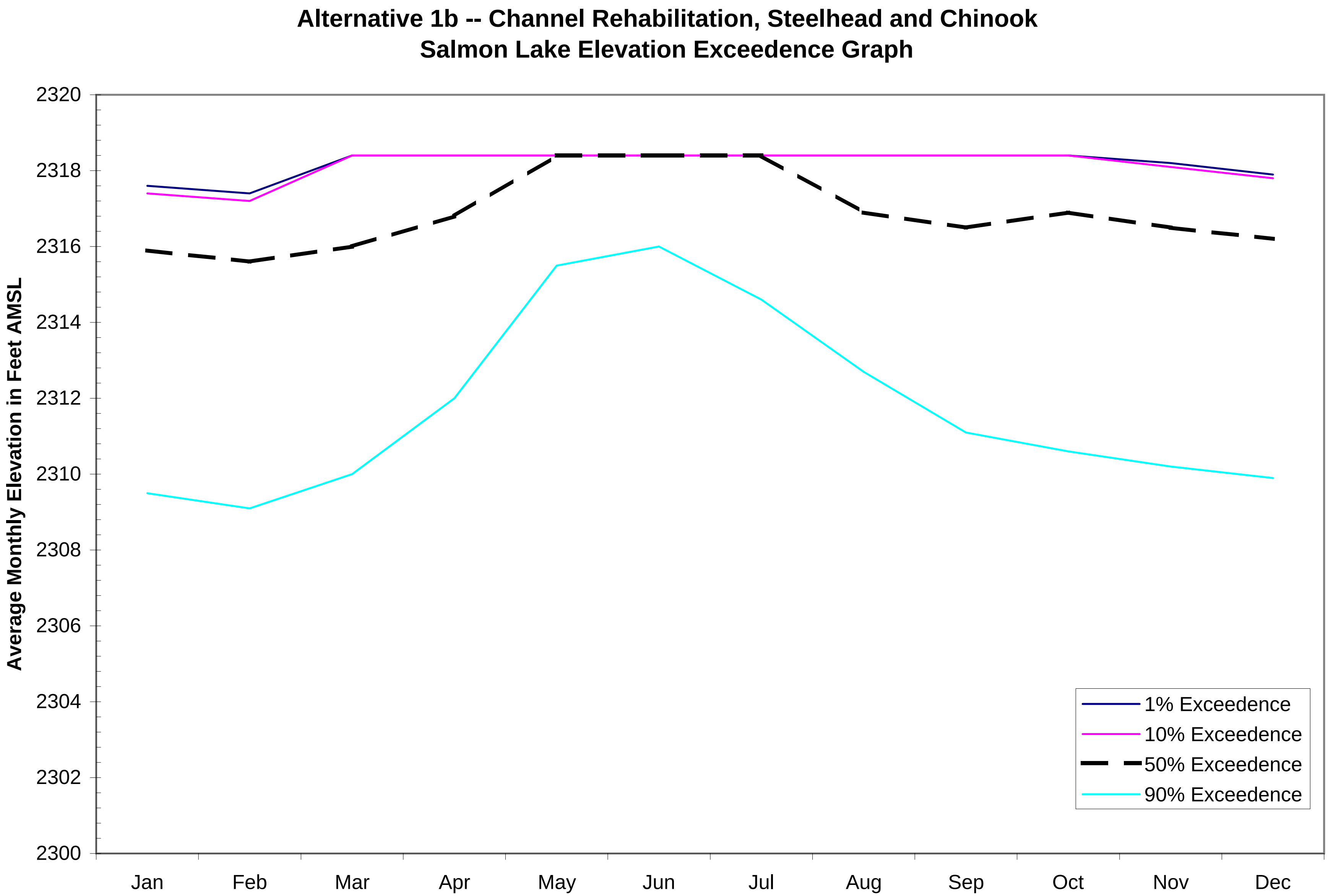
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1b -- Channel Rehabilitation, Steelhead and Chinook
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
2318
2316
2314
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2310
2308
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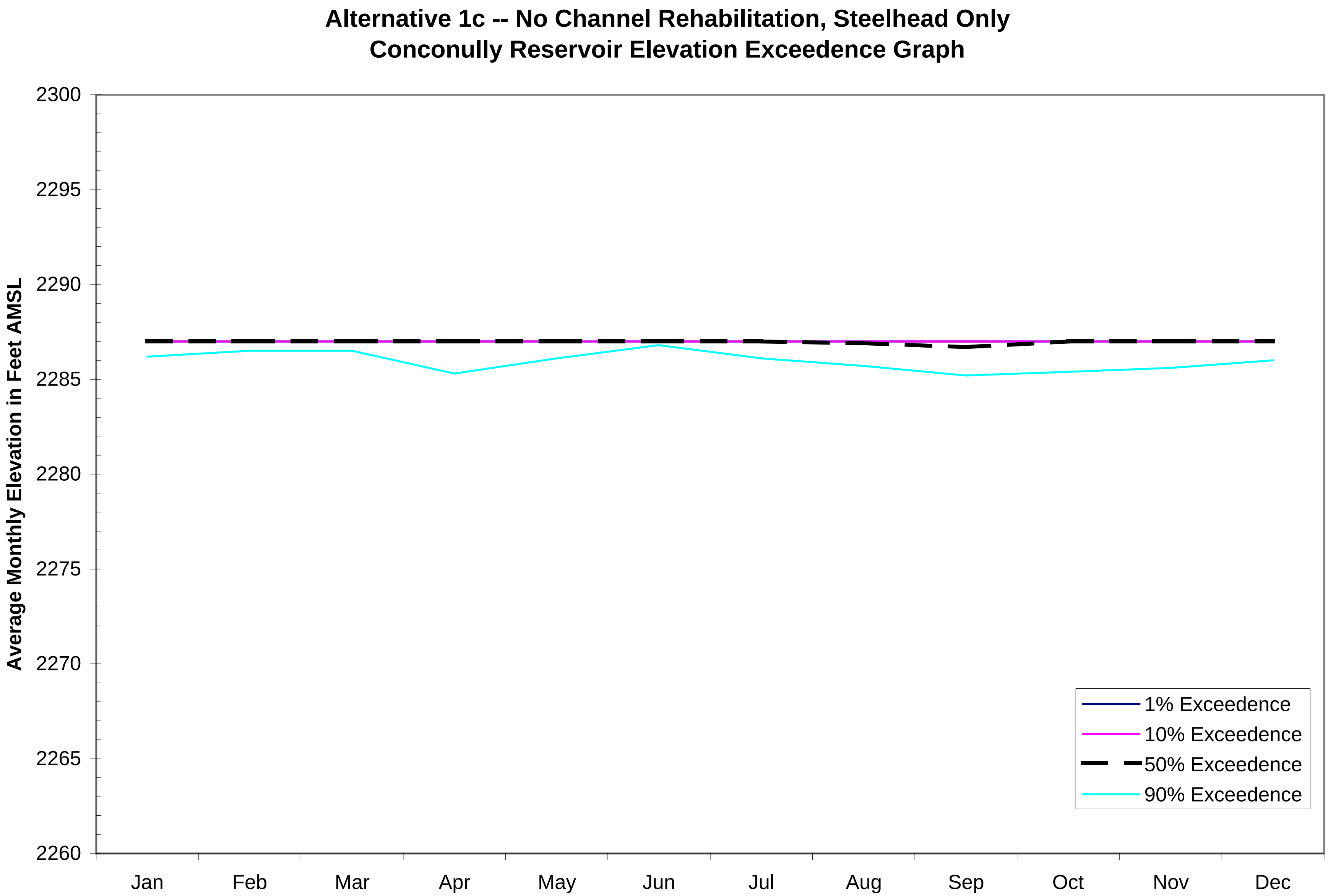
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1c -- No Channel Rehabilitation, Steelhead Only
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
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2290
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1% Exceedence
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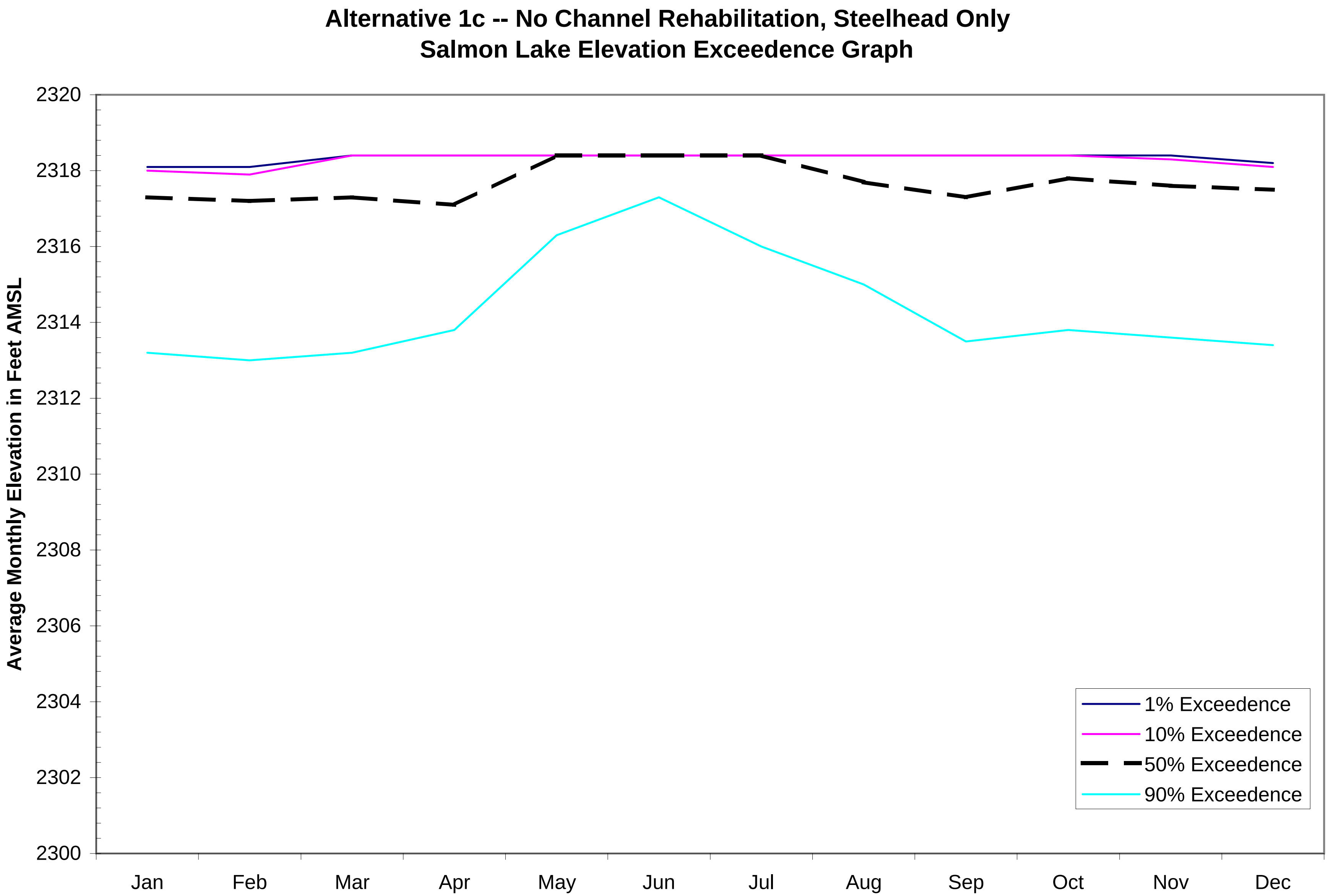
50% Exceedence
90% Exceedence


Alternative 1c -- No Channel Rehabilitation, Steelhead Only
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
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2310
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1% Exceedence
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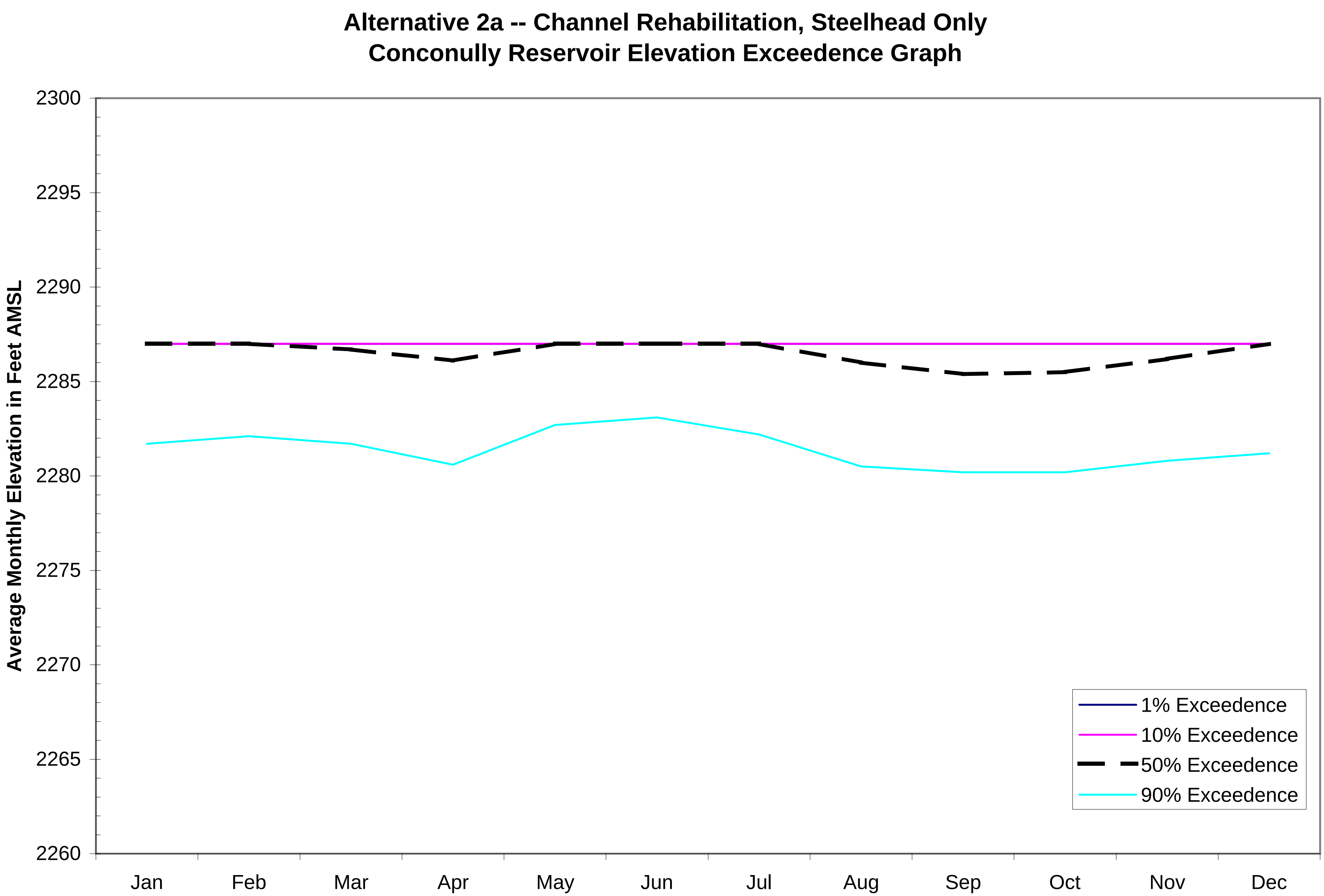
50% Exceedence
90% Exceedence


Alternative 2a -- Channel Rehabilitation, Steelhead Only
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
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1% Exceedence
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50% Exceedence
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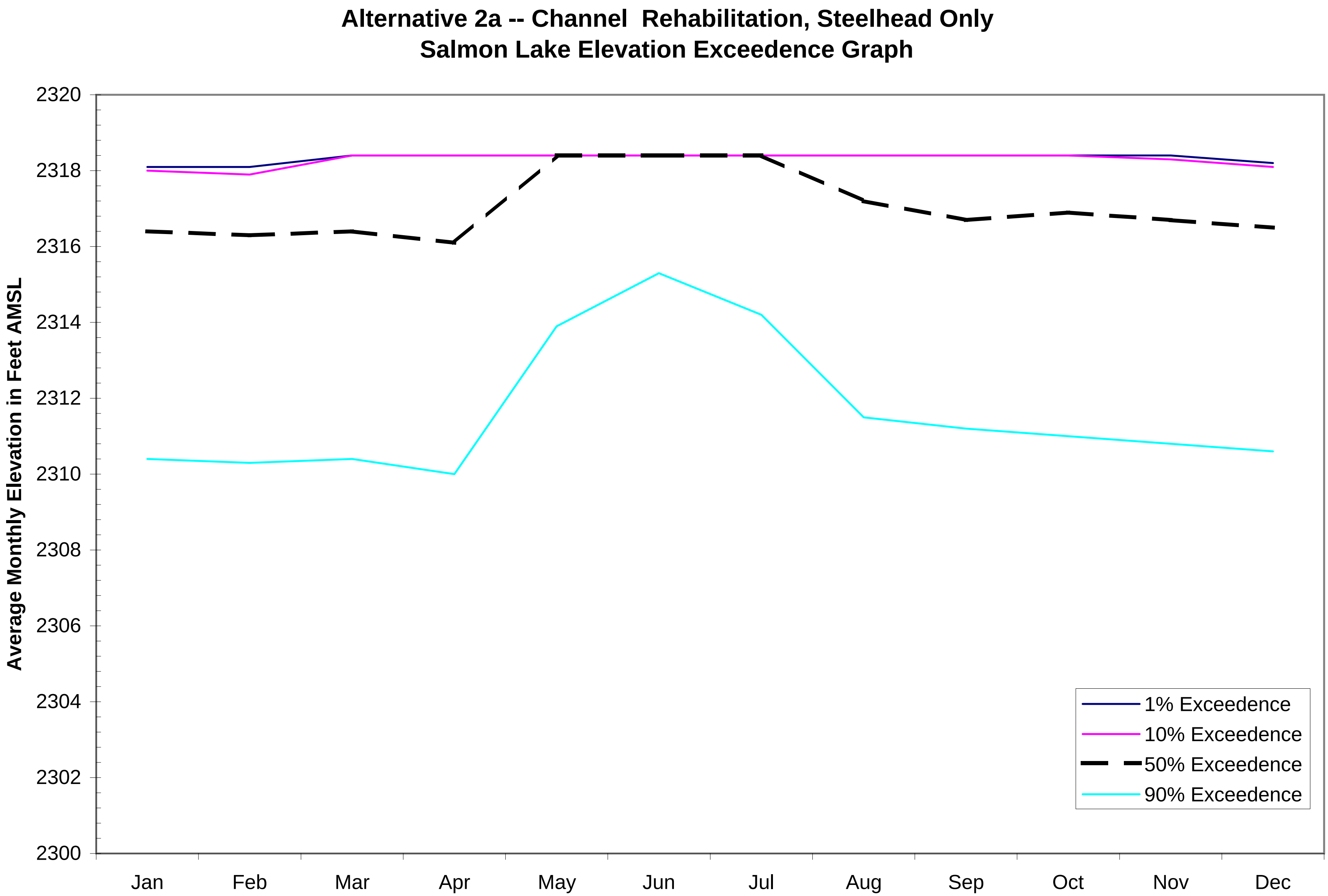
Alternative 2a -- Channel Rehabilitation, Steelhead Only
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
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2310
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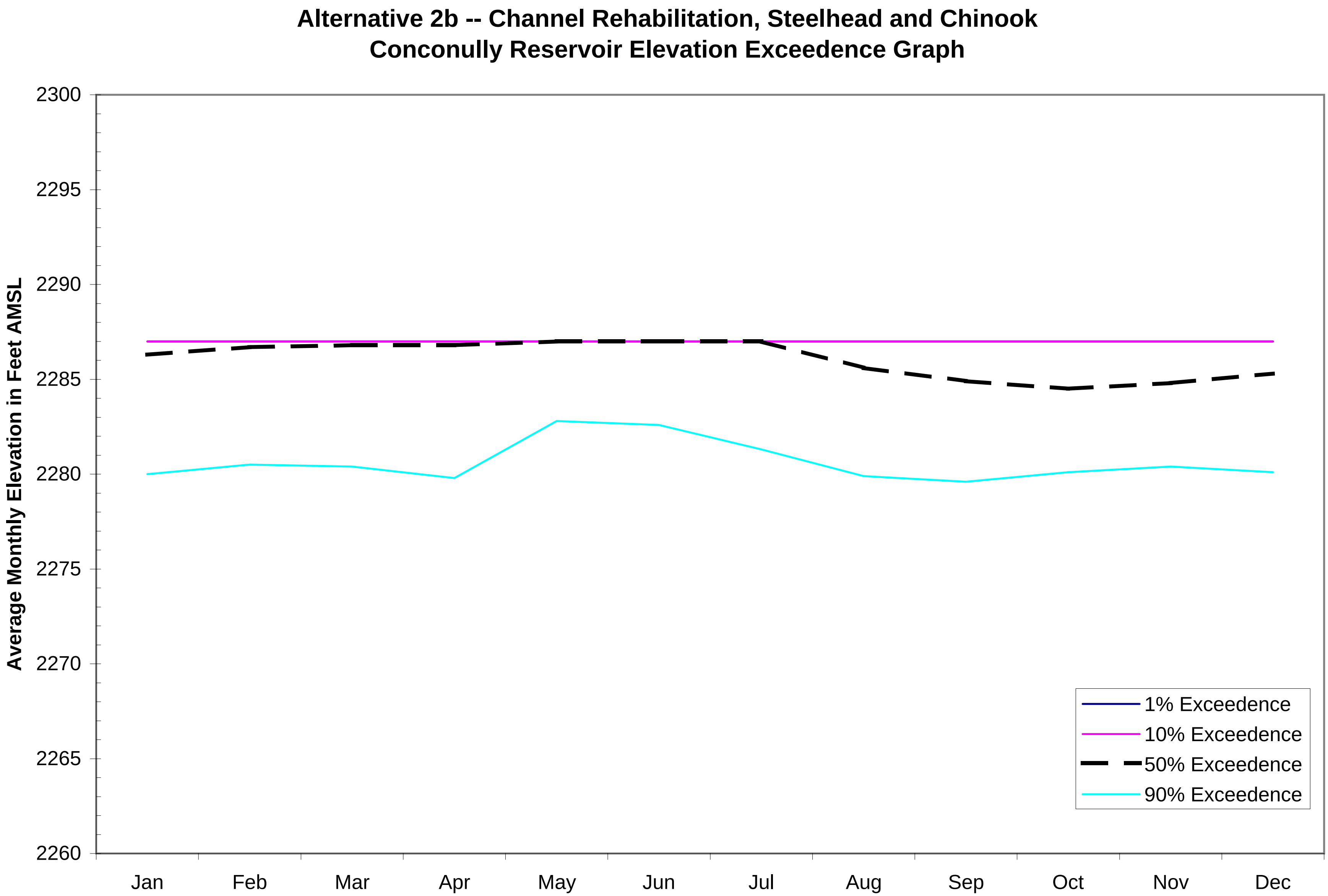
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2b -- Channel Rehabilitation, Steelhead and Chinook
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
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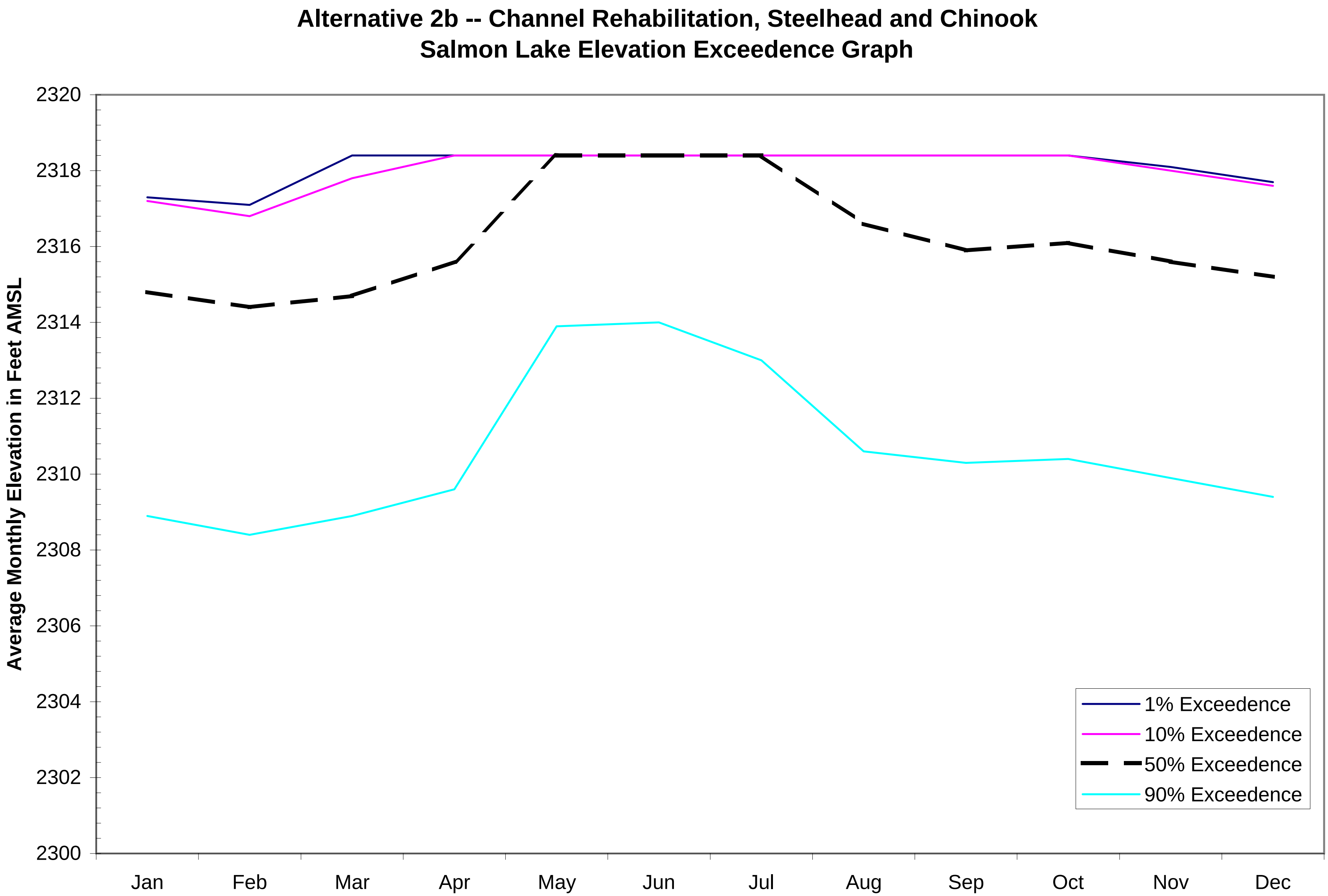
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2b -- Channel Rehabilitation, Steelhead and Chinook
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
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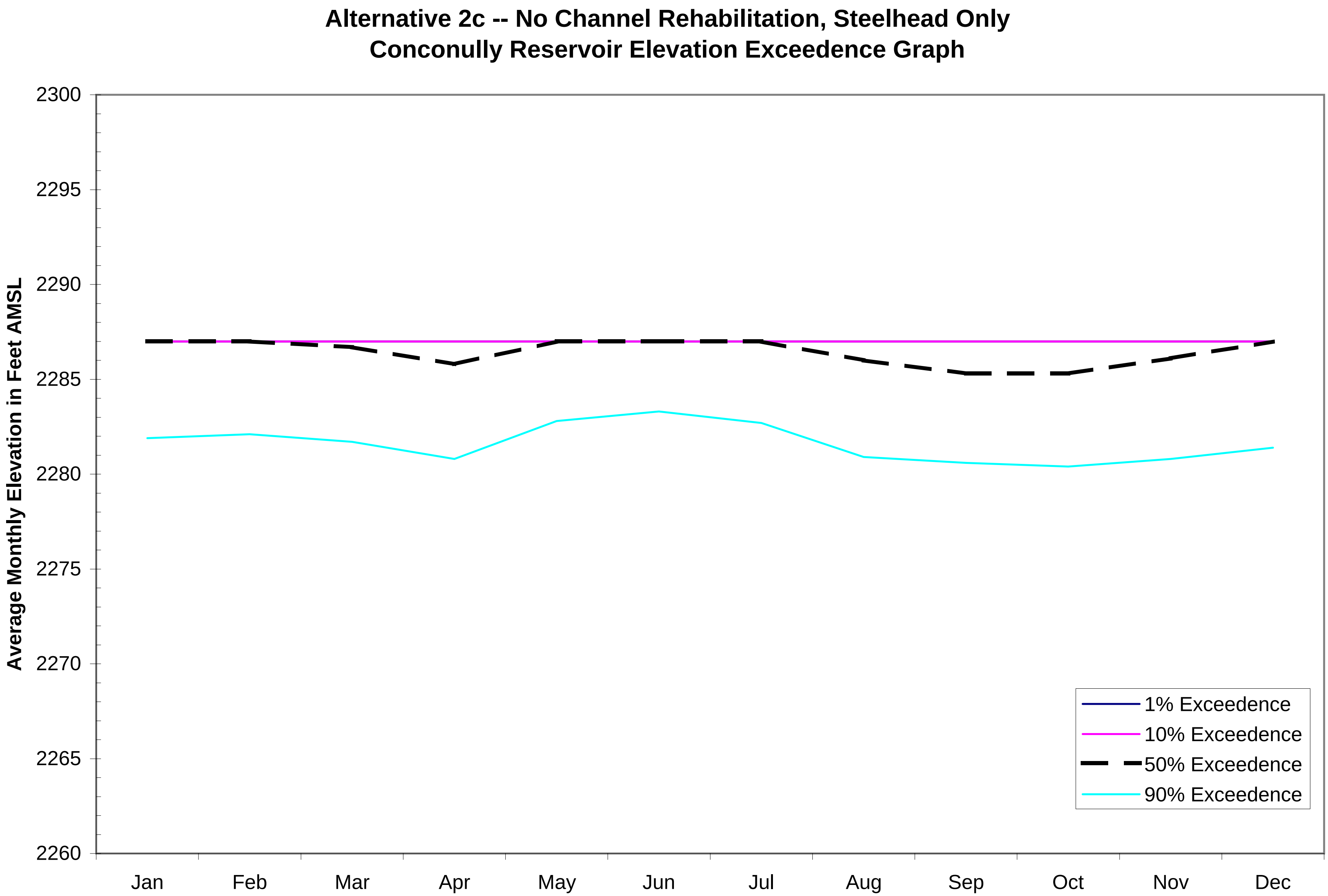
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2c -- No Channel Rehabilitation, Steelhead Only
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
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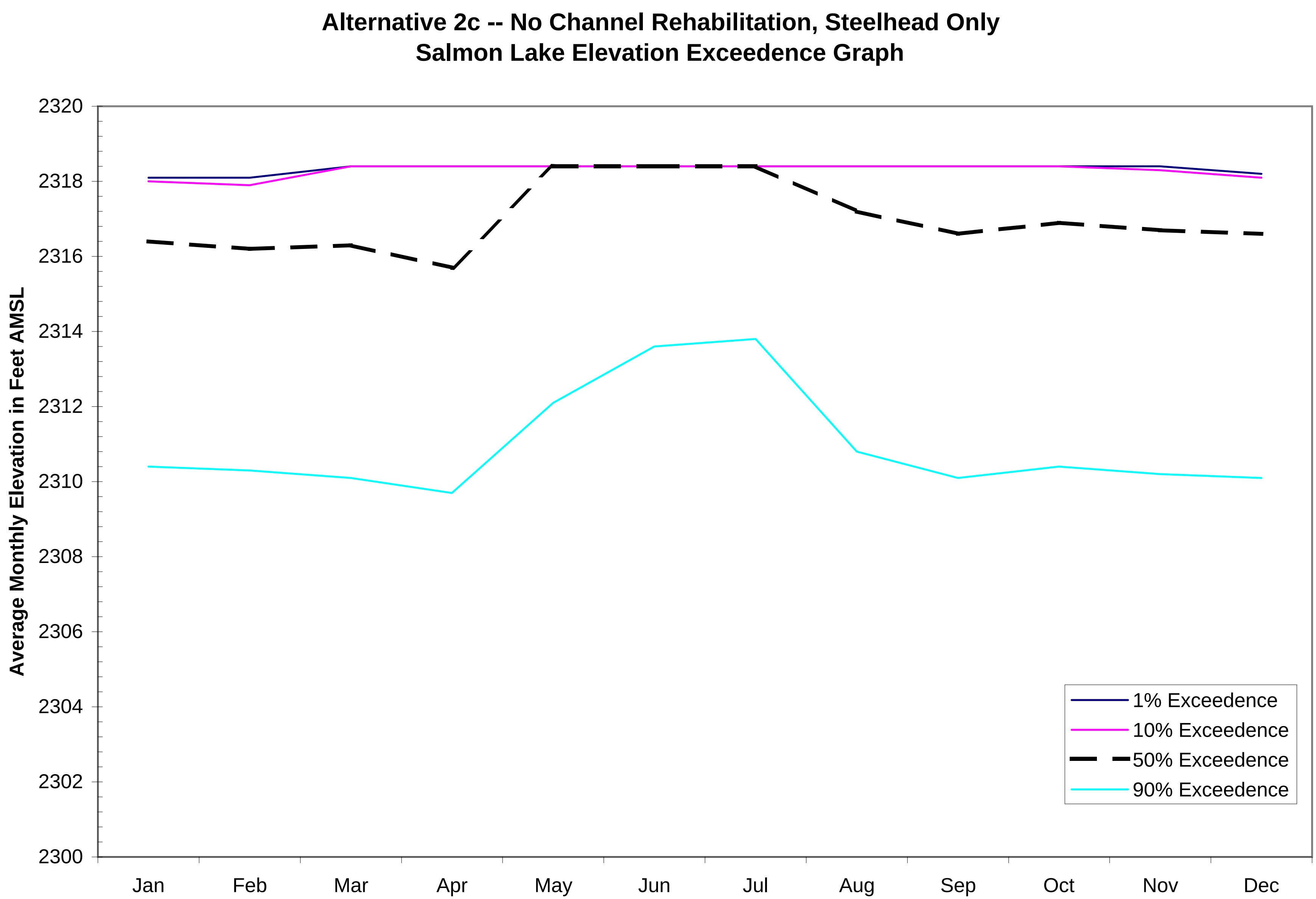
Alternative 2c -- No Channel Rehabilitation, Steelhead Only
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
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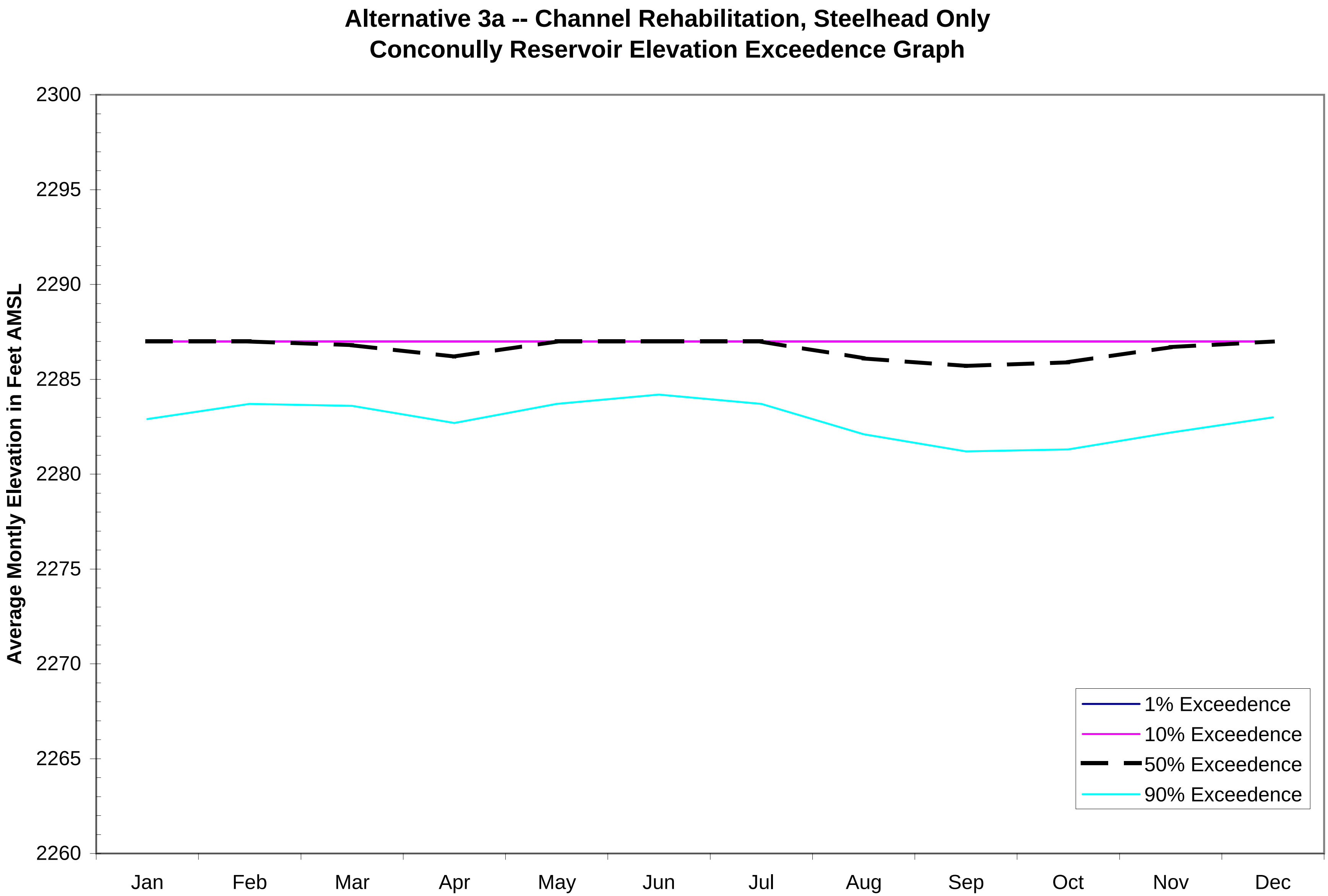
Alternative 3a -- Channel Rehabilitation, Steelhead Only
Conconully Reservoir Elevation Exceedence Graph
Average Montly Elevation in Feet AMSL
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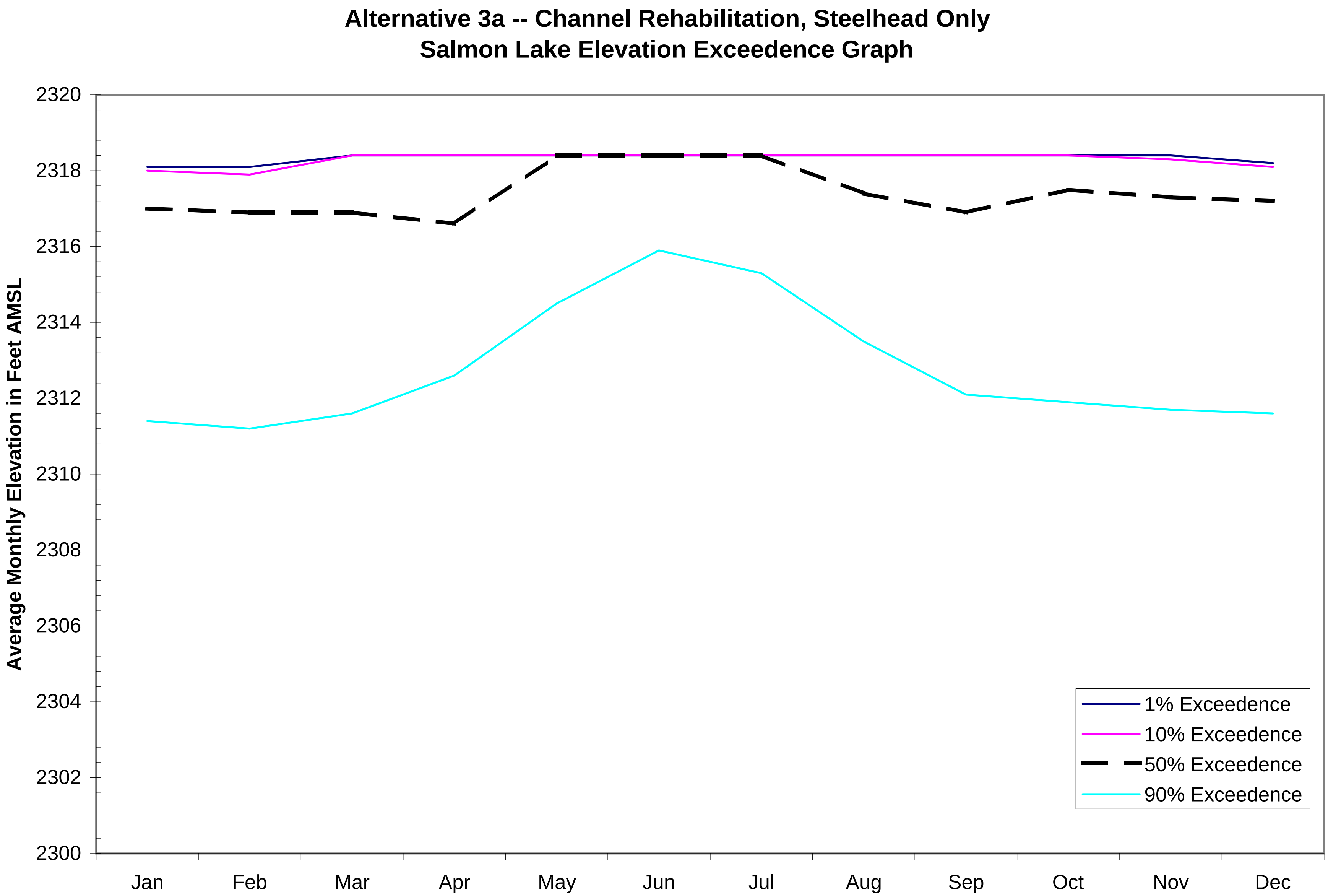
Alternative 3a -- Channel Rehabilitation, Steelhead Only
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
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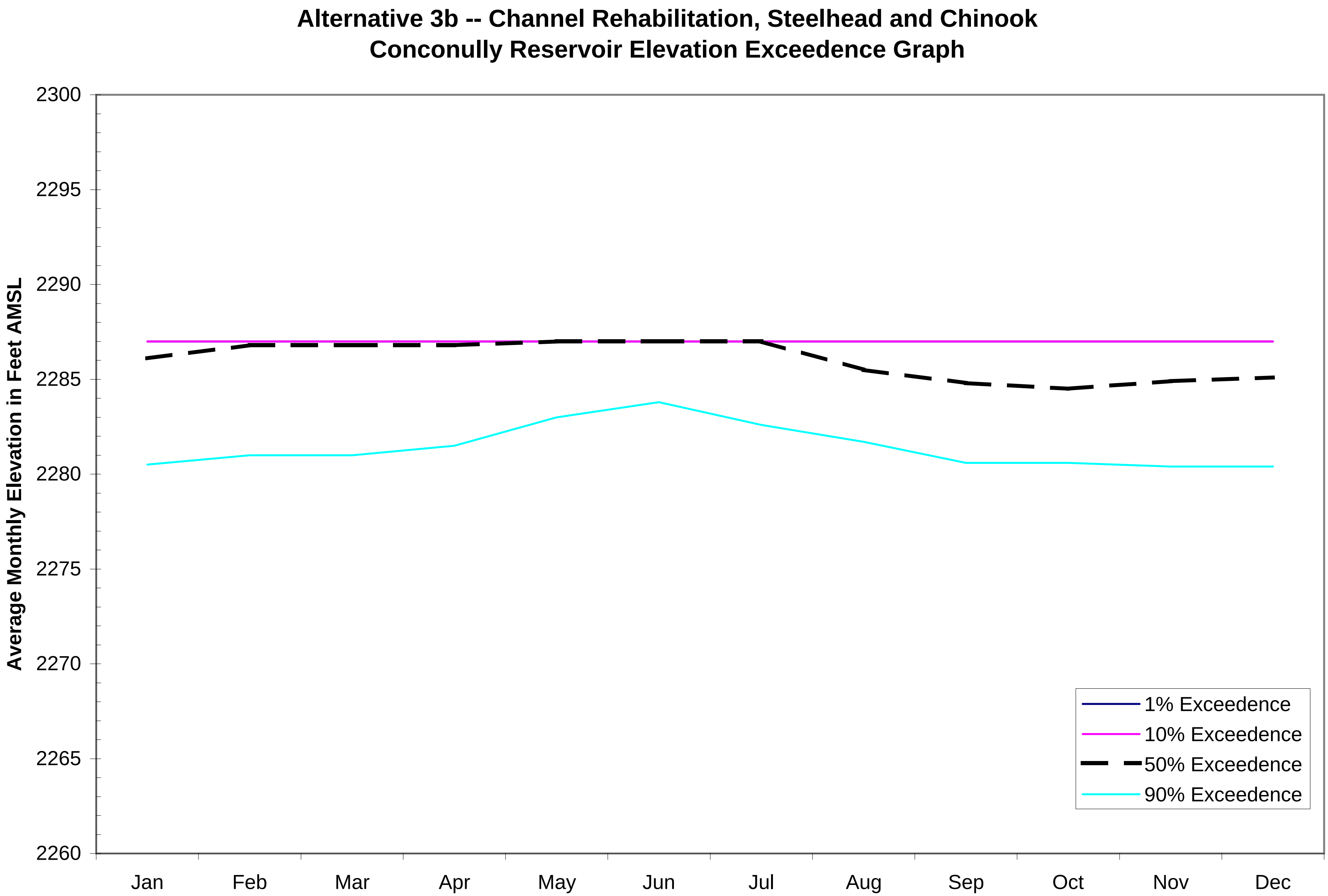
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3b -- Channel Rehabilitation, Steelhead and Chinook
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
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2280
2275
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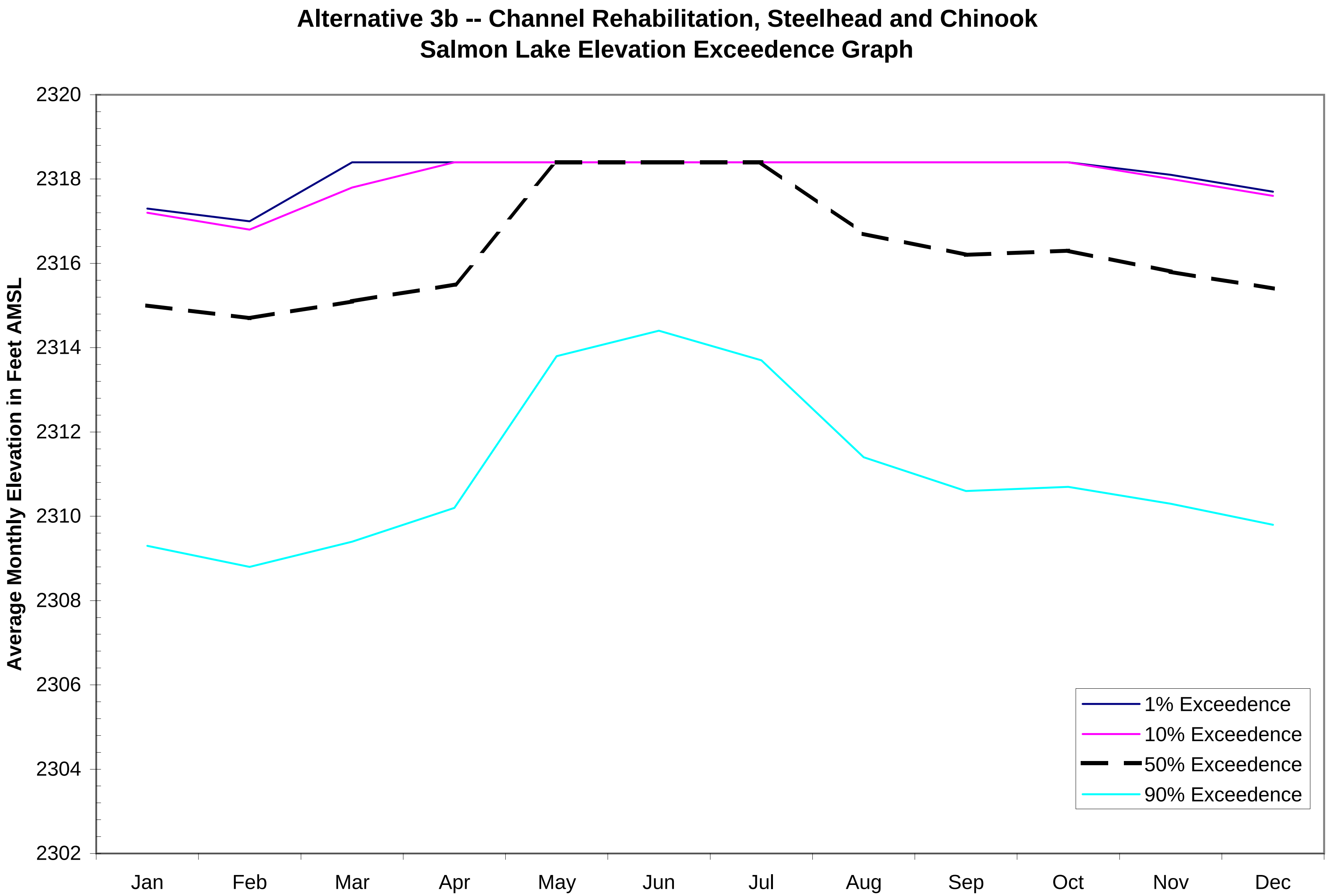
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3b -- Channel Rehabilitation, Steelhead and Chinook
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
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1% Exceedence
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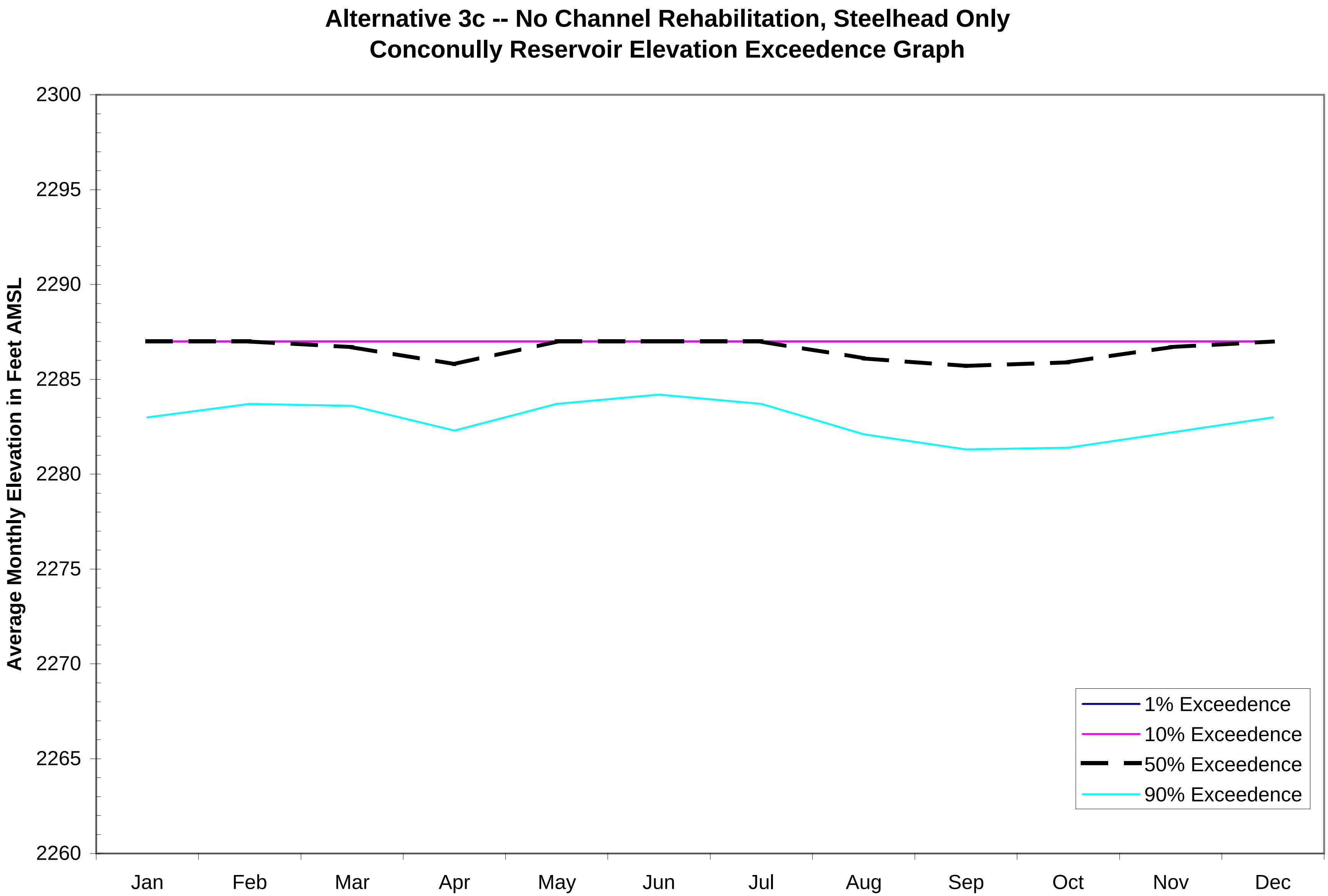
Alternative 3c -- No Channel Rehabilitation, Steelhead Only
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
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2280
2275
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1% Exceedence
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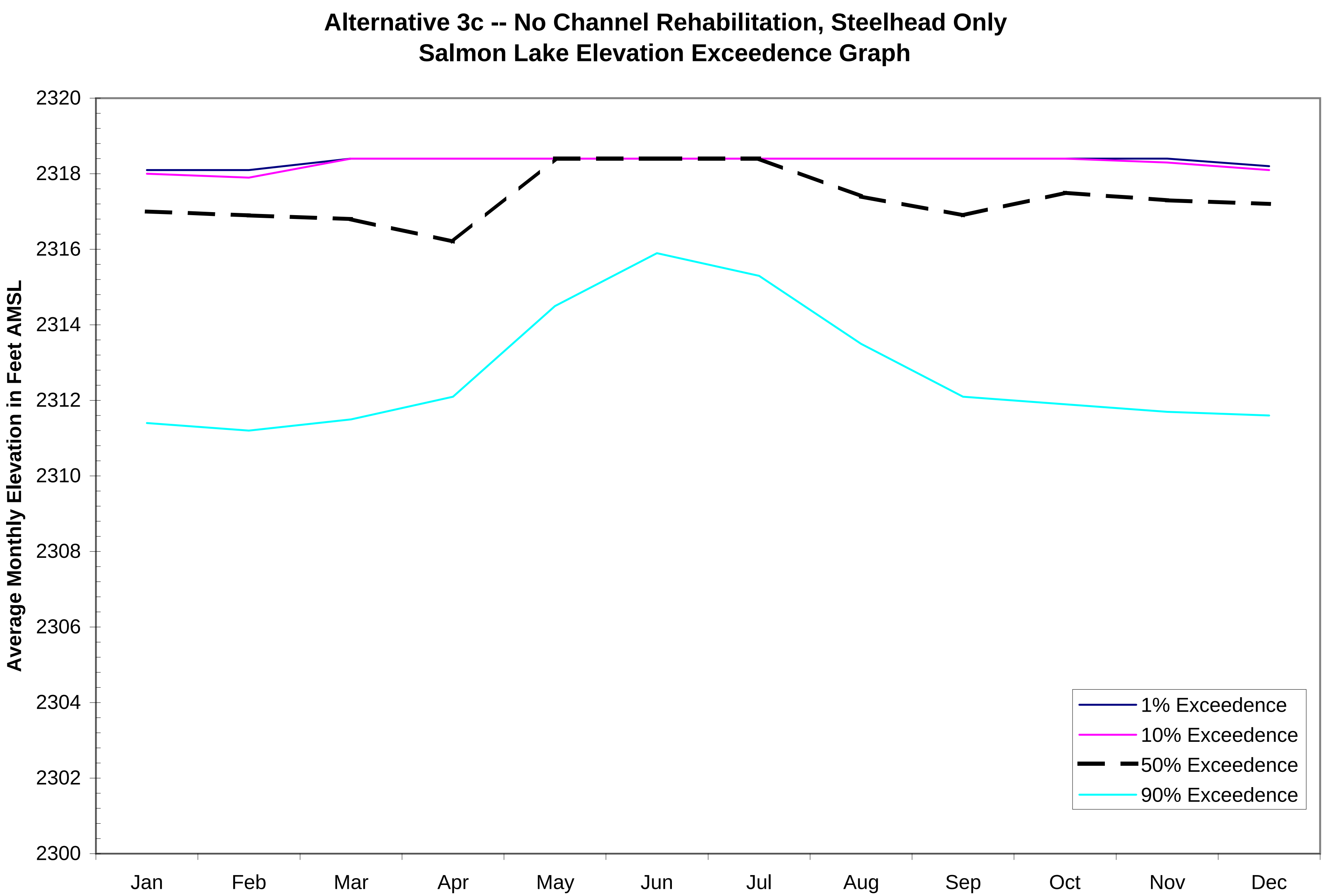
Alternative 3c -- No Channel Rehabilitation, Steelhead Only
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
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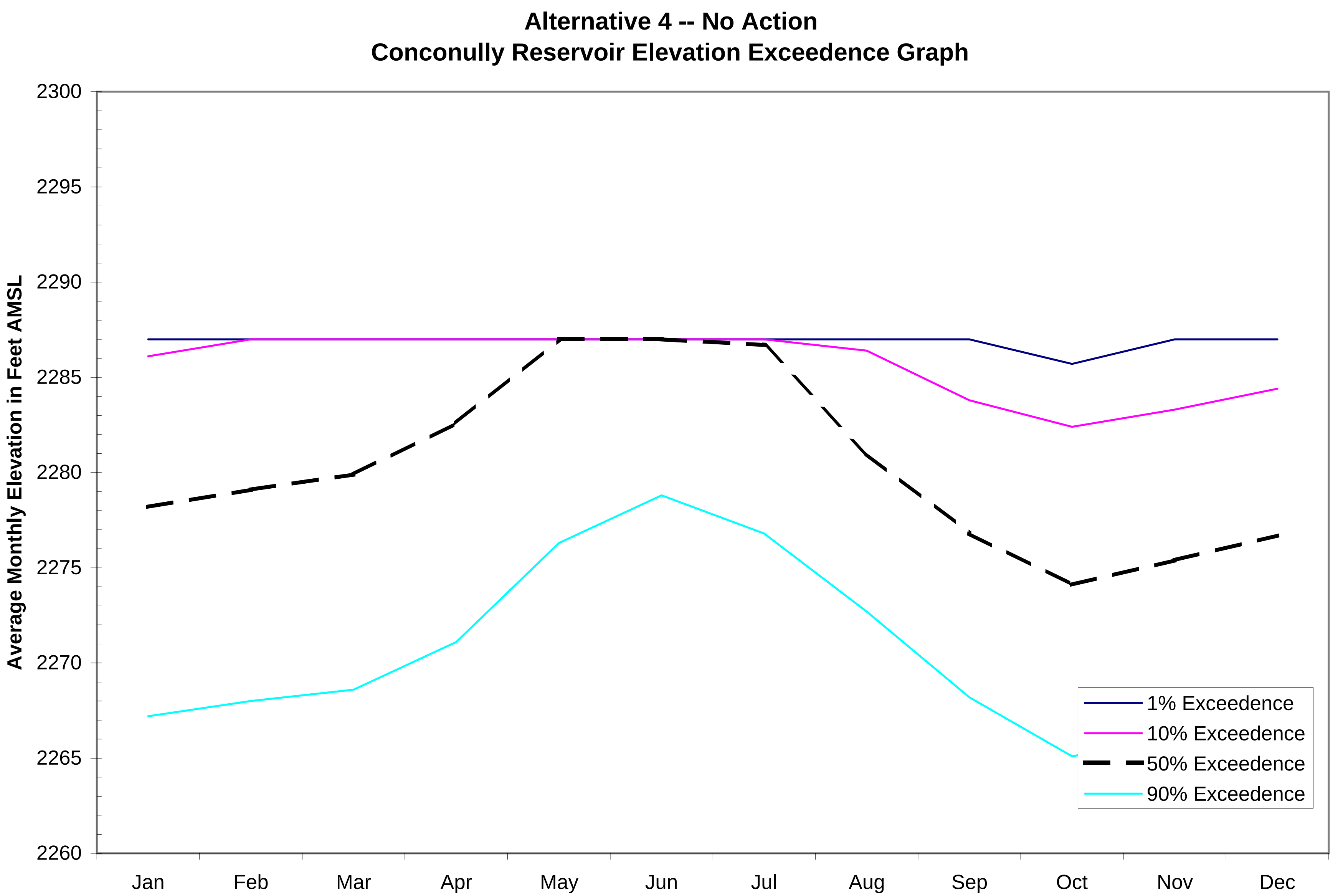
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 4 -- No Action
Conconully Reservoir Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2300
2295
2290
2285
2280
2275
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2265
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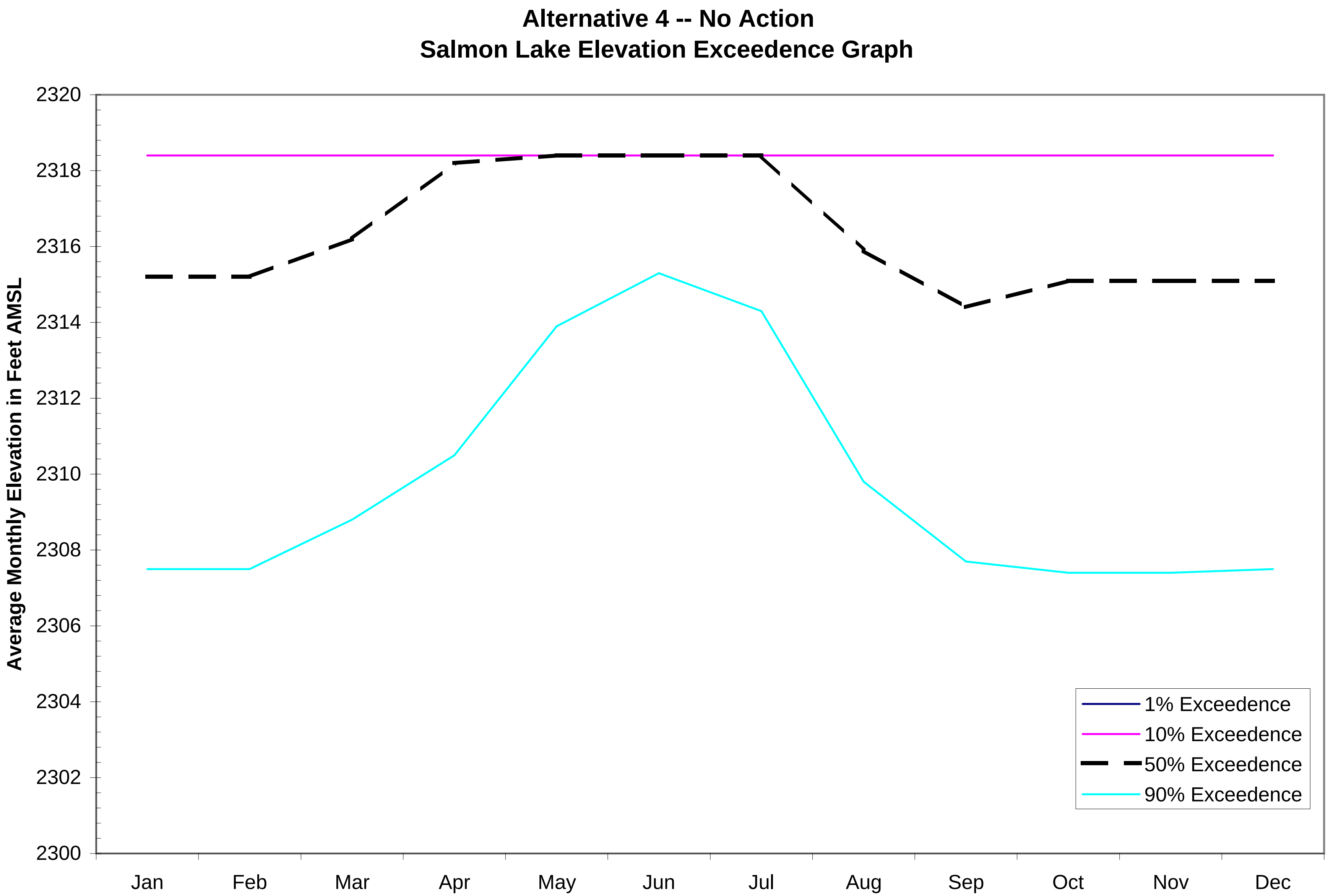
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 4 -- No Action
Salmon Lake Elevation Exceedence Graph
Average Monthly Elevation in Feet AMSL
2320
2318
2316
2314
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2310
2308
2306
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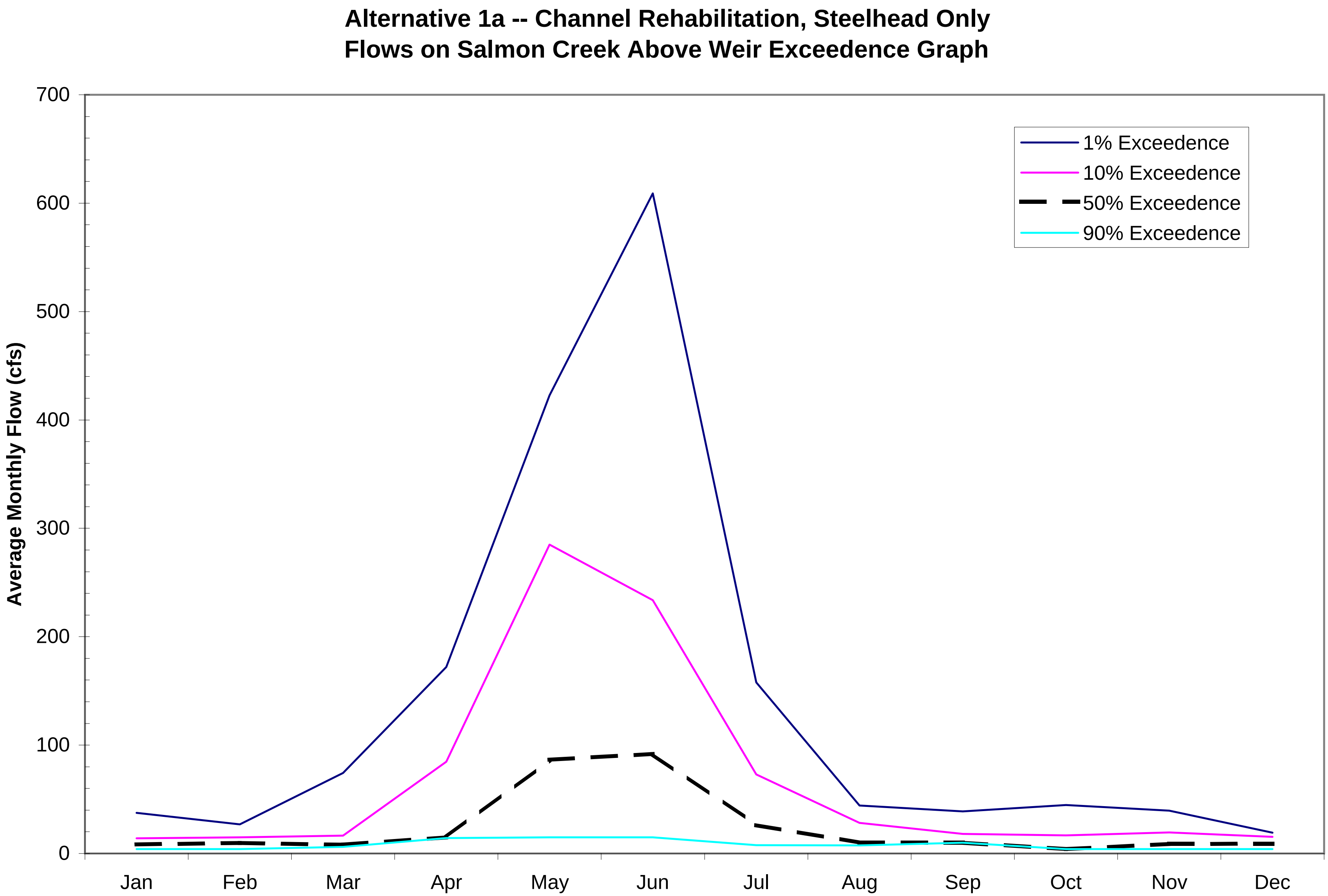
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

APPENDIX D-3:
Simulated Salmon Creek Streamflow Exceedance Curves


Alternative 1a -- Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
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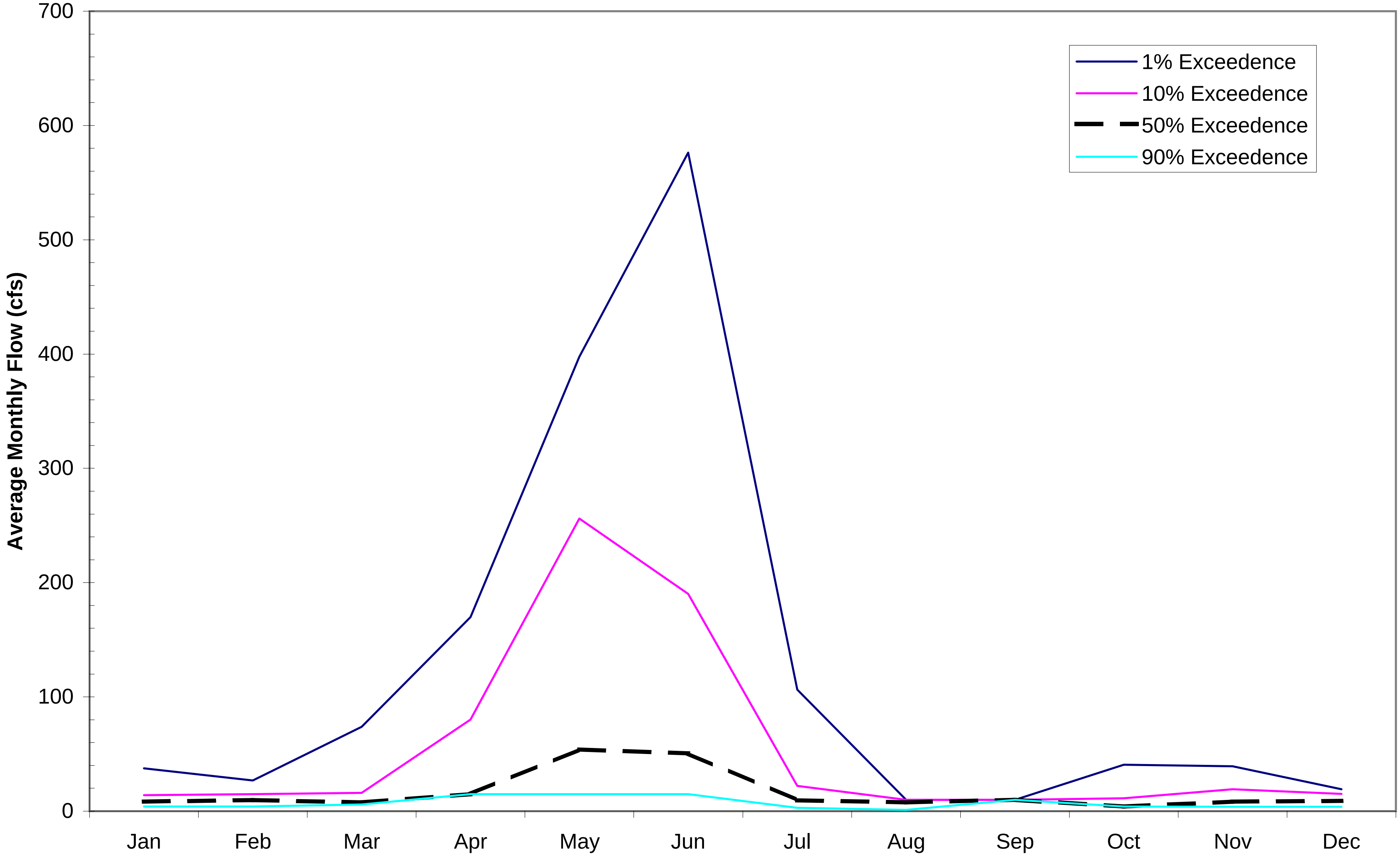
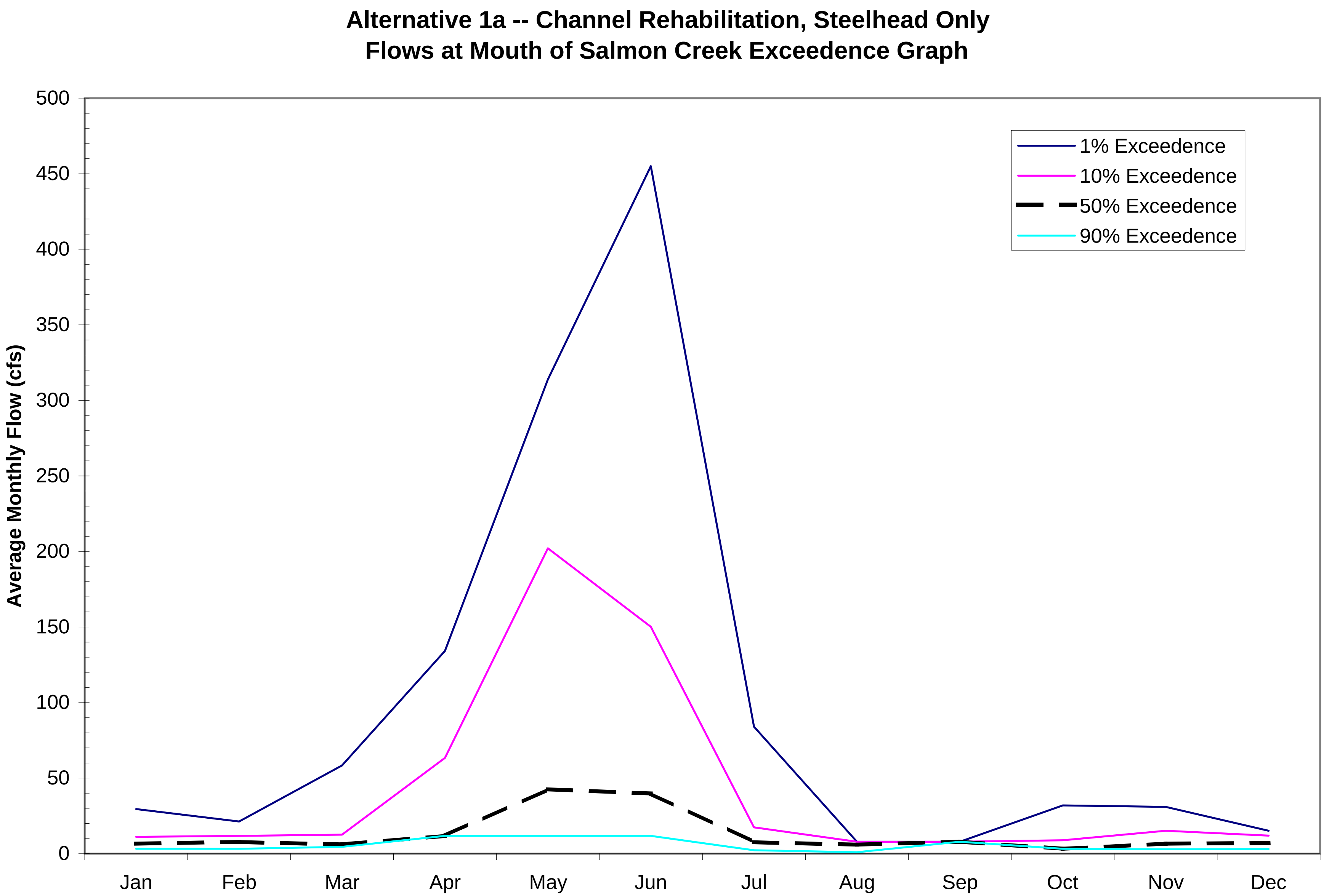
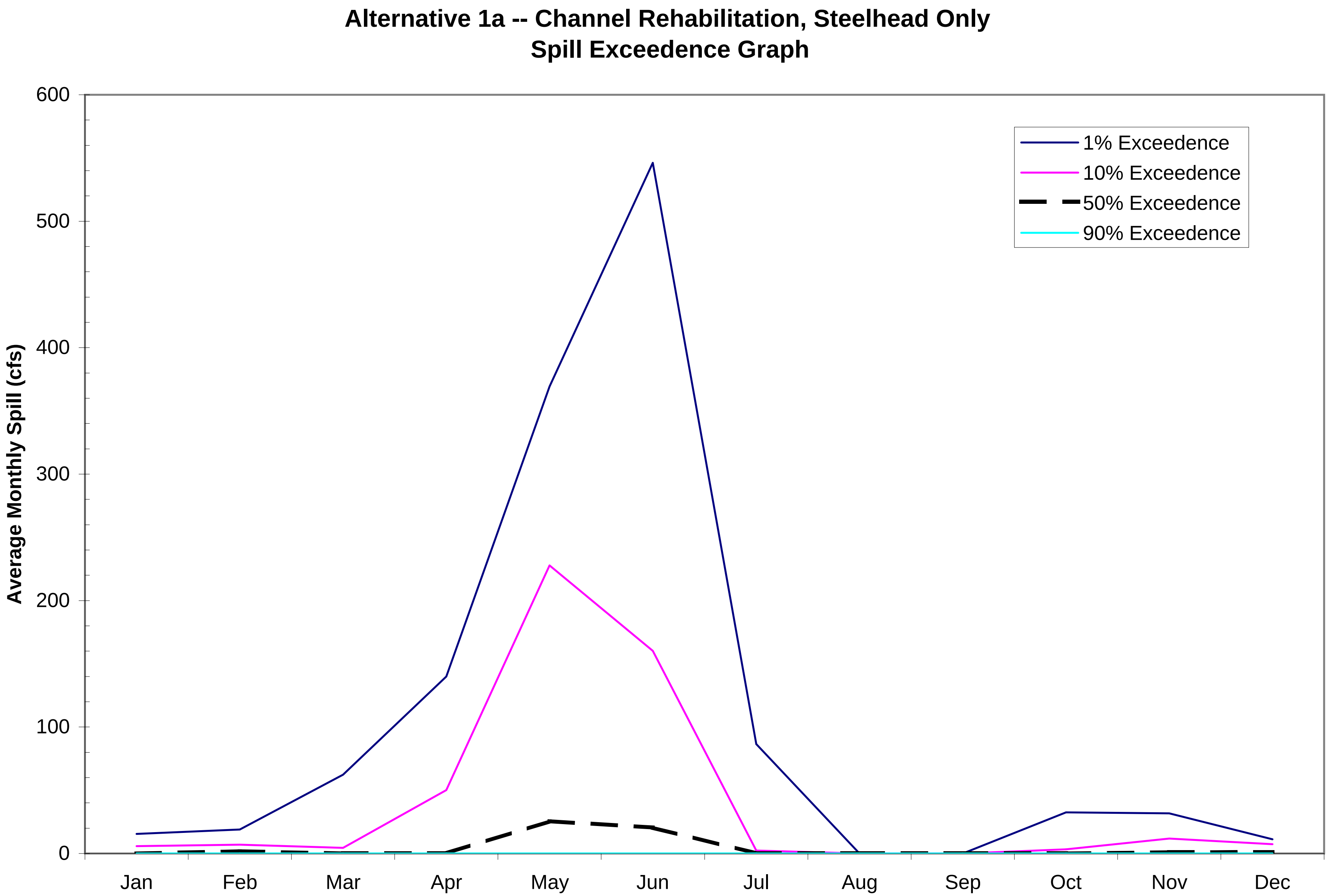
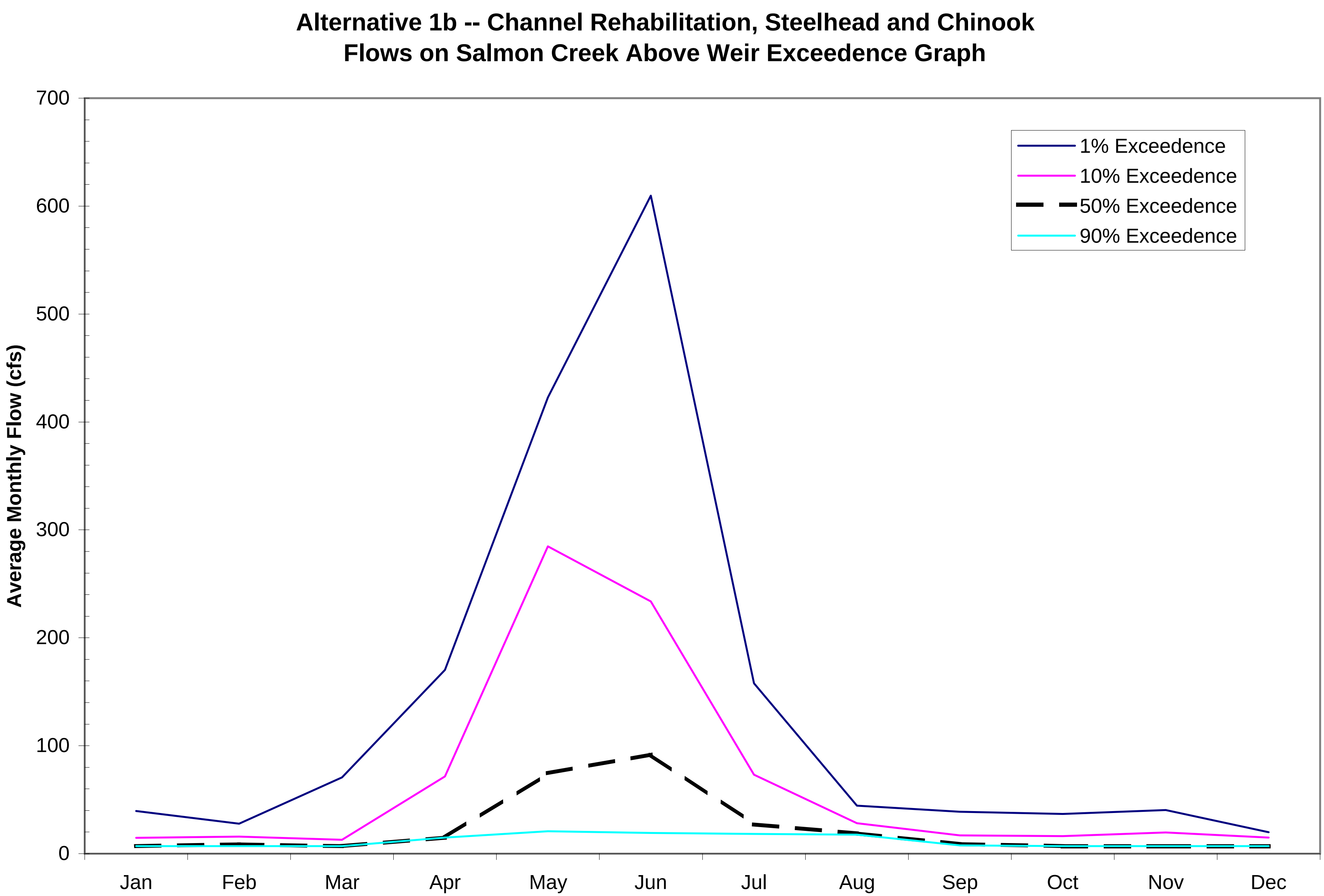
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

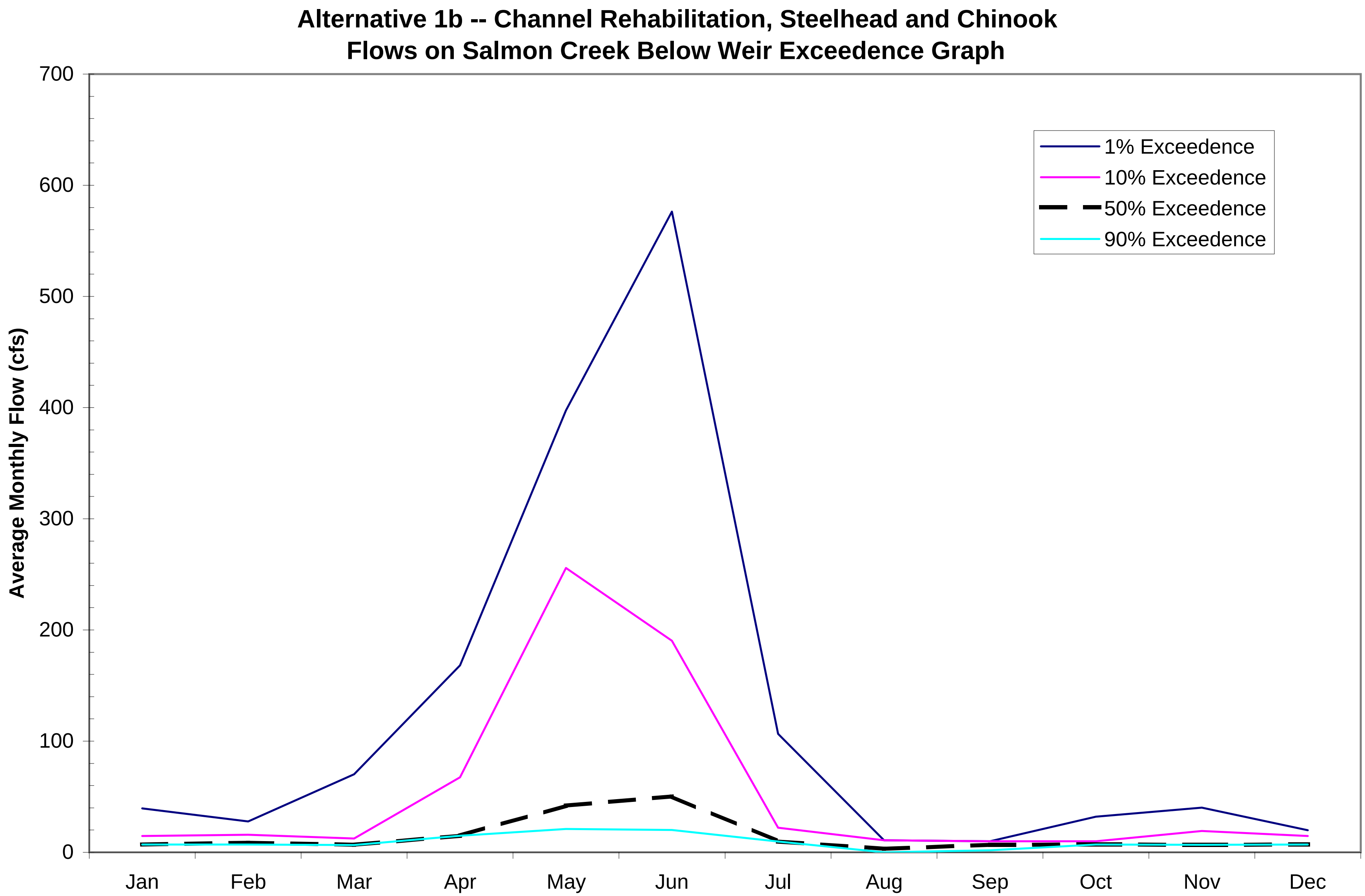
Alternative 1a -- Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Below Weir Exceedence Graph

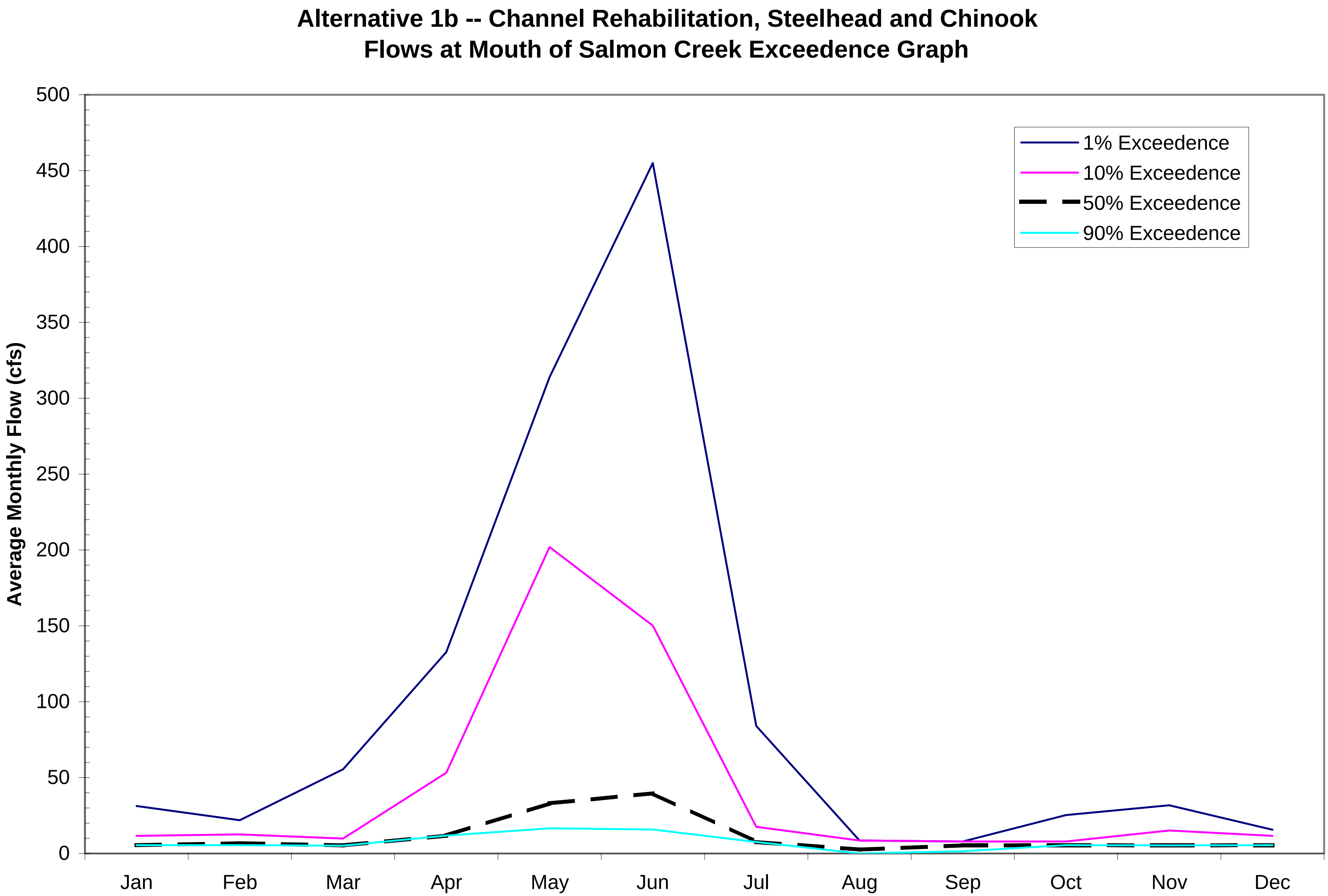


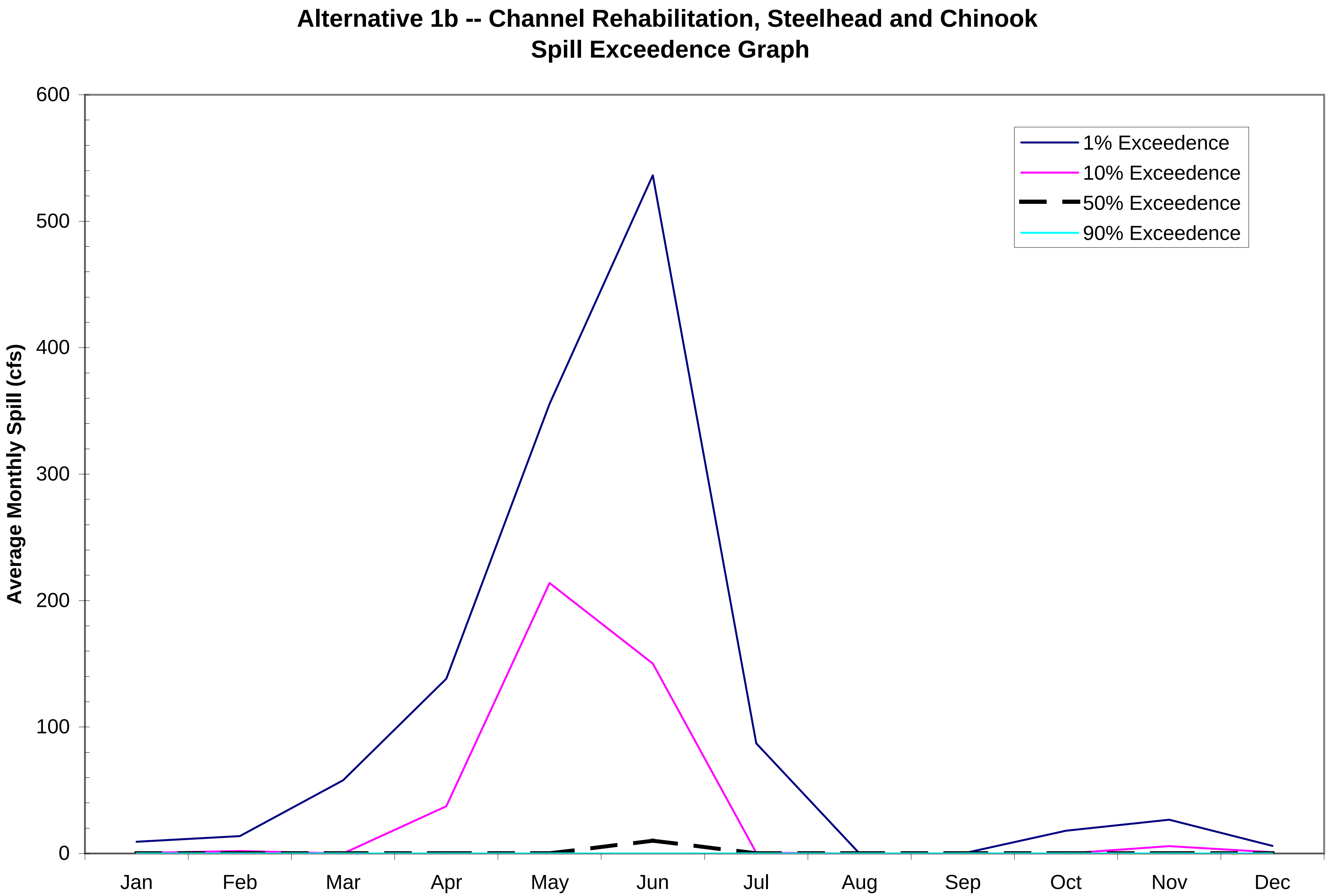

Alternative 1a -- Channel Rehabilitation, Steelhead Only
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
0
50
100
150
200
250
300
350
400
450
500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

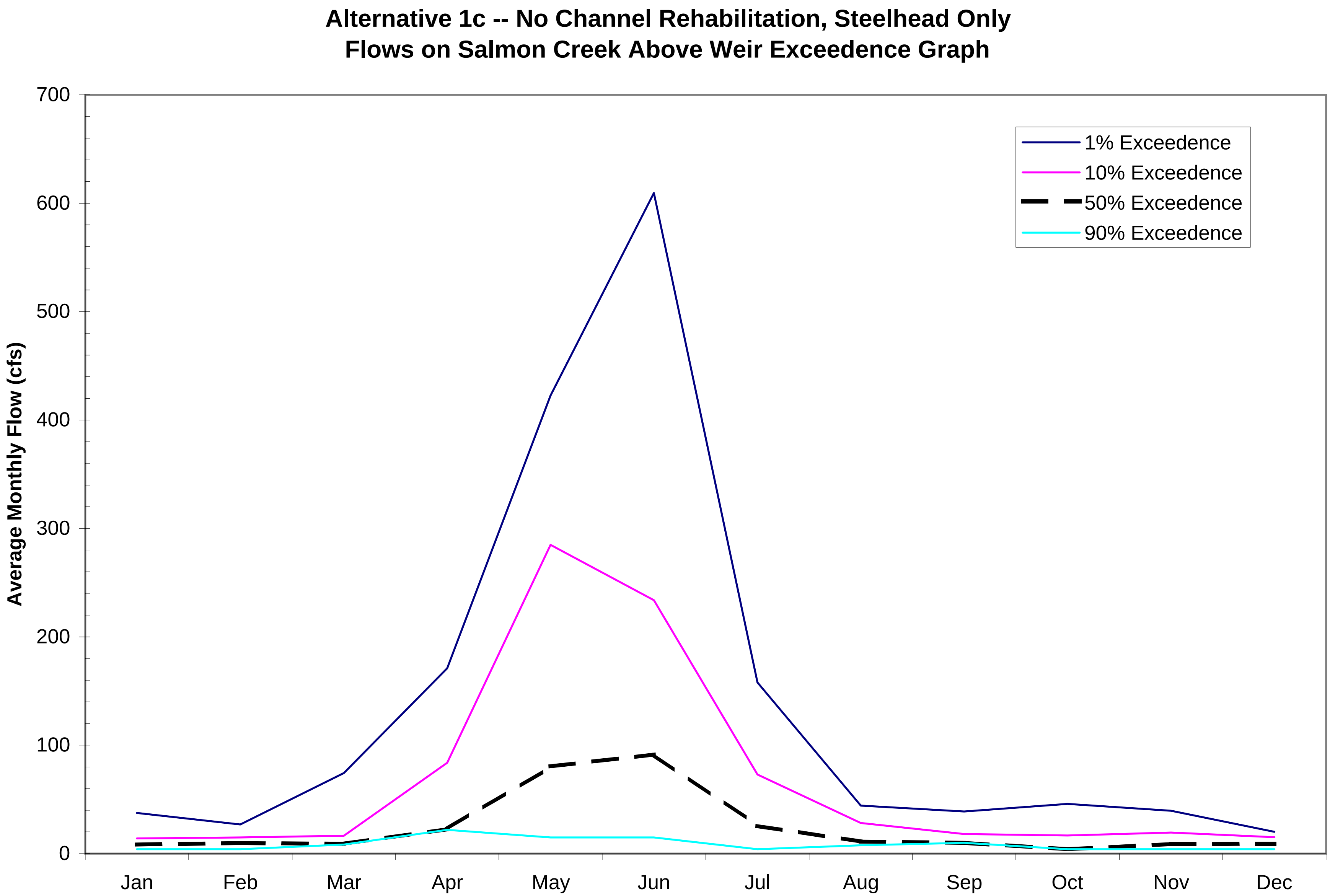

Alternative 1a -- Channel Rehabilitation, Steelhead Only
Spill Exceedence Graph
Average Monthly Spill (cfs)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

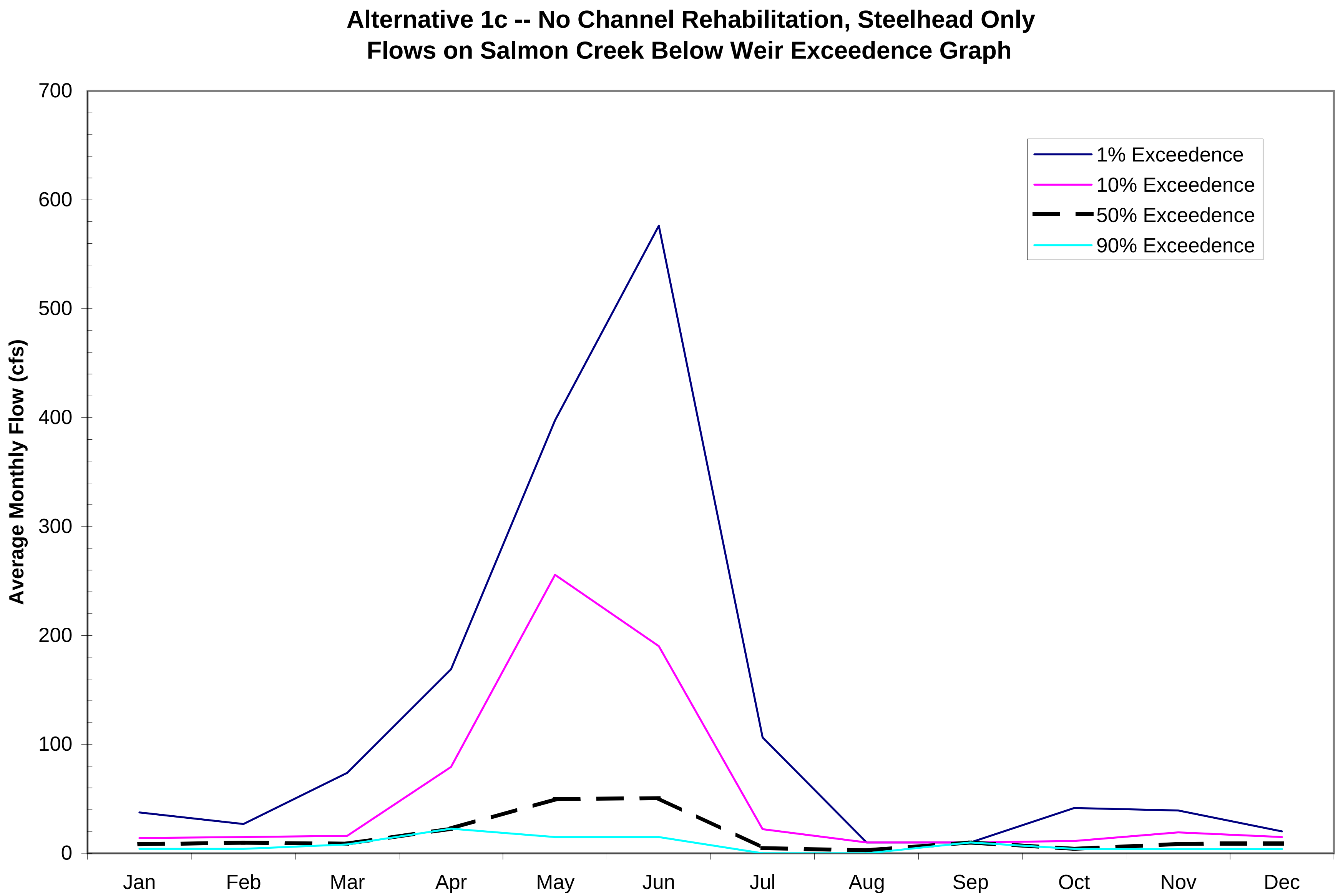

Alternative 1b -- Channel Rehabilitation, Steelhead and Chinook
Flows on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

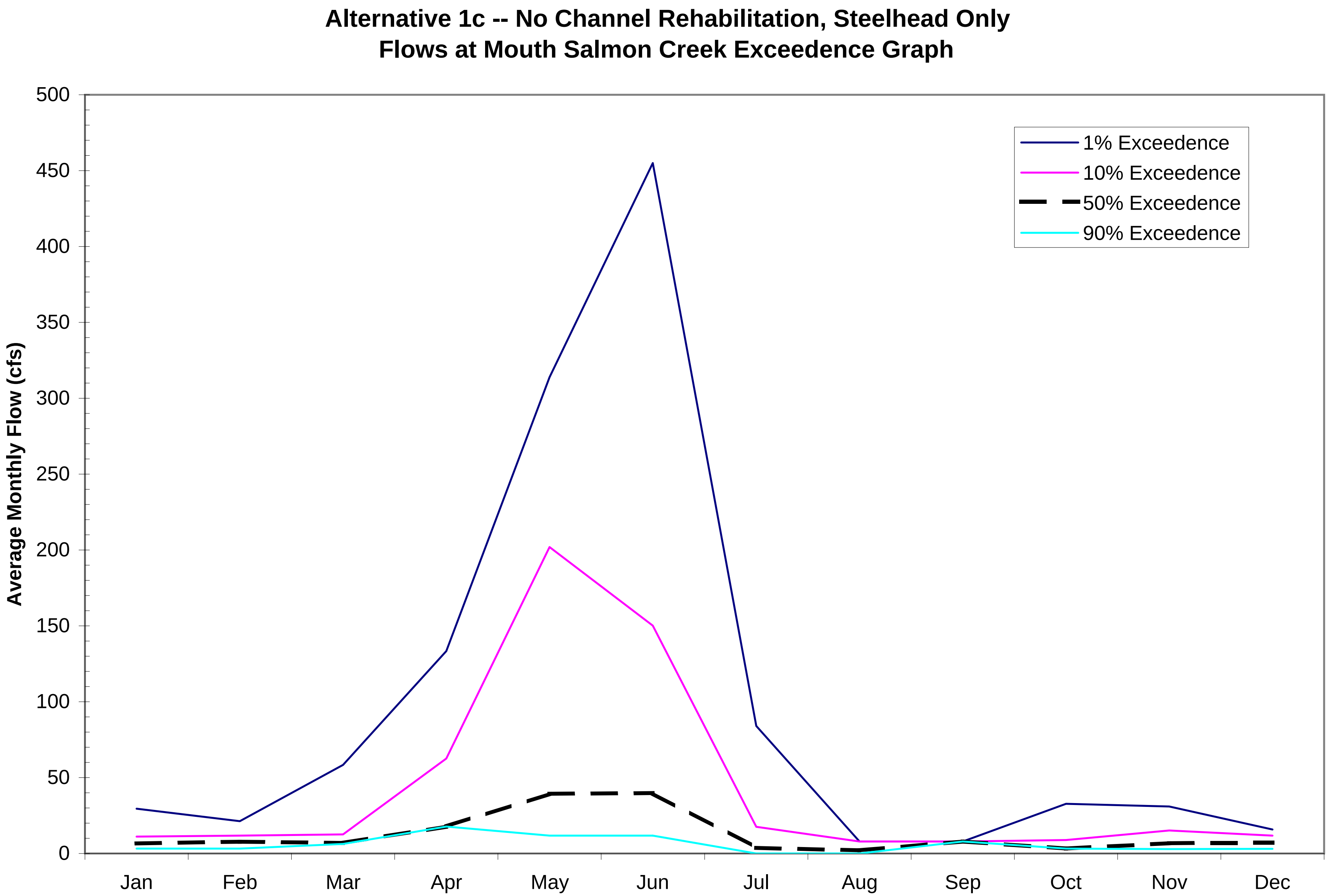

Alternative 1b -- Channel Rehabilitation, Steelhead and Chinook
Flows on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1b -- Channel Rehabilitation, Steelhead and Chinook
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

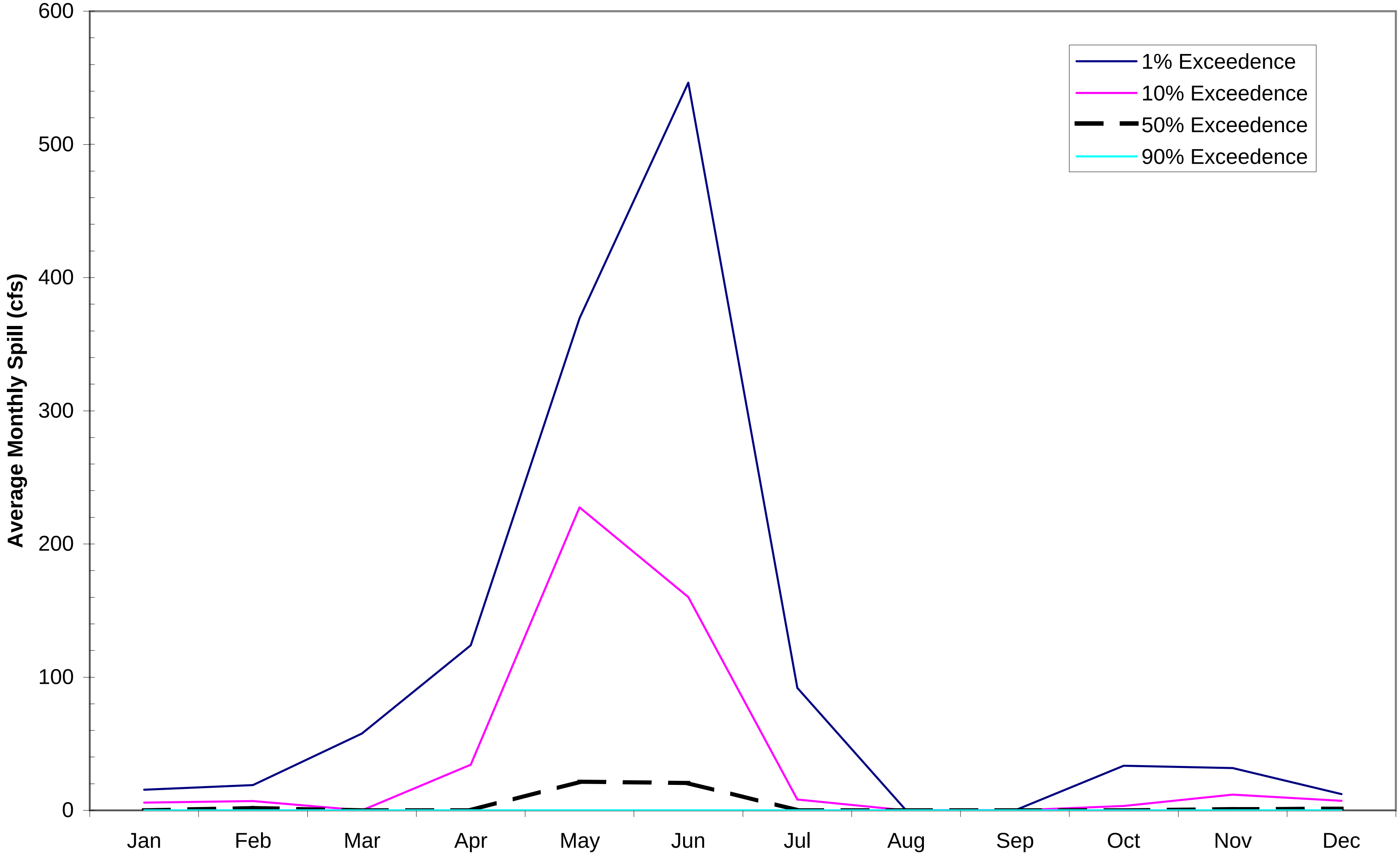

Alternative 1b -- Channel Rehabilitation, Steelhead and Chinook
Spill Exceedence Graph
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence
Average Monthly Spill (cfs)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

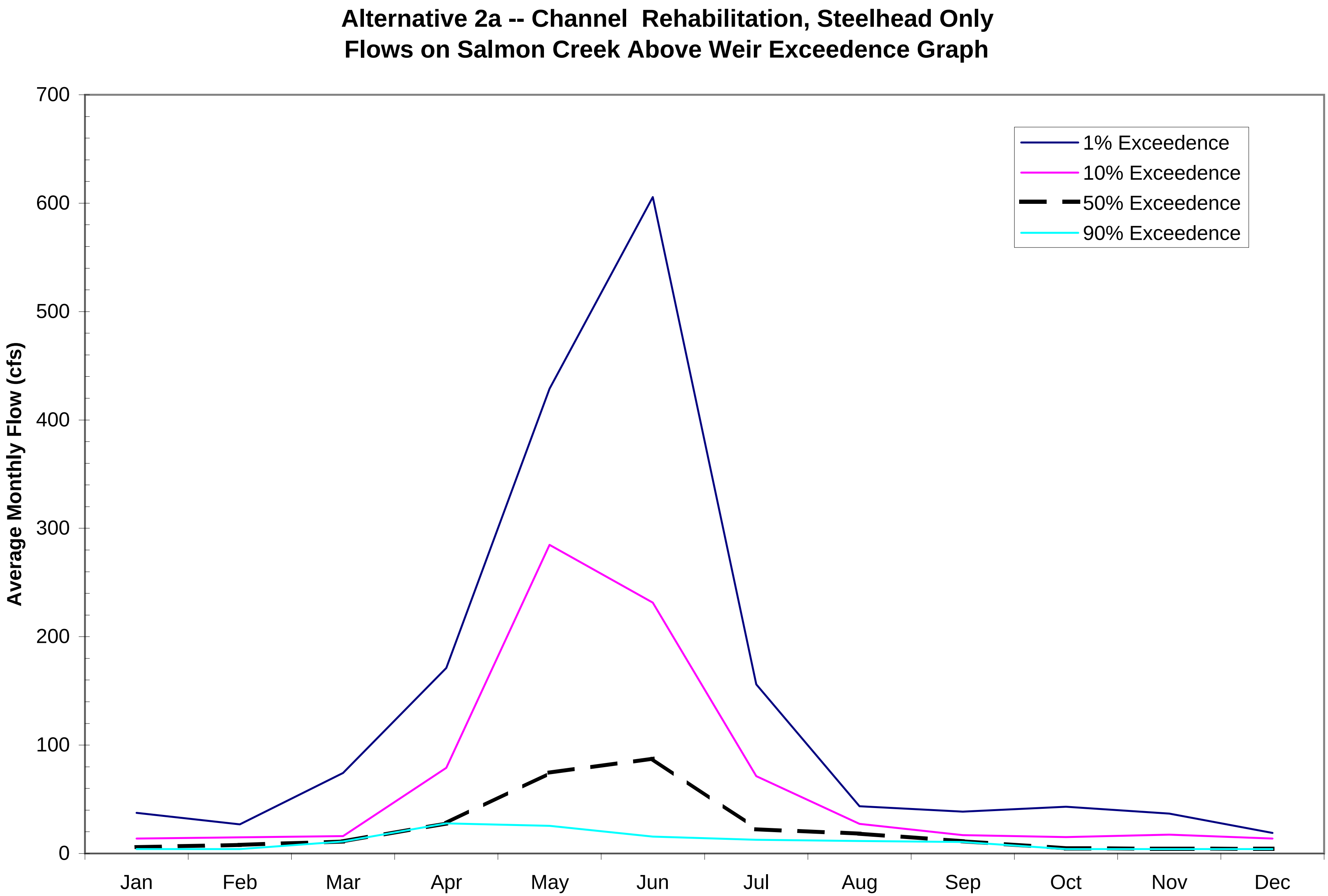

Alternative 1c -- No Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1c -- No Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 1c -- No Channel Rehabilitation, Steelhead Only
Flows at Mouth Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

Alternative 1c -- No Channel Rehabilitation, Steelhead Only
Spill Exceedence Graph




Alternative 2a -- Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Above Weir Exceedence Graph
700
600
500
400
300
200
100
0
Average Monthly Flow (cfs)
Jan
Feb
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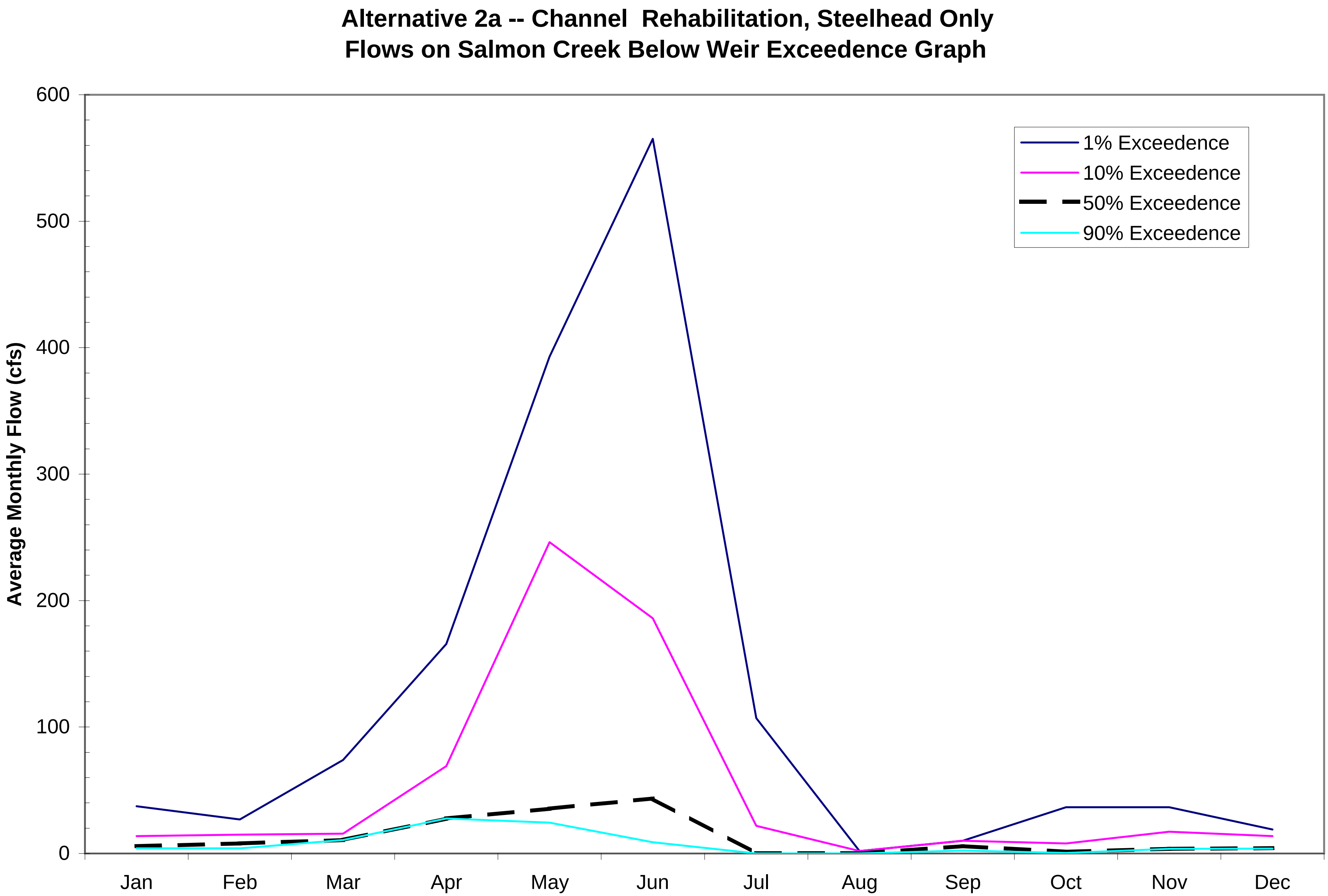
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2a -- Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
600
500
400
300
200
100
0
Jan
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Jun
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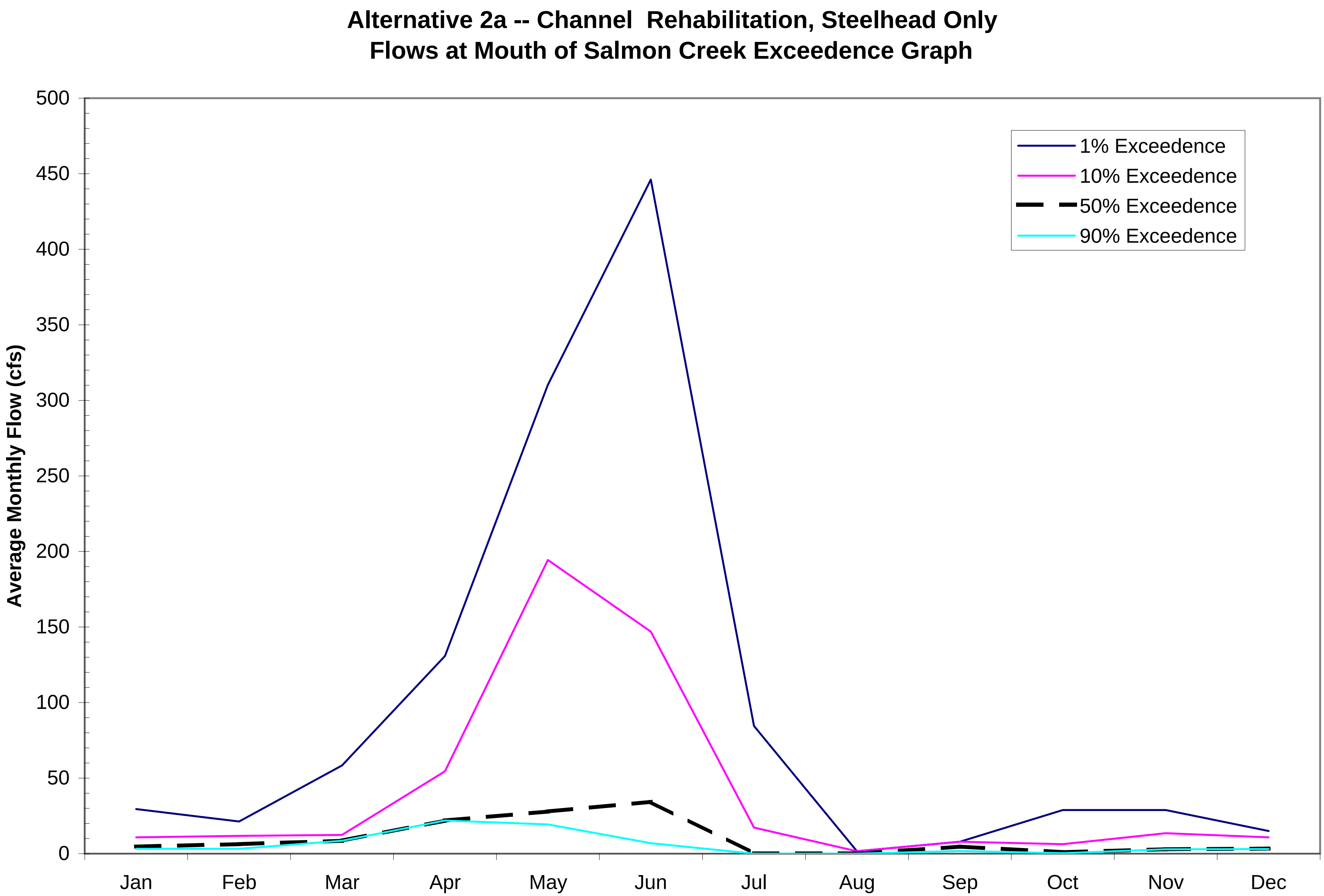
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2a -- Channel Rehabilitation, Steelhead Only
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
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0
Jan
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May
Jun
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Aug
Sep
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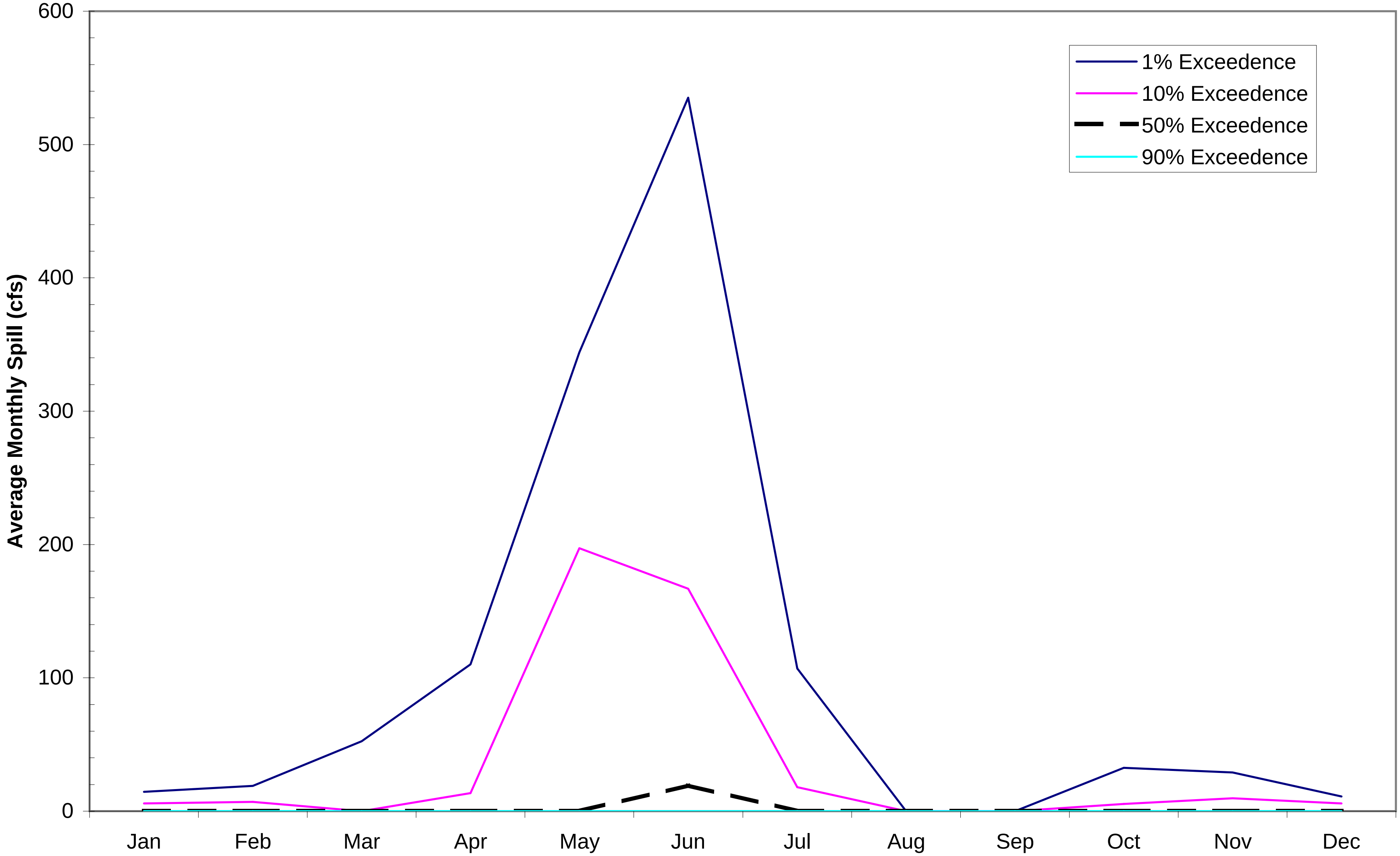
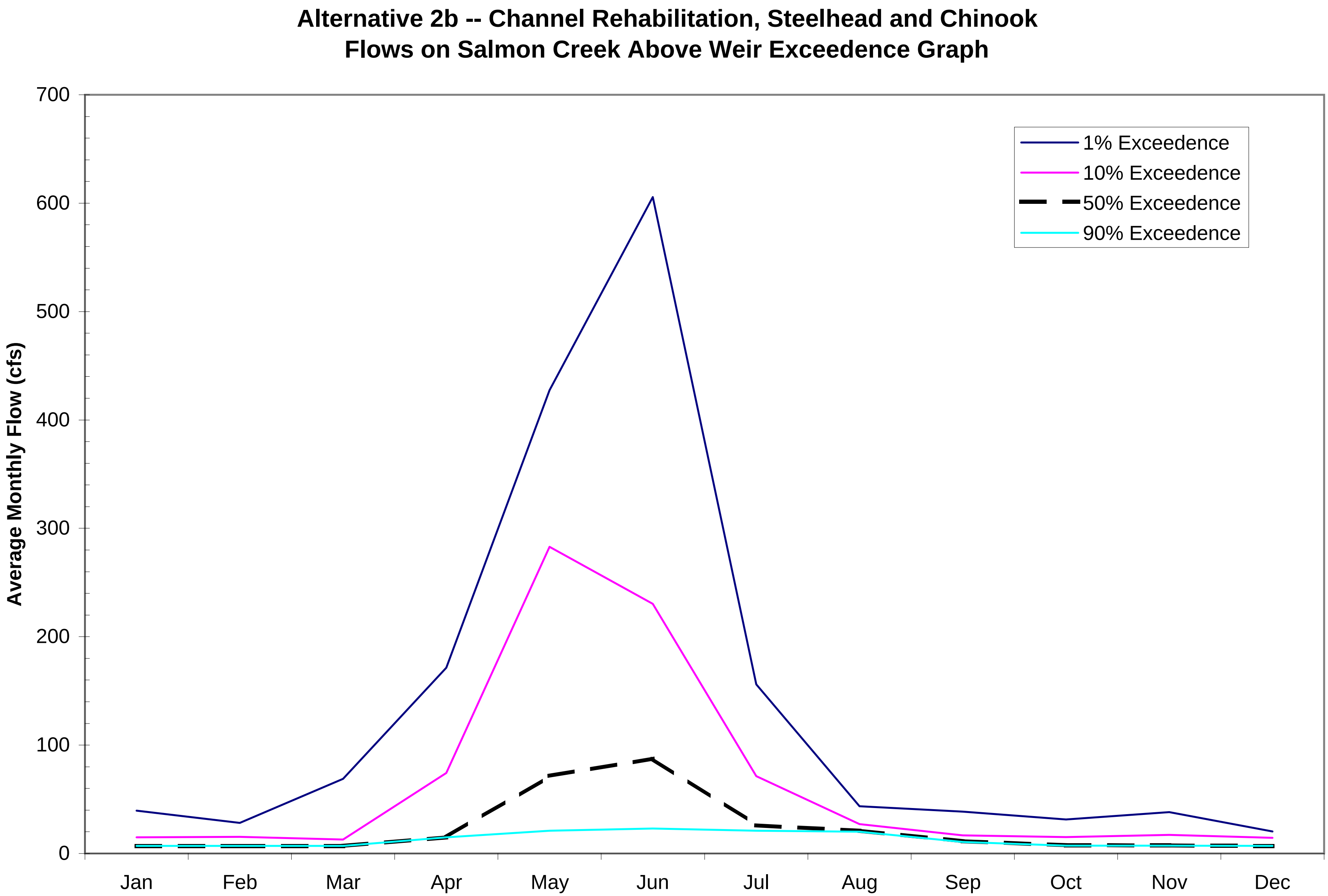
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

Alternative 2a -- Channel Rehabilitation, Steelhead Only
Spill Exceedence Graph




Alternative 2b -- Channel Rehabilitation, Steelhead and Chinook
Flows on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
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May
Jun
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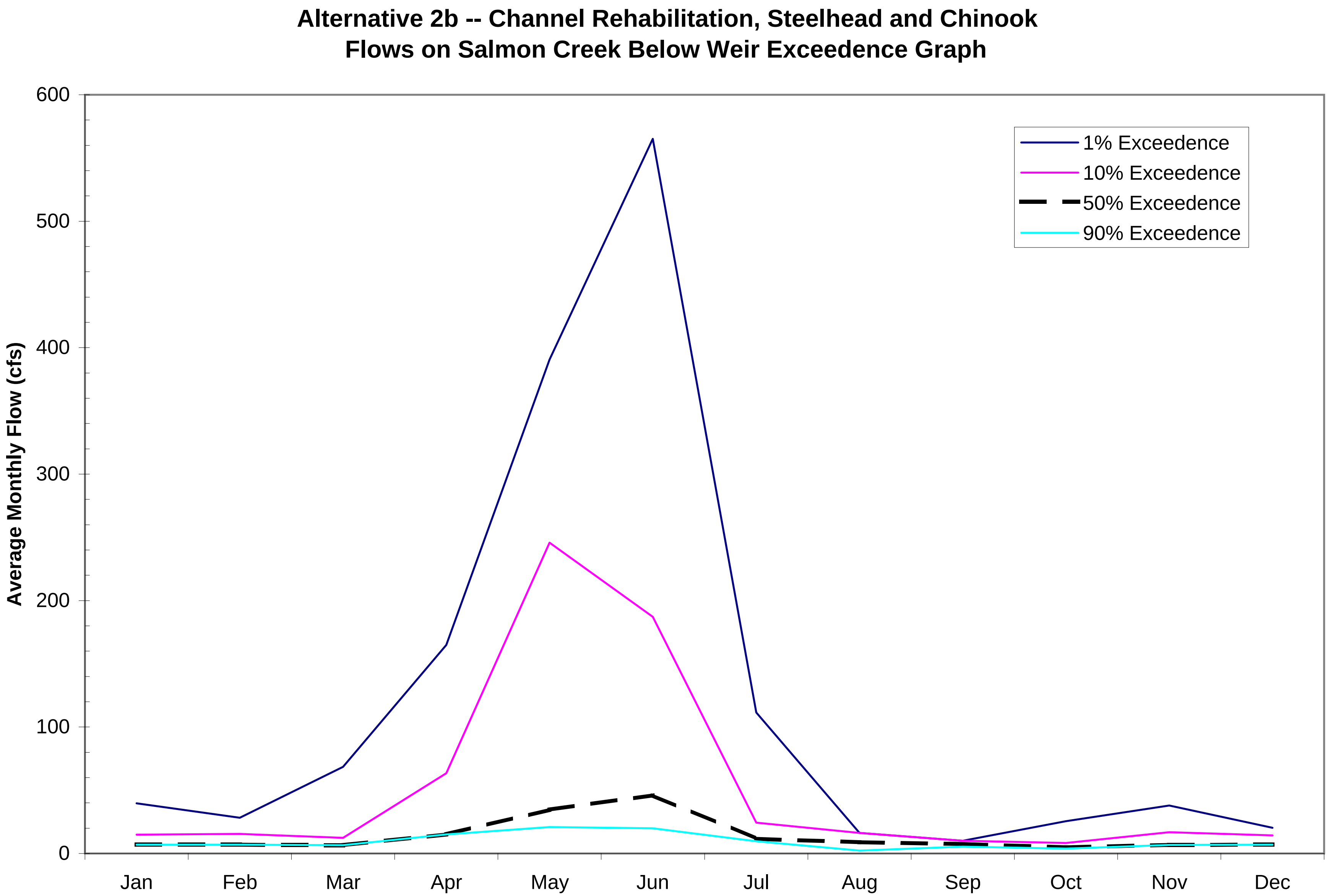
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2b -- Channel Rehabilitation, Steelhead and Chinook
Flows on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
600
500
400
300
200
100
0
Jan
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May
Jun
Jul
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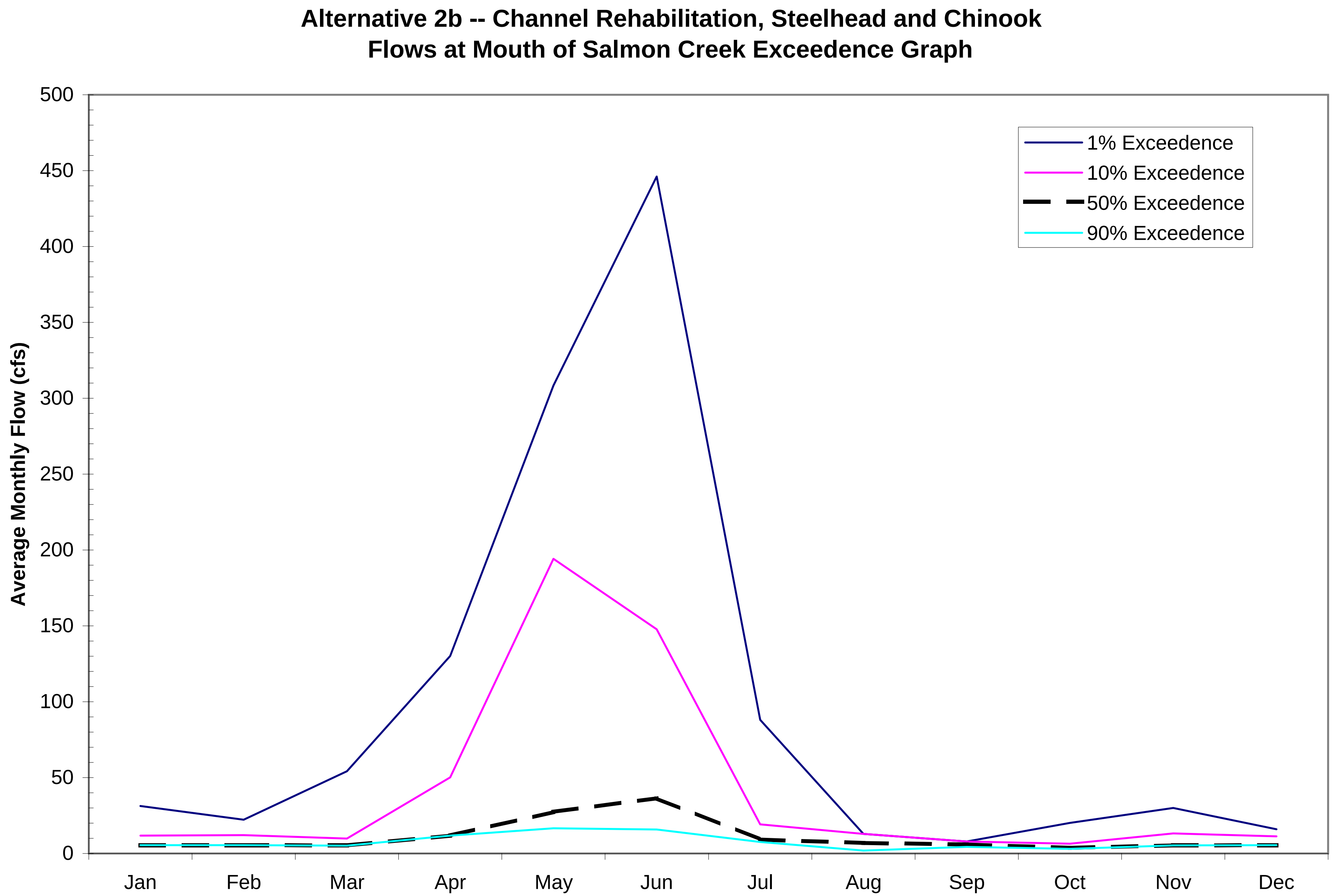
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2b -- Channel Rehabilitation, Steelhead and Chinook
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
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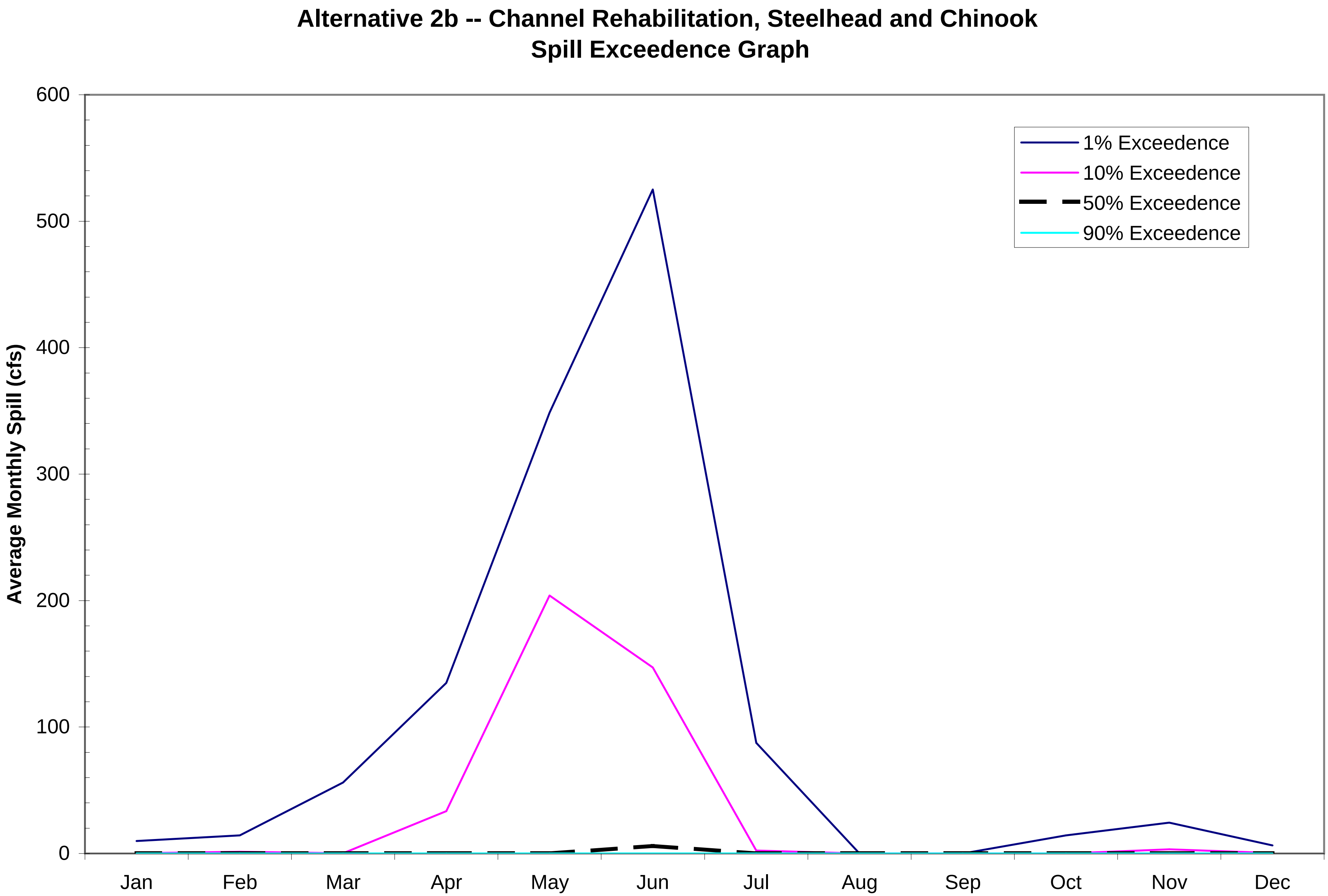
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2b -- Channel Rehabilitation, Steelhead and Chinook
Spill Exceedence Graph
Average Monthly Spill (cfs)
0
100
200
300
400
500
600
Jan
Feb
Mar
Apr
May
Jun
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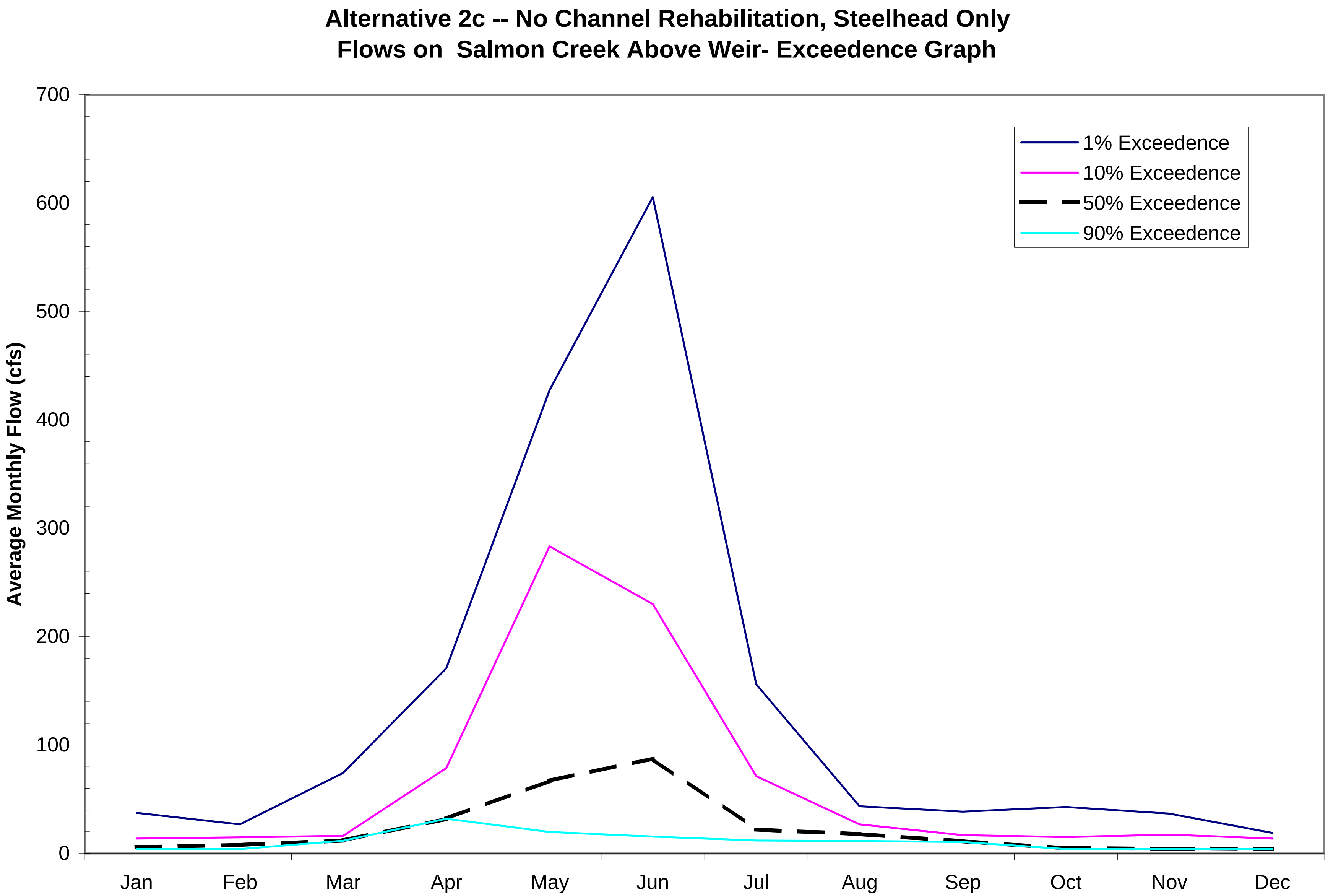
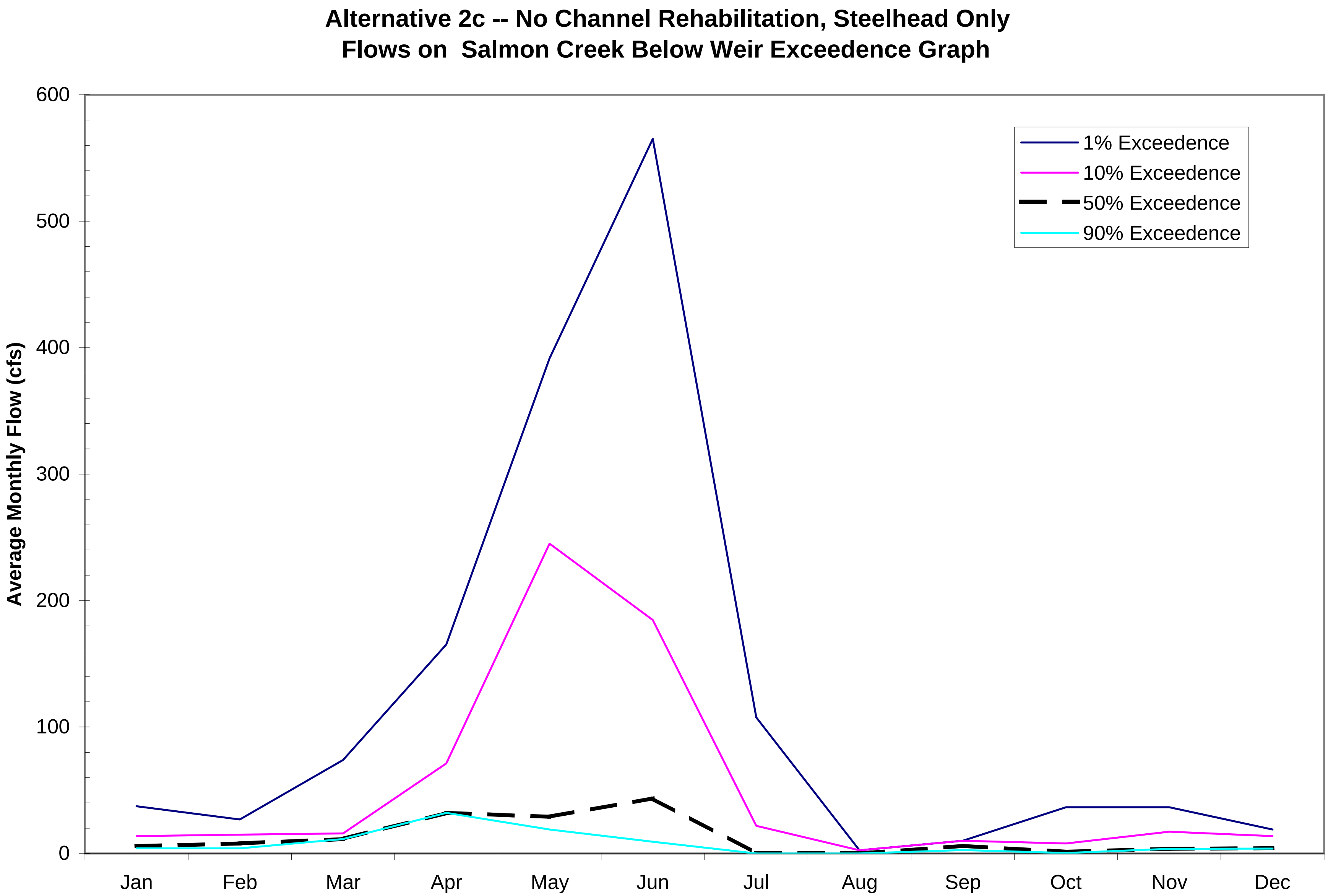
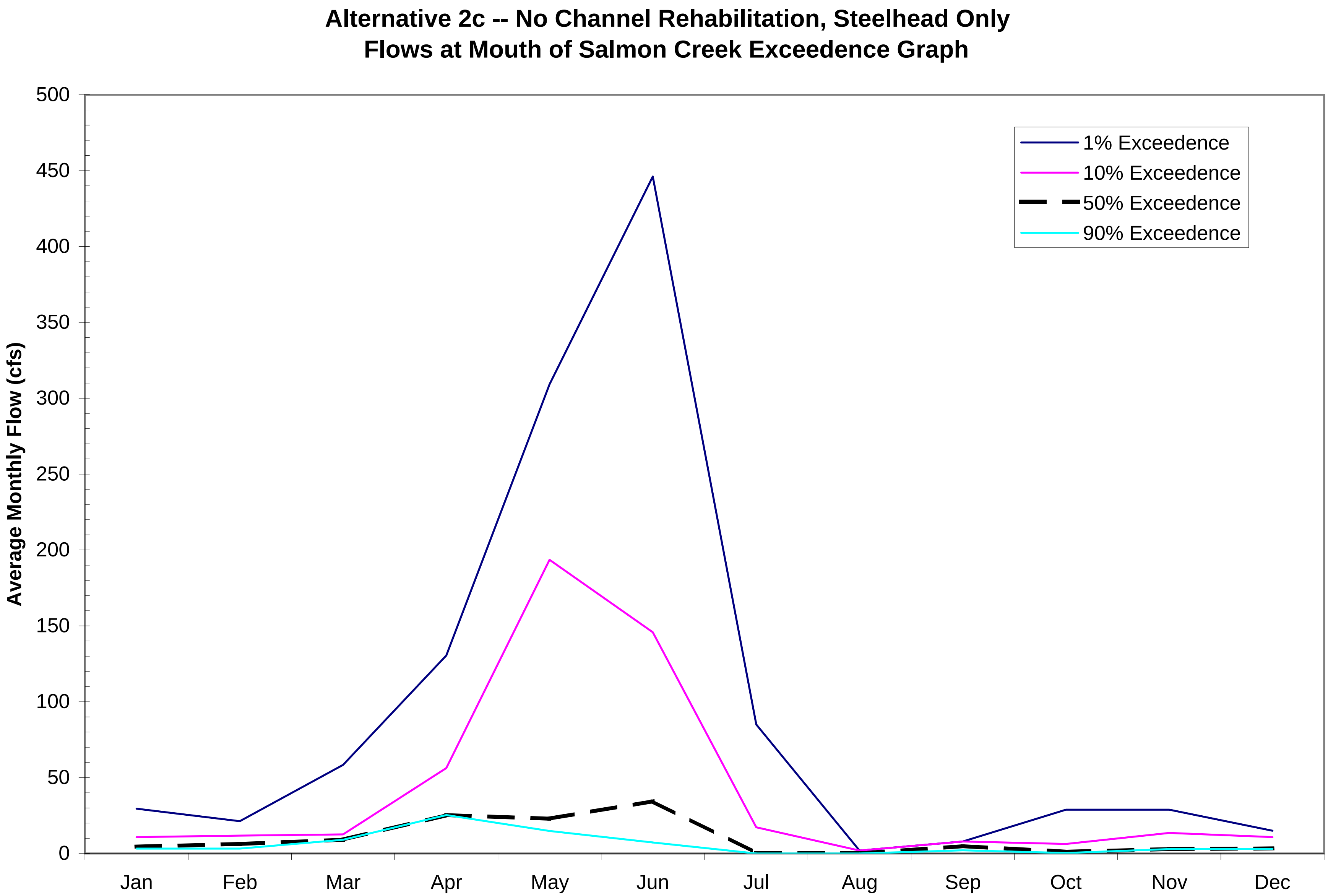
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2c -- No Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Above Weir- Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2c -- No Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2c -- No Channel Rehabilitation, Steelhead Only
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
Feb
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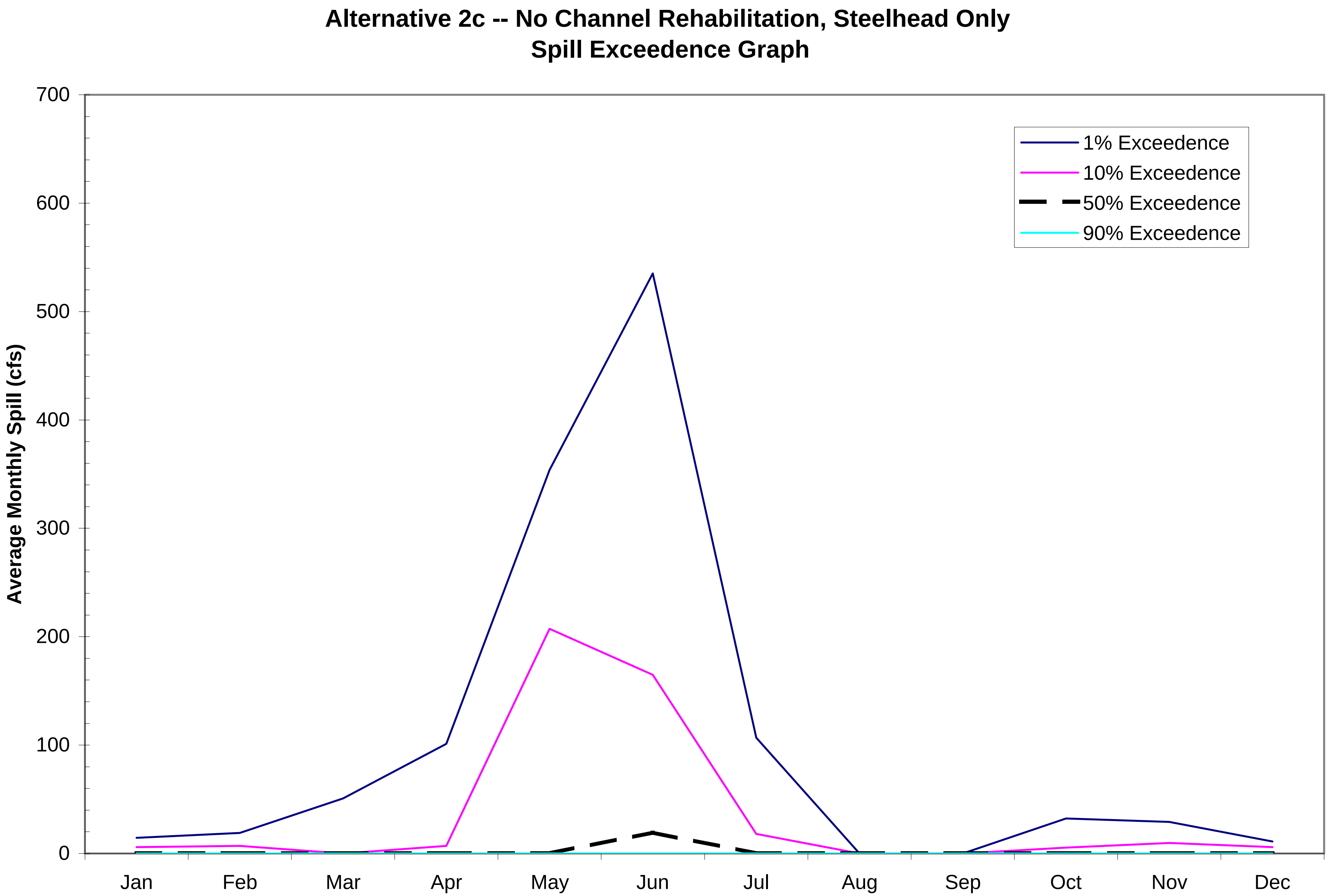
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 2c -- No Channel Rehabilitation, Steelhead Only
Spill Exceedence Graph
Average Monthly Spill (cfs)
700
600
500
400
300
200
100
0
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence
Jan
Feb
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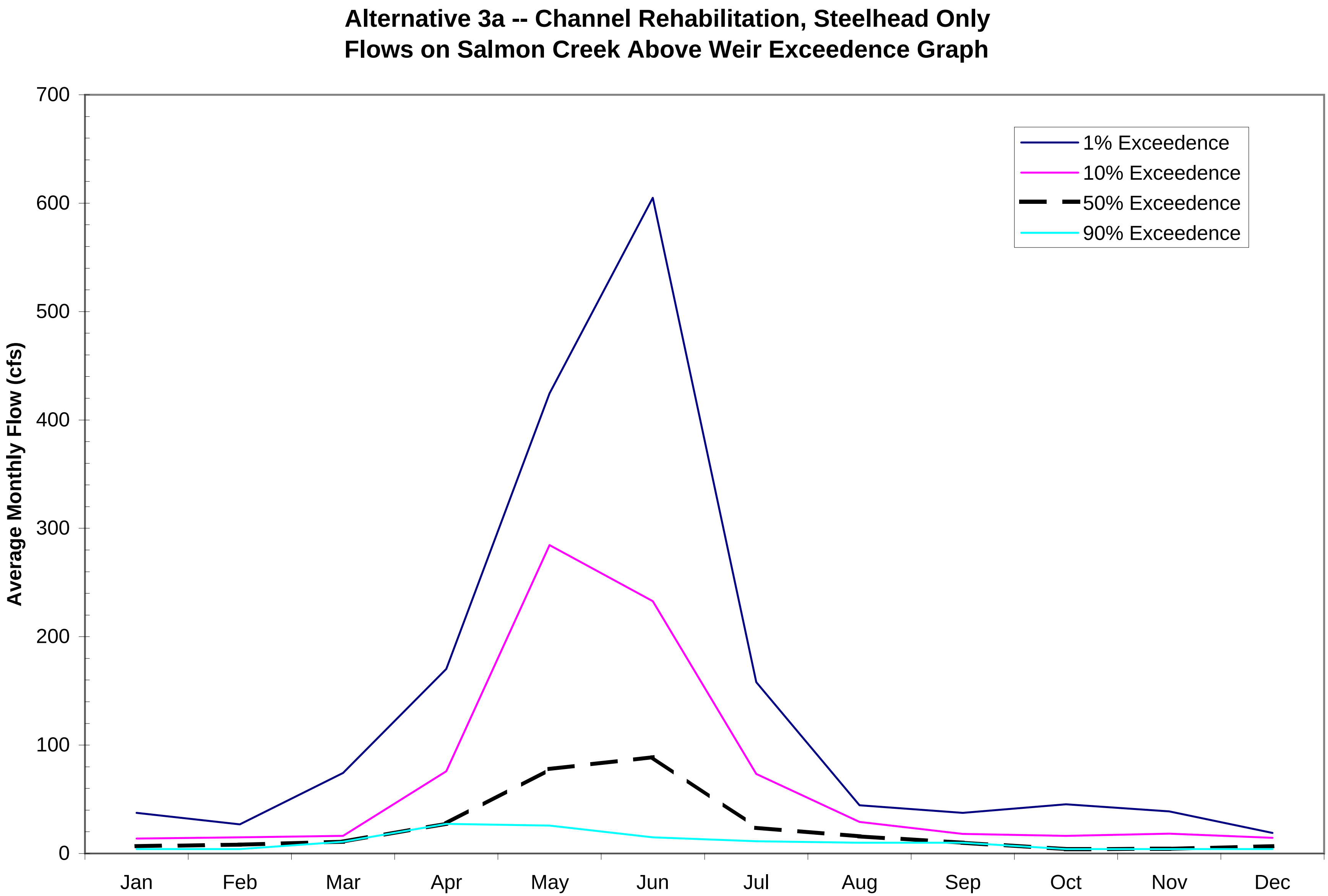
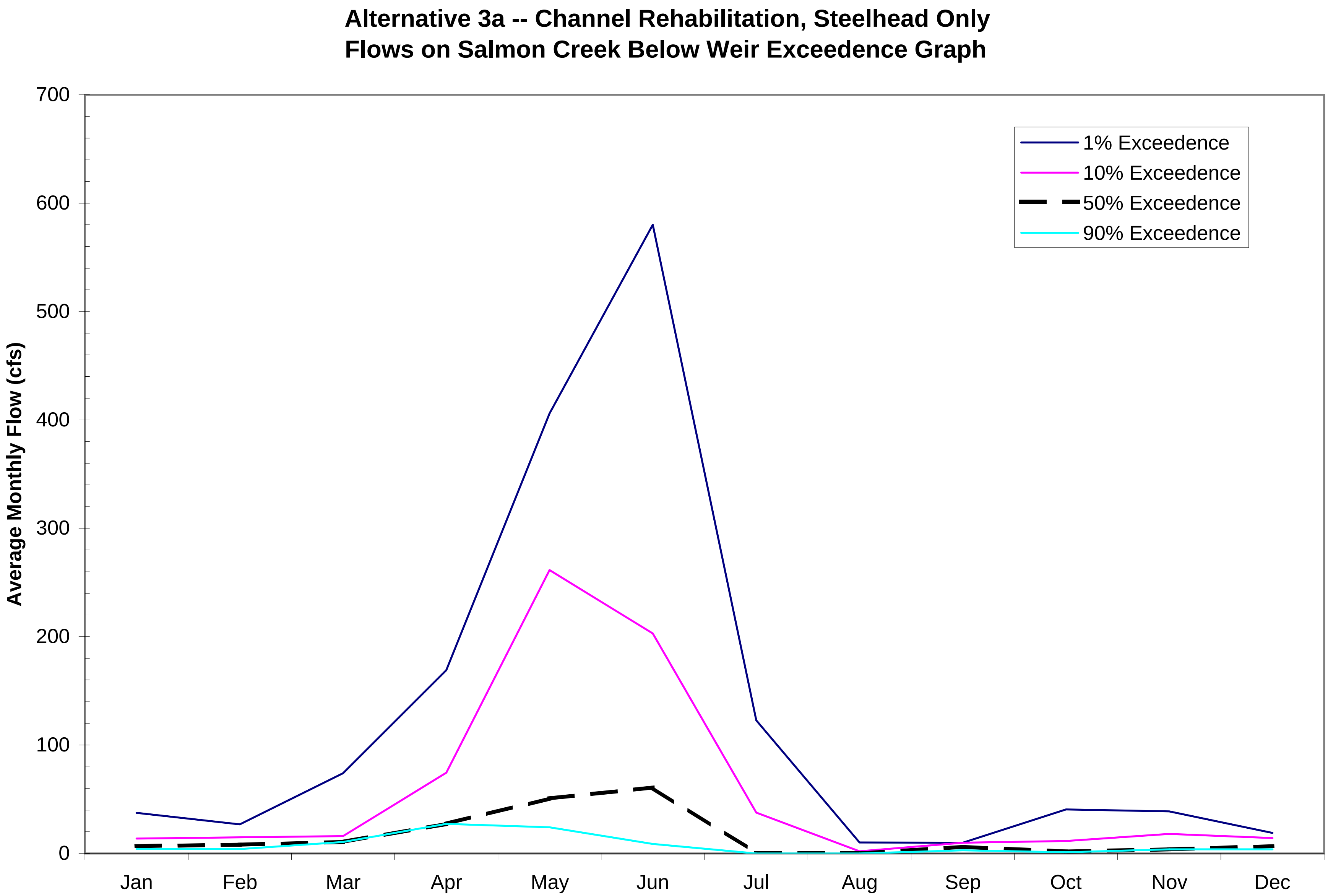
Nov
Dec


Alternative 3a -- Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3a -- Channel Rehabilitation, Steelhead Only
Flows on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
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Apr
May
Jun
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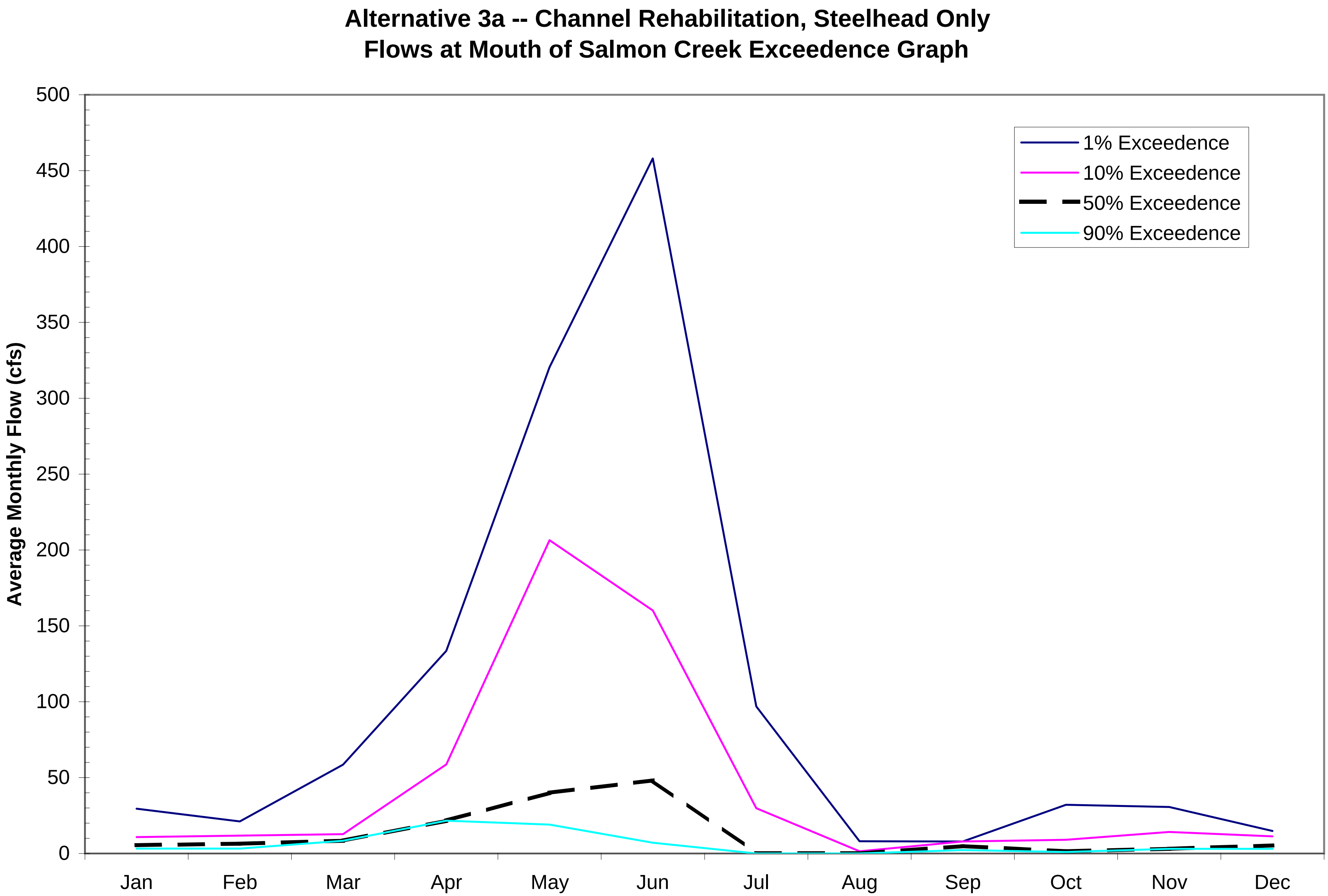
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3a -- Channel Rehabilitation, Steelhead Only
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
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Mar
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May
Jun
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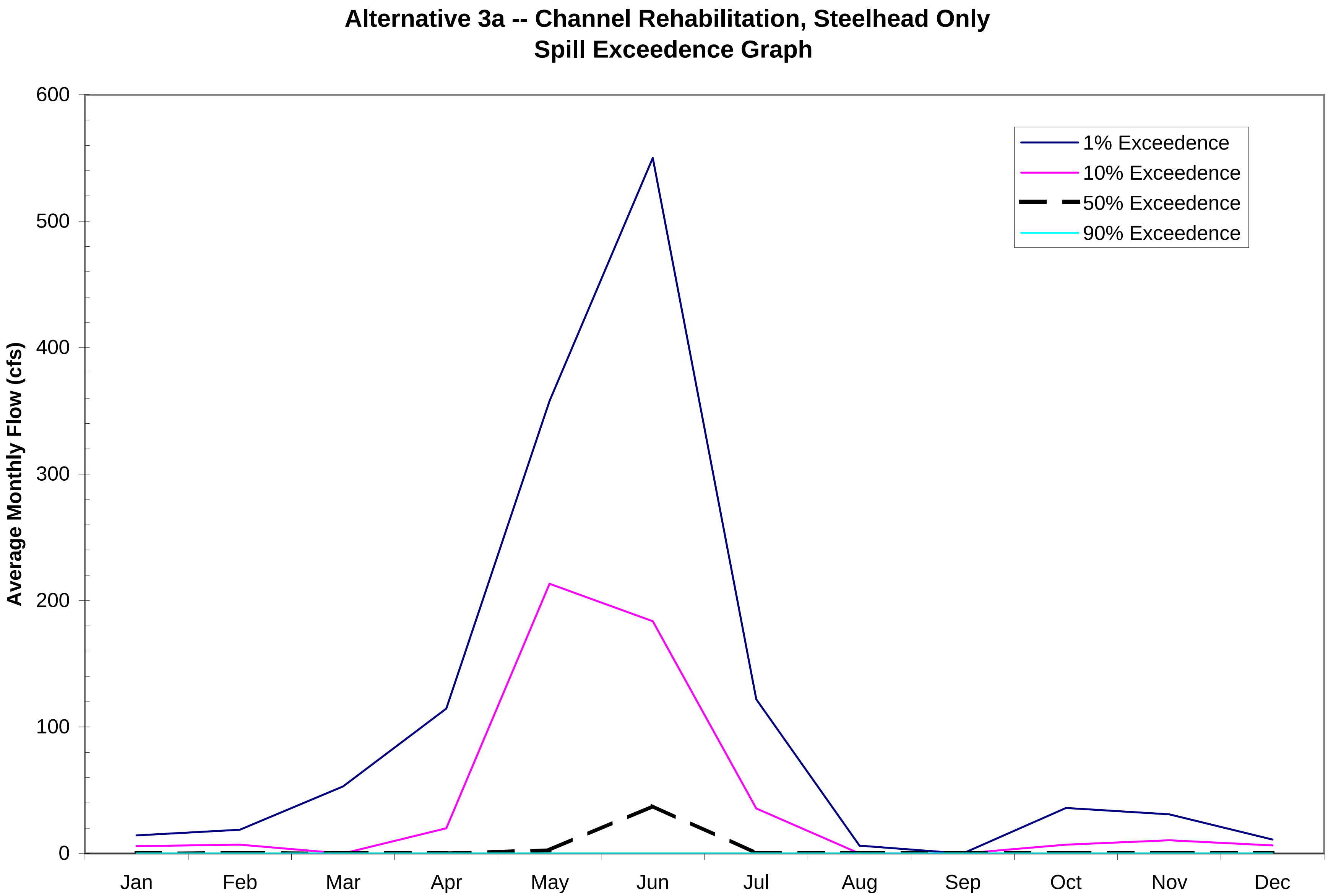
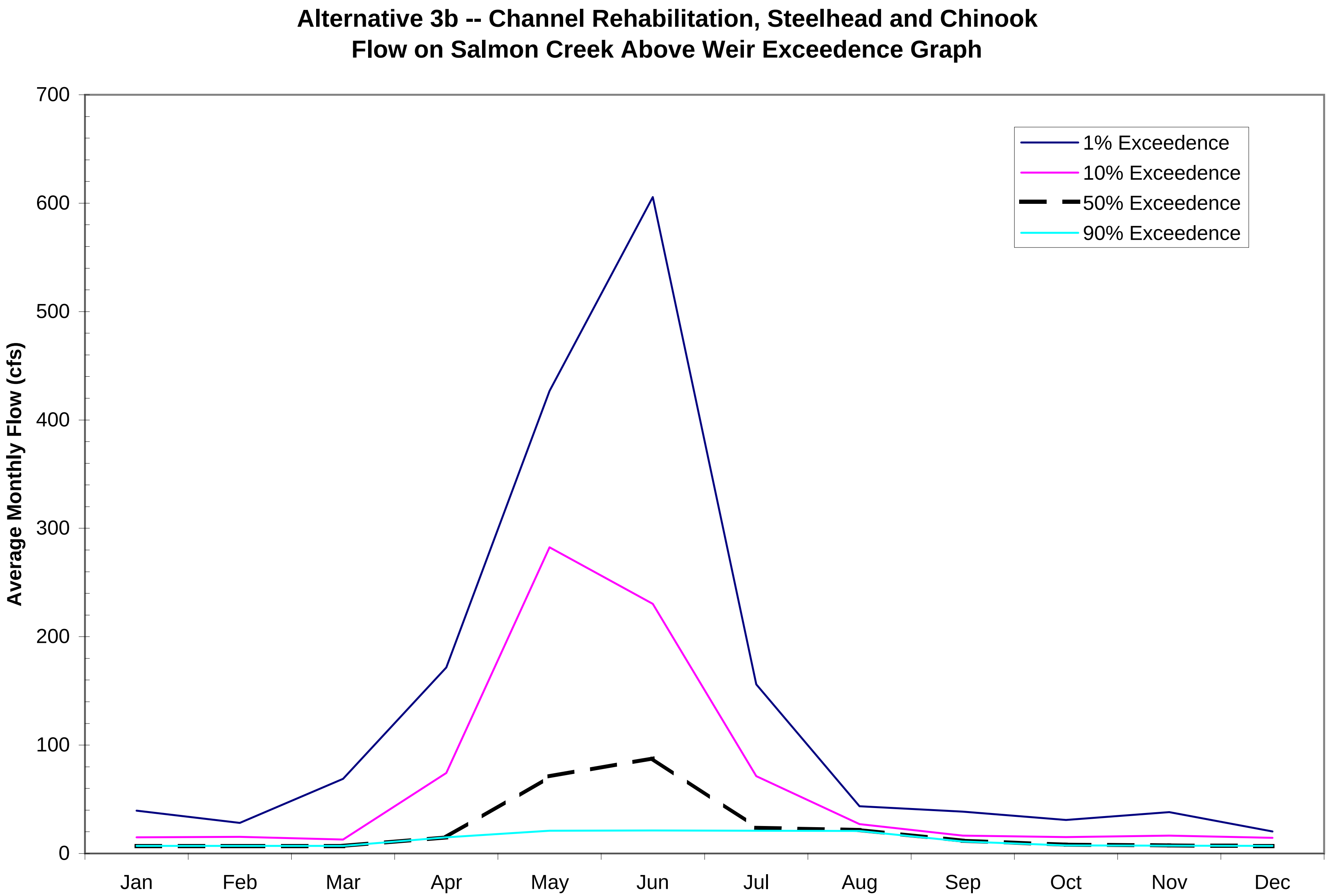
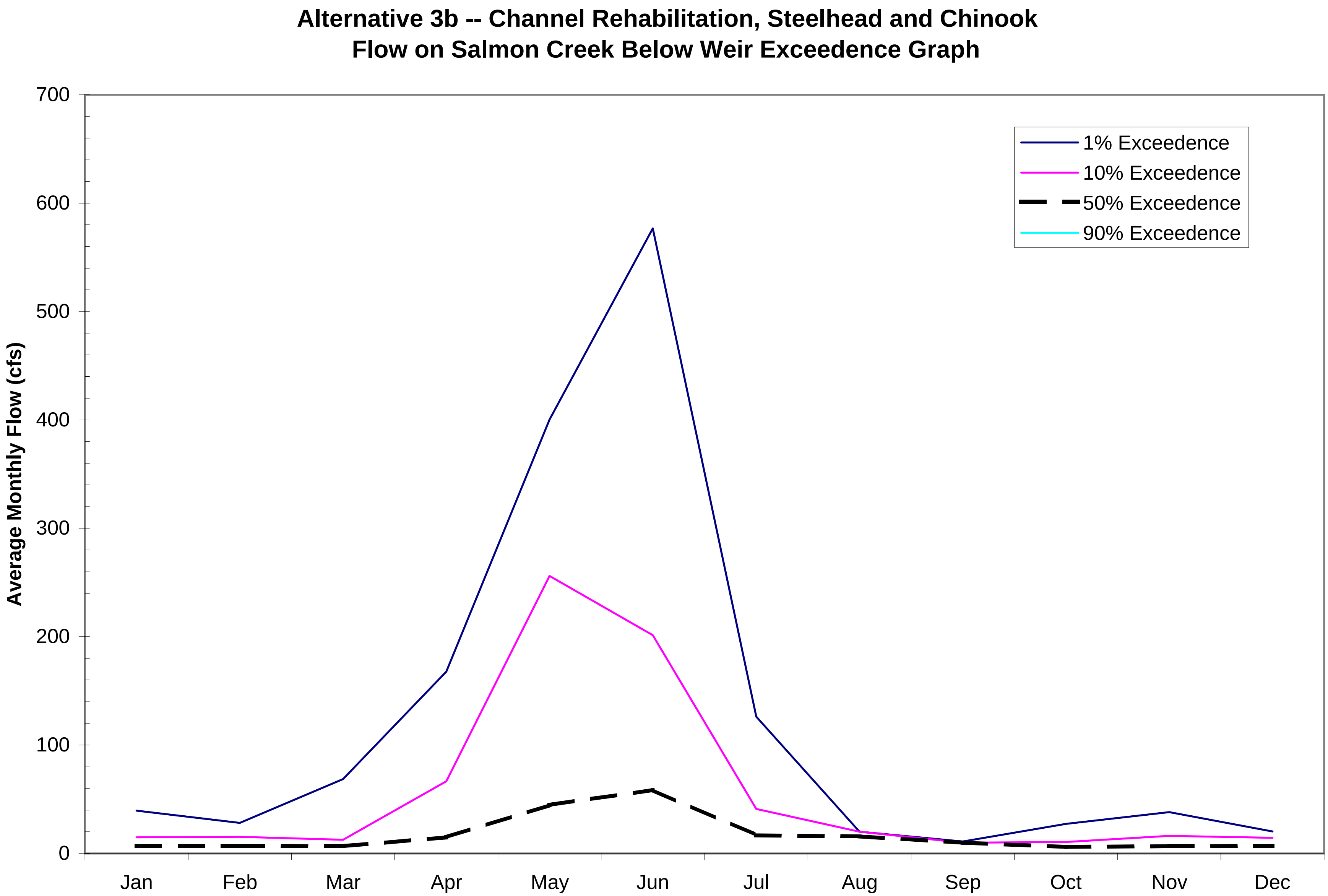
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence



Alternative 3a -- Channel Rehabilitation, Steelhead Only
Spill Exceedence Graph
Average Monthly Flow (cfs)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3b -- Channel Rehabilitation, Steelhead and Chinook
Flow on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3b -- Channel Rehabilitation, Steelhead and Chinook
Flow on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
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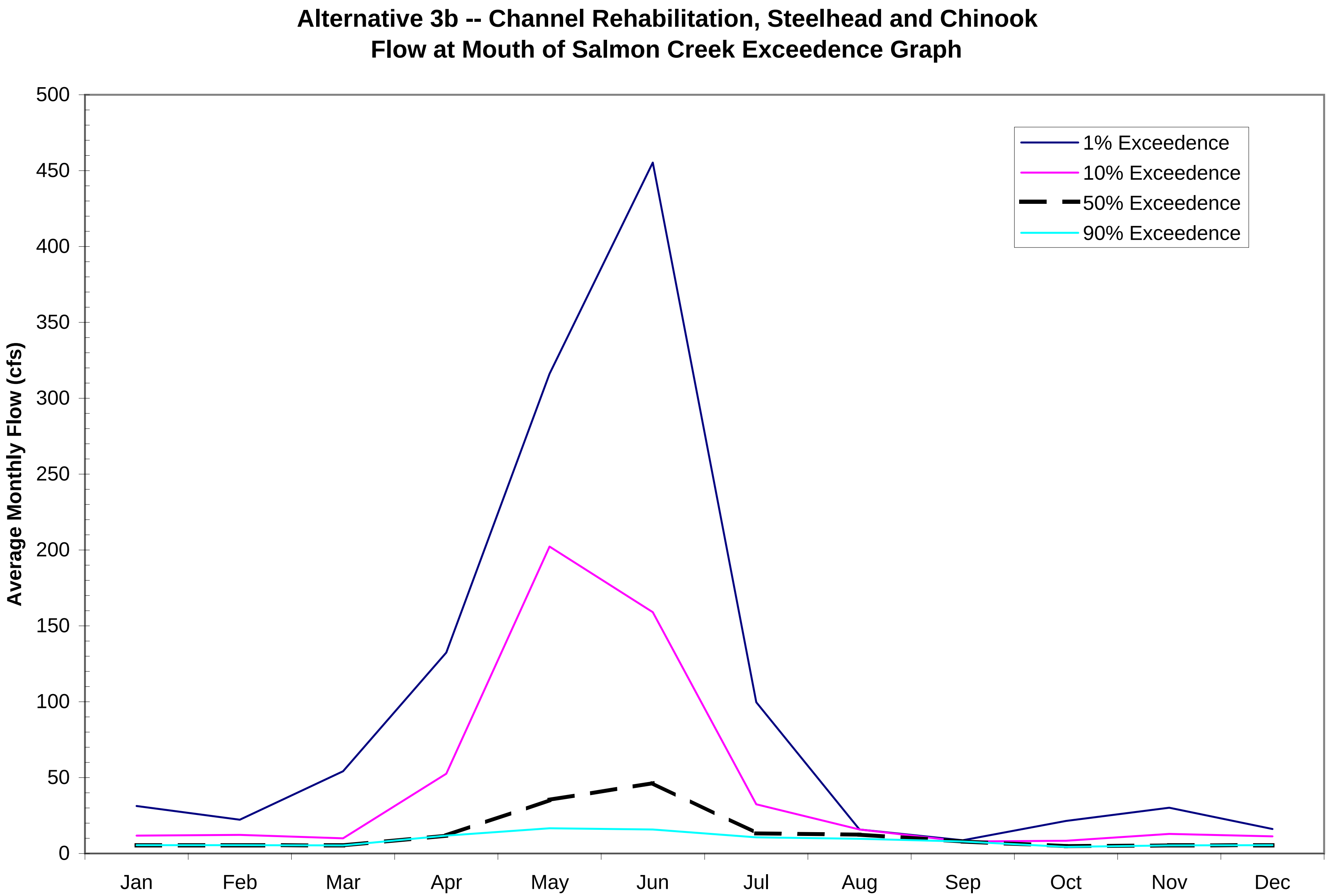
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3b -- Channel Rehabilitation, Steelhead and Chinook
Flow at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
Feb
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Apr
May
Jun
Jul
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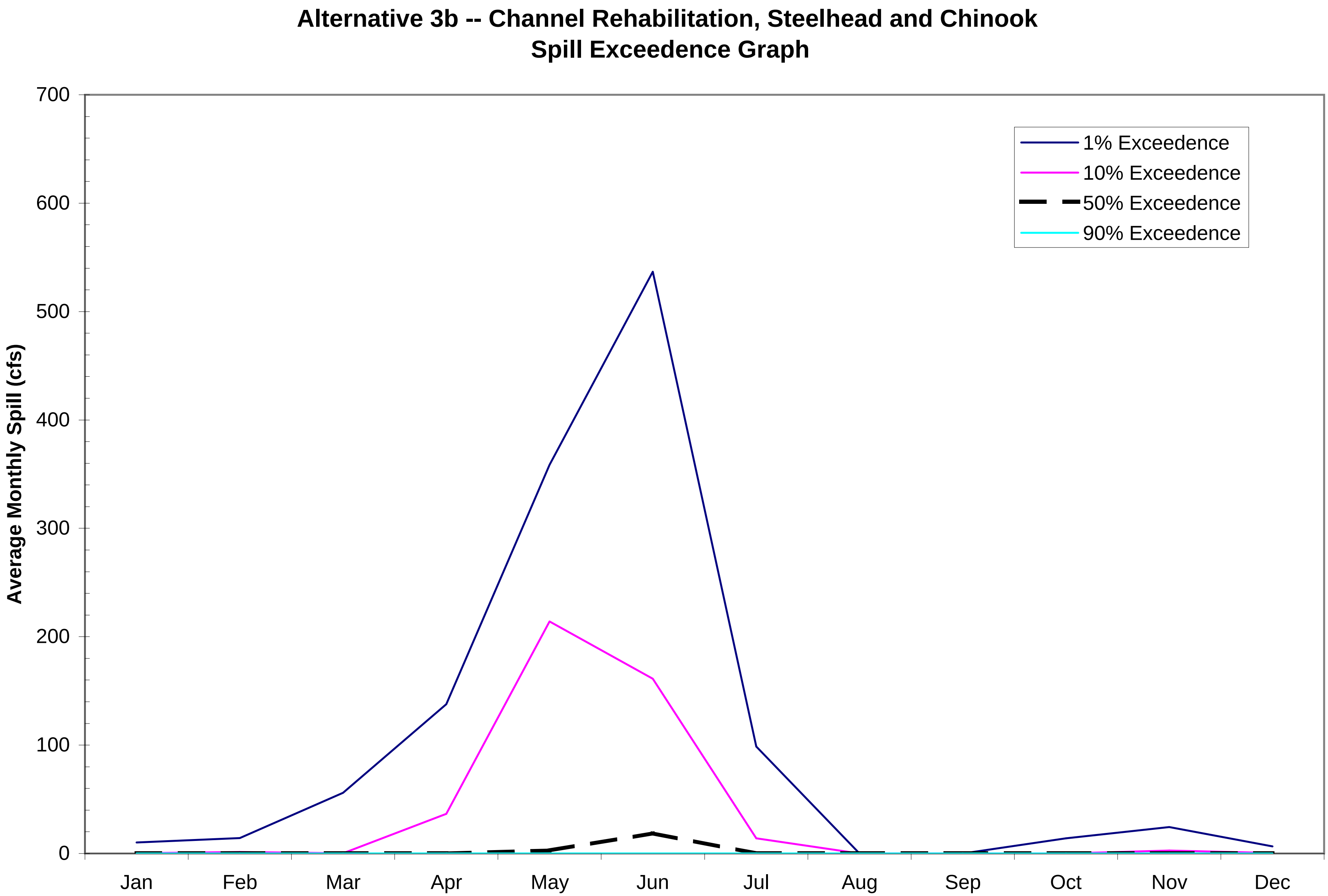
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3b -- Channel Rehabilitation, Steelhead and Chinook
Spill Exceedence Graph
Average Monthly Spill (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
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May
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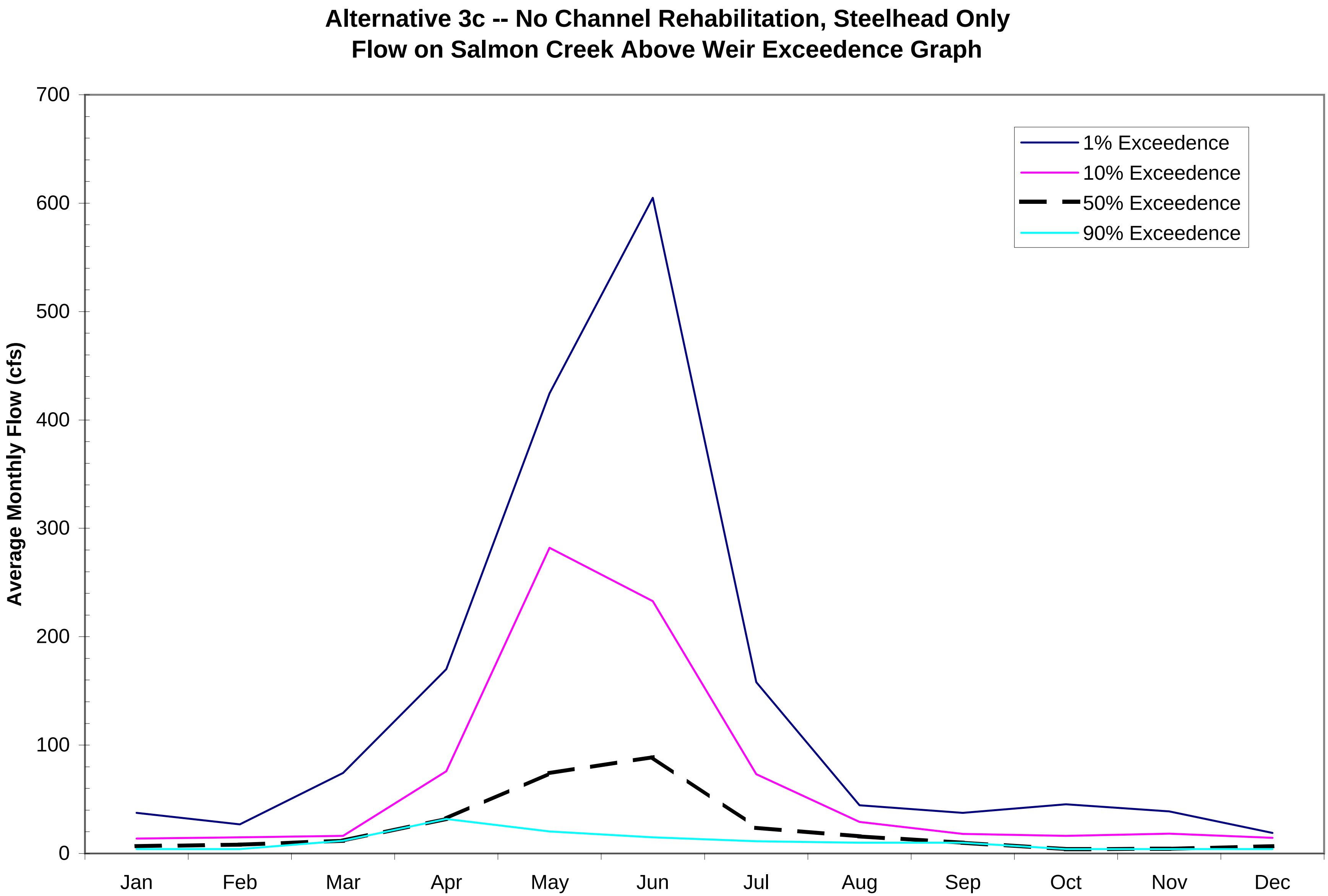
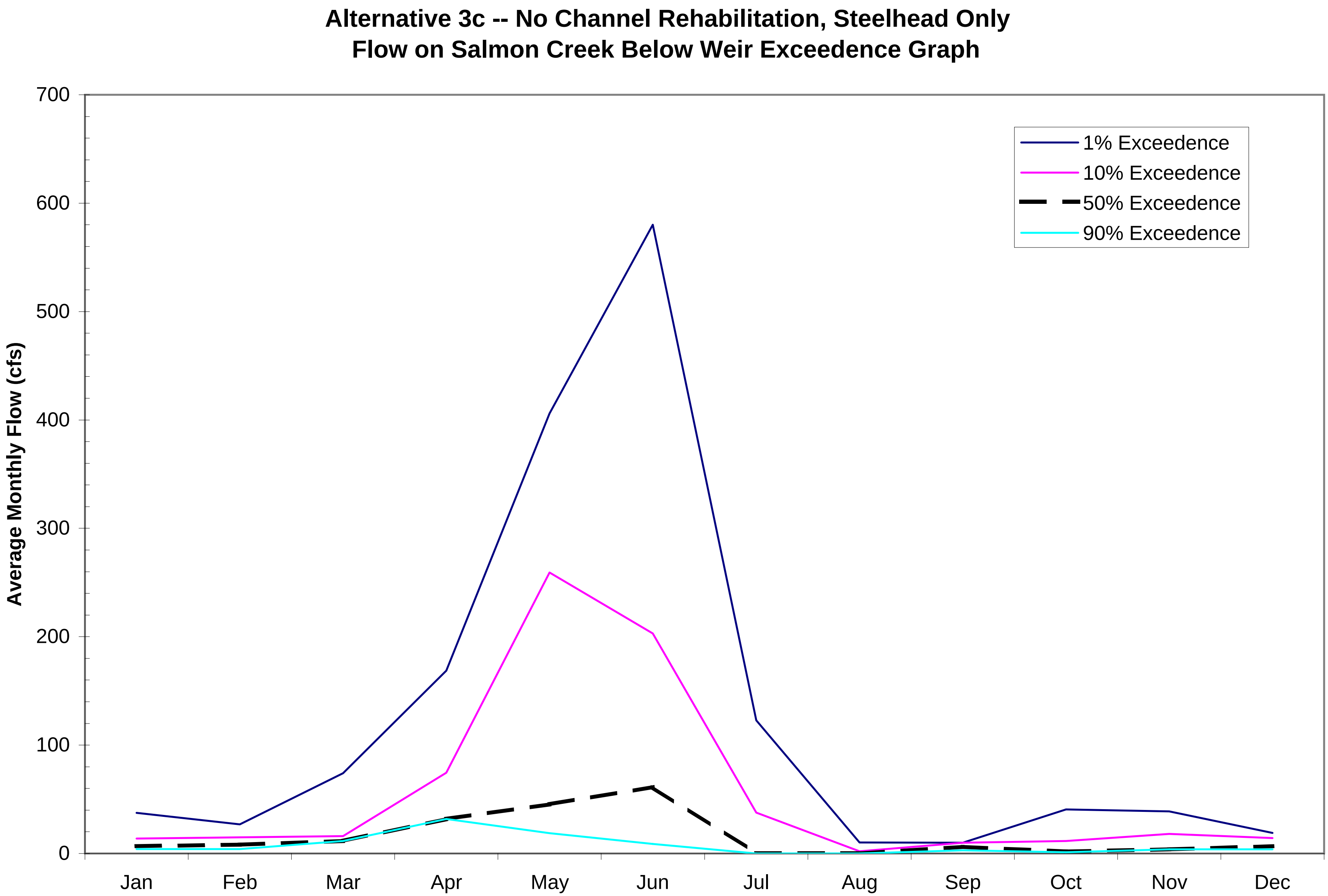
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3c -- No Channel Rehabilitation, Steelhead Only
Flow on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3c -- No Channel Rehabilitation, Steelhead Only
Flow on Salmon Creek Below Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
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May
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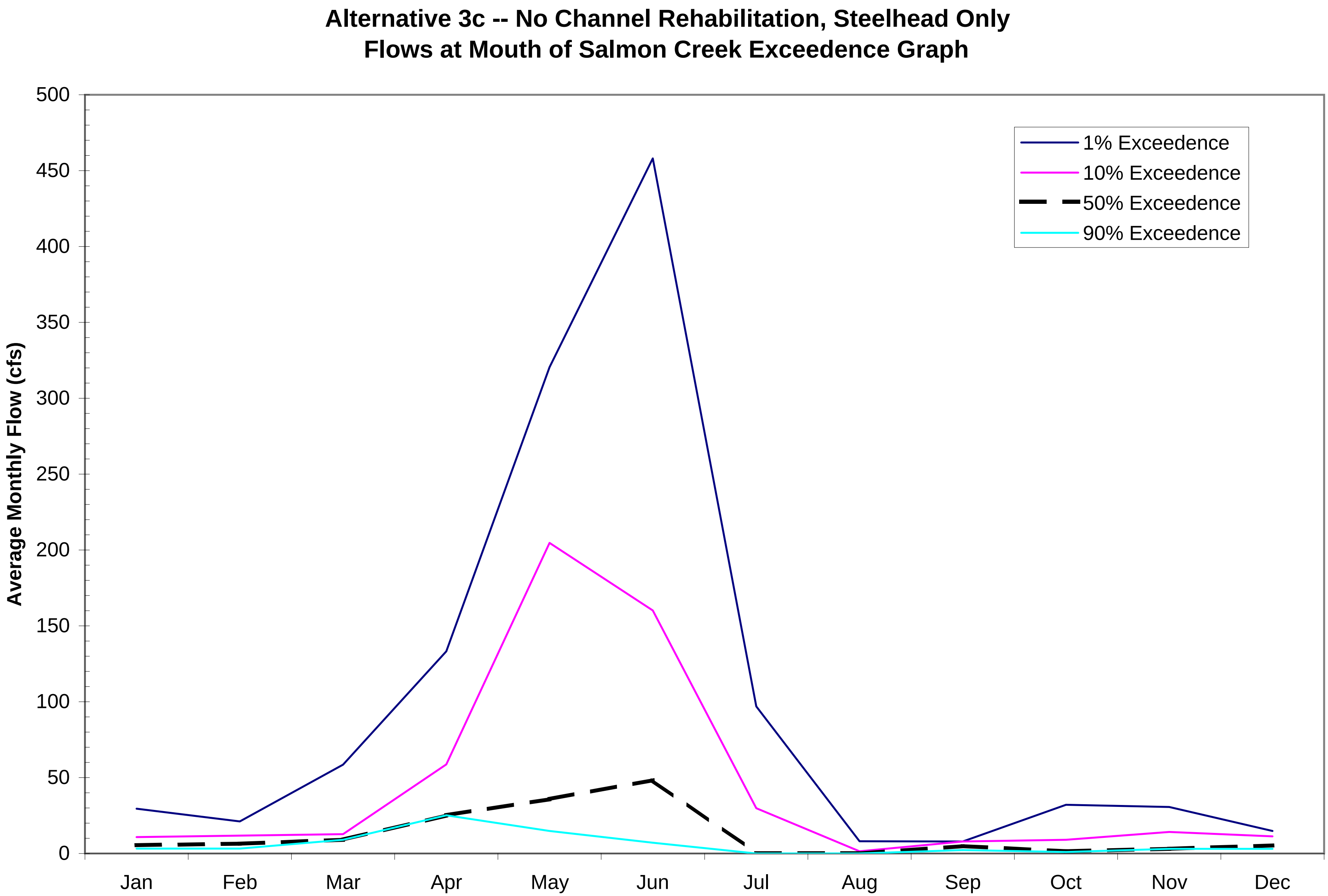
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3c -- No Channel Rehabilitation, Steelhead Only
Flows at Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
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0
Jan
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May
Jun
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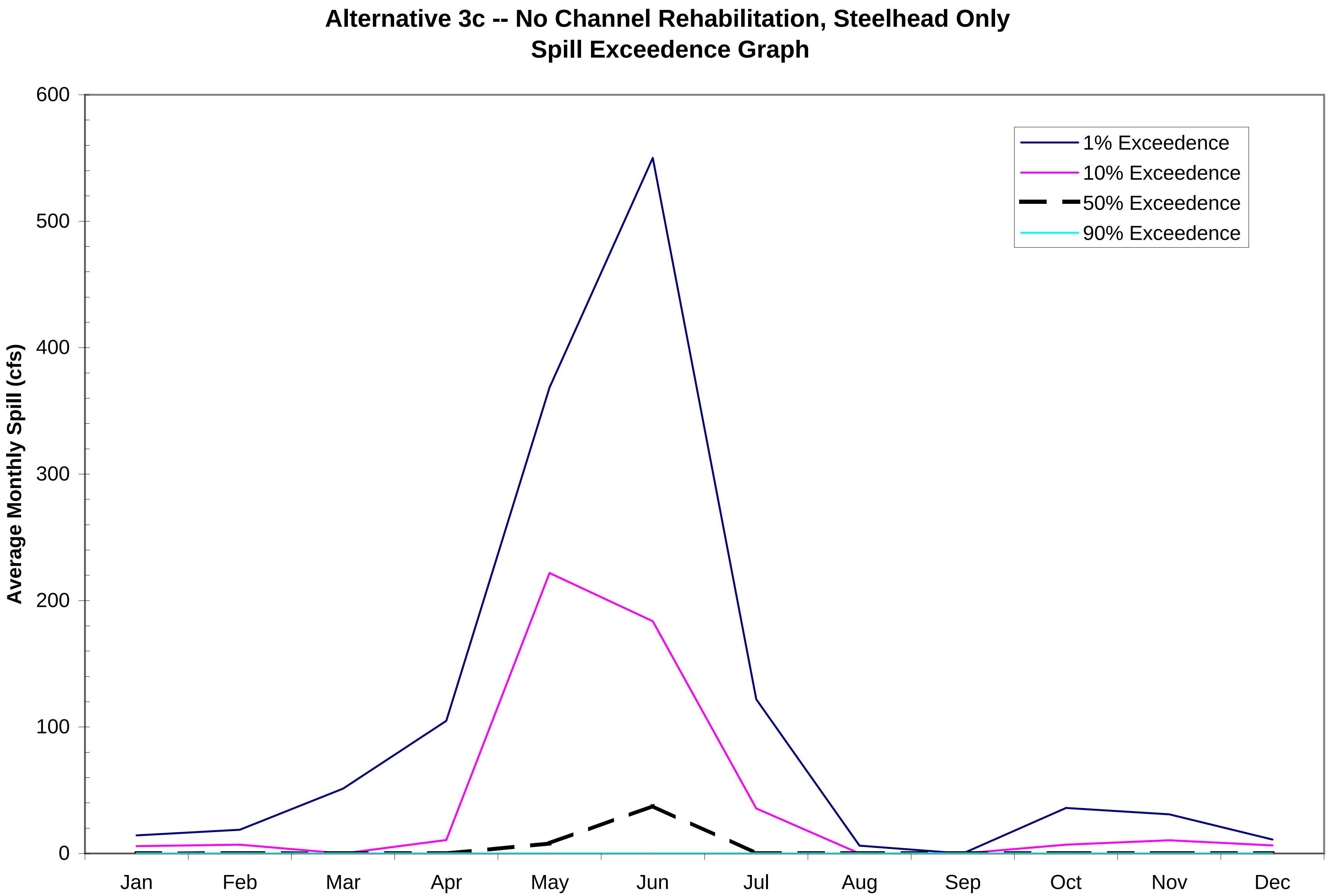
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence


Alternative 3c -- No Channel Rehabilitation, Steelhead Only
Spill Exceedence Graph
Average Monthly Spill (cfs)
600
500
400
300
200
100
0
Jan
Feb
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May
Jun
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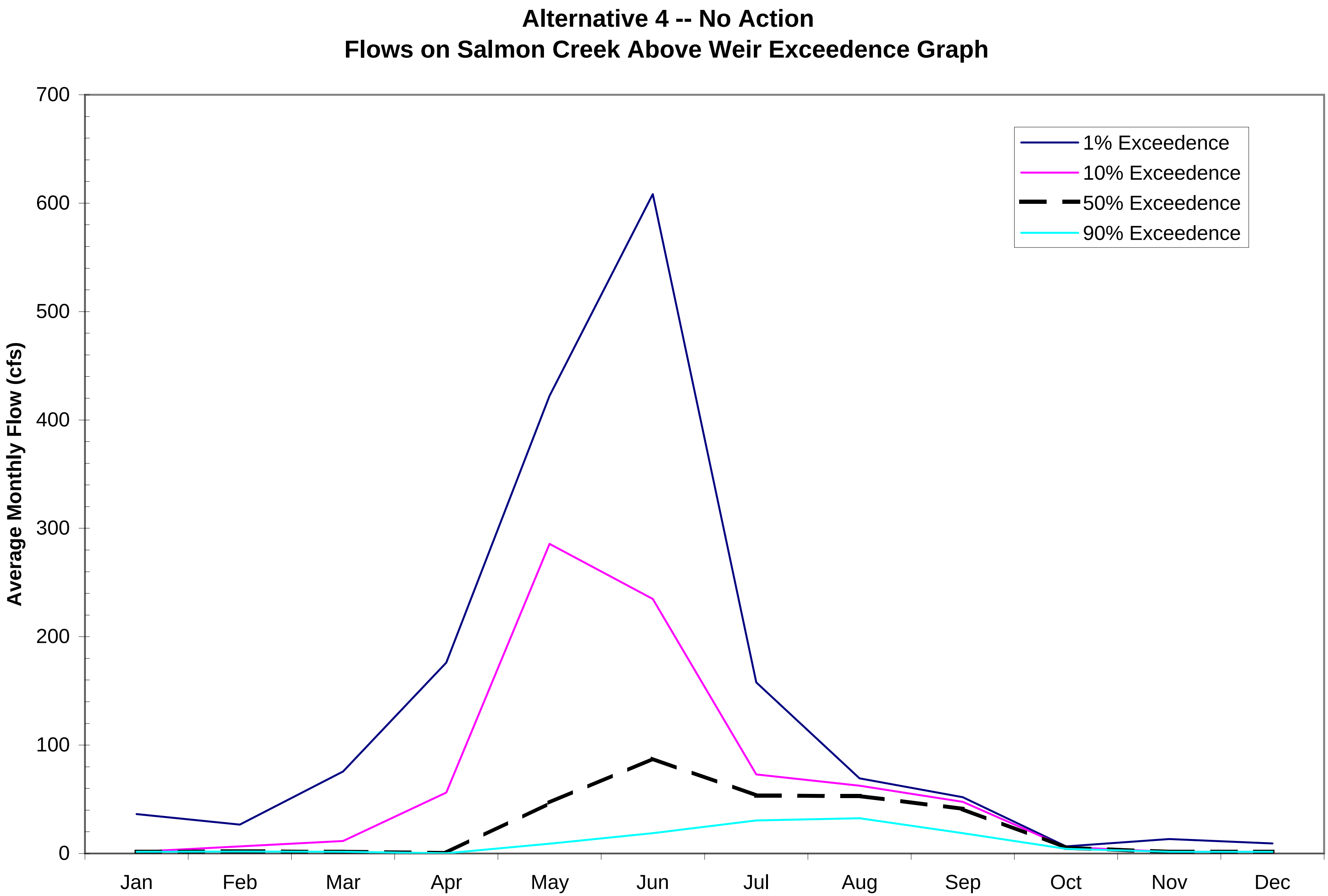
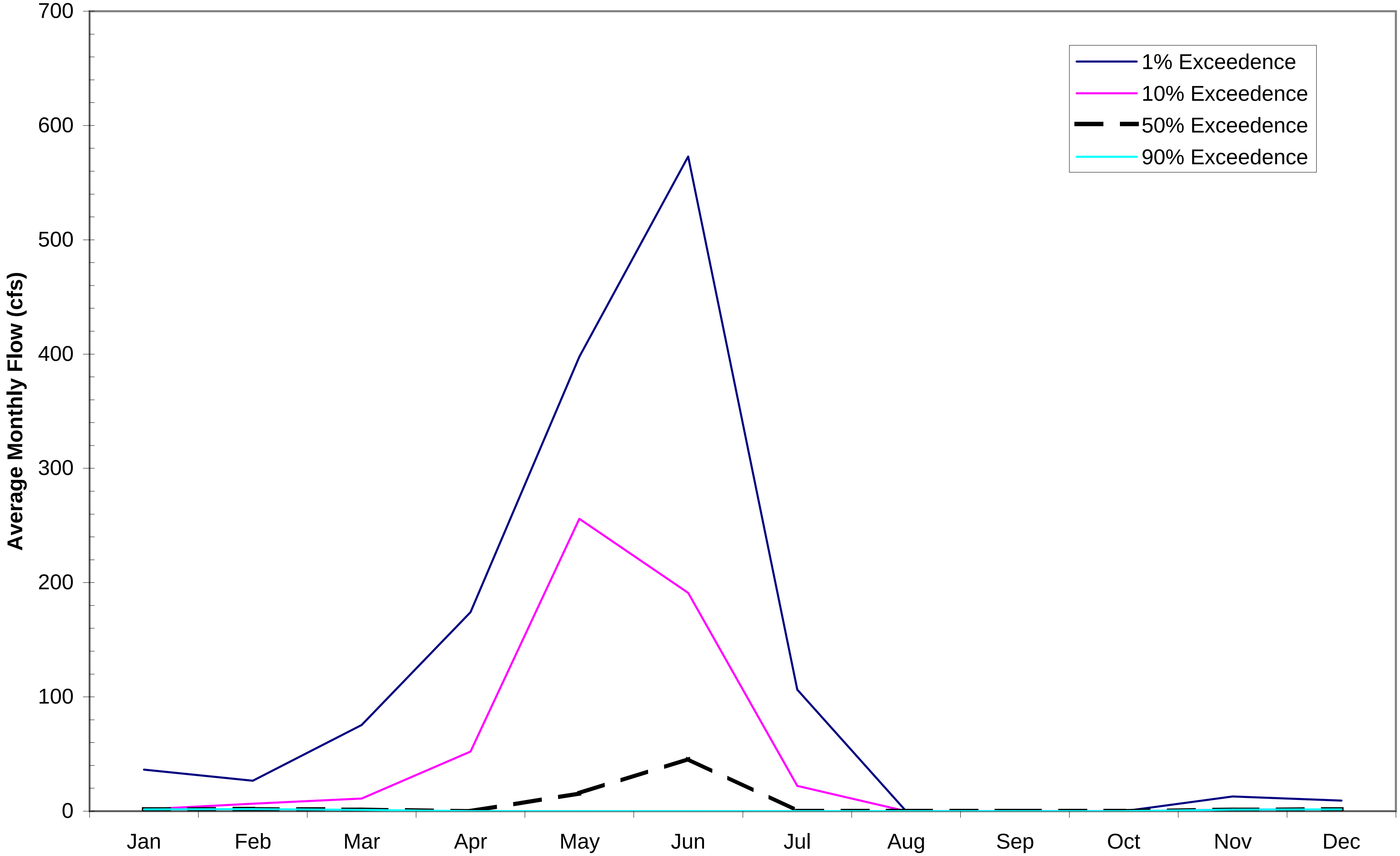
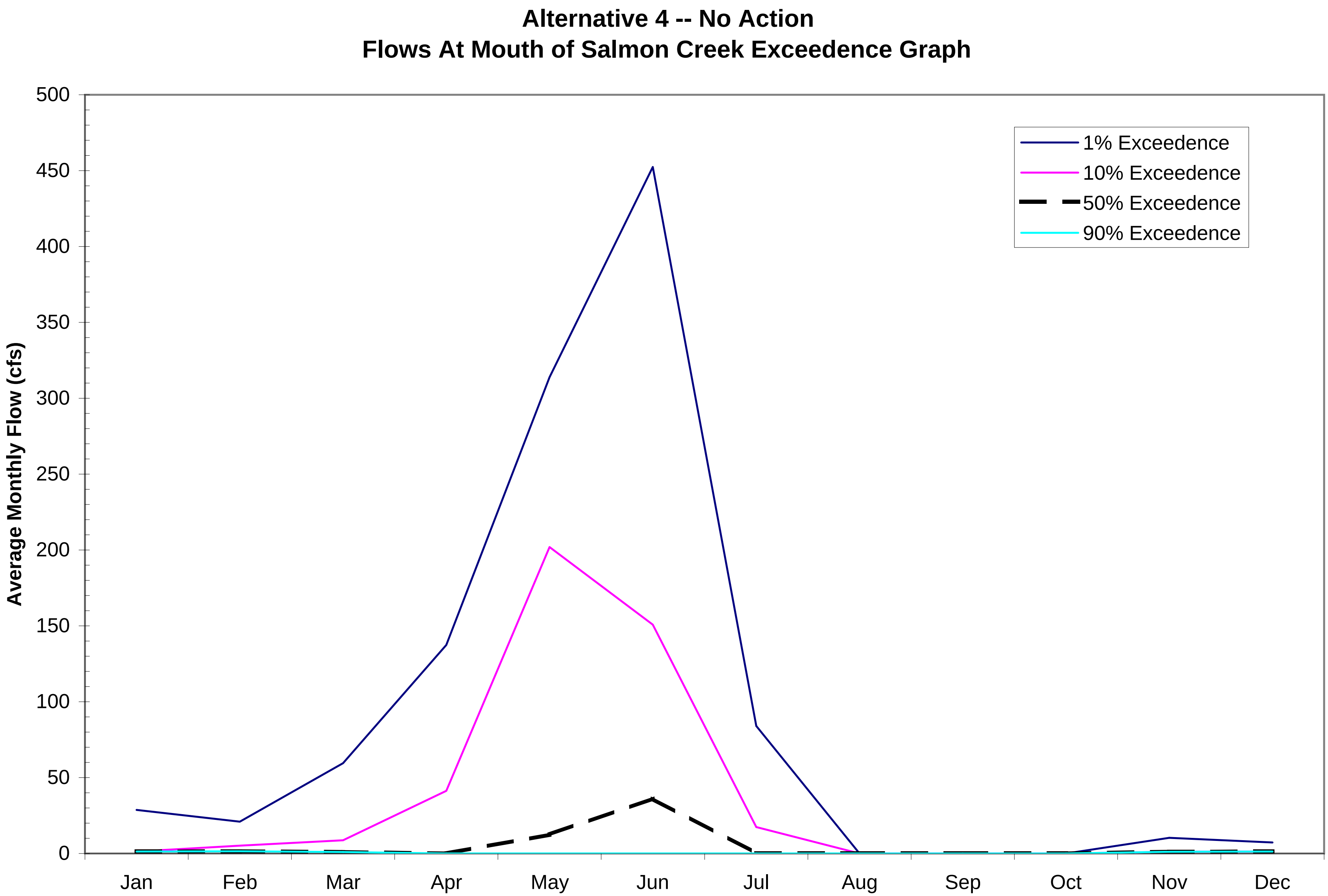
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

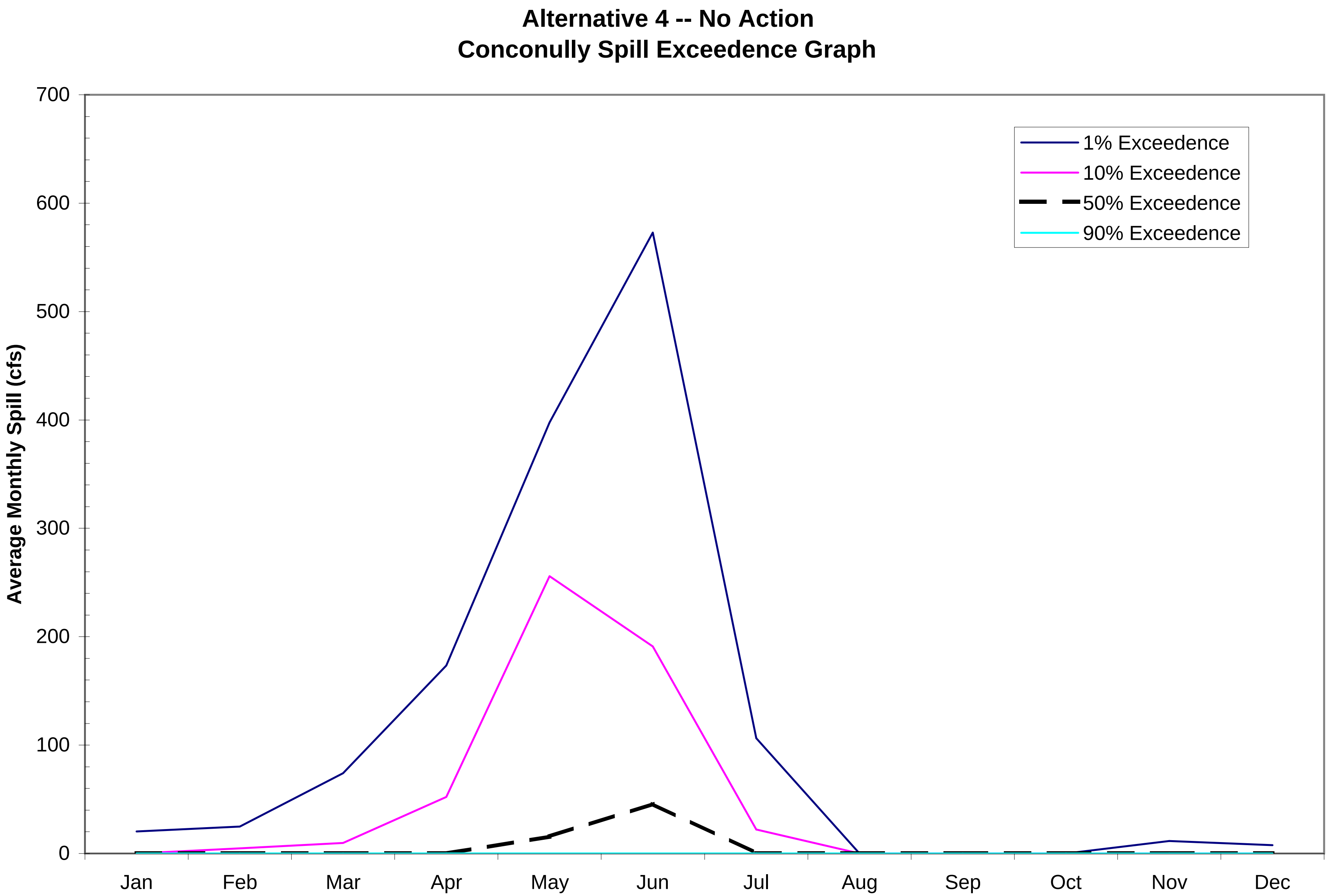

Alternative 4 -- No Action
Flows on Salmon Creek Above Weir Exceedence Graph
Average Monthly Flow (cfs)
0
100
200
300
400
500
600
700
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

Alternative 4 -- No Action
Flows on Salmon Creek Below Weir Exceedence Graph

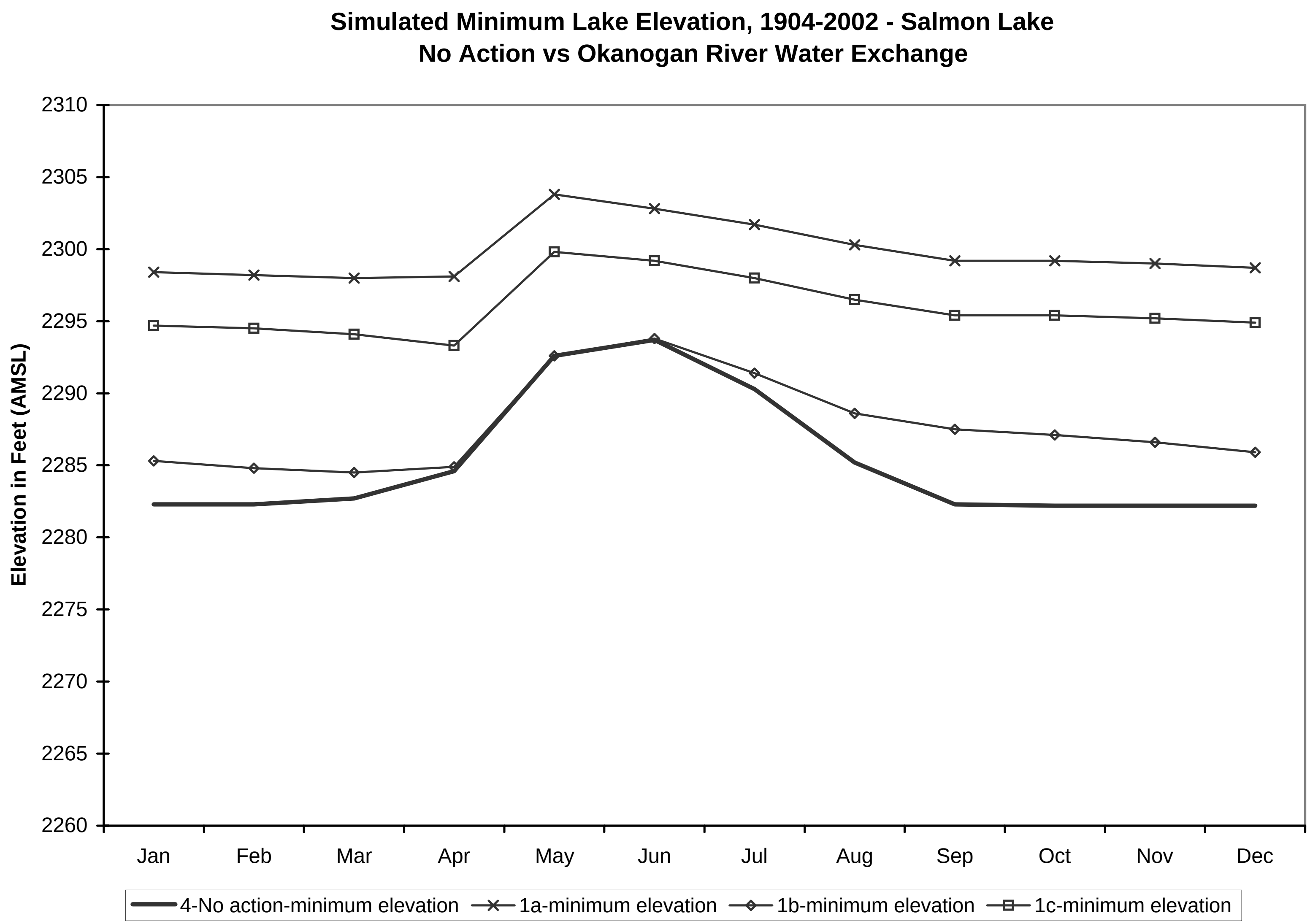


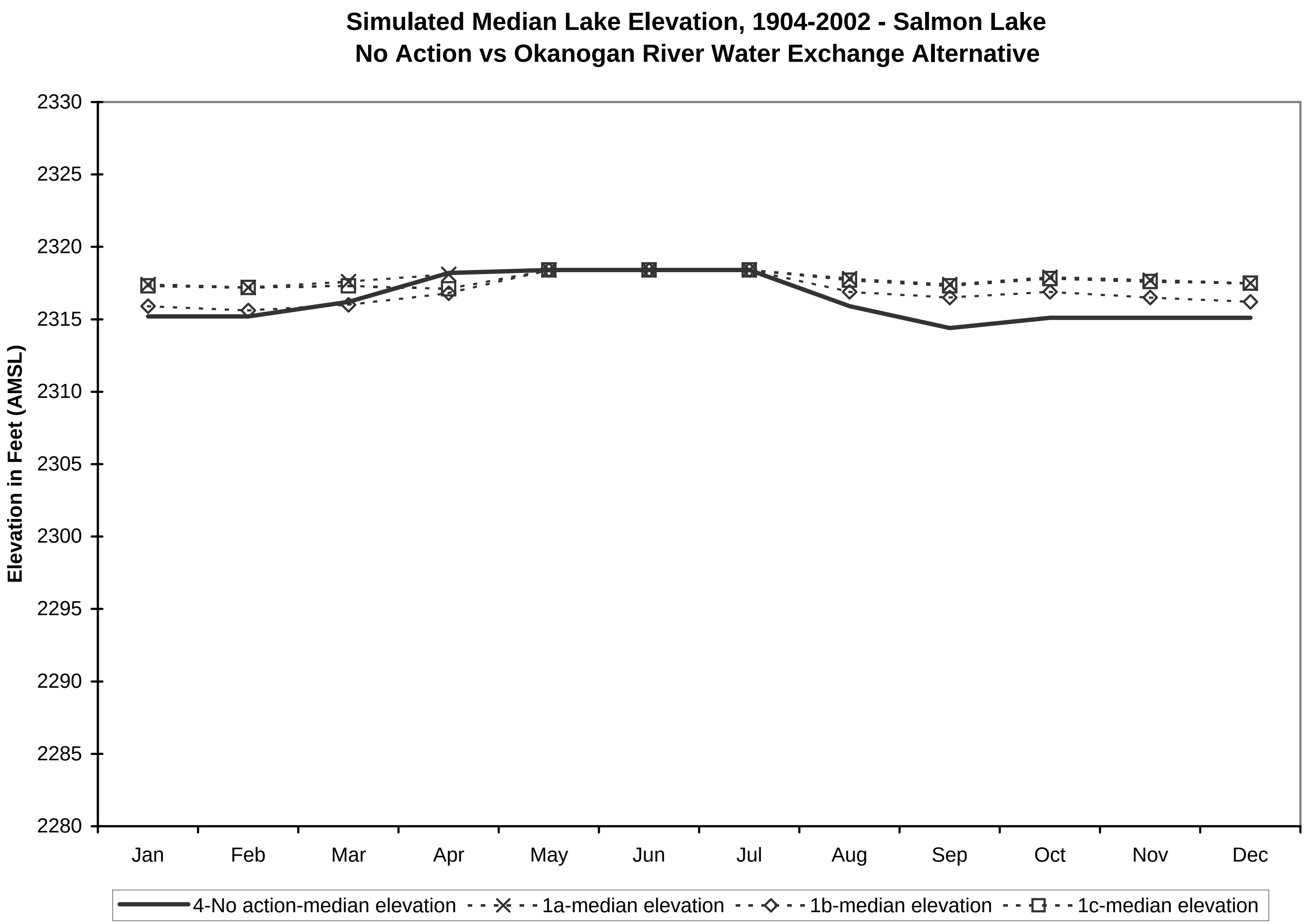


Alternative 4 -- No Action
Flows At Mouth of Salmon Creek Exceedence Graph
Average Monthly Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

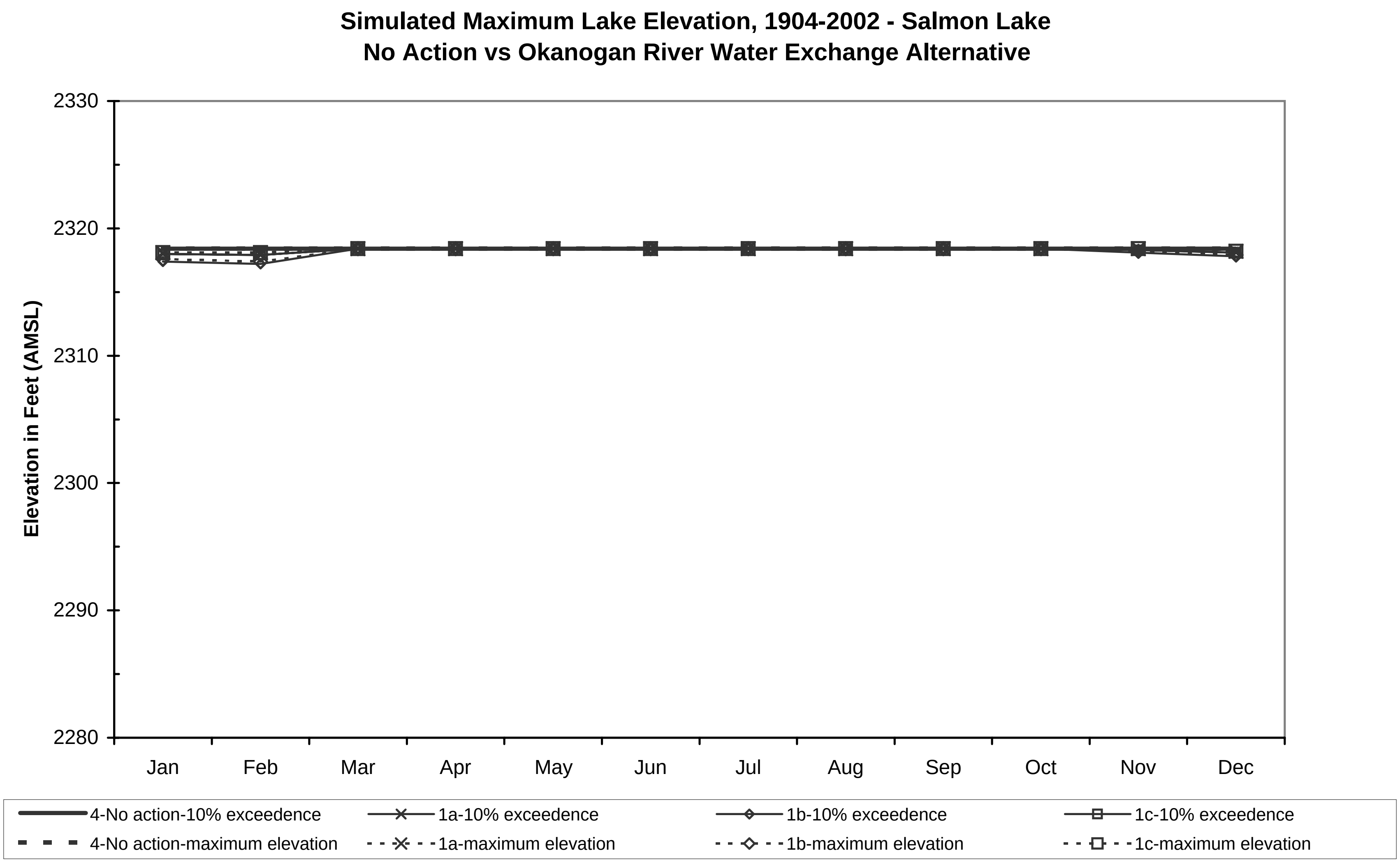

Alternative 4 -- No Action
Conconully Spill Exceedence Graph
Average Monthly Spill (cfs)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1% Exceedence
10% Exceedence
50% Exceedence
90% Exceedence

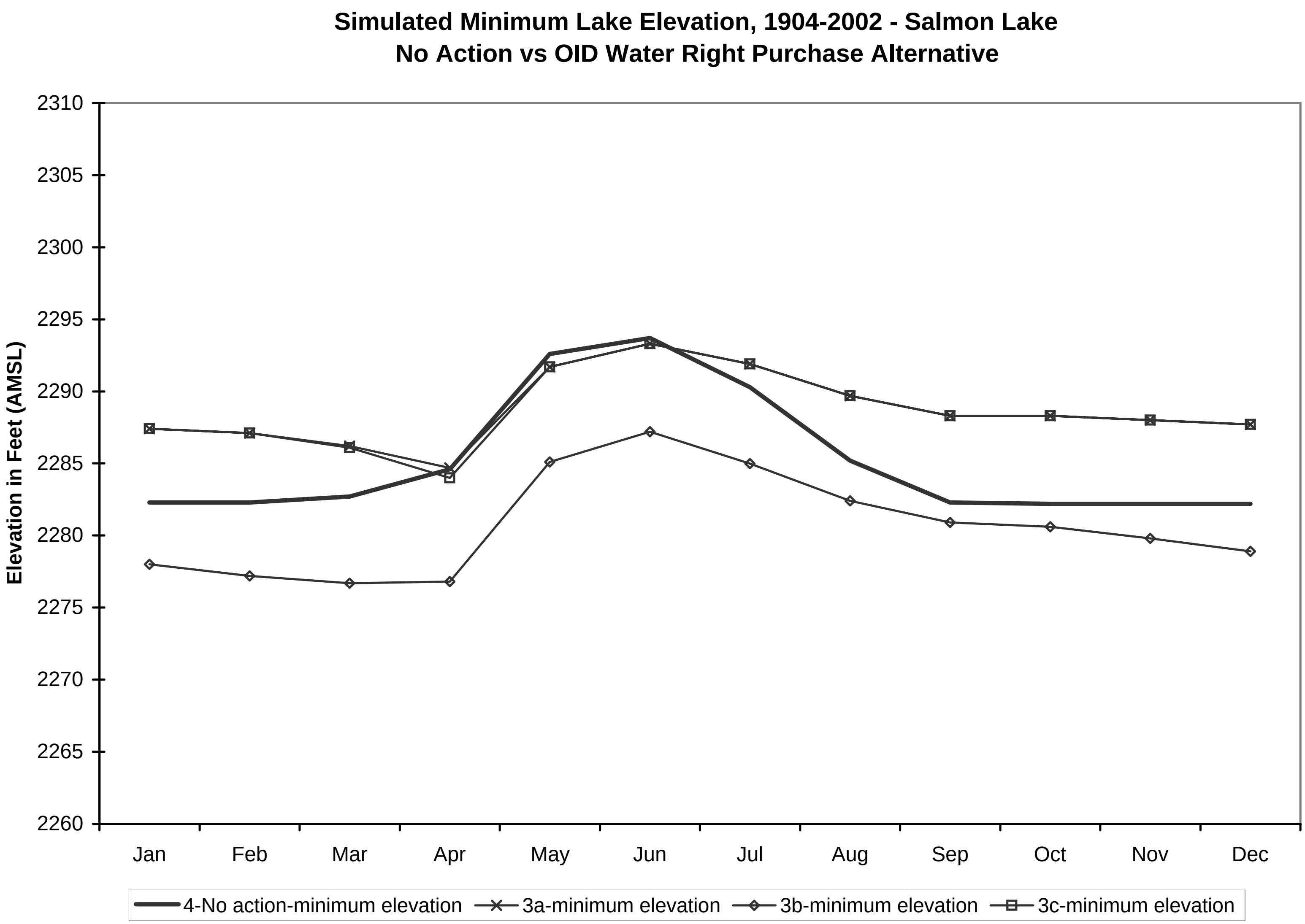
APPENDIX D-4:
Simulated Lake Elevations
(Conconully and Salmon Lake Reservoirs)

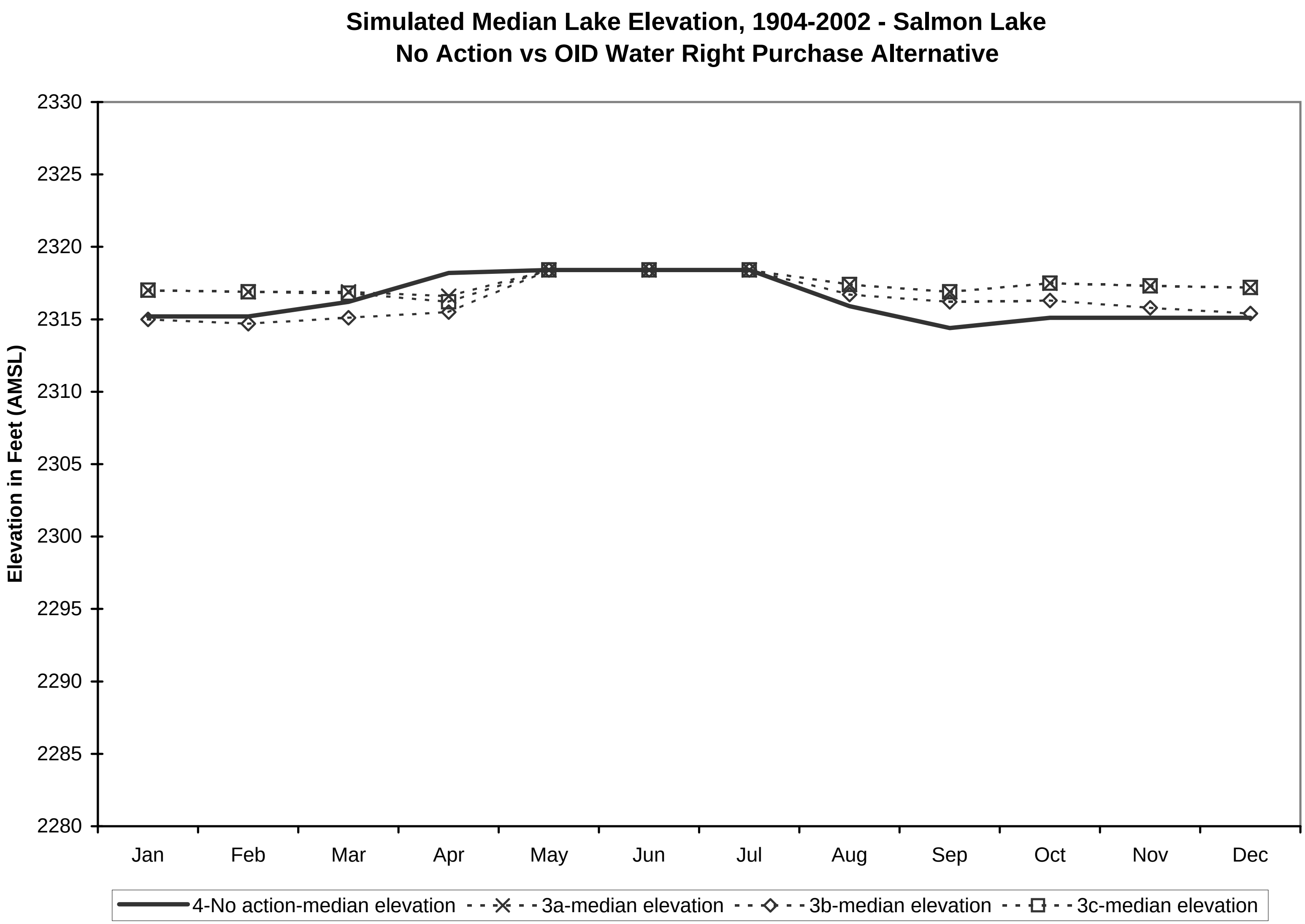

Simulated Minimum Lake Elevation, 1904-2002 - Salmon Lake
No Action vs Okanogan River Water Exchange
Elevation in Feet (AMSL)
2310
2305
2300
2295
2290
2285
2280
2275
2270
2265
2260
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum elevation
1a-minimum elevation
1b-minimum elevation
1c-minimum elevation

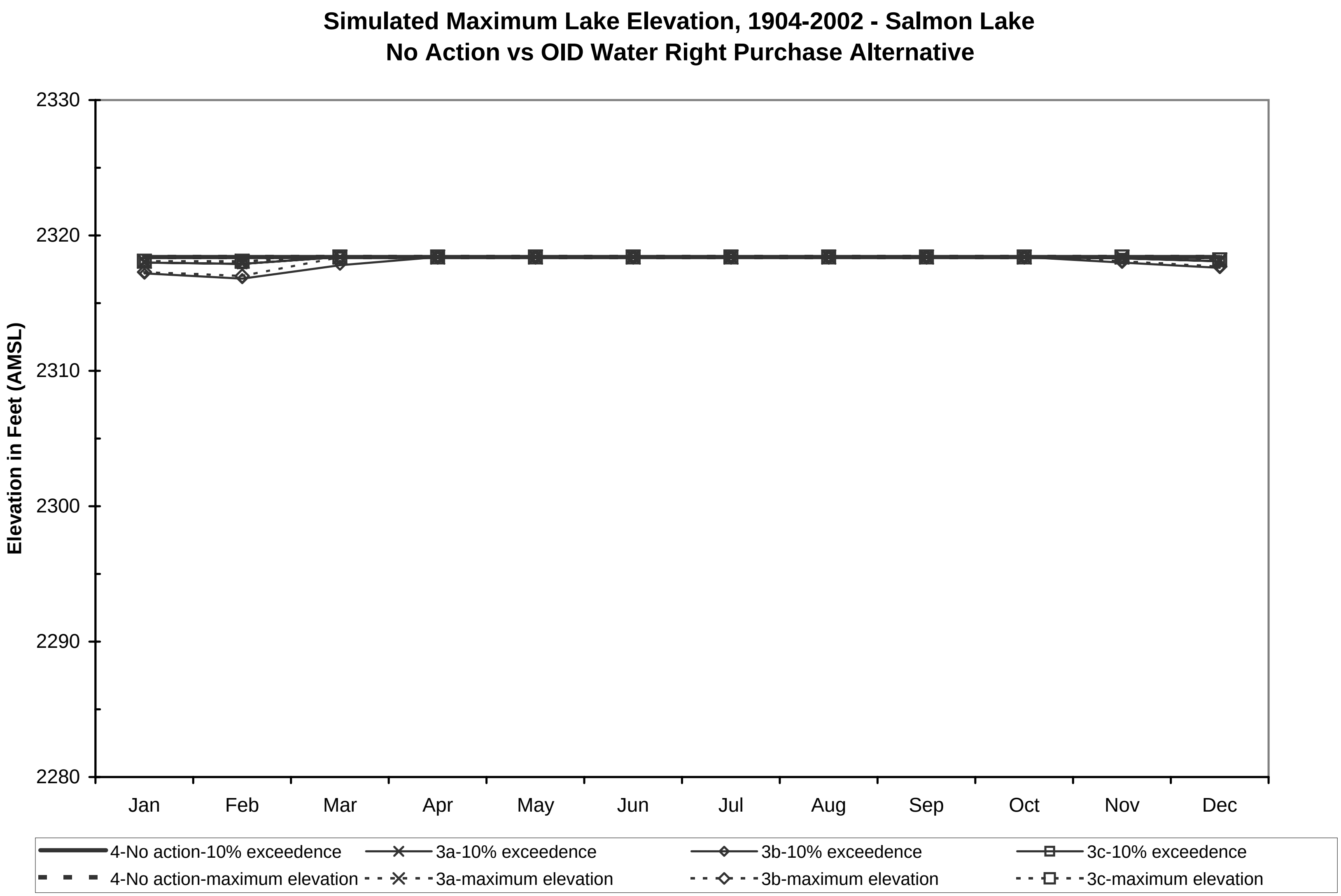


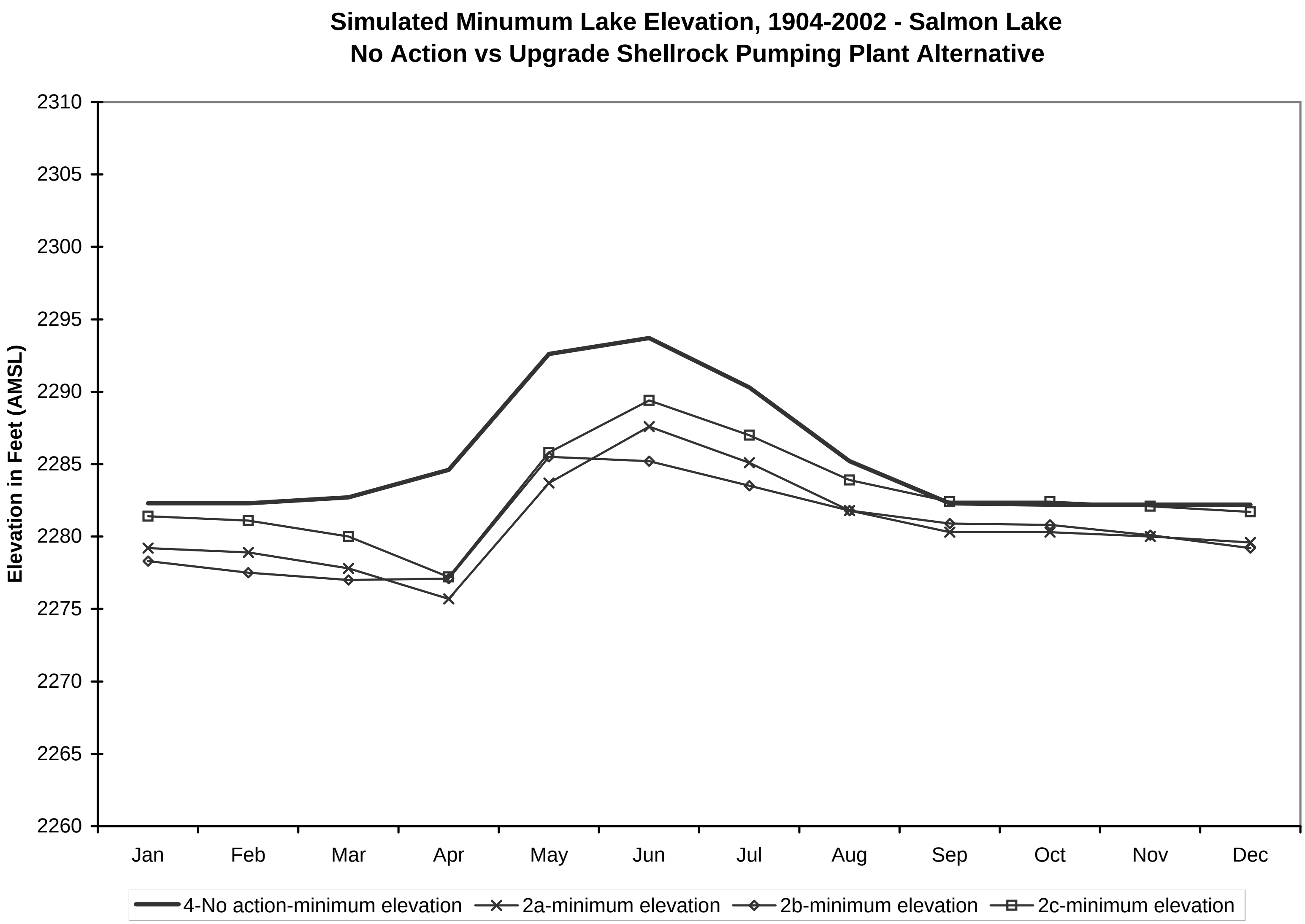
Simulated Median Lake Elevation, 1904-2002 - Salmon Lake
No Action vs Okanogan River Water Exchange Alternative
Elevation in Feet (AMSL)
2330
2325
2320
2315
2310
2305
2300
2295
2290
2285
2280
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median elevation
1a-median elevation
1b-median elevation
1c-median elevation

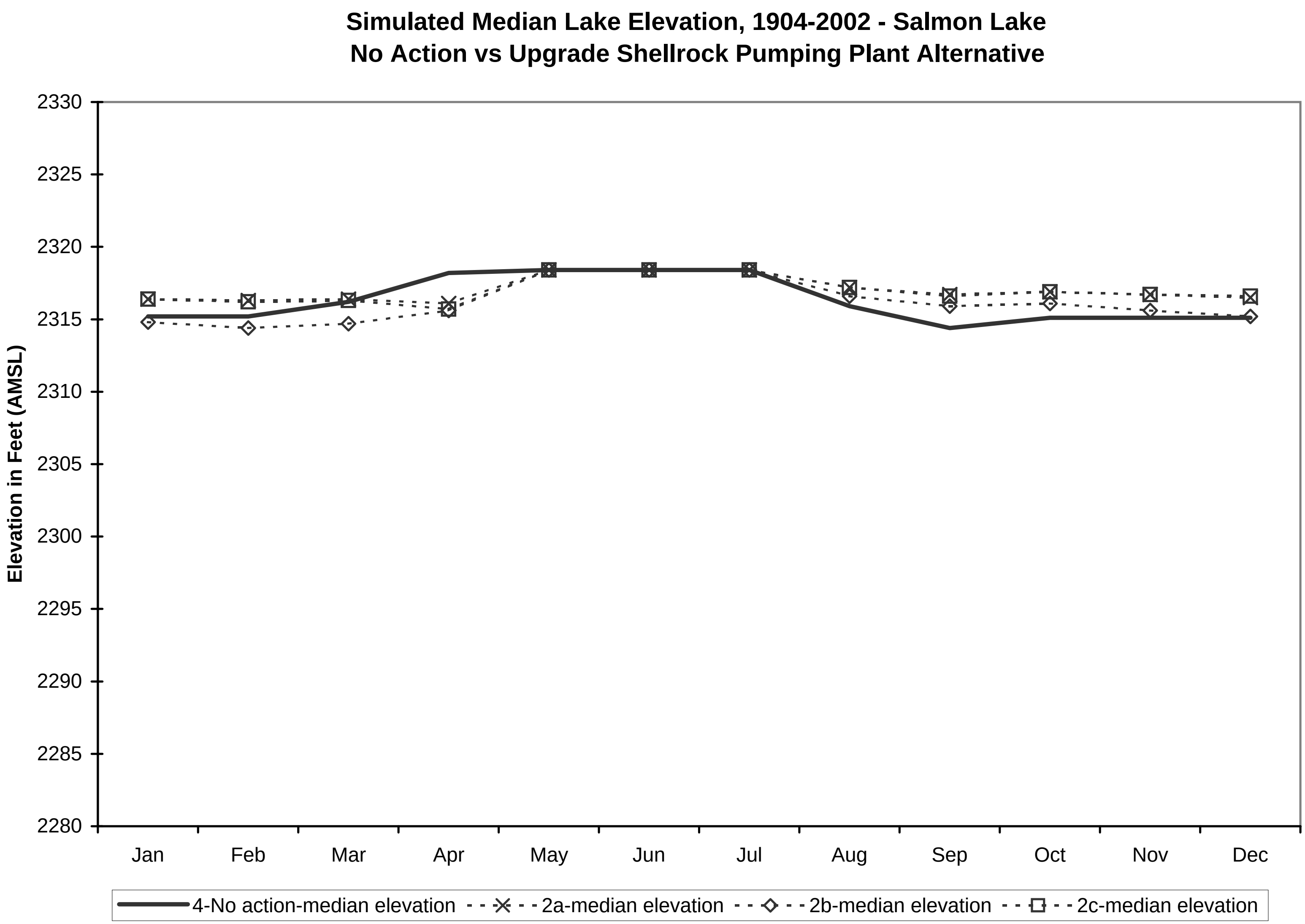

Simulated Maximum Lake Elevation, 1904-2002 - Salmon Lake
No Action vs Okanogan River Water Exchange Alternative
Elevation in Feet (AMSL)
2330
2320
2310
2300
2290
2280
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
1a-10% exceedence
1b-10% exceedence
1c-10% exceedence
4-No action-maximum elevation
1a-maximum elevation
1b-maximum elevation
1c-maximum elevation

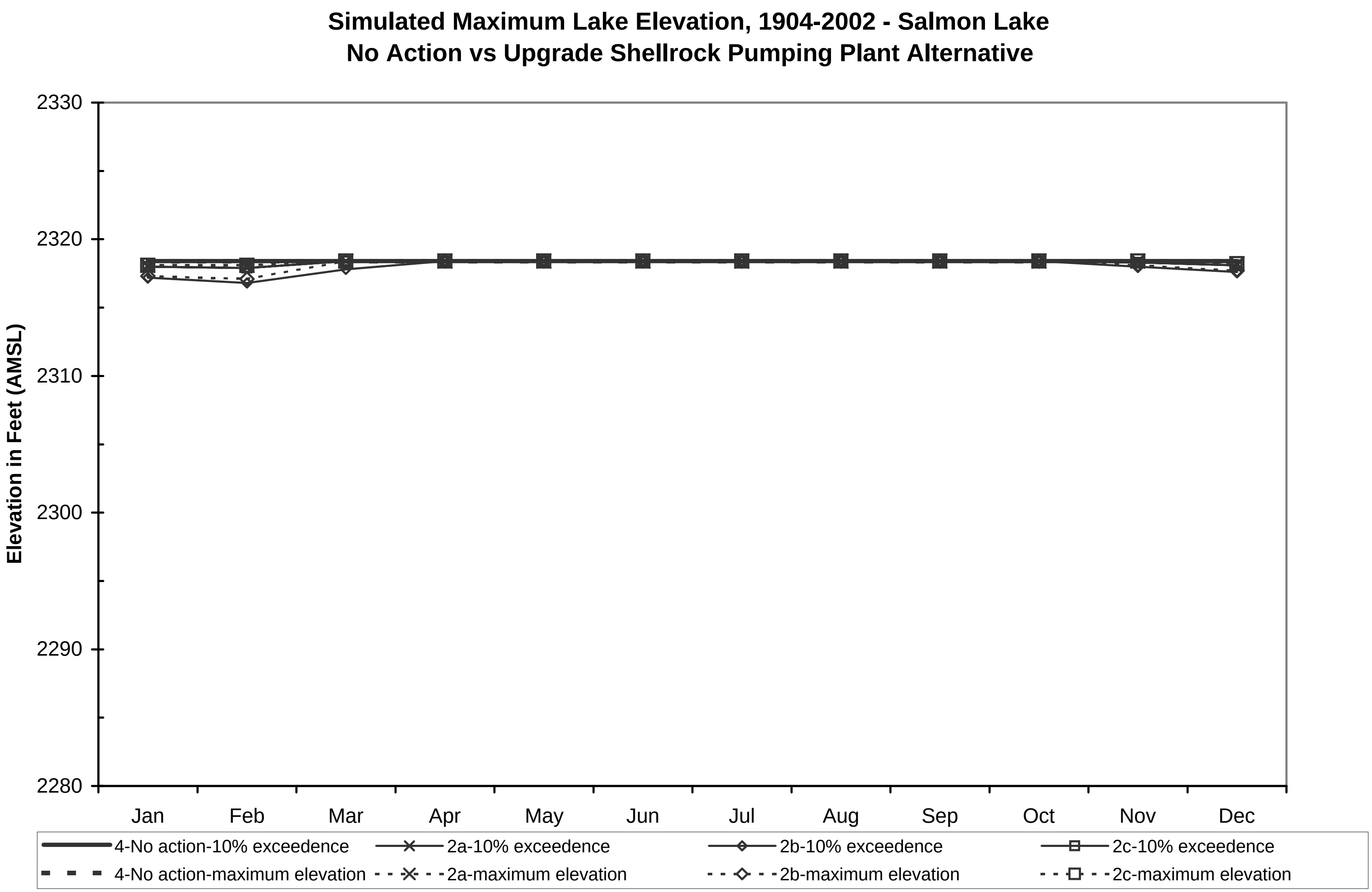

Simulated Minimum Lake Elevation, 1904-2002 - Salmon Lake
No Action vs OID Water Right Purchase Alternative
Elevation in Feet (AMSL)
2310
2305
2300
2295
2290
2285
2280
2275
2270
2265
2260
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum elevation
3a-minimum elevation
3b-minimum elevation
3c-minimum elevation

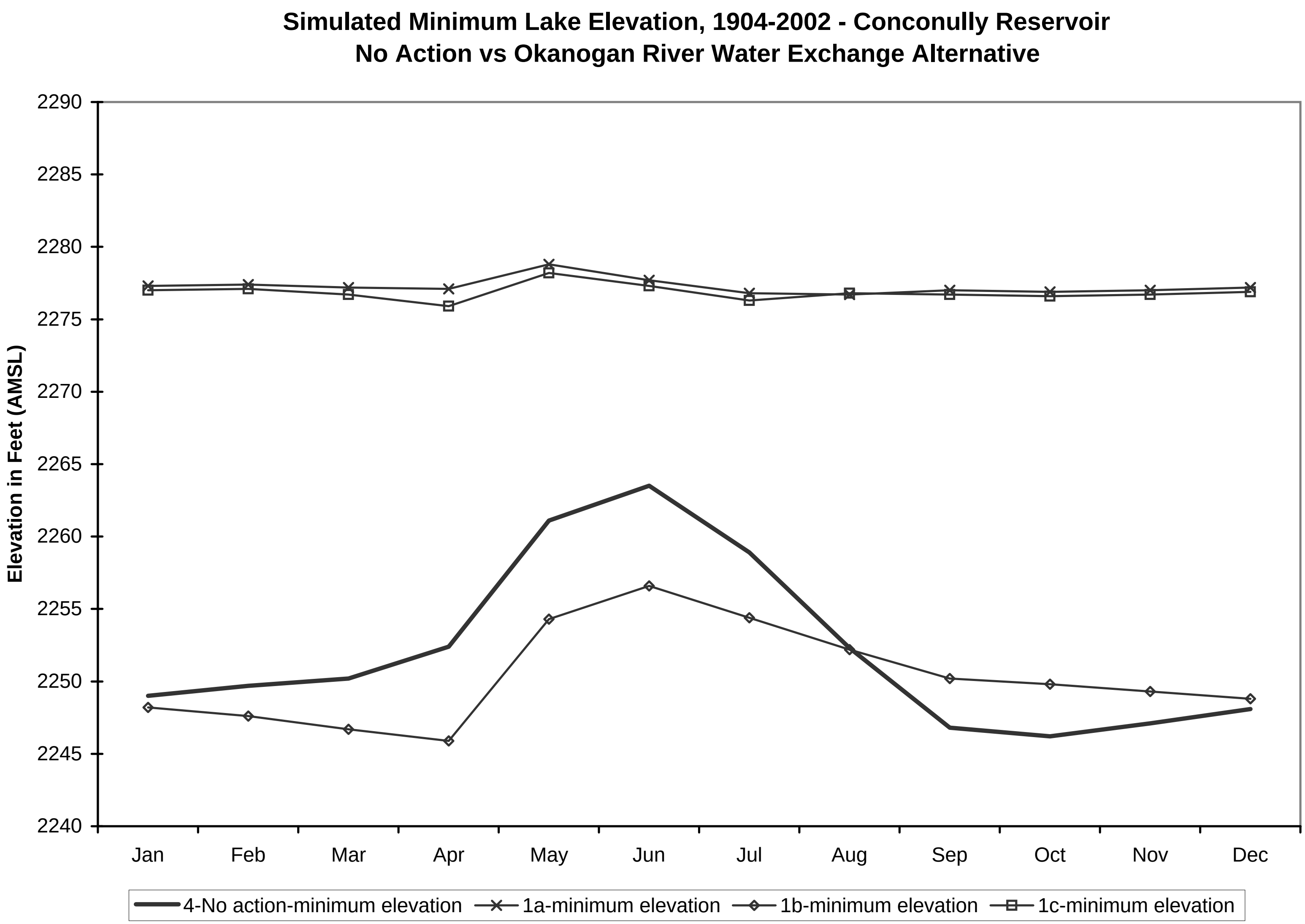

Simulated Median Lake Elevation, 1904-2002 - Salmon Lake
No Action vs OID Water Right Purchase Alternative
Elevation in Feet (AMSL)
2330
2325
2320
2315
2310
2305
2300
2295
2290
2285
2280
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median elevation
3a-median elevation
3b-median elevation
3c-median elevation

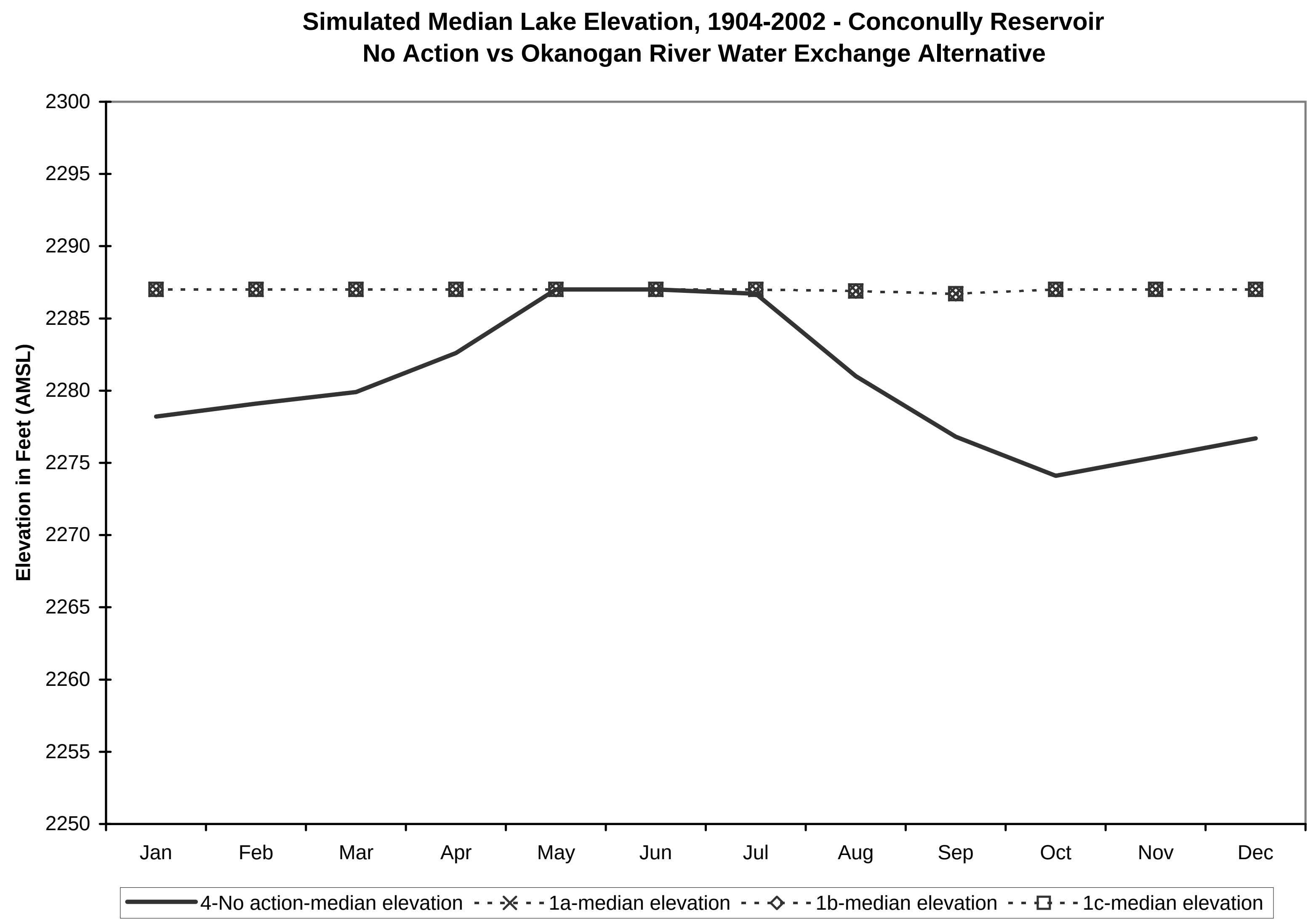

Simulated Maximum Lake Elevation, 1904-2002 - Salmon Lake
No Action vs OID Water Right Purchase Alternative
Elevation in Feet (AMSL)
2330
2320
2310
2300
2290
2280
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
3a-10% exceedence
3b-10% exceedence
3c-10% exceedence
4-No action-maximum elevation
3a-maximum elevation
3b-maximum elevation
3c-maximum elevation

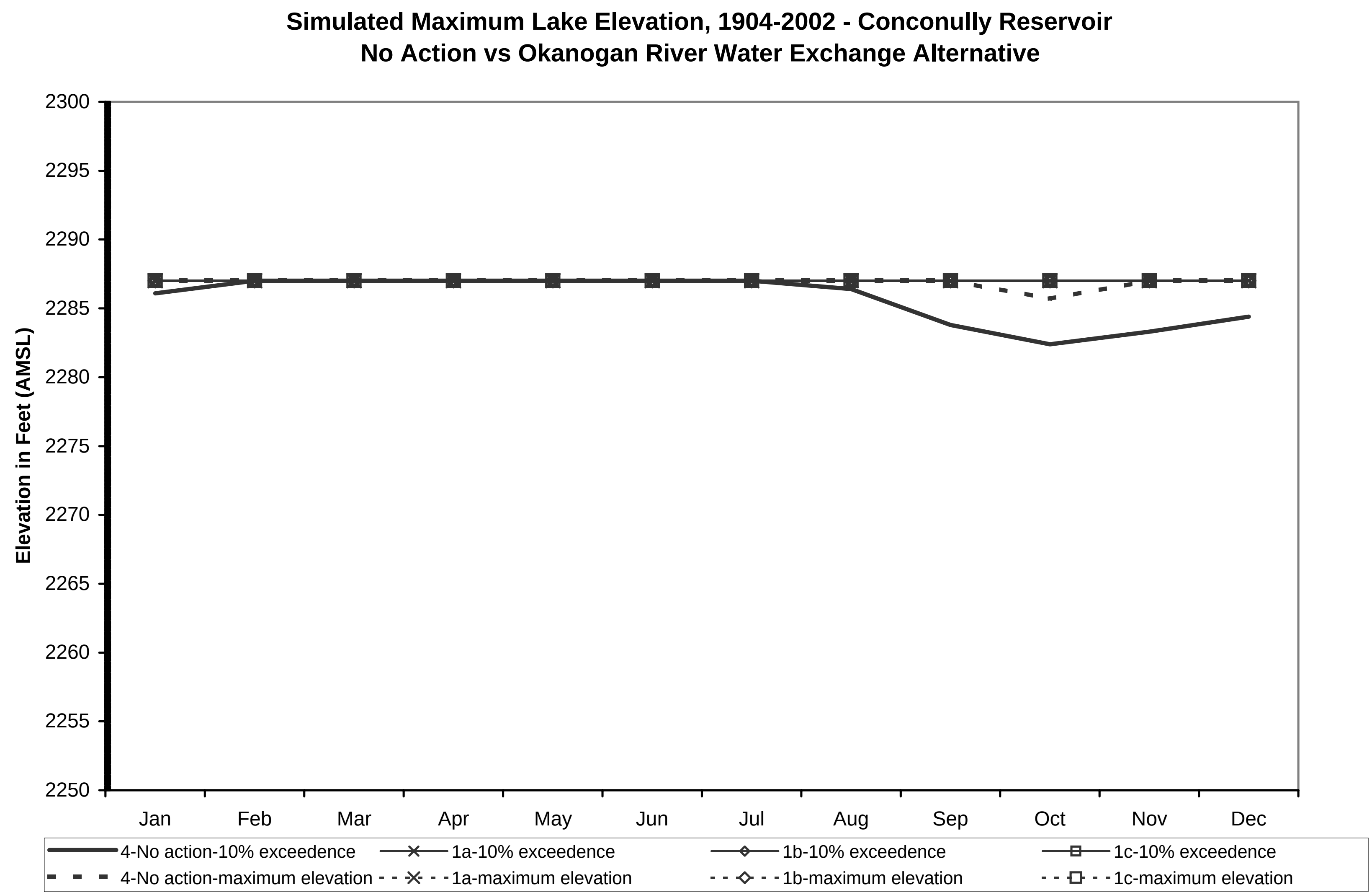

Simulated Minumum Lake Elevation, 1904-2002 - Salmon Lake
No Action vs Upgrade Shellrock Pumping Plant Alternative
Elevation in Feet (AMSL)
2310
2305
2300
2295
2290
2285
2280
2275
2270
2265
2260
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum elevation
2a-minimum elevation
2b-minimum elevation
2c-minimum elevation

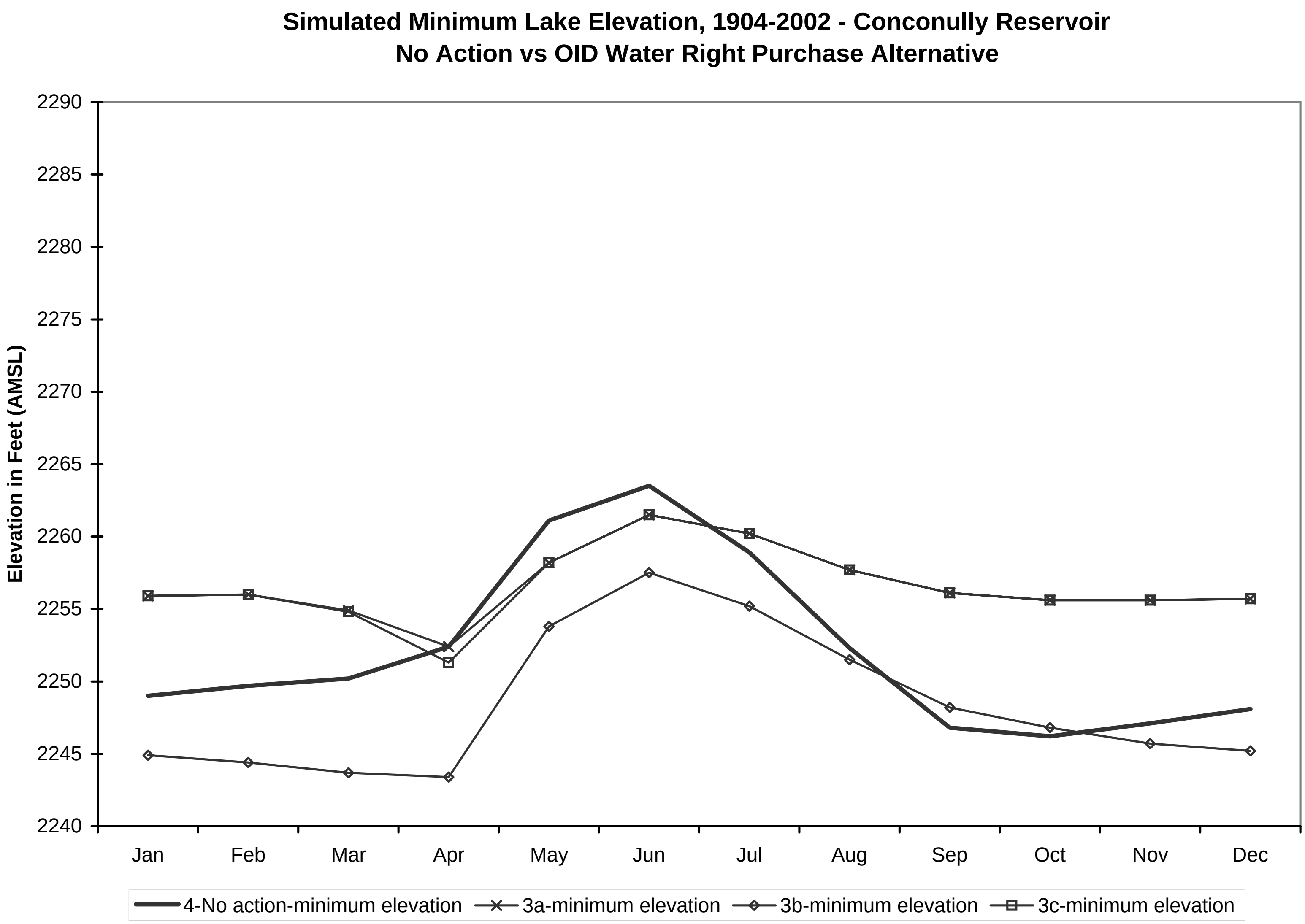

Simulated Median Lake Elevation, 1904-2002 - Salmon Lake
No Action vs Upgrade Shellrock Pumping Plant Alternative
Elevation in Feet (AMSL)
2330
2325
2320
2315
2310
2305
2300
2295
2290
2285
2280
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median elevation
2a-median elevation
2b-median elevation
2c-median elevation

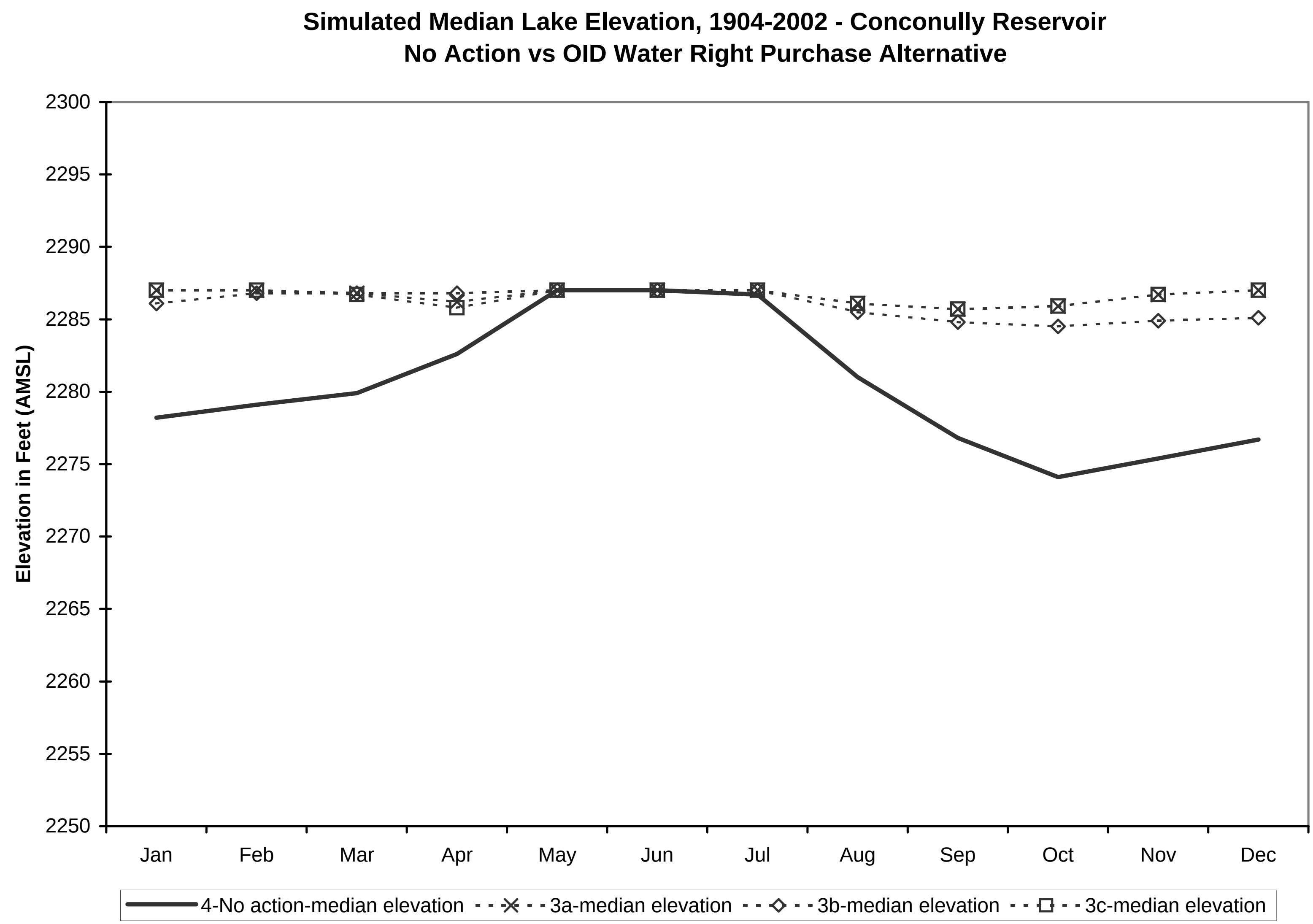

Simulated Maximum Lake Elevation, 1904-2002 - Salmon Lake
No Action vs Upgrade Shellrock Pumping Plant Alternative
Elevation in Feet (AMSL)
2330
2320
2310
2300
2290
2280
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
2a-10% exceedence
2b-10% exceedence
2c-10% exceedence
4-No action-maximum elevation
2a-maximum elevation
2b-maximum elevation
2c-maximum elevation

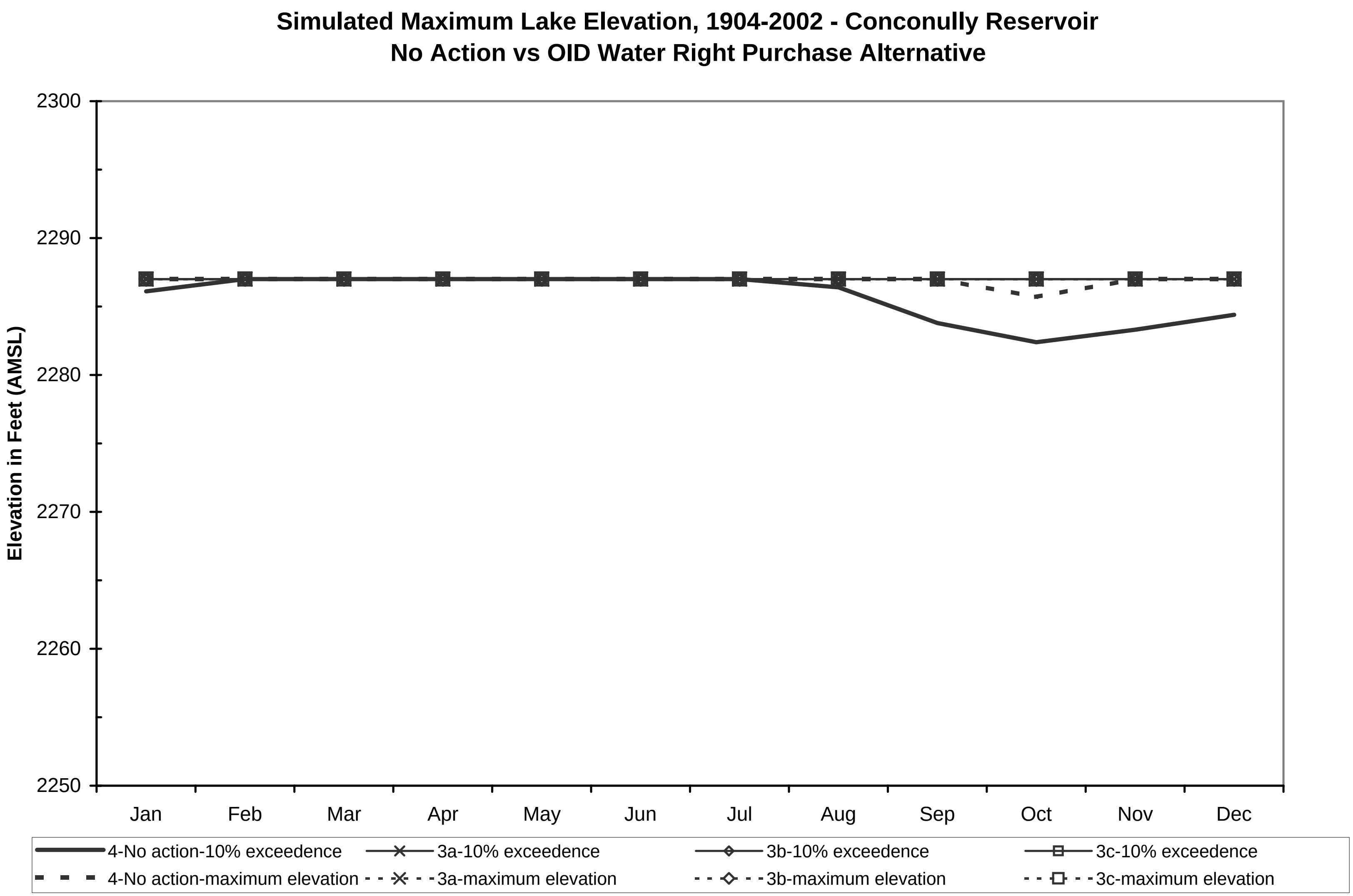

Simulated Minimum Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs Okanogan River Water Exchange Alternative
Elevation in Feet (AMSL)
2290
2285
2280
2275
2270
2265
2260
2255
2250
2245
2240
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum elevation
1a-minimum elevation
1b-minimum elevation
1c-minimum elevation

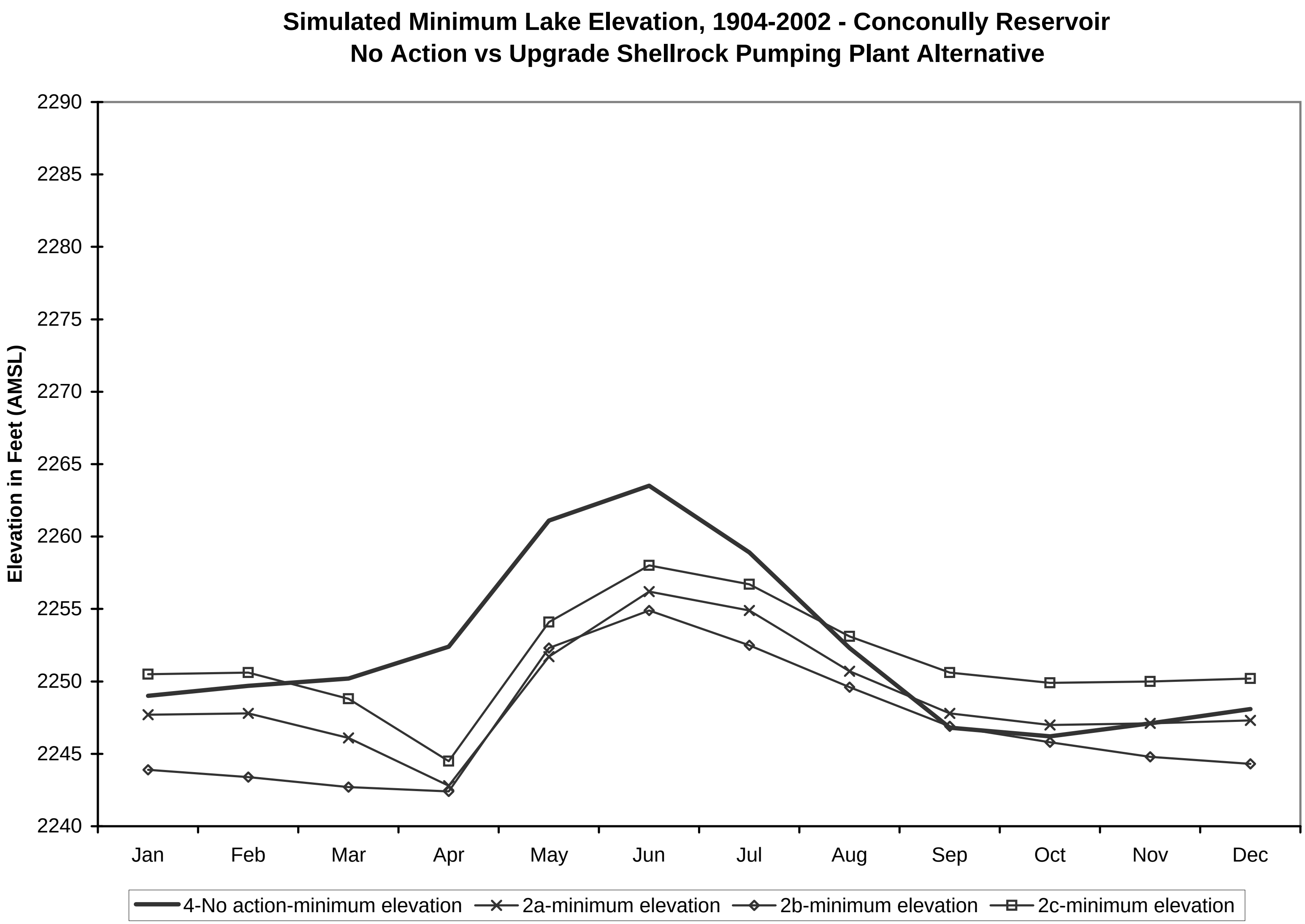

Simulated Median Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs Okanogan River Water Exchange Alternative
Elevation in Feet (AMSL)
2300
2295
2290
2285
2280
2275
2270
2265
2260
2255
2250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median elevation
1a-median elevation
1b-median elevation
1c-median elevation

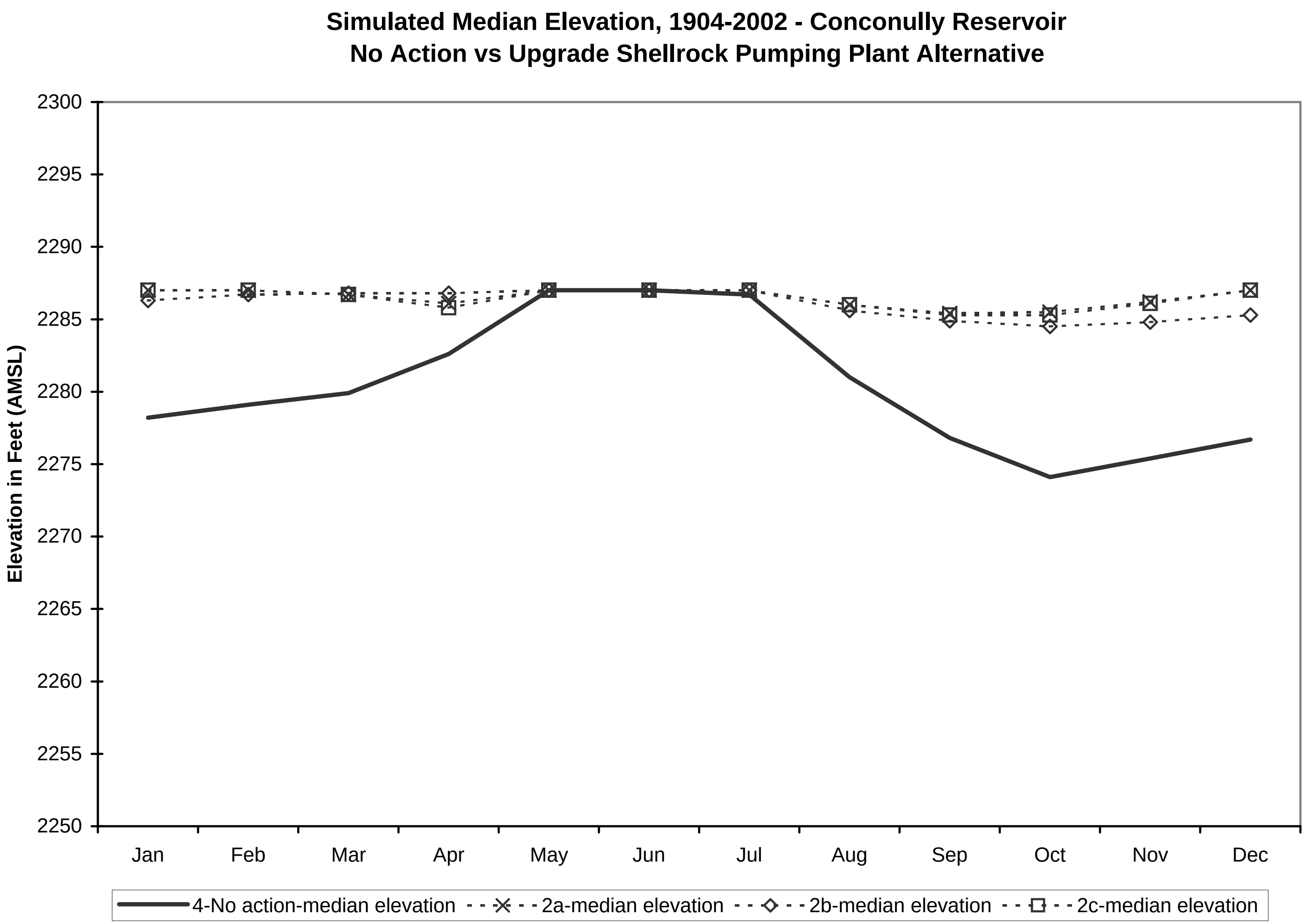

Simulated Maximum Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs Okanogan River Water Exchange Alternative
Elevation in Feet (AMSL)
2300
2295
2290
2285
2280
2275
2270
2265
2260
2255
2250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
1a-10% exceedence
1b-10% exceedence
1c-10% exceedence
4-No action-maximum elevation
1a-maximum elevation
1b-maximum elevation
1c-maximum elevation

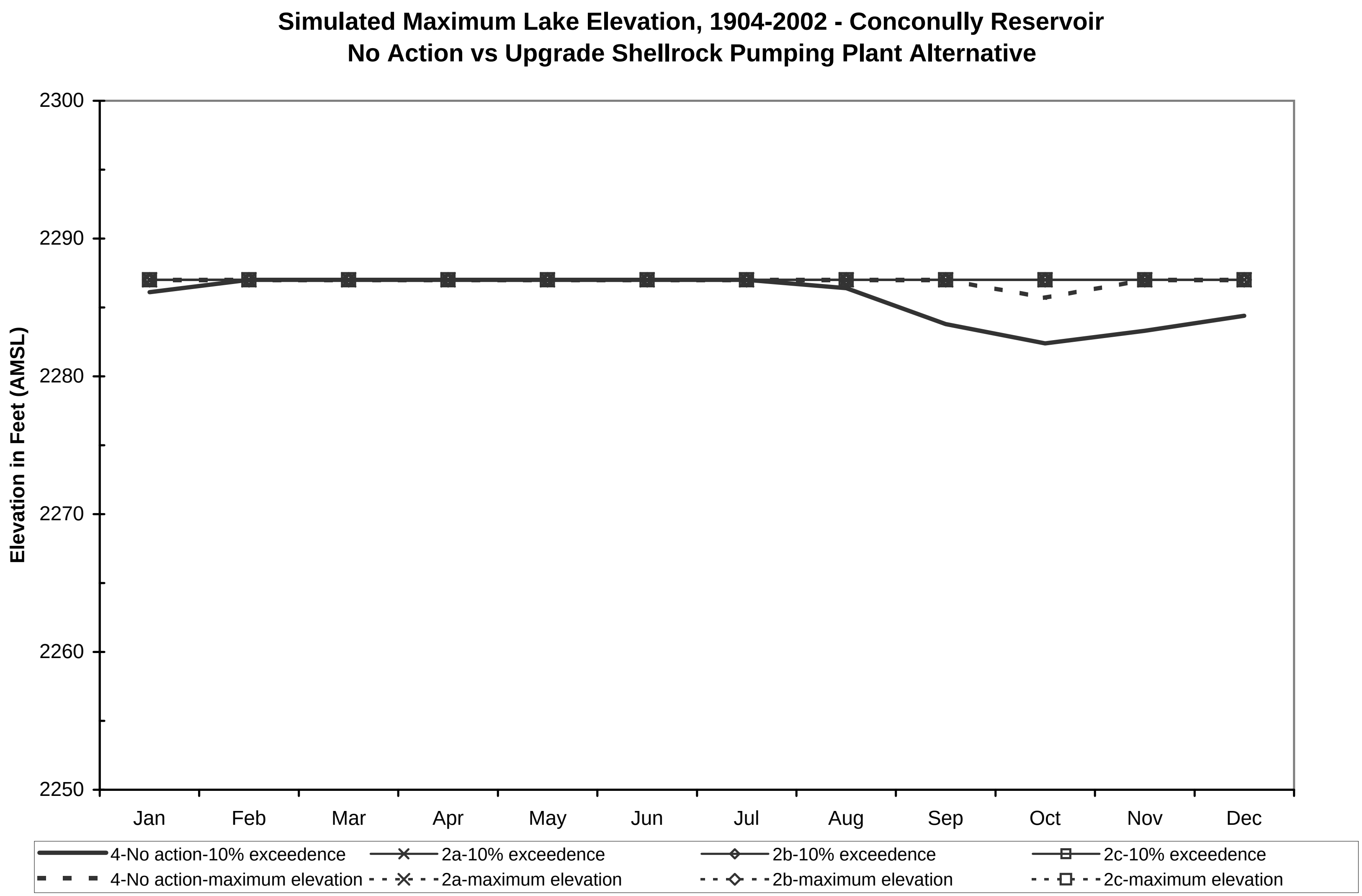

Simulated Minimum Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs OID Water Right Purchase Alternative
Elevation in Feet (AMSL)
2290
2285
2280
2275
2270
2265
2260
2255
2250
2245
2240
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum elevation
3a-minimum elevation
3b-minimum elevation
3c-minimum elevation


Simulated Median Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs OID Water Right Purchase Alternative
Elevation in Feet (AMSL)
2300
2295
2290
2285
2280
2275
2270
2265
2260
2255
2250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median elevation
3a-median elevation
3b-median elevation
3c-median elevation

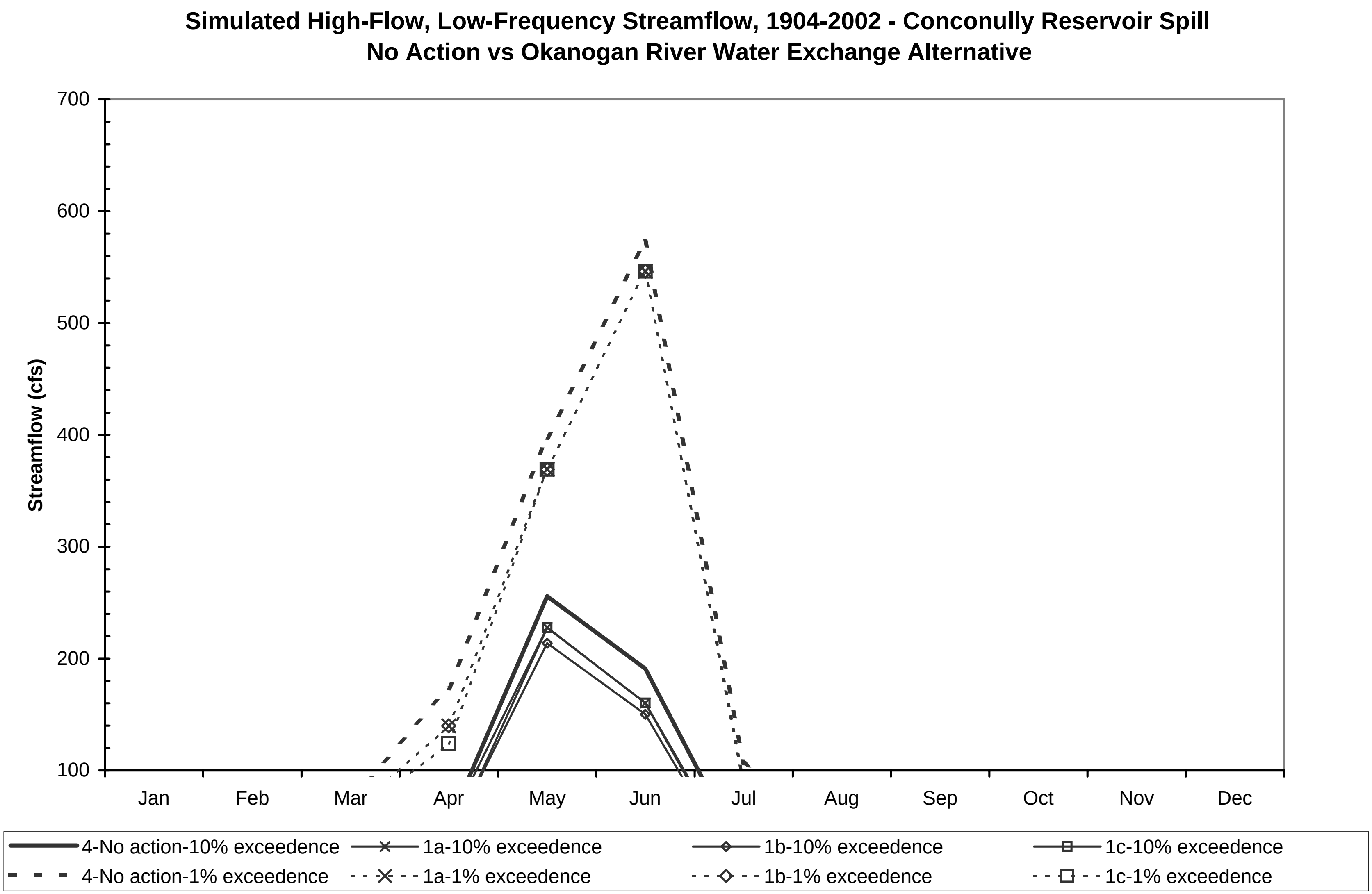

Simulated Maximum Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs OID Water Right Purchase Alternative
Elevation in Feet (AMSL)
2300
2290
2280
2270
2260
2250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
3a-10% exceedence
3b-10% exceedence
3c-10% exceedence
4-No action-maximum elevation
3a-maximum elevation
3b-maximum elevation
3c-maximum elevation


Simulated Minimum Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs Upgrade Shellrock Pumping Plant Alternative
Elevation in Feet (AMSL)
2290
2285
2280
2275
2270
2265
2260
2255
2250
2245
2240
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum elevation
2a-minimum elevation
2b-minimum elevation
2c-minimum elevation

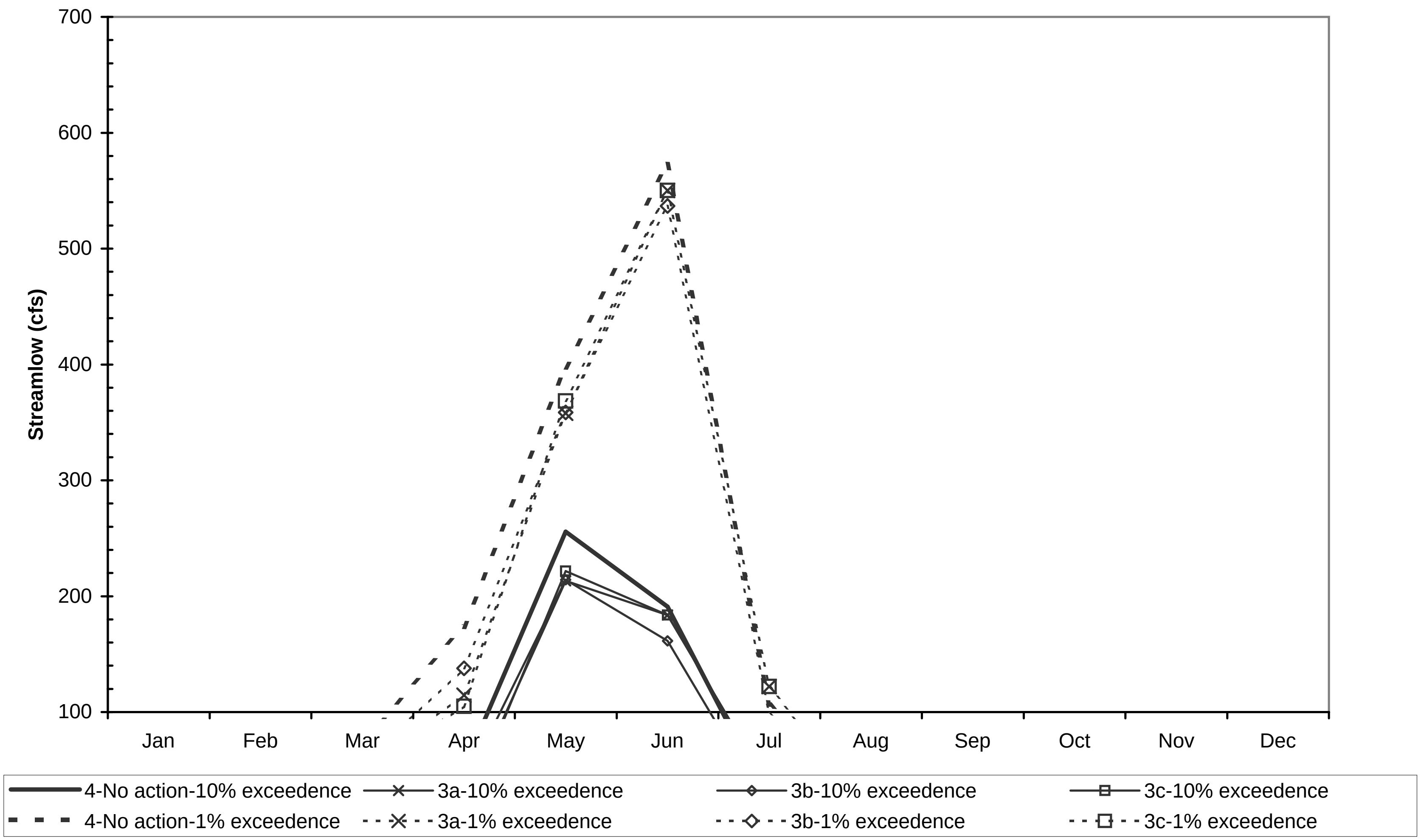

Simulated Median Elevation, 1904-2002 - Conconully Reservoir
No Action vs Upgrade Shellrock Pumping Plant Alternative
Elevation in Feet (AMSL)
2300
2295
2290
2285
2280
2275
2270
2265
2260
2255
2250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median elevation
2a-median elevation
2b-median elevation
2c-median elevation

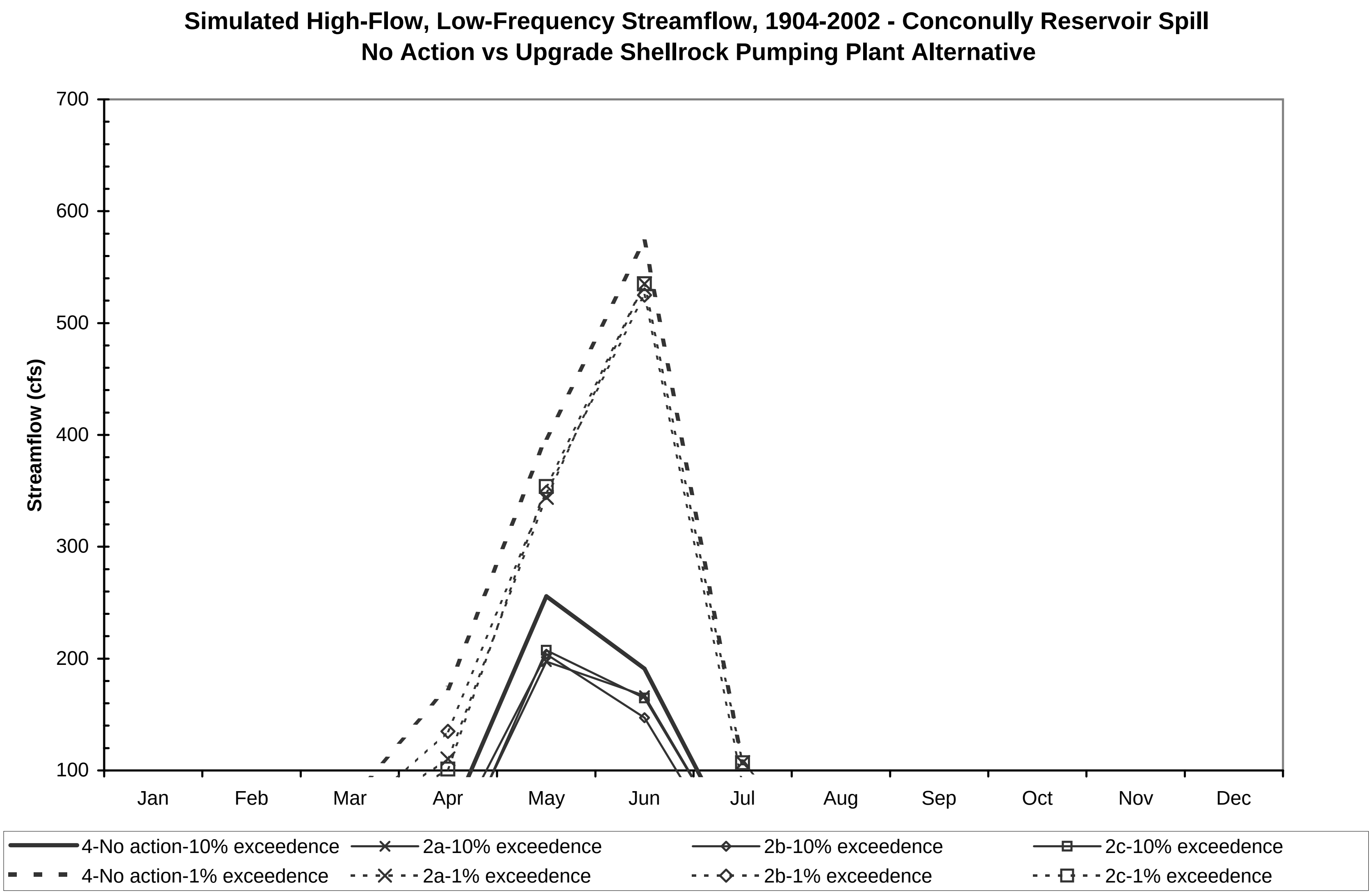

Simulated Maximum Lake Elevation, 1904-2002 - Conconully Reservoir
No Action vs Upgrade Shellrock Pumping Plant Alternative
Elevation in Feet (AMSL)
2300
2290
2280
2270
2260
2250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
2a-10% exceedence
2b-10% exceedence
2c-10% exceedence
4-No action-maximum elevation
2a-maximum elevation
2b-maximum elevation
2c-maximum elevation

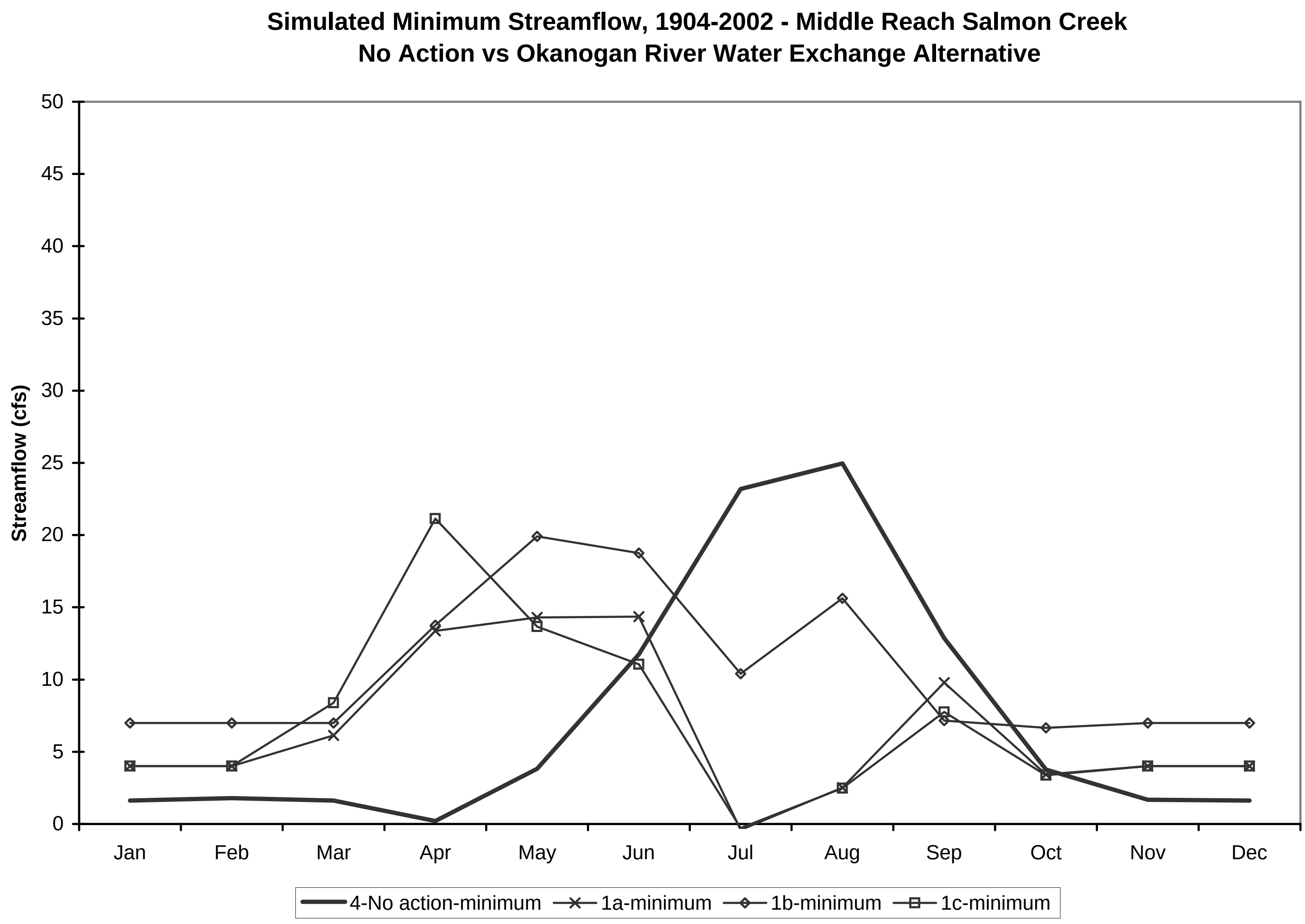
APPENDIX D-5:
Simulated Streamflows for Salmon Creek (Above Weir, Below Weir, Below Watercress Springs, and at the Mouth)

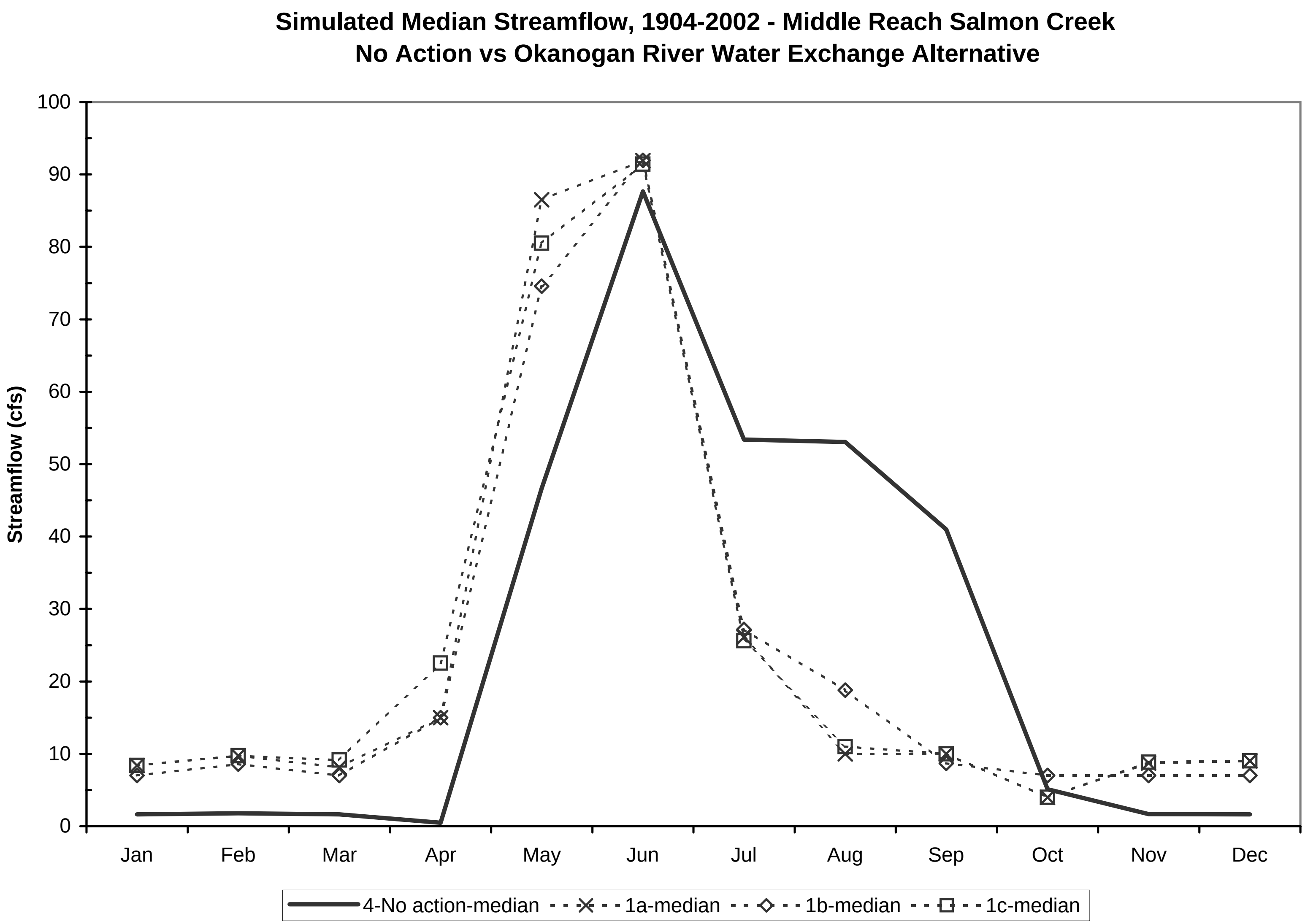

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Conconully Reservoir Spill
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
1a-10% exceedence
1b-10% exceedence
1c-10% exceedence
4-No action-1% exceedence
1a-1% exceedence
1b-1% exceedence
1c-1% exceedence

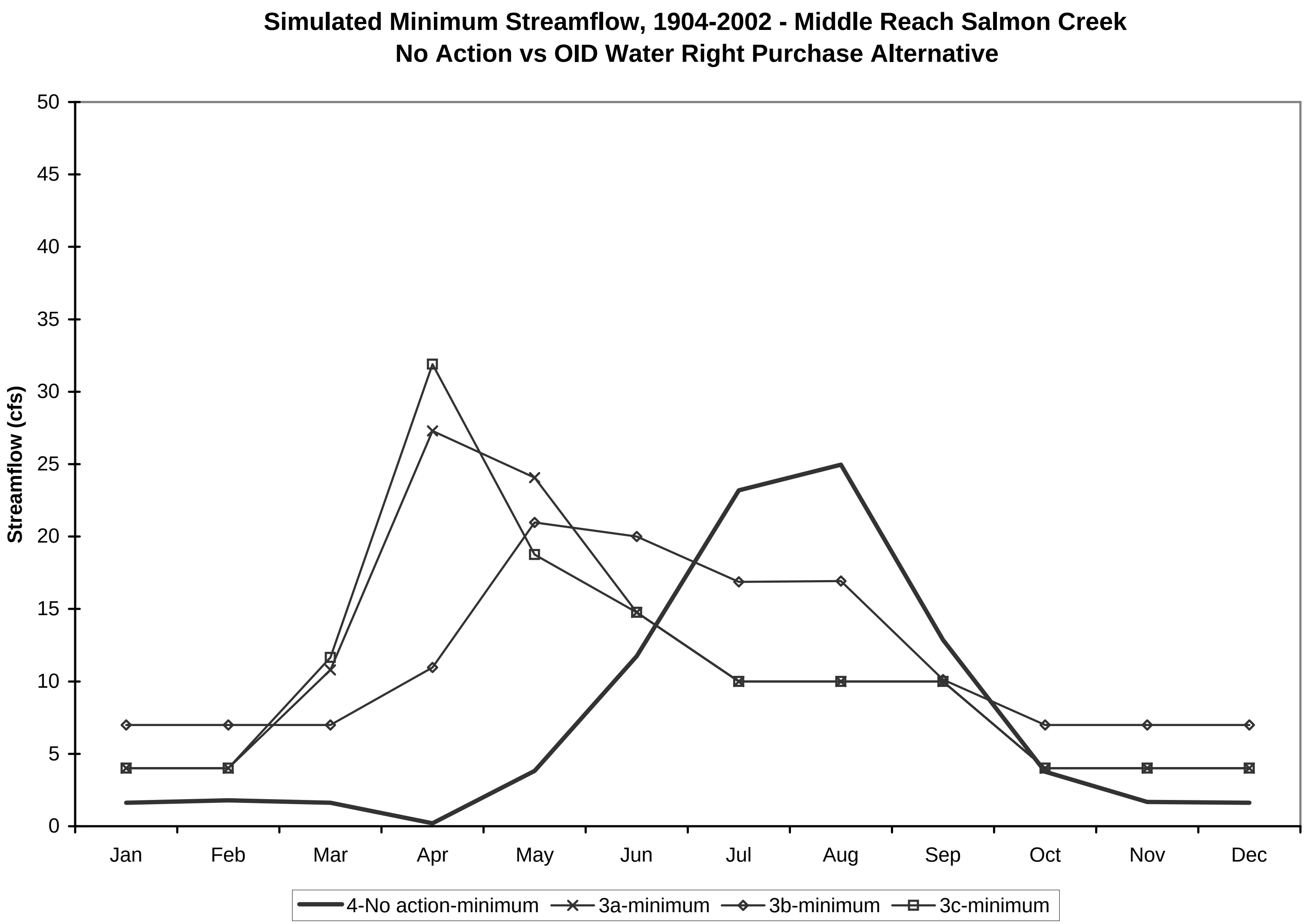
Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Conconully Reservoir Spill
No Action vs OID Water Right Purchase Alternative

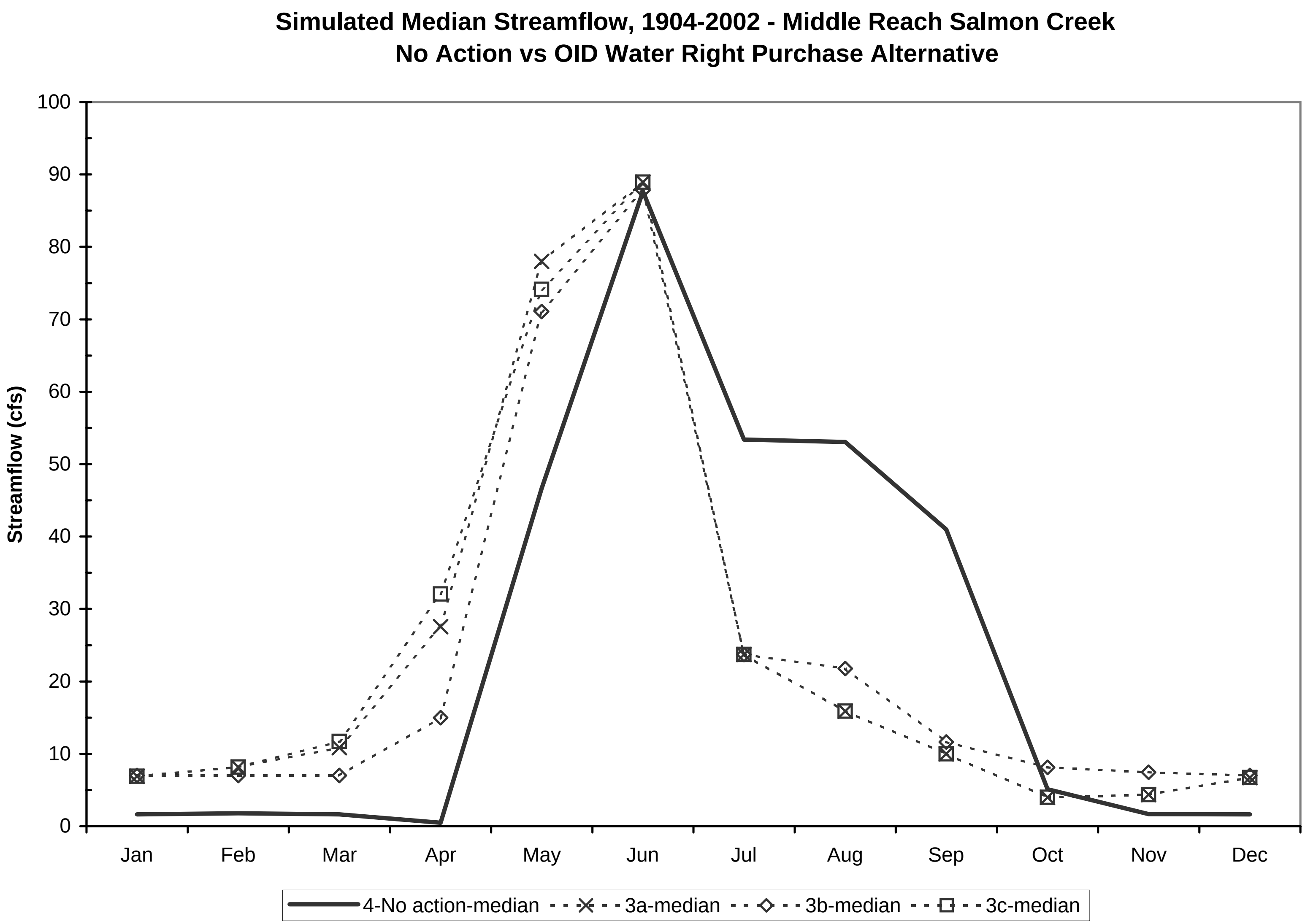


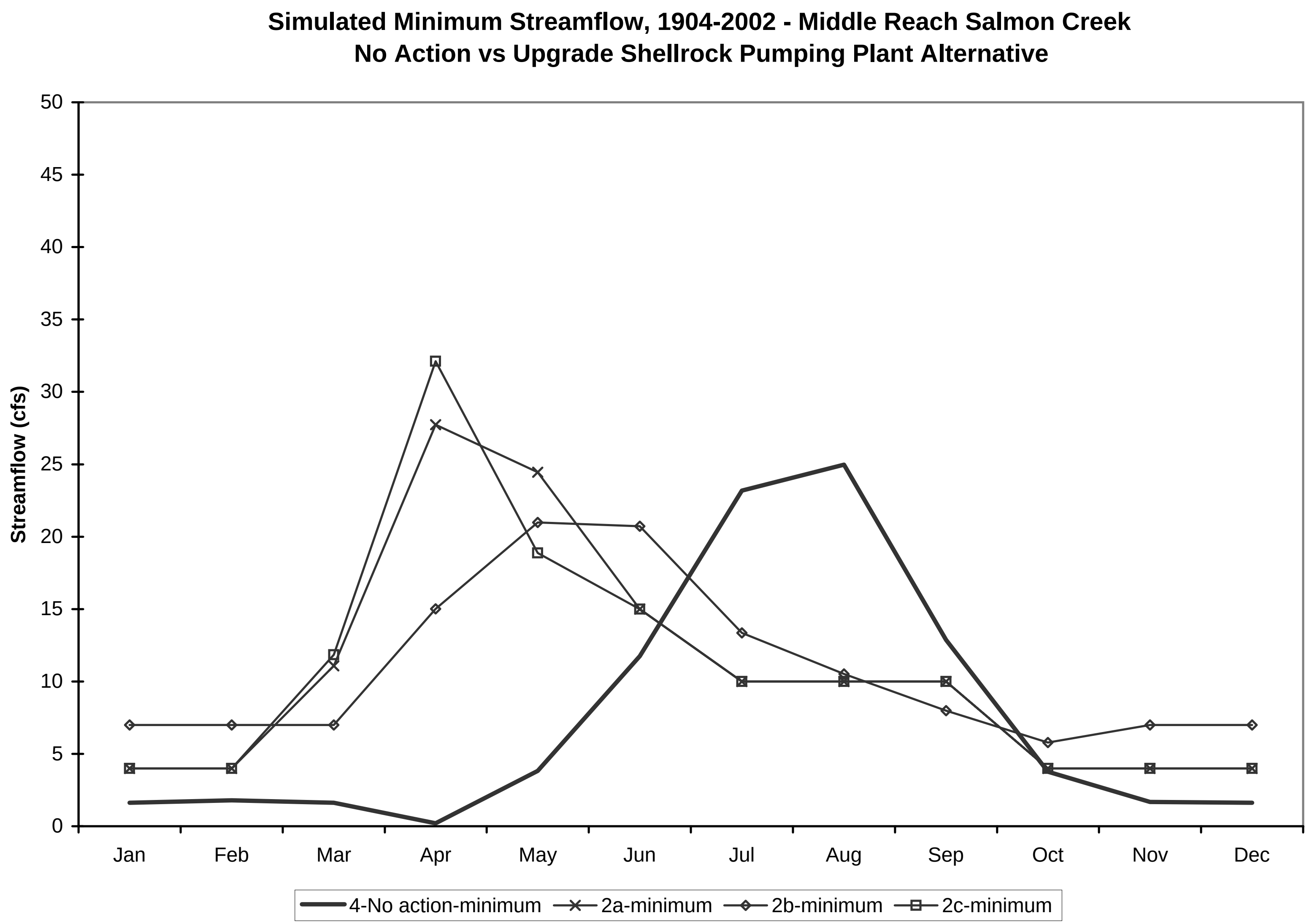

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Conconully Reservoir Spill
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
2a-10% exceedence
2b-10% exceedence
2c-10% exceedence
4-No action-1% exceedence
2a-1% exceedence
2b-1% exceedence
2c-1% exceedence

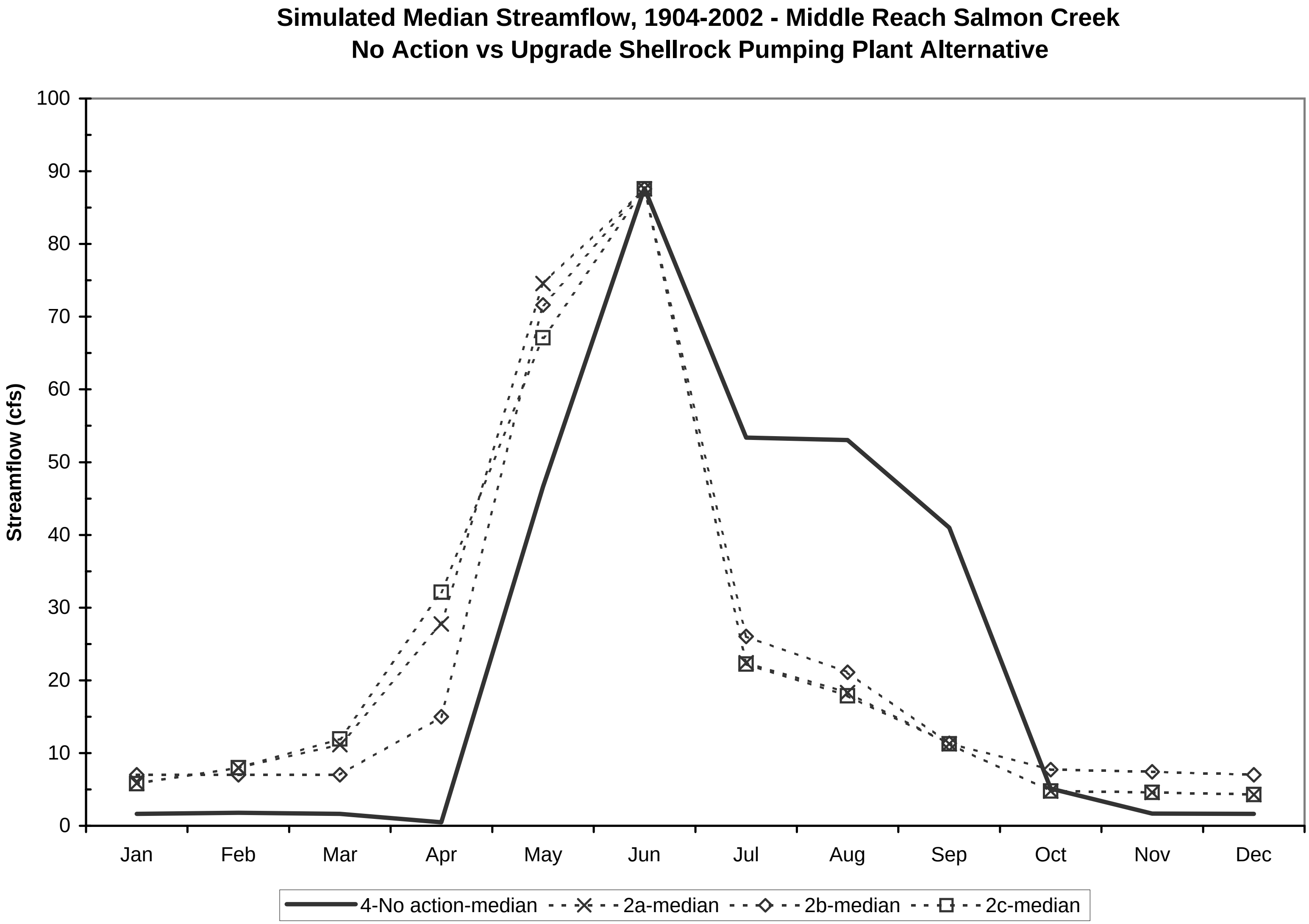

Simulated Minimum Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
1a-minimum
1b-minimum
1c-minimum

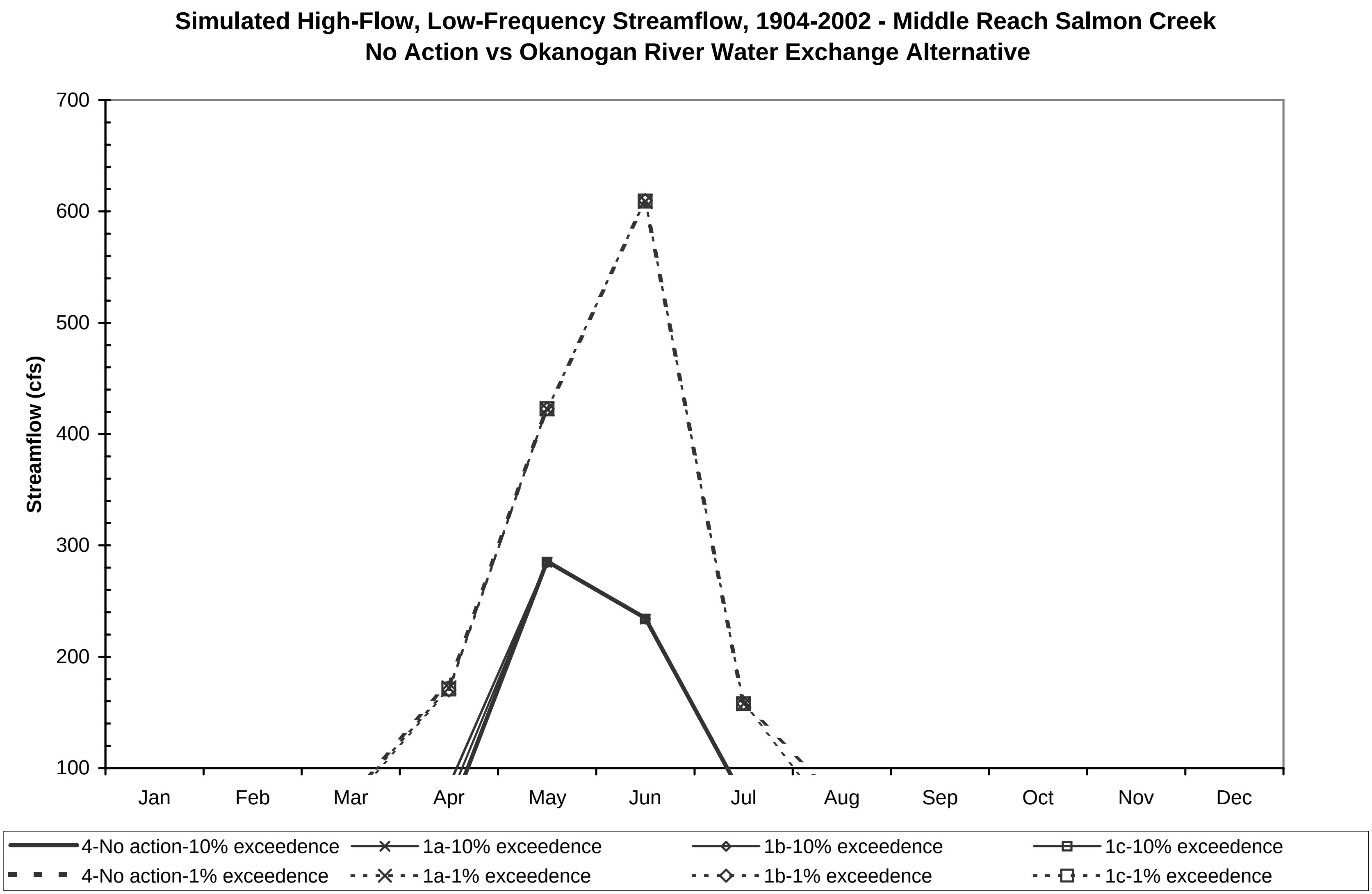

Simulated Median Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
1a-median
1b-median
1c-median

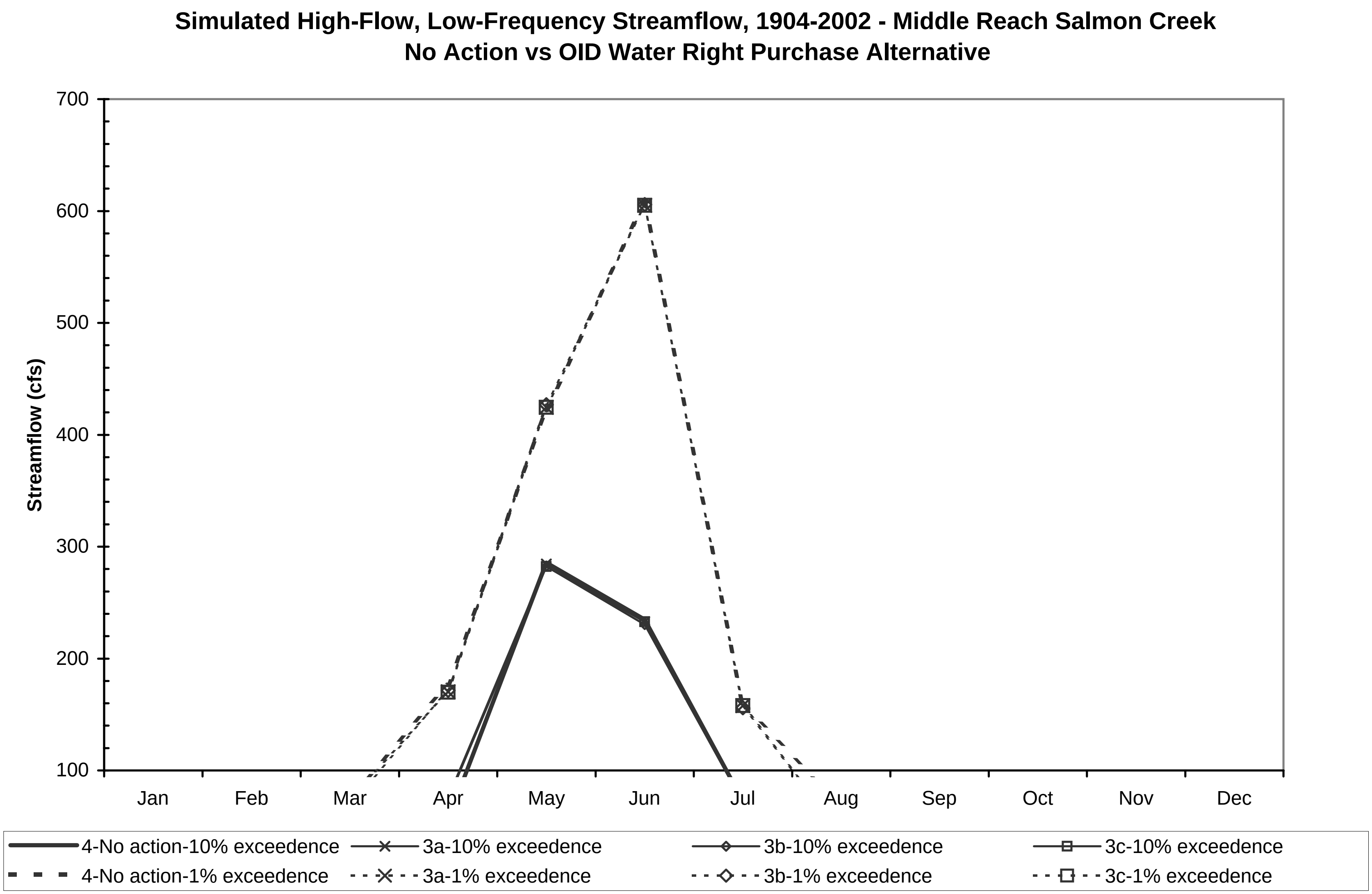

Simulated Minimum Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
3a-minimum
3b-minimum
3c-minimum

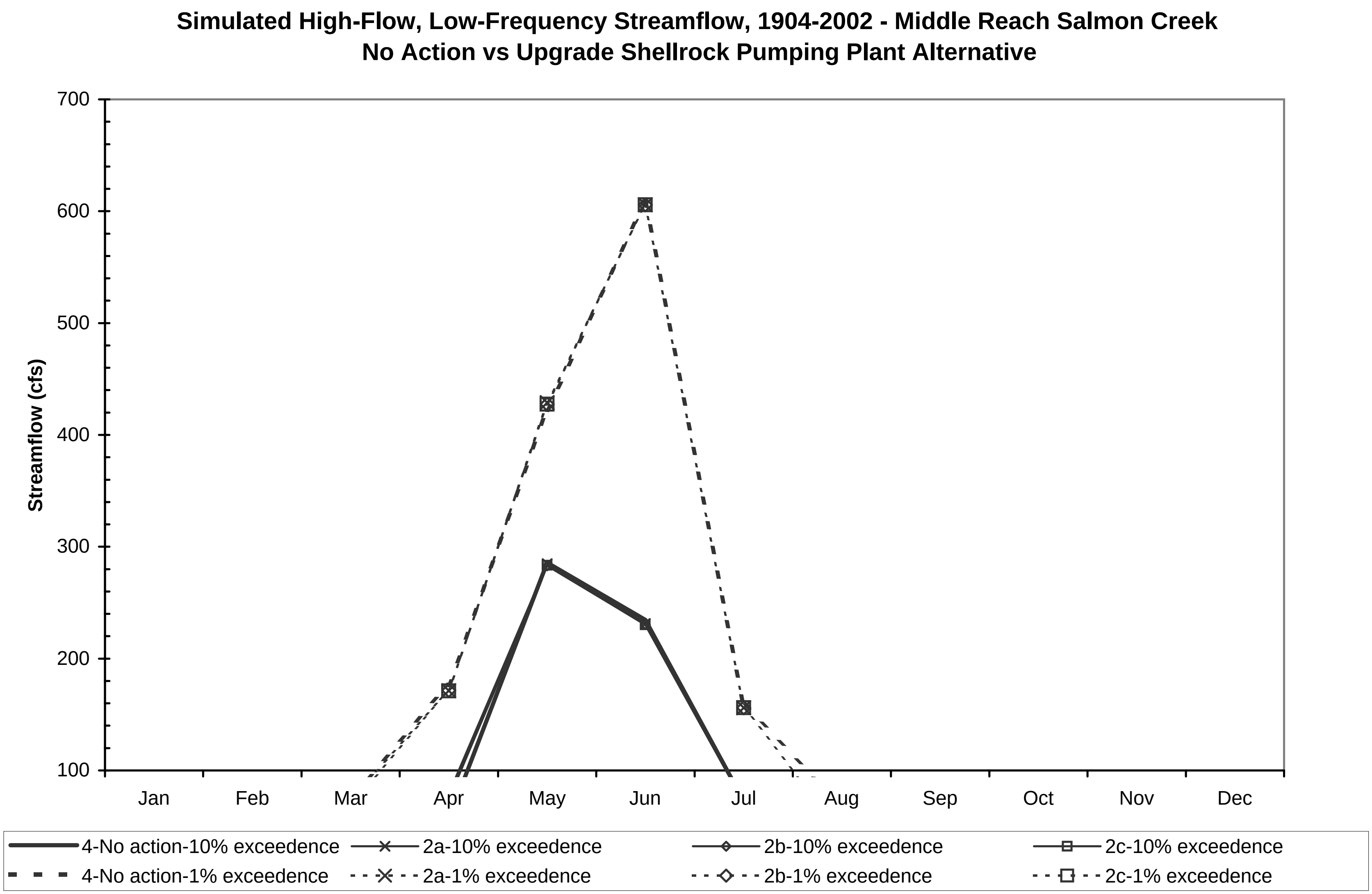

Simulated Median Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
3a-median
3b-median
3c-median

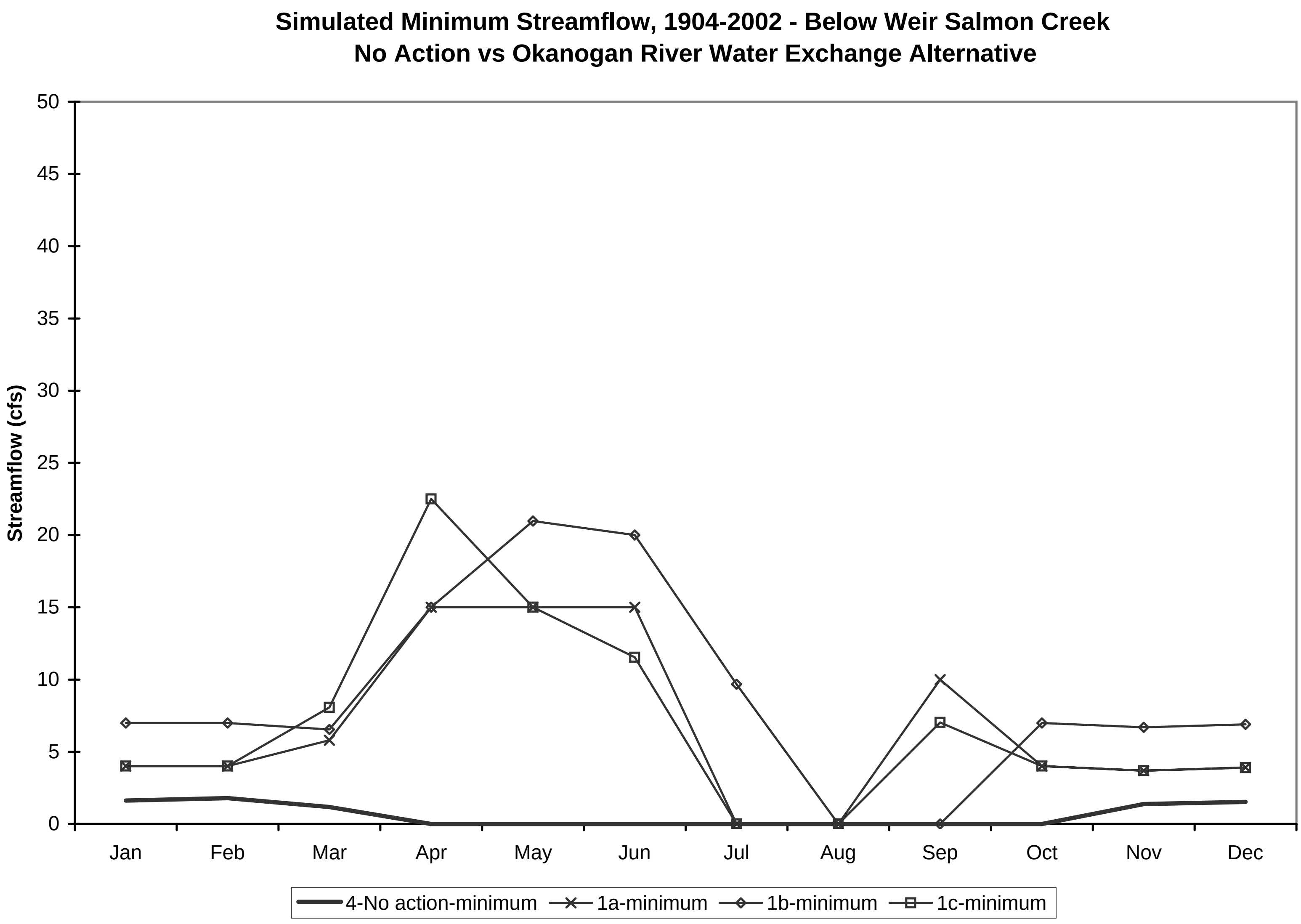

Simulated Minimum Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
2a-minimum
2b-minimum
2c-minimum

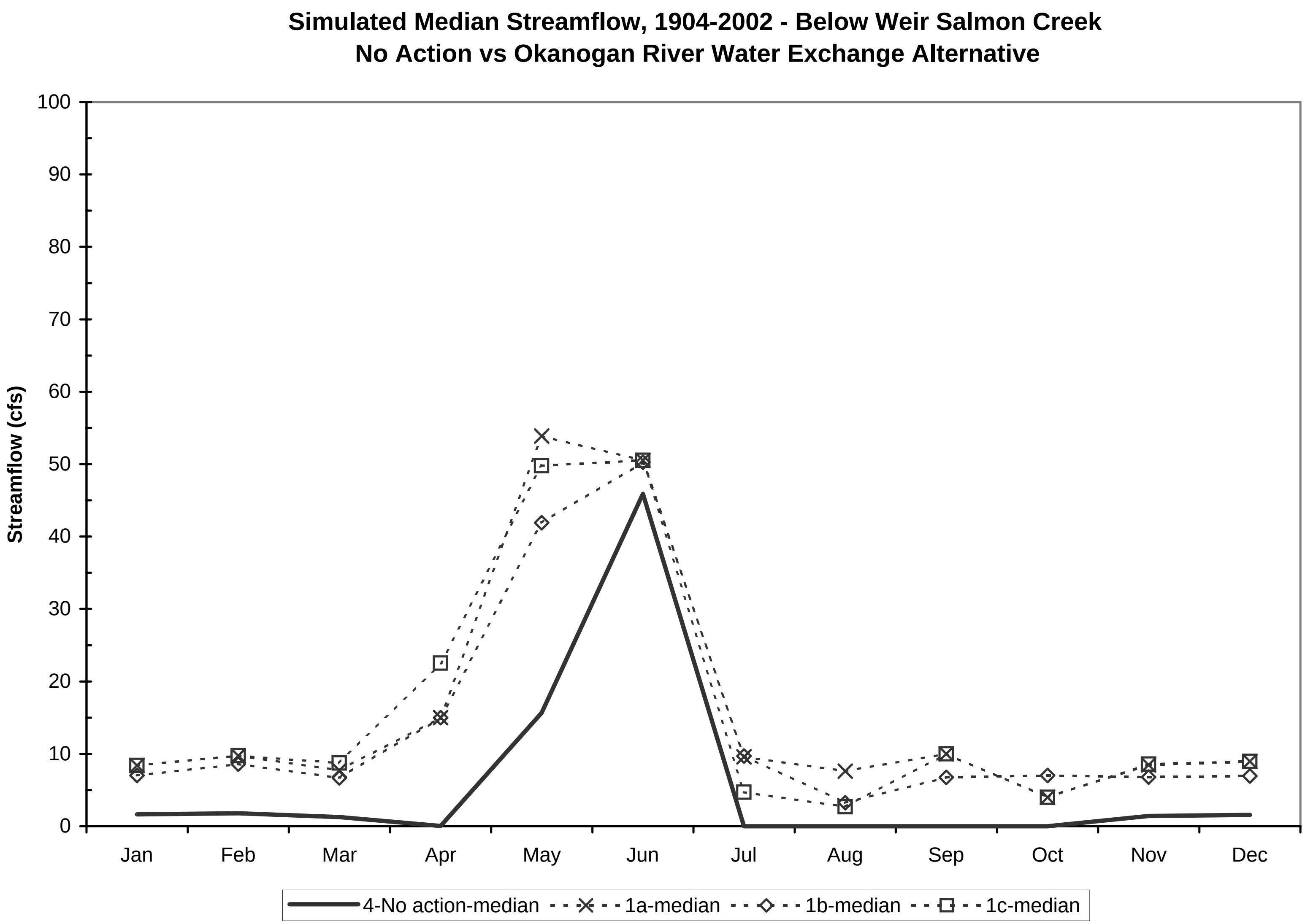

Simulated Median Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
2a-median
2b-median
2c-median

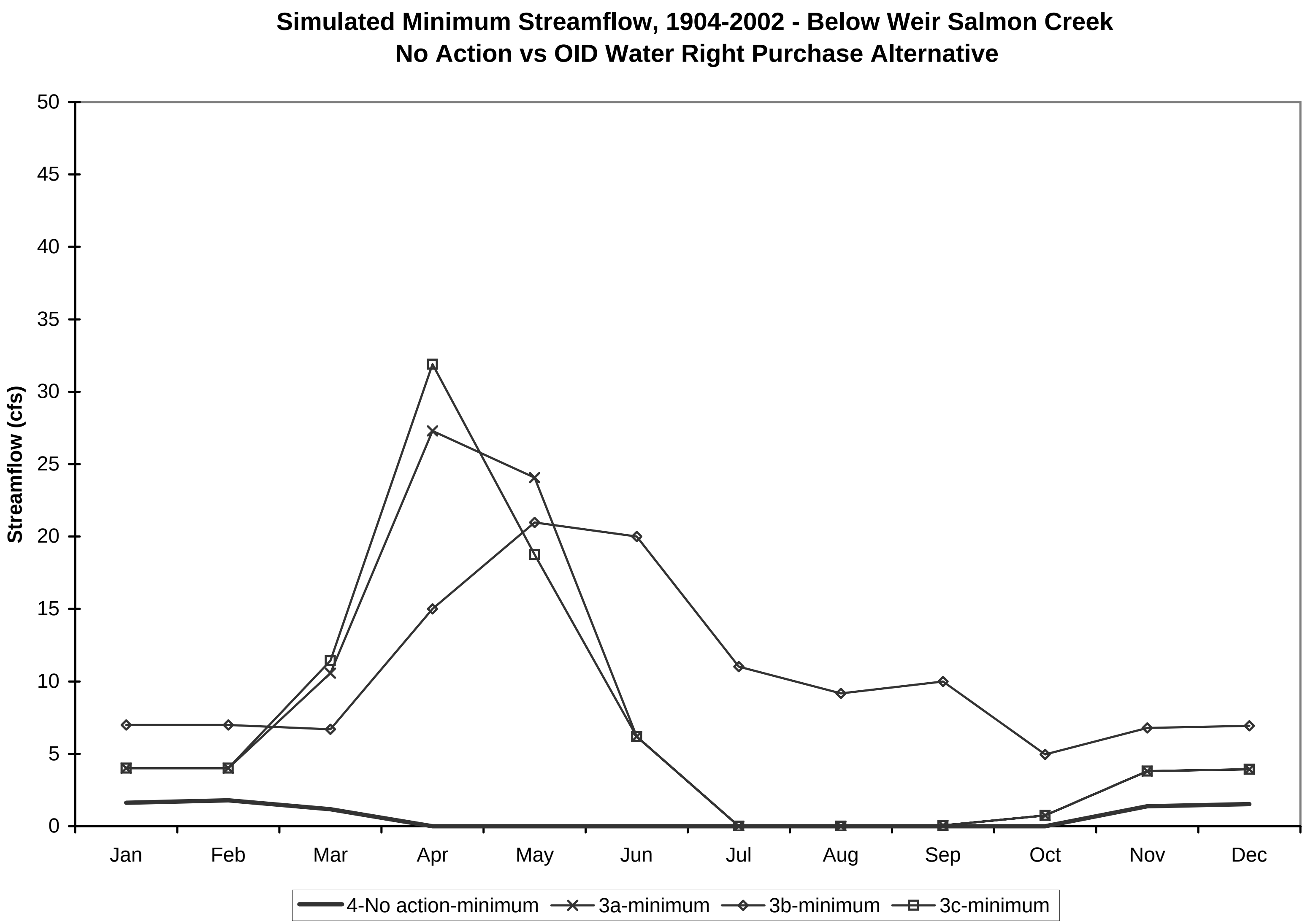

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
1a-10% exceedence
1b-10% exceedence
1c-10% exceedence
4-No action-1% exceedence
1a-1% exceedence
1b-1% exceedence
1c-1% exceedence

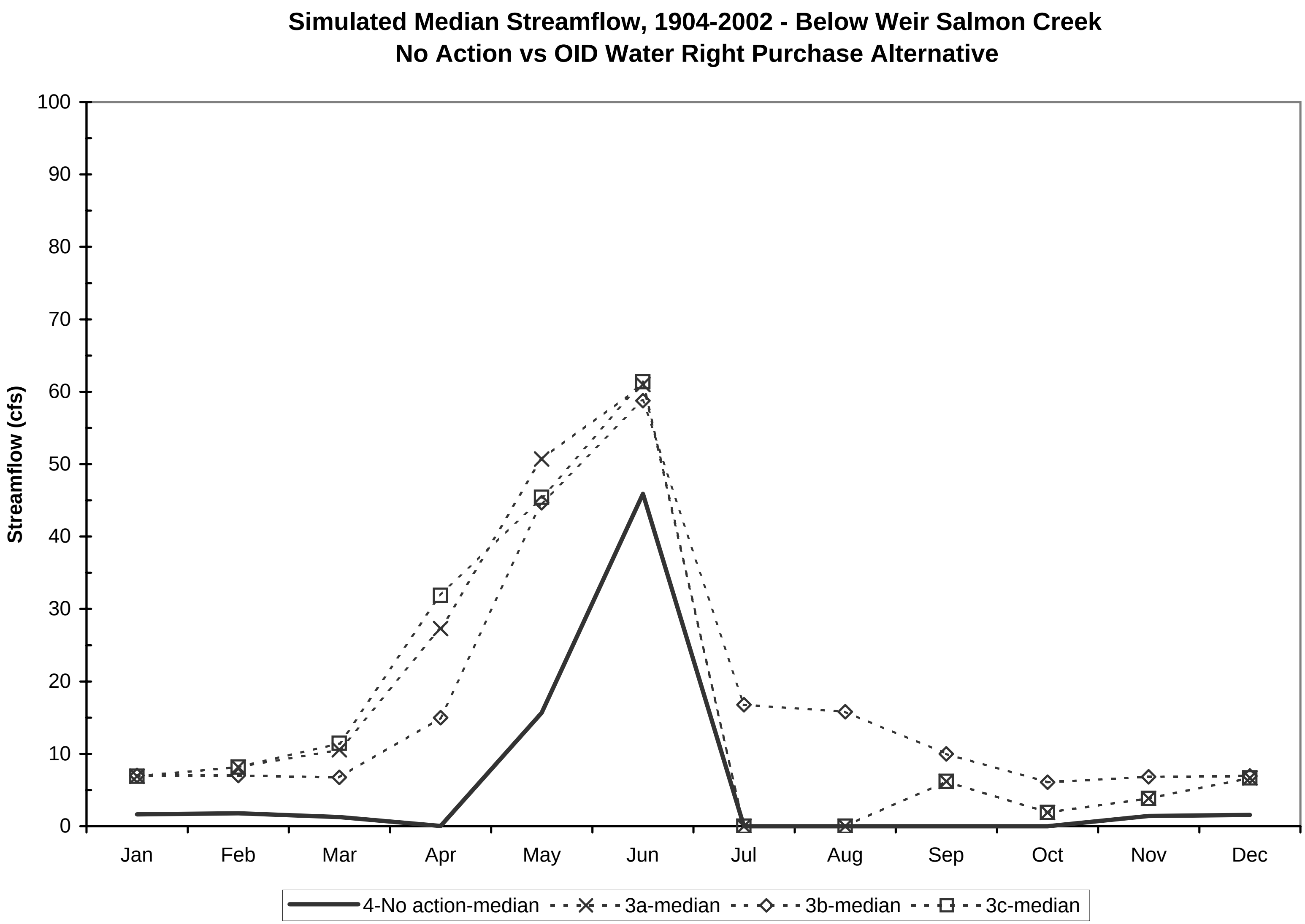

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
3a-10% exceedence
3b-10% exceedence
3c-10% exceedence
4-No action-1% exceedence
3a-1% exceedence
3b-1% exceedence
3c-1% exceedence


Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Middle Reach Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
2a-10% exceedence
2b-10% exceedence
2c-10% exceedence
4-No action-1% exceedence
2a-1% exceedence
2b-1% exceedence
2c-1% exceedence

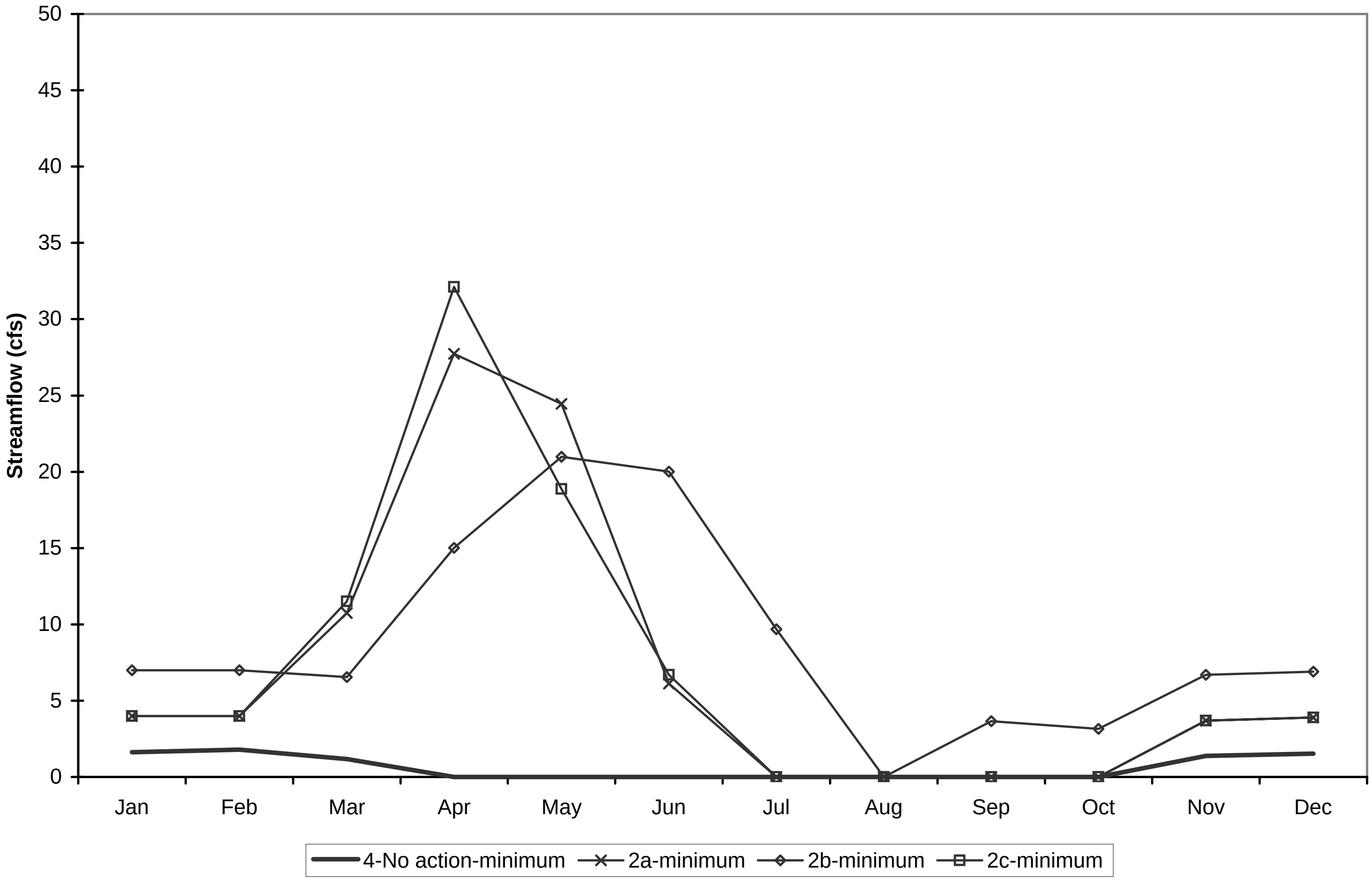

Simulated Minimum Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
1a-minimum
1b-minimum
1c-minimum

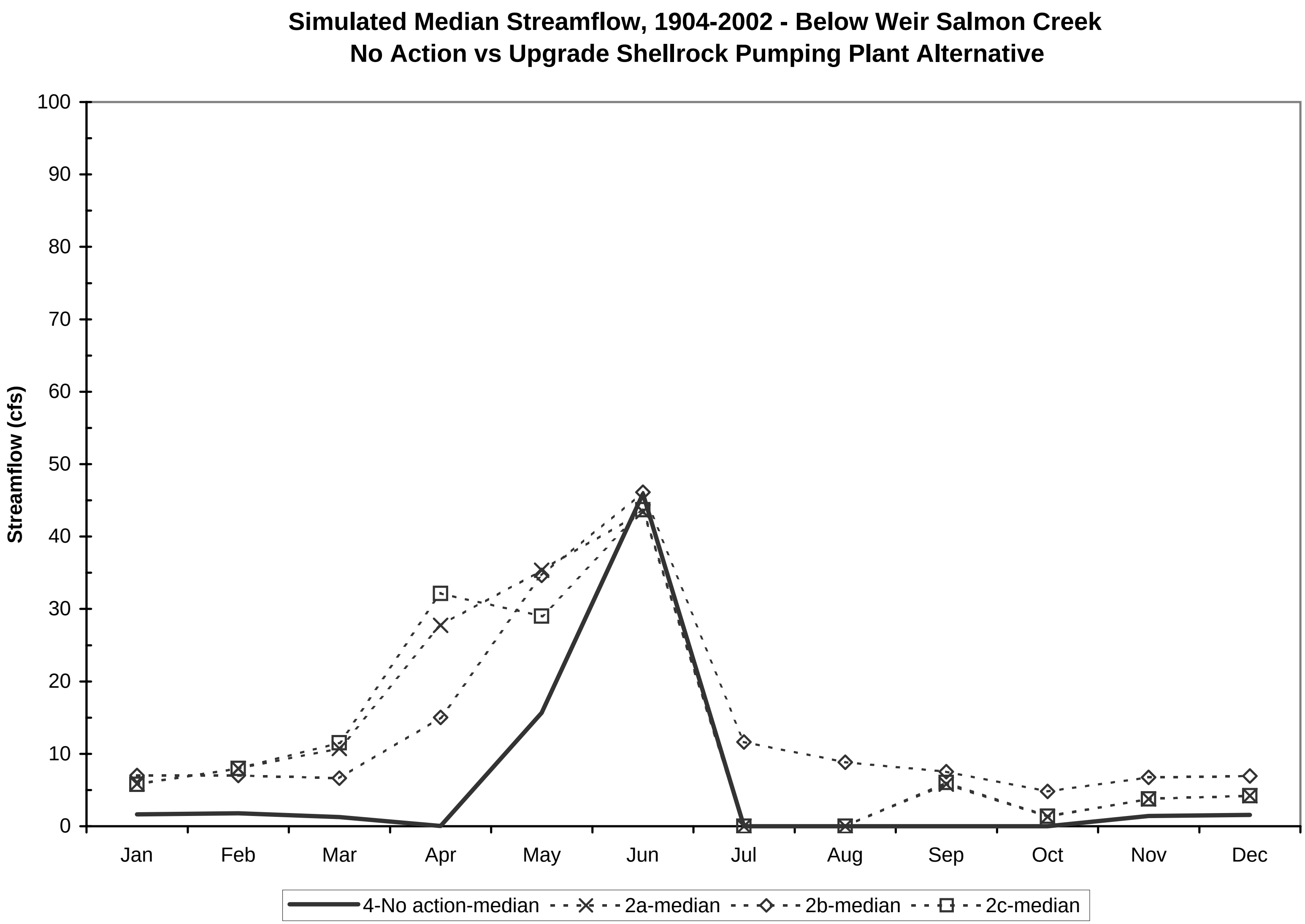

Simulated Median Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
1a-median
1b-median
1c-median

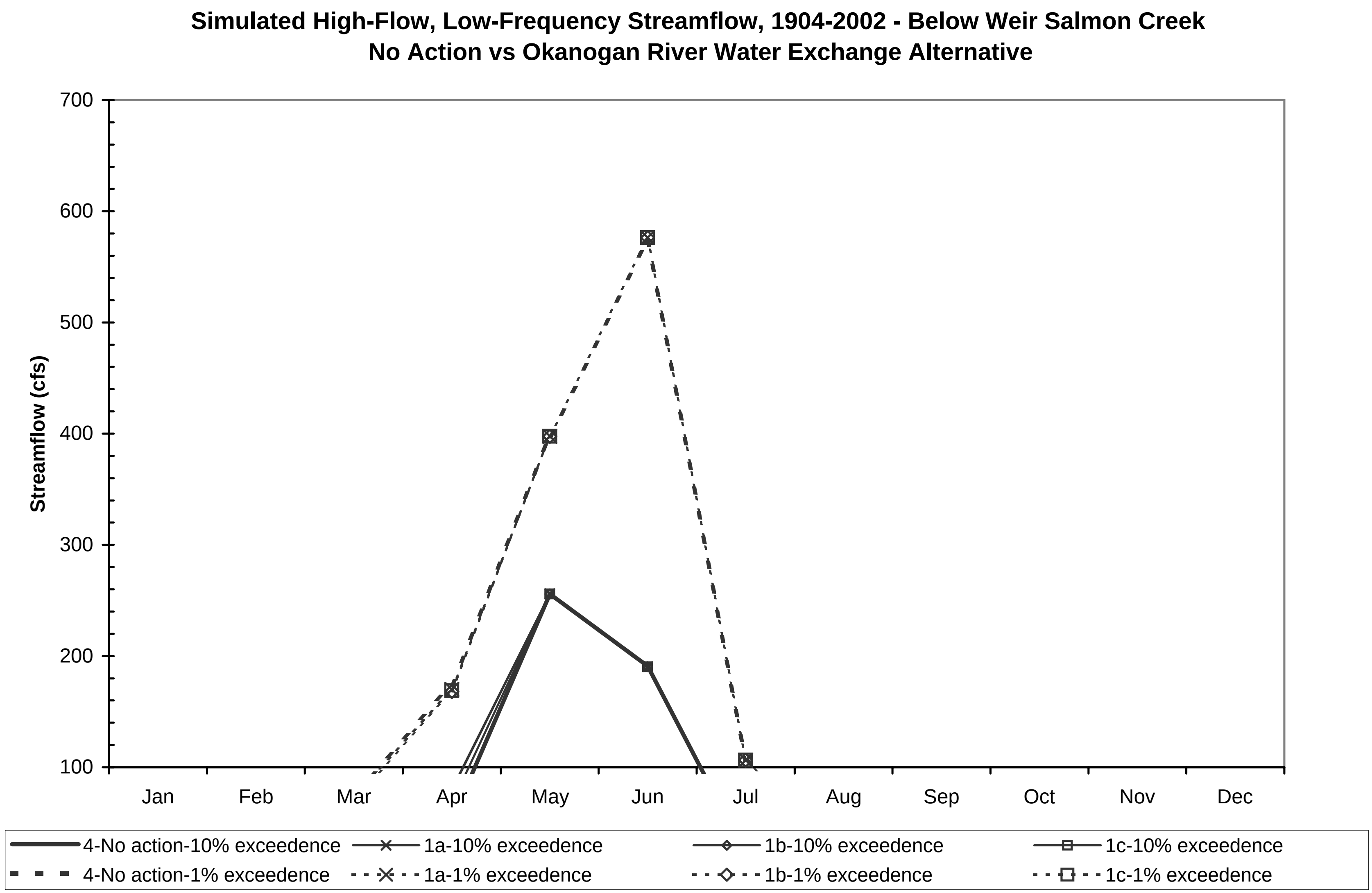

Simulated Minimum Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
3a-minimum
3b-minimum
3c-minimum

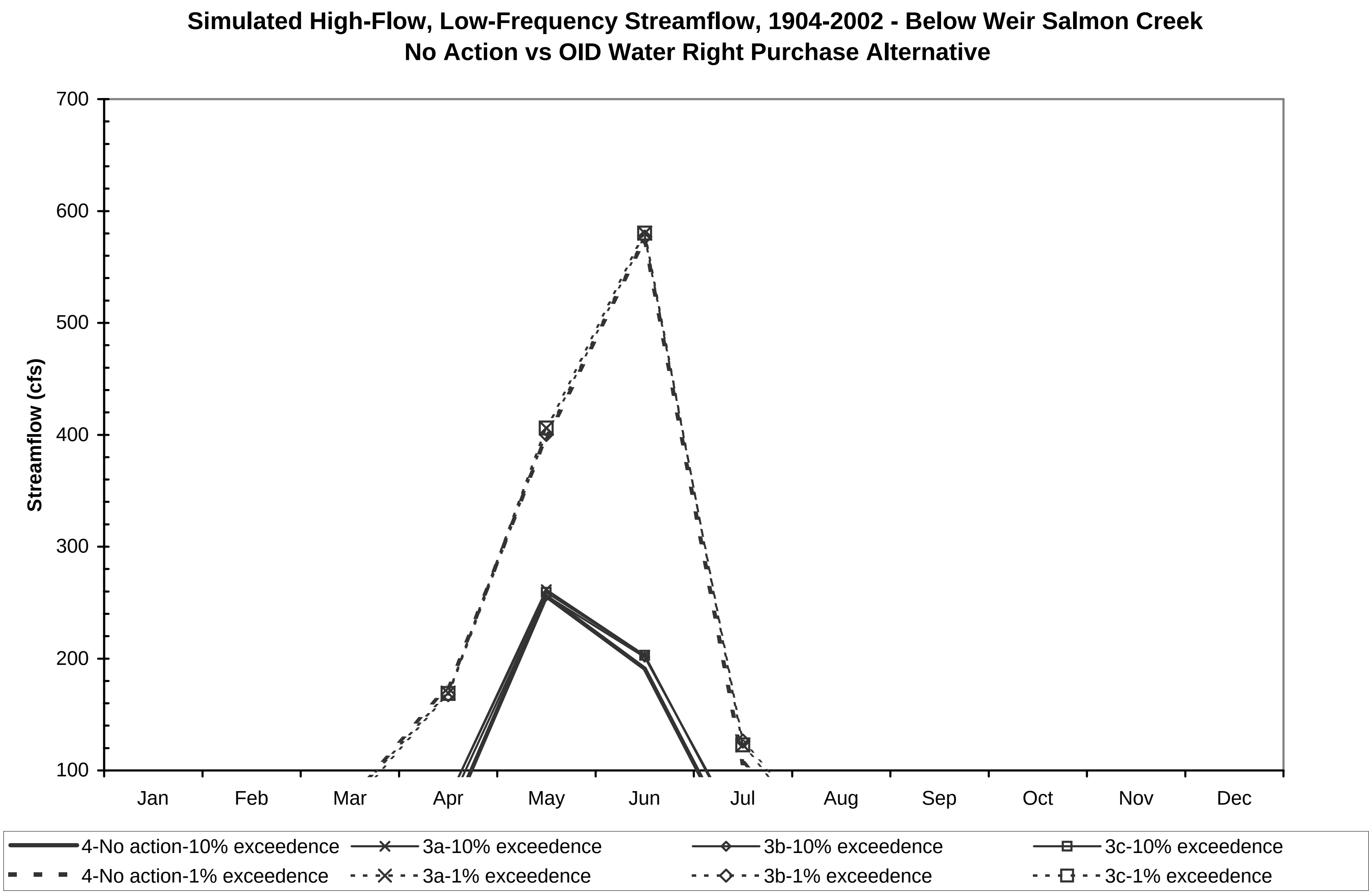

Simulated Median Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
3a-median
3b-median
3c-median

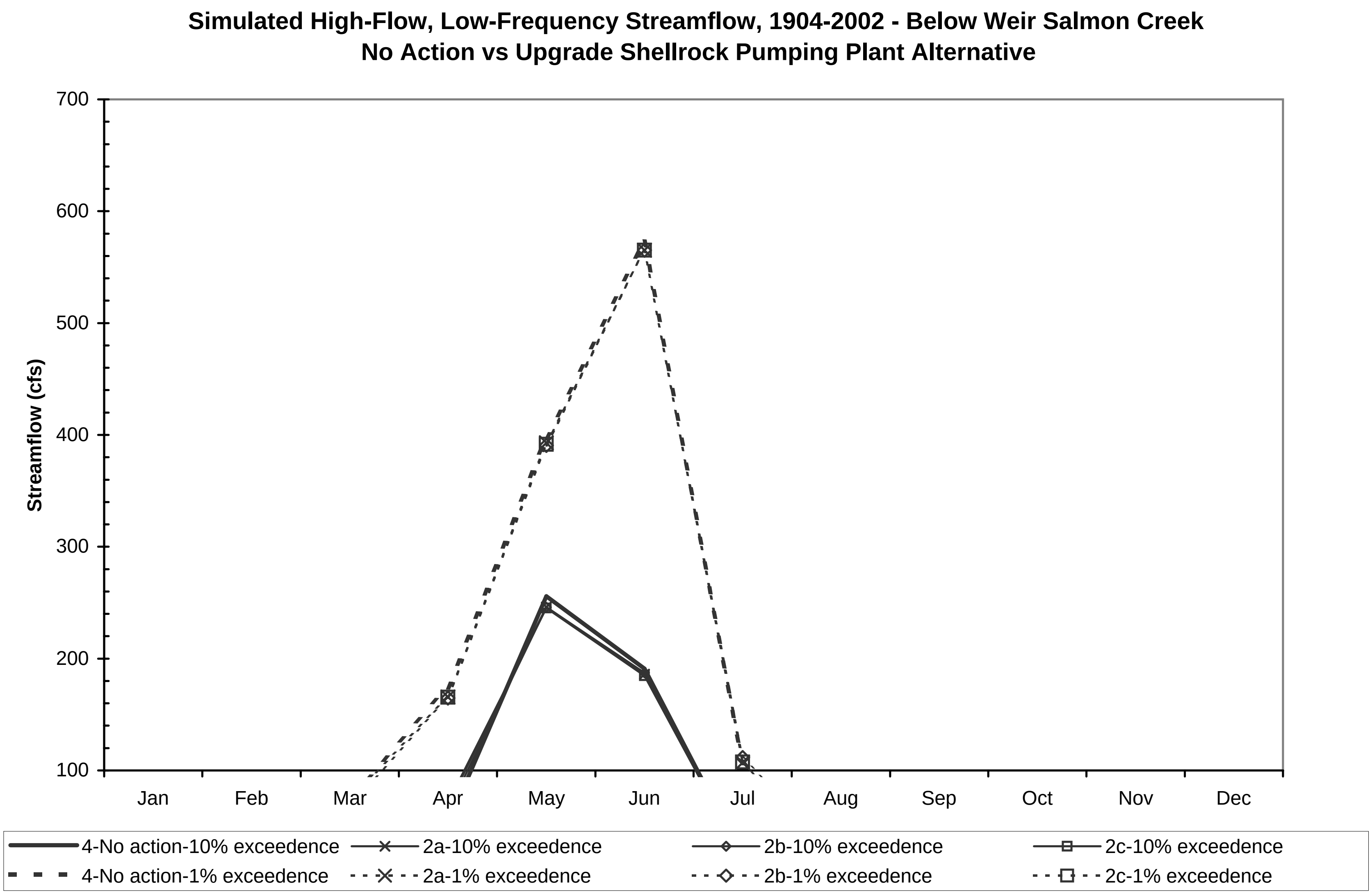
Simulated Minimum Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative

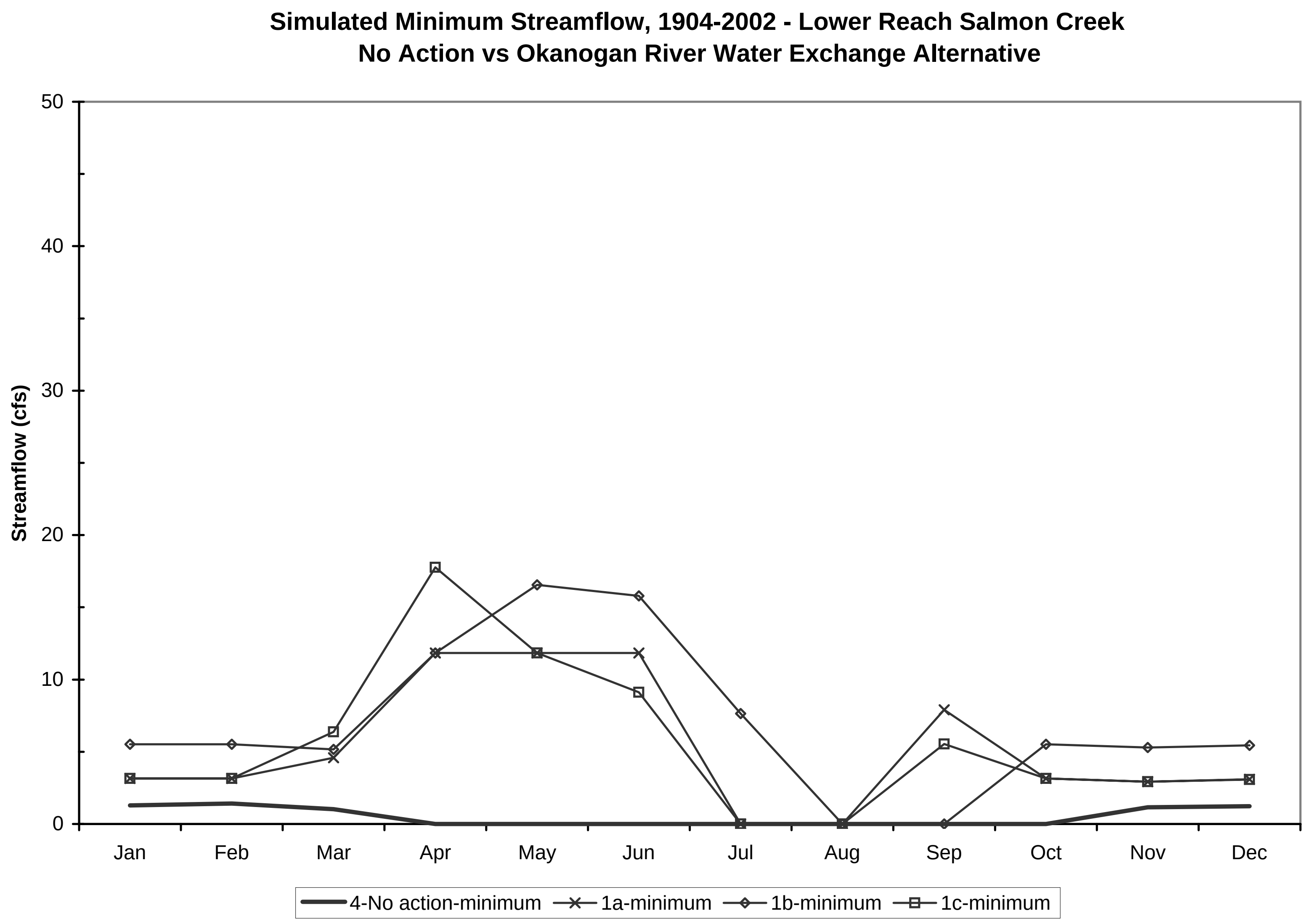



Simulated Median Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
2a-median
2b-median
2c-median

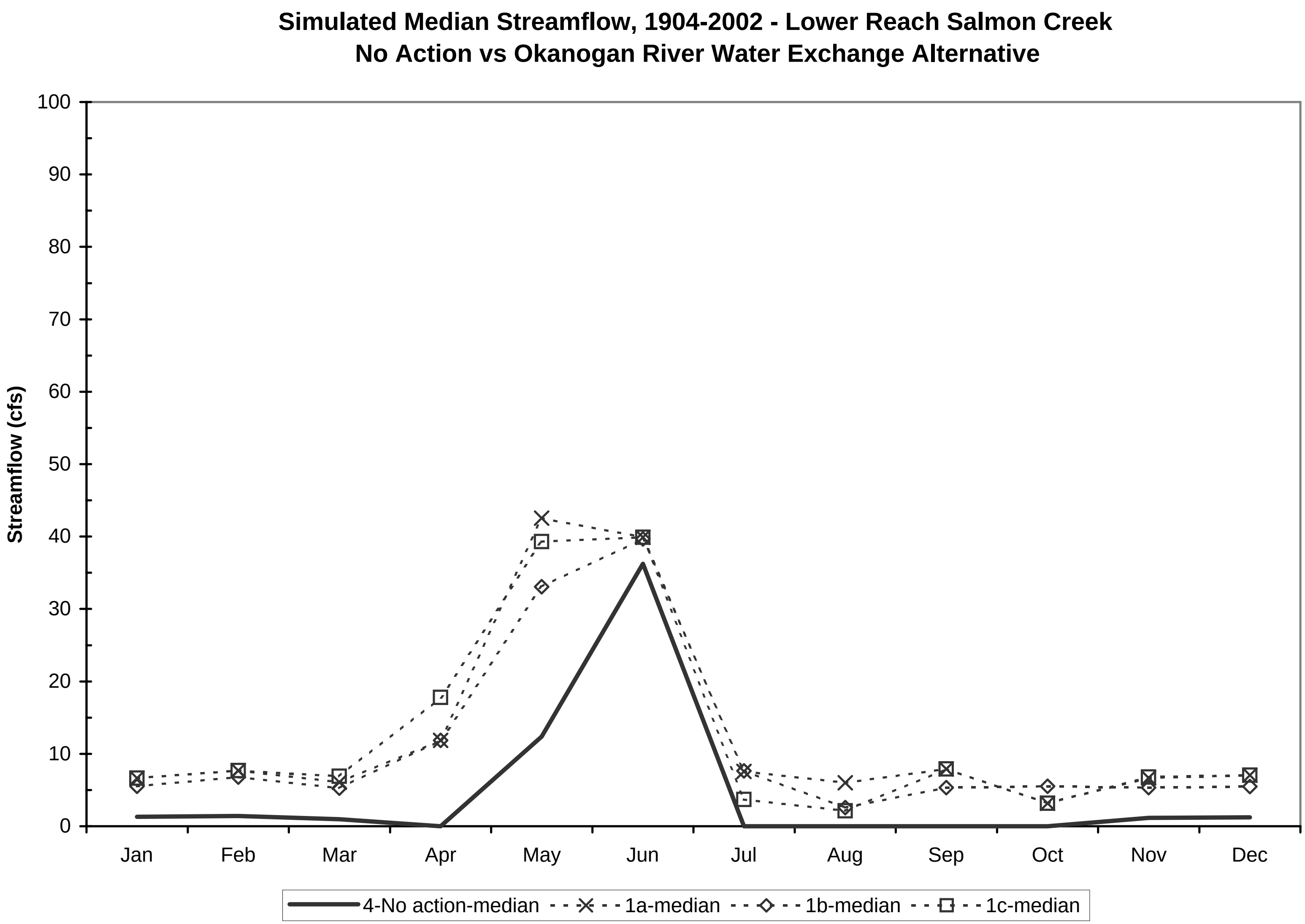

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
1a-10% exceedence
1b-10% exceedence
1c-10% exceedence
4-No action-1% exceedence
1a-1% exceedence
1b-1% exceedence
1c-1% exceedence

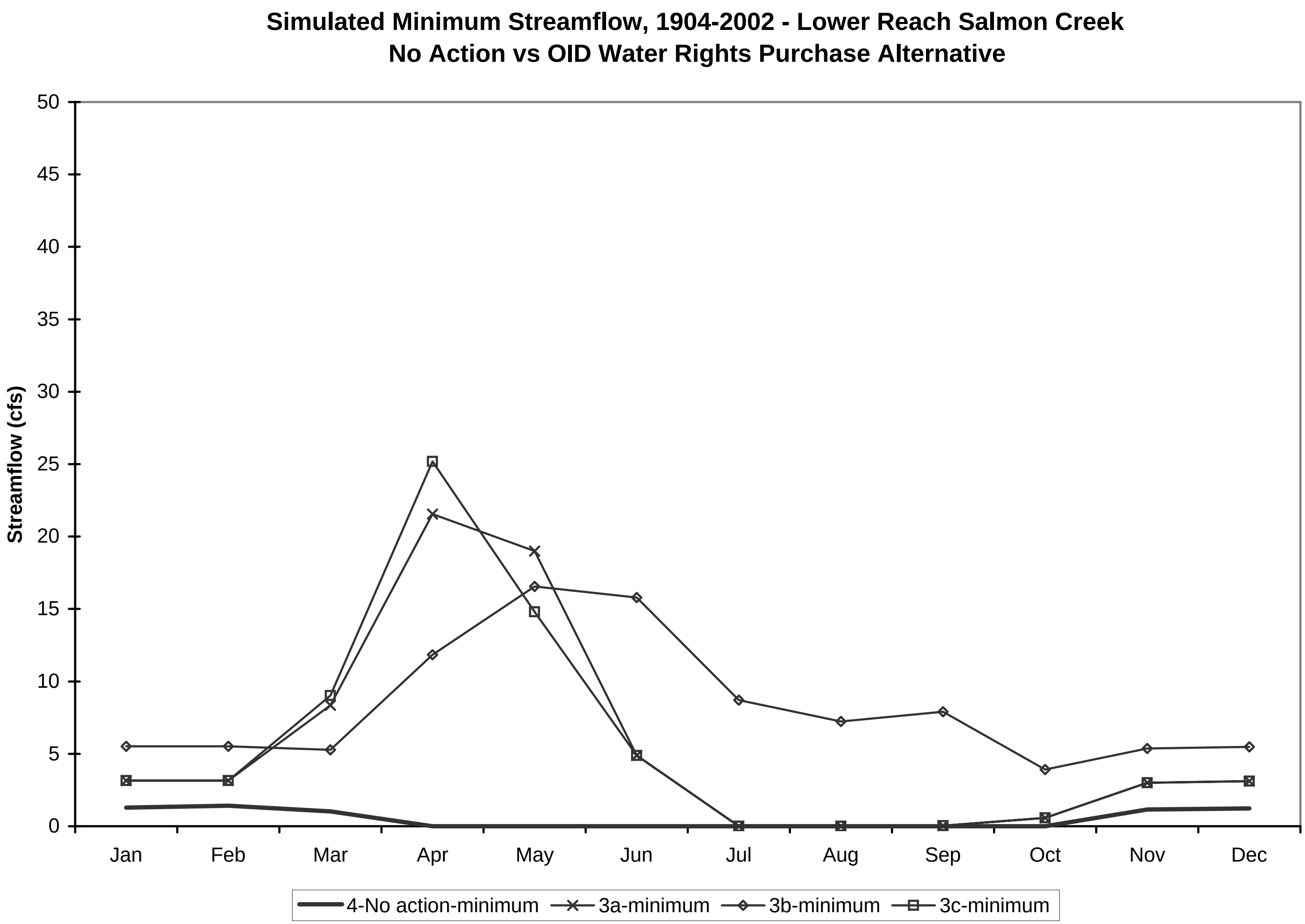

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
3a-10% exceedence
3b-10% exceedence
3c-10% exceedence
4-No action-1% exceedence
3a-1% exceedence
3b-1% exceedence
3c-1% exceedence

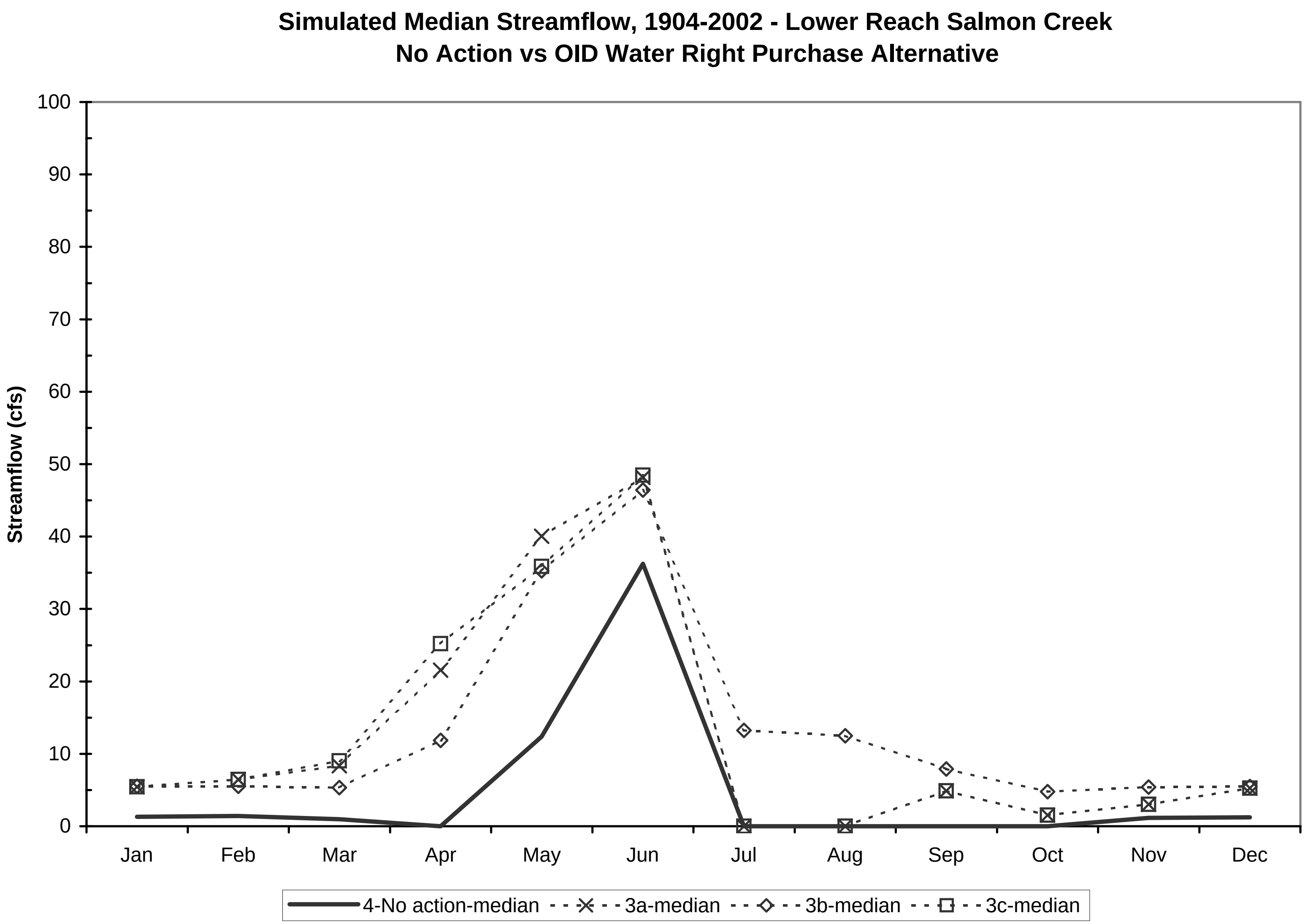

Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Below Weir Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
700
600
500
400
300
200
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
2a-10% exceedence
2b-10% exceedence
2c-10% exceedence
4-No action-1% exceedence
2a-1% exceedence
2b-1% exceedence
2c-1% exceedence

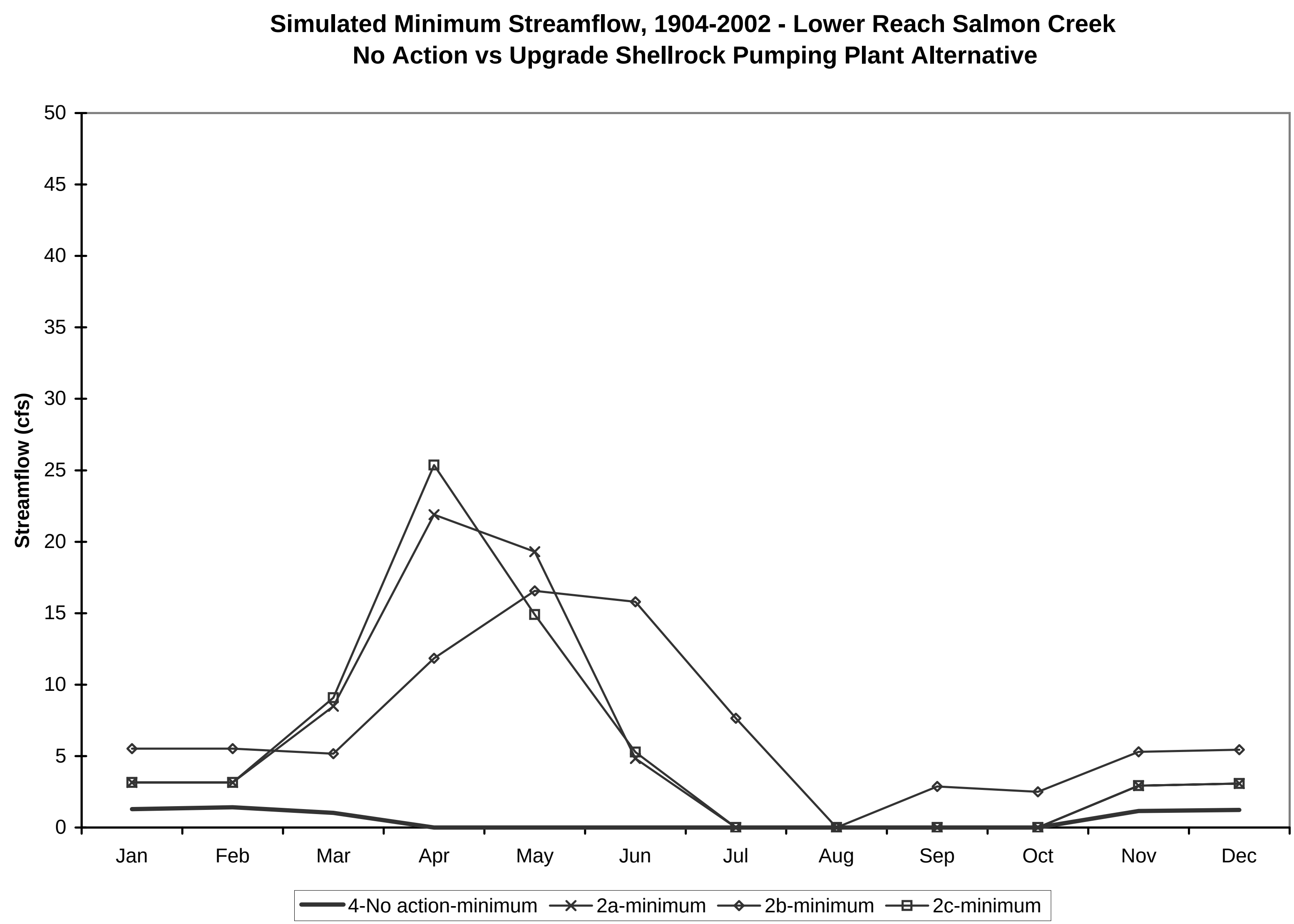


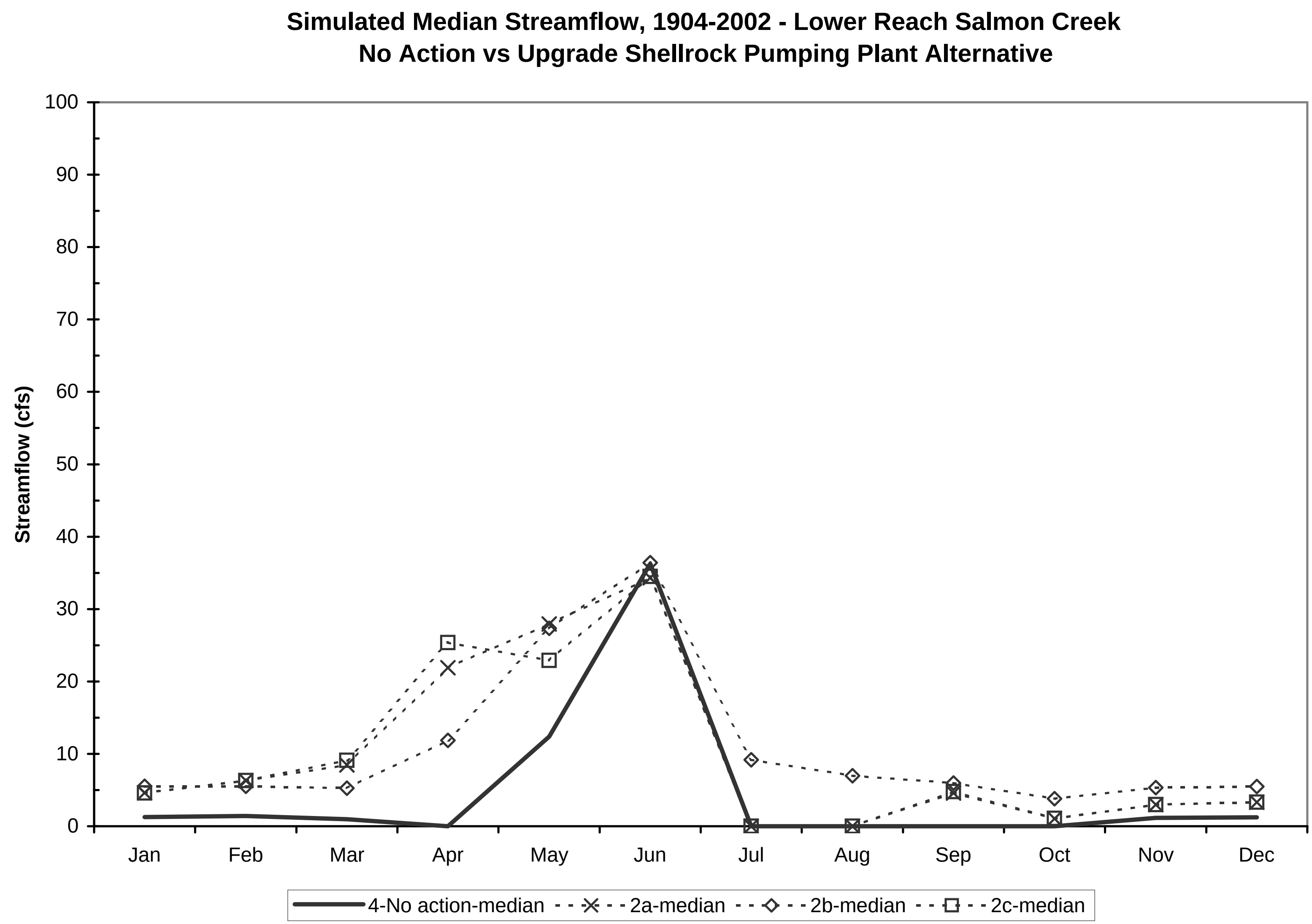
Simulated Minimum Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
0
10
20
30
40
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
1a-minimum
1b-minimum
1c-minimum


Simulated Median Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
1a-median
1b-median
1c-median

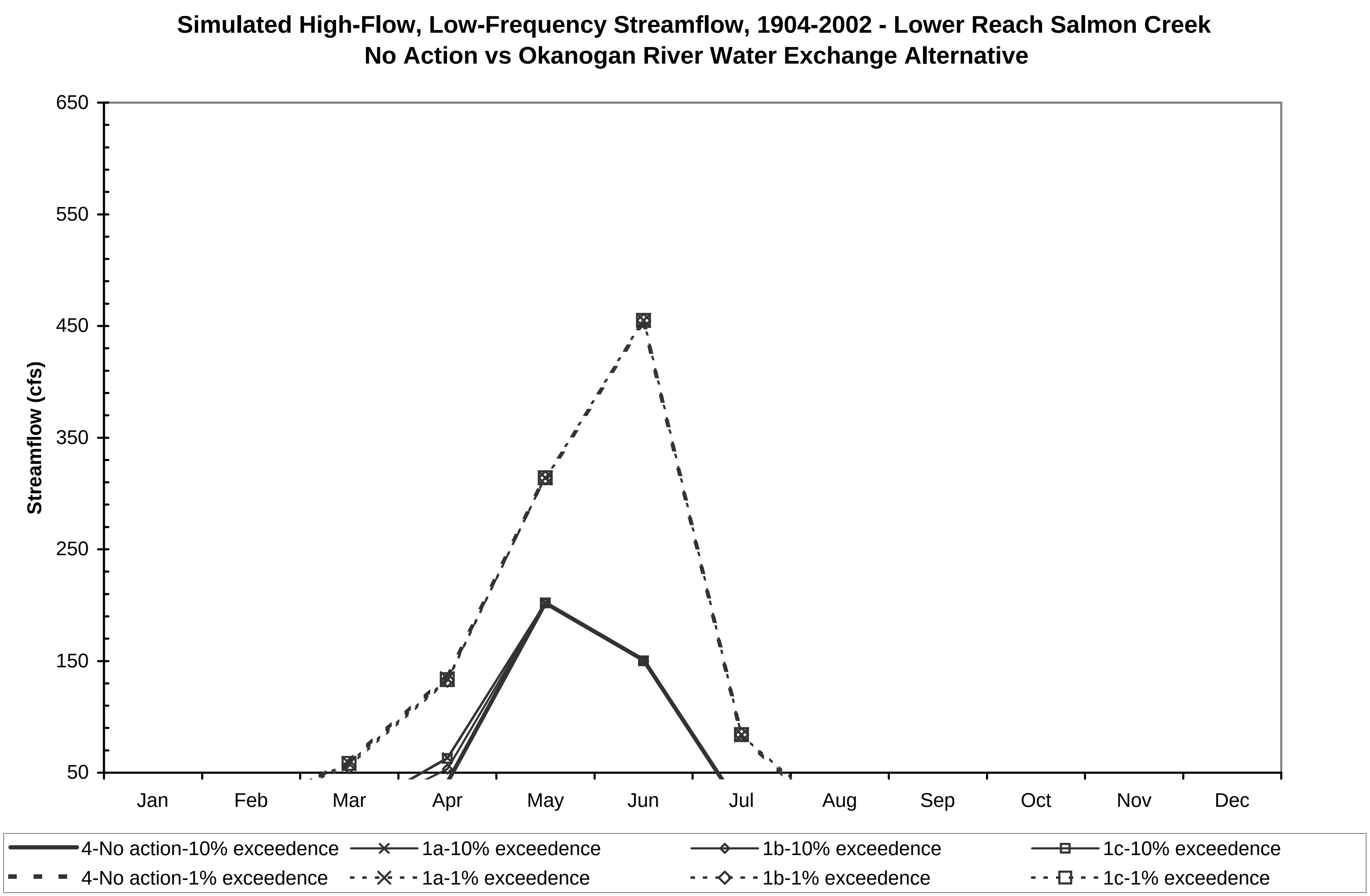

Simulated Minimum Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs OID Water Rights Purchase Alternative
Streamflow (cfs)
50
45
40
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
3a-minimum
3b-minimum
3c-minimum

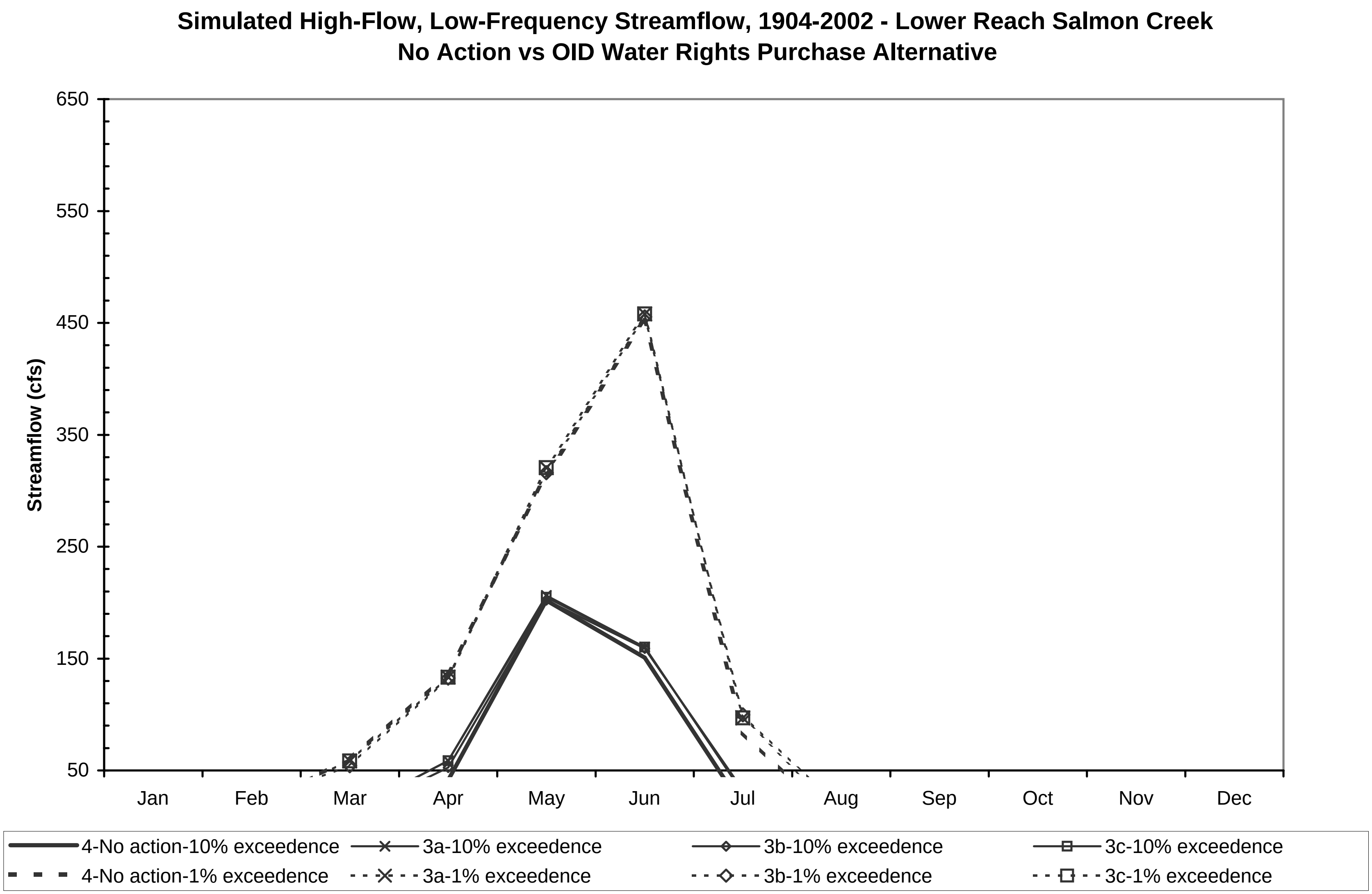

Simulated Median Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs OID Water Right Purchase Alternative
Streamflow (cfs)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
3a-median
3b-median
3c-median

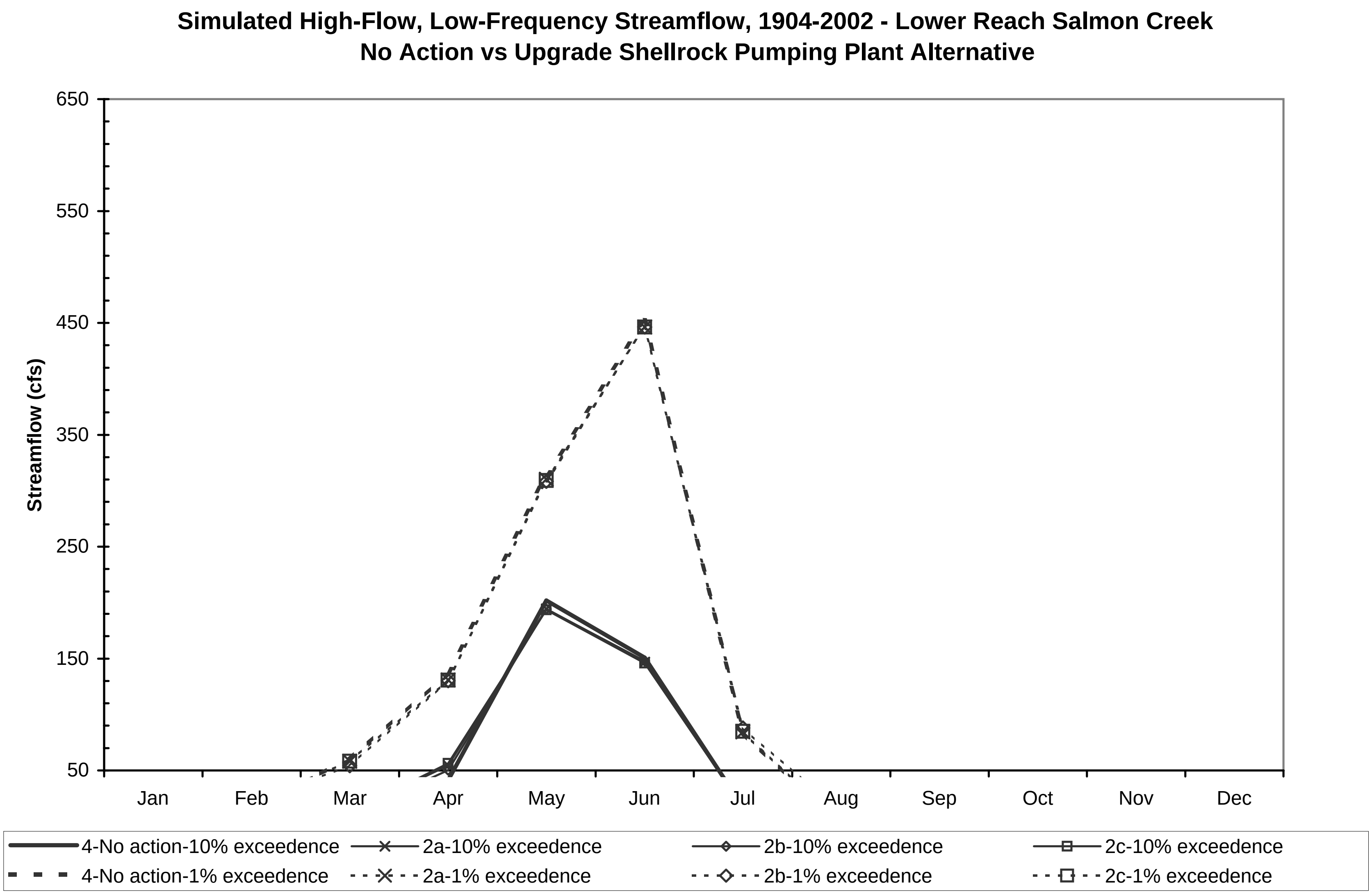

Simulated Minimum Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-minimum
2a-minimum
2b-minimum
2c-minimum



Simulated Median Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-median
2a-median
2b-median
2c-median


Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs Okanogan River Water Exchange Alternative
Streamflow (cfs)
650
550
450
350
250
150
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
1a-10% exceedence
1b-10% exceedence
1c-10% exceedence
4-No action-1% exceedence
1a-1% exceedence
1b-1% exceedence
1c-1% exceedence


Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs OID Water Rights Purchase Alternative
Streamflow (cfs)
650
550
450
350
250
150
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
3a-10% exceedence
3b-10% exceedence
3c-10% exceedence
4-No action-1% exceedence
3a-1% exceedence
3b-1% exceedence
3c-1% exceedence


Simulated High-Flow, Low-Frequency Streamflow, 1904-2002 - Lower Reach Salmon Creek
No Action vs Upgrade Shellrock Pumping Plant Alternative
Streamflow (cfs)
650
550
450
350
250
150
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
4-No action-10% exceedence
2a-10% exceedence
2b-10% exceedence
2c-10% exceedence
4-No action-1% exceedence
2a-1% exceedence
2b-1% exceedence
2c-1% exceedence

APPENDIX D-6:

Summary of Simulated Effects of Salmon Creek Streamflows on Okanogan River Streamflow Based on Water Year Type for All Alternatives

Appendix D-6. Summary of Simulated Effects of Salmon Creek Streamflows on Okanogan River Streamflow Based on Water Year Type for All Alternatives

	Water Year Type				
	Wet	**Above normal**	**Normal**	**Below normal**	**Dry**
HISTORIC CONDITION					
Salmon Creek flow at mouth (acre-feet/year)					
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)					
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.24%	0.20%	0.19%	0.12%	0.11%
% of Okanogan River pumped at Shellrock					
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4
ALTERNATIVE 1 - NEW 80 CFS PUMP ON THE OKANOGAN RIVER					
1a - Steelhead only, no channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	24,371	16,078	13,534	9,361	6,254
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,292,185	2,522,294	2,167,439	1,821,502	1,241,765
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.60%	0.57%	0.61%	0.55%	0.69%
% of Okanogan River pumped at Shellrock	0.45%	0.68%	0.92%	1.09%	2.13%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.5
1b - Steelhead and Chinook, channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	23,751	15,056	13,264	9,260	6,477
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,291,711	2,521,366	2,167,791	1,822,064	1,242,976
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.58%	0.53%	0.57%	0.54%	0.66%
% of Okanogan River pumped at Shellrock	0.42%	0.63%	0.82%	0.96%	1.82%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.5
1c - Steelhead only, channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	24,195	15,763	13,345	9,287	6,214
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,292,234	2,522,214	2,167,508	1,821,566	1,241,945
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.60%	0.57%	0.61%	0.55%	0.67%
% of Okanogan River pumped at Shellrock	0.44%	0.67%	0.89%	1.05%	2.04%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.5

Appendix D-6. Summary of Simulated Effects of Salmon Creek Streamflows on Okanogan River Streamflow Based on Water Year Type for All Alternatives

	Water Year Type				
	Wet	**Above normal**	**Normal**	**Below normal**	**Dry**
ALTERNATIVE 2 - UPGRADE SHELLROCK TO 35 CFS					
2a - Steelhead only, no channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	22,674	13,892	12,082	8,120	5,613
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,292,119	2,521,895	2,168,436	1,823,088	1,244,444
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.54%	0.47%	0.50%	0.45%	0.52%
% of Okanogan River pumped at Shellrock	0.33%	0.49%	0.64%	0.76%	1.44%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4
2b - Steelhead and Chinook, channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	23,232	14,755	13,040	9,049	6,575
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,292,253	2,522,323	2,169,226	1,823,753	1,245,336
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.57%	0.54%	0.58%	0.56%	0.72%
% of Okanogan River pumped at Shellrock	0.34%	0.51%	0.65%	0.77%	1.49%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4
2c - Steelhead only, channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	22,651	14,004	12,141	8,134	5,619
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,292,061	2,522,025	2,168,392	1,823,075	1,244,485
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.54%	0.49%	0.52%	0.46%	0.54%
% of Okanogan River pumped at Shellrock	0.33%	0.49%	0.64%	0.76%	1.44%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4

Appendix D-6. Summary of Simulated Effects of Salmon Creek Streamflows on Okanogan River Streamflow Based on Water Year Type for All Alternatives

	Water Year Type				
	Wet	**Above normal**	**Normal**	**Below normal**	**Dry**
ALTERNATIVE 3 - 5100 AF WATER RIGHTS PURCHASE					
3a - Steelhead only, no channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	24,538	15,551	13,551	9,184	6,002
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,295,955	2,525,937	2,172,243	1,826,748	1,247,939
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.57%	0.51%	0.54%	0.49%	0.55%
% of Okanogan River pumped at Shellrock	0.21%	0.33%	0.44%	0.52%	1.01%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4
3b - Steelhead and Chinook, channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	25,083	16,378	14,786	10,392	7,574
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,295,914	2,526,143	2,173,202	1,827,577	1,249,347
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.62%	0.60%	0.68%	0.65%	0.89%
% of Okanogan River pumped at Shellrock	0.24%	0.36%	0.46%	0.54%	1.03%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4
3c - Steelhead only, channel rehabilitation					
Salmon Creek flow at mouth (acre-feet/year)	24,545	15,557	13,559	9,185	6,005
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,295,953	2,525,935	2,172,241	1,826,747	1,247,939
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.58%	0.52%	0.56%	0.50%	0.57%
% of Okanogan River pumped at Shellrock	0.21%	0.33%	0.44%	0.52%	1.01%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4
ALTERNATIVE 4 - NO ACTION					
Salmon Creek flow at mouth (acre-feet/year)	18,309	9,907	8,300	3,909	1,277
Okanogan River flow from Salmon Creek to Malott (acre-feet/year)	3,292,403	2,522,350	2,170,385	1,824,185	1,243,925
Salmon Creek inflow at mouth as a % of Okanogan River flow	0.25%	0.21%	0.19%	0.13%	0.09%
% of Okanogan River pumped at Shellrock	0.01%	0.10%	0.06%	0.21%	0.83%
Average # of months/year Okanogan River WAC instream requirements not met	0.4	0.3	1.2	1.4	6.4

APPENDIX D-7:

Summary of Simulated Annual Totals or Annual Averages for Okanogan Irrigation District Irrigation Delivery Data

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 1a. New 80 cfs OID Pump Station (No WAC Instream Flow Restrictions on Pumping From Okanogan), Abandon Shellrock, Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	7649	-53	-1533	1012	0	0	5508	12583	14169	0.89	0.90	0.76
1905	8747	-51	-1452	1611	0	0	3728	12583	14086	0.89	0.90	0.76
1906	6865	-52	-1481	1391	0	0	5859	12583	14116	0.89	0.90	0.76
1907	7559	-51	-1461	1541	0	0	4996	12583	14096	0.89	0.90	0.76
1908	5545	-52	-1482	1305	0	0	7268	12583	14117	0.89	0.90	0.76
1909	7814	-53	-1505	1214	0	0	5113	12583	14141	0.89	0.90	0.76
1910	6838	-62	-1840	1163	0	0	8557	14655	16557	0.89	0.77	0.65
1911	6700	-67	-1952	1550	0	0	9921	16151	18171	0.89	0.70	0.59
1912	6268	-54	-1536	1695	0	0	6901	13274	14863	0.89	0.86	0.72
1913	6907	-60	-1711	1447	0	0	7864	14448	16219	0.89	0.79	0.66
1914	6961	-62	-1763	1527	0	0	8234	14897	16722	0.89	0.76	0.64
1915	8816	-63	-1791	1634	0	0	6599	15196	17050	0.89	0.75	0.63
1916	10084	-55	-1575	1758	0	0	3406	13619	15249	0.89	0.83	0.70
1917	8057	-66	-1923	1288	0	0	8335	15691	17681	0.89	0.72	0.61
1918	1759	-64	-1840	1221	0	0	13947	15023	16927	0.89	0.76	0.63
1919	5521	-65	-1877	1486	0	0	10510	15576	17518	0.89	0.73	0.61
1920	360	-70	-2120	1249	0	0	17042	16462	18652	0.88	0.69	0.57
1921	5497	-64	-1859	1569	0	0	10341	15484	17407	0.89	0.73	0.61
1922	5531	-71	-2108	1410	0	0	11965	16727	18906	0.88	0.68	0.57
1923	7127	-64	-1829	1664	0	0	8562	15461	17353	0.89	0.73	0.62
1924	1155	-68	-2032	1213	0	0	15733	16002	18102	0.88	0.71	0.59
1925	4551	-67	-1932	1339	0	0	11915	15806	17805	0.89	0.72	0.60
1926	468	-73	-2233	1275	0	0	17750	17187	19494	0.88	0.66	0.55
1927	5442	-68	-2017	1864	0	0	11390	16612	18697	0.89	0.68	0.57
1928	5792	-69	-2057	1234	0	0	11297	16197	18323	0.88	0.70	0.58
1929	32	-64	-1915	284	0	0	15880	14217	16196	0.88	0.80	0.66
1930	-1	-66	-1985	670	0	0	16359	14977	17028	0.88	0.76	0.63
1931	-21	-67	-2027	903	0	0	16647	15435	17529	0.88	0.74	0.61
1932	29	-64	-1920	316	0	0	15919	14280	16264	0.88	0.79	0.66
1933	5189	-63	-1884	1436	0	0	10326	15005	16951	0.89	0.76	0.63
1934	4340	-67	-1954	1251	0	0	12312	15881	17902	0.89	0.71	0.60
1935	5394	-61	-1772	1208	0	0	9568	14337	16170	0.89	0.79	0.66
1936	3173	-61	-1810	1345	0	0	11930	14577	16448	0.89	0.78	0.65
1937	5857	-57	-1686	1486	0	0	8143	13743	15486	0.89	0.83	0.69
1938	6302	-64	-1838	1551	0	0	9375	15326	17228	0.89	0.74	0.62
1939	1217	-68	-1963	1191	0	0	15519	15897	17928	0.89	0.71	0.60
1940	3354	-64	-1851	1543	0	0	12410	15393	17308	0.89	0.74	0.62
1941	10849	-60	-1711	2487	0	0	3750	15314	17085	0.90	0.74	0.63
1942	10526	-62	-1788	1982	0	0	4731	15388	17239	0.89	0.74	0.62
1943	5727	-61	-1752	1242	0	0	9243	14400	16213	0.89	0.79	0.66
1944	4033	-64	-1916	1486	0	0	11894	15432	17412	0.89	0.74	0.61
1945	4529	-59	-1756	1291	0	0	10070	14075	15890	0.89	0.81	0.67
1946	5052	-56	-1592	1148	0	0	8632	13185	14832	0.89	0.86	0.72
1947	2554	-54	-1578	920	0	0	10741	12583	14215	0.89	0.90	0.75
1948	9536	-51	-1503	1658	0	0	2943	12583	14137	0.89	0.90	0.76
1949	2914	-56	-1607	873	0	0	10907	13032	14694	0.89	0.87	0.73
1950	5739	-57	-1696	1282	0	0	8427	13694	15448	0.89	0.83	0.69
1951	7105	-56	-1600	1821	0	0	6594	13864	15520	0.89	0.82	0.69
1952	5680	-55	-1566	1129	0	0	7785	12973	14594	0.89	0.87	0.73
1953	7311	-55	-1543	1444	0	0	6066	13223	14820	0.89	0.86	0.72
1954	4554	-53	-1590	995	0	0	8677	12583	14226	0.88	0.90	0.75
1955	6245	-57	-1695	1034	0	0	7880	13407	15159	0.88	0.85	0.71
1956	5929	-57	-1628	1456	0	0	7989	13689	15374	0.89	0.83	0.70
1957	4736	-54	-1562	1269	0	0	8467	12857	14473	0.89	0.88	0.74
1958	7025	-64	-1851	1665	0	0	8801	15576	17491	0.89	0.73	0.61
1959	6031	-52	-1474	1339	0	0	6819	12662	14189	0.89	0.90	0.75
1960	4737	-61	-1748	1085	0	0	10227	14240	16049	0.89	0.80	0.67
1961	5815	-66	-1920	1532	0	0	10525	15885	17872	0.89	0.71	0.60
1962	613	-54	-1616	1031	0	0	12805	12779	14448	0.88	0.89	0.74
1963	5090	-56	-1613	1168	0	0	8767	13355	15025	0.89	0.85	0.71
1964	3332	-53	-1594	1046	0	0	9852	12583	14230	0.88	0.90	0.75
1965	2976	-60	-1771	948	0	0	11805	13899	15729	0.88	0.82	0.68
1966	38	-57	-1701	157	0	0	14146	12583	14341	0.88	0.90	0.75
1967	6307	-62	-1846	1541	0	0	9004	14945	16853	0.89	0.76	0.63
1968	3802	-56	-1650	1022	0	0	10098	13216	14922	0.89	0.86	0.72
1969	4248	-54	-1552	1265	0	0	9101	13008	14614	0.89	0.87	0.73
1970	2801	-60	-1784	1137	0	0	12156	14250	16094	0.89	0.80	0.66
1971	4220	-57	-1627	1134	0	0	9797	13467	15151	0.89	0.84	0.71
1972	8323	-51	-1447	1588	0	0	4170	12583	14081	0.89	0.90	0.76
1973	1469	-56	-1665	845	0	0	12444	13036	14758	0.88	0.87	0.73
1974	7224	-51	-1461	1871	0	0	5353	12936	14448	0.90	0.88	0.74

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 1a. New 80 cfs OID Pump Station (No WAC Instream Flow Restrictions on Pumping From Okanogan), Abandon Shellrock, Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	6429	-53	-1566	1676	0	0	6571	13057	14676	0.89	0.87	0.73
1976	5999	-53	-1514	1151	0	0	6999	12583	14149	0.89	0.90	0.76
1977	26	-64	-1927	351	0	0	15963	14349	16339	0.88	0.79	0.65
1978	8444	-54	-1532	1739	0	0	4703	13300	14886	0.89	0.85	0.72
1979	481	-64	-1900	1120	0	0	15319	14958	16921	0.88	0.76	0.63
1980	7378	-60	-1728	2093	0	0	7373	15057	16845	0.89	0.75	0.64
1981	6193	-60	-1737	1540	0	0	8521	14457	16253	0.89	0.79	0.66
1982	10440	-59	-1679	2013	0	0	3908	14622	16360	0.89	0.78	0.65
1983	9430	-52	-1491	2212	0	0	3356	13454	14998	0.90	0.84	0.71
1984	8653	-56	-1597	1792	0	0	5020	13812	15465	0.89	0.82	0.69
1985	1089	-67	-2011	1150	0	0	15603	15765	17843	0.88	0.72	0.60
1986	3430	-64	-1853	1270	0	0	12378	15162	17079	0.89	0.75	0.63
1987	2872	-61	-1748	1230	0	0	12073	14366	16175	0.89	0.79	0.66
1988	4631	-61	-1751	1419	0	0	10314	14552	16364	0.89	0.78	0.65
1989	4296	-59	-1700	1431	0	0	10232	14201	15959	0.89	0.80	0.67
1990	7446	-61	-1734	1983	0	0	7397	15032	16826	0.89	0.76	0.64
1991	5632	-63	-1868	1224	0	0	9891	14815	16747	0.88	0.77	0.64
1992	2289	-63	-1890	1267	0	0	13340	14943	16895	0.88	0.76	0.63
1993	7420	-52	-1528	1304	0	0	5438	12583	14163	0.89	0.90	0.76
1994	4766	-68	-1967	1194	0	0	12001	15927	17962	0.89	0.71	0.60
1995	5474	-55	-1556	1546	0	0	7999	13409	15020	0.89	0.85	0.71
1996	6946	-64	-1866	1398	0	0	8953	15367	17298	0.89	0.74	0.62
1997	9050	-58	-1661	1807	0	0	5159	14297	16016	0.89	0.79	0.67
1998	11940	-69	-1978	2421	0	0	4872	17187	19234	0.89	0.66	0.56
1999	11256	-61	-1761	1585	0	0	3786	14804	16627	0.89	0.77	0.64
2000	6832	-62	-1790	1244	0	0	8507	14730	16582	0.89	0.77	0.65
2001	1328	-67	-2015	1129	0	0	15235	15610	17692	0.88	0.73	0.60
2002	5413	-66	-1950	1147	0	0	10928	15472	17488	0.88	0.73	0.61
Average	**5308**	**-60**	**-1750**	**1355**	**0**	**0**	**9491**	**14345**	**16155**	**0.888**	**0.797**	**0.668**
Maximum	**11940**	**-51**	**-1447**	**2487**	**0**	**0**	**17750**	**17187**	**19494**	**0.897**	**0.902**	**0.760**
Minimum	**-21**	**-73**	**-2233**	**157**	**0**	**0**	**2943**	**12583**	**14081**	**0.877**	**0.660**	**0.549**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 1b. New 80 cfs OID Pump Station (No WAC Instream Flow Restrictions on Pumping From Okanogan), Abandon Shellrock, Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead and Chinook with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	7476	-53	-1533	1012	0	0	5681	12583	14169	0.89	0.90	0.76
1905	8701	-51	-1452	1611	0	0	3773	12583	14086	0.89	0.90	0.76
1906	6524	-52	-1476	1393	0	0	6194	12583	14111	0.89	0.90	0.76
1907	7351	-51	-1462	1538	0	0	5207	12583	14096	0.89	0.90	0.76
1908	5156	-52	-1477	1304	0	0	7653	12583	14112	0.89	0.90	0.76
1909	7461	-53	-1506	1211	0	0	5470	12583	14141	0.89	0.90	0.76
1910	6728	-62	-1855	1162	0	0	8682	14655	16572	0.88	0.77	0.65
1911	8197	-68	-1963	1515	0	0	8470	16151	18182	0.89	0.70	0.59
1912	6238	-54	-1569	1717	0	0	6941	13274	14896	0.89	0.86	0.72
1913	7050	-60	-1761	1461	0	0	7758	14448	16268	0.89	0.79	0.66
1914	7585	-62	-1790	1528	0	0	7635	14897	16748	0.89	0.76	0.64
1915	9061	-62	-1797	1721	0	0	6274	15196	17055	0.89	0.75	0.63
1916	10369	-55	-1577	1743	0	0	3138	13619	15251	0.89	0.83	0.70
1917	8144	-66	-1953	1280	0	0	8287	15691	17711	0.89	0.72	0.60
1918	2844	-63	-1873	1329	0	0	12787	15023	16959	0.89	0.76	0.63
1919	6835	-65	-1940	1533	0	0	9213	15576	17580	0.89	0.73	0.61
1920	3028	-70	-2098	1334	0	0	14268	16462	18630	0.88	0.69	0.57
1921	5378	-64	-1921	1590	0	0	10500	15484	17469	0.89	0.73	0.61
1922	6261	-70	-2096	1540	0	0	11092	16727	18893	0.89	0.68	0.57
1923	5506	-64	-1921	1573	0	0	10367	15461	17446	0.89	0.73	0.61
1924	2797	-68	-2041	1236	0	0	14078	16002	18111	0.88	0.71	0.59
1925	3511	-67	-1998	1359	0	0	13001	15806	17871	0.88	0.72	0.60
1926	3549	-72	-2171	1558	0	0	14323	17187	19430	0.88	0.66	0.55
1927	2814	-69	-2086	1673	0	0	14279	16612	18767	0.89	0.68	0.57
1928	2844	-69	-2072	1246	0	0	14248	16197	18338	0.88	0.70	0.58
1929	1375	-61	-1841	973	0	0	13771	14217	16119	0.88	0.80	0.66
1930	1958	-64	-1931	1060	0	0	13954	14977	16972	0.88	0.76	0.63
1931	2233	-66	-1979	1182	0	0	14065	15435	17480	0.88	0.74	0.61
1932	1221	-60	-1832	1165	0	0	13786	14280	16172	0.88	0.79	0.66
1933	1753	-63	-1915	1270	0	0	13961	15005	16983	0.88	0.76	0.63
1934	2556	-67	-2030	1250	0	0	14172	15881	17978	0.88	0.71	0.60
1935	6104	-60	-1801	1262	0	0	8832	14337	16198	0.89	0.79	0.66
1936	4028	-61	-1844	1316	0	0	11138	14577	16481	0.88	0.78	0.65
1937	5139	-57	-1713	1351	0	0	9023	13743	15514	0.89	0.83	0.69
1938	7364	-64	-1849	1522	0	0	8353	15326	17238	0.89	0.74	0.62
1939	2677	-68	-2009	1225	0	0	14071	15897	17973	0.88	0.71	0.60
1940	2480	-64	-1915	1592	0	0	13299	15393	17372	0.89	0.74	0.62
1941	11173	-60	-1716	2448	0	0	3470	15314	17091	0.90	0.74	0.63
1942	10934	-62	-1788	1982	0	0	4322	15388	17239	0.89	0.74	0.62
1943	6657	-60	-1743	1339	0	0	8209	14400	16204	0.89	0.79	0.66
1944	4027	-65	-1947	1463	0	0	11954	15432	17443	0.88	0.74	0.61
1945	5602	-59	-1750	1389	0	0	8892	14075	15883	0.89	0.81	0.67
1946	5252	-55	-1637	1203	0	0	8423	13185	14877	0.89	0.86	0.72
1947	1426	-54	-1603	955	0	0	11859	12583	14240	0.88	0.90	0.75
1948	9536	-51	-1508	1623	0	0	2983	12583	14142	0.89	0.90	0.76
1949	3779	-56	-1602	928	0	0	9982	13032	14690	0.89	0.87	0.73
1950	6257	-57	-1701	1356	0	0	7839	13694	15452	0.89	0.83	0.69
1951	7505	-56	-1602	1806	0	0	6211	13864	15522	0.89	0.82	0.69
1952	6213	-54	-1558	1227	0	0	7146	12973	14586	0.89	0.87	0.73
1953	7394	-55	-1578	1313	0	0	6148	13223	14856	0.89	0.86	0.72
1954	4332	-53	-1583	1046	0	0	8840	12583	14219	0.88	0.90	0.75
1955	6615	-57	-1688	1113	0	0	7424	13407	15152	0.88	0.85	0.71
1956	6678	-56	-1625	1497	0	0	7196	13689	15371	0.89	0.83	0.70
1957	5274	-53	-1571	1308	0	0	7899	12857	14482	0.89	0.88	0.74
1958	7809	-64	-1859	1737	0	0	7952	15576	17499	0.89	0.73	0.61
1959	6157	-52	-1469	1423	0	0	6603	12662	14183	0.89	0.90	0.75
1960	6565	-60	-1742	1162	0	0	8316	14240	16043	0.89	0.80	0.67
1961	7265	-66	-1972	1627	0	0	9030	15885	17923	0.89	0.71	0.60
1962	406	-55	-1662	875	0	0	13215	12779	14496	0.88	0.89	0.74
1963	5512	-56	-1662	1272	0	0	8289	13355	15074	0.89	0.85	0.71
1964	3335	-54	-1603	960	0	0	9945	12583	14239	0.88	0.90	0.75
1965	3791	-59	-1747	1210	0	0	10704	13899	15704	0.89	0.82	0.68
1966	290	-54	-1635	891	0	0	13091	12583	14272	0.88	0.90	0.75
1967	7157	-62	-1851	1550	0	0	8151	14945	16858	0.89	0.76	0.63
1968	4877	-55	-1648	1208	0	0	8835	13216	14920	0.89	0.86	0.72
1969	4612	-54	-1609	1319	0	0	8740	13008	14671	0.89	0.87	0.73
1970	3405	-60	-1788	1235	0	0	11458	14250	16098	0.89	0.80	0.66
1971	4937	-56	-1663	1403	0	0	8846	13467	15186	0.89	0.84	0.70
1972	8244	-52	-1475	1441	0	0	4425	12583	14110	0.89	0.90	0.76
1973	1661	-55	-1647	1024	0	0	12054	13036	14739	0.88	0.87	0.73
1974	7334	-52	-1488	1666	0	0	5477	12936	14477	0.89	0.88	0.74

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 1b. New 80 cfs OID Pump Station (No WAC Instream Flow Restrictions on Pumping From Okanogan), Abandon Shellrock, Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead and Chinook with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	6498	-53	-1560	1724	0	0	6448	13057	14669	0.89	0.87	0.73
1976	5605	-53	-1551	1159	0	0	7422	12583	14187	0.89	0.90	0.75
1977	1470	-61	-1856	993	0	0	13803	14349	16266	0.88	0.79	0.66
1978	8359	-54	-1609	1610	0	0	4994	13300	14963	0.89	0.85	0.72
1979	1953	-64	-1924	1083	0	0	13909	14958	16946	0.88	0.76	0.63
1980	7756	-60	-1732	2068	0	0	7025	15057	16849	0.89	0.75	0.64
1981	6976	-60	-1778	1535	0	0	7783	14457	16294	0.89	0.79	0.66
1982	10934	-59	-1678	2024	0	0	3400	14622	16359	0.89	0.78	0.65
1983	9624	-52	-1491	2212	0	0	3162	13454	14998	0.90	0.84	0.71
1984	9003	-56	-1597	1792	0	0	4669	13812	15465	0.89	0.82	0.69
1985	2534	-67	-2022	1175	0	0	14144	15765	17854	0.88	0.72	0.60
1986	1952	-64	-1941	1216	0	0	13999	15162	17167	0.88	0.75	0.62
1987	4168	-60	-1739	1332	0	0	10666	14366	16166	0.89	0.79	0.66
1988	4949	-60	-1804	1495	0	0	9972	14552	16416	0.89	0.78	0.65
1989	5077	-59	-1751	1537	0	0	9396	14201	16010	0.89	0.80	0.67
1990	7672	-61	-1745	1941	0	0	7225	15032	16838	0.89	0.76	0.64
1991	6319	-62	-1860	1317	0	0	9103	14815	16738	0.89	0.77	0.64
1992	1818	-63	-1909	1256	0	0	13840	14943	16914	0.88	0.76	0.63
1993	6862	-52	-1536	1317	0	0	5992	12583	14171	0.89	0.90	0.76
1994	6623	-67	-1959	1285	0	0	10046	15927	17953	0.89	0.71	0.60
1995	5971	-56	-1599	1386	0	0	7707	13409	15064	0.89	0.85	0.71
1996	7714	-64	-1846	1578	0	0	7985	15367	17277	0.89	0.74	0.62
1997	9542	-58	-1667	1765	0	0	4716	14297	16022	0.89	0.79	0.67
1998	12534	-69	-1978	2421	0	0	4278	17187	19234	0.89	0.66	0.56
1999	11799	-61	-1761	1585	0	0	3243	14804	16627	0.89	0.77	0.64
2000	7462	-62	-1794	1295	0	0	7828	14730	16585	0.89	0.77	0.65
2001	2424	-67	-2005	1150	0	0	14107	15610	17681	0.88	0.73	0.61
2002	5999	-66	-1958	1241	0	0	10255	15472	17495	0.88	0.73	0.61
Average	**5676**	**-60**	**-1762**	**1412**	**0**	**0**	**9079**	**14345**	**16167**	**0.887**	**0.797**	**0.667**
Maximum	**12534**	**-51**	**-1452**	**2448**	**0**	**0**	**14323**	**17187**	**19430**	**0.897**	**0.902**	**0.760**
Minimum	**290**	**-72**	**-2171**	**875**	**0**	**0**	**2983**	**12583**	**14086**	**0.882**	**0.660**	**0.551**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 1c. New 80 cfs OID Pump Station (No WAC Instream Flow Restrictions on Pumping From Okanogan), Abandon Shellrock, Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with No Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	7649	-53	-1533	1012	0	0	5508	12583	14169	0.89	0.90	0.76
1905	8747	-51	-1452	1611	0	0	3728	12583	14086	0.89	0.90	0.76
1906	6865	-52	-1481	1391	0	0	5859	12583	14116	0.89	0.90	0.76
1907	7451	-51	-1461	1541	0	0	5104	12583	14096	0.89	0.90	0.76
1908	5539	-52	-1482	1305	0	0	7274	12583	14117	0.89	0.90	0.76
1909	7424	-52	-1535	1221	0	0	5526	12583	14171	0.89	0.90	0.76
1910	6993	-62	-1840	1163	0	0	8402	14655	16557	0.89	0.77	0.65
1911	6523	-67	-1967	1553	0	0	10110	16151	18185	0.89	0.70	0.59
1912	6370	-54	-1595	1686	0	0	6866	13274	14922	0.89	0.86	0.72
1913	7269	-60	-1768	1448	0	0	7558	14448	16276	0.89	0.79	0.66
1914	7562	-62	-1763	1527	0	0	7633	14897	16722	0.89	0.76	0.64
1915	9369	-63	-1791	1634	0	0	6047	15196	17050	0.89	0.75	0.63
1916	10339	-55	-1575	1758	0	0	3151	13619	15249	0.89	0.83	0.70
1917	8032	-66	-1971	1295	0	0	8401	15691	17728	0.89	0.72	0.60
1918	1856	-64	-1897	1223	0	0	13905	15023	16984	0.88	0.76	0.63
1919	5879	-65	-1897	1455	0	0	10204	15576	17538	0.89	0.73	0.61
1920	889	-70	-2137	1188	0	0	16593	16462	18670	0.88	0.69	0.57
1921	6060	-65	-1920	1507	0	0	9901	15484	17469	0.89	0.73	0.61
1922	5435	-70	-2096	1529	0	0	11928	16727	18893	0.89	0.68	0.57
1923	7557	-64	-1887	1620	0	0	8235	15461	17412	0.89	0.73	0.61
1924	912	-69	-2066	1112	0	0	16112	16002	18136	0.88	0.71	0.59
1925	5073	-67	-1968	1342	0	0	11425	15806	17841	0.89	0.72	0.60
1926	1252	-73	-2207	1447	0	0	16768	17187	19467	0.88	0.66	0.55
1927	5168	-69	-2044	1805	0	0	11751	16612	18724	0.89	0.68	0.57
1928	5691	-69	-2057	1228	0	0	11404	16197	18323	0.88	0.70	0.58
1929	-16	-61	-1863	877	0	0	15280	14217	16141	0.88	0.80	0.66
1930	307	-65	-1959	936	0	0	15758	14977	17001	0.88	0.76	0.63
1931	435	-66	-2013	1033	0	0	16047	15435	17514	0.88	0.74	0.61
1932	-26	-61	-1868	916	0	0	15319	14280	16209	0.88	0.79	0.66
1933	5333	-63	-1891	1362	0	0	10263	15005	16959	0.88	0.76	0.63
1934	4873	-67	-1954	1251	0	0	11778	15881	17902	0.89	0.71	0.60
1935	5926	-61	-1805	1205	0	0	9072	14337	16202	0.88	0.79	0.66
1936	3736	-61	-1836	1280	0	0	11458	14577	16474	0.88	0.78	0.65
1937	5758	-57	-1686	1487	0	0	8240	13743	15486	0.89	0.83	0.69
1938	6821	-64	-1838	1551	0	0	8856	15326	17228	0.89	0.74	0.62
1939	921	-68	-2055	1080	0	0	16019	15897	18020	0.88	0.71	0.59
1940	3995	-64	-1892	1541	0	0	11813	15393	17349	0.89	0.74	0.62
1941	11371	-60	-1711	2487	0	0	3228	15314	17085	0.90	0.74	0.63
1942	10729	-62	-1788	1982	0	0	4528	15388	17239	0.89	0.74	0.62
1943	6328	-61	-1752	1242	0	0	8643	14400	16213	0.89	0.79	0.66
1944	4230	-65	-1925	1468	0	0	11723	15432	17421	0.89	0.74	0.61
1945	5072	-59	-1754	1327	0	0	9489	14075	15887	0.89	0.81	0.67
1946	4854	-55	-1598	1228	0	0	8756	13185	14839	0.89	0.86	0.72
1947	2161	-53	-1591	968	0	0	11098	12583	14227	0.88	0.90	0.75
1948	9558	-51	-1505	1641	0	0	2940	12583	14139	0.89	0.90	0.76
1949	2979	-56	-1602	928	0	0	10783	13032	14690	0.89	0.87	0.73
1950	6097	-57	-1669	1424	0	0	7899	13694	15420	0.89	0.83	0.69
1951	7706	-56	-1608	1766	0	0	6056	13864	15528	0.89	0.82	0.69
1952	5677	-54	-1559	1218	0	0	7691	12973	14586	0.89	0.87	0.73
1953	7398	-55	-1546	1425	0	0	6000	13223	14823	0.89	0.86	0.72
1954	4139	-53	-1590	995	0	0	9092	12583	14226	0.88	0.90	0.75
1955	6324	-57	-1689	1107	0	0	7722	13407	15153	0.88	0.85	0.71
1956	6416	-57	-1631	1434	0	0	7527	13689	15377	0.89	0.83	0.70
1957	4755	-53	-1565	1315	0	0	8406	12857	14476	0.89	0.88	0.74
1958	7558	-65	-1861	1621	0	0	8323	15576	17502	0.89	0.73	0.61
1959	5881	-52	-1471	1360	0	0	6945	12662	14186	0.89	0.90	0.75
1960	5074	-60	-1744	1119	0	0	9852	14240	16045	0.89	0.80	0.67
1961	6100	-66	-1952	1527	0	0	10276	15885	17903	0.89	0.71	0.60
1962	112	-54	-1628	991	0	0	13357	12779	14461	0.88	0.89	0.74
1963	5026	-56	-1648	1252	0	0	8782	13355	15060	0.89	0.85	0.71
1964	3332	-53	-1596	1024	0	0	9876	12583	14233	0.88	0.90	0.75
1965	2738	-59	-1755	1123	0	0	11851	13899	15713	0.88	0.82	0.68
1966	38	-57	-1701	157	0	0	14146	12583	14341	0.88	0.90	0.75
1967	6908	-62	-1846	1542	0	0	8404	14945	16853	0.89	0.76	0.63
1968	3724	-55	-1647	1240	0	0	9955	13216	14919	0.89	0.86	0.72
1969	4319	-54	-1551	1314	0	0	8980	13008	14613	0.89	0.87	0.73
1970	2817	-60	-1797	1161	0	0	12129	14250	16107	0.88	0.80	0.66
1971	4077	-56	-1604	1411	0	0	9639	13467	15127	0.89	0.84	0.71
1972	8393	-51	-1456	1526	0	0	4171	12583	14090	0.89	0.90	0.76
1973	874	-56	-1655	971	0	0	12902	13036	14747	0.88	0.87	0.73
1974	7342	-52	-1466	1837	0	0	5274	12936	14454	0.90	0.88	0.74

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 1c. New 80 cfs OID Pump Station (No WAC Instream Flow Restrictions on Pumping From Okanogan), Abandon Shellrock, Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with No Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	6566	-53	-1566	1676	0	0	6434	13057	14676	0.89	0.87	0.73
1976	5694	-53	-1569	1162	0	0	7349	12583	14205	0.89	0.90	0.75
1977	52	-62	-1880	877	0	0	15362	14349	16291	0.88	0.79	0.66
1978	8847	-54	-1548	1631	0	0	4425	13300	14902	0.89	0.85	0.72
1979	366	-64	-1944	985	0	0	15616	14958	16966	0.88	0.76	0.63
1980	7966	-60	-1728	2094	0	0	6785	15057	16845	0.89	0.75	0.64
1981	6829	-60	-1761	1527	0	0	7921	14457	16277	0.89	0.79	0.66
1982	10741	-59	-1679	2011	0	0	3608	14622	16361	0.89	0.78	0.65
1983	9643	-52	-1491	2212	0	0	3143	13454	14998	0.90	0.84	0.71
1984	8953	-56	-1597	1792	0	0	4720	13812	15465	0.89	0.82	0.69
1985	908	-68	-2037	1069	0	0	15893	15765	17869	0.88	0.72	0.60
1986	3399	-64	-1899	1279	0	0	12447	15162	17125	0.89	0.75	0.62
1987	3181	-60	-1743	1271	0	0	11718	14366	16170	0.89	0.79	0.66
1988	5233	-61	-1751	1416	0	0	9714	14552	16364	0.89	0.78	0.65
1989	4632	-59	-1724	1466	0	0	9884	14201	15983	0.89	0.80	0.67
1990	7961	-61	-1767	1969	0	0	6930	15032	16860	0.89	0.76	0.63
1991	6062	-63	-1868	1225	0	0	9460	14815	16746	0.88	0.77	0.64
1992	2468	-63	-1919	1234	0	0	13223	14943	16925	0.88	0.76	0.63
1993	7418	-52	-1543	1301	0	0	5459	12583	14178	0.89	0.90	0.75
1994	5366	-68	-1967	1195	0	0	11401	15927	17962	0.89	0.71	0.60
1995	5790	-55	-1556	1546	0	0	7684	13409	15020	0.89	0.85	0.71
1996	7547	-64	-1866	1398	0	0	8353	15367	17298	0.89	0.74	0.62
1997	9350	-58	-1661	1807	0	0	4859	14297	16016	0.89	0.79	0.67
1998	12117	-69	-1978	2421	0	0	4695	17187	19234	0.89	0.66	0.56
1999	11556	-61	-1761	1585	0	0	3486	14804	16627	0.89	0.77	0.64
2000	7432	-62	-1790	1244	0	0	7907	14730	16582	0.89	0.77	0.65
2001	1366	-67	-2029	1089	0	0	15251	15610	17706	0.88	0.73	0.60
2002	5816	-66	-1967	1152	0	0	10537	15472	17505	0.88	0.73	0.61
Average	**5488**	**-60**	**-1759**	**1383**	**0**	**0**	**9293**	**14345**	**16164**	**0.888**	**0.797**	**0.667**
Maximum	**12117**	**-51**	**-1452**	**2487**	**0**	**0**	**16768**	**17187**	**19467**	**0.897**	**0.902**	**0.760**
Minimum	**-26**	**-73**	**-2207**	**157**	**0**	**0**	**2940**	**12583**	**14086**	**0.877**	**0.660**	**0.550**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 2a. Upgrade Shellrock to 35 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	9243	-37	-1356	1556	3806	0	0	13213	14605	0.90	0.86	0.73
1905	10511	-42	-1417	1737	2830	0	0	13619	15079	0.90	0.83	0.71
1906	8984	-36	-1333	1493	4267	0	0	13375	14744	0.91	0.85	0.73
1907	9077	-36	-1128	1432	3970	0	0	13315	14479	0.92	0.85	0.74
1908	7206	-28	-1044	1140	5750	0	0	13024	14096	0.92	0.87	0.76
1909	9207	-37	-1141	1084	3854	0	0	12967	14145	0.92	0.88	0.76
1910	7462	-29	-1092	643	7090	0	0	14074	15195	0.93	0.81	0.70
1911	8780	-35	-1183	1015	6985	0	0	15563	16781	0.93	0.73	0.64
1912	8336	-33	-1089	1441	5186	0	0	13840	14962	0.92	0.82	0.72
1913	8798	-35	-1166	1190	5679	0	0	14465	15667	0.92	0.78	0.68
1914	9426	-37	-1356	1379	5577	0	0	14989	16382	0.91	0.76	0.65
1915	10755	-43	-1433	1549	4554	0	0	15381	16857	0.91	0.74	0.63
1916	11976	-48	-1557	1870	2284	0	0	14525	16130	0.90	0.78	0.66
1917	9578	-37	-1375	1012	6037	0	0	15216	16628	0.92	0.75	0.64
1918	3326	-12	-576	311	10970	0	0	14019	14608	0.96	0.81	0.73
1919	8285	-33	-1120	1055	6985	0	0	15172	16325	0.93	0.75	0.66
1920	4455	-17	-654	302	10998	0	0	15084	15755	0.96	0.75	0.68
1921	6422	-25	-826	855	8479	0	0	14905	15756	0.95	0.76	0.68
1922	7213	-28	-949	697	8743	0	0	15675	16653	0.94	0.72	0.64
1923	6812	-27	-838	870	8086	0	0	14903	15768	0.95	0.76	0.68
1924	4135	-15	-721	274	10998	0	0	14671	15407	0.95	0.77	0.69
1925	4229	-16	-620	355	10699	0	0	14646	15283	0.96	0.77	0.70
1926	4928	-19	-583	420	10998	0	0	15743	16346	0.96	0.72	0.65
1927	4400	-18	-487	619	10998	0	0	15512	16016	0.97	0.73	0.67
1928	4324	-16	-722	278	10998	0	0	14862	15600	0.95	0.76	0.69
1929	2745	-9	-710	250	10998	0	0	13274	13993	0.95	0.86	0.76
1930	3361	-12	-715	255	10998	0	0	13887	14613	0.95	0.82	0.73
1931	3596	-13	-648	285	10998	0	0	14218	14879	0.96	0.80	0.72
1932	2668	-10	-502	337	10998	0	0	13491	14003	0.96	0.84	0.76
1933	3215	-12	-507	347	10998	0	0	14041	14560	0.96	0.81	0.73
1934	4016	-15	-651	296	10998	0	0	14644	15310	0.96	0.78	0.70
1935	5818	-22	-879	616	8278	0	0	13811	14712	0.94	0.82	0.73
1936	5345	-21	-766	700	8815	0	0	14074	14861	0.95	0.81	0.72
1937	6472	-25	-858	895	7162	0	0	13646	14529	0.94	0.83	0.74
1938	8700	-34	-1305	1237	6570	0	0	15167	16506	0.92	0.75	0.65
1939	4097	-15	-720	271	10998	0	0	14631	15366	0.95	0.78	0.70
1940	3302	-13	-386	510	10998	0	0	14411	14810	0.97	0.79	0.72
1941	12706	-51	-1644	2150	2561	0	0	15722	17417	0.90	0.72	0.61
1942	11602	-47	-1501	2202	3569	0	0	15826	17373	0.91	0.72	0.62
1943	8065	-32	-1187	1127	6394	0	0	14368	15586	0.92	0.79	0.69
1944	5540	-22	-711	745	9163	0	0	14716	15448	0.95	0.77	0.69
1945	7277	-29	-1069	1012	6819	0	0	14010	15108	0.93	0.81	0.71
1946	7109	-28	-1080	1020	6333	0	0	13354	14462	0.92	0.85	0.74
1947	2692	-9	-679	424	9882	0	0	12310	12998	0.95	0.92	0.82
1948	11200	-45	-1311	1667	2038	0	0	13550	14905	0.91	0.84	0.72
1949	5446	-20	-1154	776	7948	0	0	12995	14170	0.92	0.87	0.76
1950	8271	-33	-1101	1127	5576	0	0	13841	14974	0.92	0.82	0.71
1951	9661	-39	-1362	1674	4576	0	0	14511	15911	0.91	0.78	0.67
1952	8152	-32	-1257	1353	5311	0	0	13528	14816	0.91	0.84	0.72
1953	9227	-37	-1237	1277	4408	0	0	13638	14912	0.91	0.83	0.72
1954	5060	-19	-916	664	7760	0	0	12550	13485	0.93	0.90	0.79
1955	7540	-29	-1117	857	6106	0	0	13356	14502	0.92	0.85	0.74
1956	8795	-35	-1265	1468	5213	0	0	14177	15477	0.92	0.80	0.69
1957	7038	-28	-1095	1044	6173	0	0	13133	14256	0.92	0.86	0.75
1958	9594	-38	-1323	1525	5884	0	0	15642	17003	0.92	0.73	0.63
1959	7864	-31	-1100	1224	5210	0	0	13167	14298	0.92	0.86	0.75
1960	7388	-29	-1189	862	6951	0	0	13984	15202	0.92	0.81	0.70
1961	8498	-34	-1101	1130	6985	0	0	15479	16613	0.93	0.73	0.64
1962	1603	-5	-563	311	10998	0	0	12344	12912	0.96	0.92	0.83
1963	7369	-29	-1066	1098	6187	0	0	13559	14654	0.93	0.84	0.73
1964	4469	-17	-813	561	8247	0	0	12447	13276	0.94	0.91	0.81
1965	4513	-17	-816	556	9188	0	0	13424	14256	0.94	0.85	0.75
1966	1386	-4	-492	330	10998	0	0	12217	12713	0.96	0.93	0.84
1967	8819	-35	-1141	1176	6004	0	0	14822	15999	0.93	0.77	0.67
1968	6115	-24	-973	916	7239	0	0	13273	14270	0.93	0.86	0.75
1969	6275	-25	-939	1074	6890	0	0	13275	14239	0.93	0.85	0.75
1970	4020	-15	-781	434	9823	0	0	13481	14276	0.94	0.84	0.75
1971	6489	-26	-904	1127	6985	0	0	13672	14602	0.94	0.83	0.73
1972	10195	-41	-1348	1564	3076	0	0	13446	14835	0.91	0.84	0.72
1973	1783	-5	-634	290	10998	0	0	12433	13072	0.95	0.91	0.82
1974	9256	-37	-1318	1782	4194	0	0	13877	15233	0.91	0.82	0.70

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 2a. Upgrade Shellrock to 35 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	8578	-34	-1090	1548	4783	0	0	13786	14910	0.92	0.82	0.72
1976	7594	-30	-1101	1025	5421	0	0	12909	14041	0.92	0.88	0.76
1977	2844	-10	-711	259	10998	0	0	13380	14101	0.95	0.85	0.76
1978	10379	-42	-1262	1525	3343	0	0	13943	15247	0.91	0.81	0.70
1979	3304	-12	-715	332	10998	0	0	13908	14634	0.95	0.82	0.73
1980	9156	-37	-1266	1724	5854	0	0	15431	16734	0.92	0.74	0.64
1981	8555	-34	-1155	1302	5915	0	0	14584	15773	0.92	0.78	0.68
1982	12043	-48	-1573	1988	2880	0	0	15289	16911	0.90	0.74	0.63
1983	11259	-45	-1450	2242	2412	0	0	14417	15913	0.91	0.79	0.67
1984	10211	-41	-1366	2006	3741	0	0	14550	15957	0.91	0.78	0.67
1985	3914	-14	-719	359	10998	0	0	14537	15271	0.95	0.78	0.70
1986	3404	-13	-577	312	10998	0	0	14124	14713	0.96	0.80	0.73
1987	4104	-16	-697	534	9742	0	0	13668	14381	0.95	0.83	0.74
1988	6260	-25	-873	907	7951	0	0	14220	15118	0.94	0.80	0.71
1989	6329	-25	-869	1007	7657	0	0	14099	14993	0.94	0.81	0.71
1990	9157	-37	-1135	1531	5726	0	0	15242	16414	0.93	0.74	0.65
1991	7089	-28	-1039	829	7529	0	0	14380	15447	0.93	0.79	0.69
1992	3396	-13	-506	344	10771	0	0	13992	14511	0.96	0.81	0.74
1993	8077	-32	-1031	1065	4870	0	0	12949	14012	0.92	0.88	0.76
1994	8225	-32	-1358	910	7461	0	0	15206	16596	0.92	0.75	0.64
1995	8057	-32	-1204	1403	5679	0	0	13903	15139	0.92	0.82	0.71
1996	9517	-38	-1382	1318	5864	0	0	15279	16699	0.91	0.74	0.64
1997	10606	-42	-1413	1656	4011	0	0	14817	16273	0.91	0.77	0.66
1998	13024	-52	-1703	2126	3808	0	0	17203	18958	0.91	0.66	0.56
1999	12422	-50	-1590	1866	2613	0	0	15262	16901	0.90	0.74	0.63
2000	9537	-38	-1437	1206	5423	0	0	14691	16166	0.91	0.77	0.66
2001	3797	-14	-719	264	10998	0	0	14327	15059	0.95	0.79	0.71
2002	6740	-26	-1085	625	8412	0	0	14666	15777	0.93	0.77	0.68
Average	**7069**	**-28**	**-1027**	**1003**	**7153**	**0**	**0**	**14171**	**15225**	**0.931**	**0.804**	**0.706**
Maximum	**13024**	**-4**	**-386**	**2242**	**10998**	**0**	**0**	**17203**	**18958**	**0.973**	**0.929**	**0.842**
Minimum	**1386**	**-52**	**-1703**	**250**	**2038**	**0**	**0**	**12217**	**12713**	**0.900**	**0.660**	**0.564**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 2b. Upgrade Shellrock to 35 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead and Chinook with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	7528	-29	-1339	1556	5032	0	0	12747	14116	0.90	0.89	0.76
1905	9326	-37	-1312	1697	3392	0	0	13066	14415	0.91	0.87	0.74
1906	7227	-28	-1224	1400	5396	0	0	12770	14022	0.91	0.89	0.76
1907	7831	-31	-1179	1499	4750	0	0	12869	14080	0.91	0.88	0.76
1908	6031	-23	-1207	1265	6570	0	0	12636	13866	0.91	0.90	0.77
1909	7815	-31	-1221	1164	4807	0	0	12534	13786	0.91	0.91	0.78
1910	6755	-26	-1099	649	7006	0	0	13285	14410	0.92	0.85	0.74
1911	8170	-32	-1284	1116	6693	0	0	14663	15979	0.92	0.77	0.67
1912	6793	-27	-1013	1398	6039	0	0	13190	14230	0.93	0.86	0.75
1913	7792	-30	-1189	1181	5936	0	0	13690	14909	0.92	0.83	0.72
1914	8232	-32	-1285	1321	5867	0	0	14102	15420	0.91	0.80	0.69
1915	9523	-38	-1365	1500	4844	0	0	14464	15867	0.91	0.78	0.67
1916	10776	-43	-1444	1829	2712	0	0	13830	15317	0.90	0.82	0.70
1917	8439	-33	-1349	956	6209	0	0	14222	15604	0.91	0.80	0.69
1918	3016	-11	-671	405	10527	0	0	13268	13949	0.95	0.86	0.77
1919	6704	-26	-990	924	7509	0	0	14122	15138	0.93	0.80	0.71
1920	3387	-12	-633	281	10998	0	0	14021	14666	0.96	0.81	0.73
1921	5380	-21	-757	786	8539	0	0	13928	14706	0.95	0.81	0.73
1922	6150	-24	-903	651	8677	0	0	14551	15478	0.94	0.78	0.69
1923	5606	-22	-755	787	8299	0	0	13915	14693	0.95	0.82	0.73
1924	3362	-12	-735	288	10802	0	0	13706	14452	0.95	0.83	0.74
1925	3160	-12	-566	301	10758	0	0	13641	14219	0.96	0.83	0.75
1926	3695	-14	-496	334	10998	0	0	14516	15027	0.97	0.78	0.71
1927	3221	-13	-375	507	10998	0	0	14339	14726	0.97	0.79	0.73
1928	3294	-12	-702	258	10998	0	0	13837	14550	0.95	0.82	0.74
1929	1997	-6	-701	241	10998	0	0	12529	13236	0.95	0.91	0.81
1930	1596	-4	-701	241	10998	905	0	13035	13740	0.95	0.87	0.78
1931	969	-2	-632	269	10998	1698	0	13301	13935	0.95	0.85	0.77
1932	526	0	-493	328	10998	1379	0	12738	13231	0.96	0.89	0.81
1933	2241	-8	-493	333	10998	114	0	13185	13686	0.96	0.86	0.78
1934	3031	-11	-632	278	10998	0	0	13663	14306	0.96	0.83	0.75
1935	4647	-17	-843	581	8656	0	0	13024	13884	0.94	0.87	0.77
1936	4425	-17	-739	673	8919	0	0	13262	14018	0.95	0.86	0.76
1937	5187	-20	-762	799	7675	0	0	12879	13661	0.94	0.88	0.78
1938	7793	-30	-1288	1230	6570	0	0	14274	15592	0.92	0.80	0.69
1939	3110	-11	-702	252	10998	0	0	13648	14360	0.95	0.83	0.75
1940	2354	-9	-318	442	10978	0	0	13447	13774	0.98	0.84	0.78
1941	11520	-46	-1527	2377	3005	0	0	15329	16902	0.91	0.74	0.63
1942	10822	-43	-1426	1994	3709	0	0	15056	16525	0.91	0.75	0.65
1943	7407	-29	-1334	1201	6435	0	0	13680	15043	0.91	0.83	0.71
1944	4187	-16	-601	635	9500	0	0	13705	14322	0.96	0.83	0.75
1945	6382	-25	-1062	1005	6985	0	0	13286	14373	0.92	0.85	0.74
1946	5930	-23	-1055	995	6886	0	0	12734	13811	0.92	0.89	0.77
1947	1521	-4	-590	335	10447	0	0	11709	12304	0.95	0.97	0.87
1948	10015	-40	-1205	1594	2600	0	0	12964	14209	0.91	0.88	0.75
1949	4660	-17	-1224	819	8226	0	0	12465	13705	0.91	0.91	0.78
1950	5982	-23	-895	921	6986	0	0	12971	13889	0.93	0.88	0.77
1951	7956	-32	-1215	1595	5443	0	0	13747	14994	0.92	0.83	0.71
1952	6995	-27	-1224	1316	5865	0	0	12924	14176	0.91	0.88	0.75
1953	8149	-32	-1303	1342	4946	0	0	13103	14437	0.91	0.87	0.74
1954	4585	-17	-1004	752	7808	0	0	12124	13144	0.92	0.94	0.81
1955	6831	-26	-1104	843	6173	0	0	12718	13847	0.92	0.89	0.77
1956	7523	-30	-1187	1410	5738	0	0	13455	14672	0.92	0.84	0.73
1957	5946	-23	-1093	1043	6709	0	0	12581	13697	0.92	0.90	0.78
1958	8264	-33	-1209	1437	6174	0	0	14633	15874	0.92	0.78	0.67
1959	6920	-27	-1156	1300	5682	0	0	12719	13902	0.91	0.89	0.77
1960	7279	-28	-1440	1093	6570	0	0	13474	14942	0.90	0.84	0.72
1961	7456	-29	-1026	1055	6985	0	0	14441	15496	0.93	0.79	0.69
1962	1060	-2	-562	310	10998	0	0	11804	12367	0.95	0.96	0.87
1963	6129	-24	-1003	1035	6740	0	0	12877	13904	0.93	0.88	0.77
1964	3350	-12	-827	575	8862	0	0	11948	12787	0.93	0.95	0.84
1965	3894	-14	-812	551	9108	0	0	12727	13553	0.94	0.89	0.79
1966	870	-2	-492	330	10998	0	0	11704	12198	0.96	0.97	0.88
1967	5854	-23	-815	849	7796	0	0	13662	14500	0.94	0.83	0.74
1968	5288	-20	-993	936	7482	0	0	12694	13706	0.93	0.89	0.78
1969	5614	-22	-947	1082	6985	0	0	12712	13681	0.93	0.89	0.78
1970	3049	-11	-737	390	10005	0	0	12697	13444	0.94	0.89	0.80
1971	5846	-23	-898	1121	6985	0	0	13032	13953	0.93	0.87	0.77
1972	9001	-36	-1291	1528	3695	0	0	12898	14225	0.91	0.88	0.75
1973	1886	-5	-730	386	10417	0	0	11954	12689	0.94	0.95	0.84
1974	8390	-34	-1193	1778	4421	0	0	13363	14589	0.92	0.85	0.73

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 2b. Upgrade Shellrock to 35 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead and Chinook with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	6707	-27	-943	1374	5923	0	0	13034	14004	0.93	0.87	0.76
1976	5931	-22	-1167	1060	6630	0	0	12431	13621	0.91	0.91	0.79
1977	2077	-6	-701	249	10998	0	0	12617	13324	0.95	0.90	0.80
1978	8533	-34	-1121	1415	4430	0	0	13223	14377	0.92	0.86	0.74
1979	2541	-8	-714	300	10921	0	0	13040	13762	0.95	0.87	0.78
1980	7818	-31	-1137	1661	6230	0	0	14540	15708	0.93	0.78	0.68
1981	7189	-28	-1045	1186	6399	0	0	13700	14774	0.93	0.83	0.72
1982	11101	-44	-1489	2024	3046	0	0	14637	16171	0.91	0.78	0.66
1983	10444	-42	-1410	2363	2879	0	0	14234	15686	0.91	0.80	0.68
1984	9378	-37	-1354	1873	4132	0	0	13992	15384	0.91	0.81	0.70
1985	2946	-10	-702	310	10998	0	0	13542	14253	0.95	0.84	0.75
1986	2521	-9	-563	297	10998	0	0	13245	13816	0.96	0.86	0.77
1987	3094	-11	-662	499	9957	0	0	12877	13550	0.95	0.88	0.79
1988	5043	-20	-790	825	8299	0	0	13357	14167	0.94	0.85	0.76
1989	5290	-21	-803	940	7892	0	0	13299	14122	0.94	0.85	0.76
1990	7924	-32	-1027	1447	6000	0	0	14312	15371	0.93	0.79	0.70
1991	6869	-26	-1139	910	7030	0	0	13644	14809	0.92	0.83	0.72
1992	2698	-10	-493	331	10619	0	0	13144	13647	0.96	0.86	0.78
1993	6475	-25	-936	971	5857	0	0	12342	13304	0.93	0.92	0.80
1994	6781	-26	-1302	855	7875	0	0	14183	15510	0.91	0.80	0.69
1995	6752	-27	-1122	1340	6270	0	0	13214	14362	0.92	0.86	0.75
1996	8255	-32	-1307	1254	6154	0	0	14323	15663	0.91	0.79	0.68
1997	9680	-39	-1397	1688	4170	0	0	14103	15539	0.91	0.80	0.69
1998	12326	-49	-1621	2249	3521	0	0	16426	18097	0.91	0.69	0.59
1999	11541	-46	-1532	1703	2761	0	0	14427	16005	0.90	0.79	0.67
2000	8064	-31	-1362	1109	6009	0	0	13789	15182	0.91	0.82	0.70
2001	2851	-10	-702	247	10998	0	0	13384	14096	0.95	0.85	0.76
2002	5915	-22	-1070	610	8312	0	0	13744	14836	0.93	0.83	0.72
Average	**5964**	**-23**	**-992**	**977**	**7442**	**41**	**0**	**13410**	**14425**	**0.930**	**0.849**	**0.745**
Maximum	**12326**	**0**	**-318**	**2377**	**10998**	**1698**	**0**	**16426**	**18097**	**0.976**	**0.970**	**0.877**
Minimum	**526**	**-49**	**-1621**	**241**	**2600**	**0**	**0**	**11704**	**12198**	**0.901**	**0.691**	**0.591**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 2c. Upgrade Shellrock to 35 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with No Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	9180	-37	-1351	1556	3806	0	0	13154	14542	0.90	0.86	0.74
1905	10440	-42	-1410	1747	2830	0	0	13565	15017	0.90	0.84	0.71
1906	8912	-35	-1326	1495	4267	0	0	13314	14675	0.91	0.85	0.73
1907	9005	-36	-1121	1426	3970	0	0	13245	14402	0.92	0.86	0.74
1908	6986	-28	-998	1091	5859	0	0	12911	13937	0.93	0.88	0.77
1909	9136	-36	-1134	1077	3854	0	0	12896	14066	0.92	0.88	0.76
1910	7424	-29	-1095	646	7028	0	0	13973	15097	0.93	0.81	0.71
1911	8637	-34	-1173	1005	6985	0	0	15421	16628	0.93	0.74	0.64
1912	8283	-33	-1083	1441	5155	0	0	13763	14879	0.92	0.82	0.72
1913	8783	-35	-1198	1217	5625	0	0	14393	15626	0.92	0.79	0.68
1914	9341	-37	-1348	1378	5546	0	0	14880	16265	0.91	0.76	0.66
1915	10691	-43	-1453	1576	4523	0	0	15295	16791	0.91	0.74	0.64
1916	11916	-48	-1550	1880	2253	0	0	14451	16049	0.90	0.79	0.67
1917	9479	-37	-1368	1002	6006	0	0	15082	16488	0.91	0.75	0.65
1918	3271	-12	-574	309	10913	0	0	13906	14492	0.96	0.82	0.74
1919	8155	-32	-1111	1045	6985	0	0	15042	16185	0.93	0.75	0.66
1920	4313	-16	-650	298	10998	0	0	14943	15609	0.96	0.76	0.69
1921	6412	-25	-834	863	8378	0	0	14794	15653	0.95	0.77	0.68
1922	7126	-28	-950	698	8687	0	0	15533	16511	0.94	0.73	0.65
1923	6718	-27	-832	864	8055	0	0	14779	15638	0.95	0.77	0.68
1924	4002	-15	-717	271	10998	0	0	14539	15271	0.95	0.78	0.70
1925	4194	-16	-626	361	10615	0	0	14528	15170	0.96	0.78	0.71
1926	4760	-19	-568	405	10998	0	0	15577	16164	0.96	0.73	0.66
1927	4244	-17	-471	603	10998	0	0	15357	15845	0.97	0.74	0.68
1928	4188	-16	-718	274	10998	0	0	14726	15460	0.95	0.77	0.69
1929	2648	-9	-708	249	10998	0	0	13177	13895	0.95	0.86	0.77
1930	3249	-11	-712	252	10998	0	0	13775	14499	0.95	0.82	0.74
1931	3474	-13	-645	283	10998	0	0	14097	14755	0.96	0.81	0.73
1932	2569	-9	-501	336	10998	0	0	13393	13903	0.96	0.85	0.77
1933	3103	-12	-504	344	10998	0	0	13929	14445	0.96	0.81	0.74
1934	3886	-15	-647	293	10998	0	0	14514	15176	0.96	0.78	0.71
1935	5823	-22	-886	624	8183	0	0	13721	14630	0.94	0.83	0.73
1936	5269	-21	-762	696	8785	0	0	13968	14750	0.95	0.81	0.73
1937	6417	-25	-855	893	7128	0	0	13558	14438	0.94	0.84	0.74
1938	8572	-34	-1293	1230	6570	0	0	15045	16372	0.92	0.75	0.65
1939	3967	-15	-717	268	10998	0	0	14501	15232	0.95	0.78	0.70
1940	3247	-13	-385	509	10934	0	0	14292	14690	0.97	0.79	0.73
1941	12682	-51	-1641	2248	2526	0	0	15764	17456	0.90	0.72	0.61
1942	11640	-47	-1507	2152	3538	0	0	15776	17329	0.91	0.72	0.62
1943	7870	-31	-1153	1090	6456	0	0	14232	15416	0.92	0.80	0.69
1944	5477	-22	-710	745	9107	0	0	14597	15329	0.95	0.78	0.70
1945	7212	-28	-1066	1009	6788	0	0	13915	15009	0.93	0.82	0.71
1946	7029	-27	-1076	1016	6333	0	0	13274	14377	0.92	0.86	0.74
1947	2691	-9	-687	433	9828	0	0	12255	12951	0.95	0.93	0.83
1948	11129	-45	-1304	1666	2038	0	0	13484	14832	0.91	0.84	0.72
1949	5422	-20	-1203	822	7948	0	0	12969	14192	0.91	0.88	0.75
1950	8238	-32	-1136	1163	5559	0	0	13791	14960	0.92	0.82	0.72
1951	9630	-39	-1357	1684	4516	0	0	14434	15830	0.91	0.79	0.68
1952	8073	-32	-1250	1353	5311	0	0	13456	14738	0.91	0.84	0.73
1953	9070	-36	-1207	1247	4458	0	0	13532	14775	0.92	0.84	0.72
1954	5030	-19	-921	669	7731	0	0	12490	13430	0.93	0.91	0.80
1955	7495	-29	-1118	858	6072	0	0	13277	14424	0.92	0.85	0.74
1956	8733	-35	-1260	1470	5185	0	0	14094	15388	0.92	0.81	0.70
1957	6968	-27	-1094	1043	6173	0	0	13063	14184	0.92	0.87	0.75
1958	9365	-37	-1277	1497	5946	0	0	15493	16808	0.92	0.73	0.64
1959	7778	-31	-1124	1253	5254	0	0	13130	14285	0.92	0.86	0.75
1960	7233	-28	-1165	834	6985	0	0	13860	15053	0.92	0.82	0.71
1961	8357	-33	-1087	1116	6985	0	0	15339	16459	0.93	0.74	0.65
1962	1535	-4	-563	311	10998	0	0	12276	12843	0.96	0.92	0.83
1963	7285	-29	-1061	1093	6187	0	0	13475	14565	0.93	0.84	0.73
1964	4450	-17	-820	568	8207	0	0	12389	13225	0.94	0.92	0.81
1965	4464	-17	-819	559	9150	0	0	13338	14173	0.94	0.85	0.76
1966	1321	-4	-492	330	10998	0	0	12153	12649	0.96	0.93	0.85
1967	8753	-35	-1153	1187	5973	0	0	14725	15913	0.93	0.77	0.67
1968	6034	-23	-969	911	7239	0	0	13192	14184	0.93	0.86	0.75
1969	6199	-24	-935	1069	6890	0	0	13199	14158	0.93	0.86	0.76
1970	3931	-14	-779	432	9814	0	0	13384	14177	0.94	0.85	0.75
1971	6412	-25	-908	1131	6985	0	0	13595	14528	0.94	0.83	0.74
1972	10129	-40	-1382	1606	3112	0	0	13424	14847	0.90	0.85	0.72
1973	1710	-5	-633	290	10998	0	0	12360	12998	0.95	0.92	0.82
1974	9235	-37	-1317	1794	4194	0	0	13869	15224	0.91	0.82	0.70

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 2c. Upgrade Shellrock to 35 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with No Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	8498	-34	-1082	1548	4782	0	0	13712	14828	0.92	0.83	0.72
1976	7523	-30	-1097	1017	5423	0	0	12837	13963	0.92	0.88	0.77
1977	2745	-9	-709	257	10998	0	0	13281	13999	0.95	0.85	0.76
1978	10326	-41	-1256	1523	3312	0	0	13863	15161	0.91	0.82	0.71
1979	3192	-11	-712	325	10998	0	0	13792	14516	0.95	0.82	0.74
1980	8983	-36	-1220	1700	5891	0	0	15319	16574	0.92	0.74	0.65
1981	8479	-34	-1147	1296	5885	0	0	14479	15660	0.92	0.78	0.68
1982	11796	-47	-1481	1985	3034	0	0	15286	16815	0.91	0.74	0.64
1983	11334	-46	-1471	2296	2381	0	0	14494	16011	0.91	0.78	0.67
1984	10278	-41	-1387	1956	3710	0	0	14516	15944	0.91	0.78	0.67
1985	3786	-14	-716	352	10998	0	0	14406	15136	0.95	0.79	0.71
1986	3288	-12	-575	309	10998	0	0	14008	14595	0.96	0.81	0.73
1987	4295	-16	-734	572	9491	0	0	13608	14358	0.95	0.83	0.75
1988	6258	-25	-881	916	7859	0	0	14127	15033	0.94	0.80	0.71
1989	6335	-25	-878	1016	7565	0	0	14013	14916	0.94	0.81	0.72
1990	9100	-36	-1134	1529	5672	0	0	15130	16300	0.93	0.75	0.66
1991	7058	-27	-1042	837	7456	0	0	14282	15351	0.93	0.79	0.70
1992	3350	-13	-506	343	10708	0	0	13882	14401	0.96	0.82	0.74
1993	8108	-32	-1038	1073	4783	0	0	12893	13963	0.92	0.88	0.77
1994	8087	-31	-1348	900	7461	0	0	15069	16448	0.92	0.75	0.65
1995	8001	-32	-1205	1411	5655	0	0	13831	15068	0.92	0.82	0.71
1996	9422	-37	-1374	1315	5833	0	0	15160	16571	0.91	0.75	0.65
1997	10361	-41	-1347	1609	4092	0	0	14675	16063	0.91	0.77	0.67
1998	13000	-52	-1700	2214	3748	0	0	17209	18962	0.91	0.66	0.56
1999	11565	-46	-1535	1733	3399	0	0	15115	16696	0.91	0.75	0.64
2000	8667	-34	-1393	1161	6141	0	0	14542	15969	0.91	0.78	0.67
2001	3673	-13	-715	261	10998	0	0	14202	14931	0.95	0.80	0.72
2002	4243	-16	-753	293	10450	0	0	14217	14985	0.95	0.80	0.71
Average	**6951**	**-27**	**-1019**	**999**	**7173**	**0**	**0**	**14077**	**15123**	**0.931**	**0.810**	**0.711**
Maximum	**13000**	**-4**	**-385**	**2296**	**10998**	**0**	**0**	**17209**	**18962**	**0.973**	**0.934**	**0.846**
Minimum	**1321**	**-52**	**-1700**	**249**	**2038**	**0**	**0**	**12153**	**12649**	**0.900**	**0.660**	**0.564**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 3a. 5100 AF Water Rights Purchase from OID, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	6871	-28	-891	640	2327	0	0	8919	9838	0.91	0.87	0.74
1905	7434	-30	-930	947	1497	0	0	8919	9879	0.90	0.87	0.74
1906	6290	-26	-830	909	2576	0	0	8919	9775	0.91	0.87	0.74
1907	6975	-28	-833	848	1958	0	0	8919	9781	0.91	0.87	0.74
1908	5350	-22	-707	743	3556	0	0	8920	9649	0.92	0.87	0.75
1909	7473	-30	-866	567	1775	0	0	8919	9815	0.91	0.87	0.74
1910	6192	-25	-740	364	4375	0	0	10167	10931	0.93	0.76	0.67
1911	6363	-26	-794	534	4990	0	0	11067	11886	0.93	0.70	0.61
1912	6457	-26	-796	811	2890	0	0	9335	10158	0.92	0.83	0.72
1913	6921	-28	-832	762	3217	0	0	10042	10901	0.92	0.77	0.67
1914	7048	-29	-902	815	3379	0	0	10311	11242	0.92	0.75	0.65
1915	7651	-31	-962	908	2925	0	0	10491	11484	0.91	0.74	0.63
1916	8422	-34	-1020	1126	1047	0	0	9542	10596	0.90	0.81	0.69
1917	7340	-30	-877	596	3760	0	0	10789	11696	0.92	0.72	0.62
1918	2815	-11	-313	157	7742	0	0	10390	10714	0.97	0.74	0.68
1919	6089	-25	-765	432	4990	0	0	10721	11511	0.93	0.72	0.63
1920	3653	-15	-401	163	7856	0	0	11256	11671	0.96	0.69	0.62
1921	5937	-24	-741	485	5008	0	0	10665	11430	0.93	0.72	0.64
1922	5568	-22	-661	417	6112	0	0	11414	12097	0.94	0.68	0.60
1923	6248	-25	-727	519	4637	0	0	10652	11404	0.93	0.72	0.64
1924	3329	-13	-364	171	7856	0	0	10979	11356	0.97	0.70	0.64
1925	4435	-18	-519	157	6805	0	0	10860	11397	0.95	0.71	0.64
1926	4153	-17	-458	157	7856	0	0	11692	12166	0.96	0.66	0.60
1927	3672	-15	-400	233	7856	0	0	11346	11761	0.96	0.68	0.62
1928	4828	-19	-525	203	6609	0	0	11096	11640	0.95	0.70	0.63
1929	2234	-9	-332	154	7856	0	0	9903	10244	0.97	0.78	0.71
1930	2914	-11	-554	94	7856	0	0	10299	10864	0.95	0.75	0.67
1931	3125	-12	-487	125	7856	0	0	10606	11105	0.96	0.73	0.66
1932	2243	-9	-304	139	7856	0	0	9925	10238	0.97	0.78	0.71
1933	2692	-11	-315	155	7856	0	0	10377	10703	0.97	0.74	0.68
1934	3386	-13	-479	125	7856	0	0	10874	11366	0.96	0.71	0.64
1935	6369	-25	-787	167	4252	0	0	9976	10788	0.92	0.77	0.67
1936	4335	-17	-512	318	5998	0	0	10121	10650	0.95	0.76	0.68
1937	5150	-21	-601	442	4649	0	0	9619	10241	0.94	0.80	0.71
1938	6022	-25	-808	746	4635	0	0	10570	11403	0.93	0.73	0.64
1939	3277	-13	-361	157	7856	0	0	10916	11290	0.97	0.71	0.64
1940	3806	-15	-441	157	7105	0	0	10612	11068	0.96	0.73	0.66
1941	9349	-38	-1113	1731	633	0	0	10561	11713	0.90	0.73	0.62
1942	8478	-35	-1049	1246	1965	0	0	10606	11689	0.91	0.73	0.62
1943	5921	-24	-749	717	4149	0	0	10013	10787	0.93	0.77	0.67
1944	4626	-19	-544	405	6168	0	0	10635	11198	0.95	0.73	0.65
1945	5302	-21	-668	593	4612	0	0	9818	10507	0.93	0.79	0.69
1946	5247	-21	-656	515	4198	0	0	9283	9960	0.93	0.83	0.73
1947	2493	-10	-311	193	6557	0	0	8922	9243	0.97	0.87	0.79
1948	8134	-33	-930	736	1012	0	0	8919	9882	0.90	0.87	0.74
1949	3825	-16	-545	549	5378	0	0	9191	9752	0.94	0.84	0.75
1950	6561	-26	-794	393	3455	0	0	9589	10409	0.92	0.80	0.70
1951	7366	-30	-944	992	2306	0	0	9690	10664	0.91	0.80	0.68
1952	5785	-24	-755	865	3283	0	0	9154	9933	0.92	0.84	0.73
1953	6543	-27	-821	668	2942	0	0	9305	10152	0.92	0.83	0.72
1954	4017	-16	-491	393	5018	0	0	8921	9428	0.95	0.87	0.77
1955	5875	-24	-697	286	3977	0	0	9416	10137	0.93	0.82	0.72
1956	6502	-27	-857	808	3158	0	0	9585	10469	0.92	0.81	0.70
1957	5070	-21	-671	594	4113	0	0	9085	9777	0.93	0.85	0.74
1958	7189	-29	-925	886	3599	0	0	10720	11674	0.92	0.72	0.62
1959	5669	-23	-730	768	3283	0	0	8968	9721	0.92	0.86	0.75
1960	5128	-21	-663	529	4945	0	0	9918	10602	0.94	0.78	0.69
1961	6257	-25	-783	482	4976	0	0	10907	11715	0.93	0.71	0.62
1962	1153	-5	-126	162	7856	0	0	9040	9171	0.99	0.85	0.79
1963	5777	-23	-715	346	4001	0	0	9385	10123	0.93	0.82	0.72
1964	3658	-15	-425	273	5431	0	0	8921	9361	0.95	0.87	0.78
1965	3641	-15	-443	159	6371	0	0	9713	10171	0.95	0.79	0.72
1966	1026	-4	-112	157	7856	0	0	8923	9039	0.99	0.86	0.81
1967	7148	-29	-864	378	3707	0	0	10341	11233	0.92	0.75	0.65
1968	4309	-17	-565	585	4990	0	0	9302	9884	0.94	0.83	0.74
1969	4518	-18	-585	538	4724	0	0	9176	9780	0.94	0.84	0.74
1970	3541	-14	-427	217	6607	0	0	9924	10366	0.96	0.78	0.70
1971	4627	-19	-621	530	4935	0	0	9452	10092	0.94	0.82	0.72
1972	7251	-30	-893	868	1722	0	0	8919	9842	0.91	0.87	0.74
1973	1328	-5	-145	182	7835	0	0	9195	9346	0.98	0.84	0.78
1974	6406	-26	-908	811	2849	0	0	9132	10066	0.91	0.85	0.72

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 3a. 5100 AF Water Rights Purchase from OID, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	6491	-26	-788	954	2575	0	0	9205	10020	0.92	0.84	0.73
1976	5647	-23	-709	632	3372	0	0	8920	9652	0.92	0.87	0.75
1977	2231	-9	-251	157	7856	0	0	9985	10244	0.97	0.77	0.71
1978	8042	-32	-949	511	1780	0	0	9351	10333	0.90	0.83	0.70
1979	2524	-10	-274	256	7856	0	0	10351	10635	0.97	0.75	0.68
1980	7339	-30	-1005	908	3195	0	0	10407	11442	0.91	0.74	0.64
1981	6353	-26	-804	786	3738	0	0	10047	10877	0.92	0.77	0.67
1982	8616	-35	-1047	1327	1284	0	0	10145	11227	0.90	0.76	0.65
1983	7946	-33	-953	1677	805	0	0	9443	10428	0.91	0.82	0.70
1984	7171	-29	-922	1120	2318	0	0	9658	10609	0.91	0.80	0.69
1985	3050	-12	-331	274	7856	0	0	10836	11180	0.97	0.71	0.65
1986	2965	-12	-331	157	7694	0	0	10474	10816	0.97	0.74	0.67
1987	4585	-18	-606	157	5876	0	0	9994	10618	0.94	0.77	0.69
1988	5182	-21	-678	535	5088	0	0	10105	10804	0.94	0.76	0.67
1989	4948	-20	-634	640	4960	0	0	9894	10547	0.94	0.78	0.69
1990	7264	-29	-893	937	3114	0	0	10393	11316	0.92	0.74	0.64
1991	5674	-23	-686	585	4713	0	0	10264	10973	0.94	0.75	0.66
1992	2956	-12	-320	157	7561	0	0	10342	10674	0.97	0.75	0.68
1993	6744	-27	-812	514	2501	0	0	8920	9759	0.91	0.87	0.75
1994	6296	-26	-839	604	4896	0	0	10931	11796	0.93	0.71	0.62
1995	6143	-25	-876	670	3505	0	0	9416	10318	0.91	0.82	0.71
1996	7081	-29	-905	805	3642	0	0	10594	11528	0.92	0.73	0.63
1997	7525	-31	-964	958	2462	0	0	9950	10944	0.91	0.78	0.66
1998	9357	-38	-1140	1590	1919	0	0	11688	12867	0.91	0.66	0.57
1999	9307	-38	-1124	951	1159	0	0	10255	11417	0.90	0.75	0.64
2000	7085	-29	-900	764	3291	0	0	10211	11139	0.92	0.76	0.65
2001	3082	-12	-339	157	7856	0	0	10743	11095	0.97	0.72	0.66
2002	5313	-21	-648	157	5858	0	0	10659	11329	0.94	0.72	0.64
Average	**5452**	**-22**	**-678**	**555**	**4672**	**0**	**0**	**9979**	**10679**	**0.935**	**0.778**	**0.685**
Maximum	**9357**	**-4**	**-112**	**1731**	**7856**	**0**	**0**	**11692**	**12867**	**0.987**	**0.865**	**0.805**
Minimum	**1026**	**-38**	**-1140**	**94**	**633**	**0**	**0**	**8919**	**9039**	**0.898**	**0.660**	**0.566**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 3b. 5100 AF Water Rights Purchase from OID, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Cana to 90 cfs, Provide Instream Flows for Steelhead and Chinook with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	5581	-21	-1072	1295	3227	0	0	9009	10103	0.89	0.86	0.72
1905	6655	-27	-943	1353	2199	0	0	9238	10207	0.91	0.84	0.71
1906	5352	-21	-965	1123	3519	0	0	9008	9994	0.90	0.86	0.73
1907	5926	-24	-907	1235	2890	0	0	9121	10051	0.91	0.85	0.72
1908	4172	-15	-963	1016	4693	0	0	8902	9881	0.90	0.87	0.74
1909	6057	-23	-1017	959	2868	0	0	8845	9884	0.89	0.87	0.74
1910	5457	-20	-1037	587	4021	0	0	9008	10065	0.90	0.86	0.72
1911	5188	-19	-1065	897	4703	0	0	9704	10789	0.90	0.80	0.67
1912	4754	-19	-763	1176	4091	0	0	9240	10022	0.92	0.84	0.73
1913	5409	-21	-957	920	3935	0	0	9288	10265	0.90	0.83	0.71
1914	5536	-21	-983	1021	3951	0	0	9504	10508	0.90	0.81	0.69
1915	6460	-25	-1033	1171	3158	0	0	9730	10789	0.90	0.79	0.67
1916	7698	-31	-1019	1439	1504	0	0	9591	10642	0.90	0.80	0.68
1917	5857	-22	-1139	714	3992	0	0	9402	10563	0.89	0.82	0.69
1918	1785	-5	-667	401	7405	0	0	8919	9591	0.93	0.87	0.76
1919	4549	-17	-863	797	4990	0	0	9456	10336	0.91	0.82	0.70
1920	1669	-5	-630	278	7856	0	0	9168	9803	0.94	0.84	0.74
1921	3524	-13	-673	702	5798	0	0	9338	10024	0.93	0.83	0.73
1922	3627	-13	-778	526	6121	0	0	9483	10274	0.92	0.81	0.71
1923	3940	-15	-650	682	5355	0	0	9312	9977	0.93	0.83	0.73
1924	1792	-5	-725	278	7708	0	0	9049	9778	0.93	0.85	0.74
1925	2078	-7	-598	333	7247	0	0	9053	9658	0.94	0.85	0.75
1926	1719	-6	-492	329	7856	0	0	9406	9903	0.95	0.82	0.73
1927	1127	-4	-229	361	7856	0	0	9111	9344	0.98	0.85	0.78
1928	2105	-6	-700	256	7422	0	0	9077	9783	0.93	0.85	0.74
1929	1156	-2	-699	239	7856	0	0	8550	9251	0.92	0.90	0.79
1930	1232	-2	-734	274	7856	0	0	8625	9362	0.92	0.89	0.78
1931	577	0	-652	289	7856	674	0	8744	9395	0.93	0.88	0.77
1932	490	0	-462	297	7856	266	0	8445	8908	0.95	0.91	0.82
1933	939	-2	-457	297	7856	0	0	8632	9092	0.95	0.89	0.80
1934	1518	-4	-630	275	7856	0	0	9015	9649	0.93	0.86	0.75
1935	2978	-10	-735	473	6108	0	0	8813	9558	0.92	0.88	0.76
1936	2670	-9	-629	563	6371	0	0	8965	9604	0.93	0.86	0.76
1937	3709	-14	-635	672	5127	0	0	8859	9507	0.93	0.87	0.77
1938	4937	-19	-1017	960	4693	0	0	9554	10590	0.90	0.81	0.69
1939	1592	-4	-700	250	7856	0	0	8994	9698	0.93	0.86	0.75
1940	1295	-4	-322	446	7646	0	0	9060	9387	0.97	0.85	0.78
1941	8543	-34	-1109	2022	1189	0	0	10611	11754	0.90	0.73	0.62
1942	7152	-29	-960	1495	2446	0	0	10104	11093	0.91	0.76	0.66
1943	4886	-18	-1070	937	4558	0	0	9292	10381	0.90	0.83	0.70
1944	2838	-10	-576	610	6371	0	0	9233	9819	0.94	0.84	0.74
1945	4160	-15	-862	805	4990	0	0	9077	9954	0.91	0.85	0.73
1946	4029	-15	-862	802	4890	0	0	8844	9721	0.91	0.87	0.75
1947	1111	-2	-580	325	7360	0	0	8213	8795	0.93	0.94	0.83
1948	7525	-30	-884	1294	1273	0	0	9180	10093	0.91	0.84	0.72
1949	3368	-11	-1087	661	5733	0	0	8664	9762	0.89	0.89	0.75
1950	4442	-17	-757	784	4505	0	0	8957	9731	0.92	0.86	0.75
1951	5475	-22	-885	1302	3648	0	0	9518	10425	0.91	0.81	0.70
1952	4981	-19	-963	1024	3987	0	0	9011	9993	0.90	0.86	0.73
1953	5963	-23	-1048	1088	3158	0	0	9138	10209	0.90	0.84	0.71
1954	3698	-13	-929	677	5130	0	0	8564	9505	0.90	0.90	0.77
1955	5456	-20	-980	720	3643	0	0	8819	9819	0.90	0.88	0.74
1956	5234	-20	-904	1130	3861	0	0	9302	10226	0.91	0.83	0.71
1957	4072	-15	-870	818	4770	0	0	8775	9660	0.91	0.88	0.75
1958	5476	-21	-901	1132	4105	0	0	9790	10712	0.91	0.79	0.68
1959	5164	-20	-946	1089	3708	0	0	8995	9960	0.90	0.86	0.73
1960	4816	-17	-1177	830	4693	0	0	9144	10338	0.88	0.84	0.70
1961	4576	-17	-809	839	4990	0	0	9578	10405	0.92	0.81	0.70
1962	644	0	-560	308	7856	0	0	8247	8808	0.94	0.94	0.83
1963	4166	-16	-809	841	4744	0	0	8927	9751	0.92	0.86	0.75
1964	2333	-7	-735	483	6296	0	0	8370	9113	0.92	0.92	0.80
1965	2709	-9	-751	491	6278	0	0	8718	9478	0.92	0.89	0.77
1966	524	0	-491	328	7856	0	0	8217	8707	0.94	0.94	0.84
1967	3851	-15	-650	684	5310	0	0	9181	9845	0.93	0.84	0.74
1968	3946	-14	-865	808	4984	0	0	8858	9738	0.91	0.87	0.75
1969	3776	-14	-755	890	4990	0	0	8886	9656	0.92	0.87	0.75
1970	2224	-7	-733	386	6834	0	0	8704	9443	0.92	0.89	0.77
1971	3842	-15	-702	926	4990	0	0	9041	9758	0.93	0.85	0.75
1972	6444	-25	-966	1205	2432	0	0	9090	10081	0.90	0.85	0.72
1973	1452	-3	-726	382	7283	0	0	8387	9117	0.92	0.92	0.80
1974	5683	-23	-842	1432	3158	0	0	9409	10273	0.92	0.82	0.71

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 3b. 5100 AF Water Rights Purchase from OID, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Cana to 90 cfs, Provide Instream Flows for Steelhead and Chinook with Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	4716	-19	-691	1147	4003	0	0	9156	9866	0.93	0.84	0.74
1976	4151	-15	-961	827	4711	0	0	8714	9690	0.90	0.89	0.75
1977	1190	-2	-699	247	7856	0	0	8591	9293	0.92	0.90	0.78
1978	6443	-26	-858	1172	2512	0	0	9242	10126	0.91	0.84	0.72
1979	1452	-3	-714	281	7767	0	0	8782	9500	0.92	0.88	0.77
1980	5090	-20	-784	1357	4239	0	0	9881	10686	0.92	0.78	0.68
1981	4768	-18	-820	913	4440	0	0	9283	10121	0.92	0.83	0.72
1982	7629	-31	-1025	1612	1838	0	0	10024	11079	0.90	0.77	0.66
1983	7471	-30	-1002	1970	1671	0	0	10080	11111	0.91	0.77	0.65
1984	6236	-25	-960	1482	2951	0	0	9685	10669	0.91	0.80	0.68
1985	1557	-4	-699	274	7856	0	0	8984	9687	0.93	0.86	0.75
1986	1362	-4	-561	295	7757	0	0	8849	9414	0.94	0.87	0.77
1987	2291	-8	-664	502	6729	0	0	8850	9522	0.93	0.87	0.76
1988	3281	-12	-672	707	5799	0	0	9102	9786	0.93	0.85	0.74
1989	3520	-13	-674	811	5472	0	0	9116	9803	0.93	0.85	0.74
1990	5294	-21	-732	1153	3977	0	0	9672	10425	0.93	0.80	0.70
1991	4642	-17	-969	739	4807	0	0	9201	10188	0.90	0.84	0.71
1992	1613	-5	-491	329	7380	0	0	8826	9322	0.95	0.87	0.78
1993	5030	-19	-802	836	3677	0	0	8723	9543	0.91	0.88	0.76
1994	4665	-17	-1144	697	5246	0	0	9447	10607	0.89	0.82	0.69
1995	4580	-18	-857	1078	4393	0	0	9177	10051	0.91	0.84	0.72
1996	5511	-21	-1017	965	4132	0	0	9570	10608	0.90	0.81	0.69
1997	6351	-25	-992	1315	2993	0	0	9642	10659	0.90	0.80	0.68
1998	8030	-32	-1070	1733	2145	0	0	10807	11908	0.91	0.71	0.61
1999	8004	-32	-1091	1214	1577	0	0	9672	10795	0.90	0.80	0.67
2000	5750	-22	-1124	872	3835	0	0	9312	10457	0.89	0.83	0.70
2001	1517	-4	-699	245	7856	0	0	8915	9618	0.93	0.87	0.76
2002	4487	-16	-1051	591	5212	0	0	9223	10290	0.90	0.84	0.71
Average	**4064**	**-15**	**-819**	**806**	**5092**	**9**	**0**	**9137**	**9972**	**0.917**	**0.847**	**0.732**
Maximum	**8543**	**0**	**-229**	**2022**	**7856**	**674**	**0**	**10807**	**11908**	**0.975**	**0.940**	**0.836**
Minimum	**490**	**-34**	**-1177**	**239**	**1189**	**0**	**0**	**8213**	**8707**	**0.884**	**0.714**	**0.611**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 3c. 5100 AF Water Rights Purchase from OID, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with No Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	6871	-28	-891	640	2327	0	0	8919	9838	0.91	0.87	0.74
1905	7434	-30	-930	947	1497	0	0	8919	9879	0.90	0.87	0.74
1906	6290	-26	-830	909	2576	0	0	8919	9775	0.91	0.87	0.74
1907	6948	-28	-826	840	1985	0	0	8920	9773	0.91	0.87	0.74
1908	5210	-21	-669	695	3705	0	0	8920	9611	0.93	0.87	0.76
1909	7472	-30	-866	568	1775	0	0	8919	9815	0.91	0.87	0.74
1910	6238	-25	-747	371	4330	0	0	10167	10938	0.93	0.76	0.67
1911	6363	-26	-794	534	4990	0	0	11067	11886	0.93	0.70	0.61
1912	6457	-26	-796	811	2890	0	0	9335	10158	0.92	0.83	0.72
1913	6921	-28	-832	762	3217	0	0	10042	10901	0.92	0.77	0.67
1914	7048	-29	-902	815	3379	0	0	10311	11242	0.92	0.75	0.65
1915	7651	-31	-962	908	2925	0	0	10491	11484	0.91	0.74	0.63
1916	8422	-34	-1020	1126	1047	0	0	9542	10596	0.90	0.81	0.69
1917	7340	-30	-877	596	3760	0	0	10789	11696	0.92	0.72	0.62
1918	2816	-11	-313	157	7742	0	0	10390	10714	0.97	0.74	0.68
1919	6089	-25	-765	432	4990	0	0	10721	11510	0.93	0.72	0.63
1920	3653	-15	-401	163	7856	0	0	11256	11671	0.96	0.69	0.62
1921	5938	-24	-741	485	5007	0	0	10665	11430	0.93	0.72	0.64
1922	5568	-22	-661	417	6112	0	0	11414	12097	0.94	0.68	0.60
1923	6248	-25	-727	519	4637	0	0	10652	11404	0.93	0.72	0.64
1924	3329	-13	-364	171	7856	0	0	10979	11356	0.97	0.70	0.64
1925	4435	-18	-519	157	6805	0	0	10860	11397	0.95	0.71	0.64
1926	4153	-17	-458	157	7856	0	0	11692	12166	0.96	0.66	0.60
1927	3672	-15	-400	233	7856	0	0	11346	11761	0.96	0.68	0.62
1928	4829	-19	-525	203	6608	0	0	11096	11640	0.95	0.70	0.63
1929	2234	-9	-332	154	7856	0	0	9903	10244	0.97	0.78	0.71
1930	2914	-11	-554	94	7856	0	0	10299	10864	0.95	0.75	0.67
1931	3125	-12	-487	125	7856	0	0	10606	11105	0.96	0.73	0.66
1932	2243	-9	-304	139	7856	0	0	9925	10238	0.97	0.78	0.71
1933	2692	-11	-315	155	7856	0	0	10377	10703	0.97	0.74	0.68
1934	3386	-13	-479	125	7856	0	0	10874	11366	0.96	0.71	0.64
1935	6369	-25	-787	167	4252	0	0	9976	10788	0.92	0.77	0.67
1936	4335	-17	-512	318	5998	0	0	10121	10650	0.95	0.76	0.68
1937	5150	-21	-601	442	4649	0	0	9619	10241	0.94	0.80	0.71
1938	6022	-25	-808	746	4635	0	0	10570	11403	0.93	0.73	0.64
1939	3277	-13	-361	157	7856	0	0	10916	11290	0.97	0.71	0.64
1940	3806	-15	-441	157	7105	0	0	10612	11068	0.96	0.73	0.66
1941	9349	-38	-1113	1731	633	0	0	10561	11713	0.90	0.73	0.62
1942	8478	-35	-1049	1246	1965	0	0	10606	11689	0.91	0.73	0.62
1943	5795	-23	-715	673	4284	0	0	10014	10752	0.93	0.77	0.68
1944	4625	-19	-544	405	6168	0	0	10635	11198	0.95	0.73	0.65
1945	5302	-21	-668	593	4612	0	0	9818	10507	0.93	0.79	0.69
1946	5247	-21	-656	515	4198	0	0	9283	9960	0.93	0.83	0.73
1947	2493	-10	-311	193	6557	0	0	8922	9243	0.97	0.87	0.79
1948	8134	-33	-930	736	1012	0	0	8919	9882	0.90	0.87	0.74
1949	3825	-16	-545	549	5378	0	0	9191	9752	0.94	0.84	0.75
1950	6561	-26	-794	393	3455	0	0	9589	10409	0.92	0.80	0.70
1951	7366	-30	-944	992	2306	0	0	9690	10664	0.91	0.80	0.68
1952	5785	-24	-755	865	3283	0	0	9154	9933	0.92	0.84	0.73
1953	6494	-26	-806	647	2996	0	0	9305	10137	0.92	0.83	0.72
1954	4017	-16	-491	393	5018	0	0	8921	9428	0.95	0.87	0.77
1955	5875	-24	-697	286	3976	0	0	9416	10137	0.93	0.82	0.72
1956	6502	-27	-857	808	3158	0	0	9585	10469	0.92	0.81	0.70
1957	5070	-21	-671	594	4113	0	0	9085	9777	0.93	0.85	0.74
1958	7189	-29	-925	886	3599	0	0	10720	11674	0.92	0.72	0.62
1959	5636	-23	-721	759	3317	0	0	8968	9711	0.92	0.86	0.75
1960	5087	-21	-651	513	4990	0	0	9918	10589	0.94	0.78	0.69
1961	6256	-25	-783	483	4976	0	0	10907	11715	0.93	0.71	0.62
1962	1153	-5	-126	162	7856	0	0	9040	9171	0.99	0.85	0.79
1963	5777	-23	-715	346	4001	0	0	9385	10123	0.93	0.82	0.72
1964	3658	-15	-425	273	5431	0	0	8921	9361	0.95	0.87	0.78
1965	3641	-15	-443	159	6371	0	0	9713	10171	0.95	0.79	0.72
1966	1026	-4	-112	157	7856	0	0	8923	9039	0.99	0.86	0.81
1967	7148	-29	-864	378	3707	0	0	10341	11233	0.92	0.75	0.65
1968	4309	-17	-565	585	4990	0	0	9302	9884	0.94	0.83	0.74
1969	4518	-18	-585	538	4724	0	0	9176	9780	0.94	0.84	0.74
1970	3542	-14	-428	217	6607	0	0	9924	10366	0.96	0.78	0.70
1971	4569	-18	-596	509	4990	0	0	9453	10067	0.94	0.82	0.72
1972	7251	-30	-893	868	1722	0	0	8919	9842	0.91	0.87	0.74
1973	1329	-5	-145	182	7835	0	0	9195	9346	0.98	0.84	0.78
1974	6406	-26	-908	811	2849	0	0	9132	10066	0.91	0.85	0.72

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 3c. 5100 AF Water Rights Purchase from OID, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Upgrade Feeder Canal to 90 cfs, Provide Instream Flows for Steelhead Only with No Channel Rehabilitation.

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	6491	-26	-788	954	2575	0	0	9205	10020	0.92	0.84	0.73
1976	5647	-23	-709	632	3372	0	0	8920	9652	0.92	0.87	0.75
1977	2231	-9	-251	157	7856	0	0	9985	10244	0.97	0.77	0.71
1978	8042	-32	-949	511	1780	0	0	9351	10333	0.90	0.83	0.70
1979	2524	-10	-274	256	7856	0	0	10351	10635	0.97	0.75	0.68
1980	7339	-30	-1005	908	3195	0	0	10407	11442	0.91	0.74	0.64
1981	6353	-26	-804	786	3738	0	0	10047	10877	0.92	0.77	0.67
1982	8548	-35	-1024	1302	1355	0	0	10145	11205	0.91	0.76	0.65
1983	7946	-33	-953	1677	805	0	0	9443	10428	0.91	0.82	0.70
1984	7171	-29	-922	1120	2318	0	0	9658	10609	0.91	0.80	0.69
1985	3050	-12	-331	274	7856	0	0	10836	11180	0.97	0.71	0.65
1986	2996	-12	-335	157	7668	0	0	10474	10821	0.97	0.74	0.67
1987	4449	-18	-559	157	5965	0	0	9994	10571	0.95	0.77	0.69
1988	5224	-21	-665	498	5070	0	0	10105	10791	0.94	0.76	0.67
1989	4946	-20	-634	641	4960	0	0	9894	10547	0.94	0.78	0.69
1990	7264	-29	-893	937	3114	0	0	10393	11316	0.92	0.74	0.64
1991	5674	-23	-686	585	4713	0	0	10264	10973	0.94	0.75	0.66
1992	2986	-12	-323	157	7533	0	0	10342	10677	0.97	0.75	0.68
1993	6744	-27	-812	517	2498	0	0	8920	9759	0.91	0.87	0.75
1994	6296	-26	-839	604	4896	0	0	10931	11796	0.93	0.71	0.62
1995	6143	-25	-876	670	3505	0	0	9416	10318	0.91	0.82	0.71
1996	7081	-29	-905	805	3642	0	0	10594	11528	0.92	0.73	0.63
1997	7410	-30	-930	919	2582	0	0	9950	10910	0.91	0.78	0.67
1998	9357	-38	-1140	1590	1919	0	0	11688	12867	0.91	0.66	0.57
1999	9307	-38	-1124	951	1159	0	0	10255	11417	0.90	0.75	0.64
2000	7085	-29	-900	764	3291	0	0	10211	11139	0.92	0.76	0.65
2001	3082	-12	-339	157	7856	0	0	10743	11095	0.97	0.72	0.66
2002	5314	-21	-648	157	5858	0	0	10659	11329	0.94	0.72	0.64
Average	**5445**	**-22**	**-675**	**552**	**4679**	**0**	**0**	**9979**	**10676**	**0.935**	**0.778**	**0.685**
Maximum	**9357**	**-4**	**-112**	**1731**	**7856**	**0**	**0**	**11692**	**12867**	**0.987**	**0.865**	**0.805**
Minimum	**1026**	**-38**	**-1140**	**94**	**633**	**0**	**0**	**8919**	**9039**	**0.898**	**0.660**	**0.566**

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 4. No Action Alternative, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Feeder Canal at 30 cfs, No Instream Flow Requirements

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1904	13166	-52	-1480	950	0	0	0	12584	14116	0.89	0.90	0.76
1905	12492	-50	-1403	1546	0	0	0	12584	14038	0.90	0.90	0.76
1906	12732	-51	-1426	1329	0	0	0	12584	14061	0.90	0.90	0.76
1907	12565	-50	-1405	1475	0	0	0	12585	14039	0.90	0.90	0.76
1908	12823	-50	-1426	1238	0	0	0	12585	14061	0.90	0.90	0.76
1909	12643	-49	-1351	1046	297	0	0	12585	13985	0.90	0.90	0.77
1910	15372	-61	-1731	1077	0	0	0	14657	16448	0.89	0.77	0.65
1911	16321	-64	-1776	1376	297	0	0	16154	17994	0.90	0.70	0.59
1912	12907	-51	-1384	1507	297	0	0	13276	14711	0.90	0.85	0.73
1913	14495	-57	-1567	1283	297	0	0	14450	16074	0.90	0.79	0.67
1914	15166	-60	-1712	1504	0	0	0	14898	16671	0.89	0.76	0.64
1915	15377	-61	-1747	1629	0	0	0	15197	17006	0.89	0.75	0.63
1916	13539	-54	-1535	1670	0	0	0	13620	15209	0.90	0.83	0.70
1917	16388	-65	-1858	1227	0	0	0	15693	17615	0.89	0.72	0.61
1918	7610	-31	-852	445	7856	0	0	15028	15910	0.94	0.76	0.67
1919	15688	-62	-1702	1357	297	0	0	15578	17342	0.90	0.73	0.62
1920	9161	-37	-1032	518	7856	0	0	16466	17535	0.94	0.69	0.61
1921	14107	-55	-1475	1233	1678	0	0	15487	17017	0.91	0.73	0.63
1922	15590	-61	-1648	1171	1678	0	0	16730	18439	0.91	0.68	0.58
1923	7852	-32	-880	670	7856	0	0	15465	16377	0.94	0.73	0.65
1924	9631	-39	-1114	562	6965	0	0	16005	17158	0.93	0.71	0.62
1925	9934	-40	-1158	669	6405	0	0	15809	17008	0.93	0.72	0.63
1926	9784	-40	-1105	697	7856	0	0	17192	18336	0.94	0.66	0.58
1927	8916	-36	-1003	884	7856	0	0	16616	17656	0.94	0.68	0.61
1928	8940	-36	-1006	448	7856	0	0	16202	17244	0.94	0.70	0.62
1929	6870	-28	-767	291	7856	0	0	14222	15017	0.95	0.80	0.71
1930	7771	-31	-877	264	7856	0	0	14982	15890	0.94	0.76	0.67
1931	8181	-33	-919	355	7856	0	0	15440	16392	0.94	0.74	0.65
1932	6813	-27	-760	403	7856	0	0	14284	15072	0.95	0.79	0.71
1933	7559	-31	-846	471	7856	0	0	15009	15886	0.94	0.76	0.67
1934	16547	-65	-1860	1260	0	0	0	15883	17808	0.89	0.71	0.60
1935	7840	-32	-900	558	6874	0	0	14341	15273	0.94	0.79	0.70
1936	13960	-55	-1478	1109	1044	0	0	14580	16113	0.90	0.78	0.66
1937	12332	-49	-1277	1062	1678	0	0	13746	15072	0.91	0.83	0.71
1938	15683	-62	-1772	1479	0	0	0	15328	17162	0.89	0.74	0.62
1939	8622	-35	-969	427	7856	0	0	15901	16905	0.94	0.71	0.63
1940	7750	-31	-868	692	7856	0	0	15397	16297	0.94	0.74	0.66
1941	14533	-58	-1594	2183	253	0	0	15316	16968	0.90	0.74	0.63
1942	15270	-61	-1740	1920	0	0	0	15389	17190	0.90	0.74	0.62
1943	14817	-58	-1667	1310	0	0	0	14402	16127	0.89	0.79	0.66
1944	7819	-32	-876	670	7856	0	0	15436	16344	0.94	0.74	0.65
1945	14138	-55	-1521	1219	297	0	0	14077	15654	0.90	0.81	0.68
1946	13243	-52	-1417	1116	297	0	0	13188	14657	0.90	0.86	0.73
1947	4951	-20	-545	345	7856	0	0	12587	13152	0.96	0.90	0.81
1948	12341	-49	-1343	1338	297	0	0	12584	13977	0.90	0.90	0.77
1949	13725	-53	-1527	889	0	0	0	13034	14614	0.89	0.87	0.73
1950	12294	-48	-1271	1045	1678	0	0	13697	15016	0.91	0.83	0.71
1951	13785	-55	-1551	1687	0	0	0	13866	15472	0.90	0.82	0.69
1952	13211	-52	-1479	1295	0	0	0	12975	14506	0.89	0.87	0.74
1953	13190	-52	-1424	1214	297	0	0	13225	14701	0.90	0.86	0.73
1954	12823	-50	-1369	885	297	0	0	12586	14005	0.90	0.90	0.76
1955	12629	-50	-1325	840	1316	0	0	13410	14785	0.91	0.85	0.72
1956	13733	-54	-1528	1498	43	0	0	13691	15274	0.90	0.83	0.70
1957	12914	-50	-1379	1078	297	0	0	12860	14289	0.90	0.88	0.75
1958	15682	-62	-1775	1732	0	0	0	15578	17415	0.89	0.73	0.61
1959	12532	-49	-1343	1228	297	0	0	12665	14057	0.90	0.90	0.76
1960	14857	-58	-1671	1115	0	0	0	14242	15972	0.89	0.80	0.67
1961	15871	-63	-1723	1505	297	0	0	15888	17674	0.90	0.71	0.61
1962	5166	-21	-569	352	7856	0	0	12783	13373	0.96	0.89	0.80
1963	13460	-53	-1445	1098	297	0	0	13358	14856	0.90	0.85	0.72
1964	6122	-25	-704	488	6704	0	0	12587	13315	0.95	0.90	0.80
1965	14576	-57	-1647	1029	0	0	0	13901	15605	0.89	0.82	0.69
1966	4929	-20	-542	365	7856	0	0	12587	13149	0.96	0.90	0.81
1967	15020	-59	-1627	1317	297	0	0	14947	16634	0.90	0.76	0.64
1968	13271	-52	-1420	1123	297	0	0	13219	14691	0.90	0.86	0.73
1969	12887	-50	-1376	1253	297	0	0	13010	14436	0.90	0.87	0.74
1970	6805	-27	-759	380	7856	0	0	14254	15041	0.95	0.80	0.71
1971	13352	-52	-1431	1303	297	0	0	13470	14953	0.90	0.84	0.72
1972	12369	-49	-1332	1300	297	0	0	12585	13966	0.90	0.90	0.77
1973	13653	-53	-1510	949	0	0	0	13039	14602	0.89	0.87	0.73
1974	12694	-51	-1428	1723	0	0	0	12938	14417	0.90	0.88	0.74

Appendix D-7. Summary of Annual Totals or Annual Averages for OID Irrigation Delivery Data

Model Run 4. No Action Alternative, Shellrock at 25 cfs (No WAC Instream Flow Restrictions on Pumping From Okanogan), Feeder Canal at 30 cfs, No Instream Flow Requirements

Year	Salmon Creek Diversion	Canal Seepage Loss	Canal Spill Loss	Pumpage from Duck Lake	Pumpage from Shellrock at Okanogan	Critical Period Shortage	Pumpage from New Station at Okanogan River	Total Irrigaton Delivery	Total Demand From System	Delivery Efficiency	Maximum On-Farm Efficiency	Minimum On-Farm Efficiency
1975	12654	-50	-1354	1512	297	0	0	13060	14464	0.90	0.87	0.74
1976	12997	-51	-1446	1085	0	0	0	12585	14082	0.89	0.90	0.76
1977	6950	-28	-776	352	7856	0	0	14353	15157	0.95	0.79	0.71
1978	13128	-52	-1417	1346	297	0	0	13302	14771	0.90	0.85	0.72
1979	8395	-34	-969	527	7042	0	0	14961	15964	0.94	0.76	0.67
1980	14939	-59	-1690	1869	0	0	0	15059	16808	0.90	0.75	0.64
1981	14388	-57	-1551	1382	297	0	0	14459	16067	0.90	0.78	0.67
1982	14397	-58	-1636	1921	0	0	0	14624	16318	0.90	0.78	0.66
1983	12862	-52	-1459	2105	0	0	0	13456	14966	0.90	0.84	0.72
1984	13671	-55	-1544	1742	0	0	0	13813	15412	0.90	0.82	0.69
1985	16467	-63	-1808	1173	0	0	0	15769	17639	0.89	0.72	0.61
1986	7756	-31	-869	455	7856	0	0	15166	16067	0.94	0.75	0.67
1987	6888	-28	-769	423	7856	0	0	14371	15167	0.95	0.79	0.71
1988	13180	-52	-1367	1116	1678	0	0	14555	15974	0.91	0.78	0.67
1989	12698	-50	-1311	1188	1678	0	0	14204	15564	0.91	0.80	0.69
1990	13509	-53	-1420	1538	1462	0	0	15035	16509	0.91	0.75	0.65
1991	14510	-57	-1548	1097	817	0	0	14818	16424	0.90	0.77	0.65
1992	7460	-30	-835	496	7856	0	0	14947	15812	0.95	0.76	0.68
1993	12339	-49	-1319	1076	538	0	0	12585	13953	0.90	0.90	0.77
1994	16650	-65	-1882	1226	0	0	0	15929	17876	0.89	0.71	0.60
1995	13218	-52	-1416	1364	297	0	0	13411	14879	0.90	0.85	0.72
1996	15723	-62	-1777	1485	0	0	0	15369	17208	0.89	0.74	0.62
1997	14015	-56	-1521	1563	297	0	0	14299	15876	0.90	0.79	0.67
1998	16912	-68	-1945	2289	0	0	0	17188	19201	0.90	0.66	0.56
1999	15016	-60	-1704	1554	0	0	0	14806	16570	0.89	0.77	0.65
2000	15268	-60	-1725	1249	0	0	0	14731	16516	0.89	0.77	0.65
2001	8319	-34	-934	407	7856	0	0	15615	16582	0.94	0.73	0.65
2002	14586	-57	-1532	800	1678	0	0	15476	17064	0.91	0.73	0.63
Average	**12229**	**-48**	**-1348**	**1101**	**2414**	**0**	**0**	**14348**	**15745**	0.91	0.80	0.68
Maximum	**16912**	**-20**	**0**	**2289**	**7856**	**0**	**0**	**17192**	**19201**	0.96	0.90	0.81
Minimum	**4929**	**-68**	**0**	**264**	**0**	**0**	**0**	**12584**	**13149**	0.89	0.66	0.56

APPENDIX E:
Water Quality Criteria

APPENDIX E -- WATER QUALITY CRITERIA FOR CLASS A (EXCELLENT) FROM STATE OF WASHINGTON DEPARTMENT OF ECOLOGY

(i) Fecal coliform organisms:

(A) Freshwater – fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

(ii) Dissolved oxygen:

(A) Freshwater – dissolved oxygen shall exceed 8.0 mg/L.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 18.0 degrees C (freshwater) or 16.0 degrees C (marine water) due to human activities. When natural conditions exceed 18.0 degrees C (freshwater) and 16.0 degrees C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 degrees C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T+7) (freshwater) or t=12/(T-2) (marine water). Incremental temperature increases resulting from non-point source activities shall not exceed 2.8 degrees C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a human-caused variation within the above range of less than 0.5 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

APPENDIX F:
Socioeconomics Resource Report

Socioeconomic Analysis of Salmon Creek Rehabilitation PDEIS

Resource Report

Socioeconomic Analysis of Salmon Creek Rehabilitation PDEIS

Resource Report

Prepared for

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August 18, 2003

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Introduction

Background

The Colville Confederated Tribes (Tribes) have received funds from the Bonneville Power Administration's Fish and Wildlife program to investigate the feasibility of restoring and rehabilitating Salmon Creek, located in Okanogan County, Washington. The goal of such restoration efforts is to enhance anadromous salmonid populations in Salmon Creek. A proposed action has been identified to examine alternatives for rehabilitation of Salmon Creek, and in particular to examine water supply options for creating flows favorable to salmon. The primary existing user of Salmon Creek water, and predominant affected party, is the Okanogan Irrigation District (OID), which claims water rights to a large portion of its natural flow. The formal examination of these action alternatives are presented in this Programmatic Draft Environmental Impact Statement (PDEIS).

The water supply alternatives include two options for substituting Okanogan River water in the OID for Salmon Creek water. The options reflect either the enhancement of an existing pump (the "Shellrock alternative") or the construction of an entirely new pump system (the "Pump Exchange alternative"). A third water supply alternative involves the purchase and permanent use of a portion of the OID's water rights. The water use alternatives reflect three separate enhancement options. The first would provide passage flows for steelhead. The second would provide passage flows for both steelhead and Chinook salmon. The third is called a rehabilitation option, and provides for year-round flows that benefit both passage and rearing of steelhead and Chinook.

Purpose and Scope

The purpose of the study is to conduct a socioeconomic analysis of the proposed action alternatives for rehabilitation of Salmon Creek and restoration of flows therein. The purpose of this report is to provide a resource and documentation of the analysis, and to serve as the information base for the socioeconomic sections of the PDEIS. The analysis examines various components of economic impacts distinctly, and includes the following elements:

- Determination of the effects of the proposed actions on the OID;
- Property value and tax base impacts;
- Regional and indirect impacts on the communities and Okanogan County; and
- Recreation impacts and nonmarket benefits associated with reoperation of reservoirs on Salmon Creek.

In addition, water rights and other related elements are presented in this report. They include:

- A description of the characteristics of the Okanogan Irrigation District;
- The construction of an agricultural impacts model of the OID; and
- A detailed examination of the water right purchase alternative, including transfer programs, case studies, and issues affecting implementation.

The scope of the analysis is limited to the action alternatives examined in the PDEIS, and the geographic region of Okanogan County.

Organization of the Report

The remainder of this report contains seven additional sections. They include a characterization of the OID, followed by a description of an agricultural impacts model constructed to determine impacts to OID. This includes a description of the agricultural land base under the No Action Alternative.

The next section provides an examination of the property tax system in Okanogan County and determination of the tax base impacts to be realized as a result of the proposed action alternatives. The section which follows contains a description of both the economic base for Okanogan County and the regional impacts model constructed for Okanogan County. Issues associated with the water purchase alternative are presented in the next section. This includes a discussion of existing water transfer programs, case studies involving water purchases, and issues associated with Washington's water transfer rules.

The next to last section provides an analysis of the impacts of the proposed action alternatives. This includes the direct impacts on affected parties, with a particular focus on OID. An analysis is also provided of the regional and indirect impacts of the action alternatives. The final section provides an analysis of the recreation impacts of the water supply alternatives, with a particular focus on the reoperation of Conconully Reservoir and Salmon Lake. The economic effects associated with anticipated changes in recreation activity are discussed qualitatively as compared to the No Action Alternative. Finally, the section contains a discussion of the nonmarket benefits associated with improved flows as they affect Salmon Creek.

Document Okanogan Irrigation District (Task 3230)

Okanogan Irrigation District Characteristics

The Okanogan Irrigation District (OID) in Okanogan County, Washington, was authorized in 1905 to serve 10,000 acres. Currently, OID consists of 5,032 assessed acres near the Okanogan River. Irrigation water is primarily supplied to the district through a diversion from Salmon Creek, a tributary to the Okanogan River. Two storage facilities, Conconully Reservoir and Salmon Lake, store Salmon Creek flows and are operated to meet downstream irrigation demand within the district. Supplemental water supplies are pumped directly from the Okanogan River at the Shellrock pumping station and from Duck Lake when Salmon Creek supplies are inadequate to meet irrigation demands.

The Salmon Creek diversion dam, located approximately 12 miles downstream from Conconully Reservoir, diverts water from Salmon Creek into the Main Canal. The Main Canal is 7.6 miles of open concrete lined canal that runs along the western border of the district. Water is diverted from the Main Canal into five laterals consisting of more than 44 miles of closed, pressurized pipeline. The maximum capacity of the Main Canal is estimated to be 80 cubic feet per second (cfs).

OID has more than 600 member accounts with assessable acres ranging from approximately 0.2 acres to 230 acres per account. The average assessed acreage per account in the district is 8.2 acres and the median is 3.5 acres. While the district supports a large number of full-time producers, part-time producers with primary sources of income other than farming manage much of the irrigated acreage. In addition, an increasing share of the district is being converted from commercial agricultural production to rural/residential uses with parcels smaller than five acres. According to OID crop reports, urban lands served by district water supplies increased from 115 acres in 1990 to approximately 550 acres in 1998. This trend toward smaller acreages within the district has continued in recent years. Currently, nearly one-third of the district's annual assessment fees are paid by members with less than five acres served by district water supplies.

Crops in OID consist primarily of tree fruits and forage crops. Approximately half of the assessed acres in the district are planted to tree fruits. Apples are the most prevalent tree fruit in the district, followed by pears and cherries. In addition, more than 1,300 acres are planted to pasture and hay crops.

Financial Conditions and Repayment Obligations

The projected total 2003 assessment for OID is approximately $650,000. Assessment charges vary according to the size of the account. Small acreages receiving OID service are generally assessed at a higher rate than larger acreages. In addition, small acreage accounts are charged a fixed fee that varies according to size category rather than a fixed per acre fee. In addition to the variable assessment fee, each account is charged a fixed fee of $50 per acre. Table 1 shows how district charges vary with acreage. On average, each assessed acre is projected to pay approximately $129 in 2003.

Table 1
Okanogan Irrigation District Assessment Schedule, 2003

Acres	Assessment
0.01-1.00	$142
1.01-1.50	$213
1.51-2.40	$284
Remaining Acres	$120/acre

Source: Tom Sullivan, Okanogan Irrigation District.

In addition to assessments, OID receives revenue from a variety of sources including grants, interest, and charges to domestic well users benefiting from groundwater recharge at Duck Lake. Planned expenditures for 2003 include approximately $500,000 for operations and maintenance, $65,000 for debt repayment associated with the Shellrock facility, and nearly $240,000 in rehabilitation and betterment bond payments. Debt obligations are projected to remain relatively constant at approximately $60 per acre through 2013 but will decline to less than $14 following repayment of the rehabilitation and betterment bond in 2014.

Develop Agricultural Production Model for OID (Task 3231)

Current Crop Production and Markets

Agricultural production within OID consists primarily of orchard crops. Apples are the most commonly produced tree fruit and are planted to more acres than any other crop produced in the district. Common apple varieties found in the district include Red Delicious, Golden Delicious, Gala, and Braeburn, among others. Pears and cherries are other important crops but are grown on fewer acres than apples. Growers in the district have increased the acreage of pears substantially due to poor apple market conditions in recent years. Similarly, cherry acreage has doubled in OID during the last five years but still represents a relatively small amount of district acreage. Other, less hardy tree fruit has not increased in acreage substantially, however. Climate conditions within OID make the production of less winter hardy tree fruits more risky and tend to limit variety choice even among apples. Stone fruits, such as apricots and peaches, tend to be more susceptible to freeze damage and are not commonly grown within OID.

While orchard crops generate a major share of crop revenues within OID, forage crops are produced on a large portion of the district's irrigated acres. Hay and pasture production has generally been increasing over the last decade as orchard crops have been removed due to depressed prices and land has been subdivided and converted to small acreage rural/residential sites. Many of these rural/residential sites maintain small pastures or hay fields to support livestock on the property.

Table 2 provides the cropping history for OID from 1991 through 1998 as well as current estimates collected from parcel records maintained by the Okanogan County Assessor's Office. Currently, an estimated 3,907 acres (harvested acreage plus young trees) are irrigated compared to 4,317 acres in 1990. Although total apple acreage has declined by nearly 700 acres since 1990, total orchard acreage in production (including young trees) declined by only 315 acres over the same period as producers shifted from apples to other tree fruits.

Table 2
Crop Production in Okanogan Irrigation District, Selected Years, 1990-Present

	1990	1991	1992	1994	1995	1996	1998	Current
Harvested Acreage								
Alfalfa/Other Hay	534	539	539	554	636	636	610	473
Pasture	828	808	808	876	805	805	800	870
All Apples	2,289	2,222	2,222	2,250	2,173	2,173	1,810	1,586
Red Delicious								*660*
Golden Delicious								*287*
Other Varieties								*638*
Apricots	3							4
Cherries	8	8	8	25	15	15	50	107
Peaches	31	31	31	25	17	17	10	5
Pears	458	456	456	450	260	260	260	436
Other Crops								30
Family Plots	106	113	113	24	127	127		
Total Harvested Acreage	**4,257**	**4,177**	**4,177**	**4,204**	**4,061**	**4,061**	**3,550**	**3,510**
Acres Not Harvested								
Cropland (young trees)	60	69	69	32	174	174	602	397
Fallow or Idle	470	571	571	365	301	96	76	321
Roads, ditches, drains	136	100	100	96	96	301	255	255
Urban/Suburban Lands	115	121	121	335	400	400	549	549
Total Acres Not Harvested	**781**	**861**	**861**	**828**	**971**	**971**	**1,482**	**1,522**
Total Assessed Acreage	**5,038**	**5,038**	**5,038**	**5,032**	**5,032**	**5,032**	**5,032**	**5,032**

Sources: Okanogan Irrigation District Crop Reports, 1990-1998. Okanogan County Assessor's Office.

Apple acreage by variety has not been historically collected and reported by OID.[1] Current apple variety information was obtained by reviewing Assessor field notes for each district parcel at the Okanogan County Assessor's Office. In total, 660 acres of Red Delicious, 287 acres of Golden Delicious, and 638 acres of other apple varieties remain in the district. This variety mix is consistent with a recent fruit survey of the Wenatchee District, which includes OID, conducted by the Washington Agricultural Statistics Service. The 2001 survey reported that of the 54,000 acres in the Wenatchee District, 41.5 percent were planted to Red

1 Personal communication with Tom Sullivan, OID Manager, March 2003.

Delicious, 16.5 percent were planted to Golden Delicious, and 42 percent were planted to other apple varieties.[2] Since 1993, Red Delicious acreage has declined by more than 25 percent throughout Washington State, while Golden Delicious acreage has shown only a slight decline. Total Washington State apple acreage was estimated at 192,000 acres in 2001, compared to 172,000 acres in 1993. Current estimates place Washington's total apple crop at 175,000 acres.[3]

Orchardists have pulled a significant portion of the older varieties of apple trees in Okanogan County, and throughout the state. One local expert estimates that growers have removed the trees on 15 percent of the apple acreage in Okanogan County, primarily consisting of Red and Golden Delicious. Some of this acreage has not yet been replanted to trees or other crops and remains fallow. This trend is more dramatic in the northern fruit growing areas of the county including OID, where there tends to be colder sites that are less attractive for fruit production than other available land in the region.[4] Within OID, approximately 25 to 30 percent of the apple acreage with older, less marketable varieties has been pulled in recent years, with nearly half of the acreage currently not replanted to tree crops.

Crop Value

The estimated market value of agricultural products sold in the county in 1997 was $133.5 million, primarily from crop production. An estimated 568 farms contain nearly 30,000 acres of orchard crops in Okanogan County.[5] In comparison, Washington State reported more than 300,000 acres in orchards. Washington State is the leading U.S. producer of apples and pears, producing approximately 50 percent of total U.S. apple and pear crops.[6] Orchard crops are labor and input intensive relative to many other irrigated crops. As a result, a large portion of the regional economy is comprised of industries that directly support orchard production with labor and input supply, as well as industries that process, package, and market the harvested fruit.

The total value of crops grown in OID in 2002 is estimated to be $12,152,039 (see Table 3). This estimate is based on 2002 crop prices and current crop information collected at the Okanogan County Assessor's Office and supplemented with historic crop reports provided by

2 Washington Agricultural Statistics Service, "Washington Fruit Survey 2001."

3 Tom Schotzko, "Apple Outlook, 2002 Crop," Washington State University Cooperative Extension.

4 Personal communication with Dan McCarthy, Okanogan County Pest Control, April 30, 2003.

5 USDA, "1997 Census of Agriculture."

6 Northwest Horticultural Council, May 2003.

OID to account for parcels without crop information provided. Value per acre is based on the farm level rather than retail price of each crop.

Apples accounted for 37.5 percent of crop acres and contributed nearly 72 percent to total farm revenues within the district. Conversely, pasture and hay comprised 30 percent of the acres, but 4 percent of value. Pears are the second highest revenue crop in the district, earning 17.8 percent of the value from 10.3 percent of the acreage. Lastly, cherries make up 2.5 percent of the acres and 5.9 percent of value.

Table 3
Crop Acres, Value per Acre, and Total Crop Value, Okanogan Irrigation District, 2002

Crop	Acres	Value/Acre	Total Value	Percent of Acres	Percent of Value
Alfalfa	372	$810	$301,646	8.8%	2.5%
Other Hay	101	$845	$84,930	2.4%	0.7%
Pasture	870	$435	$375,638	20.6%	0.8%
Apples	1,586	$5,381	$8,533,949	37.5%	71.9%
Pears	436	$4,842	$2,111,724	10.3%	17.8%
Cherries	107	$6,528	$696,500	2.5%	5.9%
Apricots	4	$3,132	$12,234	0.1%	0.1%
Peaches	5	$6,895	$35,419	0.1%	0.3%
Other Minor Crops	30	$-	$-	0.7%	0.0%
Young Trees	397	$-	$-	9.4%	0.0%
Fallow/Idle	321	$-	$-	7.6%	0.0%
Total	**4,228**		**$12,152,039**	**100.0%**	**100.0%**

Note: Totals may appear not to add precisely due to rounding.

Source: Washington Growers Clearing House, May 2003, Washington State Agricultural Statistics Service.

Apple prices vary considerably by variety. As shown on Figure 1, Red Delicious prices have been consistently below other varieties over the last five years. According to published Washington crop budgets for Red Delicious, the breakeven price is approximately $13.20 per pack. As shown below, the average price did not reach the breakeven level between 1997 and 2002. Furthermore, there has only been one year in the last decade that the Red Delicious price has exceeded $13.00.[7] Some newer Red Delicious crops are able to earn a profit because of high quality fruit production. However, older trees, which represent the majority of Red Delicious acres in Washington State and OID, generally have a lower

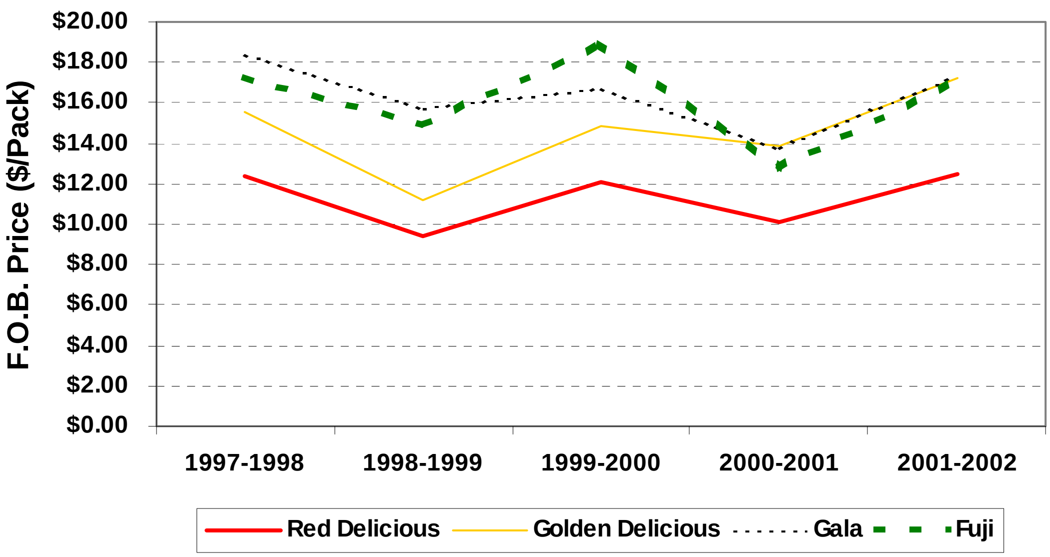
7 Washington Growers Clearing House, May 2003.

packout of high quality fruit and earn lower prices. On average, Red Delicious producers have experienced estimated net losses of approximately $1,000 per acre in recent years.[8]

Golden Delicious is a marginal performing apple variety with prices high enough in some years to earn a profit, but below breakeven levels in others. Much of the acreage consists of trees more than 20 years old which can make it difficult to produce and market the highest quality fruit. The estimated breakeven price for Golden Delicious is $13.09. Average prices were above breakeven levels in four of the last five years and average net returns for Golden Delicious with good yields have been approximately $450 per acre in recent years. However, older trees, with lower yields and less high quality fruit, have generally experienced losses.

Other apple varieties such as Gala and Fuji earn higher prices and tend to be more profitable than Red and Golden Delicious. For example, the average estimated net returns to Gala and Fuji production have been $1,328 and $793 per acre, respectively.

Figure 1
Washington Apple Prices by Variety, 1997-2002



Source: Washington Growers Clearing House, May 2003.

Pear prices in Washington have remained relatively stable over the last five years. Figure 2 shows pear prices by variety from 1997 through 2002. Prices have ranged from $12.57 to $17.37 with D'Anjou pear prices lagging behind Bartlett and Bosc. The estimated breakeven price for Bartlett and Bosc is $15.68 and $14.43 for D'Anjou. Consequently, pear production has been profitable in recent years. The average net return across all varieties is estimated to

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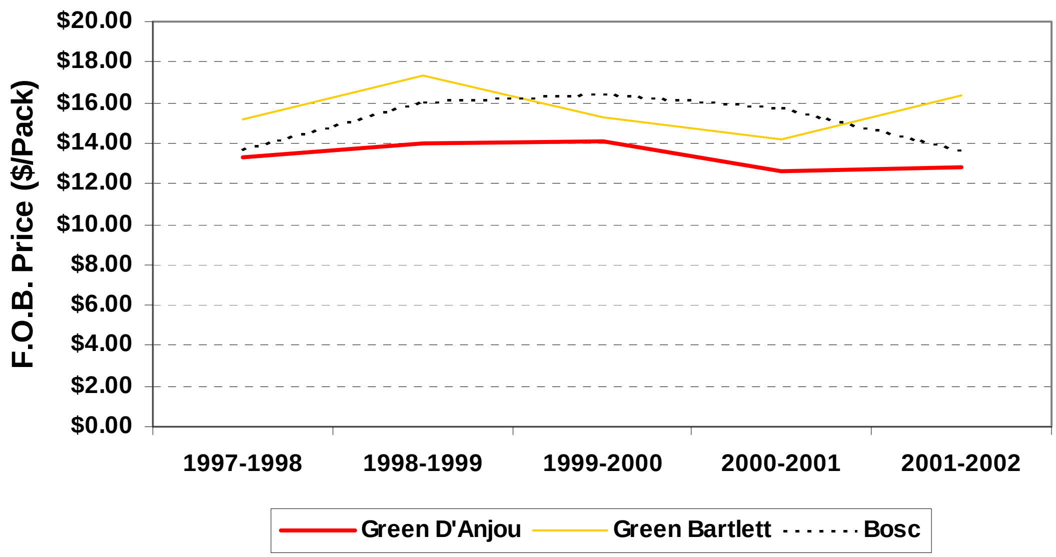
8 Derived from crop budgets assembled by Jim DuBruille, Wenatchee Valley College, and Washington State University Cooperative Extension.

be $201 per acre. Average prices for the major crops produced within OID are summarized in Table 4.

Figure 2
Washington Pear Prices by Variety, 1997-2002



Source: Washington Growers Clearing House, May 2003.

Table 4
Selected Crop Prices, 1987-2001

Year	Apples ($/ton)	Cherries ($/ton)	Bartlett Pears ($/ton)	Winter Pears ($/ton)	Alfalfa Hay ($/ton)	Other Hay ($/ton)
1997	$328	$1,430	$262	$280	$111	$136
1998	$230	$1,310	$290	$267	$98	$123
1999	$342	$1,730	$228	$341	$107	$135
2000	$258	$1,630	$254	$267	$120	$139
2001	$354	$1,360	$216	$316	$112	$142
Average	**$302**	**$1,492**	**$250**	**$294**	**$110**	**$135**

Source: Washington State Agricultural Statistics Service and Washington Growers Clearing House.

Agricultural Production Model

An economic model describing agricultural production in OID was developed in order to estimate how the water supply alternatives are likely to affect crop choice, crop production, district revenues, and profits. The model utilizes annual water delivery information estimated by the Water Allocation Model to estimate changes in irrigated acreage, cropping pattern, and total district production resulting from changes in district water supply. The "objective" of the model is to maximize annual profits from total crop production within the district. Water supply shortage criteria were incorporated into the economic model in order to determine the maximum irrigable acres that can be supported by the annual water supply estimated by the Water Allocation Model. Outputs from the model for each action alternative include the acreage, production, gross revenues, costs and profits for each crop.

Nine irrigated crop types are included in the model, based upon current and historic crop production in the district. The crops are alfalfa hay, other hay, pasture, apples, pears, cherries, apricots, peaches, and "other" crops.[9] Apple acres are allocated to variety according to OID apple variety information collected at the Okanogan County Assessor's Office. In addition, each variety is further disaggregated according to tree age categories in order to account for differences in the marketable quantity of fruit harvested from older versus younger trees. The age classification was accomplished using information provided by the recent tree fruit survey of the Wenatchee District conducted by Washington Agricultural Statistics Service. Other, non-agricultural uses of OID assessed acres such as young tree, urban yards, and fallow lands are included in the model as well.

Crop prices used in the model are the average prices from 1997 through 2001 reported by Washington Agricultural Statistics Service and Washington Growers Clearing House. Production costs for each crop were obtained from budgets published by Washington State University Cooperative Extension and Jim DuBruille of Wenatchee Valley College. The crop budgets were adjusted to reflect growing conditions and production costs faced by growers receiving OID water. Crop yields were obtained from a variety of sources including OID, Washington Agricultural Statistics Service, and knowledgeable experts. Table 5 provides crop price, average yield, production costs, and gross and net returns for each harvested crop included in the economic model. The figures shown do not include owner-operator labor.

In general, there are many sources of variation in per acre farm profits. The values presented in the table are intended to reflect "average" producers within the district. Actual yields, production costs, and net returns to ownership could be higher or lower for individual growers than the values shown. In addition, growers that are able to produce the highest quality fruit can earn higher prices than those presented.

9 Peaches, apricots, and other minor crops within the district are not explicitly modeled and are assumed to remain fixed under each alternative.

Table 5
Crop Prices, Yields, Costs, and Returns Used in the Agricultural Production Model

Crop	Units	Avg. Yield	Price ($/Unit)	Gross Return per Acre	Variable Costs per Acre	Fixed Costs per Acre	Total Costs per Acre	Net Profit (Loss) per Acre
Alfalfa (tons)	Tons	7.0	$109.50	$766.50	$505.77	$222.12	$727.89	$38.61
Other Hay (tons)	Tons	6.5	$135.00	$877.50	$620.44	$226.11	$846.55	$30.95
Pasture (tons consumed)[1/]	Tons	3.2	$135.00	$432.00	$282.81	$136.88	$419.68	$12.32
Apples (bins)[2/]								
Red Delicious (Pre 1981)	Bins	34.0	$72.19	$2,454.48	$2,360.00	$1,410.00	$3,770.00	-$1,315.52
Golden Delicious (Pre 1981)	Bins	36.0	$101.57	$3,656.34	$2,475.00	$1,410.00	$3,885.00	-$228.66
Other Apples (Pre 1981)	Bins	34.0	$151.85	$5,162.96	$2,898.00	$2,042.00	$4,940.00	$222.96
Red Delicious (1981-1985)	Bins	38.0	$72.19	$2,743.24	$2,460.00	$1,410.00	$3,870.00	-$1,126.76
Golden Delicious (1981-1985)	Bins	41.0	$101.57	$4,164.17	$2,600.00	$1,410.00	$4,010.00	$154.17
Other Apples (1981-1985)	Bins	36.0	$151.85	$5,466.66	$2,948.00	$2,042.00	$4,990.00	$476.66
Red Delicious (Post 1985)	Bins	40.0	$72.19	$2,887.63	$2,510.00	$1,410.00	$3,920.00	-$1,032.38
Golden Delicious (Post 1985)	Bins	45.0	$101.57	$4,570.43	$2,700.00	$1,410.00	$4,110.00	$460.43
Other Apples (Post 1985)	Bins	38.0	$151.85	$5,770.36	$2,998.00	$2,042.00	$5,040.00	$730.36
Cherries (tons)	Tons	4.9	$1,492.00	$7,322.74	$3,222.55	$2,620.20	$5,842.75	$1,479.99
Pears (bins)	Bins	31.8	$141.91	$4,509.03	$2,898.00	$1,410.00	$4,308.00	$201.03

[1/] Pasture yields are converted to the estimated tons of grass hay (dry matter) consumed by livestock. The yield is valued at the same price as grass hay.

[2/] Apples are divided into three tree age categories: those that were planted prior to 1981, those planted between 1981 and 1985, and trees planted after 1985.

Sources: Washington Growers Clearing House; Washington Agricultural Statistics; Washington State University Cooperative Extension; Jim DuBruille, Wenatchee Valley College.

Constraints reflecting historic changes in cropping patterns are incorporated in the model in order to reflect physical limits on suitable land for orchard and hay crops, as well as marketing limits for crops such as cherries and pears. In addition, lower bounds were placed on crop and non-crop acres assessed by OID to reflect current land use characteristics. For example, there are many landowners that are part-time farmers and manage small irrigated plots of five acres or less. These smaller plots, which are often associated with rural/residential use, have land prices that exceed the per acre market price of commercial agricultural land within OID. Furthermore, the small plots are not managed as a primary source of income and use is unlikely to be responsive to any changes presented by the water supply alternatives. Consequently, lower bounds reflecting the total acreage in each crop farmed on small plots (five acres or less) are incorporated into the model structure. Similar constraints are placed on OID assessed acres that are currently being used for urban yards/gardens, roads, ditches, and drains.

The Water Allocation Model provides annual irrigation delivery and crop water demand estimates for each model year. By comparing water delivery to water demand and incorporating irrigation conveyance and application efficiency information, it is possible to determine the estimated water shortage or surplus for each model year. Shortage criterion developed by the Bureau of Reclamation are applied to the annual district water supply data provided by the Water Allocation Model in order to determine the sustainable irrigated acreage in the district. The shortage criterion allow for a maximum 50 percent water shortage in a single year and a ten-year maximum cumulative shortage of 100 percent.

Acreage Base and Cropping Pattern under the No Action Alternative

Apple production within OID and much of eastern Washington is currently in a transitional period. Poor fruit prices for some prevalent varieties caused by overproduction, international competition, and quality considerations have prompted growers to shift to alternative crops, including other tree fruits, new apple varieties, and annual crops. Currently, some acreage within OID that has historically produced tree fruits is idle as producers decide what crops to plant. Other acreage with trees removed is being used for forage crops either as a temporary or permanent crop change. Because these shifts are currently taking place within the district, a projected baseline that differs from the current cropping pattern is used to represent the No Action Alternative. The projected baseline is determined through crop and acreage shifts estimated by the agricultural production model. Table 6 compares the current crop acreage with the crop acres applied to the No Action Alternative.

Table 6
Comparison of Current Crop Acres with No Action Alternative Acres

Crop	Current Acres	No Action Alternative
Hay	473	636
Pasture	870	970
Apples	1,586	1,467
Red Delicious	*660*	*185*
Golden Delicious	*287*	*98*
Other Apples	*638*	*1,184*
Pears	436	449
Cherries	107	213
Apricots	4	4
Peaches	5	5
Other Minor Crops	30	30
Young Trees	397	377
Urban Yards/Gardens	549	549
Fallow/Idle	321	76
Roads, Ditches, and Drains	255	255
Total	**5,032**	**5,032**

The projected baseline (No Action Alternative) contains a higher number of acres in pasture and hay crops, fewer apple acres, and more pear and cherry acres. These changes are consistent with current trends in the district and reflect the transition from less profitable Red and Golden Delicious to other crops and apple varieties. Overall acreage devoted to orchard crops is projected to decline slightly from 2,535 to 2,515 acres. Acreages in minor crops and urban yards/gardens were held constant.

Property Value and Tax Base Implications

Introduction

There are several facets to the taxation of an agricultural enterprise in the State of Washington. Farmland can be taxed at its highest and best use value. In Okanogan County this is considered its market value for agricultural production. Under state law, agricultural land can also be taxed as "open space." If the agricultural land is planted to perennial plants, such as orchards and vineyards, the trees and vines may be taxed. Personal property, such as farm machinery and irrigation systems, is also taxed. All of these facets of taxation are discussed below.

Taxation on Open Space Agricultural and Farm Land

In 1970, the Washington State legislature enacted the "Open Space Law" (Chapter 84.34 of the Revised Code of Washington (RCW)), which includes the "Open Space Taxation Act." This Act "…allows property owners to have their open space, farm and agricultural, and timberlands valued at their current use rather than their highest and best use."[10]

Eligibility

Agricultural and farm land must meet the following requirements to be eligible for the "Open Space Taxation Act" and its "current use" tax provision:[11]

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[10] Washington State Department of Revenue, January 1993, "Open Space Taxation Act."

[11] Washington State Department of Revenue, January 1993, "Open Space Taxation Act."

- Contiguous 20 acres or greater parcels either used primarily for livestock or agricultural production for commercial purposes or enrolled in a U.S. Department of Agricultural cropland retirement program;

- Parcel(s) between 5 and 20 acres principally devoted to agricultural uses which produce $100 or more per acre per year for three of five calendar years if classified before 1993, or $200 or more per acre per year for three of five calendar years if classified in or after 1993;

- Parcel(s) less than five acres primarily used for agriculture that produces $1,000 or more per year in three of five calendar years if classified before 1993, and $1,500 or more per year if classified in or after 1993.

- Uses associated with agricultural purposes providing these uses do not exceed 20 percent of the classified land;

- Noncontiguous parcel(s) between one to five acres that is part of the farming operations; and

- Land used by owners and employees for their principal place of residence.

Valuation Method

Open space farm and agricultural land is assessed at its true and fair value in the following manner:

- Assessors use the "net cash rental" valuation, an average of three years of annual rent on other farm and agricultural land of similar quality and location.[12]

- The assessed value is capitalized at typical rates after subtracting establishment, production, harvest, and delivery costs from the assessed value. [13]

- Component for property taxes equals a figure obtained by dividing the assessed value of all property in the county into the property taxes levied within the county in the year preceding the assessment and multiplying the quotient obtained by one hundred.[14]

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12 Washington State Legislature, 2003, "RCW 84.34.065."

13 Okanogan Assessor's Office, February 2003, "Current Use/Open Space Agriculture."

14 RCW 84.34.065.

Valuation of Open Space Agricultural and Farm Land

The Department of Revenue uses code numbers to identify the different types of land use.[15] The code numbers, corresponding land use description, and assessed value per acre are presented in Table 7.

Table 7
Open Space Agricultural and Farm Land Values

Land Use Code	Land Use	2002 Current Use Valuation per acre*	2003 Current Use Valuation per acre**
831	Orchard	$600	$672
832	Irrigated Alfalfa	$400	$500 to $921
833	Dryland Alfalfa	$100	$129
834	Improved Pasture	N/A	N/A
835	Irrigated Pasture	$150	$200
836	Range Land	$6	$6
837	Dryland Grain	$100	$100

*Okanogan County Assessor valuation, January 30, 2002.

**Okanogan County Assessor valuation, January 29, 2003.

Taxation of Perennial Plants, including Orchards and Grapes

For tax purposes, crops are divided into two classifications: 1) growing crops (tax exempt) and 2) perennial plants (taxable). To distinguish between the two groups, the Washington Department of Revenue states that "growing crops" are grown from soil for annual production, and "perennial plants" produce fruit or some other vegetation that are harvested annually.[16] Fruit orchards and grape vineyards are considered perennial plants.

When the perennial plants qualify the land for farm and agricultural classification, the assessor needs to determine if the market dictates that the perennial plant has a true and fair market value, irrespective of the highest and best use of the land. If this is the case, that value

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15 Department of Revenue, April 1999, "Land Use Codes"

16 State of Washington, Department of Revenue, October 2002, "Property Tax Advisory."

is the improvement value when the land is classified as farm and agricultural land.[17] Table 8 provides the valuation for different types of perennial plants.

Table 8
Valuation of Perennial Plants

Fruit Types	Value Per Acre
Apple	$1,000
Pear	$1,500
Cherry	$2,000
Stone Fruits	$1,000
Wine Grape Vines	$1,000

Under certain circumstances, perennial plants may have true and fair value of zero as a result of limited yields of the plants or change in market conditions for the crop.[18] In Okanogan County, orchards are taxed a flat rate because of current poor markets for the varieties of apples commonly grown.[19] In addition, Red and Golden Delicious trees more than 16 years old are not taxed.

Taxation on Agricultural and Farm Land Not Meeting the "Open Space" Criteria

Agricultural and farm land in Okanogan County that does not meet the criteria listed above is assessed using market value (comparable sales). This results in a wide range of values as sales in different areas vary.[20]

Irrigated Land Values

In recent years, the market value of land with water rights in Okanogan County and within OID has declined dramatically. Currently, it is estimated that bare ground with OID water rights is selling at between $1,000 and $2,000 per acre compared to $6,000 per acre in the mid-to late-1990s. However, the majority of the recent transactions are "forced sales" prompted by foreclosure. In general, there are few buyers in the market relative to the

[17] State of Washington, Department of Revenue, October 2002, "Property Tax Advisory."

[18] State of Washington, Department of Revenue, October 2002, "Property Tax Advisory."

[19] Personal communication with Jim White, Chief Appraiser, Okanogan County, April 8, 2003.

[20] Personal communication with Jim White, Chief Appraiser, Okanogan County, June 11, 2003.

availability of land. One local expert indicated that land with water rights outside of the district is selling for a higher price due to the relative ease in transferring of water rights to new lands and new uses, whereas such transfers of irrigation district water rights are more difficult to accomplish.[21] The low market value of irrigated land within OID has resulted in a conversion from commercial agricultural to rural/residential use in some areas of the district. These subdivided parcels, which retain rights to OID water, tend to sell for a significantly higher per acre price than land remaining in agricultural use.[22]

Non-Irrigated Land Values

Non-irrigated parcels in OID are assessed using market values. There are approximately 80 parcels of land in the district that are larger than five acres and designated as agricultural or farm land not classified as open space or undeveloped land. The average market value per acre for these parcels is $3,054, with values ranging from a low of $567 per acre to a high of $11,571 per acre. The wide range of value contained in this data set limits its use for analytical purposes.

Personal Property Valuation on Agriculture and Farm Lands

Agricultural and farm equipment that is not licensed is subject to the personal property tax.[23] The Department of Revenue assesses the value of personal property by starting with the original cost of the item. The "Index to Personal Property Valuation Indicators" and "2003 Personal Property Valuation Percent Good Indicators" determine the depreciation and economic life of personal property including tractors, combines, and irrigation systems. The minimum value factor is 20 percent which is used to value personal property in the years following the economic life of the property.[24] Much of the agricultural and farm equipment in the study area has already reached its economic life and is taxed at 20 percent of its initial value. The tax impacts that might result from reductions in farm equipment associated with crop acreage changes were not quantified in this analysis as it is unclear how much of this property, if any, would leave the local area. Agricultural personal properties have the following economic life and depreciation rates:

- Tractors have an economic life of 12.5 years with 12 percent depreciation annually until the minimum 20 percent is reached at 12.5 years.

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[21] Personal communication with Richard Witt, Appraiser, June 16, 2003.

[22] Personal communication with Jim White, Chief Appraiser, Okanogan County, May 2003.

[23] Personal communication with Jim White, Chief Appraiser, Okanogan County, April 8, 2003.

[24] State of Washington, Department of Revenue, December 2002, "2003 Personal Property Valuation Guidelines for Assessing Property as of January 1, 2003."

- Combines have an economic life of seven years with 20 percent deprecation annually until the minimum 20 percent is reached at seven years.

- Irrigation systems have an economic life of eight years with 18 percent depreciation annually until the minimum 20 percent is reached at eight years.[25]

Levy Rate

The levy rate is the rate per $1,000 of assessed value used to determine the property tax; that is, the assessed value of your property multiplied by the levy rate for the area that a property lies within determines the annual amount of property taxes. This amount can change from year to year based on changes in assessed value and/or the levy rate.[26] The levy rate is found in the Taxing Code Authority database for Okanogan County and ranges between 12.81 and 14.65 for the parcels discussed in this report.[27] For purposes of analysis the average levy rate, 13.73, is used.

Summary of Valuation

The appraised values for agricultural land vary widely in the assessment database. The objective of this study is to provide some measure of how changing agricultural land from irrigated to non-irrigated would affect the tax base and thereby, taxes. The methods used to value open space use (Table 7) offer the best chance of making a meaningful comparison of this. As presented in this table, irrigated cropland is valued from $500 to $921 per acre. For analytical purposes, a mid-range value of $725 per acre is used. Non-irrigated cropland is valued between $100 to $129 per acre and a mid-range value of $125 is used. Thus, when an acre changes from an irrigated status to a non-irrigated status but remains in agricultural production, its use value changes $600.

Conclusion

Agricultural enterprises are taxed in a number of different ways as described above. Agricultural personal property and perennial plants in the study area are not a factor in considering tax changes. It is assumed that the equipment defined as agricultural personal

25 State of Washington, Department of Revenue, December 2002, "Index to Personal Property Valuation Indicators" and "Combined Table—2003 Personal Property Valuation Percent Good Indicators."

26 Okanogan County Assessor's Office, February 2003, www.okanagancounty.org/Assessor.

27 Okanogan County Assessor's Office, 2003, "2003 Levy Rates Okanogan County."

property would continue to be utilized within Okanogan County. In addition, it is assumed that land affected by irrigation curtailment or water right transfers consists of annual and perennial crops that are not taxable.

The taxation for agricultural land only is thus the main focus, based on the effects of reducing irrigation for those lands. The only effects resulting from alternatives to the No Action Alternative were from the Water Purchase Alternative. Under the Water Purchase Alternative, 1,470 acres of irrigated cropland would shift to non-irrigated cropland. Using the value change of $600, this would result in a value change of $882,000. Using the levy rate of 13.73, this would reduce tax revenues by $12,110. It should be mentioned that if budgets for entities in the levy districts do not change, this reduction results in a redistribution of the tax burden among taxpayers.

Regional Economic Impacts Model (Task 3233)

Economic Base of Okanogan County

Study Region Definition

For the purposes of this analysis, the study region is defined as Okanogan County, Washington. Okanogan County is Washington's largest county in terms of land area, with nearly 3.4 million acres.[28] About 30 percent of the land within the county is in private ownership. The Colville Indian Reservation occupies approximately 700,000 acres of the county, and is located in the southeast corner of the county. The remainder of the land area is made up of state and federal land.[29]

Economic Base Information

IMPLAN Base Information

An input-output (I-O) model has been developed for this study, incorporating economic activity in Okanogan County. The model is used to measure the indirect effect that changes in crop production may have on the regional economy, in terms of changes in industry output, employment, and income. The model is based on IMPLAN ("IMpact analysis for PLANning"), a system of software and data used to perform economic impact analysis. Originally developed by the USDA Forest Service, the system is now maintained and

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[28] 3,371,698 acres, according to U.S. Department of Agriculture, *1997 Census of Agriculture*.

[29] "Okanogan County Demographics," from the Okanogan County website, http://www.okanogancounty.org /DEMO.HTM, accessed June 9, 2003.

marketed by the Minnesota IMPLAN Group, Inc. (MIG). The databases are developed by MIG annually, using data collected at the national, state, and county level for all possible elements from a variety of state and federal sources. The model developed for this study is based on 2000 data, the most recently available at the time of this analysis.

Table 9 displays the base data for the Okanogan County IMPLAN model developed for this study. Three different economic measures are presented here and will be referenced when discussing impacts later in this report. "Output" (also known as total industry output) is the first measure, and represents the value of production of goods and services by businesses in the local economy. This can serve as an overall measure of the local economy, and is useful for comparing regions and looking at impacts.

The second measure is "Personal Income," which is the sum of employee compensation and proprietor income. Employee compensation represents total payroll costs, including wages and salaries paid to workers plus benefits such as health insurance, as well as retirement payments and non-cash compensation. Proprietor income includes payments received by self-employed individuals as income, such as income received by private business owners, doctors, or lawyers. This measure is useful to show how the employees and proprietors of businesses producing the output share in the fortunes of those businesses. The third measure is "Employment." This represents the annual average number of employees, whether full- or part-time, of the businesses producing the output.

Table 9
2000 Okanogan County IMPLAN Model

Industry	**Output** *($millions)*	**Income** *($millions)*	**Employment** *(# of jobs)*
Agriculture, Forestry, and Fishing	$202.329	$94.907	5,480
Mining	$17.024	$3.843	92
Construction	$119.066	$33.523	1,081
Manufacturing	$159.396	$40.709	1,172
Transportation, Communication, and Public Utilities	$56.535	$16.636	450
Trade (Retail and Wholesale)	$161.580	$72.227	4,165
Finance, Insurance, and Real Estate	$206.812	$22.947	1,062
Services	$223.606	$115.075	5,152
Government	$216.778	$156.300	4,618
Other[1/]	-$0.743	$1.232	119
TOTAL	**$1,362.383**	**$557.401**	**23,391**

[1/] For this model, "other" consists primarily of domestic services (such as cleaning and maid services), as well as an "inventory valuation adjustment," used to estimate the value of goods removed from inventory that were produced in a previous time period at a different value.

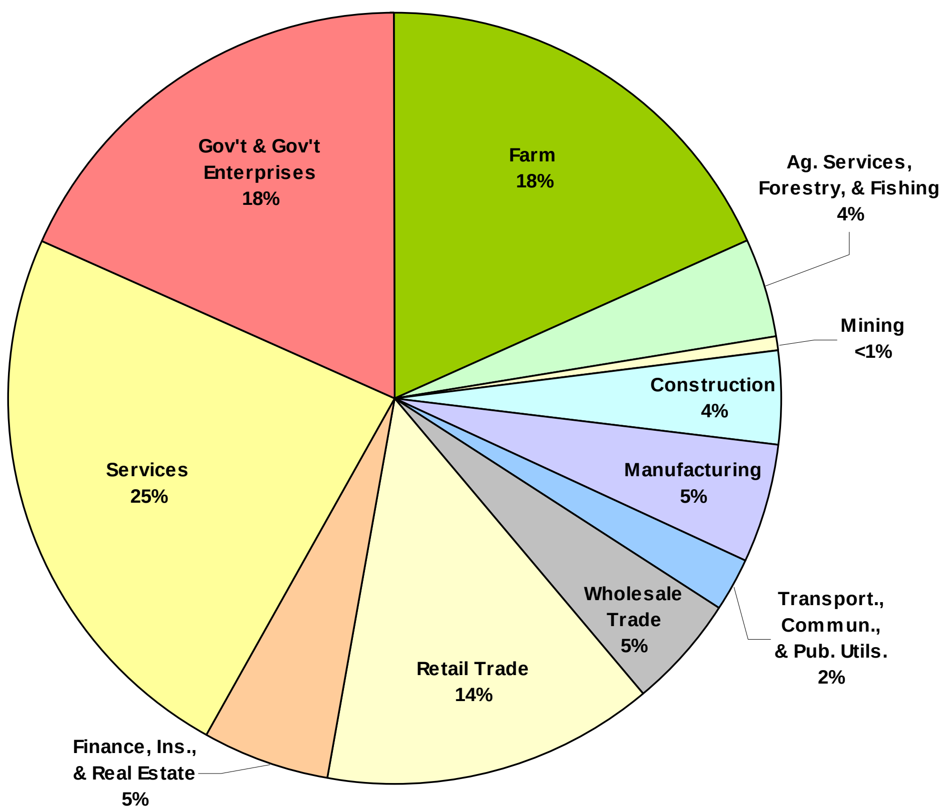
Source: 2000 IMPLAN data from Minnesota IMPLAN Group, Inc., with modifications by NEA.

Nearly $1.4 billion in goods and services are produced within Okanogan County, with local industry supporting over 23,000 jobs and earnings in excess of $557 million. The most significant industries in terms of output, each accounting for about 15 to 16 percent of the total county output, are services; government; finance, insurance, and real estate; and agriculture, forestry, and fishing. Nearly 5,500 jobs, or 23 percent of county employment, are in the agriculture, forestry, and fishing industry, making it the largest employer in the county. Other significant employers are services, government, and wholesale and retail trade.

Employment and Earnings

Employment and earnings by industry are presented in Figures 3 and 4. These employment numbers from the Department of Commerce's Regional Economic Information System (REIS) count all jobs, including non-agricultural wage and salary employment, agricultural employment, and non-agricultural jobs that are not covered by state unemployment insurance, such as the self-employed. These numbers may differ slightly from the IMPLAN model data, which are compiled from a number of sources.

Figure 3
Okanogan County 2000 Employment by Industry



Source: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, May 2002, *Regional Economic Information System (REIS), 1969-2000*, CD-ROM.

The importance of agricultural production to Okanogan County's economy is evident by the large share, nearly one-quarter of total county jobs, found either on farms or in the agricultural services, forestry, and fishing sector. Over 85 percent of these agricultural jobs are in fruit orchards.[30] Apples are the prominent crop produced in Okanogan County, although other orchard crops are also grown, such as pears and cherries. Livestock production, primarily cattle, is also an important element of the county's agricultural sector.

The services sector is also a significant employer in Okanogan County, providing one-quarter of the total jobs in the county. One of the largest areas of employment in the services sector is health services, which includes private hospitals (public hospitals fall into the government category), dentist and doctor offices, nursing care facilities, and other health-related businesses.[31] Membership organizations also are significant employers in Okanogan County that belong to the services sector, and include unions, religious organizations, fraternal organizations, tribal administration, and similar groups. One of the larger employers in the county is the Colville Tribal Enterprise, which belongs to this division of the services sector.[32] Social services, such as individual and family social services, job training and vocational rehabilitation services, child day care, and residential care, and lodging services, such as hotels and motels, also provide employment within the county's services sector.

With 18 percent of employment, government is another significant employer in the county. Government is typically a large sector in all counties, but is even larger in Okanogan County due to the state and federal management of forests, parks, and dams in the county, as well as regulatory oversight of farming. Local government makes up about two-thirds of government employees, and many of these jobs are in primary and secondary education, as well as other executive and legislative work and public hospitals. A small portion of government employment is for the state, and includes employees of community colleges and social workers. The federal government has a large share, about 22 percent, of the government jobs in the county. Many of these jobs are related to the operation of the large irrigation system, while others are involved in land, mineral, or wildlife conservation.[33]

Retail and wholesale trade account for 14 and 5 percent of employment, respectively. Within the retail sector, eating and drinking establishments employ the most workers, followed by food stores and auto dealers and service stations.[34] About 80 percent of wholesale trade

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30 Washington State Employment Security Department, Labor Market and Economic Analysis Branch, September 2002, *Okanogan County Profile*, p. 18.

31 Ibid., p. 23.

32 Ibid.

33 Ibid.

34 Ibid., p. 21.

employment is related to wholesale fresh fruit and vegetable distribution, primarily for apples, but also pears, other tree fruits, grain, and livestock/meat products.[35]

The other sectors of the local economy are responsible for smaller shares of employment. Finance, insurance, and real estate provide a little over five percent of the total jobs in the county, most of these in real estate and banking. Manufacturing employment contributes slightly less than five percent of total jobs, and the majority of these jobs are in lumber and wood processing. About four percent of total county jobs are in construction, which includes special trade contractors, general building contractors, heavy construction workers, and other construction trade workers. Transportation, communication, and public utilities, with just over two percent of total employment, consists mainly of trucking and warehousing; communications such as telephone, television, or radio services; and utilities such as electric, gas, and sanitary services. About one-third of these jobs are in trucking and warehousing, related to the transportation of agricultural crops. Mining is the smallest sector in the county in terms of employment, with less than one percent of the total jobs found in this sector.

Earnings represent the sum of three components of personal income: wage and salary disbursements, other labor income (includes employer contribution to pension and profit-sharing, health and life insurance, and other non-cash compensation), and proprietors' income. Earnings reflect the amount of income that is derived directly from work and work-related factors. Earnings can be used as a proxy for the income that is generated within a geographical area by industry sectors, and can be used to identify the significant income-producing industries of a region or to show trends in industry growth or decline.

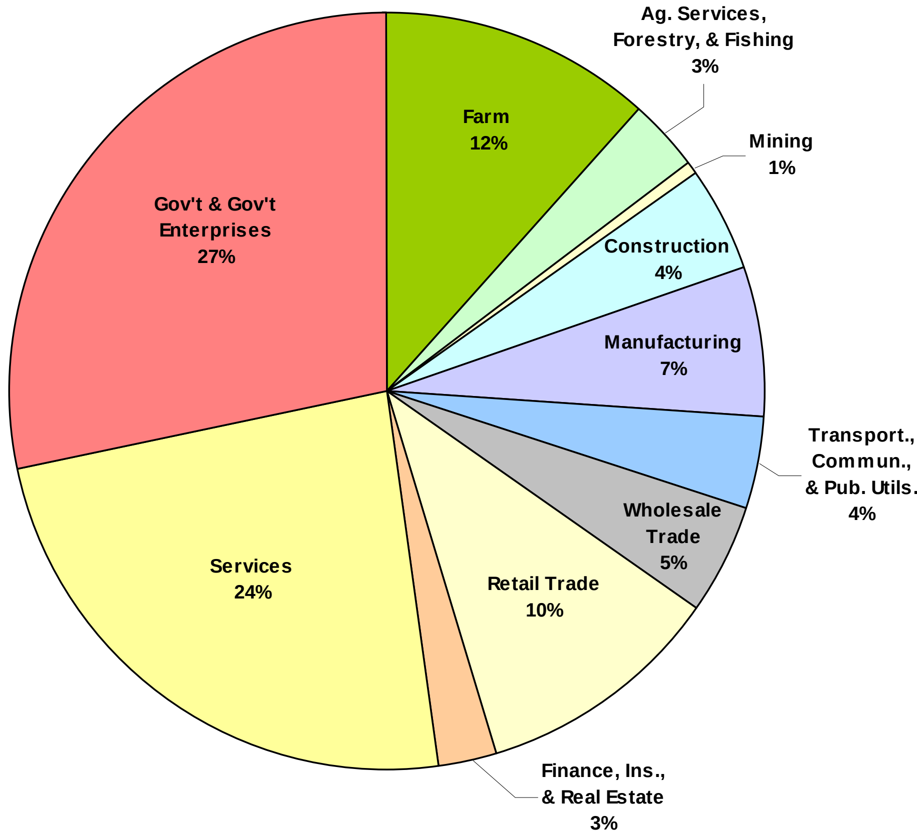
In terms of earnings, government is the largest sector in the county, with 27 percent of all earnings. The government sector accounts for just 18 percent of jobs in the county, but these jobs tend to be higher paying than those in some other sectors, such as agriculture or retail trade. The second largest county sector in terms of earnings is the services sector, contributing 24 percent of total earnings. As in the government sector, higher pay also characterizes the manufacturing and transportation, communication, and public utilities sectors, where five and two percent of total jobs, respectively, are responsible for seven and four percent of total earnings.

While agricultural jobs make up a large portion of county employment, earnings for farm and agricultural services, forestry, and fishing workers make up a lesser share of the total county earnings. Farm employment accounts for 18 percent of all jobs in the county, yet only contributes 12 percent of total earnings, and jobs in the agricultural services, forestry, and fishing sector account for four percent of total employment, yet only three percent of total earnings. The preponderance of part-time and seasonal workers in the agricultural industry,

35 Washington State Employment Security Department, Labor Market and Economic Analysis Branch, *Okanogan County Profile,* September 2002, p. 21.

as well as the tendency for wages to be lower for these jobs than those in other industries, contributes to this lesser earning power. This is also true for retail trade, where employment makes up 14 percent of total jobs, but these jobs earn just 10 percent of the county's total earnings.

Figure 4
Okanogan County 2000 Earnings by Industry



Source: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, May 2002, *Regional Economic Information System (REIS), 1969-2000*, CD-ROM.

The labor force is made up of all persons 16 years of age or older within a specific geographic area who are either working or actively looking for work. The unemployment rate is the percentage of people within this labor force who are not employed, but still actively seeking work. The unemployment rate for Okanogan County has been almost five percentage points higher than the state average in the past three decades, only falling below 10 percent during the relatively prosperous 1990s.[36] The annual average unemployment rate

36 Ibid., p. 10.

for Okanogan County was 11.6 percent in 2002, compared to a rate of 6.4 percent for Washington State.[37]

The seasonal nature of many agricultural jobs leads to a changing unemployment pattern in Okanogan County throughout the year. During the summer months, the unemployment rate typically falls, as agricultural work opportunities increase, and the unemployment rate increases in the winter months when agricultural work opportunities slacken off. This seasonality is typical of counties with agricultural or timber dependent economies.

Population

Age, race, and ethnic characteristics of the Okanogan County population, as recorded by the 2000 Census, are presented in Table 10. A total of 39,564 people lived within the county in 2000. The distribution among age groups is fairly similar to that of the state of Washington except for a slightly larger percentage, 14 percent, of county residents are over the age of 65, compared to less than 11 percent for the state, and a smaller percentage of county residents, 16 percent, belong to the age group of 20 to 34 years, compared to 21 percent for the state.[38]

The county population is predominantly white, with 75 percent of those counted by the 2000 Census identifying themselves as white. The next largest racial group is American Indian or Alaska Native, which accounts for 11 percent of the county population, likely due to the presence of the Colville Indian Reservation. Of the 4,537 people within Okanogan County that identified their race as American Indian or Alaska Native, 3,369 live on the reservation.[39] Another 10 percent of the county population identified themselves as "Some Other Race." Because the 2000 Census allowed the selection of more than one race for each person, another three percent of the county population selected "two or more races."

Hispanic origin is tallied separately from race, as a person of Hispanic origin can be of any race. Over 14 percent of the county's population identified themselves as being of Hispanic origin in the 2000 Census, as compared to 7 percent of the state population.[40] The economic

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37 Washington State Employment Security Department, Labor Market and Economic Analysis Branch, April 1, 2003, *2001 Annual Average Washington State Resident Civilian Labor Force and Employment*.

38 U.S. Census Bureau, Census 2000, *Table DP-1 Profile of General Demographic Characteristics: 2000,* Geographic Area: Washington.

39 U.S. Census Bureau, 2000 Census of Population and Housing, 2002, *Summary Population and Housing Characteristics,* PHC-1-49, Washington, p. 48.

40 U.S. Census Bureau, Census 2000, *Table DP-1 Profile of General Demographic Characteristics: 2000,* Geographic Area: Washington.

dominance of agriculture and specifically labor-intensive orchard crops such as apples and cherries in Okanogan County has drawn many laborers of Hispanic origin to the area.[41]

Table 10
Age, Race, and Ethnicity Characteristics of Okanogan County Population

Age, Race, and Ethnicity Characteristics	Number of People	Percentage of County Total
Age Group (years)		
0 to 19 years	12,012	30%
20 to 34 years	6,156	16%
35 to 44 years	5,757	15%
45 to 54 years	5,937	15%
55 to 64 years	4,145	10%
65 years and over	5,557	14%
Race		
White	29,799	75%
Black or African American	109	<1%
American Indian and Alaska Native	4,537	11%
Asian	176	<1%
Native Hawaiian and Other Pacific Islander	28	<1%
Some Other Race	3,791	10%
Two or More Races	1,124	3%
Hispanic Origin		
Hispanic	5,688	14%
Non-Hispanic	33,876	86%
TOTAL POPULATION	**39,564**	**100%**

Note: Percentages may not appear to add to 100 due to rounding.

Source: U.S. Census Bureau, Census 2000, *Table DP-1 Profile of General Demographic Characteristics: 2000,* Geographic Area: Okanogan County, California.

Most of the residents of Okanogan County, or 60 percent of the total population, live outside of the incorporated areas of the county, as shown in Table 11. The largest city is Omak, with a population of 4,721 people, or 12 percent of the county's residents. The cities of Okanogan, with a population of 2,484, and Brewster, with a population of 2,189, each account for about six percent of the county total. The other cities and towns are even smaller, with the smallest being Conconully, with only 185 residents.

41 Washington State Employment Security Department, Labor Market and Economic Analysis Branch, September 2002, *Okanogan County Profile*, p. 6.

Table 11
Okanogan County Cities and Population (2000)

City	Number of People	Percentage of County Total
Brewster	2,189	6%
Conconully	185	<1%
Coulee Dam (part)	915	2%
Elmer City	267	1%
Nespelem	212	1%
Okanogan	2,484	6%
Omak	4,721	12%
Oroville	1,653	4%
Pateros	643	2%
Riverside	348	1%
Tonasket	1,013	3%
Twisp	938	2%
Winthrop	349	1%
Incorporated	15,917	40%
Unincorporated	23,647	60%

Source: Washington State Office of Financial Management, Forecasting Division, June 28, 2002, *April 1 Population of Cities, Towns, and Counties Used for Allocation of Selected State Revenues State of Washington,* (Census 2000 series).

Economic Well-Being

Personal income is another indicator of a region's economic vitality. Personal income encompasses not only earnings, such as wages and salaries and other work-related compensation as discussed previously, but also transfer payments and investment income. Transfer payments are comprised of payments such as income maintenance, unemployment insurance, retirement benefits, and medical payments. Investment income includes interest, dividends, and rent from investments.

Per capita income is calculated by dividing the total personal income by the total population for a particular area. This figure can be used to compare regions or time periods, and is a useful indicator of the character of consumer markets and the overall economic "well-being" of area residents. Per capita income provides a good measure of how personal income is growing relative to a population, but does not necessarily indicate how that income is distributed among the population.

Okanogan County's per capita income in 2000 was $20,117, which was substantially less than that of the state of Washington, or $31,230.[42] Okanogan County ranked 34th of Washington's 39 counties in terms of per capita income, with King County reporting the highest, at $45,536.[43]

Another measure used to indicate economic well-being in a region is the percentage of people who are estimated to live below the poverty level. These data are based on national levels set for minimum income requirements for various different sizes of households. There is no correction for the variation in costs of living among areas. For example, if housing prices and food prices in a county were lower than national levels, then a family in that county with an income at the national poverty level might be better off than a family with the same income living elsewhere in the nation. However, poverty figures can be useful to permit comparison between geographic areas and time periods.

The most recent available poverty data is from the 2000 Census, and is based on income levels reported for 1999. In 1999, 1,697 families in Okanogan County were found to have incomes below the poverty level, representing 16.0 percent of all families in the county for which poverty status was determined.[44] This is much greater than the 7.3 percent of families living in poverty that was reported for the state of Washington.[45] When individual people are counted, 8,311, or 21.3 percent, of the Okanogan County residents for which poverty status was determined lived below the poverty level in 1999.[46] This is also a far greater rate than that of the state, which reported that 10.6 percent of individuals for which poverty status was determined had incomes below the poverty level in 1999.[47]

Defining Regional Impacts

Regional economic impact analysis provides for the measurement of income, industry output, and employment adjustments that occur as a result of changes in the demand for regionally produced goods and services. Measures of economic impacts are generally developed to

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42 U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, May 2002, *Regional Economic Information System (REIS), 1969-2000*, CD-ROM.

43 Ibid.

44 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Okanogan County, Washington.

45 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Washington.

46 U.S. Census Bureau, Census 2000, *Table DP-3*, *Profile of Selected Economic Characteristics: 2000*, Geographic Area: Okanogan County, Washington.

47 U.S. Census Bureau, Census 2000, *Table DP-3, Profile of Selected Economic Characteristics: 2000*, Geographic Area: Washington.

provide an indication of modifications in the level of economic activity caused by resource changes within a region. Among the most common measures of economic impacts are jobs, employment earnings, total personal income, and industry outputs associated with the sales of goods and services. Depending on whether the resource adjustments include increases or decreases in the demand for local products, changes in the economic impact measures may be either positive or negative.

The impact measures are generally developed to provide an indication of the relative magnitude of changes to economic activity in a region. Increases or decreases in the sales of goods and services provide an overall indication of the impacts to regional economic activity. Economic impact models were developed so that the economic effects of changes in crop production resulting from changes in the allocation of Salmon Creek water supplies could be quantified.

One of the most commonly used methods of quantifying regional economic changes is through the use of an input-output model. A business is linked to the regional economy through its purchase of inputs required to produce goods and services and through the sales of these goods to other businesses in the local area. The input-output model includes detailed information on the purchases of production inputs from local business, purchases of inputs from outside the region, purchases of labor inputs, and payments to management and ownership.

Direct Effects

Because the businesses within a local economy are linked together through the purchase and sales patterns of goods and services produced in the local area, an action which has a *direct* impact on one or more local industries is likely to have an *indirect* impact on many other businesses in the region. Direct impacts are the change in industry sales. These sales can be either for inputs to other industries in the region, or for final consumption by households and government in the region, or for exports from the region

For example, a decline in the production of wheat (a direct impact) will lead to a reduction in spending in the adjacent area as farms reduce production. Firms providing production inputs and support services to the farms would see a decline in their industry outputs as the demand for their products also declines. These additional effects are known as the indirect economic impacts. As household income is affected by the reductions in regional economic activity, additional impacts occur. The additional effects generated by reduced household spending are known as *induced* economic impacts.

Measuring the direct impacts is a key step in analyzing the impacts on a regional economy. Frequently, the impacts are measured in physical quantities, such as the change in the quantity of a crop that is produced or in the quantity of power generated. These physical quantities must be converted to a sales value for introduction to the input-output model.

Regional Impacts

These input-output models are used to measure these direct, indirect, and induced linkages within a regional economy. The tool most often used to measure these interrelationships is known as a multiplier. An input-output model generates a variety of multipliers and each is associated with a specific industry. A multiplier is a single number that quantifies the total economic effects (for all businesses) which arise from direct changes in the economic activity of a single industry. Multipliers can be generated to measure the total output, income, and employment effects associated with changes in the demand for regional goods and services. For example, an output multiplier of 2.5 for the fruit industry would indicate that a $100,000 decline in sales by this industry would lead to an overall decline of $250,000 in business sales throughout the economy, including the initial $100,000 loss to the fruit sector. An employment multiplier of 2.0 for the railroad industry would indicate that a loss of 10 jobs in this sector would lead to an additional loss of 10 jobs in other industries for a total loss of 20 jobs throughout the regional economy.

IMPLAN models the economy by organizing and tracking the transactions of businesses and industries into as many as 528 sectors. It is a “non-survey” or secondary I-O system, as it does not require primary, survey-based data. It is based on national average technical relationships among industries to which information has been added on regional economic activity. The software allows for national average conditions to be adjusted in order to account for unique regional conditions. IMPLAN is a widely-used tool to analyze regional impacts of policy changes because of the ease with which specific regional or local information can be incorporated into a model. While such information generally is from secondary sources, primary data, if available, can be incorporated as easily.

Changes to the data are commonly made in order to “fine tune” the model, so that it accurately reflects the region’s unique economy. The IMPLAN data were compared with published sources in order to verify the accuracy of the data. Employment and earnings were compared to Regional Economic Information System (REIS, from the U.S. Department of Commerce) data, as well as county-level employment and earnings data from the Washington Employment Department. In most cases, the IMPLAN data were fairly consistent with other data sources, so no changes were made to employment or income data in the model.

The regional purchase coefficients (RPCs), which indicate the portion of locally produced goods and services used to meet local demand, were also evaluated. RPCs are by definition always positive and never larger than one. The supply/demand pool ratio, which is the ratio of local supply of a commodity to local demand, also serves as an upper limit for the RPCs. The appropriateness of the RPC for a commodity is evaluated based on a number of factors, including the size of the economy and number of economic linkages within the economy, as well as the nature of the commodity itself. "Commodities" are defined as bundles of goods, and in some cases, this bundle of goods is small (e.g., for Sector 1, dairy farm products, the primary commodity is raw milk, with some livestock sales), while in others it is large (e.g., for Sector 315, screw machine products and bolts, a large number of different commodities are produced). For commodities where the bundle of goods is large, it is more important to know specifically which good(s) are being produced locally, and how much is likely to be used to meet local demand. Adjustments to a small number of RPCs were made based on local trading patterns, determined by identifying the manufacturers of certain goods within the county and knowledge of local conditions. For example, the RPC associated with hay and pasture was revised to reflect the fact that most of the hay demanded in the county would be supplied by local producers rather than imported from outside the county.

Measuring Regional Impacts

Impacts are measured by estimating the direct effect on the economy of a proposed action. Direct effects occur when there is a change in final demand in one or more sectors of the economy. Basically, final demand is comprised of sales to final consumption within the economy or sales that are exported from the local economy either as intermediate goods or for consumption elsewhere. Final consumption within the economy is primarily by households and government entities.

For example, the change expected here is in the production of fruit, or a change in fruit sales to final demand or exports. This would be the direct effect. It, and any other compensating changes, is entered into the IMPLAN model as a change in final demand and the indirect and induced changes are estimated by the model. The results are analyzed and their significance discussed later in this report.

Water Purchase Alternative, Issues, and Case Studies (Task 3234)

Under the Water Purchase Alternative, water rights would be permanently acquired from OID and used to meet instream flow objectives in Salmon Creek. A review of existing water acquisition programs was conducted to provide guidance on water acquisition methods that have been effective in other areas. Specific attention was focused on programs that have acquired water rights from irrigation districts for environmental purposes. The programs presented in this review are limited to programs that involved making water available through crop fallowing rather than water conservation or source substitution. In addition to this review, alternative program structures were presented and discussed with OID in order to elicit a program structure that would likely be followed by the district if water purchases were determined to be an acceptable alternative. Lastly, the Washington Department of Ecology was consulted in order to determine the agency's likely course of action when assessing the proposed water right transfers.

Western Water Transfer Programs – A Summary

Water acquisitions by federal and state agencies and nonprofit groups for flow augmentation are increasing throughout the Pacific Northwest and other western states. In 1990, for example, it is estimated that less than $500,000 was spent on water right purchases and leases for environmental purposes. In comparison, current annual expenditures are estimated at $20 million.[48]

Active water acquisition programs have been increasing in the Pacific Northwest primarily due to efforts to improve habitat conditions for federally protected fish species. Currently, there are programs to purchase or lease water for instream flows in the Yakima, Walla Walla,

48 Landry, Clay, 2001, "Buy that Fish a Drink," *Water Law*, 12 (4):240.

and Dungeness River Basins in Washington, the Deschutes and Klamath River Basins in Oregon, and the Snake and Lemhi River Basins in Idaho. Active environmental purchase programs also exist in Montana, California, and Nevada, among other states.

Contract Structure

A variety of methods are used to procure water in the programs reviewed. Acquisition methods include permanent purchases, leases, donations, dry year options, and split-season leases. In many cases, program policies and state water law have restricted the acquisition methods that can be utilized. For example, split-season leases have not been allowed in some states and permanent purchases have not been an element of public programs in others. The most common contract term has been an annual lease extending throughout the irrigation season. Leases are often negotiated directly with the water right holder or district or some type of auction mechanism is employed in which water right holders submit bids to sell or lease water their water rights. In other cases, a standing offer price is used.

Few water acquisition programs implemented to augment streamflows have permanently acquired water rights from irrigation districts. Many districts are reluctant to allow a permanent transfer of water outside of district boundaries due to uncertainties surrounding water rights and potential impacts on remaining district members and the surrounding community. Due to the limited number of active public programs that permanently acquire water rights for instream flows from irrigation districts, this review was expanded to include irrigation district involvement in permanent transfers for other purposes, including municipal and industrial development. Several of the programs are summarized below.

Yakima River Basin, Washington

In Washington State, the Bureau of Reclamation, Upper Columbia Area Office, has been permanently acquiring water rights under the Yakima River Basin Watershed Enhancement Program in an effort to improve streamflow conditions for federally protected fish species. A limited number of these purchases have involved water rights within irrigation districts. USBR deals with the water right owners individually and negotiates prices based upon appraised value. In all cases, the Upper Columbia Area Office continues to pay the annual district assessment fees associated with the water rights.[49] All water right purchases have come from land used to produce forage crops.

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[49] Personal communication with Jim Esget, USBR Upper Columbia Area Office, April 2003.

Stillwater National Wildlife Refuge, Nevada

The U.S. Fish and Wildlife Service in Fallon, Nevada, has one of the most active programs identified to permanently acquire water rights from irrigation districts. USFWS has been buying water rights from within the Newlands Project since 1985 to improve water supply to the Stillwater National Wildlife Refuge. USFWS has purchased over 33,000 acre-feet of entitlements with a goal of acquiring 75,000 acre-feet. In most cases, USFWS purchases the land and appurtenant water rights together through negotiation with individual property owners. The appraised market value of the property is used to establish payment. The water rights are then transferred to the refuge and the land is sold as dryland property if it is located outside of the refuge boundary.[50] All water right purchases have come from land used to produce forage crops primarily in support of local dairy operations. USFWS pays annual assessment fees to the irrigation districts for all water transferred to the refuge.

California Irrigation Districts

Glenn-Colusa Irrigation District

Glenn-Colusa Irrigation District (GCID) is located in the northern Sacramento Valley. Its service area includes almost 130,000 acres. The dominant crop is rice, accounting for about 70 percent of planted acres. The district has pre-1914 rights to Sacramento River water and is also a Central Valley Project (CVP) contractor.

GCID has made water transfers for more than a decade, typically to other agricultural districts and to some municipal and industrial (M&I) users in the area. The district's transfer program is compatible with other district objectives. Recently, the district negotiated with Metropolitan Water District of Southern California (MWD) to sell water under an option arrangement. In none of these cases is water transferred for more than a year, and GCID does not anticipate making any permanent transfers. GCID also does not anticipate changing substantially the amount of water it transfers in the future.

GCID determines the availability of water for transfer based on information from board members (who are farmers) and from other feedback from the irrigators it services. Transfer opportunities are open to all irrigators in the district. The water for transfers is typically from conserved water based on improved irrigation techniques and from groundwater substitution. It is not taken from the district's surface water supplies, unless such water is made available by land fallowing. The district currently does not have a policy regarding the maximum amount of land in its service area which may be fallowed to provide water for transfer.

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50 Personal communication with Richard Grimes, USFWS, Fallon, Nevada.

Prices for transferred water are determined by negotiations between the district and the buyer. Both cost and market considerations enter into pricing. The district receives payment for the transferred water, then pays the irrigator(s) making the water available. If land is fallowed, the district does not have specific requirements for maintenance and pest control on the land. However, the seller is responsible for all assessments and fees connected with the water the seller makes available for transfer.

San Joaquin River Exchange Contractors Water Authority

The San Joaquin River Exchange Contractors Water Authority (Exchange Contractors) is a joint-powers authority with four separate member agencies centered around Los Banos, California. The combined service areas of the four agencies include almost 240,000 acres. Prominent crops are cotton, grains, alfalfa, and nuts. The Exchange Contractors hold pre-1914 water rights on the San Joaquin River. In lieu of diversions from the river, the Exchange Contractors receive water conveyed by the Delta-Mendota Canal. All water delivered is for agricultural purposes.

Transfers are done by the Exchange Contractors rather than by the individual agencies. All transfers are for a single year and must be compatible with the Exchange Contractors' transfer policy. Transfers have been made for about 10 years, but no permanent transfers have been made and no permanent transfers are anticipated at any time in the future. The amount of water available for transfers is determined by the district managers. Historically, transfers have gone only to other agricultural districts and to local wildlife refuges. In the future, the Exchange Contractors may make transfers to M&I users.

Water for transfer is made available through water conservation using improved irrigation techniques and tailwater recovery systems. In the past, some water has also been made available by land fallowing. The Exchange Contractors do not currently have a policy on the maximum amount of land which can be fallowed in any year, but anticipate having such a policy in the future.

Prices for transferred water are based on both current market prices and negotiations. Firm water is more expensive than option year water. Payment goes from the buyer to the Exchange Contractors, which subtracts its costs and provides net proceeds to the irrigator. The irrigator is responsible for all assessments and fees. Irrigators fallowing land are responsible for maintaining their land and for monitoring groundwater levels, since parts of the Exchange Contractors service area are reliant on recharge for groundwater use.

Tulare Lake Basin Water Storage District

Tulare Lake Basin Water Storage District (TLB) is a State Water Project (SWP) contractor in Corcoran, California in the San JoaquinValley. All water is used for irrigated agriculture, with cotton, grains, and hay the prominent crops. The district has been making single-year exchanges for about 20 years and permanent transfers for two years. The district does not decide in any year how much water to transfer, but rather responds to requests from landowners in the area.

Transfers have been made to other agricultural districts and, more recently, to M&I users. TLB has made single-year transfers to agricultural districts and permanent transfers to M&I users. The only water source is SWP water. District policy requires that irrigators wishing to sell water permanently must designate the land which will no longer be irrigated with SWP water. If an irrigator has alternative water sources, he or she may continue to irrigate the land. If the alternative source is groundwater, the transfer amount is limited to the amount of SWP water that has historically been applied to the land.

Pricing for the water is set based on negotiations between the individual irrigator and the buyer. The TLB does not get involved in the negotiations. The seller is responsible for all fees and assessments. However, the district charges a flat $5,000 fee for administration. If land is fallowed to make water available for transfer, the landowner must create a one-half mile buffer around his or her land to protect neighboring parcels from weeds and pests.

Wheeler Ridge-Maricopa Water Storage District

Wheeler Ridge-Maricopa Water Storage District (WRM) is a member of Kern County Water Agency (KCWA) and receives SWP water for which KCWA contracts. Cultivated land within WRM ranges from 60,000 to about 95,000 acres depending on water availability, crop prices, and other factors. Historically, most district land was in annual crops, particularly cotton. More recently, however, many more acres of permanent crops have been developed, while the acreage of land in annual crops has fallen. Since the early 1990s, WRM has diversified its portfolio of water sources to include not only SWP water, but also groundwater from district wells, water banks, and other sources.

WRM has made both temporary and permanent transfers for about 20 years. Temporary transfers have been made to other agricultural districts and environmental users, while permanent transfers have been made to M&I users. Permanent transfers have gone primarily to urban districts. Sources of water include surface water, groundwater substitution, and crop fallowing. The district has transferred some SWP water permanently.

Pricing is based on market forces as well as costs. The seller is responsible for all assessments and fees, but the district does not have a policy on maintenance or pest control on land which has been fallowed.

Summary

A summary of the elements that are consistent across the programs is provided below.

- Permanent transfers of water rights outside of irrigation districts are occurring more frequently in some regions but are still relatively uncommon. Some irrigation districts have established water transfer policies prohibiting a permanent sale of water rights.

- All permanent transfers reviewed for this analysis involved water used to produce relatively low valued forage crops or water made available through conservation. No water transfers from permanent crops such as orchards were identified.

- Purchase prices are negotiated between the buyer and seller and are often based upon an appraisal of market value of the water rights individually or the land and water rights together.

- In all cases reviewed, annual assessments associated with the permanently transferred water are paid to the district. In some cases the buyer is required to pay annual assessment fees to the irrigation district in order to prevent increased assessments to other irrigators in the district. In others, the irrigation district requires the water right seller to pay the assessment fees.

Washington Water Transfer Rules

A key step in the instream flow water right transfer process is to quantify the amount of water that can be transferred from its current use to instream flows. In Washington, the highest annual consumptive use quantity within the last five years of continuous use can be permanently transferred to a trust water right for instream flows if the transfer involves the full water right. For a partial transfer, the transferable quantity is determined as the average two highest years of use within the most recent five year period of continuous use.[51] In either

[51] Washington Department of Ecology, January 2003, "Washington Water Acquisition Program, Finding Water to Restore Streams."

case, there can be no impairment to other water right holders. Washington's quantification procedures differ from other states. In Oregon, for instance, the full diversion quantity listed on the water right is allowed to be transferred provided there is no injury to other water right holders.

"Primary" and "secondary" stream reaches are considered when quantifying instream flow water right transfers in Washington. The primary reach is the portion of the stream between the historical point of diversion and the point at which return flows contribute to stream flow. The secondary reach is the reach downstream of the primary reach. Washington transfer rules allow the full, historic diversion quantity to be transferred to instream flows in the primary reach. Below the primary reach, only the consumptive portion of the water right can be protected as an instream flow right.

Washington Department of Ecology (Ecology), which has responsibility for overseeing state water rights, has not made a preliminary determination of the extent, validity, and transferable quantity associated with OID's Salmon Creek water rights. However, Ecology has indicated that it would need to look at the full extent and use of all of OID's water rights as part of the determination.[52] In addition, because some acres within OID are only served by Salmon Creek while others receive a mix of water supply, Ecology may need to examine intra-district water use as well. At this point, it cannot be determined which acres will be idled as a result of the Water Purchase Alternative. Furthermore, it is unclear if the transferable quantity from acres served only by Salmon Creek would differ from acres served by multiple water sources.

52 Personal communication with Bob Barwin, Washington Department of Ecology, June 2003.

Direct and Indirect Impacts of Water Supply Alternatives (Task 3236)

The following sections describe the direct and indirect economic impacts of the three water supply alternatives. As previously mentioned, three distinct flow regimes representing different enhancement options are analyzed for each action alternative. Each enhancement option results in different water supply volumes to OID from each source available to the district. However, while the mix of water supply may differ among the three enhancement options, the Water Allocation Model estimates that overall district crop water needs are met in most years. Consequently, the impacts are presented for each action alternative but separate impacts are not provided for each of the enhancement options.

Impacts on Okanogan Irrigation District

No Action Alternative

As previously described, a projected baseline is used to establish the cropping pattern within OID due to cropping changes that are currently in progress within the district. According to the Water Allocation Model used by the hydrologist in this study, annual water diversions to OID average 15,745 acre-feet from all supply sources and range between 13,149 and 19,201 acre-feet. The Water Allocation Model allows OID to respond to reduced water supplies through short-term improvements in on-farm irrigation efficiency and increased pumping from the Shellrock Pump Station. According to the Water Allocation Model, these two actions allow OID to divert and pump adequate water supplies to fully meet crop irrigation needs in all model years.

According to data provided by OID, the variable cost (energy and O&M) of operating Shellrock averaged $40.19 per acre-foot pumped in 2001 and 2002. Under the No Action Alternative, pumping from Shellrock is estimated to increase over historic levels. Between

1987 and 2002, OID pumped an average of 1,733 acre-feet annually from Shellrock. In comparison, the Water Allocation Model predicts that OID will pump an average of 2,414 acre-feet from Shellrock each year. The estimated annual variable cost associated with this level of pumping is $97,021 compared to $69,642 historically. This increased level of pumping would result in somewhat higher assessment charges to district members due to higher water delivery costs. In this analysis, the increased pumping costs are incorporated into the estimation of direct economic impacts as an increase in production costs.

Table 12 summarizes the cropping pattern, revenues, and returns estimated under the No Action Alternative.

Table 12
OID Crop Acres, Revenues, and Net Income, No Action Alternative

Crop	Model Acres	Revenue per Acre	Costs per Acre	Net Income per Acre	OID Revenue	OID Net Income
Alfalfa	591	$767	$728	$39	$453,225	$22,831
Other Hay	45	$878	$847	$31	$39,232	$1,384
Pasture	969	$432	$420	$12	$418,766	$11,938
Apples	1,467	$5,308	$4,833	$475	$7,786,644	$696,318
Pears	450	$4,509	$4,308	$201	$2,029,066	$90,466
Cherries	213	$7,323	$5,843	$1,480	$1,559,743	$315,237
Apricots	4	1/	1/	1/	1/	1/
Peaches	5	1/	1/	1/	1/	1/
Other Minor Crops	30	1/	1/	1/	1/	1/
Young Trees	377	1/	1/	1/	1/	1/
Urban Yards/Gardens	549	-	-	-	-	-
Fallow/Idle	76	-	-	-	-	-
Roads, Ditches, and Drains	255	-	-	-	-	-
Total	**5,032**				**$12,286,675**	**$1,138,173**
Adjusted for Additional Pumping at Shellrock					**$12,286,675**	**$1,110,795**

1/ Crop revenues, production costs, and returns were not calculated for minor crops (apricots, peaches, and "other") and young trees. Acreages in minor crops were assumed not to vary under the alternatives and therefore were not explicitly modeled.

Under the No Action Alternative, annual revenues and net income to producers within the district are estimated to be $12,286,675 and $1,138,173, respectively. These revenues and net returns do not include minor crops or annual costs associated with young (non-bearing) fruit trees. Total net income is reduced to $1,110,795 after adjusting for the increased costs associated with pumping additional water above historic levels at Shellrock.

Impacts of Okanogan River Pump Exchange (80 cfs)

Under the Okanogan River Pump Exchange Alternative, it is assumed that OID will not bear any of the fixed costs associated with constructing the facility or pipelines to convey the water to the district. However, OID will pay pumping costs equivalent to the annual pumping costs identified under the No Action Alternative ($97,021 per year). Pumping costs beyond the No Action level are assumed to be paid by a public agency located outside of Okanogan County. The Water Allocation Model estimates that pumping from the Okanogan River would average as high as 9,491 acre-feet annually and that district irrigation needs are fully met in all years.

Impacts of Shellrock Pump Upgrade (35 cfs)

Under the Shellrock Pump Upgrade Alternative, it is assumed that OID will only be responsible for pumping costs up to the amount estimated under the No Action Alternative ($97,021 per year) and that a public agency would pay capital and operating costs above that amount. Under the alternative, the Water Allocation Model estimates that district irrigation needs are fully met in all years for two of the enhancement options and all but four of the 99 model years under the other enhancement option (steelhead and Chinook) according to the Water Allocation Model. The level of shortage identified by the model is within the range allowed by the shortage criteria. As a result, the long-term cropping pattern, total production, crop revenue, and net income within the district are not estimated to change relative to the No Action Alternative. The shortages, which occur during periods of sustained drought, will require the district to ration water supplies and may result in a small reduction in crop yields. However, the level and duration of the estimated shortages indicate that yield losses are likely to be minor and are therefore not specifically addressed in this analysis. As a result, the cropping pattern, total production, and crop revenue within the district is estimated to not change relative to the No Action Alternative. Impacts of Water Purchase Alternative

Structure and Analysis of Water Purchase Alternative

Several potential alternative structures of the Water Purchase Alternative were presented to the OID Board in order to determine the most appropriate structure for impact analysis. The alternative structures included:

- Limit participation to specific district locations or service areas;
- Limit participation to certain crop types;
- Allow open access to all district members;

- Place upper acreage limits on district member participation;
- Allow district members to individually negotiate price; and
- Set a fixed price for water.

The Board indicated that if it were to pursue the Water Purchase Alternative, it would allow any district member to participate rather than restrict participation according to location or crop type. In addition, the price of water would be set through negotiation at the district level and would not vary across participating acreage or district members. Lastly, upper limits would be placed on participation of each district member if more acres than needed to meet the streamflow objective were enrolled in the program.[53] This is an unlikely scenario, however. As demonstrated by other programs in effect, permanently acquiring water rights on a large scale typically requires a significant amount of time and occurs incrementally.

The following criteria and assumptions are applied in the analysis of the Water Purchase Alternative. These criteria and assumptions are developed from the requirements as specified by the OID Board, review of existing transfer programs, discussions with Ecology, and analysis of property values in the area.

- Water would be made available to the instream flow water right through irrigated land retirement. The same volume of water (5,100 acre-feet) would be allocated to instream flows in Salmon Creek in all years and could not be carried over as reservoir storage for use in subsequent years.
- Crop acres are retired according to estimated profitability with the least profitable crops retired first. This is consistent with observed activity in other water purchase programs. In addition, because the price for water rights would be set by the district rather than negotiated on an individual basis, owners of less productive land with less profitable crops would have more of an incentive to sell water than owners of more productive land.
- No crops are retired from accounts with less than five assessed acres. Small acreage properties (less than five acres) are not generally used for commercial agriculture and agricultural income from these properties does not contribute a large portion of the overall income of the residents. Furthermore, these rural/residential parcels sell for a significantly higher price per acre than larger agricultural properties within the district boundaries. Consequently, it less likely that the small acreage properties would be willing to permanently sell their water rights.

53 Personal communication with OID Board, March 2003.

- The water right purchaser would pay the annual irrigation assessment for retired acres. This is an important assumption because it allows assessment fees to remaining district members to be unaffected by land retirement. If the assessment fee on the retired land was not continued, district fixed costs would spread over fewer acres and assessment fees would increase as a result. The higher assessment fees could have additional impacts on crop production and income within the district.

- A water purchase price is not determined in this analysis for permanently transferred water. However, the decline in net income estimated by the Agricultural Production Model represents the estimated *minimum* level of payment that would be required to leave irrigators no worse off. A premium above this amount is typically required to bid water away from irrigators. The level of premium depends upon many specific factors that were not analyzed in this study.

- Because there are little, if any, return flows to lower Salmon Creek, it is assumed in this analysis that the full diversion quantity would be transferable to an instream flow water right.

Under the Water Purchase Alternative, the Water Allocation Model estimates that irrigation diversions by OID would range between 9,972 and 10,679 among the three enhancement options. Despite the smaller district size, pumping from Shellrock would be significantly increased over the No Action Alternative, on average. Pumping at Shellrock would increase to as much as 5,092 acre-feet in an average year, compared to 2,414 acre-feet under the No Action Alternative. Under one of the enhancement options, crop water requirements are not fully met in two consecutive years out of the 99 model years. The shortage criteria are not violated and the remaining district acreage (following the water right sale) will not be impacted in the long-term. The shortages may result in a small reduction in crop yield but the impact is expected to be insignificant due to the low level of shortage.

Table 13 summarizes the change in cropping pattern and irrigated acres associated with the Water Purchase Alternative. Total irrigated acreage within OID is reduced by 1,470 acres under this alternative. Hay and pasture acres are reduced by 941 acres. Orchard crops, primarily consisting of apples, are reduced as well. Due to the reduction in orchard crops, the estimated acreage in young trees is also reduced.[54]

Estimated changes in revenue and net income are shown in Table 14. Total OID revenue is estimated to decline by $2.9 million annually. Net income is not projected to change

[54] It is assumed that no more than 15 percent of the orchard acres are in young trees.

however because it is assumed that the reduction is income is exactly offset by payments to growers participating in the water purchase program.

Table 13
Change in OID Cropping Pattern Under the Water Purchase Alternative

Crop	Acreage Change
Hay	-444
Pasture	-497
Apples	-260
Pears	-190
Cherries	0
Apricots	0
Peaches	0
Other Minor Crops	0
Young Trees	-79
Urban Yards/Gardens	0
Fallow/Idle	0
Roads, Ditches, and Drains	0
Total Acreage Reduction	**-1,470**

Table 14
Change in Revenue and Net Income, Water Purchase Alternative

Action Alternative	Change in Revenue	Change in Net Income
3	-$2,913,048	$0

Indirect Impacts on the Economy of Okanogan County

Each of the action alternatives would cause some changes in economic activity in Okanogan County. All of the alternatives had an effect on household income within the county, and the water purchase alternative also had an effect on agricultural revenue.

For the Water Purchase Alternative, the additional losses anticipated in agricultural revenue were also entered into the economic impact model for Okanogan County. The impacts resulting from the change in agricultural revenues are presented in Table 15. The losses in agricultural revenue are estimated to be $2.9 million under the Water Purchase Alternative. These result in additional indirect and induced losses of economic output within the local economy, with the total loss to output of nearly $4.1 million, primarily in the agriculture sector. Job losses associated with the change in agricultural revenue are fairly significant, and are estimated to be 118 jobs. Most of these jobs lost are farm labor directly involved in the production and harvesting of the crop that is no longer produced. The agricultural jobs lost represent about two percent of the total jobs in the agriculture sector. Income is reduced by nearly $1.8 million annually in Okanogan County.

Table 15
Economic Impacts of Change in Agricultural Revenue,
Water Purchase Alternative (Action Alternative 3)

Impacts	**Direct**	**Indirect**	**Induced**	**Total**
Output *($)*	-$2,913,048	-$502,140	-$639,924	$4,055,112
Income *($)*	-$1,356,617	-$203,545	-$213,318	-$1,773,479
Employment *(jobs)*	-96.0	-11.9	-10.5	-118.4

Economic Impacts of Reservoir Reoperation (Task 3237)

Recreation in Conconully and Okanogan County

Okanogan County Overview

In 1972, the North Cascades Scenic Highway (Highway 20) was completed, thus significantly reducing the travel time for people from Seattle and other areas on the I-5 corridor to the scenic North Cascades and to Lake Chelan. Since that time tourism has increased in importance in Okanogan County.[55] Okanogan County offers impressive vistas, including large glaciers in the North Cascades. It also offers opportunities for alpine and nordic skiing, hiking, biking, mountain and rock climbing, snowmobiling, fishing, hunting, lake and river recreation, rodeos, pow-wows, and other outdoor activities.[56]

Okanogan County can be viewed as having five distinct recreation regions, as defined by the geography of the county, the prevalence of federal lands, and the types of recreation available. These are the northwest, southwest, central, northeast, and southeast areas, which are described below.

The Okanogan National Forest, including the Pasayten Wilderness, covers a great deal of the northwestern area of the county and includes a large section of the Northern Cascade

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[55] Twisp Chamber of Commerce, 2002, "Welcome to Twisp, Washington!" Webpage: http://www.twispinfo.com/history.html, accessed June 17, 2003. Okanogan County Tourism Council, 2002, "Camping and Fishing Guide to Washington's Okanogan County." The Omak Chronicle, Inc.

[56] The Omak Chronicle, Inc., 2002, *Vacationland: The Official Visitors' Guide to Okanogan Country 2002-03*, The Chronicle, Omak, Washington. Omak-Okanogan County Chronicle, 2003, *InfoBook Okanogan County 2003*, Omak, Washington.

Mountains. The Pacific Crest National Scenic Trail is located near the northwest border of the county. The area is popular for cross-country skiing and snowmobiling in the winter, and in the summer, hiking, biking, rafting, and fishing are common.[57]

The southwest region includes the popular Methow River Valley as well as more of the Okanogan National Forest, which includes a portion of the Lake Chelan-Sawtooth Wilderness along the southwest border of the county. Towns in the area include Pateros, Methow, Carlton, Twisp, Winthrop, and Mazama, of which Twisp, Winthrop, and Mazama are perhaps the best known for outdoor recreation and tourism. This area is also popular for cross-country skiing in the winter, and hiking, biking, rafting, camping, and fishing in the summer.[58]

The central county region is defined by the Okanogan River Valley that extends from the confluence of the Okanogan and Columbia rivers in the south, to Osoyoos Lake in the north at the Canadian border. The Okanogan Valley includes, from the southern county border to the northern border, the towns of Brewster, Monse, Malott, Okanogan, Omak, Riverside, Tonasket, Ellisforde, and Oroville.[59] These towns are popular for rodeos, horseback riding, fishing, hunting, motorcycle riding, snowmobiling, and skiing.[60]

West of the Okanogan River Valley are the towns of Conconully, Loomis, and Nighthawk. Fishing, hunting, camping, water sports, and snowmobiling are popular in this area. The Okanogan National Forest extends only partway into this region from the west, with a small section of the forest extending east above the northern border of Conconully that features several campgrounds.[61]

The northeast section of the county is delineated by the Okanogan Highlands that includes the towns of Wauconda, Havillah, Chesaw, and Molson. Patches of the Okanogan National Forest appear throughout this region. Downhill skiing at the Sitzmark Ski Hill, fishing and water sports at various lakes, hunting, camping, and other activities are popular in this area.[62]

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57 Okanogan County Tourism Council, 2002. The Omak Chronicle, Inc., 2002. Omak-Okanogan County Chronicle, 2003.

58 Okanogan County Tourism Council, 2002. The Omak Chronicle, Inc., 2002. Omak-Okanogan County Chronicle, 2003. Twisp Chamber of Commerce, 2002.

59 Okanogan County Tourism Council, 2002.

60 Omak-Okanogan County Chronicle, 2003.

61 Okanogan County Tourism Council, 2002. The Omak Chronicle, Inc., 2002. Omak-Okanogan County Chronicle, 2003.

62 Okanogan County Tourism Council, 2002. The Omak Chronicle, Inc., 2002. Omak-Okanogan County Chronicle, 2003.

The western half of the Colville Indian Reservation covers most of the southeast section of the county. The reservation includes the towns of Disautel, Nespelem, and Keller. Just south of the Colville Indian Reservation and located on the Columbia River are the towns of Bridgeport, Coulee Dam, and Elmer City. The reservation features the unusually deep glacially formed Omak Lake and a number of camping sites that are open to non-tribal members.[63] Coulee Dam is noted for its laser light shows performed at the Grand Coulee Dam among other attractions, and Bridgeport is the location of a State Park. Gaming is also available at the Confederated Colville Tribes' Coulee Dam Casino.[64]

There are six state parks within the county. Those that feature camping are, from west to east Pearrygin Lake near Winthrop, Alta Lake south of Methow and Pateros, Conconully State Park, Bridgeport State Park, and Osoyoos Lake State Park. Fort Okanogan State Park and Museum is a day use park overlooking the Columbia River north of Bridgeport. Three state parks are located outside the county but near its borders: Twenty Five Mile Creek and Lake Chelan located on Lake Chelan, and Steamboat Rock, southwest of Grand Coulee.[65]

Lake Chelan and the North Cascades National Park are close to the county's southwest border, and the Colville National Forest includes many lands just east of the northern part of the county's eastern border. Chief Joseph Dam is located just south of the county along the Columbia River.[66] The Canadian border forms the northern boundary of the county. Several British Columbia Provincial Parks dot the border region.[67] Osoyoos Lake, which tops the Okanogan River Valley, is shared with Canada.[68]

Conconully

The city of Conconully is on the North Fork of Salmon Creek. It was originally settled as a mining community. Dams form two lakes near the city: Salmon Lake, an off-stream storage reservoir, and Conconully Reservoir, formed just downstream within Salmon Creek.

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63 Okanogan County Tourism Council, 2002. The Omak Chronicle, Inc., 2002. Omak-Okanogan County Chronicle, 2003. Widel, Elizabeth, 2000, "Okanogan County Geology (Or How The Okanogan Grew)," The Chronicle, Inc., Omak, WA, Webpage, http://www.omakchronicle.com/geology/geodex1.htm, accessed June 17, 2003.

64 Qwestdex, Online Directory, http://www.qwestdex.com/, accessed June 18, 2003. The Omak Chronicle, Inc., 2002. Washington State Parks and Recreation Commission, March, 1999, "Adventures for a Lifetime: A Comprehensive Guide to Washington State Parks."

65 Washington State Parks and Recreation Commission, March, 1999.

66 Okanogan County Tourism Council, 2002. The Omak Chronicle, Inc., 2002.

67 Government of British Columbia, Ministry of Water, Land, and Air Protection, British Columbia Parks, Recreation, Website, http://wlapwww.gov.bc.ca/bcparks/explore/regions.htm, accessed June 23, 2003.

68 Okanogan County Tourism Council, 2002.

Conconully is located approximately 19 miles from Okanogan and 16 miles west of Riverside.

Recreation and the Conconully Economy

Employment within the town of Conconully is highly dependent upon recreation. The Conconully Chamber of Commerce's membership directory includes seven camping and lodging facilities, three of which also provide boating access and rentals, three restaurants, and one general store.[69] One additional motel was not listed in the membership directory. The state park also provides access for fishing, camping, and boating. Another general store and one recreational vehicle park closed within the last three years. Privately owned or rented cabins and summer homes dot the area, with some 28 summer homes along the north shore of Salmon Lake.[70]

Fishermen and boaters impact the Conconully economy by paying locally for camping spaces and other lodging, paying for boat rentals and launch fees, and buying fishing equipment, gasoline for boats and cars, camping supplies and equipment, and food and drink. During fall and winter, hunters and snowmobilers rent cabins or motel rooms, and frequent the restaurants and the general store in town.

Recreation businesses and tourism are service sectors with a dominant role in the local economy. Service sectors generally receive lower income per worker than professional or production market sectors. Median household income in Conconully was $23,314 in 1999, which is lower than the 1999 median household income for Okanogan County of $29,726.[71]

Recent Conditions and Recreation

NEA staff interviewed owners of Conconully businesses that are supported largely by tourism and recreation. The purpose of the interviews was to determine: (1) the nature and capacity of the business, including peak seasons; (2) the types of patron activities the business supports, the origin of their patrons, and visitation length; and (3) opinions regarding the qualitative relationship between lake levels and visitation. Efforts were made to contact all such businesses, including those listed in the Conconully Chamber of Commerce's membership directory as well as non-members. All were phoned and later interviewed in person. The Conconully State Park manager was also interviewed. Finally, the former owner

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69 Omak-Okanogan County Chronicle, 2003.

70 Highlands Associates, n.d., *Salmon Creek Project: Salmon Lake Level Increase Built Environment Analysis*, Okanogan, Washington.

71 U.S. Census Bureau, 2000, *Census 2000 Summary File 3 (SF3) Sample Data*, Table: "P56, Median Household Income in 1999 (Dollars) by Age of Householder." Omak-Okanogan County Chronicle, 2003.

of a now-defunct general store was interviewed over the phone. Interviews were completed with 13 persons, including the owners or representatives of a total of seven camping and lodging facilities, three of which also provide boating access and rentals, three restaurants, two general stores, and the manager of the state park. The findings of these interviews are summarized below.

Since about 1999, Conconully residents and business owners have experienced a consistent decline in spring and summer water levels at both Salmon Lake and Conconully Reservoir. The record of lake levels discussed below documents this observation. During the height of the fishing and summer seasons in 2001 and 2002, and at the beginning of the fishing season in 2003, lake levels were low enough to expose large expanses of muddy flats up to lakeshores and around boat launches and docks.

The muddy lakeshore area is unattractive and has affected boat launching from docks and ramps. Some trucks that were used in the attempt to launch boats got stuck in the mud and had to be towed out. Motorboats that were successfully launched were forced to navigate carefully around exposed tree stumps. Boat operators also had to clean off milfoil and other vegetation from their propellers, as this vegetation thrived in the low water levels. Families coming up in the summer were discouraged from swimming or waterskiing due to the necessity to either walk through a large muddy area or the inability to launch a boat and because of the water vegetation. Thus, boating, fishing, waterskiing, and swimming in the Conconully lakes became difficult and unattractive.

After experiencing more than one year of low lake levels, it is reported that a large percentage of repeat visitors to Conconully decided not to return. In addition, it was reported that some tourists saw the condition of the lakes, and left to look for another location to camp. Business owners reported that they began to see their profits decline dramatically and are concerned that their businesses may ultimately fail if lake levels do not improve.

Businesses in Conconully

All business owners had purchased the business from prior owners within the last eleven years. Three owners purchased in 1992 and 1993, two in 1995 and 1996, two in 1998, three in 1999, and two in 2000. Most of the businesses had been open for many decades before the current owners purchased them. In some cases, the current owners made major repairs and improvements to the businesses, thereby increasing their investments. Many of the current owners are retirees or "second jobbers" who planned to support their retirements from the businesses.

Prior to the recent low lake levels, approximately 230 seats were available for three meals a day, seven days a week in restaurants and bars year-round. Since the recent decline in water levels, one restaurant has decreased its non-weekend hours. Including the state park, 231 RV spaces, 25 cabins, and 8 tent spaces are available in town. Approximately 40 additional RV pads were available prior to the closure of one RV park in town. Eighteen motel rooms with kitchenettes or one-bedroom apartments were available among the businesses studied, and additional motel rooms are available at one other location. Finally, before 2000 there was roughly 4,800 square feet of store space, which has decreased to 2,800 square feet with the closure of one of the general stores. In addition to these general stores, two or more resorts and RV parks have some small space devoted to sales of propane, fishing, and "last-minute" items.

All of the restaurants are open year-round. The state park and three RV park/cabin businesses without lake access are open year-round. One RV park without lake access, and three RV parks with access to the lakes are open from the beginning of fishing season in April through the end of hunting season at the end of October, although one resort opened occasionally in winter for winter sports. The general store is open year round.

Patrons and Recreational Activities

The peak visitation period for all businesses and the state park generally fall between late April and early November. Fishing is dominant in late April through May. Another peak occurs in August when families with children come for swimming and water sports. Weekend holidays and Conconully celebrations, including those in the winter, provide other visitation opportunities.

Recreational visitors and tourists to Conconully range in age from families with babies to 80-year-old retirees. The average age of many repeat visitors is about 55, and many of the older visitors are in their late sixties and seventies. Visitors generally come from the I-5 corridor in Washington, although some visitors come from as far away as California. Most visitors come to Conconully to fish and/or enjoy motor-powered water sports. Some older visitors have been coming to the town for many years, in some cases since the late 1950s, and generations of families have come in the summer for fishing and reunions.

Business owner estimates of visitors from the "westside" (western Washington) range from a low of no winter visitors, to a high of 95 percent of all summer visitors. Businesses open only in the spring through fall season indicate a range of 65 to 95 percent of their visitors are from the westside. Out-of-county visitors from the "eastside," primarily the areas of Wenatchee, Spokane, and the Tri-Cities, are estimated to constitute a low of five percent for seasonal businesses, to a high of 50 percent of all visitors to year-round businesses. During the winter, visitors from Omak and Okanogan constitute from zero to about 10 or 15 percent of the visitors, with the rest generally being local residents.

Spring and summer fishing and motorized water sports are the foundations of Conconully's recreation economy, with business owners estimating that 60 to 90 percent of their April through August visitors fish and participate in water-based recreation. Camping and room rentals increase along with visitation for fishing and water sports. Fishing is mostly for trout stocked in the lakes. In addition to the Washington Department of Fish and Wildlife's stocking of rainbow trout, local residents purchased large, fast-growing, sterile trout and stocked the lakes with those. Most fishing, approximately 70 percent, is catch and keep. Other activities occurring in the summer include over 30 family reunions per summer, over 12 weddings per summer (mostly at the state park), four-wheeling, hiking, biking, birdwatching, and even "deer counting." Hunting and snowmobiling generally provide fewer out-of-county visitors but are nonetheless important contributors to the town's economy in the fall and winter seasons.

Length of visitor stays varies with the season and the type of services offered. A very small number of visitors stay the entire summer season. A small number stay several months in the spring and summer. Generally, the largest number of visitors stay for weekends, and a smaller group stay for week-long periods in the summer. In the winter, it is estimated that about one-third of the local residents of Conconully leave the area for warmer regions. Some snowmobilers come from outside the county, but most fall and winter visitors are from Omak and Okanogan.

There are a number of local town events, such as "Outhouse Races" the "Supermush" dog sled races (two winter events), Independence Day Parade, "Miners' Daze" that celebrates the town's mining heritage, the Grubstake Open golf tournament, and the Western Swing Jam. The impact of these events depends on the type of business. Those lodging businesses that were not located on the lake generally did not believe that the events drew a significant number of non-local and non-county visitors. In contrast, businesses on the lakes found that these events did increase their business. The general store owners and the restaurant owners believed that patronage increased with out-of-towners, but it is not clear how many of the patrons were from outside the county.

There is some impact to Conconully from festivals in other towns. The attendees at the August Omak Stampede often escape the heat and crowding of Omak by camping in Conconully. It appears that there is greater consensus among business owners that the Stampede encourages more visitors from the westside than do Conconully events. Conversely, one business owner expressed the belief that loss of business in Conconully likely means losses in business for other towns in the county.

Historic Lake Levels and Recreation

The general consensus among business owners is the past two years were "the worst" in terms of lake levels, although some noted that lake levels have been getting progressively worse for about four years. The past two years saw the Conconully Reservoir at less than one-third full and boat ramps, docks, and beaches were almost 100 feet from the water. In the past, in the middle of the summer, water levels used to flood some campsites at the state park.

Historic records on lake levels for Salmon Lake and Conconully Reservoir were provided by the hydrologist for this study for 58 years. In Salmon Lake, the highest recorded level was 2,318.9 feet above sea level, occurring in May of 1956. The lowest minimum level recorded was 2,287.4 feet, occurring from January through March 1971. The difference between these two levels is 31.5 feet in elevation. In 1971, strong spring inflows followed the low levels of January through March, raising the level to 2,318.4 feet, within one half foot of the highest level of record. The situation was different in 2001 and 2002. While the lowest levels in those years were not as low as in 1971, they were still very low and there were not strong inflows in the spring to refill the lake.

In 45 of the 58 years (78 percent) of record, the annual maximum level was within two feet of the maximum level for all years, and in 48 of the 58 years (83 percent), it was within three feet. This indicates that the supply of water from the watershed feeding the lake will fill the lake close to capacity in about three out of four years. The pattern displayed in the data indicates that it is rare for the lake to not fill to near capacity two years in a row. The exception to this pattern began in 1999 and continues to present, with the highest lake level reached during this period in 2002, when the highest level was about 20 feet below full capacity.

A similar but more extreme pattern occurs in Conconully Reservoir. There, the maximum level, 2,288.0 feet, was reached in May 1983 and again in April 1998. The lowest minimum level, 2,248.7 feet, was reached in September 2001, for a difference of almost 40 feet in lake elevation. In 36 of the 58 years (62 percent) of record, the annual maximum level was within two feet of the maximum level for all years, and other levels were all below three feet of the maximum level.

Impacts to Businesses of Recent Low Lake Levels

At Salmon Lake the past two years, the low lake levels resulted in about 40 feet of mud surrounding the water of the lake. No water came around the beach side of the “T” dock at one resort and there was only six inches of water on the lakeside of the 90-foot dock. In the years before lake levels started to drop, by mid-summer the water lapped the grassy area above the beach.

There is universal agreement among all business owners and the park manager that the consistency of low lake levels, especially at the beginning of the fishing season, was primarily to blame for a dramatic loss in business and for the close of the general store. By fall, even the smallest boats had no access to the water at Conconully reservoir. Boating hazards, such as getting stuck in the mud trying to launch, exposed tree stumps, and milfoil, became common, especially at the lower lake. Older patrons had to be transported to distant access points, since it was too dangerous for them to fish from the rocky shorelines at the upper lake, or wade through mud at either lake. Families could not swim unless they were willing to wade through the mud and to swim with milfoil and other vegetation in the water. Waterskiing was too dangerous with exposed tree stumps.

In addition, low water levels appear to have decreased water in wells at lakeside businesses and cabins. One business had to buy bottled water for their guests and send them to the state park for showers when their well went dry. Some summer homeowners abandoned their homes due to low well water and one has purchased a new home elsewhere. Another business could not operate the laundry facility due to low water in their well.

Most of the business owners and the state park manager agree that fishing success and fish size is actually quite high for those who fish the two lakes. However, access to the lakes for Conconully’s traditional customer base has decreased significantly. This year, only a few local residents were seen fishing at the start of the fishing season. One business owner observed that the town was historically full at the start of the fishing season.

Businesses estimated that impacts to them range from losses in patrons in low-lake-level years over normal years from about 20 to 40 percent. The state park had about 50 percent of normal visitation last year and this year may have even lower visitation. Some older repeat patrons that had been returning to Conconully every year for three or more decades reportedly have cancelled reservations or failed to make them this year. Several businesses are up for sale, and, as already noted, one general store went out of business.

Those who had been in Conconully for many years, or whose families had lived in the area, explained that while other drought years had occurred in the past, Salmon Lake had rarely if ever dropped to its current level and the droughts rarely impacted the lake levels for two or more years. They attribute the major loss of visitation due to the consistency of the low lake levels. Customers in the past who would have been willing to tolerate one year of low lake levels felt that they could not afford to spend their vacations for a second year being unable to fish, boat, or swim.

Most businesses agreed with the sentiment that water levels could easily go all the way up to the spillways and trip valves and would not damage their business. While a few state park camping sites would be flooded, the rest of the town could likely take the overflow campers from the state park. One business owner on the lower reservoir stated that water half way up the bank would be better than it is now.

Impacts of the Water Supply Alternatives on Recreation

A No Action Alternative and three action alternatives were examined for their impact on recreation through two component characteristics: absolute lake level and seasonal fluctuations in lake level. The comparisons were made for wet, normal, and dry water year types. Historically, Salmon Lake has experienced less lake level drawdown during the summer than Conconully Reservoir because OID manages it as a backup water supply. Under the No Action Alternative, the Salmon Lake elevation changes by nearly eight feet during dry years to less than three feet during normal and wet years. According to the Water Allocation Model, Salmon Lake would experience less lake level fluctuation during the recreation season (April through September) under all of the action alternatives. Similarly, Conconully Reservoir would experience less fluctuation for all action alternatives and water year types. Under the No Action Alternative, Conconully Reservoir level varies by nearly 14 feet in dry years, nine feet in normal years, and five feet in wet years. Reservoir levels would be higher in dry, wet, and normal years under the action alternatives versus the No Action Alternative. Considered alone, the reduced variation in lake levels during the recreation season would tend to have a positive impact on lake-based recreation.

In addition to lake level fluctuation, the absolute lake levels for the action alternatives were compared to lake levels predicted under the No Action Alternative for each water year type. The elevations of both Conconully Reservoir and Salmon Lake reach maximum levels during the recreation season for nearly all of the alternatives and water year types. In addition, the lake levels tend to be higher, on average, for the action alternatives during the recreation season. Average lake levels are reduced only in Salmon Lake and Conconully Reservoir during dry water years. The impact is relatively small, however, as levels average no more than a few feet less than those achieved in the No Action Alternative during the recreation season.

Conconully has an economy based primarily on recreation, of which recreation on Conconully Reservoir and Salmon Lake is an important component. Recreation on the lakes is sensitive to the timing, degree, and duration of low lake levels. The longer the lakes are low during the fishing and summer seasons, the fewer visitors that can be expected to come to Conconully. Low lake levels, or an increase in lake level variability, during the recreation season will ultimately hurt the economy, while activities that stabilize and maintain higher lake levels will likely enable the economy to recover. As described above, the majority of the action alternatives will either improve or not impact lake level conditions at Conconully Reservoir and Salmon Lake and consequently would improve or not affect the local economy. Only the Water Purchase Alternative in dry years would result in lower lake levels during the recreation season and could result in a small, negative economic impact. The lake level and associated recreation impacts are summarized in Table 16.

Table 16
Recreation Impacts, Salmon Lake and Conconully Reservoir, Compared to No Action Alternative

	Salmon Lake			Conconully Reservoir		
Water Year:	**Wet**	**Normal**	**Dry**	**Wet**	**Normal**	**Dry**
Shellrock Pump Upgrade Alternative						
Alternative 1	N/C	N/C	+	N/C	N/C	+
Okanogan River Pump Exchange Alternative						
Alternative 2	N/C	N/C	+	N/C	N/C	+
Water Purchase Alternative						
Alternative 3	N/C	N/C	-	N/C	N/C	-

N/C = no change
\+ = positive (beneficial)
\- = somewhat negative

Lower Salmon Creek

Rainbow trout, brook trout, and some kokanee spilled over during flood events can be found in the middle reach of Salmon Creek. However, Washington Department of Fish and Game prevents any fishing in the reaches of Salmon Creek below Conconully, and this has been the case for some years.[72] The lower reach of the creek is dewatered except in rare cases of flood conditions. The lack of flow in this reach has prevented fish from inhabiting this area.

It is likely that additional water and stream rehabilitation would be beneficial to game species in addition to the target species.[73] However, this benefit may be mitigated by competition between game fish and populations of steelhead and Chinook.[74] It is uncertain under what conditions the middle and/or lower reaches may be opened to sport fishing, given that endangered species might be taken incidentally if sport fishing were to occur in the same reaches. Thus, the benefits of the alternatives on recreational sport fishing in the middle and lower reaches, and the subsequent impacts on the recreation economy cannot be assessed at this time.

72 Washington Department of Fish and Wildlife, May 1, 2003, Fishing in Washington, Sport Fishing Rules, 2003/2004 Pamphlet Edition, Olympia, Washington, p. 72, Webpage: http://www.wa.gov/wdfw/fish/regs/2003/2003sportregs.pdf, accessed July 8, 2003. Personal communication with Ryan Layton, Conconully State Park Ranger, April 29, 2003.

73 ENTRIX, n.d., “3.5.4 Environmental Impact of Feeder Canal Upgrade,” Salmon Creek Rehabilitation PDEIS.

74 Personal communication with Greg Reub, ENTRIX, Inc., July 3, 2003.

Lower Salmon Creek Rehabilitation – A Review of Nonmarket Benefits

Stream restoration involves the repair of a natural resource asset. In the case of Salmon Creek, the objective of the restoration of flows is the enhancement of spawning and rearing habitat for salmon and steelhead. This restoration and enhancement of the fishery is expected to produce benefits to society. Some of these benefits result from direct use of the fishery. Other benefits may not involve direct use but may still be important in understanding the total benefits associated with the repair of a natural resource asset.

The direct use value comes from fishing and other visits to the resource involving non-consumptive use such as viewing the fish, bird watching, etc. Nonmarket valuation techniques are commonly used to quantify these types of benefits. These involve devising a way to measure use, such as establishing a relationship between fish catch, angler effort, and a per day value for the number of days or the number of fish per angler. Typically the value is estimated using a nonmarket valuation technique such as the travel cost method and the contingent valuation method. Principles and guidelines for using these techniques for evaluating benefits from federal water resource projects are contained in “Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies,” published by the U.S. Water Resources Council, March 1973.

In addition to direct use values, there are nonuse values. Randall and Peterson[75] define these as option value, quasi-option value, and existence value. Option value and quasi-option value relate to the value of maintaining options for the future and differ only in how the existence of future information is treated. Existence value is the value an individual obtains from just knowing something exists. In a natural resource context, this typically means maintaining a natural resource in a certain condition (or preserving it). If a particular state of resource condition declines, such as the diminishing of the population of a species, then individuals will suffer a loss in existence value. Conversely, the restoration in a natural resource that has been perceived as diminished will result in a gain in existence value to individuals.

Because of the size of the Salmon Creek project and its predominantly local nature, gains in direct use values are likely to be small, particularly if measured using the travel cost method, which is one possible method for site measurement. On the other hand, measurement of existence value using contingent valuation methods is likely to identify significant values over a wider geographic area. Loomis[76] studied the existence value of the removal of dams on the Elwha River and the restoration of the river for anadromous fish habitat in

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[75] Peterson, George L., and Alan Randall, eds., 1984, *Valuation of Wildland Resources*, Chapter 1, Westview Press, Boulder, CO, p. 29.

[76] Loomis, John B., February 1996, “Measuring the economic benefits of removing dams and restoring the Elwha River: Results of a contingent valuation survey,” *Water Resources Research*, Vol. 32, pp. 441-447.

Washington. He found that the mean annual value per household locally (Clallam County) was $59 per year for ten years, for the state $73, and $68 in the rest of the United States. Since Salmon Creek is a small project and has not received widespread publicity as did the Elwha dams, a similar study would likely produce much lower values for Salmon Creek. It is cited here to illustrate that existence values exist, can be measured, and can be perceived to exist over a wider geographic area than use values. In a companion study, Loomis[77] included a variable for distance from the site to test the idea that values would be lower the farther removed the respondents to the survey were from the site. He found this to be true. However, since a majority of households were outside the immediate site, even though their values diminished with distance the sheer preponderance of numbers meant that a large part of the total benefit came from outside the immediate area.

Effects on Valuation of Personal Property on the Salmon Lake Shoreline

There are concerns that fluctuations in lake levels or long term lowering of lake levels will affect property values and thereby affect taxable property values. Research indicates that proximity to lakes and characteristics of lakes does influence the value of property located on or near a lake.[78] The value that owners perceive that they receive from proximity to a lake may be capitalized into the value of the property. It is very likely that this would be the case with Salmon Lake and Conconully Reservoir if fluctuations in lake levels or long term lowering of lake levels were to occur.

Current assessed values for selected homes on the shore of Salmon Lake were investigated. Assessed value of property bordering the Salmon Lake shoreline do not include the value of land as the land is federal property and, therefore, exempt from taxation.[79] The land is under long-term lease by the homeowners. The analysis was limited to Okanogan County Road No. 4290 (Fish Lake Road), an area that contains private homes. As a result, the study of tax impacts along the Salmon Lake shoreline focuses on the valuation of the homes on the Bureau of Reclamation land. The 2002 Okanogan County Assessor parcel database shows

77 Loomis, John B., 1996, “How large is the extent of the market for public goods: evidence from a contingent valuation survey,” *Applied Economics*, pp. 779-782.

78 Feather, Timothy D., 1992, “Valuation of Lake Resources through Hedonic Pricing,” IWR Report 92-R-8, U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources.

79 Parcels with cabins located in the 2002 Okanogan Assessor Parcel database and selected by ENTRIX for the following report: “Salmon Creek Water Supply Alternatives Scoping Report,” Task 0301, December 2002, p. 2

the assessed values for these homes range from $25,400 to $81,900, with an average value of $38,857.[80]

Levy Rate

The levy rate is the rate per $1,000 of assessed value used to determine the property tax; that is, the assessed value of your property multiplied by the levy rate for the area that your property lies within determines the annual amount of property taxes. This amount can change from year to year based on changes in assessed value and/or the levy rate.[81] The levy rate is found in the Taxing Code Authority database for Okanogan County and ranges between 12.81 and 14.65 for the parcels discussed in this report.[82]

Potential Tax Effect

The direction of the effect could be either positive or negative. That is, the alternatives could have either a stabilizing or a destabilizing effect. For purposes of illustration, consider a 10 percent change in assessed value of an average home. This represents a change in assessed value of $3,886. At the lower levy rate, this would reflect a tax change of about $50 per property per year and at the higher levy rate a change of $57. Such a change would result in a minor redistribution of the tax burden.

Under most alternatives for both lakes water level conditions would be more stable than under the No Action Alternative. Rather than a reduction in assessed values, this would likely increase real estate values over time and provide a basis for assessed values to increase.

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80 Parcels with cabins located in the 2002 Okanogan Assessor Parcel database and selected by ENTRIX for the following report: "Salmon Creek Water Supply Alternatives Scoping Report," Task 0301, December 2002, Attachment.

81 Okanogan County Assessor's Office, February 2003, www.okanagancounty.org/Assessor.

82 Okanogan County Assessor's Office, 2003, "2003 Levy Rates Okanogan County."

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APPENDIX G:

Bonneville Power Administration Correspondence With Tribes

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

September 23, 2002

In reply refer to: KEC-4

Ms. Adelin Fredin
Tribal Historic Preservation Officer
Confederated Tribes of the Colville Reservation
P.O. Box 150
Nespelem, WA 99155

Dear Ms. Fredin:

The Bonneville Power Administration (BPA) is funding a water conservation project to improve the water controls for the Okanogan Irrigation District in Okanogan County, Washington. Under its responsibilities to Section 106 of the National Historic Preservation Act, BPA has determined that the action is a federal undertaking. BPA has further determined that the undertaking has no potential to affect historic properties. Pursuant to 36 CRF 800.4(a)(4), BPA is initiating consultation with you, as you have requested, as the Tribal Historic Preservation Officer for the Confederated Tribes of the Colville Reservation.

The project is to automate the gates at Conconully Reservoir so that the Okanogan Irrigation District can remotely control water releases from their offices in Omak instead of having to drive up to the dam and control the gates manually. The work is limited to three locations:

- Setting up the remote control machinery and devices at the dam, within the existing structures;
- Setting up computers and a receiver at the OID offices in town; and
- Placing an antenna on an existing fire lookout tower on Omak Mountain.

The work does not involve any ground disturbance; all work, including the placing of the antenna, will occur within or on existing structures. A number of private companies already have repeaters and large satellite equipment attached to the lookout tower.

In this initiation of consultation, BPA seeks your comments on the proposed project and our determination discussed above. If you have any questions or concerns, please do not hesitate to contact me at 503-230-5373.

On a separate note, I am also enclosing a copy of the "Joint Study on Salmon Creek - Final Report" for your background on the Salmon Creek rehabilitation project, as you requested. We will be setting up another meeting with you on that project in about a month after we finish determining the feasible water supply alternatives for the environmental impact statement. You will see that the Joint Study looked at a large number of alternatives to supply water to Salmon Creek for fish. We are narrowing down this list to the feasible alternatives to be addressed in detail in the EIS. Once we have a final set of alternatives we will be able to get back with you to finalize the APE for the project.

Sincerely,

/s/ Nancy Weintraub
Nancy Weintraub
Environmental Protection Specialist

Enclosure
Joint Study on Salmon Creek - Final Report

cc:
Ms. Allison Brooks, State Historic Preservation Officer/Washington
Mr. Bob Shank, Tribal Liaison - KT/Spokane

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

June 12, 2003

In reply refer to: KEC-4

Mr. Scott Williams
Office of Archaeology and Historic Preservation
PO Box 48343
Olympia, WA 98504-8343

Dear Mr. Williams:

The Bonneville Power Administration (BPA) proposes to fund a fish habitat improvement project in Okanogan County, Washington. Pursuant to its responsibilities under Section 106 of the National Historic Preservation Act and 36 CFR 800, BPA has determined that the proposed action is a federal undertaking that has the potential to cause effects on historic properties and seeks to initiate consultation with the State Historic Preservation Office. BPA is also initiating consultation pursuant to 36 CFR 800.4(a)(4) with the Confederated Tribes of the Colville Indian Reservation.

The proposed project is to increase the flow of water in Salmon Creek and improve the streambed in the lower section of the creek to improve passage for anadromous fish. This will improve access to good spawning habitat in the middle and upper reaches of the creek to the base of Conconully Reservoir, a distance of 11 miles. For over 80 years, Salmon Creek has been dewatered during the summer months because the water has been diverted and used for irrigation purposes by the Okanogan Irrigation District (OID).

Options for increasing water flows in Salmon Creek include building a new pump station on the shore of the Okanogan River to exchange Okanogan River water for water currently being diverted out of Salmon Creek for irrigation. This option would include building a new pipeline from the pump station to a sediment pond upstream of OID Diversion 2. The pipeline route crosses State Route 215 from the pump station site and proceeds over flat, undeveloped land. It then rises up a 25-percent grade to Pogue Flat. It continues north along Conconully Road and west on Glover Road to the Diversion 3 pump station, then crosses orchard land to terminate at Diversion 2 - a total distance of 10,630 feet (2 miles) in length. Approximately 85 percent of the route lies on Pogue Flat, which has a 1.5 percent grade. The pipeline would be a 48-inch pipe. Excavation would require an 8 x 8 foot trench the entire length of the proposed line.

A second option for providing water from the Okanogan River to replace water being diverted from Salmon Creek for irrigation is to upgrade the existing Shellrock pump station in the town of Okanogan from its current use at 24 cfs to a capability of providing 35 cfs. It is not known at this time if any ground disturbing activity will be required for this option. The Bureau of

Reclamation estimates that potential upgrades may include electrical upgrades, intake pipe improvements, and potentially some augmentation of the pipeline feeding to the OID.

Another component of this project is the replacement of the North Fork Salmon Creek feeder canal, which was built in 1920 and is used to fill Salmon Lake near the town of Conconully. There are two options being considered for replacement of this canal. Option 1 would replace the canal with a 100 cfs buried pipeline along the alignment of the existing canal. This route is approximately 0.7 miles in length. Option 2 would bury a new similarly sized pipeline underneath North Fork Salmon Creek Road from the diversion towards the town of Conconully to Lake St., and then beneath Lake St. east to the outfall into Salmon Lake. This route is slightly longer than option 1, but has better access for construction and maintenance.

The lower section of Salmon Creek from the confluence with the Okanogan River to the OID diversion, a distance of approximately 4.3 miles, is proposed for rehabilitation work. Work could include a combination of reestablishing riparian vegetation, site-specific treatment of eroding stream banks, floodplain reconnection, and changes to land use management practices to enhance channel and habitat conditions. Some locations in the lower two miles of the creek will require entire lengths of the streambed to be reconstructed to recreate a defined low-flow channel. This section of Salmon Creek runs through the town of Okanogan.

The Area of Potential Effect (APE) for the proposed project has been determined and is located on the attached vicinity map. It is also described below for each of the project components.

Project Component	**Area of Potential Effect**
Lower Salmon Creek rehabilitation work from the confluence of Salmon Creek and Okanogan River upstream for 4.3 miles to the Okanogan Irrigation District (OID) diversion dam.	100 feet wide on either bank of Salmon Creek for the entire length.
Proposed 80 cfs pumping station located on the west shore of the Okanogan River.	Approximately a 100 x 100 foot area, which would include the bank shaping and armoring, an intake located on the bank, and a pump station structure.
Upgrade of the Shellrock pumping facility to 35 cfs from current use at 24 cfs.	The area immediately surrounding the pump station and intake location. The horizontal APE for any pipeline upgrades would be 15 feet on either side of the center line of the existing pipeline.
The pipeline from the proposed pump station on the west bank of the Okanogan River to Diversion 2 of the OID.	The horizontal APE should be considered 15 feet on either side of the center line.
The North Fork Salmon Creek feeder canal replacement option of burying a pipeline in the current location of the canal.	Extend 50 feet on both sides of the center line of the canal alignment for the entire length of the replacement.
The North Fork Salmon Creek feeder canal replacement option of burying a pipeline in the existing roadway from the diversion towards the town of Conconully and then east on Lake St. to the outfall into Salmon Lake.	Approximately 15 feet on either side of the center line of the road for this option. If the canal is dismantled and removed, 50 feet on both sides of the center line of the canal would be included as well.

Background research and an initial field survey by you and Steve Tromly indicate that the area has a moderate to possibly high potential for cultural resources. The bank of the Okanogan River and first and second terrace with a southern exposure above the confluence of Salmon Creek and the Okanogan River are moderate to high probability of having cultural resources. Alluvial benchs along Salmon Creek are moderate for containing prehistoric cultural resources. The alluvial benches are high probability of containing historic era properties based on information from local residents (original Okanogan Town trash dump) and preliminary reconnaissance by Mr. Tromly and Mr. Williams. The North Fork Salmon Creek Feeder Canal was constructed in 1920, making it greater than 50 years of age, which is a main criteria for a significant historic property. The following actions have been recommended by Steve Tromly to take place before initiation of any project activities:

1) Intensive pedestrian survey of the above listed APEs.
2) Shovel test probes at the Okanogan pumping station site and any proposed disturbed area around the Shellrock pumping station.
3) Shovel test probes along any proposed pipeline near the town of Okanogan on banks, terraces, and landforms with less than a 10% slope. These should be spaced at 20 – 40 meter intervals. An alternative for the shovel probes would be cultural resource monitoring of pipeline excavation on banks, terraces, and landforms with less than a 10% slope.
4) Historic documentation of the North Fork Salmon Creek Feeder Canal. The canal may or may not be significant.
5) Shovel test probes along those alluvial benches of Salmon Creek that will be affected by stream rehabilitation. Some benches were noted to have little soil deposition and should be considered low probabilty of containing subsurface cultural resources.
6) Avoidance of the historic Okanogan Town trash dump located along the north bank of Salmon Creek.

After the above surveys are conducted, a technical report will be prepared and submitted to your office and the Colville tribes. In this initiation of consultation, BPA seeks your concurrence on the proposed project and APE discussed above. We also seek any information that you might have on known archaeological resources in the project area. If you have any questions or concerns, please do not hesitate to contact me at 503-230-3796.

Sincerely,

/s/ Donald Rose 06/12/03
Donald L. Rose
Environmental Protection Specialist

Enclosure:
Vicinity Maps

Cc:
Ms. Hilary Lyman, Colville Tribe
Mr. Robert Hamilton, Bureau of Reclamation
Mr. Tom Sullivan, Okanogan Irrigation District
Mr. Jeremy Pratt, Entrix

STATE OF WASHINGTON
OFFICE OF COMMUNITY DEVELOPMENT
Office of Archaeology and Historic Preservation
1063 S. Capitol Way, Suite 106 - Olympia, Washington 98501
(Mailing Address) PO Box 48343 - Olympia, Washington 98504-8343
(360) 586-3065Fax Number (360) 586-3067

June 18, 2003

Mr. Donald Rose
BPA
905 NE 11th Ave.
Portland, Oregon 97232-4170

In future correspondence please refer to:
Log: 061803-11-BPA
Property: Salmon Creek Fish Habitat Improvement
Re: Determination of Eligibility for the National Register of Historic Places

Dear Mr. Rose:

We have reviewed the materials forwarded to our office for the above referenced project. Thank you for your description of the area(s) of potential effect for the project. We concur with the definition of the APE. We look forward to the results of your cultural resources survey efforts, your consultation with the concerned tribes, and receiving the survey report. We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4) and the survey report when it is available.

Given the probability of deeply buried cultural deposits, especially on the first terrace above the Okanogan River, we would request that any shovel probes on the river terraces be excavated to at least one meter (39 inches) deep.

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised.

Sincerely,

/s/ Scott Williams
Scott Williams
Assistant State Archaeologist
(360) 586-3089
ScottW@cted.wa.gov

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

June 12, 2003

In reply refer to: KEC-4

Ms Camille Pleasants, THPO
Confederated Tribe of the Colville
History & Archaeology Dept.
P.O. Box 150
Nespelem, WA 99155

Dear Ms. Pleasants:

The Bonneville Power Administration (BPA) proposes to fund a fish habitat improvement project in Okanogan County, Washington. Pursuant to its responsibilities under Section 106 of the National Historic Preservation Act and 36 CFR 800, BPA has determined that the proposed action is a federal undertaking that has the potential to cause effects on historic properties and seeks to initiate consultation with the Confederated Tribes of the Colville Indian Reservation. BPA is also initiating consultation pursuant to 36 CFR 800.4(a)(4) with the State Historic Preservation Office (SHPO).

The proposed project is to increase the flow of water in Salmon Creek and improve the streambed in the lower section of the creek to improve passage for anadromous fish. This will improve access to good spawning habitat in the middle and upper reaches of the creek to the base of Conconully Reservoir, a distance of 11 miles. For over 80 years, Salmon Creek has been dewatered during the summer months because the water has been diverted and used for irrigation purposes by the Okanogan Irrigation District (OID).

Options for increasing water flows in Salmon Creek include building a new pump station on the shore of the Okanogan River to exchange Okanogan River water for water currently being diverted out of Salmon Creek for irrigation. This option would include building a new pipeline from the pump station to a sediment pond upstream of OID Diversion 2. The pipeline route crosses State Route 215 from the pump station site and proceeds over flat, undeveloped land. It then rises up a 25-percent grade to Pogue Flat. It continues north along Conconully Road and west on Glover Road to the Diversion 3 pump station, then crosses orchard land to terminate at Diversion 2 - a total distance of 10,630 feet (2 miles) in length. Approximately 85 percent of the route lies on Pogue Flat, which has a 1.5 percent grade. The pipeline would be a 48-inch pipe. Excavation would require an 8 x 8 foot trench the entire length of the proposed line.

A second option for providing water from the Okanogan River to replace water being diverted from Salmon Creek for irrigation is to upgrade the existing Shellrock pump station in the town of Okanogan from its current use at 24 cfs to a capability of providing 35 cfs. It is not known at this time if any ground disturbing activity will be required for this option. The Bureau of Reclamation estimates that potential upgrades may include electrical upgrades, intake pipe improvements, and potentially some augmentation of the pipeline feeding to the OID.

Another component of this project is the replacement of the North Fork Salmon Creek feeder canal, which was built in 1920 and is used to fill Salmon Lake near the town of Conconully. There are two options being considered for replacement of this canal. Option 1 would replace the canal with a 100 cfs buried pipeline along the alignment of the existing canal. This route is approximately 0.7 miles in length. Option 2 would bury a new similarly sized pipeline underneath North Fork Salmon Creek Road from the diversion towards the town of Conconully to Lake St., and then beneath Lake St. east to the outfall into Salmon Lake. This route is slightly longer than option 1, but has better access for construction and maintenance.

The lower section of Salmon Creek from the confluence with the Okanogan River to the OID diversion, a distance of approximately 4.3 miles, is proposed for rehabilitation work. Work could include a combination of reestablishing riparian vegetation, site-specific treatment of eroding stream banks, floodplain reconnection, and changes to land use management practices to enhance channel and habitat conditions. Some locations in the lower two miles of the creek will require entire lengths of the streambed to be reconstructed to recreate a defined low-flow channel. This section of Salmon Creek runs through the town of Okanogan.

The Area of Potential Effect (APE) for the proposed project has been determined and is located on the attached vicinity map. It is also described below for each of the project components.

Project Component	**Area of Potential Effect**
Lower Salmon Creek rehabilitation work from the confluence of Salmon Creek and Okanogan River upstream for 4.3 miles to the Okanogan Irrigation District (OID) diversion dam.	100 feet wide on either bank of Salmon Creek for the entire length.
Proposed 80 cfs pumping station located on the west shore of the Okanogan River.	Approximately a 100 x 100 foot area, which would include the bank shaping and armoring, an intake located on the bank, and a pump station structure.
Upgrade of the Shellrock pumping facility to 35 cfs from current use at 24 cfs.	The area immediately surrounding the pump station and intake location. The horizontal APE for any pipeline upgrades would be 15 feet on either side of the center line of the existing pipeline.
The pipeline from the proposed pump station on the west bank of the Okanogan River to Diversion 2 of the OID.	The horizontal APE should be considered 15 feet on either side of the center line.
The North Fork Salmon Creek feeder canal replacement option of burying a pipeline in the current location of the canal.	Extend 50 feet on both sides of the center line of the canal alignment for the entire length of the replacement.
The North Fork Salmon Creek feeder canal replacement option of burying a pipeline in the existing roadway from the diversion towards the town of Conconully and then east on Lake St. to the outfall into Salmon Lake.	Approximately 15 feet on either side of the center line of the road for this option. If the canal is dismantled and removed, 50 feet on both sides of the center line of the canal would be included as well.

Background research and an initial field survey by BPA's archaeologist, Steve Tromly, and Scott Williams of the Washington SHPO have already taken place. Results from the onsite visit indicate that the area has a moderate to possibly high potential for cultural resources. The bank of the Okanogan River and first and second terrace with a southern exposure above the confluence of Salmon Creek and the Okanogan River are moderate to high probability of having cultural resources. Alluvial benchs along Salmon Creek are moderate for containing prehistoric cultural resources. The alluvial benches are high probability of containing historic era properties based on information from local residents (original Okanogan Town trash dump) and preliminary reconnaissance by Mr. Tromly and Mr. Williams. The North Fork Salmon Creek Feeder Canal was constructed in 1920, making it greater than 50 years of age, which is a main criteria for a significant historic property. The following actions are recommended to take place before initiation of any project activities:

7) Intensive pedestrian survey of the above listed APEs.
8) Shovel test probes at the Okanogan pumping station site and any proposed disturbed area around the Shellrock pumping station.
9) Shovel test probes along any proposed pipeline near the town of Okanogan on banks, terraces, and landforms with less than a 10% slope. These should be spaced at 20 – 40 meter intervals. An alternative for the shovel probes would be cultural resource monitoring of pipeline excavation on banks, terraces, and landforms with less than a 10% slope.
10) Historic documentation of the North Fork Salmon Creek Feeder Canal. The canal may or may not be significant.
11) Shovel test probes along those alluvial benches of Salmon Creek that will be affected by stream rehabilitation. Some benches were noted to have little soil deposition and should be considered low probabilty of containing subsurface cultural resources.
12) Avoidance of the historic Okanogan Town trash dump located along the north bank of Salmon Creek.

In previous meetings with your staff on this project last year, it was agreed that Guy Moura would provide BPA with information about Traditional Cultural Properties that might be affected by this project. I would like to work with you to set up a contract for this work.

Upon receipt of comments from your office concerning the proposed project and APE and any Traditional Cultural Properties, it is BPA's intent to contract or conduct the inventory described above of the proposed APE. All aspects of the inventory will be conducted or supervised by personnel who meet the Secretary of Interior standards. The BPA Archaeologist will be directly or indirectly involved to ensure that a complete, intensive, and professional inventory project is conducted.

After the above surveys are conducted, a technical report will be prepared and submitted to your office and the SHPO. In this initiation of consultation, BPA seeks your comments on the proposed project and APE discussed above. I look forward to working with you on identification of TCPs. If you have any questions or concerns, please do not hesitate to contact me at 503-230-3796.

Sincerely,

/s/ Donald Rose 06/12/03
Donald L. Rose

Environmental Protection Specialist

Enclosure:
Vicinity Map

cc:
Mr. Scott Williams, SHPO
Ms. Hilary Lyman, Colville Tribes
Mr. Robert Hamilton, Bureau of Reclamation
Mr. Jeremy Pratt, Entrix
Mr. Tom Sullivan, Okanogan Irrigation District

The Confederated Tribes of the Colville Reservation
P.O. Box 150, Nespelem, WA 99155 (509) 634-2695
FAX: (509) 634-2694

November 6, 2003

Mr. Donald Rose
Environmental Protection Specialist
Department of Energy
Bonneville Power Administration
P.O. Box 3621
Portland, OR 97208-3621

RE: KEC-4 Salmon Creek Restoration Project

Dear Mr. Rose:

Per your telephone discussion with Guy Moura in August of 2002, we are forwarding a scope of work and budget for TCP studies related to the Salmon Creek Project. As you requested, we waited until fiscal year 2004 to send the SOW. We look forward to working with BPA on this project.

If you have any questions or concerns about our proposal; you may contact me at (509) 634-2654 or Guy Moura, TCP Coordinator, at (509) 634-2695.

Sincerely,

/s/ Camille Pleasants
Camille Pleasants
Program Manager

CC Guy Moura - for the file
Chrono

Coordination with Tribes

Feb. 21, 2002 -	Meeting with Adeline Fredin, Shawn Hess, Guy Moura of the Colville Confederated Tribe, Kimberly Demuth of Entrix, and Nancy Weintraub, BPA.
July 8, 2002 -	Meeting with Adeline Fredin, Shawn Hess, Guy Moura of the Colville Confederated Tribe, Kimberly Demuth of Entrix, and Nancy Weintraub, BPA
Sept. 23, 2002 -	Joint Study on Salmon Creek final report mailed to Adeline Fredin, THPO.
Sept. 23, 2002 -	Initiation of consultation letter mailed to Adeline Fredin, THPO.
June 10,2003 -	Phone call from Shaun Hess to Don Rose about Salmon Creek project. We discussed need for initiation of consultation and TCP identification.
June 12, 2003 -	Initiation of consultation letter mailed by BPA to Camille Pleasants, THPO. Sent Tromly report on identification of APEs. Requested scope of work for TCP identification.
June 12, 2003 -	Phone call from Don Rose and Shaun Hess. Shaun said he would email scope of work for TCP identification.
June 13, 2003 -	Phone call from Don Rose to Shaun Hess. Guy Moura does not have a scope of work. Guy will put together and send scope of work after looking at APEs.
June 26, 2003 -	Phone call from Don Rose to Shaun Hess. Shaun says CCT will provide written response to initiation letter by July 11, 2003 and provide scope of work for TCP identification.
July 22, 2003 -	Phone call from Don Rose to Guy Moura. Guy says he has not been able to get a scope of work for TCP identification put together. He gave me some verbal information about TCPs in the vicinity of the project.
Nov. 6, 2003 -	Received scope of work from Camille Pleasants for TCP identification.

APPENDIX H:

Colville Confederated Tribes Response to the NWPCC Independent Science Review Panel

March 22, 2002

1996604200

Northwest Power Planning Council
Attn: Larry Cassidy
851 SW 6th Avenue, Suite 1100
Portland, OR. 97204-1348

Re: ISRP Review of Project 199604200: Restore and Enhance Anadromous Fish Populations and Habitat in Salmon Creek

The ISRP's review of the Salmon Creek project addresses some important science concerns related to our project, the resolution and clarification of which will help us to improve the overall quality of this project. However, it was also clear to us from the ISRP's response that our proposal and presentations did not adequately explain certain key elements of our proposal. We are very concerned that the ISRP reached a "no fund" recommendation based on a lack of clarity in aspects of our proposal and significant resultant misunderstandings of our project. We would also like to address some major policy issues associated with the Salmon Creek project which need to be considered along with our response to the science related issues in a reconsideration of the ISRP's "no fund" recommendation. Our response will address the science review issues first and then summarize the key policy considerations we hope the Council will take into account in their decision on the Salmon Creek project.

The Colville Confederated Tribes (Tribes) respectfully request that the Council set aside the ISRP's "no fund" recommendation. The ISRP's incomplete and inaccurate understanding of the project (represented for instance, by their concern that there is no documentation of fish production and no monitoring/evaluation program) suggests that a more appropriate determination at this stage would be to request additional information and clarification through a "response review is needed" designation. In project proposal reviews in preceding years the ISRP has in fact *commended* the Salmon Creek project and recommend it for funding. Additionally, the Council has historically directed substantial dollar commitments to the Salmon Creek project, indicating support for the project.

It appears that in part the ISRP had difficulty reviewing the Salmon Creek funding proposal because many specific details of the project can't be finalized until the NEPA review and rehabilitation design work is completed (this work is currently underway). The NEPA process will result in identification of a preferred salmon recovery scenario with a corresponding preferred water supply alternative. In addition, the stream rehabilitation design will have advanced well beyond the conceptual level presented in the project proposal in concurrence with the NEPA review.

The Tribes propose to revise the FY 2003-2005 Salmon Creek proposal to assure a more thorough understanding by the ISRP of the project and its scientific basis. This proposed revision will be completed prior to the final ISRP review scheduled for June. Budgets for FY 2001 (committed) and FY 2002 (in process) will carry the Salmon Creek NEPA analysis and design to that milestone. The NEPA EIS and

Record of Decision signed by BPA will provide a sound basis for final selection of the preferred alternative. Just as the Council has conditioned continuation of the Salmon Creek program on review of the NEPA scoping document, we suggest that the Council direct the program to present the outcome of NEPA as a condition of continued funding. At that time, a revised budget and funding strategy can be submitted for Council consideration with greater detail and certainty based on the selection of a preferred alternative through NEPA.

In the meanwhile, it will be necessary to complete processing of the FY 2002 funds and to provide additional "lifeline funding" to maintain current staffing by the Tribes and BPA and to complete the NEPA process. We appreciate your consideration of this critical request and look forward to your favorable review of our suggestions. The Salmon Creek project is a highly visible and important project to the Colville Confederated Tribes, the Okanogan Irrigation District, and the people and natural resources of Washington State. Your continued support of this model project is essential to its successful implementation.

Sincerely,

Colville Confederated Tribes
Joe Peone, Director
Fish and Wildlife Department

cc: Bob Austin, BPA
Dale Bambrick, NMFS
Dennis Beach, WDFW-Ephrata
Mark Fritz, NWPPC
Stacy Horton, NWPPC
Tom Karier, NWPPC
Tracy Lloyd, WDFW-Ephrata
Bob Lohn, NMFS
Doug Marker, NWPPC
Sara McNary, BPA
Craig Nelson, Okanogan Conservation District
Richard Price, OID
Tom Sullivan, OID

SCIENCE CONSIDERATIONS

The ISRP review states water temperatures in the Okanogan River exceed 80 degrees F, which is unsuitable for salmon.

It is true that in summertime elevated water temperatures in the Okanogan River create a thermal barrier to migrating salmonids, particularly sockeye salmon that migrate during those months. During 2000, high water temperatures (peak-74^{o}F, CCT, unpublished data) have been recorded in the Okanogan River (~ RM 15; Figure 1). However, the proposed pump station, at least conceptually, is intended to deliver "warm" water from the Okanogan River to orchards and farmland within the irrigation district while allowing "cool" water (peak-66.3^{o}F (2000), CCT, unpublished data; Figure 2) historically diverted from Salmon Creek to flow downstream. In addition, this would also address Washington Department of Ecology's (WDOE's) 303D listing of inadequate flows in lower Salmon Creek. The cool water, which has been diverted historically for irrigation, would flow through the lowermost 4.3-mile reach of Salmon Creek to the Okanogan River providing benefit to both adult and juvenile salmonids. In addition, this "cool" water discharge from Salmon Creek would likely create a thermal refuge in the Okanogan River, and likely be utilized by migrating sockeye salmon. Based upon radio-telemetry tagging studies conducted by Douglas County PUD, sockeye have held in cool water refugia created by tributaries, such as Aneas Creek (~ 4 cfs, 64 ^{o}F, CCT, unpublished data), during migration through the Okanogan River. The thermal refugia may also be used by juvenile salmonids. For instance, Belchik (1997), reported extensive use thermal refugia at tributary mouths in the Klamath River.

It is also important to note discussions by area biologists and consultants have been directed towards selecting "early returning" spring Chinook salmon adults as broodstock for Salmon Creek. By selecting "early returning" adults for broodstock, it is expected that progeny would also be "early returning" and avoid the thermal barrier that develop in the Okanogan River. We anticipate that diligent pursuit of this concept will likely result in the successful development of an early run chinook salmon stock unique to the Okanogan Basin.

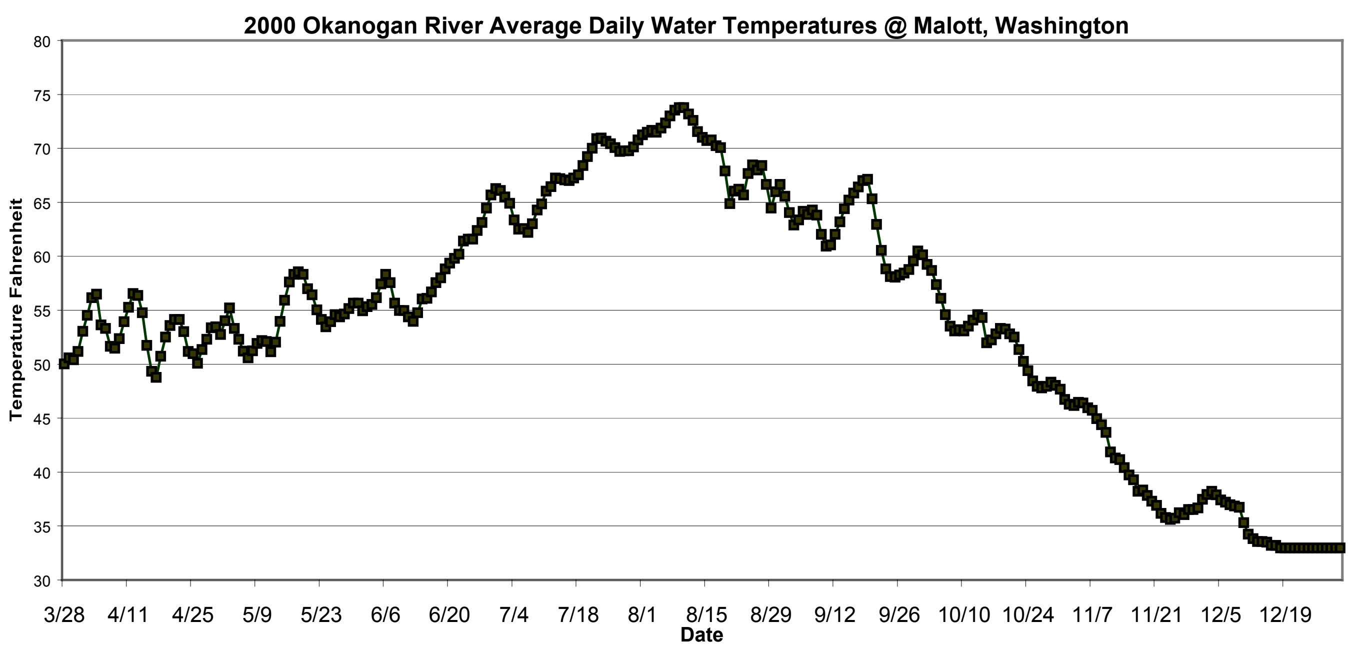

Figure 1. Daily average water temperatures (^{o}F) in the Okanogan River at Malott, WA. during 2000 (CCT, unpublished data).

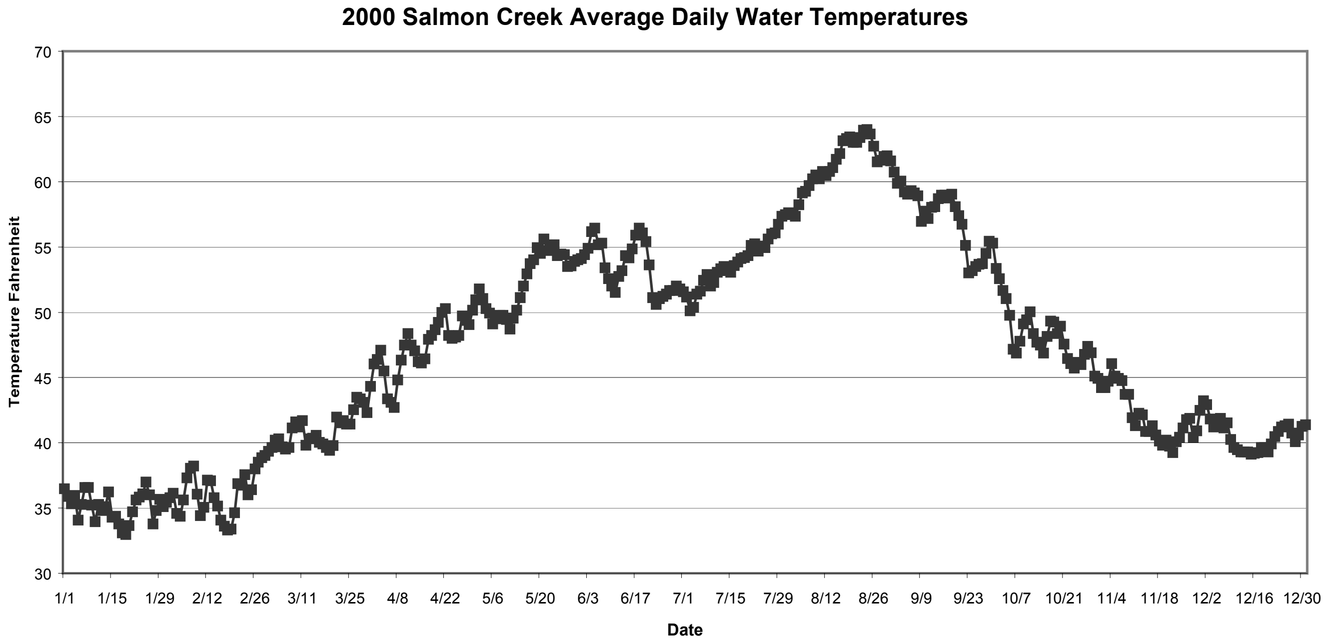

Figure 2. Daily average water temperatures (^oF) in Salmon Creek, within the middle reach, during 2000 (CCT, unpublished data).

The ISRP review states, "No significant benefit to fish is to be expected from this proposed project, which focuses on highly degraded habitat (de watered etc.) that would take an extensive effort and considerable resources to restore." And "an alluvial fan at the mouth does not allow passage of salmonids except at flood stage. An Entrix study found released flows alone would not restore the stream. A channel would be dug."

Again, it is true that limited spawning and rearing habitat exists in the lower 4.3 miles of Salmon Creek. The primary function of this reach in the context of this proposal is to provide passage. The limitations of this particular reach are due to the steep gradient of this stream reach and the current condition of the stream channel. However, based upon field evaluations, approximately 2.6 miles (RM 4.3 to 1.7) of the lower reach is capable of providing adequate spawning and rearing habitat for anadromous salmonids. This reach would require only "spot" treatments to improve bank stability and grade control. More extensive stream channel restoration techniques (installation of instream structures, reconstruction of stream bank, removal of fluvial deposition, reestablishment of riparian vegetation) will be required in the lowermost 1.7 miles. However, by rehabilitating this reach, a migration corridor for anadromous salmonids would be ensured and access provided to approximately 11 miles of good spawning and rearing habitat. Furthermore, spawning and rearing habitat would likely improve within the lower 4.3 miles as continuous flows were provided which would in turn promote development of increased habitat complexity. Looking farther to the future (10 to 15 years), it may be desirable to also undertake habitat improvement work within the lower 1.7 miles of Salmon Creek.

The ISRP review states, "There are no remnant stocks of spring chinook, so they would need to be introduced from outside. There is no description of a monitoring and evaluation plan that ought to be undertaken."

It is true that there are no remnant stocks of spring chinook in the Okanogan River. However, the Colville Tribes are attempting a reintroduction of spring chinook salmon within the Okanogan Basin at Omak Creek, a tributary to the Okanogan River approximately 4 river miles upstream of Salmon Creek. The Carson stock spring chinook salmon has been approved in both the Okanogan River and in Omak Creek and is currently being used in both systems. It is likely, therefore, that this stock would initially be planted in Salmon Creek.

The use and source of Carson stock chinook salmon and the development of a monitoring and evaluation plan are still under consideration. Several monitoring and evaluation techniques (i.e. redd surveys, snorkel surveys, adult trapping, smolt trapping, etc.) have been discussed as potential options. However, it has been suggested that the preferred option to evaluate production in Salmon Creek should be smolt monitoring. This technique would provide the most accurate estimate of production in Salmon Creek. If smolt monitoring is the agreed upon option, then this option will be further developed and described in a detailed monitoring and evaluation plan. An important element of development of the monitoring and evaluation plan, and use of Carson stock chinook salmon, is consultation and approval by the National Marine Fisheries Service (NMFS). Any final decision will be contingent upon consultation with and approval by the NMFS.

The ISRP review states rough predictive estimates that 150 steelhead, and 130 chinook might result from restoration of this stream reach.

The predictive estimates (150 steelhead, 130 spring chinook) offered to the ISRP the proposal presentations in Wenatchee represent a very conservative number within an expected range. However, based upon field surveys and survival rates for different life stages, predictive estimates could be substantially greater (steelhead 6 to 804; spring chinook 121 to 184) than the numbers expressed during that presentation, particularly in the case of steelhead.

Production estimates were developed based on habitat sampling conducted during 1997. Potential spawning habitat estimates were based upon preferred substrate, depth and velocity criteria for each species. The production estimate cited above is for the eleven-mile reach beginning at the Okanogan Irrigation District diversion dam (RM 4.3) upstream to the base of the Conconully Reservoir Dam (~ RM 15.0). However, this estimate for the eleven-mile reach is based upon the evaluation of spawning habitat from ~RM 15.0 to 9.0, or a 6-mile reach in the uppermost section of the 11 mile reach.

The estimate of steelhead fry production was based upon the poorest substrate (highest % of fine sediment, 41.9%) measured in the sample reaches within the six-mile reach and equated to 50% egg-to-fry survival. For the 11-mile reach, the production of steelhead fry was estimated at 530,128. Using Bjorn's (1978) range for steelhead fry-to-yearling (0.4 to 3.8%) on the Big Springs Creek on the Lemhi River, a range for smolt production was estimated to be 2,120 to 20,145. The smolt-to-adult returns recorded at Wells Hatchery from 1986 to 1994 ranged from .28 to 3.99%. Applying this range of smolt-to-adult return to the smolt estimates (2,120 to 20,145), the estimated adult steelhead return is 6 to 804. Based upon available habitat in the Okanogan River, the Washington Department of Fish and Wildlife (WDFW) estimate current escapement levels for naturally produced steelhead within the U.S. portion of the Okanogan River at between 300 and 500 fish. The estimated production of steelhead in Salmon Creek would clearly contribute a substantial proportion to the Okanogan River as well as providing resiliency to the steelhead population in this basin.

Similarly, during the 1997 Salmon Creek spawning habitat evaluation we estimated egg production for spring chinook at 1,091,070 (based upon fecundity and available habitat) for the six-mile reach. Extrapolating that estimate for an 11-mile reach provides an egg estimate of 1,582,051. Using Mullin et al. (1992), egg-to-smolt survival range for the Entiat River of 1.55% to 2.35%, provides an estimate of 24,521 to 37,178 smolts. Using an average smolt-to-adult return from the Methow River Basin from 1985 to 1990 of .66% results in a range of 161 to 245 spring chinook adults returning to Salmon Creek. One other factor that would likely influence the number of returning adult spring chinook to Salmon Creek is that the Okanogan River typically becomes a thermal barrier to migrating salmonids from about mid-July to mid-September. Water temperatures measured in the Okanogan River in 1997 exceeded the lethal water temperature for spring chinook by July 20, and by Aug 1 during 1998. According to the Douglas County PUD, approximately 25% of the adult spring chinook salmon migration at Wells Dam occurs after July 20. Therefore to err towards the conservative our estimates for adult spring chinook salmon returns to Salmon Creek were reduced by 25%, thus 121 to 184.

It is also important to recognize that production estimates for Salmon Creek are based on the present day (1997) conditions upstream of the Okanogan Irrigation District diversion dam. The Natural Resource Conservation Service is in the process of employing a Range Conservationist and Environmental Engineer to work with landowners on reducing surface erosion and streambank failure. This effort should result in a reduction of fine sediment delivered to the stream channel. Over time, the proportion of fine sediment in spawning gravels would decrease and fish production would likely increase.

Large-scale investment in steelhead projects in the Okanogan Basin, such as the proposed Salmon Creek Project, appear less warranted based on the greater uncertainty of positive outcomes.

The proposed scale of investment for the Okanogan Basin is relative compared to other recent and ongoing investments in hatchery facilities and habitat, lower in the Columbia Basin. Hatchery and tributary investments to increase the viability of other ESU's do not affect the Upper Columbia River steelhead ESU; it is still endangered, at high risk of extinction, and a legal threat to the operation of the Federal Columbia River Power System, PUD hydroelectric projects, and the local economy of the Columbia Cascade Province. Furthermore, the lower basin hatchery and tributary habitat investments do not return one fish to the Colville Tribes and do nothing to restore even a minimal ceremonial and subsistence fishery for the Tribes.

Monitoring was Explicitly Addressed in the Proposal

It is difficult to understand how the review could fault the lack of plans to monitor and evaluate. The first paragraph of the proposal describes the purpose of the proposed Steam Management and Recovery Plan (SRMP) as "to monitor and evaluate measurable improvements to habitat productivity and populations in Salmon Creek." This is further addressed in the proposal abstract (under the head "monitoring and evaluation") and in the body of the proposal (the topic is broadly discussed under the section regarding the SMRP and a paragraph on monitoring is provided for each element of the proposal). If this was a reason for the "no fund" recommendation, it overlooks the contents of the proposal itself.

Literature cited

Belchik, M. 1997. Summer locations and salmonid use of cool water areas in the Klamath River Iron Gate Dam to Seiad Creek. Yurok Tribal Fisheries Program, Klamath, California. 13 pp.

Bjornn, T. C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. University of Idaho, College of Forestry, Wildlife and Range Sciences Bulletin 27, Moscow.

Mullan, J.W., K.R. Williams, G.Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary steams. U.S. Fish and Wildlife Service.Monograph I.

POLICY CONSIDERATIONS

- ***A History of Positive Reviews:*** The Salmon Creek project is essentially unchanged since it received a complimentary and positive recommendation from the ISRP in the 2001 proposal process. That review stated in part "The proposal is very well done with clearly stated problems and measurable objectives. It was good to see the results of the watershed assessments being put to use. The need for the project is clear and the area is historically important." The inconsistency between the 2001 and 2003 reviews puzzles and troubles us. We are particularly concerned because the Salmon Creek program satisfies all of the criteria necessary to be rated "fundable": that is, it is scientifically sound, benefits fish and wildlife, has clearly defined objectives and outcomes, and provides for monitoring and evaluation of results (see further discussion below). It is disturbing that the ISRP review is not couched in terms of these criteria (except in the case of comments on monitoring and evaluation, and these comments simply overlook the content of the proposal as discussed further below).

  Positive reviews have been forthcoming outside the Council process as well. For example, the Colville Tribes have been involved in Washington's ongoing process to revise state water law under the auspices of a joint Executive and Legislative working group consisting of representatives of the Governor's office and the Director of Ecology, as well as members of the key legislative committees with authority over water resources policy. That working group has unanimously acknowledged the Salmon Creek project as a model project. Recognition of the Salmon Creek Project is one of the few things that the diverse interests comprising this working group have been able to agree upon.

- ***Track Record of Funding:*** The Salmon Creek program is an ongoing project which has received funding since 1997. Salmon Creek funding totals nearly $6.5 M to date, with $3.3 M of that provided through the Council's program. Since the Salmon Creek project inception, project proponents have matched Council funding with funding from other sources virtually dollar for dollar. We are unaware of any other Council project of this scope that has achieved a similar level and breadth of funding support. Our ability to leverage funds to this degree demonstrates a high level of confidence in the merits of this project on the part of multiple funding sources; each of which is committed to scientifically and economically defensible salmonid mitigation and rehabilitation. Those who have provided matching funding support have done so in part because they were assured by the Council's ongoing investment in the Salmon Creek project. The Council's support of this project indicated to other project funding sources that the project was carefully reviewed and relatively steadfast. For example, recent BPA comments to the Council (on the Blue Mountain and Mountain Snake project proposals) note that BPA gave top priority to existing (ongoing) projects where a decision to not fund the project would significantly jeopardize the investment that the Region has made to date. The Council is not well served by the appearance of fluctuation in its scientific and policy objectives when seeking to leverage its investments in salmon mitigation programs. The Tribes are pursuing a funding strategy that is anticipated to continue leveraging supplementary funding opportunities. We would be delighted to discuss this project's funding history and our leveraged funding strategy in detail with the Council or its staff at any time.

- ***NEPA Process:*** Important concerns raised by the ISRP include water supply, restoration design, fish production, and the use of Okanogan River water in the project. Each of these concerns has been raised and is being addressed through the Salmon Creek NEPA process. The Salmon Creek NEPA has been initiated under current funding and will be completed under funding provided for fiscal years 2001 and 2002. NEPA is intended to be the environmental "full-disclosure" process for federal decision-making, and it is essential that decision-makers engaged in the NEPA process not prejudge the outcome of the NEPA analysis. The Council has directed that the NEPA Scoping Document be presented for review as a condition of proceeding further with the Salmon Creek project. The NEPA scoping period did not close until after the ISRP review and the Scoping Document is now under preparation and will be brought to the Council in April. Assumptions made in the ISRP review have the effect of prejudging the outcome of NEPA analysis, as we comment further below.

- ***NEPA Alternatives:*** The ISRP review appears to be based on the assumption that one among several NEPA alternatives will be the one selected for implementation (the full-scale, 80 cfs Okanogan River pump exchange). While it is true that this option has been the basis for past funding proposals, in fact this alternative may not be the preferred alternative and it would be inappropriate to draw such a conclusion today. The Council was presented with the higher cost alternatives because at the time FY 2003 proposals were due, a three-year program needed to be scoped and NEPA had not been initiated. Therefore, the decision was made to submit costs for the pump exchange project in order to ensure that there would be sufficient funds available if that alternative were ultimately selected for implementation. As a result of the NEPA scoping several new alternatives have been identified, all of which will almost certainly be less costly, some of them substantially less. A final decision on this question may not be made before the Draft EIS is published (currently scheduled for June 2003). Among the alternatives under consideration are several which have emerged in the just-concluded scoping process that would require less water, less (or no) infrastructure, and could cost much less money to complete. As the BPA NEPA Statement of Purpose and Need makes clear, the selection of a preferred alternative is a decision to fund, and cost effectiveness will be more appropriately taken into account when actual costs and benefits are clear. Alternatives under consideration also include means to offset or pay for pumping costs should the pump exchange alternative be preferred. In their review the ISRP also focused on issues that concerned the public in their comment during NEPA scoping. These concerns will be addressed in the NEPA process now underway, and should not be the basis for premature termination of the alternatives analysis and NEPA-based decision-making by BPA, as advised by the Council.

- ***The "Shellrock" Alternative:*** We are already pumping water, it is not a new concept. Okanogan Irrigation District currently holds Okanogan River water rights and pumps water from the Okanogan River as necessary to meet irrigation demand using an existing District pump station at Shellrock. The alternative which the ISRP made comments about merely extends an existing approach to water supply in the basin. One variation on this alternative that has emerged from NEPA scoping would provide water only for steelhead (not spring Chinook), resulting in a much lower water requirement. This water requirement could be supplied by upgrading the existing Shellrock facility. The Phase 1 (conceptual planning) estimate of the cost of upgrading Shellrock was $0.5 M. If this is selected an the alternative, it would profoundly revise the calculus upon which the ISRP review is based.

- ***The "Farm" and "District" Water Purchase Alternatives:*** Other NEPA alternatives are being developed as a result of scoping comments. These include analysis of purchasing individual farms and placing the water shares appurtenant to them in Washington's Trust Water Program, or negotiating with the District for purchase of a share of the District's water rights. Neither of these alternatives would require costly infrastructure, but both entail extended financial analysis in the course of NEPA compliance. It is possible that either or both may be substantially less expensive than the Okanogan River pump exchange.

- ***The Implications of the NEPA "No Action" Alternative:*** A "no fund" decision by the Council would place the Okanogan Irrigation District and rural economy of the region in serious jeopardy of realizing the full impact of the NEPA "No Action" alternative. All NEPA analyses are required to consider a "No Action" alternative, which in this case would be to do nothing to increase flows in Salmon Creek, rehabilitate habitat and recover salmonids. Under such an alternative, the District's water diversions, which have supported an irrigation economy for the Okanogan area for more than 80 years, would be subject to enforcement under the Endangered Species Act as the Okanogan Basin is listed as "critical habitat" by NMFS for summer steelhead. Enforcement could result in federal reallocation of water to instream flows, without the benefits of planning and investment to offset what certainly would be very significant social and economic effects for the region. To accept this outcome when a true "win-win" solution is within grasp would be a tragedy (the Salmon Creek project has been favorably received by the relevant federal and state agencies). Actions taken or not taken here set a precedent and establish a model for small rural agricultural communities throughout the Northwest. Throughout the region, the economic viability of these communities depends upon finding truly mutual, inclusive solutions to the challenges posed by salmonid listings.

- ***A Model for Columbia River Basin Collaboration between Tribes and Irrigators:*** The Tribes have joined the Okanogan Irrigation District to forestall precisely the "No Action" type of scenario described above. The Tribes and District have worked diligently and collaboratively for years so that both sets of objectives can be met: salmonids may have the instream flows necessary for their recovery, while irrigation may continue with the reliability necessary for economic survival. The ISRP considers only the fish side of this equation in its review, but the benefits of the project are greater and more is at stake than just the number of fish returned, important as this may be; the Council would serve the Northwest well by considering both sides as far as it is able

- ***Salmon Recovery is a Social Goal:*** Recovery of listed species is a social choice and a policy goal as much as it is a science-based activity. Science guides social actions to be as effective and well chosen as they can be, but science has nothing to say about the social values that may be placed upon an investment. In the ISRP review of the Salmon Creek project, the ISRP steps beyond their mandate of providing independent scientific review and wanders into the arena of social choices and policy making. Whether or not the level of investment warrants the return is a question that lies beyond the expertise and purview of a purely scientific review. For example, even assuming that the fish production of the project were as low as the ISRP identified in their review, the augmentation of steelhead populations achieved would represent a *100 percent* increase in the average number of steelhead returning to the Okanogan watershed. Another example of comparing the investment to the cost is apparent with the Snake River Sockeye program. This is a strong science based program, but even beyond the purely scientific merits it's the programs cost or investment has been acceptable to the general public or region including us From a Council policy point of view, and from the Tribes' point of view, this achievement may be a very worthwhile investment, one whose significance is inappropriately understated by the analysis of "dollars per pound" of fish, as we discuss further below.

- ***Mitigation of Upper Columbia Hydro Impacts on Colville Confederated Tribes Fisheries is Profoundly Overdue:*** The Regional Power Act, which established the Northwest Power Planning Council in 1980, reflected the region's awakening to the need to mitigate the vast effects of the Federal Columbia River System upon the fish and wildlife resources of the Columbia Basin. Even a small spring chinook run in the Okanogan/Salmon Creek may be highly significant to the Colville Tribes, considering what was lost after Grand Coulee was constructed and the paucity of mitigation that has followed in the ensuing decades. Most Colville tribal members have historically relied on fisheries that were severely reduced by the construction and operation of Grand Coulee dam, which eliminated 1240 river miles of habitat and inundated many tribal fishing sites on the Columbia River that had been available to tribal members prior to the Dam's completion in 1940. The Salmon Creek project represents one among many steps that will be needed to address these longstanding impacts to tribal members, and the Tribe feels strongly that the Okanogan Basin must be a focus of concern and significant investment in the Council's larger fish and wildlife program. Considering the scant fisheries resources remaining to the Tribes, the returns of fish to Salmon Creek will be of profound cultural and spiritual importance to tribal members. The Tribes request that the Council put due emphasis on these values and not rely on cost calculations that ignore them.

- ***Distinguish Costs of Rehabilitation from Cost of Water Supply:*** The ISRP Review fails to distinguish between the cost of Salmon Creek restoration (or rehabilitation) and the cost of water supply alternatives. The latter are *alternatives*, subject to NEPA analysis leading to a decision which has not yet been made, and may or may not include high investment in infrastructure (e.g., pump exchange) depending on alternative levels of flow, as discussed above. The cost to rehabilitate the lower reaches of Salmon Creek to allow fish passage is reasonable. The required investment in water supply will be fully analyzed in the ongoing NEPA process, and BPA as the lead agency will select that alternative that meets its obligations in an environmentally sound and cost-effective manner.

- ***Are There Known, Less Costly Alternatives That Meet the Same Objectives?*** The Council should compare the Salmon Creek investment to other Okanogan Basin alternatives before coming to a "no fund" decision. The ISRP in its review document states that it will base its recommendations for habitat restoration projects on an "…attempt to estimate the expected contribution to fish runs and to relate these expectations to the historical and current runs in the subbasin. The expected costs of restoration should be placed in the context of dollars per expected adult return, for purposes of comparing among potential restoration projects (a relative measure). They should also compare alternative restoration strategies for the site on the same yield and cost basis, again for comparative purposes." However, nowhere in the ISRP recommendation do we find the results of such a comparison. Indeed, given the average historical returns of steelhead to the Okanogan Basin as documented in the LFA report, the Salmon Creek project would clearly and substantially contribute to fish runs.

Anadromous fish restoration in the Columbia Cascade Province and the Okanogan River will always have greater uncertainty and likely less positive outcomes due to it's the region's location above so many run-of-the-river hydroelectric dams and because anadromous salmonid passage to much of the area has been blocked by Grand Coulee and Chief Joseph dams. This situation is largely why two of the Province's anadromous fish species are currently endangered. Decisions on fish and wildlife program investments must consider cost-effective opportunities within each ESA-listed ESU and within the waters and lands of each Native American Tribe.

Reserved Fishing and Instream Water Rights of the Colville Tribes and the Federal Trust Responsibility To Protect Those Rights

It is critically important to bear in mind that federal funding decisions affecting anadromous fish restoration on and near the Colville Reservation also implicate the federal government's trust responsibility to protect the federal reserved fishing and water rights of the Colville Tribes. The historical and legal background to this is as follows:

The Colville Reservation was established by Executive Order in 1872. At that time the Reservation consisted of all the lands within the United States bounded by the Columbia and Okanogan Rivers, roughly 3.0 million acres. The U.S. Court of Appeals for the 9th Circuit has unequivocally ruled that under the 1872 Executive Order one of the primary purposes of the Colville Reservation was to preserve tribal fisheries and access to traditional tribal fishing areas. *Confederated Tribes of the Colville Reservation v. Walton*, 647 F.2d 42 ("*Walton*"). The 9th Circuit also ruled that the Colville Tribes possesses federal reserved water rights to instream flows sufficient to preserve or restore the tribal fisheries reserved in the 1872 Executive Order. *Walton*, 647 F.2d 42.

In 1891, the Colville Tribes entered into an Agreement with United States in which the Tribes ceded the North Half of the 1872 Reservation. The ceded area consists of roughly 1.5 million acres between the

Canadian border and the current northern boundary of the Reservation. In the 1891 Agreement the Tribes expressly reserved the right to hunt and fish, which was "not to be abridged in any way." The U.S. Supreme Court has ruled that the 1891 Agreement was lawfully ratified by Congress and that the hunting and fishing rights reserved by the Tribes in that Agreement are in full force and effect today. *Antoine v. Washington*, 420 U.S. 194 (1975). The hunting and fishing rights for the North Half also include gathering rights and, most importantly for present purposes, the reserved water rights recognized in the *Walton* case to support fish restoration and preservation and to support wildlife and plant habitat.

In sum, under the above legal history, the Colville Tribes possesses reserved fishing rights and instream water rights, arising under well-settled principles of federal law, throughout the current Colville Reservation and ceded North Half, which coincides with the extent of the original 1872 Reservation. The territory encompassed by these rights includes the entire length of the Okanogan River within the United States (some 75 river miles) and the Columbia River within the United States above the Okanogan confluence (some 160 river miles), as well as all tributaries within that area. The 9th Circuit has also clearly established that the priority date for these instream flow water rights, in relation to the State of Washington's priority system, is □time immemorial□ for any stream associated with an aboriginal fishery, *Klamath Water Users Protection Association v. Patterson*, 204 F.3d 1206 (9th Cir. 2000) *and United States v. Adair*, 723 F.2d 1394 (9th Cir 1984), and 1872 for any stream in which the Tribes is attempting to establish an introduced fishery, *Walton*, 647 F.2d 42. In most cases, the fishery in question is likely to be an aboriginal fishery, which triggers the ancient time immemorial priority date for the associated instream water right.

Finally, the Tribes' fishing and water rights are federally protected tribal assets or property rights, which all agencies of the United States have a trust responsibility to protect. *Menominee Tribes of Indians v. United States*, 391 U.S. 404 (1968). *Klamath Water Users Protection Association v. Patterson*, 204 F.3d 1206 (9th Cir. 2000).

The Salmon Creek project implicates the Colville Tribes' fishing and water rights in the Okanogan River, which lies within the Colville Reservation and ceded North Half and is subject to the fishing and "time immemorial" water rights described above. Rather than assert these rights in a confrontational or litigative fashion with respect to Salmon Creek, the Colville Tribes has pursued a proactive approach emphasizing cooperation with the Okanogan Irrigation District, to demonstrate that it is eminently possible to achieve tribal goals while also protecting the water supply and economic interests of the District. We have made significant progress toward a genuine "win-win" outcome, and as noted in other sections of this paper have gained broad recognition for a model approach to resolving this difficult problem. This is precisely the type of project that any federal agency should be eager to fund, because it furthers the purpose of the federal trust responsibility to protect the Tribes' rights, and does so without obliging the United States to attempt to restrict the junior State law rights of another user group. This is the case even if the funding agency in question takes the position that it has no particular trust responsibility to take specific action to protect the interests of the Colville Tribes; the point is that even without reaching the question of a specific agency's precise responsibility, support for the Salmon Creek project is obviously consistent with the overall federal trust responsibility and furthers the purposes and goals of that responsibility.

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